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Influence of new-age technologies on marketing: A research agenda

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ABSTRACT

This study focuses on four key new-age technologies – the Internet of Things, Artificial Intelligence, Machine Learning, and Blockchain – and their respective roles in marketing. Specifically, the study examines each of these four technologies in depth, to understand their key elements, the domains in which they operate, and current use cases pertaining to these technologies. The adoption of these new-age technologies is expected to have an impact on the outcomes for firms and customers. However, these are dynamically evolving technologies that have not yet been completely explored and whose full potential has yet to be uncovered. This study presents some research questions that are pertinent to key entities (firms, customers, intermediaries, developers, and regulators), and which merit deeper investigation in the future. This study also highlights major areas that need managerial focus in the adoption of these new-age technologies.

1. Introduction

The world has continued to move towards a digital future over the years. Technology is a large and integral part of life today, with multiple factors driving and enabling this change. As customers grow increasingly tech-savvy, they demand fast and seamless digital experiences and expect immediate solutions to their needs. In response, firms are changing the way they do business by accelerating the application of technology and reinventing processes, organizational structures, and business models. By increasing investments in technology, firms can observe benefits such as lower costs and higher efficiency, and more capably meet stakeholders' expectations. For instance, by digitizing its mortgage-application and decision process, a bank was able to reduce the cost per new mortgage by 70 percent and cut the preliminary approval time from several days to one minute (Markovitch & Willmott, 2014).

In the context of technology's increasing importance, four "new-age technologies" – the Internet of Things (IoT), Artificial Intelligence (AI), Machine Learning (ML), and blockchain – are particularly noteworthy. According to Gartner's Hype Cycle for Emerging Technologies, IoT, AI, ML, and blockchain are in the breakthrough or early expectation stages, with mainstream adoption predicted to occur several years into the future. For instance, AI and ML will be available to the masses, potentially fostering communities of developers, data scientists, and architects (Panetta, 2018).

These technologies are widely considered to be the way of the future and underlie other trends that are expected to gather steam in the years ahead. For instance,

- IoT and its abundance of smart, connected products are predicted to become more pervasive (Columbus, 2017; Montresor, 2014), with the number of connected things being estimated to increase to around 75 billion by 2020 (IHS, 2016).
- This growth in IoT is expected to impact automation and connectivity of processes and devices, contribute largely to the datafication trend (Marr, 2017a), and lead to an increased investment focus on ML and AI-powered analytics (Dixon, 2016; IHS, 2016).
- AI is being applied to varied contexts, from automating fact-checking in journalism to powering chatbots that interact with customers on e-commerce websites (Newman, 2017).
- In addition to its application to cryptocurrencies, blockchain is a foundational technology that has potential applications in securing data and transactions in business as well as government, healthcare, content distribution, etc. (Council, 2018; Panetta, 2017).

While firms have been applying these new-age technologies to marketing activities and business tasks in isolation, they have only recently begun to examine the integrated application of these technologies to marketing strategies. There has been a noticeable shift towards data-driven business and marketing strategies, leading firms towards harnessing the power of new-age technologies to spur all units of their business, especially marketing. The potential of new-age technologies

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to integrate data from varied sources and mine this data using sophisticated techniques to derive powerful insights has encouraged firms to examine new-age technologies keenly. Furthermore, firms are now beginning to comprehend the new business opportunities that these new-age technologies provide, in addition to applying them to solve existing problems or augment existing capabilities.

No longer can firms rely on engaging with their customers in isolated interactions; customers today expect experiences that are effortless, intuitive, and seamless across touchpoints. New-age technologies, if applied strategically, can enable firms to meet, and even exceed these expectations. The future of marketing lies in firms' efforts to acquire a holistic understanding of their customers' needs and behaviors across platforms, devices, and varied products and services. In this light, it is critical to study the impact of these four new-age technologies specifically with regard to marketing strategies, to understand how they are currently being leveraged, and to identify the potential areas that merit deeper exploration.

In this study, we choose IoT, AI, ML, and blockchain as the focal new-age technologies on account of their future potential, their interconnectivity, and their linkage to data. Through the rest of this study, we use the term "new-age technologies" to specifically refer to these four technologies: IoT, AI, ML, and blockchain.

As more firms move towards the adoption of new-age technologies, the following questions are important from a marketing perspective:

- What do we currently know about the four focal new-age technologies – IoT, AI, ML, and blockchain?
- What do we currently know about the impact of these new-age technologies on firms and customers?
- Going forward, what would we want to know about these new-age technologies, i.e., what specific research questions would we like to see answered?

In this study, we discuss the salient elements of the four focal new-age technologies and present research questions that hold the key to understanding their future potential. Our discussion is structured in the following manner. We begin by exploring prior research within marketing that has studied new-age technology adoption, with regard to IoT, AI, ML, and blockchain. We examine the elements of new-age technologies that are most important to firms and the domains in which they operate. Based on inputs from managerial interviews, we posit that each of these four new-age technologies has an orientation that grants the firm certain unique advantages and capabilities. The managerial interviews also help us discuss the outcomes for firms and customers as a result of the adoption of new-age technologies. Based on managerial interviews, existing literature, and popular press discussions, we recognize the dynamic nature of new-age technologies and the limitations of the current knowledge pool. This leads us to identify directions for future research with the aim of expanding our knowledge of new-age technologies.

2. Related literature

In the extant marketing literature, studies have examined the adoption of different technologies by firms by considering various antecedents and marketing outcomes. This includes examining the

Table 1
Marketing literature examining new-age technologies.

Study	Study objective	Type of new-age technology studied	Key findings
(Daskou & Mangina, 2003)	To present a theoretical framework for the development of an intelligent software system aimed at integrating loyalty programs databases, consumer surveys and qualitative studies.	Artificial Intelligence	The proposed software system supports the use of more than one computational intelligence technique through agents' technology, enabling the producing firm to establish information-based relationships with both the end-customer and the retailers that distribute the goods.
(Kumar et al., 2016)	To propose a definition of intelligent agent technologies (IAT) and discuss their marketing applications.	Artificial Intelligence, Machine Learning	IAT have the autonomy to sense and proactively or reactively interact with other agent, humans, or social systems of agents in dynamic environments. IATs are characterized by the abilities to search, acquire, and analyze information, interact and communicate, negotiate, and collaborate.
(Mani & Chouk, 2017)	To develop a better understanding of the reasons for consumer resistance to smart and connected products.	Internet of Things	Perceived uselessness, perceived price, intrusiveness (including privacy concerns), perceived novelty and self-efficacy impact consumer resistance to smart products.
(De Cremer, Nguyen, & Simkin, 2017)	To consider the influence of the Internet of Things on marketing and identifying the dark side of the Internet of Things	Internet of Things	Different types of behaviors representing the dark side of IoT are identified and categorized as: transaction, knowledge and intelligence, relationship, and integrity. These dark-side behaviors include financial penalties, confusing customers, information misuse, privacy issues, switching barriers, favoritism/discrimination, unfairness, and dishonesty. These dark-side behaviors are linked to strategic IoT processes and can be addressed by adopting a holistic and more strategic approach.
(J. Wu, Chen, & Dou, 2017)	To examine the effect of interaction style on brand perceptions of consumers.	Internet of Things	A friend-style interaction has a positive effect on users' brand attachment, mediated by brand warmth and brand competence
(Ehret & Wirtz, 2017)	To examine the opportunities and threats of Industrial Internet of Things.	Internet of Things	Industrial Internet of Things impacts transaction costs and has implications for the design of business models.
(Verhoef et al., 2017)	To discuss how people, objects and the physical world interconnect with each other resulting in an increasing amount of connected data, and to understand the existing knowledge on these connections.	Internet of Things	Although research on consumer IoT is in its nascent stages, there is scope for future research in the four important areas: people, physical, products and data.
(Woodside & Sood, 2017)	To offer snapshots of the introductions of IoT, and their impact on the service-dominant logic paradigm in marketing.	Internet of Things	The proposed framework moves IoT from the periphery of business activities to the core of marketing strategy by reshaping the focus of marketing skills and practice.
(Ghose, 2018)	To examine the role of blockchain technology in addressing concerns related to the "veracity" characteristic of Big Data.	Blockchain	On account of the basic principles underlying blockchain technology, it has the potential to change the data-driven marketing business landscape, preventing ad fraud, enabling engagement tracking, offering transparency to customers.

