

Marketing Information Management Based on Machine Learning Algorithms and Data Mining Science (Amazing Scientific Progress and Terrible Technical Development)

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Abstract:

This study addresses a critical issue of managing marketing information or MKIS that flows to and from the internal and external environment of the marketing department. The CMO is taking advantage of the advent of artificial intelligence in all its branches to efficiently and effectively improve marketing mix decisions and strategies. This concise research paper concludes that harnessing the marketing information system for machine learning algorithms and investing in big data mining science is a golden opportunity to achieve marketing objectives, both qualitatively and quantitatively. This generates significant competitive advantages, most notably the hyper-personalization of customer experience.

Keywords: Marketing Information Management; Machine Learning Algorithms; Data Mining Science.

Jel Classification Codes: M30; M31; M37

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1. INTRODUCTION

Managing information flows to and from marketing activities and efforts is one of the most vital tasks facing the professional marketer. Regulating the flow of information from the internal and external marketing environment is becoming more important than ever, given its fundamental role in the commercial decision-making process. Unsurprisingly, the digital age and the intensification of competition between companies and establishments in target markets have increased the imperative of adopting specialized systems to track the flow of marketing information. This information serves as the raw material for formulating marketing strategies and policies. Quality information leads to a quality tactical marketing mix and effective sales management, whether related to product and brand planning and development, pricing and discounting methods, promotional communications, advertising, or publicity. Finally, there are physical distribution channels and logistics services.

Systems theory in marketing has given rise to what is known in contemporary literature as expert or intelligent marketing information systems. These systems are automated/human, preventive/therapeutic, and have been divided into four basic systems by academic marketing scholars: exploratory research, surveys, and opinion polls; business intelligence and marketing intelligence; accounting records and internal reporting systems; and decision support and quantitative marketing systems. Undoubtedly, the latter, thanks to its statistical approaches and mathematical methods, contributes to predicting the future and identifying trends and patterns related to competitive and market conditions. It also includes predictive modeling of consumer behavior by identifying needs, desires, and preferences. It is a system that encompasses a range of sciences useful for prediction and estimation, such as probability theory, operations research, and decision trees.

Profound computing advancements and radical technological transformations, in the context of tremendous scientific and cognitive progress, have become the defining feature of the world of finance and

business. This boom has reached its peak following the dawn of machine learning and data mining. These generative technologies and emerging innovations have yielded numerous qualitative gains in terms of economic feasibility, profit margins, and investment returns. The contributions of data mining, cleaning, and storage in cloud repositories are undoubtedly significant. In addition, the roles of adaptive algorithms, machine learning, and automated robots have extended into modern industries and projects. Cyber-physical systems have become the backbone and fundamental pillar of production and marketing. What is striking is the rush by decision-makers to harness information and communication technologies.

The birth of the fifth generation of the industrial revolution (Industry 5.0) and the hyper-intelligent society (Society 5.0) coincided with the urgent need for more advanced tools and means to keep pace with the requirements of sustainability. Computer science and fifth-generation networks (5G) had great credit in accelerating the pace of sustainable manufacturing, and the exponential growth of digital marketing and e-commerce. Along with generative artificial intelligence, neural networks, deep learning, natural language processing, and virtual assistance, many revolutionary disruptive technologies and inventions emerged, which left a tangible impact on meeting the quality of life and growing the wealth of nations. We mention, for example, but not limited to, Internet of Things (IoT) sensors, virtual reality (VR) and augmented reality (AR), i.e. the metaverse, cognitive computing, sentiment analysis, cloud computing, quantum computing, Blockchain, Semantic Web (Web 3.0), Symbiotic Web (Web 4.0), and Satellite Internet, ... etc.

The convergence of marketing information management on the one hand, and machine learning and data mining on the other, has given rise to the algorithmic marketing approach, enhanced by analytical modeling. Neuromarketing can delve deeply into the purchasing intent of current and potential shoppers, gaining proactive insight into their preferences for goods and services. In this context, the marketing environment is rich with ever-increasing data, and given its rapid growth, decision makers, strategists, and policymakers need to adopt digital computing tools and capabilities to maximize its benefits and transform it into useful information

that feeds and supports the chief marketing and sales officer. Large volumes of marketing data represent a gold mine that can be exploited to generate additional revenue and cash flow, grow market share, and strengthen competitive positions.

