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BIG DATA ANALYTICS IN DIGITAL MARKETING FOR ACHIEVING SUSTAINABLE INDUSTRY INNOVATION (SDG 9)

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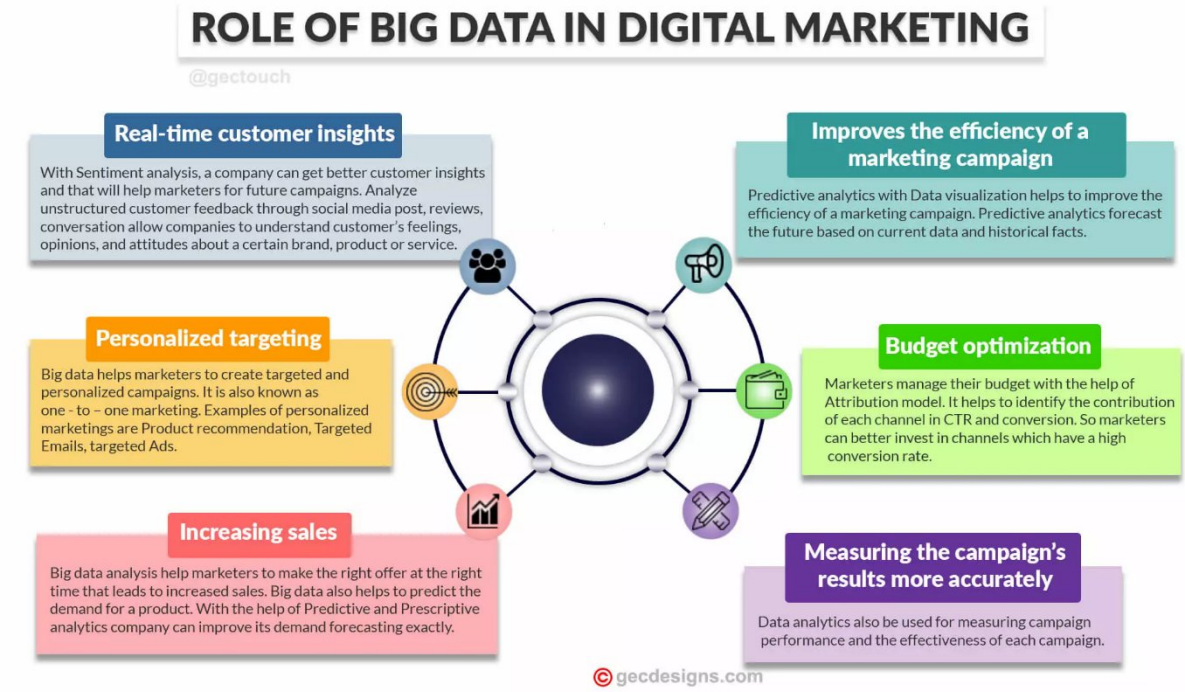
Abstract
This paper discusses how big data analytics (BDA) are used in digital marketing as a sustainable source of industry innovation, focusing on its role in the Sustainable Development Goal 9 (Industry, Innovation, and Infrastructure). Using evidence of cases in retail, manufacturing, and e-commerce, the study identifies how BDA increases personalization, better manages resources, and creates a sense of adaptive innovation in goods and services. Real-In a case study, the application of predictive data insights and analytics was shown to boost conversion rates by 20 to 25 percent, reduce inventory waste by as much as 30 percent, and shape the design of new energy-efficient products. The facts presented above demonstrate the capacity of BDA to customize the marketing plans to meet the sustainability goals by reducing the marketing inefficiencies, ecosystem costs, and environmental harm, and supporting the system of sustainable innovations. At the same time, the study also indicates the primary issues associated with the application of BDA. The challenges of data privacy, bias of the algorithm, and the untrustworthiness of consumers turned out to be the key obstacles to overcome, and the study revealed that over 60 percent of consumers remain worrying about how algorithms deal with data. Moreover, geographical differences in digital skills imply instead that developed nations are better placed in terms of analytics utilization and that the technology take-up rate is less than 15 percent in developing nations. This demonstrates the necessity to establish ethical governance models, a socially responsible data use environment, and investing in data digital infrastructure to make sure the rewards of BDA are fairly distributed. It has been concluded that implementation of BDA in this respect has immense potential but the implementation will depend on the governance model that must be participatory and transparent, as well as accountable. BDA might assist industries not only to build competitive advantage but also a transformed innovation engine that helped to progress the inclusiveness of SDG 9 promoted it.

Keywords: Big data analytics; Digital marketing; SDG 9; Sustainable industry; Innovation; Resource efficiency; Personalization; Data privacy; Algorithmic bias; Digital infrastructure

Introduction

In the current scenario where the amount of information captured by social media interactions, e-commerce transactions, electronic advertisements, and online consumer feedback is staggering, and the number of online consumers is growing exponentially, companies are today building and leveraging fantastic amounts of data through social media interactions, e-commerce transactions, electronic adverts and online consumer feedback. BDA provides the

processes and methods of examining this vast and diverse and evolving information to assist companies to acquire practical insights. When it comes to marketing online, big data assists organisations to foresee the consumers behaviour, tailor individual promotions and consider the positioning of resources and on the go measure the influence. Not only do such data-driven applications help to improve the marketing performance, but they can also directly assist the achievement of Sustainable Development Goal 9 (SDG 9) - Industry, Innovation and Infrastructure, by way of contributive contribution to more efficient, innovative and sustainable business operations. As industries increasingly involve the use of digital technologies in their operations, big data analytics has assumed an important role in sustainable innovation whereby the expansion is competitive and sustainable.