Table 2
Salient Aspects of New-Age Technologies.

Sr. No.	Parameter	Internet of things	Artificial intelligence	Machine learning	Blockchain
1	**Definition**	A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies. (Initiative, 2012)	The science of training machines to perform human tasks, by processing large amounts of data and recognizing patterns in the data through the use of an assortment of technologies such as machine learning, natural language processing, and so on. AI makes it possible for machines to learn from experience, adjust to new inputs and perform human-like tasks. (S. Insights, 2018)	A method of data analysis that automates analytical model building. It is a branch of artificial intelligence based on the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention. (Insights)	A distributed ledger and immutable database for transferring data very securely. The name is a combination of two words - the "block" that contains batched transactions and a "chain" that represents cryptographically linked blocks (Maslova, 2018a).
2	**Key Elements**	• Based on sensors that capture device-level data • Record events in the physical world, communicate them to connected computing systems to trigger responses • Computing systems analyze data in real-time at the device-level and across devices • Enable better communication between devices, and between humans and devices	• Capable of imitating human behavior in an intelligent way • Interacts with other machines to control and communicate with them, can also communicate with humans • Enables automation of routine business processes • Applies various methods such as machine learning, deep learning, natural language programming, etc. to train machines to conduct tasks in human-like ways	• A specific subset of AI that trains a machine to learn developing automated, self-training algorithms • Can perform highly frequent, large-scale, computerized analysis on huge datasets accurately and reliably, with increasing accuracy • Automates the process of learning to help machines integrate data, identify patterns in data, apply the model to new data to make predictions	• Decentralized electronic records secured by cryptography, implying greater security • Immutability of records and consensus-based system ensure integrity of records through the blockchain • Enables disintermediation rendering the middle-men unnecessary through automated execution of contracts
3	**Operative Domains**	Functional/Utilitarian efficiency	Automation and Learning	Learning and Integration	Process Economies
4	**Key Benefits to Consumer**	• Greater convenience and ease of access • Reduced need for human intervention • Real-time, proactive alerts • Easy to monitor, control and manage interconnected devices	• Personalized communication, products, and services, with increasing personal relevance • Enhanced machine-to-machine and machine-to-human interactions • Better customer experiences with products and services	• Personalized communication, products, and services • Better experiences with products and services	• Greater trust in brands due to higher traceability of products • Transparency in the supply chain logistics, contracts, etc. • Greater data security, allowing consumers to have more control over their personal information
5	**Key Benefits to Firm**	• Greater data on consumer behaviors, usage patterns, and preferences • Signal alerts in rapid response to unusual behavioral patterns • Improved customer experience through personalized customer service, promotional offers and products and services • Increased productivity, improved efficiency, and reduced operating costs through device monitoring, usage control, interconnectivity of devices, and demand assessment	• Gaining insights from patterns in consumer behaviors, usage, and preferences to predict future behaviors • Perform highly frequent, large-scale, computerized tasks accurately and reliably, without human fatigue • Improved customer experience through personalized recommendations and communications to customers, and automation of interactions • Improved efficiency on account of automation, human employees can focus on more complex tasks	• Identification of patterns in consumer behaviors, usage, and preferences • Ability to build models to predict future behaviors, usage, and preferences of customers • Can perform large-scale analyses iteratively and accurately, without fatigue, and being adaptable and adjust to new data • Improved customer experience by providing personalized recommendations and communications to customers • By handling routine analyses, allows human employees to manage more complex analysis and customer interaction	• Transparency in business operations • Reduced processing time for transactions • Ability to better track the impact of marketing communications on consumers • Automatic execution of contracts, direct compensation of customers • Can help safeguard individual consumers' identities
6	**Orientation**	Data	Analytics	Analytics	Security

(*continued on next page*)

Table 2 (*continued*)

Sr. No.	Parameter	Internet of things	Artificial intelligence	Machine learning	Blockchain
7	**Examples of Real-world Application**	● Ray: A smartphone platform that can connect with several devices, eliminating the need for individual remotes for each device. It includes a recommendation engine for viewing suggestions. ● Awair Glow: An air monitoring device with a smart plug that can track chemicals and toxins in the air, and provide recommendations to improve the air quality on its mobile app. It can connect to Google Home or Amazon Echo to control other connected devices. (Ruth, 2017)	● Apple's Siri, Amazon's Alexa, Microsoft's Cortana: Digital assistants that help users in various tasks such as checking the weather, looking for something on the web, controlling other apps, confirming schedules, etc. by recognizing speech patterns and giving results to match user preferences. ● Roomba: An AI-powered vacuum cleaner that can scan a room's size, look for obstructions, and remember the best route to clean the room. It can also identify how much cleaning is needed based on the size of the room. (Abramovich, 2018)	● Online video streaming websites such as Netflix: Provide recommendations according to algorithms that analyze the online activity of the user and compare it to the behaviors of other users. ● Google's search engine: The user's response to the results of every search query that is executed, is analyzed. If the user stays on the first page of results the algorithm sees it as a successful search; if the user goes to the next page, the algorithm sees it as the user not having got the results s/he was looking for in the first page.	● Aeternity: A platform that creates and allows activation of smart contracts, including micro and nano payments at high speeds of transactions. ● De Beers: Plans to use blockchain technology to allow consumers and industry stakeholders to trace diamonds from their origins in mines to customer purchases. This will help consumers verify and confirm the conflict-free status of consumers. (Marr, 2018b)

drivers of firms' adoption of technology such as e-business (e.g. (Wu, Mahajan, & Balasubramanian, 2003)), exploring the reasons for differences in technology adoption across firms (Srinivasan, Lilien, & Rangaswamy, 2002), and gauging the marketing impact of firms' use of technology (e.g. (Gill, Sridhar, & Grewal, 2017; Hao & Song, 2016)). Studies have also examined the increase in data as a result of the increased adoption of technology (Verhoef et al., 2017), the impact of this big data deluge on decision-making (Bharadwaj, 2018), and the changing requirements of this data with regard to analytics (Delen & Zolbanin, 2018). Research has been conducted on ways to help firms maximize insights from big data (e.g. (Erevelles, Fukawa, & Swayne, 2016)) and the impact on firm performance (e.g. (Erevelles et al., 2016; Wamba et al., 2017)). However, there has been limited focus on new-age technologies such as IoT, AI, ML, and blockchain with regard to their respective marketing impacts (Kumar, Dixit, Javalgi, & Dass, 2016). Table 1 describes the studies in marketing academic journals that have focused on these new-age technologies and their implications for marketing.