The aim of this research paper is an analytical argument and an interpretive discussion to explain the implications of adapting machine learning and harnessing big data mining science on managing the fluidity of marketing information considering the complex interaction between information systems and marketing strategy in contemporary organizational contexts. The digital world and the cyber environment, compared to the real world and the physical environment, are rich in great wealth and a huge amount of data. Marketing decision-makers and policy makers need to gain valuable insights from structured and unstructured data, thus helping in measuring and evaluating competitive performance from the perspective of hyper-customization of consumer needs and desires, and thus, achieving sustainable competitive advantage (SCA).

2. Smart Management of Marketing Information as a Dynamic Driver for Winning the Race Against Competitors in the Digital Age

2.1 Control and Dominate Markets Through Efficient and Effective Management of Marketing Information

Managing the flow of information from the marketing and competitive environments is one of the most prominent roles assigned to the chief marketing and sales executive. The value of marketing information derives its practical and field significance from its use in providing insightful insights for sound marketing decision-making. There is no doubt that establishing and activating a marketing information system in business organizations is an imperative imposed and dictated by the pressures and constraints of fierce competition, as well as by sensing and monitoring the conditions and circumstances of competitors and target market scenarios, on the one hand, and the imperative to track and monitor the needs and

desires of purchasing groups and consumer categories, on the other. Furthermore, establishing the foundations of a marketing information system as a preventative and therapeutic device that integrates human effort with equipment is a feature and a reflection of the marketing function based on human-machine collaboration to solve problems, manage complex crises, confront thorny challenges and dilemmas, and exploit and seize potential opportunities and future gains in the long term.

See: Ashmarina, S., & Zotova, A. 2016; Li, E. Y., et al. 2001; Bennett, R. 2007; El-Omari, H. A. 2019; Molina, A., et al. 2010; Talvinen, J. M. 1995; Leonidou, L. C., & Theodosiou, M. 2004; Meyer, J. A. 1998; Wöber, K. W. 2003