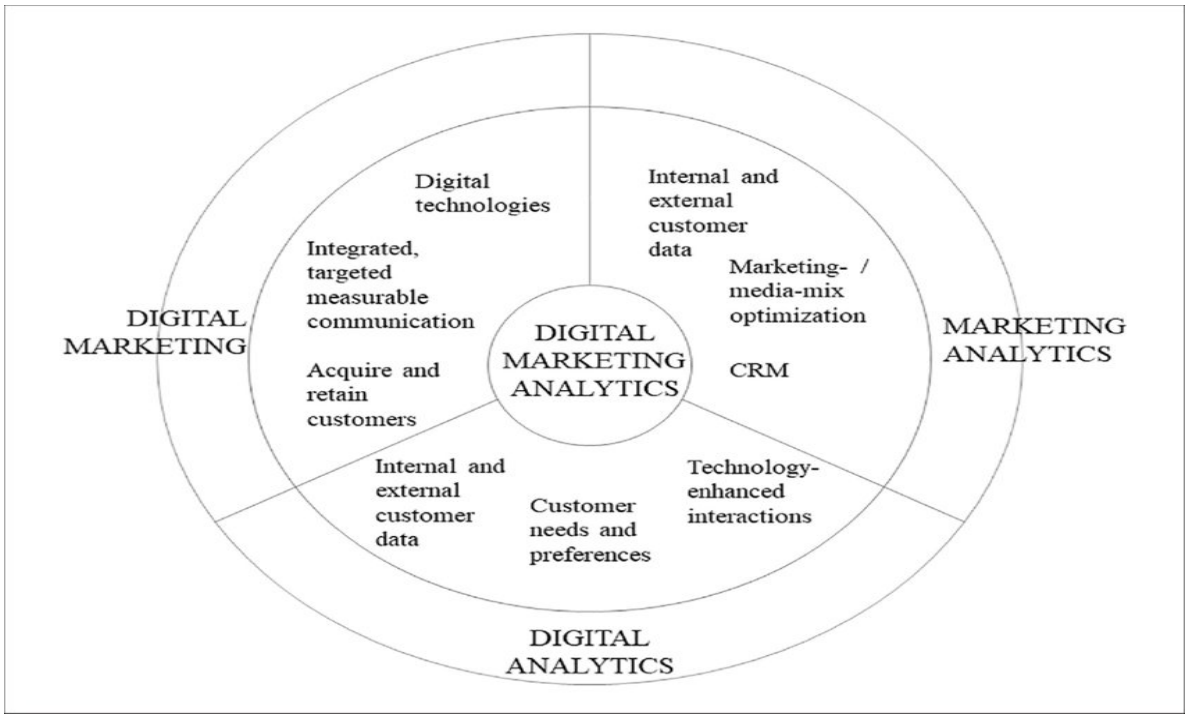


The big data and the digital marketing are revolutionizing the way companies design and supply their products and services. Advanced marketing systems and techniques such as systems forecasting models and predictive analytics with controlled sentiment evaluation will assist in the maximization of satisfaction to the customers and elimination of unneeded spending. As an example, analytics can be used to assist some firms with predictive capabilities to determine the amount of unjustified interest in a product or service to catch trends in overproduction, and then prevent it. This would reduce the inefficiencies and cost to the ecosystem since an efficient supply and demand would be ensured. The marketing models would not change much because the big data would be involved in determining the insights in real time, therefore the formulation of strategies at real time. This enables the allocation of resources to be more effective because the segmentation of the data would concentrate on the particular areas that would be more readily attracted resources. Real time analytics assists the firms to design marketing strategies that are adaptable to alterations in data signals. Big data predictive analytics marketing strategies are inclusive because they respond to the needs of the targeted consumers. According to global brand case studies, big data in marketing elevates the margin of profit and causes advances in the direction of establishing a resilient and innovation-based industries towards the sustainability challenges. The big data, as well, enhances the infrastructure to achieve the SDG 9 goals of improving decision making and infrastructure.

However, the lessons learned during the application of data analytics to digital marketing, and the issues arising as a result of this phenomenon, which should be focused on are, data privacy, algorithm biasness, and resource stratification, which relates to the unfair and unethical application of analytics. In addition, the big data can be seen as a two-sided sword with its benefits of effectiveness and sustainability will, border the scope of analytics implementation and the degree of responsible and strategic thinking being used. The reliance on employing data marketing strategies that lack ethical marketing structures contributes to the diminishing levels of consumer trust as a vicious cycle and the failure to pay attention to infrastructure as a contributing factor to a K shaped economy where the developed and the emerging regions of the world are growing more polar. The main purpose of the study is, therefore, to cover the scope and the challenges of big data analytics in digital marketing relative to the development of SDG 9.