It is evident that there have been few studies in the context of new-age technologies. To the best of our knowledge, there are no studies examining these four new-age technologies and their impacts on firms and customers, though there have been calls for more in-depth exploration in this area (Kumar, 2018; Verhoef et al., 2017). In the future, technology is expected to influence greater integration of marketing strategies and operations (Varadarajan & Yadav, 2009). The ubiquity of these new-age technologies makes it important to understand them in greater detail, currently and from a future perspective.

3. New-age technologies

We provide a brief overview of the four new-age technologies in Table 2, highlighting their key features and operative domains. As we see in Table 2, each of the four new-age technologies – IoT, AI, ML, and blockchain – have elements that set them apart from each other and lead them to operate in certain domains (Row 3).

3.1. Internet of things

What is this? IoT operates in the domain of functionality, offering ease of use and convenience to users through the application of sensors. The foundation of IoT lies in the network of sensors that capture information about each device and are individually identifiable. IoT devices have the ability to sense, compute, and communicate wirelessly over short distances, and can interconnect to form a wireless sensor network (WSN) (Gubbi, Buyya, Marusic, & Palaniswami, 2013). IoT devices can detect and record events in the physical world and share them with data centers and computing systems that analyze and interpret this data from the sensors across the network– all in real-time. Based on this analysis, alerts such as easy-to-understand visuals and relevant insights are automatically sent to the device user, while the sensing and analyses occur at the backend of the IoT networks, hidden from the user. The communication between the user and IoT devices, and between IoT devices themselves, is highly simplified and effective. Thus, IoT devices can unobtrusively embed themselves into the lives of users, automate routine activities, and increase functionality by reducing the need for human intervention.

How is this applied? For instance, the *Hamburg Port Authority* installed more than 300 roadway sensors to monitor traffic in the port area and to track wear and tear on bridges. Sensors are also used on waterways with radar and automatic identification systems that enable coordination of ship traffic and offer an integrated solution to manage roadway traffic disruptions that may occur when ship traffic requires bridge closures around the port area (Macaulay, Buckalew, & Gina, 2015). In the consumer domain, there are countless examples of IoT devices making consumers' lives simpler and more efficient. For instance, *Evo* is a popular health and wellness app that connects to

customers' smartphones and wearable devices and captures data on customers' activities such as steps, exercise, sleep, and stress levels. The application analyzes this data to deliver customized wellness programs designed to achieve goals set by the customers themselves. The application offers progress recaps, rewards, motivational nudges, and encourages customers to set new goals when the initial goals are achieved (EVO, 2018).

3.2. Artificial intelligence

What is this? AI operates in the domain of continuous learning and automation, acting as the intelligence that drives data-based analytics and enables automated decision-making. AI can be broadly understood as a technology that is capable of imitating humans and carrying out tasks in a way that is considered "intelligent" (Marr, 2016; Thompson, Li, & Bolen). The intelligence of AI is derived from its ability to self-learn and constantly improve itself by updating and adding to its knowledge base and capabilities. So, with every iteration of a task that is executed through AI, the AI agent improves with regard to its efficiency, effectiveness, and ability to identify insights for further advancement. This capability can automate non-routine tasks and activities by enabling machines to think and act like humans. AI analyzes complex data to identify behavioral patterns and insights and has the capability to learn from experience. This makes AI capable of making intelligent decisions, akin to humans, and automatically triggering responses based on prior experiences. By using various technologies such as natural language processing, AI can recognize and respond to voice commands, thus enabling machines to perform human-like tasks. AI is the power behind bots, intelligent agents, and smart assistants, and can interact with other devices and machines to control them.

How is this applied? For instance, *Palo Alto Networks* is integrating AI into its cyber threat detection and prevention software to prevent data breaches, while *Affectiva* released an AI platform that could measure emotion by sensing and analyzing facial expressions, and is looking to extend its emotion-sensing technology beyond the face to leverage human speech (Dickson, 2018). *Babylon Health* is using a mix of AI and video/text consultations to offer a digital healthcare application – with an AI-powered chatbot and AI-enabled symptom checker feature – and has future plans to move towards completely AI-powered diagnosis (O'Hear, 2016). *HSBC* leverages AI to predict the redemption of loyalty program rewards that are associated with their credit cards. AI is also applied to building models and rules within fraud management, which helps the firm to identify anomalous behavior and protect both the firm and its customers. HSBC's chatbot is also expected to supplement the expertise of bankers by providing rapid and accurate responses to a wide range of queries, thus reducing friction and wait time, and enhancing customer experience (Olenski, 2018).

3.3. Machine learning

What is this? ML is a specific subset of AI that trains a machine on how to learn by using datasets to develop automated, self-training models and integrating multiple methods such that the machine is able to identify patterns and hidden insights without explicit instructions (Thompson et al.). It is the study of computational methods to automate the acquisition of knowledge from existing examples of data (Langley & Simon, 1995), typically training a model to recognize patterns in data, apply the model to new data, and make predictions about the patterns in the new data (Bose & Mahapatra, 2001). This places ML within the learning domain. ML is based on neural networks, which rely on identifying and refining factors of importance to determine the probable outcomes of a situation and which require hard manual programming upfront. The factors of importance need to be adjusted repeatedly to arrive at the desired outcome based on the data that was input into the algorithm. When the algorithm perfects this approach, it is capable of adjusting the factors of importance to increase the accuracy of outcomes, without the need for hard coding by humans. Once it has been trained using a training dataset, the algorithm can sift through new data inputs, identify patterns similar to the patterns learned during its training, and produce increasingly accurate results. Thus, through ML, firms can develop algorithms that enable them to predict future behaviors and trends based on prior data and patterns in behaviors. ML can handle large datasets, continuously integrate multiple data sources, and perform complex analyses frequently and with decreasing error, all in service of training algorithms and delivering accurate and improved prediction results. This places ML squarely in the domain of learning and training, without the application of real intelligence (St. Louis, 2018). ML can be viewed as an approach to make machines more intelligent by developing, understanding, and evaluating learning algorithms (Langley, 1996; Thompson et al.) implying that ML is one way to advance the field of AI (Marr, 2016).

How is this applied? For instance, *Uber* uses ML to estimate arrival times for rides, identify optimal pickup locations, estimate mealtimes on UberEATS, and detect fraud. *FICO* uses ML to develop its credit rating (FICO scores) as well as to assess risks for individual customers. *Amazon* uses ML algorithms that can automatically learn to combine multiple relevance features and past search histories, and to generate individually customized search results for customers. Similar algorithms are also used to recommend products to customers such as "customers who viewed this item also viewed," "customers who bought this item also bought," as well as personalized homepage recommendations, bottom-of-item recommendations, and email recommendations (Narula, 2018).

3.4. Blockchain

What is this? Blockchain offers process economies by expediting and securing the processes and data records underlying interactions and transactions. Blockchain is a foundational technology that consists of an electronic, distributed ledger and creates an immutable database for securely transferring data (Casey & Paul, 2018). The name is a combination of two words – the "block" that contains batched transactions and a "chain" that represents cryptographically linked blocks (Maslova, 2018b). The decentralization of records ensures that no single point of weakness exists, which lowers the likelihood of hacking and data breaches. While new "blocks" of information can be appended to an existing blockchain ledger, previous data cannot be overwritten or erased, thus creating a permanent, verifiable, and traceable trail of transactions all the way back to the first record (Giordani, 2018; Iinuma, 2018). The blockchain ledger is not controlled by a single entity or central authority; it is stored as multiple copies on multiple independent computers within a network. This decentralization of the ledger implies that no single entity can make changes to the ledger without following a consensus protocol, in which a majority of the users on the network have to agree with the change after authenticating themselves via mathematical algorithms (Casey & Paul, 2018; Economist, 2015). The definitive version of the ledger is the version that is accepted by a majority of users, making it difficult for the data in the ledger to be compromised. The blockchain can also be set up to automatically execute contracts or transactions in an "if-then" manner, thus obviating the need of middlemen and intermediaries. The blockchain's security and automatic execution of transactions helps hasten processes that would otherwise be dependent on the approval of intermediaries or transacting parties. By specifying the conditions under which a transaction may be executed, a blockchain allows two or more parties to complete their transactions efficiently and more quickly, with greater security of data and assets. Thus, blockchain can help improve process efficiencies by cutting down the time and procedural formalities required for a transaction, while enabling the secure transfer of data and value.