Fig N° 1: Steps to Create a Marketing Information Management



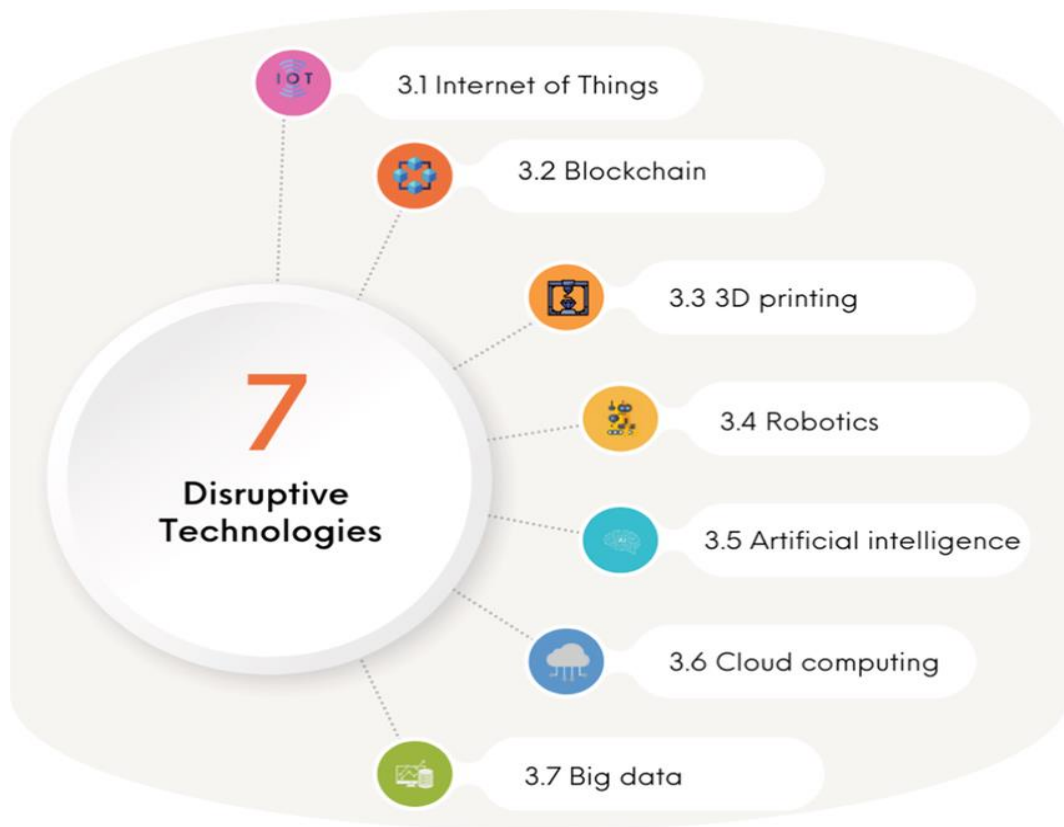
Source: Weller, J. 2017

2.2 The Contribution of Cyber-Physical Systems and Emerging Computing Technologies to Information Support for Marketing

In a related context, information technology, wired and wireless communication networks, satellites, the Internet, and fifth generation (5G) have cast their shadows on the mechanisms for collecting, capturing, sorting, classifying, coding, tabulating, and statistically analyzing data to produce marketing information useful for making informed decisions, both quantitatively and qualitatively. The efficiency and effectiveness of subsystems for managing marketing data and facts are increasing considering the rapid growth of cyber-physical systems, digital innovations, and the fourth and fifth waves of the industrial revolution, such as survey marketing research and opinion polls, marketing intelligence, internal and accounting records, and marketing decision support. These vital fields are improving their performance from the perspective of profitability and efficiency because of harnessing electronic computing tools. The strategic convergence between marketing and computer science has led to sustainable competitive advantages and capabilities and successful winning cards that have contributed significantly to growing the wealth of projects and market shares in the long term.

See: Yang, S., & Long, H. 2024; Chen, T. L., et al. 2021; Wang, Y. 2019; Lytras, M., et al. 2020; Aggarwal, K., et al. 2025; Paul, P., et al. 2018; Ratchford, B. T. 2019; Athaide, G. A., et al. 2025; Kumar, V. 2021; Buhalis, D., et al. 2023; Sharma, S., & Kumar, S. 2019

Fig N° 2: The Most Important Disruptive Technologies



Source: Gamal, A., et al. 2023

3. The Remarkable Successes and Unprecedented Gains of Machine Learning Algorithms and Data Mining Science

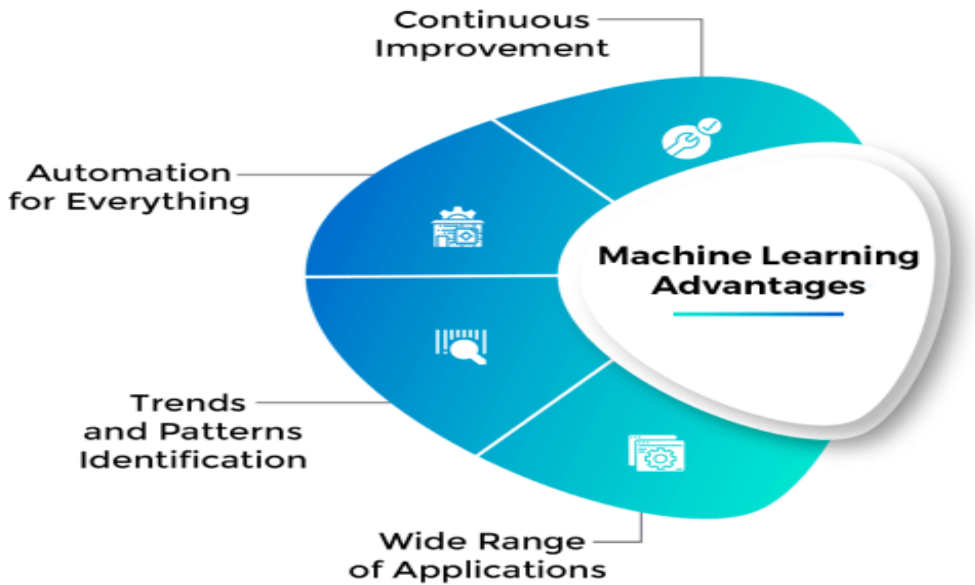
3.1 Sharing Machine Learning as a Subsystem of AI in Industry 5.0 and Society 5.0