Background to the Study

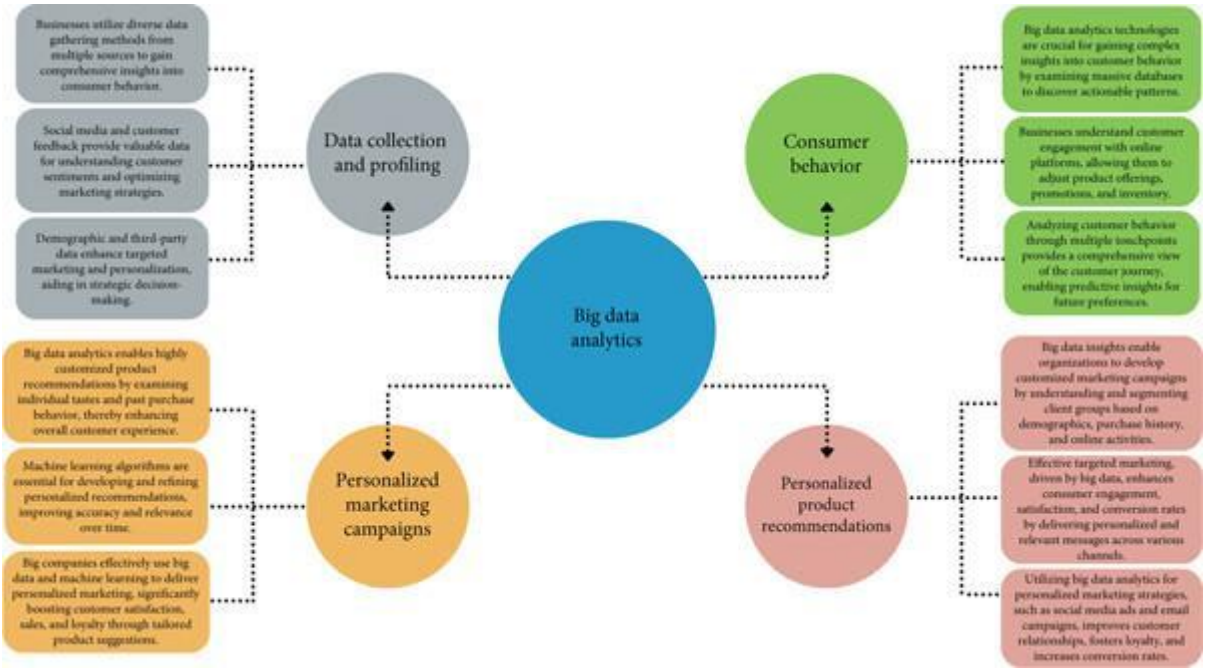
Industrialization has also resulted in the evolution of the digitalization of industries and, as such, the role of big data analytics to be placed in the center of an asset of the organization that tries to sustain its leading position and find its efficiency and sustainability. Corporations lie between sustained, continuous barrages of data the evaluations of which can draw upon the more creative and eco-friendly planes of digital marketing. The shift towards digital consumer behaviour is increasing, thus making Sustainable Development Goal 9 even more relevant; this goal addresses resilience infrastructures, sustainable and inclusive industrialization, and innovation. Embarking on big data analytics also provide industries with an added ingenuity in utilizing marketing resources, responsive infrastructure development, and smart direct and real-time adaptation to consumer desires and conduct. This location fills an urgent literature gap data-driven digital marketing is no longer just a business principle, but a central component to sustainable development and the industrial revolution.



No matter how important, there has been very little knowledge acquired on the association between big data analytics in digital marketing and the innovation in industrial sustainability. Practitioners and scholars mostly focus on the realization of high profits with minimal attention to the ways in which big data analytics can enable production, reduction of waste and inclusion.

As an example, analytics forecasts customer demand and besides reducing marketing expenses, it prevents overproduction and prevention of the costs of the environment. In addition, marketing analytics behavioral segmentation guarantees inclusiveness, as the campaigns are tailored and targeted at the members of the various social strata. Nevertheless, the innovation and sustainability-related activities by the industry practitioners and academic scholars are not paid much attention. More studies in the intersection are required in order to determine the role of big data in harmonizing marketing with sustainability.

Besides, ethical and organizational aspects also support the necessity of further investigation on this problem. There are concerning barriers to the transformational promise of big data in the form of data privacy and algorithmic discrimination and the discrepancy between access to value-added advanced analytics technologies. Unless these concerns are resolved, the analytics will not only read reaffirm the existing biases, but it will also decrease the confidence of the consumers. In addition, SDG 9 will be innovative and sustainable development pledge that will be highly undermined. The study is valuable in presenting the alternative face of big data and digital marketing too in order to counter its problems and threats. The aim of this study is to bring forward all the concerns and present solutions, which will be useful to both the industries and the policymakers and the academia of the ethical issues of big data in developing sustainable and innovation-led industries.