How is this applied? For instance, *Ubiquity* is a startup that is creating a blockchain-based system to simplify the complications in the

legal process of real estate transfer. *Transactivgrid* allows members to locally produce and sell energy while reducing the costs involved in energy distribution (Marr, 2018c). *Essentia* has also been working with the Dutch government to develop a new system to securely store passenger data and vet passengers traveling between Amsterdam and London. The goal is to reduce the number of border control checks by enabling the metrics recorded in the Netherlands to be audited by U.K. agencies (Zago, 2018).

As a result of the domains in which these four new-age technologies operate, they develop certain orientations that define them at the most foundational level.

4. Orientation of new-age technologies

Over the course of several months, we interacted with forty managers worldwide in one-to-one interviews, to discuss the focal new-age technologies, their current and potential applications in firms, and aspects of these new-age technologies that managers seek greater clarity on. Managers who participated in the study were from firms across the world: U.S. (20), Europe (10), Latin America (5), and Asia (5). About 54% of these managers were from B2C firms, and 46% were from B2B firms. These managers were holding the highest positions in marketing in their respective firms, with titles such as Chief Marketing Officer, Vice President of Marketing, or Director of Marketing. On an average, they had over 25 years of work experience. These managers were key decision-makers within their respective firms with regard to technology adoption within marketing, technology investments, resource allocation, and implementation of new technologies and processes within the marketing functions in their respective firms. Each interview lasted about forty minutes, on an average.

The interviews focused on four main areas of interest. Firstly, we asked managers to describe key elements of the four focal new-age technologies based on their exposure to these technologies. We also asked them to share their opinions on the attributes and capabilities of these new-age technologies that they perceived as being most important to their firms. Secondly, we asked managers if they had adopted any of the four focal new-age technologies within their firms. Managers who had adopted new-age technologies discussed their applications in their firms, and especially within marketing. They also mentioned the outcomes that they had observed as a result of the adoption of new-age technologies, both for their firms and their customers. Managers who had not adopted the new-age technologies were probed further to understand the underlying reasons. Thirdly, we asked managers to elaborate on the future that they envisioned with regard to new-age technologies – whether they anticipated the adoption of new-age technologies within firms to accelerate or not, potential applications of new-age technologies within marketing, as well as the challenges that they expected to face in the adoption and implementation of new-age technologies. Finally, we asked managers about any unanswered questions or concerns that they had regarding these new-age technologies, and their implications for various entities such as firms and their customers, among others.

Based on the responses from these managerial interviews we realized that each firm, irrespective of its industry or geographical location, aimed to adopt new-age technologies. However, managers were apprehensive about the hurdles that they would need to overcome in order to adopt these new-age technologies. There were several areas that managers expressed concern about, with regard to how new-age technologies would impact existing roles, processes, and practices.

The managers' responses emphasized that they expected new-age technologies to play a major role in their firms' marketing strategies in the future, with important outcomes for firms and customers. Further, the managers' concerns and questions about the implications of new-age technologies were critical in helping us identify areas for future research. Based on inputs and insights from these managers, we understood that each of the four focal new-age technologies were associated with certain application areas. This was reflected in the key attributes and capabilities of new-age technologies that managers identified, as well as the use cases that they described. We propose that each of these technologies is oriented towards a certain area of application amongst data, analytics, and security (Table 2, Row 6).

4.1. Data-oriented technology

Technology with a data orientation provides firms with access to greater and more granular data on their end customers or users. In this regard, we identify IoT to be more aligned with a data orientation and related capabilities as compared to the other three new-age technologies. IoT, at its most basic level, connects the physical world and the digital world to computing systems, by using sensors and actuators on devices and physical objects, thus enabling better communication between devices as well as between devices and humans (Lee & Lee, 2015; Manyika, Chui, Nisson, Woetzel, Dobbs, Bughin, & Aharon, 2015; McPhail, 2018; Pal, 2015). These "smart" devices monitor events in the physical world and communicate data in real-time to connected computing systems that trigger actions to manage these devices (for instance, (Bélissent, 2010; Manyika et al., 2015)). IoT makes large-scale data capture possible – billions of devices and objects are connected on a network, each one being uniquely identifiable and constantly providing data that can be further utilized to influence the devices and objects in the physical world (Coetzee & Eksteen, 2011).

It becomes clear that while sensing and monitoring are essential components of IoT, it is the data captured by these sensors involving billions of events that represents the true value of IoT (Marr, 2016; Verhoef et al., 2017), allowing firms to develop strategies and respond in ways that deliver maximum value to the end customer. In fact, practitioners and academics have noted that one of the key challenges that firms currently face is the management and interpretation of the deluge of data that results from such a large number of connected devices (for instance, (Coetzee & Eksteen, 2011; Erevelles et al., 2016; Lee & Lee, 2015; Pettey, 2018)).

In this context, IoT can be viewed as a data-oriented technology that is foundationally based on the sensing, recording, and exchange of real-time data about the state of devices and objects in the physical world. This data orientation enables IoT devices to connect with each other and with humans to provide functional efficiency and convenience to end customers. A firm that adopts IoT can enhance its access to data about its devices and customers, creating an opportunity for the development of distinct marketing capabilities.

4.2. Analytics-oriented technology

Technology that is oriented toward analytics has the ability to integrate and analyze data from multiple and varied sources, delivering customer insights to firms, and enabling them to develop better responses. In this regard, we identify AI and ML to be more aligned with an analytics orientation and related capabilities as compared to the other two new-age technologies.

The underlying needs for ML and, hence, AI are data and the analysis of data for the training and development of learning algorithms (Institute, 2017). The amount and complexity of data being generated by sources such as online click streams, voice and video, locations, and sensors have increased over time. During the same period, ML learning models and AI capabilities have been on an upward trend, delivering granular insights that would have been nearly impossible for humans to accomplish, and bringing us closer to the goal of intelligent machines (Reavie, 2018; Thompson et al.). For instance, advancements in speech and voice recognition have spurred the growth of digital personal assistants such as Apple's Siri and Amazon's Alexa. Facial recognition has powered Facebook's auto-tagging feature and iPhone X's facial recognition-based unlocking, and recommendation engines drive Netflix, Spotify, and Pandora.

ML and AI are deeply rooted in the continued learning based on data analysis, thus making them analytics-oriented technologies. A firm that adopts ML and AI can enhance the analysis and interpretation of available data, to better understand its devices and customers.

4.3. Security-oriented technology

Technology that is security-oriented can facilitate secure exchanges and detailed recordkeeping of transactions, data, agreements, assets, etc. In this regard, we identify blockchain to be more aligned with a security orientation and related capabilities as compared to the other three new-age technologies. The key features of blockchain can be described as immutability, decentralization of records, consensus-driven approvals, and cryptography-based security (Iinuma, 2018; IT Glossary). Inherently, the records on the blockchain cannot be edited or erased, and only new records can be added to the blockchain. Thus, records on the blockchain can be traced in a transparent and valid manner, all the way to the first record. The blockchain cannot be controlled by any one entity; it is dependent on consensus from a majority of the other entities on the blockchain, thus ensuring that records are not arbitrarily changed.

