

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Blockchain: Research and Applications

journal homepage: www.journals.elsevier.com/blockchain-research-and-applications

Applications of Blockchain Technology in marketing—A systematic review of marketing technology companies

Valerio Stallone^{a,b,*}, Martin Wetzels^b, Michael Klaas^a^a Zürich University of Applied Sciences, Theaterstrasse 17, 8401, Winterthur, Switzerland^b Maastricht University, 6200, MD Maastricht, the Netherlands

ARTICLE INFO

Keywords:

Blockchain
Marketing
Blockchain applications
Blockchain in marketing

ABSTRACT

Given the emerging nature of integrating Blockchain Technology (BCT) into several business fields concerning the interaction between companies and their customers, this study aims to investigate the applications of BCT in marketing through an accurate procedure of locating, selecting and analyzing existing companies using BCT in marketing. A sample that consists of 800 companies was identified using web-scraping methods. The data set was collected from initial coin offerings (ICO) websites as well as from an existing, older landscape of applications. The data set was then intensively analyzed in order to be categorized into five fields of marketing technology. Advertising and ecommerce outgrew the other fields of social & relationship, content & experience and data in absolute numbers, revealing the focus of practitioners in the past as well as gaps for the future. The authors provided future directions for researchers on and development of tools to systematically generate knowledge and improve the application of BCT and the work of practitioners in marketing.

1. Introduction

The environmental change society is facing is an explicit request for companies for being responsive to change, both internally and externally regarding their interaction with the market and the environment. The management of the external marketing environment craves for answers on technological agility. These questions arise from changes in payments, advertising, delivery and distribution, due to technological advances and discussions in academia about Blockchain Technology (BCT) and net neutrality, just to name a few [1]. Academics, practitioners, law-makers and philosophers: They might have many things in common, one of them being their interest in BCT, its application and its effects on the market outgrowing its initial attraction to the context of cryptocurrencies and financial services [2–6]. This interest is mostly due to the expectations on the application of BCT being increasing (1) honesty, (2) consideration, (3) accountability and (4) transparency in trustworthy interactions in society and business [7]. Edelman's Trust Barometer highlights the need for a democratization of trust by showing that trust inequality between the informed public and the mass population set new records [8]. Governments' efforts to react to technological changes are too slow and result in a feeling of unpreparedness for the future. This feeling of fear ends up

in giving up to non-governmental parties and trust them with the individuals' most private secrets [8]. Tapscott & Tapscott reflect this feeling by mentioning that “many people are simply unaware of the many micro-Faustian deals they make online every day” [7].

Several applications of BCT are already leveraging its disruptive potentials and preparing for a future with less micro-Faustian deals to make. New applications are arising in different areas as insurance, logistics, gaming and 3D printing. Academic sources have shown its potential implications on marketing [9–14], most of the research conducted being of conceptual nature [15]. Inspired by Scott Brinker's Marketing Technology Landscape [16], which is widely spread in practitioners' circles as visualization of the growth of entrepreneurial reactions to the technological changes in the marketing environment, Never Stop Marketing developed his ‘Blockchain Marketing Technology Landscape’ (BMTL) [17]. The team behind it shows that different areas of marketing are filled with companies, applications and projects—used as synonyms in this paper—spread all over the world. These very companies tackle the aforementioned societal and technological changes with BCT and its application. The clusters, derived from the BMTL, apply to the five most important marketing technology areas in practice: advertising, social & relationship, content & experience, ecommerce and data.

* Corresponding author.

E-mail address: valerio.stallone@zhaw.ch (V. Stallone).

Accordingly to the recommendations of Horst Treiblmaier and Mark R. Gleim & Jennifer L. Stevens, the authors will attempt to present the characteristics that make BCT stand out from the marketing perspective [13,18]. The authors will depict the actual uses and applications expanding the existing BMTL by systematically reviewing the web for additional applications as a “social construction of reality” and therefore explore a “technology that reshapes our economic system” [13,18]. This review is based on some features of the PRISMA statement [19] to provide a transparent, reproducible and scientific review. Its driving force is the researchers' curiosity to understand the particular phenomenon of BCT applications in marketing, allowing the authors to identify differences in applications' lifespan and inter- and intra-cluster differences in the aforementioned marketing technology practice areas. By doing so, the authors are able to present five propositions that will guide future BCT-related research in marketing.