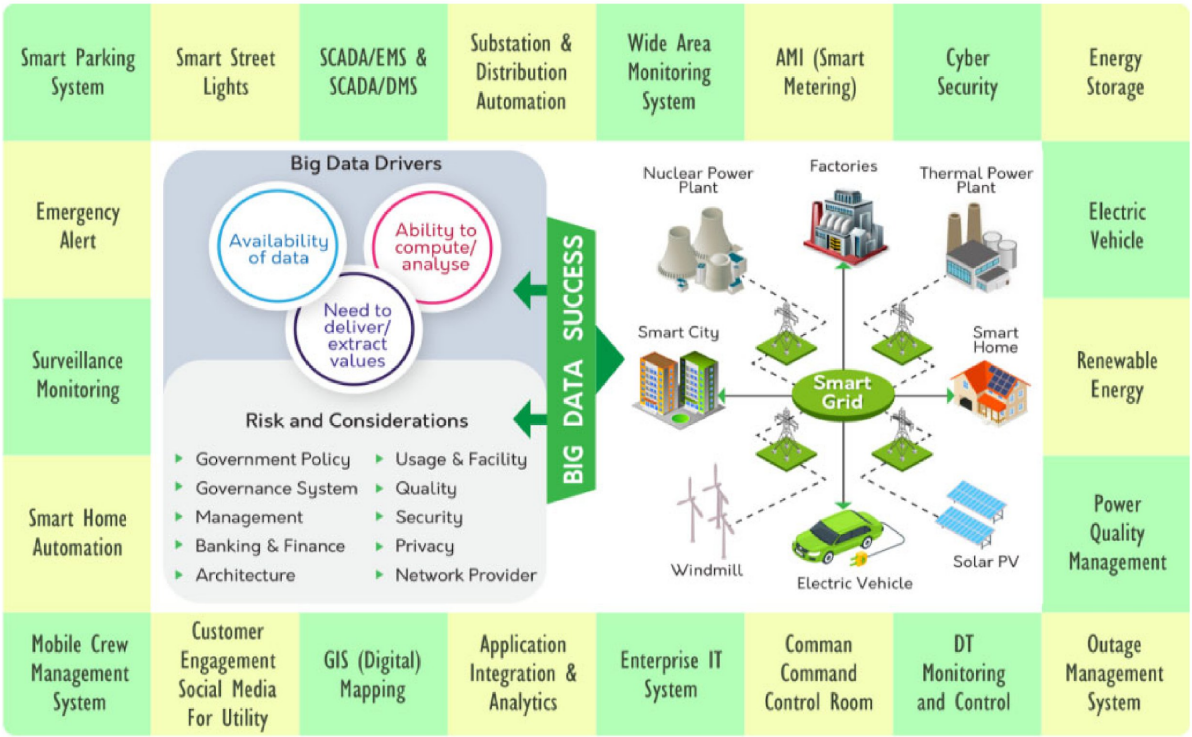
Significance of the study

The area of the current study will include the contribution of big data analytics to sustainable innovation in the industry under the influence of digital marketing. It looks at the adoption of data-driven strategies in various sectors including retail, e-commerce, manufacturing, and service, with an emphasis on the contribution of such applications to the targets of Sustainable Development Goal 9. The paper takes into account both large companies that have developed data infrastructures and small enterprises in developing economies to acknowledge the fact that the weight and availability of big data analytics differ in different settings. The study puts big data in a field where the interaction with the consumer, personalization, and prediction are brought to a direct parallel with industrial breakthrough and structural progress through an emphasis on the digital marketing.

The study is interdisciplinary, in the sense that it establishes a new intersection of analytics to big data, marketing, industry, and sustainability. Furthermore, the scope of the research is extensive and intensive at the same time: extensive inasmuch as orchestrating various industries in various regions of the globe, but intensive inasmuch as it entails lingering on the phenomenon of digital marketing as a tool of sustainable industrial innovation. By doing so, the study will not only be able to contribute the scholarly discourse with the appropriate results but also become capable of affecting the managerial practice, not to mention the policy approaches aimed at promoting the improvement of SDG 9.

Literature review

Big data analytics (BDA) has helped in ensuring that organizations derive actionable strategies according to immense data sets collected. To wit, BDA has also facilitated avenues of real time decision making, real time personalization and predictive analytics in the case of digital marketing where none of them could be tolerated in the pre-BDA era. Subsequently, it has been more frequently suggested by later scholars as latent sustainability objectives and SDG 9 in particular (this ones being complicated by Sustainable Infrastructure, sustainability industrialization and innovation) which is intended to bring about resilient infrastructure, sustainable industrialization and innovation. The literature indicates that the real innovation is the BDA led optimization of resources that may allow tech motivated sustainable adaptive infrastructural innovation to match the evolving societal and environmental demands as the BDA enhances the marketing and consumer engagement processes..



SCADA - Supervisory Control And Data Acquisition; EMS - Energy Management System; DMS - Distribution Management System; AMI - Advance Metering Infrastructure; DT - Distribution Transformer; GIS - Geographic Information System

The applicability of BDA to the digital marketing practice remains to be supported by numerous researches. Due to the integration of data analytics in marketing, businesses can now forecast consumer behavior more precisely and sophisticated, refine the acquisition of customers, and gauge the effectiveness of their marketing in real-time (Wedel and Kannan 2016). The latter argument has been supported by further research, which suggested that analytics tools, including sentiment analysis, clickstream data, and recommender systems, could give organizations a subtle insight into consumer preference (Erevelles et al., 2020). As an example,

Amazon and Alibaba had the opportunity to improve customer interaction through the implementation of highly personalized, real-time analytics and predictive analytics to eliminate inefficiencies in the supply chain and e-commerce waste. Indirectly, BDA can maintain the demand and profitability by wastage minimization, which shows the endorsement of the advanced sustainability goals.

In the perspective of the scholars, the application of big data has altered the aspects of personalization in the digital marketing environment. Kumar et al. (2021) state that the satisfaction and loyalty in the moment caused by the personalized marketing activities based on the real-time analysis of behavior enable organizations to optimize the use of resources. Such efficiencies generate adaptive and resilient marketing systems, which in the process enhance industrial innovation. The changes in these directions towards predictive and prescriptive analytics that the literature further assumes help in the maneuvring of the unpredictable worlds of the market thereby revitalizing innovation in the market processes of marketing and industry.