Since the identities of users as well as the data entries on the ledger itself are secured by cryptography, the blockchain ledger is a truly secure, yet completely transparent record base (Casey & Paul, 2018; Giordani, 2018). Once a transaction has been authenticated and entered into the blockchain ledger, it cannot be arbitrarily tampered with or modified, elevating the security of the data contained therein. The verifiability and transparency of transactions and exchanges facilitate the secure transfer of value, assets, or data between entities without the presence of a middleman (Economist, 2015).

The enhanced level of security that is made possible by the application of blockchain technology makes it a security-oriented technology that holds the potential to secure data and processes (e.g., (Biswas & Muthukkumarasamy, 2016; Tapscott, 2018; Zyskind, Nathan, & Pentland, 2015)), and can expedite exchange between entities in a trustworthy manner.

5. How do new-age technologies impact firms and customers?

The impact of these four technologies can be viewed from two key perspectives: that of the firm that is adopting these technologies, and that of the customers who benefit from the adoption of these technologies. The managerial interviews and popular press discussions helped us identify the following key benefits of new-age technology adoption for firms and customers.

5.1. Firm outcomes

The key benefits to a firm as a result of the integrated adoption of new-age technologies can be described as follows.

5.1.1. Personalization of marketing mix elements

Customer demand for personalized content has increased tremendously. As a result of access to more detailed and real-time information about customers and devices, and more sophisticated data mining capabilities, firms can gain granular insights that help them to manage the needs of their existing customers and improve their experiences. By understanding the individual preferences of customers with regard to marketing mix variables in conjunction with a big picture perspective of all customers together, firms can develop and deliver personalized offerings and communication materials. In this regard, new age technologies (for instance, AI) enable a firm to deliver right content to the right customer at the right time. Furthermore, firms can work towards reducing churn by developing nuanced customer churn models that can better predict future behaviors of customers.

For instance, *American Express* relies on ML algorithms and data analytics to help fraud detection in near real-time. As a result, the firm is not only able to save millions in losses, but also provide special offers, products, and services to cardholders, and information on industry trends and benchmarks to merchants. Fashion retailer *Burberry* uses AI and big data to identify counterfeit products, improve sales, and build and enhance personal relationships with customers. In order to do so, Burberry uses data gathered from its reward and loyalty programs to develop personalized digital and in-store shopping experiences for individual customers.

5.1.2. Better prediction of future trends

By leveraging the power of insights from advanced data mining techniques, firms can identify upcoming trends and craft responses in anticipation (for instance, develop new products, change delivery mechanisms, etc.). The interconnectivity between business functions and the automation of analytical and business processes can help firms respond to these trends more efficiently and effectively. By anticipating customer needs, firms can surprise and delight customers with offerings that are aligned with their requirements.

For instance, online streaming platform *Netflix* uses advanced data analytics to predict future content preferences of audiences. In addition to acquiring content, these insights are applied to the creation of content, and the associated investment decisions. Rather than creating just pilot episodes for shows, Netflix's strong data analytics capabilities enable it to be confident in investing in the creation of multiple episodes and seasons of new shows (Marr, 2018a).

5.1.3. Disintermediation and direct engagement

In addition to developing personalized marketing strategies to engage with their customers, new-age technologies also hold the key for firms to directly engage with their stakeholders (for instance, suppliers, customers, etc.). In the future, firms could modify their engagement strategies to communicate directly in real-time with individual customers about their products and services, brand stories, promotional content, pricing offers, etc., without intermediaries such as media buying or planning firms. Firms can validate that they are actually capturing the audience that they are paying for, as well as measure and enhance the effectiveness of their marketing efforts. Firms can use blockchain to create individual and automated smart contracts that can directly and promptly reward customer engagement using micro-currencies. (Harvey, Moorman, & Toledo, 2018). They can also connect with customers around their values and brand journeys in a way that is traceable and verifiable, thus increasing customers' trust in them.

For instance, at Disneyland, *Disney* analyzes the data captured by its RFID-enabled MagicBand wristbands to anticipate individual customer needs, enhance their journeys, and deliver memorable, personalized experiences. The MagicBand wristband plays an important role, uniquely identifying individual visitors and functioning as a hotel room key, tickets, FastPasses, payment systems, and so on. While the overall experience is more convenient for the customer, Disney collects granular customer data that helps them predict visitors' needs, anticipate their next steps in their journey at Disneyland, and deliver personalized experiences. This data also helps Disney to resolve bottlenecks, provide special services to visitors who may have been inconvenienced, and schedule staff (Marr, 2018a).

5.1.4. Productivity enhancement

As a result of more granular insights, increased automation, and greater interconnectivity of business functions, firms can improve their product development and enhancement processes and achieve process optimization (Davenport & Ronanki, 2018). Since firms can monitor their equipment, their usage, and proactively conduct maintenance, they can expect increased productivity, improved efficiency, and reduced operating costs. Applications such as smart warehousing and smart transportation enable intuitive demand fulfillment, warehouse automation, and route optimization for maximum efficiency (Mitchell).

The rise of robotics, intelligent agents, and chatbots has promoted the growth of automated customer service alternatives to handle routine queries and alert human representatives to address more complex issues. By learning with each interaction, these automated agents can deliver efficient customer service, lower costs, and provide excellent and consistent service quality (Li & Kumar, 2018).

For instance, *Harley-Davidson* was able to track and record its production steps into a real-time performance management system by transforming its York, Pennsylvania manufacturing plant into an IoT-enabled plant. The sensors could measure, record, and manage the performance of equipment and processes across the production process. The firm observed its production schedule decrease from 21 days to 6 days, and saw its operating costs decline by $200 million (Staff, 2018). *BP* uses sensors to communicate data about the conditions at each site to decision-makers and analyze the data to improve operations. The firm built its own Plant Operations Advisor (POA) – a cloud-based software – based on GE's Predix and Asset Performance Management capabilities. POA can rapidly integrate operational data from oil and gas facilities and analyze more than 155 million data points per day in real-time, to identify the root cause of a plant shutdown in 15 min – a process that takes several hours, manually. POA also helps engineers preemptively identify operational issues in performance, allowing BP to respond quickly and reduce unplanned downtime. This enables the efficient utilization of resources and improves the safety and reliability of oil and gas production and refining (States, 2016, 2018).

5.2. Customer outcomes

When a firm adopts the four new-age technologies considered in this paper, they enable the firm to create value for customers in multiple ways as discussed below.

5.2.1. Enhanced functional ease

The most evident benefit to customers as a result of the improved capabilities of firms is the increased convenience and ease in performing routine tasks. The automation of activities and reduced need for human intervention makes customers' lives simpler and hassle free. The connectivity of IoT devices provides customers with the convenience and flexibility of being able to remotely monitor, control, and manage all of their connected devices at the click of a button. The intelligent and automated nature of bots and intelligent assistants can improve customers' shopping experiences by automatically monitoring and comparing prices, recommending repurchases, making rational purchase decisions, and even making actual purchases on behalf of humans via secure bot-to-bot transactions.