The emergence of machine learning and big data analytics, enhanced by algorithmic intelligence, as a generative technology has resulted in profound transformations and radical changes in all aspects of life and economic sectors without exception. Its importance grew during the fifth generation of the industrial revolution and amidst the fifth wave of super-

intelligent societies. This digital innovation, with its empowering capabilities, has proven to be a qualitative leap and a decisive turning point, yielding many remarkable accomplishments and tangible gains on the ground. The secret to this is its emulation of induction and rational logic in many cognitive processes and mental deductions, as well as agile learning from previous experiences and cumulative expertise, which translates into the automatic performance and execution of tasks and the practice and conduct of activities without human intervention. Computational intelligence devices based on adaptive algorithms and machine learning possess extraordinary capabilities and formidable reinforcers, enabling them to think, deduce, reason, interpret, understand, predict, and even produce interactions and make decisions with high efficiency and professionalism, with exceptional speed and accuracy. As a result, it's no surprise that the era of artificial intelligence and machine learning is being described as a transformational revolution.

See: Bamakan, S. M. H., et al. 2025; Taj, I., & Zaman, N. 2022; Monteiro, A. C. B., et al. 2025; Domenteanu, A., et al. 2024; Rahman, A., et al. 2020; Mobarak, M. H., et al. 2023; Zhu, M., et al. 2022; Wu, X., et al. 2022

Fig N° 3: The Importance of Machine Learning



Source: Sun, Y. 2020

3.2 The Rise of Data Science and Its Positive Impact on Predictive Modeling and Future Foresight

The need for data mining has become increasingly urgent, especially with the developments of the fourth wave of the industrial revolution (Industry 4.0). Its importance has increased with the signs of the dawning of the fifth generation of the industrial revolution (Industry 5.0). Cyber-physical systems, computer applications, intelligent software, and all digital innovations rely on data science. In this regard, this academic direction and field of knowledge is a multidisciplinary approach, one of the fastest-growing fields, blending and combining the principles and foundations of mathematics, methods, and tools of statistical inference with advanced computer engineering and advanced information technologies. Undoubtedly, computing, programming, and algorithms have enriched this

field by improving the extraction of meaningful and significant information, thereby generating knowledge and wisdom through the automatic processing, analysis, storage, and cleaning of regular and irregular data. This is especially true given our current environment is inundated with massive amounts of data. Thus, it contributes effectively to extracting valuable insights for decision-makers so that they can shape the future and create tomorrow.

See: Mishra, P. K., & Verma, S. K. 2024; Charitidis, C., et al. 2022; Saurabh, K., et al. 2024; Mishra, S., et al. 2021; Li, G., & Guo, X. 2024; Rahman, M. M. 2025; Raschka, S., et al. 2020; Sarker, I. H., et al. 2020

Fig N° 4: The Advantages of Data Science



Source: Kadirvel, K. 2024

4. Managing Marketing Information Flow Enhanced by Machine Learning and Data Science in the Age of Marketing-Computer Convergence

4.1 The Benefits and Advantages of the Marketing Industry Adopting Disruptive Technologies Such as Machine Learning and Data Science