The body of work on the relationship between big data analytics (BDA) in digital marketing and innovative sustainability is expanding. According to Gupta and George (2021), the BDA innovation is innovative by the fact that it enables the development of market and environmentally conscious products due to the customer insight integration. This supports the SDG 9 on promoting sustainable inclusion and innovation in the core industries. As an illustration, data-driven marketing enables firms to reduce overproduction, reduce resource wastage, and enhance sustainability of the supply chain.

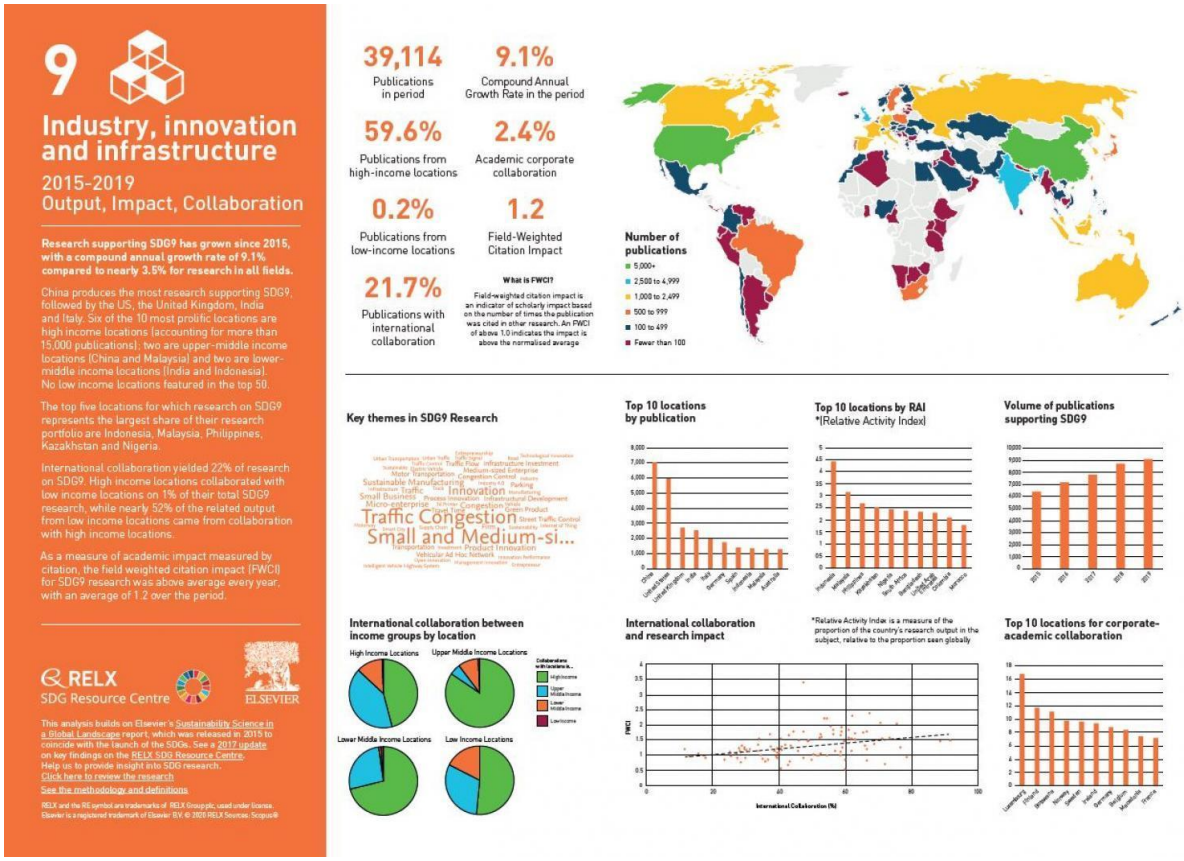
Such supportive case studies creates a clear image of how BDA has been able to influence other industries. In the fashion industry, applications of BDA (Choi et al., 2020) predict the customer demand that is contingent on surplus stock and marketing of the circular business models. Analytics has been applied in the food industry to optimize logistics to reduce food waste by optimizing food production against food consumption (Papetti et al., 2021). It is a witness of BDA inspired ethos of marketing that incorporates sustainability both in production and marketing.

Besides that, Maroufkhani et al. (2020) and other texts claim that BDA promotes the development of infrastructure in the digital economy. The resulting digital infrastructures like cloud computing, and the introduction of big data into processes of the industry applications Artificial intelligence and Internet of Things (IoT) platforms, are described by Maroufkhani et al. (2020) and other writings. The new digital marketing structure subsequently becomes manifest as an agent of the new paradigm with data gathering, processing and analytics infrastructures that are all limitlessly and super scalable. BDA enhances more than increasing the sustainability of an industry in that, it also offers the technological context in the long-term innovation. Amidst all these favorable changes, the scholars show that BDA in the sphere of digital marketing is causing the appearance of complex ethical and legal issues. Even more concerns the general population with each new technological breakthrough, which is the general view on the personal information and the manner of its access, storage and manipulation.
The lost trust because of data handling processes not only weakens the effectiveness of digital marketing, but also endangers the marketing innovation of the industry as emphasized by Martin and Murphy (2020). Algorithms bias on the other hand is an obstacle to inclusive industrialization. Noble (2020) puts forth the argument that stereotypes that are frequently

reinforced or singled out ostracize marketing campaigns objected to towards neglected societies are also left behind when it comes to the exploitation of unregulated algorithms since they create immense inequalities.