For instance, *August Smart Lock* allows doors to unlock automatically when the owner gets home, without the need for keys, and locks automatically when the doors are shut. Homeowners can grant access to guests via a one-time code or grant remote access to guests. The smart lock also maintains a detailed activity log (Albright, 2017). *Capital One* allows customers to access their account details through Alexa, while *Liberty Insurance* allows customers to check the status of their claims via Google Home. Both these applications enable customers to communicate via simple voice commands instead of spending time on long phone conversations (Morgan, 2018).

5.2.2. Greater personal relevance

As a direct outcome of the nuanced insights that are made possible by advanced analytical capabilities, customers receive offerings, communications, and information that are personally relevant to them. Customers enjoy a better customer experience as they receive proactive communications about their devices or activities in real-time, giving them the opportunity to take specific actions to enjoy specific benefits. With the increased automation and interconnectivity of business functions, customers can exercise greater flexibility in how and where they choose to interact with a firm depending on their personal preferences.

For instance, *Marriott* utilized new-age technologies and leveraged the guest profiles of its Marriott Rewards members to create two prototypes of connected rooms in partnership with Samsung and Legrand. Marriott has access to the profile of a Marriott Rewards guest, the attributes and likes/dislikes of the guest, and additional information that is used to program the room. Each room is programmed with different scenarios for three different guest profiles – a yoga-minded meeting planner; a frequent road warrior; and a family of four on vacation. The scenes and settings in the rooms can be activated and modified based on the guest profile. Guests can control the connected room using voice, TV remote, and manual controls. The vision is to have a smart hotel room that can adapt itself to match specific guests' preferences and habits, and in time, make personalized predictions about the room settings (Ting, 2017).

5.2.3. Greater traceability of products

Customers can trace the journey of the products and components to verify their authenticity and evaluate the alignment of a firm's values with their own by taking advantage of the transparency offered by blockchain. They can follow the journey of firms' offerings through the supply chain, can verify smart contracts and ownership transfers, and so on, giving them greater insight into the firms' offerings. Customers today are highly conscious of the origins of the products and services that they consume, and this helps them connect more closely with, and form positive sentiments towards the firm and its offerings. In the long run, this encourages customers to place greater trust in these brands and to patronize their offerings. Customers are also more inclined to share their personal information and opinions with firms and brands that they trust, therefore engaging with them more deeply (Harvey et al., 2018).

For instance, *Alibaba* developed an internal blockchain system to trace product authenticity through the supply chain. *BlockVerify* proposes to effectively detect and combat fraud in the drug industry using IoT and blockchain (Laurent et al., 2017). *Everledger* enables customers to verify the provenance of luxury goods, by certifying and publicly storing records of verified ownership (H., 2018). In Europe, *Carrefour* uses blockchain technology to ensure the traceability of its free-range chickens from Auvergne – customers can access information on where and how each animal was reared, the name of the farmer, the type of feed used, treatments given, quality labels, the location of slaughter, etc. (Carrefour, 2018). *Volkswagen Financial Services* and *Renault* tested vehicle telematics tracking, whereby information about a vehicle's mileage, engine usage history, repair and maintenance history, etc. can be accurately captured on the blockchain and made available to manufacturers, dealers, buyers, insurance companies, and other entities involved in the car purchase process (Lannquist, 2018).

5.2.4. Effective firm-customer engagement

In the long run, customers are more engaged with the firm when they receive offerings and communications that are personalized to their needs and preferences. They are more inclined to directly contribute by purchasing the firm's products or consuming its services, as well as by referring the firm's offerings to other customers, creating word-of-mouth on social media, and providing feedback (Kumar & Pansari, 2016). In today's digital age, customers are vocal and near instantaneous in sharing their thoughts and opinions about brands and experiences. They expect seamless experiences that are intuitive, convenient, frictionless, and delightful – all of which are made possible with new-age technologies.

For instance, the *Amazon Go* store in Seattle was designed to combine machine vision, IoT sensors, and a mobile app to enable customers to swipe their app at the store entrance and walk out with the items they need ("just walk out technology"). The systems in the store are capable of tallying items as the customer places them in the shopping bag or places them back on the shelves, and automatically charges the

customer's linked Amazon account. This allows the customer the convenience of shopping and leaving the store without needing to wait in long check-out lines. Amazon also gains insights to develop and deliver personalized coupons to customers for future shopping visits, guide shoppers to their preferred items via mobile devices, alert customers when items are out of stock or on sale, and potentially even analyze shopping lists to simplify shopping visits (Insights, 2018).

Thus, firms and customers stand to benefit from the adoption of new-age technologies in sustained ways. This has a positive impact on firm performance by way of cost efficiencies, increased revenues, and positive word-of-mouth.

6. Future research questions

While we gained some understanding of these four new-age technologies from the managerial interviews, the dynamic and ever-evolving nature of these technologies imply that there is a lot more to be known. In this section, we consider the key questions that face the firms, the customers, the intermediaries, technology developers, and regulators, with regard to the focal new-age technologies spanning data orientation, analytics orientation, and security orientation.

6.1. Firm-facing unknowns

The four new-age technologies discussed in this study have far-reaching impacts on firms and their business processes. They can be adopted independently of each other, but their value can be greatly enhanced by their integrated adoption. Together, they enable interconnectivity of business functions within firms, thus helping them operate at a quicker pace and experience increased productivity and process efficiencies. The granular and real-time measurement and analysis of the activities of devices and customers help firms to anticipate future trends and make decisions to take advantage of these trends. Firms and customers now share control, with customers having increased control over firms' offerings and business operations.

Furthermore, new-age technologies and changing customer preferences have led to the development of new business models and the rise of new players. The emergence of platforms as a preferred business model and the development of ecosystems fostering direct firm-customer engagement have made way for new intermediaries that function as matchmakers between customers and providers. The role of new-age technologies in driving and facilitating these new business models warrants deeper examination, as they can streamline processes, automate smart and real-time decision-making, and enhance firms' abilities to anticipate and meet customer expectations. Given these factors, we identify the following research topics:

- The nature of a firm's business may not require, or even be appropriate for the adoption of all four new-age technologies. This may lead firms to consider adopting one or two of these new-age technologies, which may lead them to observe different outcomes as compared to those observed by a firm adopting all four new-age technologies. Therefore,

RQ1: What are the benefits accruing to a firm with the adoption of one of these new-age technologies, as compared to the adoption of two or more of these new-age technologies?

- A firm may not have sufficient financial or human resources to adopt any or all of the four new-age technologies, or it may lack the technological expertise to effectively implement them. Similarly, there could be other internal and external factors that could influence the firm in its adoption of new-age technologies. Therefore,

RQ2: What are the critical factors that a firm needs to consider, in deciding if it should adopt any or all of these four new-age technologies, given its internal and external environment?

- A firm that decides to adopt new-age technologies will need to have a person or team driving the effective integration of new-age technologies with the existing technological infrastructure and ensuring acceptance across the firm. The selection of this person and the formation of this team are critical to the smooth implementation of these new-age technologies. Therefore,

RQ3: What additional skills and resources should the firm develop or acquire, to ensure the effective integration of these new-age technologies into the firm's processes and practices? Which entities within the firm should manage this integration of new-age technologies into the firm's processes and practices?

- Depending on the nature of the firm and the industry it operates in, the impact observed by a firm that chooses to adopt certain new-age technologies in specific ways may be different from that observed by another firm in a different industry that adopts the same new-age technologies. Similarly, the impact of new-age technologies may be different for more established firms as compared to newer, younger firms. Therefore,

RQ4: What are the differences in the impact that may be observed by firms that choose to adopt new-age technologies, depending on the nature of their businesses, the industries in which they operate, and their age and lifecycle stages?