There is an urgent and pressing need to adapt artificial intelligence (AI) with its progressive branches and revolutionary wings to enhance the outcomes of systematically enhanced marketing, also known in the literature as marketing information systems. These include generative AI, large language models, virtual assistants, neural networks, natural language processing, computer vision, deep learning, voice chatbots, sentiment analysis, and many others. These technologies help marketers, engineers of tactical marketing mix paths and programs, make more informed and optimized strategic decisions. Undoubtedly, information support and feedback are becoming increasingly important due to market conditions, competitive pressures, changing consumer tastes, digital transformation, technological advancements, and other drives for the creation of a specialized department dedicated to providing information liquidity to the Chief Marketing Officer (CMO). This issue has received significant attention from the agendas of professional marketers seeking to dominate and control markets. In a related context, due to the overlap between advanced information systems and digital marketing strategies, data science plays a significant and growing role in enhancing the performance of marketing information systems. Accordingly, embracing the science of extracting and analyzing complex data supported by artificial intelligence represents a strategic gain and a qualitative leap in managing the flow and fluidity of information to and from the marketing environment, as the quality of marketing decisions depends on the quality of marketing information derived from historical and current event data. The mechanical and dynamic interaction between the marketing industry and data science considering the Fourth and Fifth Industrial Revolutions, in addition to the increasing expansion of available data, has resulted in the birth of many

innovative marketing methodologies specifically designed to adapt to digital transformations and emerging technologies. These include, but are not limited to, proactive marketing, agile marketing, predictive marketing, real-time marketing, cloud marketing, quantum marketing, etc.

See: Rosário, A., et al. 2021; Hwang, Y. H. 2019; Miklosik, A., & Evans, N. 2020; Basu, R., et al. 2025; Dzyabura, D., & Yoganarasimhan, H. 2018; Syam, N., & Kaul, R. 2021; Zare, Z., et al. 2025; Saura, J. R. 2021

4.2 Harnessing Machine Learning Algorithms and Data Mining to Improve Professional Marketer Decision Making

In this regard, we can cite the most significant impacts of embracing machine intelligence and data science in enhancing marketing process outcomes and improving marketing information system outputs, making them superior, distinctive, and successful—that is, exceptional, unique, and differentiated performance in target markets. These are as follows:

- Improving the competitive performance of marketing research and surveys, marketing intelligence, surveillance, and vigilance systems, and internal records and reporting systems.

- Accurately and quickly diagnosing changes and variables in the internal and external marketing environments, examining strengths and weaknesses, and efficiently tracking opportunities and threats.

- Optimizing marketing results by improving feedback and reactions, as well as benchmarking and measuring performance against the best and most effective competitors.

- Assisting marketing management in making informed, insightful, wise, prudent, and rational operational, tactical, and strategic decisions.

- Participating with the chief marketing and sales executives in resolving difficult and complex problems, on the one hand, and in identifying and exploiting business opportunities, on the other.

- Enabling those responsible for the marketing information system to synergize and coordinate with other information systems, such as human

resources, operations, production, accounting, and finance.

- Allocation of algorithmic and automated marketing mixes based on the capabilities of personalized and optimized marketing, in addition to instant, and real-time marketing.

- Harnessing databases, analytical, and predictive modeling to increase the efficiency of product management, pricing methods, integrated marketing communications, and distribution channels.