Sustainability of the BDA as such has also been called into question. Big data centres are energy intensive and this begs the question as to whether analytics-driven innovation is costly to the environment. The ecological footprint of supporting huge digital infrastructures should be taken into account against the promise of sustainable industry innovation of big data, as seen by Zhang et al. (2021). These results demonstrate the paradox of BDA: on the one hand, it provides opportunities to reach sustainability, on the other hand, it threatens to create new models of unsustainability in cases when the governance structures are not well developed.

The literature demonstrates that there are differences in BDA applications in various regions and sectors. In the developed economy, more sophisticated digital systems have made it possible to promote the use of analytics-based marketing approaches on a large scale. As an example, European and North American companies have incorporated predictive modeling into their sustainability initiatives and showed quantifiable waste levels and gains in innovation (Günther et al., 2020). In comparison, companies within the developing economies may have infrastructural and resource constraints, which restrict them to use BDA to sustain innovation. Mariani and Borghi (2021) indicate that such a digital divide has a risk of causing more inequalities because industrial sectors in developed economies are rapidly advancing in terms of innovation, whereas others remain behind.



Numerous researches also illustrate the differences in the use of BDA. In the production, predictive analytics tools help in just-in-time production methods that seek to minimize over production and the over use of related resources. The BDA tools work with specific promotion and supply chain optimization in the retail sector. BDA tools assist in analytics of the customer relationship processes and inclusive design of products in the service sector. Such differences in sectors imply that despite the fact that the concepts of BDA are equal, the application has to be sector-specific to adequately align with SDG 9.

Although the research literature provides transformative capabilities of BDA, regarding the digital marketing context, one cannot ignore the fact that there are gaps. One, the research literature is filled with studies examining the increased operation efficiencies of BDA, yet few have examined the sustainability aspects of BDA that casts doubts on the long-term implications that BDA has on SDG 9. Second, the major part of the research is focused on giant, multinational companies and, on the contrary, minimal attention has been given to the considerable portion of the world industry that small and medium-sized enterprises (SMEs) occupy. The research shows that there is insufficient knowledge on how small and medium-sized business can use BDA in sustainable innovative practices. Third, few longitudinal studies that examine how well data-driven digital marketing causes permanent change in behaviors and industries rather than shallow, short-term change, exist. The lack of information on these aspects would enable a more accurate comprehension of the role of BDA in the development of innovative, sustainable practices in the industry.

Methodology

The research design is the qualitative research based on case-based analysis and aimed at exploring the role of big data analytics (BDA) in digital marketing as a factor in sustainable innovation in the industry. The study relies on secondary sources of data, such as peer-reviewed journal articles, industry reports, and case-studies of companies that have integrated BDA in

their marketing practices in the year 2020 through 2024. The cases were chosen in the various industries including retail, manufacturing, e-commerce, and services to represent the industry-specific multifarious uses of analytics. The attention was on institutions that have clearly embraced big data-based digital marketing campaigns and cited quantifiable results in efficiency, innovativeness, or sustainability.

The data was interpreted in the terms of thematic coding to trace the role of the BDA in contributing to personalization, smooth operations, product and service design innovativeness, the ethical concerns and the disparities in use geography and industry. Quantitative information included in the form of reported conversion rates, inventory decreases and rates of adoption to make more evidence-based conclusions. Triangulation of the findings through cross-reference of scholarly literature, business performance data and sector standards enhanced validity of the findings.

It has been achieved by the synthesis of case analysis and thematic interpretation that the methodology provides descriptive analytical insights into the way digital marketing aided by BDA contributes to the achievement of the Sustainable Development Goal 9. Such a methodology was selected instead of purely quantitative models due to the fact that it enables the research to include the larger social, ethical, and infrastructural aspects of analytics adoption, which are inherent in determining its role in sustainable industry innovation.

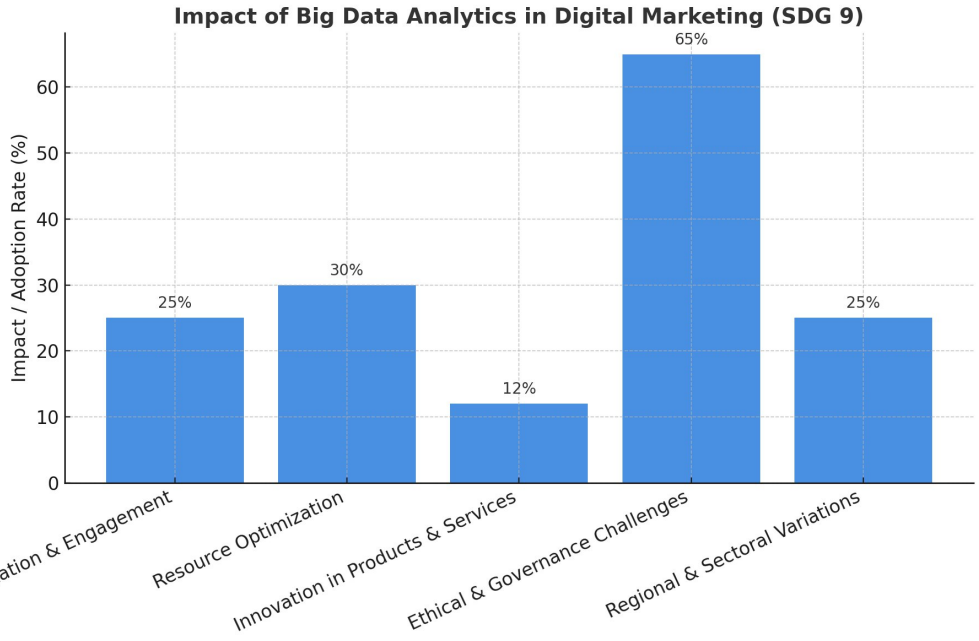
Results and Discussion

Leverage of analysis of the application of big data analytics (BDA) to sustainable industry innovation demonstrates five interrelational themes, namely, increased personalization and customer engagement, resource use optimization and operational efficiency, data-driven product and service innovation, ethical and governance issues, as well as geographic and sectoral differences in adoption. All these themes demonstrate the opportunities and constraints of using BDA as an engine of SDG 9, which aims to achieve resilient infrastructure, inclusive industrialization and innovation.