- It is critical for firms to maintain strong direct relationships with their customers; ideally firms should engage with customers, while making the most of the platform as a facilitator. Firms that fail to do so may find customers engaging more with the intermediary platforms than with the firms. Therefore,

RQ5: How can firms leverage these new-age technologies to profitably adapt to new business models favoring platforms and ecosystems for direct firm-customer interactions?

- The adoption of new-age technologies involves financial and human resource investments, while providing benefits across processes and departments. The efficiency and effectiveness of new-age technology adoption may need to be evaluated using new metrics that capture the multifaceted nature of their impact. Therefore,

RQ6: How can firms measure the return on investment of the adoption of new-age technologies?

6.2. Customer-facing unknowns

The adoption of new-age technologies enables greater automation, intuitive actions and responses that reduce the need for human intervention and make customers' lives more convenient. These technologies have deeply and unobtrusively embedded themselves into customers' lives, making themselves increasingly vital while empowering customers.

Personalization that provides thoughtful recommendations and fulfill customer needs in a more nuanced manner offers value to customers (A. M. N. Staff, 2019). While new-age technologies offer intuitive and personalized customer experiences and offerings, these technologies also record and analyze every action and decision made by customers. Customers have some control over the data that is shared with firms, but they do not have clear visibility into how their data is being stored, utilized, and disposed of. In a future where data is currency, this aspect of new-age technologies and their applications is likely to gain prominence.

Customers are evolving, and their behaviors and demands are

increasingly technology oriented. For instance, millennials, who are in the prime of their lives and hold potential as long-term customers over their lifetime, are very tech-savvy. As customers, they demand instant gratification, and prefer simple, fast, and personalized solutions to their needs. They turn to technology as a way to engage with firms and with each other, preferring experiences and solutions that reflect their individual identities and beliefs (Kumar & Ramachandran, 2018). Customers are also increasingly interested in having access to information about firms and their offerings to evaluate the alignment of their personal values with that of the firms. New-age technologies facilitate transparency and traceability on the part of firms and enable customers to assess and make decisions based on the alignment of their values with firms. Given these factors, we identify the following research topics:

- The potential of new-age technologies to simplify customers' lives has not yet been fully explored, and future applications could lead to an enhanced quality of life for customers. The expanding capabilities of these new-age technologies will lead to potential benefits for customers. Therefore,

RQ7: How can these new-age technologies help customers enhance their quality of life?

- Customers share their personal data with firms in the course of using products and services based on new-age technologies. The emphasis on privacy and ethics with regard to customer data is increasing. Customers are increasingly aware of the downside of sharing their personal data with firms. Therefore,

RQ8: To what extent are customers willing to give firms access to their personal data, in order to benefit from the use of these new-age technologies?

- New-age technologies can help a customer verify whether a firm's offerings are reflective of the customer's individual values, grant greater autonomy to the customer, and provide solutions aimed at the customer's wellbeing. Therefore,

RQ9: How can these new-age technologies help customers be more aligned with their personal values and needs such as autonomy, wellbeing, and sustainability?

6.3. Intermediary-facing unknowns

The role and types of intermediaries have changed in the current business landscape that includes new-age technologies. With the rise of platform-based business models and direct firm-customer engagement, traditional intermediaries are facing a changing business landscape. Disintermediation is one of the potential consequences of the adoption of new-age technologies, although intermediaries can create value in new ways to stay relevant to firms and customers.

Platforms are key intermediaries in the new business model, matching firms' offerings to customer needs in a data-driven, digital space. Their operations are based on transparency and build on existing process efficiencies. The role of new-age technologies in the growth of platform-based business models is expanding, with increasing emphasis on matching supply to demand in the most convenient and efficient way possible.

Furthermore, it is necessary for intermediaries to find ways to engage with both customers and firms and adapt themselves to create value in the new business models. Intermediaries can continue to stay relevant by developing ecosystems to facilitate and exercise some control over firm-customer engagement, or by applying new-age technologies to reduce customer costs, or by using new-age technologies to increase process efficiencies. Given these factors, we identify the following research topics:

- The direct firm-customer engagement that is enabled by new-age technologies has implications for intermediaries, as they will need to modify their roles to adapt to new business models. The new-age technologies can potentially assist intermediaries in crafting new roles and capabilities or improving existing capabilities in reevaluating their roles in business models and processes. Therefore,

RQ10: What is the possible impact that these new-age technologies can have on the current roles of intermediaries in business processes, with regard to the development of new capabilities or enhancement of existing capabilities?

- The modified or new business models resulting from the adoption of new-age technologies require intermediaries to identify ways to leverage new-age technologies to their advantage. This may be in the form of process efficiencies or marketing efficiencies or both. Therefore,

RQ11: How can intermediaries leverage these new-age technologies to improve their process and marketing efficiencies in their modified or new business processes?

- In order to truly derive value from new-age technologies and adapt to new business models, intermediaries' employees need to have expertise and skills with regard to applying these new-age technologies. The specific skills that are necessary are likely to vary depending on the new-age technologies that are adopted, new business models, and the industries that the intermediaries are involved in, among other factors. Therefore,

RQ12: What skills and capabilities do intermediaries need to develop or strengthen in order to extract the maximum value from these new-age technologies?

6.4. Technology developer-facing unknowns

Technology developers can facilitate the integration of different new-age technologies in a seamless manner, thus ensuring that they all function together in harmony. This necessitates technology developers to help firms and intermediaries create, develop, and manage platforms and ecosystems to connect them to customers. The rapid advancement in new-age technologies requires technology developers to be adept in keeping up with new developments in the field. This also encourages the development of communities and markets of technology developers.

Technology developers play an important role in ensuring that the technology-human interactions and interfaces are intuitive, integrated, and engaging. While developing applications and platforms, technology developers also need to ensure the security of device and customer data. Given these factors, we identify the following research topics:

- There is a growing emphasis on interconnectivity of devices and platforms and the creation of ecosystems to manage these devices and platforms. Control over devices and applications is shared between firms, customers, and other entities, requiring technology developers to think differently in developing applications and programs. Therefore,

RQ13: What are the implications for technology developers in the context of creating applications and programs that account for the interconnectivity of devices and the shared control of devices and applications among multiple entities?

- As a direct consequence of having multiple entities sharing control over connected devices and platforms, technology developers will need to take their needs and preferences into account when developing applications and programs. This could mean involving firms,

customers, platforms and other intermediaries, etc. in the process of developing applications and programs to manage connected devices. Therefore,

RQ14: Will this sharing of control across multiple entities have any impact on technology developers co-developing applications and programs by seeking input from firms and customers to understand their needs?

- The expertise required to manage new-age technologies is likely to be more advanced than the skills that technology developers have hitherto acquired. These new-age technologies are more intelligent, intuitive, and sophisticated than technologies of the past, and require technology developers to cultivate a different mindset and skillset. Therefore,

RQ15: Do technology developers need to develop specific skills to manage new-age technologies and their concomitant applications and programs? If so, how can they develop these skills?

6.5. Regulator-facing unknowns

New-age technologies imply a greater influx of data than ever before, raising concerns with respect to data security and ethics. The collection, utilization, storage, and disposal of customer data is critical, suggesting the need for new standards and norms to regulate these processes. Considering the international nature of firms, their operations, and their customers, data security and ethical standards need to be globally consistent and enforceable. Regulation such as the General Data Protection Regulation (GDPR) in the European Union is a strong first step towards granting consumers greater control over their information, and laying down uniform data protection rules for all firms operating in the EU, regardless of where they are based (EuropeanCommission, 2018). However, going forward there is a need for an international set of standards, and a regulatory body or governmental authority to enforce these standards.