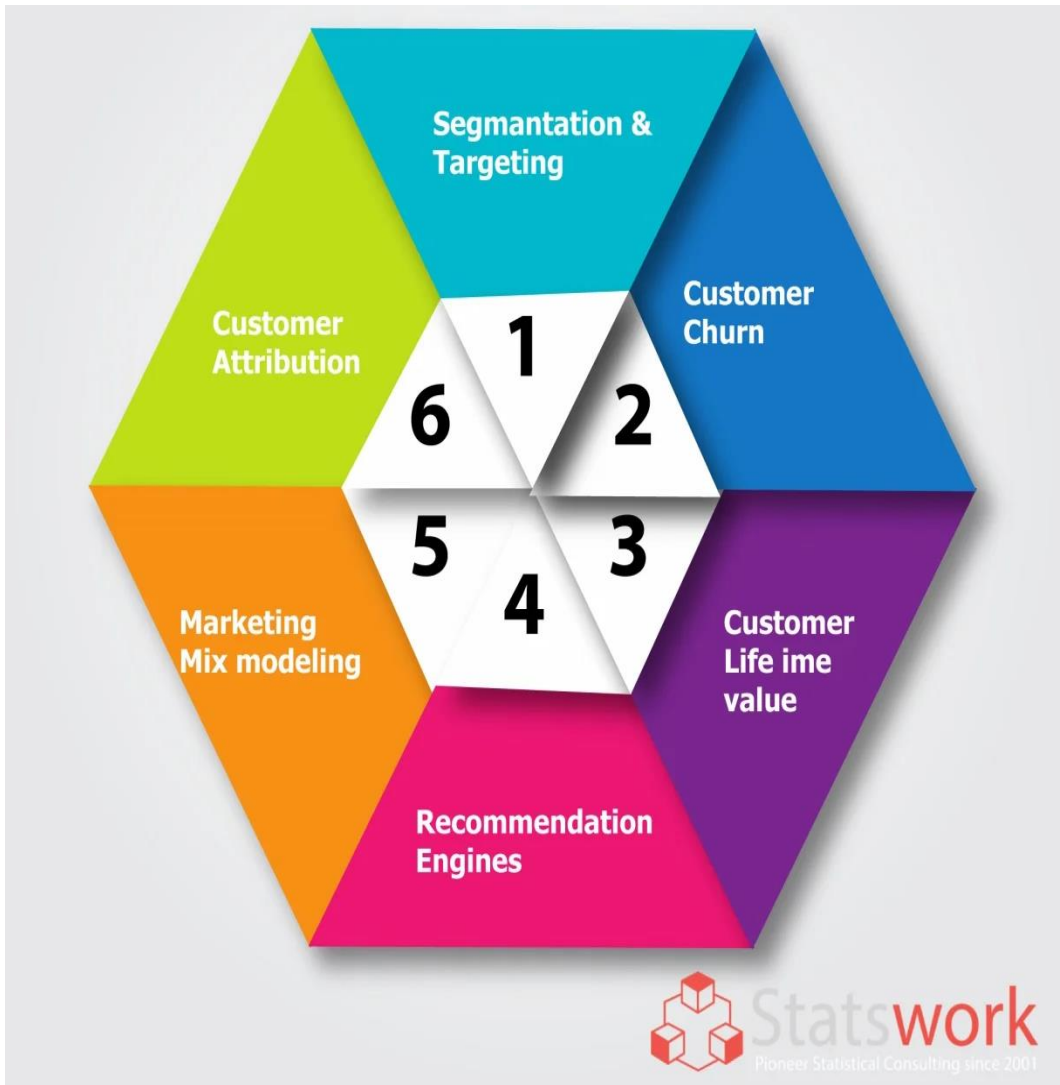
- Adapting customer relationship management programs and logistics supply chain management activities to the requirements of cloud computing, quantum computing, the Internet of Things, and blockchain.

- Gaining a sustainable competitive advantage centered on hyper-personalization and intelligent management of shopper experiences and journeys, particularly in virtual reality worlds.

This research did not ignore or neglect the ethical considerations, legal implications, and cybersecurity of personal information and data. Discussing issues of privacy, autonomy, and individual freedom, and raising this issue requires allocating a large space for expressing opinions, which the research does not have the capacity to do. However, it can be said that marketing information systems in general, and marketing decision support systems in particular, should consider the ethical constraints of protecting individual data and avoiding bias and violating users' privacy. Marketing and sales management should not be swept away by the euphoria and ecstasy of harnessing statistical and mathematical techniques enhanced by intelligent algorithms and machine learning to manipulate emotions and commodify purchasing intentions by analyzing current and historical data. These technologies have the superior ability to predict future events and outcomes, such as guiding shoppers' behavior, managing their expectations, controlling their preferences, and penetrating their choices. This is especially true in the context of the evolving dynamic landscape of generative artificial intelligence and large language models, and their prowess in gaining practical insights, drawing profound conclusions, and making immediate decisions regarding increasing customer awareness of brands.