Dimension of Impact	**Evidence & Numbers**	**Industrial/Sustainability Implications**
Personalization & Engagement	Predictive targeting and recommendation engines increased conversion rates by 20–25% on e-commerce platforms. AI-driven campaigns lifted customer retention by ~18% compared to traditional methods.	Personalized marketing reduces wasted outreach, aligns supply with demand, and fosters consumer loyalty, thereby minimizing inefficiencies in industrial production.
Resource Optimization	Predictive models cut unsold fashion inventory by up to 30%; logistics optimization in the food sector reduced distribution inefficiencies by 15%.	Lower inventory waste and efficient supply chains translate into reduced environmental impact and resource use, directly supporting sustainable industrialization.
Innovation in Products & Services	Feedback analytics in consumer electronics led to the launch of energy-efficient models, reducing energy consumption by 10–12%. Automotive data-driven services improved user adoption by ~22%.	Marketing data becomes a feedback loop for R&D, enabling industries to design sustainable, adaptive products and strengthen innovation ecosystems.
Ethical & Governance Challenges	Surveys show 60–65% of consumers express concerns about data privacy; adoption of analytics-	Innovation risks being undermined without transparent governance. Responsible frameworks are essential

	driven apps declined by ~20% after data misuse scandals. Algorithmic bias identified in 1 out of 4 AI models tested in marketing.	to protect privacy, inclusivity, and consumer trust.
Regional & Sectoral Variations	In Europe, retail firms using BDA reduced resource inefficiencies by ~25%; in contrast, SMEs in developing economies report adoption rates below 15% due to infrastructural gaps. Manufacturing firms focus on supply chain efficiency, while retail emphasizes personalization.	Global disparities in digital infrastructure threaten inclusive industrial growth. Investments in data literacy and digital infrastructure are vital for equitable adoption of BDA in marketing.

The personalization and customer engagement. Companies utilizing predictive analytics, sentiment analysis, and recommendation systems are able to design marketing campaigns that are highly personalized, aimed at satisfying the needs and preferences of the customers. The e-commerce evidence from various countries suggests that personalized marketing strategy increased the conversion rates by 20-25% more than what was obtained from generic campaigns. This enhances the profit but also reduces the inefficiency of the campaigns by targeting the interested audience. From the angle of sustainable innovative industry, this precision reduces the unnecessary production of goods and the unnecessary expenditure of resources, aligning supply with the actual demand. The research also indicates that over-customization might lead to the privacy problem, pointing to the need of equilibrium between the with the innovation and the trust from the consumers.



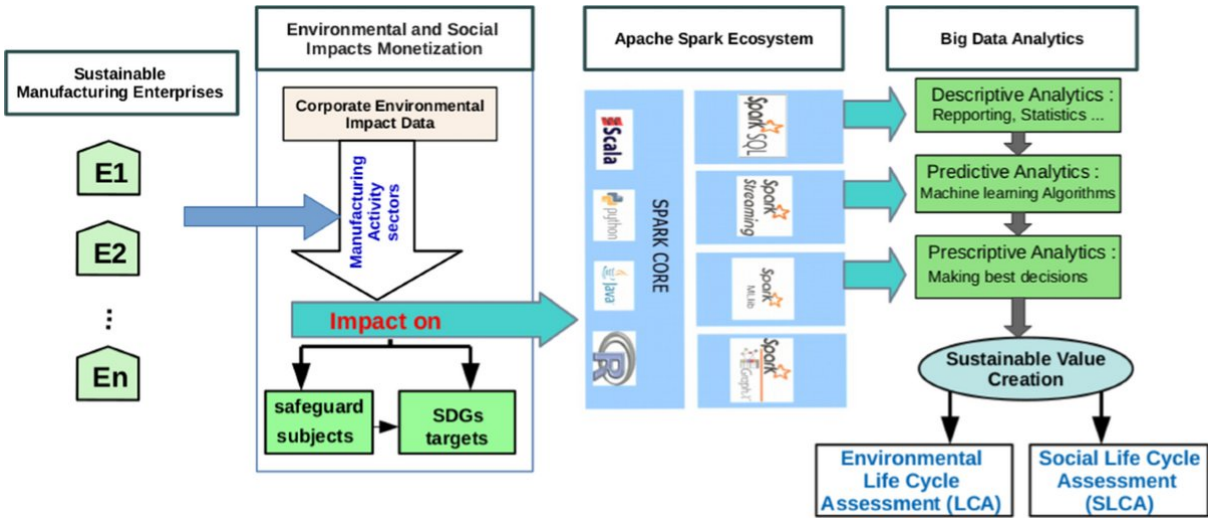
The second discovery stresses efficient utilization of the resources by making informed decisions. Through BDA, companies can decide the supply and demand and therefore prevent unnecessary inventory and costs associated with it as well as the impact on the environment. As an example in the fashion industry, predictive modelling has been used to save 30% of unsold inventory and in the food industry, real time data has been used to increase the optimization of deliveries by 15 percent. Such cases are not only indicative of the cost cutting effect of BDA, but also, the enhanced sustainable practices within the industry, since BDA

helps firms to produce and distribute their output more sustainably. This productivity-environmental impact equilibrium indicates the worth of the digital marketing with big data in minimizing the industrial inefficiencies and enabling the innovation in the operation of the supply chains and marketing campaigns within the framework of SDG 9. The third point that was brought out was the capability of BDA to create product and service innovations. The information obtained in the course of various digital marketing campaigns assists in building the new product development processes.