There are also environmental consequences of the aforementioned data influx. Data centers as well as new-age technologies themselves consume extensive amounts of electricity, and this is expected to increase in the future. The use of technology, especially new-age technologies, contributes heavily to the drain on global electricity levels. Increasing the use of new-age technologies can intensify this pressure on environmental resources, making their long-term sustainability a grave concern. Given these factors, we identify the following research topics.

- The deluge of individual-level customer data is expected to be the new reality, with firms increasingly focusing on capturing granular data about customer behaviors and preferences. At the same time, substantial environmental resources are consumed in order to capture, store, and analyze this vast data. Therefore,

RQ16: What are the implications for regulation with regard to data privacy, ethics, and the consumption of environmental resources?

- New-age technologies are currently being applied to create efficiencies with regard to processes and resources. Their ability to generate results quickly and efficiently could potentially be applied towards solving issues related to environmental sustainability and resource management. Therefore,

RQ17: Can these four new-age technologies be leveraged to address environmental challenges and sustainability concerns?

7. Managerial implications

The adoption of the four new-age technologies discussed in this study has implications for managers since they can transform business and decision-making making processes within firms. Importantly, firms face questions regarding the impact of IoT, AI, ML, and blockchain on decision-making processes. A major question facing firms is whether these four new-age technologies will impact current data management, data mining, insights generation, and customer management processes. If they do, will these new-age technologies also impact current decision-making processes and the implementation of these decisions within firms?

7.1. Implications for data management

Undoubtedly, the use of IoT, AI, ML, and blockchain will impact the current data management processes that firms follow. The use of new-age technologies such as AI and ML can enable firms to automate the process of drawing structured and unstructured data from diverse sources (scanner panels, social media, and e-commerce, sensors, devices, video/audio, networks, log files, transactional applications, websites, etc.), cleaning the data, recognizing patterns to identify useful and applicable data, and integrating the varied databases. Blockchain can help avoid data duplication and unify data entries to present an accurate and holistic perspective on customers.

For instance, credit reference agency *Experian* handles more than 3.6 petabytes of individual-level data sourced from marketing databases, transactional records, and public information records. Experian is embedding ML into their products to facilitate quicker and intuitive decision-making by training algorithms to identify the most important data points from the vast databases (Marr, 2018a).

7.2. Implications for data mining

The role of new-age technologies extends to data analysis and insights generation, with AI and ML making data mining processes more intelligent, more intuitive, and more automated. Thus, AI and ML can power the data mining process by mining large databases, applying sophisticated analytical techniques repeatedly without fatigue, while learning with every iteration of analysis. In this context, it is important that the training of AI and ML algorithms is overseen by skilled employees who understand the data and the focal new-age technologies.

For instance, *Infervision* is applying AI and deep learning to healthcare in China, by teaching and training algorithms to review CT scans to identify and diagnose cancer accurately and efficiently. In China, radiologists are unable to keep pace with the demand of examining more than 1.4 billion CT scans per year to identify early signs of lung cancer. It is difficult and tedious for radiologists to review hundreds of scans per day, and human fatigue can cause errors in diagnoses. Training ML algorithms to identify signs of cancer supplements the efforts of radiologists and diagnose cancer accurately and efficiently (Marr, 2018a).

7.3. Implications for insights generation

New-age technologies can help firms derive key insights that enable quick and action-oriented decision-making. Managers can potentially automate the process of insights generation and refocus human resources and skills towards implementing and ensuring the effectiveness of decision-making processes. It is important for firms to invest in their employees in order to ensure that they develop the skills to oversee and refine the process of applying new-age technologies for insights generation. New-age technologies can also aid implementation of decisions; for instance, IoT devices can trigger alerts to customers in response to the firm's decision to send out personalized communications based on a certain insight. Several firms have already adopted new-age technologies to power their decision-making processes.

For instance, *Walmart* uses the SAP HANA platform to process the data from half a trillion transaction records across millions of

customers, international locations, and its e-commerce channel. The HANA platform helps Walmart pull in data from multiple sources, create real-time visualizations, and identify insights at an unprecedented scale and speed (Wilson, 2015). The firm also plans to integrate IoT sensors and products, which will help them monitor product usage, automatically replace products, and manage product expirations and recalls (Marr, 2017b). Additionally, the firm plans to use ML and AI to upgrade its customer service and anticipate customer needs. The firm plans to use its facial recognition technology to gauge the frustration levels of customers at checkout, and automatically trigger alerts to customer service representatives who can personally interact with frustrated customers (Randolph, 2017).

7.4. Implications for customer management

The adoption of these new-age technologies has an impact on the existing technologies that firms are currently using, specifically, on their existing customer relationship management (CRM) technologies. CRM technologies have been adopted by a large number of firms in order to optimize the value of existing and potential customers, and to provide richer customer experiences (Kumar, Shah, & Venkatesan, 2006). A natural question is whether or not the four focal new-age technologies are expected to substitute CRM technologies altogether?

We believe that the new-age technologies can potentially augment the capabilities of existing CRM technologies by enhancing the efficiency, effectiveness, responsiveness, and personalization of marketing strategies and activities. AI and ML for instance, can help CRM systems by automating routine tasks such as data input, forecast updating, determination of call lists, etc. By helping CRM systems identify behavioral patterns and preferences, they can automate and personalize customer responses, communication material, data collection, quote generation, etc. Over time, AI and ML algorithms can expedite customer segmentation, lead customization, and marketing element customization. Employees can thus productively apply their time toward relationship building and engagement activities. IoT can capture data on customers, thus providing a rich database for CRM systems. Blockchain can ensure the security of customer data on CRM systems and allow CRM systems to directly deliver reward/loyalty points and personalized offers to customers, without any intermediation. We do not expect new-age technologies to face-off with existing CRM technologies; rather, we expect them to enhance the value derived from CRM technologies.

Hence, firms need to focus on the integration of these new-age technologies with existing CRM technologies. The integration of new-age technologies and CRM technologies has become more frequent in recent years, with several CRM solutions providers developing new-age technology solutions in-house or acquiring other firms offering new-age technology solutions.

For instance, *Salesforce* has developed an AI platform called Einstein. Einstein can learn from customer data, identify insights about each account, prioritize leads, predict outcomes, prescribe solutions, personalize communications and product recommendations, and automate routine tasks (Yonatan, 2018). *Microsoft* acquired *Genee*, an AI firm working on using natural language processing to automate the process of scheduling interactions with potential customers. *Oracle* acquired *Crosswise*, a data firm specializing in ML-based cross-device data that can potentially help in cross-device advertising, personalization, and analytics (Walker, 2017).

8. Conclusion

We expect the four focal new-age technologies to be a critical part of the future of marketing, making the adoption of new-age technologies an inevitable decision for firms. In the future, firms will need to make decisions about how many and which specific new-age technologies to adopt. This necessitates a deeper examination of their implications for firms, customers, and other entities who are involved in the implementation of new-age technologies.

This study provides a broad understanding of the current understanding of four focal new-age technologies and their impact on firms and customers. However, the study of new-age technologies in marketing is at a nascent stage, and there is much more to be learned. By presenting a research agenda, we hope to encourage researchers in marketing to study these new-age technologies in greater depth to truly uncover their potential and business implications.

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Declaration of Competing Interest

None.

Appendix A. Supplementary material

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