See: Kumar, T. S. 2020; Abakouy, R., 2019; Wang, F., & Aviles, J. 2023; Tudoran, A. A. 2022; Bhatia, K., & Khan, T. K. 2024; Chornous, G., et al. 2023; Nnaji, U. O., et al. 2024; Stanton, A. D. A., & Stanton, W. W. 2016; Johnson, D. S., et al. 2021

Fig N° 5: Application of Machine Learning in Marketing



Source: Stats Work Blog. 2021

Fig N° 6: The Marketing Value of Data Science



Source: Selvaraj, N. 2025

5. CONCLUSION

Ultimately, in a complex marketing environment and a thorny competitive landscape within the context of digital transformation, the importance of marketing information processed from raw data is growing. This is due to its urgent need, value, and importance in assisting marketing management in carrying out its activities and enabling it to fulfill its responsibilities towards customers and stakeholders. Managing information flow with operational efficiency and organizational effectiveness has become the true criterion for making better and optimal decisions. However, the fourth and fifth waves of the industrial revolution, along with the steady scientific progress and development in the field of the internet, social media, revolutionary technologies, and computing devices based on high-capacity storage media, such as machine learning and data science, have helped marketers improve the outcomes of marketing information systems and digital content. The study argued for the crucial role of those responsible for the dynamics of intelligent algorithms, statistical and

mathematical science, and cloud databases in enhancing the results of proactive marketing support systems, known in contemporary literature as instant or real-time marketing. The study reached the following conclusions:

□ Growing market trends, turbulent competitive wars, and shifts in the tastes and moods of purchasing groups increase marketers' need for information. Accordingly, marketing information systems are a subsystem derived from management information systems and share their characteristics. However, their specificity is that they are driven by customer preferences and expectations, as well as by analysis of competitor behavior and market structure. These systems are receiving increasing attention in reshaping business practices and sales management, given the tangible results they deliver to marketing decision-makers, including improved demand forecasting and estimation, and audience appeal. Marketing research systems, intelligence, internal records and reports, and marketing decision support all play an integral role in helping marketing management achieve its quantitative and qualitative objectives.

□ Artificial intelligence and data science are two closely related fields, emerging from cyber-physical systems and generative technologies in the age of the information explosion. Machine learning, automation of repetitive tasks, instant chatbots, voice chat, virtual assistants, natural language processing, large language models, neural networks, computer vision, and other digital innovations, in addition to cloud computing, quantum computing, blockchain, virtual and augmented reality, the semantic web, the symbiotic web, the space internet, and fifth-generation networks, have provided tremendous momentum in accelerating prosperity and quality of life. Unsurprisingly, these computing developments and technological transformations benefit all stakeholders, enhancing engagement across all stakeholders.

□ Machine learning, and the science of extracting hidden and complex data are emerging technologies that use advanced tools and applications to help businesses and marketing sectors automate decisions and explore and anticipate future trends through statistical algorithms

capable of processing pre-collected data from historical and current events. Among the most important future outcomes achieved by this generative technology in extracting valuable knowledge and useful information are enhancing promotional campaigns and advertisements, predicting consumer behavior and purchasing intentions, estimating product demand, improving dynamic pricing capabilities, in addition to strengthening customer relationship management in loyalty programs, and managing supply chains, logistics, and distribution channels.

In conclusion, this descriptive and analytical study and in-depth discussion of this marketing phenomenon emphasizes the utmost necessity of developing and enhancing a marketing decision support portfolio that provides effective support in engineering and designing the marketing mix and managing and directing customer experiences and journeys. Accurate decision-making regarding predictive modeling of purchase intent is critical for any organization's survival in highly competitive markets. In today's business environment, characterized by unprecedented uncertainty, understanding consumer behavior is an integral part of targeted marketing information systems based on the computing power of artificial intelligence and data science in general, and competitive decision support centers based on complex data analytics and predictive analytics. It is the primary driver for brands to become market leaders. Therefore, it is essential that all enhanced and personalized marketing functions, as well as algorithmic and predictive marketing practices, focus on the needs and desires of the profitable customer. There is no alternative, then, to adopt smart, data-driven marketing to select the right customer, build long-term relationships with them, retain them, grow their business, and manage their expectations. This, in turn, ensures sustainable growth and profitability, and generates a competitive advantage based on gaining valuable, deeper insights from complex data processing that competitors find difficult to match or keep up with. Ultimately, ethical and legal issues, transparency and accountability, personal data protection and cybersecurity, as well as privacy, independence, and individual freedom, continue to cast their shadows as constraints on the social responsibility and ethical commitment of marketing. These are real concerns and obsessions that require independent,

detailed research to discuss the measures and procedures to address these serious challenges, given their complex implications and highly complex details.

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