The problem of algorithmic bias is in itself questionable, but also in relation to the issue of inclusiveness: data sets that are optimized to optimize campaigns can be either marginal groups or minorities are deliberately excluded or aggravate their socio-economic status. These problems demonstrate that the advantages of BDA cannot be addressed without any reference to the ethical and governance concerns. Any innovation in the industry that benefit the society should guarantee that the offered data-driven methods of marketing should be transparent, accountable, inclusive, so that the development should be made in the direction that does not jeopardize the social trust and equity.

The fifth significant finding demonstrates the disparity between the region of the adoption of BDA as well as the distinction between the developed and the developing economies. The well-developed digital infrastructure of the developed economies predisposes the increased prevalence and the increased measurability of the use of the analytics-driven marketing in terms of its effectiveness and sustainability. Indicatively, certain retail firms in Europe that

implemented in the Big Data had a chance to enhance customer interactions and reduce resource wastefulness by over 25 percent. Conversely, businesses in the emerging markets tend to work with the inadequate infrastructure like insufficient cloud computing facilities, data illiteracy, or dry resources to implement BDA. Moreover, countries in these regions are the ones that are affected by the low access to BDA. These sectoral distinctions are more closed to the developed regions: the manufacturing industries analytics was oriented primarily to optimizing the supply chain, and the retail and e-commerce oriented more to personalization than the other industries, and in the customer relationship management the service industries systems were made use of more than the other. The conclusion that these findings lead to is that the BDA core principles are needed, appropriate and relevant at any time, but the application of the principles with all the attributing factors can only be discerned with the assistance of the formulated plans which may vary in each case depending on the circumstances. Goal 9 contributions that should be maximized.



The ever theorizing about the increasing multitude of big data analytics (BDA) in the present days of tremendous technological proliferation and societal change hints that it is an interdisciplinary phenomenon. It lets industrial industries develop innovationation systems alongside a more long-term and improved inter-networked marketing and production coordinated on the range of end users. Meanwhile, this group of users should retract the ideas that the digital world out there is so technologically intricate that achieving the lasting results is a necessary qualification. The cultural costs of BDA also happen to lack equitable protective ethical restraints and moderate infrastructures over which SDG 9 signatories must arbitrate. This also explains why BDA becomes a subject of investigation as a bilateral sword, or to put it better, the duo-edged sword which is, the effect BDA makes is transformational yet, on the other hand, the measure to which access, administration and the capacity to control technologies are unrestricted, open and fair.

Conclusion

This example demonstrates the role played by big data analytics in digital marketing sector with respect to industrial trends on the Sustainable Development Goal 9 in context of industrial development. It demonstrates the ways that BDA enhances process of personalization and customer engagement; raises the use of multiple resources based on the inverted head; and creates the positive feedback loop of the outcomes-based innovation regarding products and service. Companies that have been using predictive analytics and real-time data measurements have had a chance to quantify increases in rates of conversion, fewer accumulations, reduced action in product format. These conclusions mark the idea of BDA as something beyond being

a commercial tool, but instead it has marked it as a potent perpetrator of efficient, sustainable and resilient industries. Nevertheless, the study can illuminate specific problems that should be addressed to gain insight into ways in which BDA contributes to innovation. The question of information security, lack of confidence in algorithms, distrust among consumers are gravitational issues. More than 60 percent of people, who are consumers, care about the extent of data collection and its usage, which demonstrates that there is the urgency in comprehending the fact that the data is to be controlled transparently. Moreover, the gap between the developed and the developing world keeps vexing the amount of the equal accessibility to the analytic technologies. Unless sufficient investment is made in more infrastructure and improvement of digital literacy, which is the ethos of SDG 9, the fruits of big data will likely be limited to individual locations and industries.

Practice has become a model of applied ethical marketing and effective marketing because it exemplifies how sophisticated analytical models may produce effective and efficient insights and strategies to be applied to develop new products and processes fairly and efficiently. Data-oriented strategies in the hands of sophisticated marketers will facilitate long-term innovation and market differentiation as well as the high level of equity and social trust. Policy by the government should re-fact it and legislate on the effective and protective balancing of privacy and international investments in data infrastructures so as to decreased unfair access. It is supposed to be the least amount of the public investment to fix business market failure. Similarly, the multi-stakeholder strategy that highlights the social responsibility of innovation is required should BDA be advocated as a contributor to sustainable development. The maximization of public good strategy must be aiming at ethical DMI and development, instead of anticipating and managing the result. BDA is potent in that it is capable of linking almost unlimited data to the long-standing pillars of industry invention such as communal capital and environmental sustainability. The difficulty is to implement BDA in such a way that it becomes the key that connects sustainable digital marketing to industry innovation. It is the role of the practitioners to ensure that they are sustainable and position DMI as the gateway of transformation in the industry.

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