2. Blockchain technology characteristics

The underlying technology, nowadays regarded as Blockchain, was proposed in 2008 under the pseudonym Satoshi Nakamoto, who introduced the first application of Blockchain, and whose true identity has not yet been revealed [20]. BCT has multiple definitions: as a name for a data structure, an algorithm, a suite of technologies, and as an umbrella term for purely distributed peer-to-peer systems with a common application [18,21], which result into issues related to the conceptual foundation of BCT in research [22]. BCT should be seen as a cryptographic, append-only decentralized ledger in which interconnected timestamped blocks of data are stored by maintaining integrity in a distributed peer-to-peer system that consists of an unknown number of peers with unknown reliability and trustworthiness [21,23]. The most important characteristics that emerged from different reviews and explorative research are immutability, transparency, programmability, decentralization, consensus and distributed trust.

Through cryptographical securitization of the interconnection of the timestamped data blocks, the nodes within the peer-to-peer network create tokens through “consensus mechanisms”. This process is also known as the agreement on which data block containing which information about a transaction must be kept in the Blockchain in order to guarantee that there will be no deviations [7]. Based on their purpose, governance, functional and technical parameters, scholars have categorized tokens into eight different archetypes, therefore pushing the limitation of them being depicted as “just cryptocurrency” [24]. There are different types of consensus mechanisms, which depend on the type of token the application is using [23]. Tokens play a crucial role in the development of a BCT application. Companies make use of so-called initial coin offerings (ICO) to increase user numbers and intensify the traction of their application by distributing tokens amongst the users. By doing so, companies enable investment opportunities and incentivize users to build communities for, around and within the companies' vision and mission [25]. Users base their investment decisions on information distributed in form of ratings by ICO rating websites [26].

BCT can be extended beyond the function of storing information about the transaction between nodes placed within the interconnected timestamped data blocks. So-called Smart Contracts allow us to translate clauses into embeddable code. The resulting agreements between parties, which are automatically enforced, establish a new paradigm with practically limitless applications, moving the BCT from second generation, which include Smart Contracts and a set of applications extending beyond cryptocurrency transactions, to a third generation “including applications in government, health, science and IoT” [23]. As stated by Treiblmaier, “the interest surrounding BCT has been fueled by the great variety of possible use cases” [18]. We will analyze how this interest reflected itself amongst the interest of scholars and practitioners in Marketing in the next sections.

3. Research on blockchain applications in marketing

Systematic reviews of academic literature on BCT applications in business show a depressing picture for marketing scholars. A first review stated that “none of the surveyed studies discussed blockchain applications for marketing ...” [27], another review did not even mention the very absence of marketing applications at all [23]. Other scholars did not mention marketing as a field in particular, they listed applications in ecommerce [28,29], in online social networks [29] in advertising [30] and in data markets [5]. Use case analyses of BCT applications in marketing show a rejoicing picture for marketing scholars. Use cases range from fields as supply chain management [9,31], digital marketing fraud prevention [9,32–34] and loyalty programs [9,33,34], just to name a few. The only review trying to be as systematic as possible was Antoniadis et al. presenting six applications fields: supply chain management, payment, marketing management, loyalty programs, digital marketing, reviews, and credential management [9]. This review reflected the authors' view on business applications sourced in the real world and therefore resulted in a categorization that did not resemble practitioners' view on marketing technology [16,17].

The categorization used by Never Stop Marketing reminds of the PESO (paid, earned, shared, owned) model described by Macnamara et al., whereas the advertising cluster represents paid media, owned media is represented by the content & experience category, shared & social & relationship cluster represents earned media, and the two clusters, ecommerce and data, enclose these media types [17,35]. This parallelism is shown in Fig. 1, where the data layer is depicted as the fundament—or the bricks—of building media types to exchange with the users and/or customers at the center, enabling transactions that might be of commercial nature.

Some scholars have focused on single clusters in their research on BCT applications in marketing. Shrestha et al. depicted applications in advertising, highlighting the multimedia sector and the underlying attributes of the applications within [25]. The paid media examples the authors made in their contribution were to be set at the intersection to owned media, as Shrestha et al. presented ways to promote the content of the companies. Their main findings were based on the BCT (Ethereum) and consensus mechanism (Proof of Stake) mostly being used in their sample. Boukis was also moving towards the same intersection: He suggested that BCT can (1)

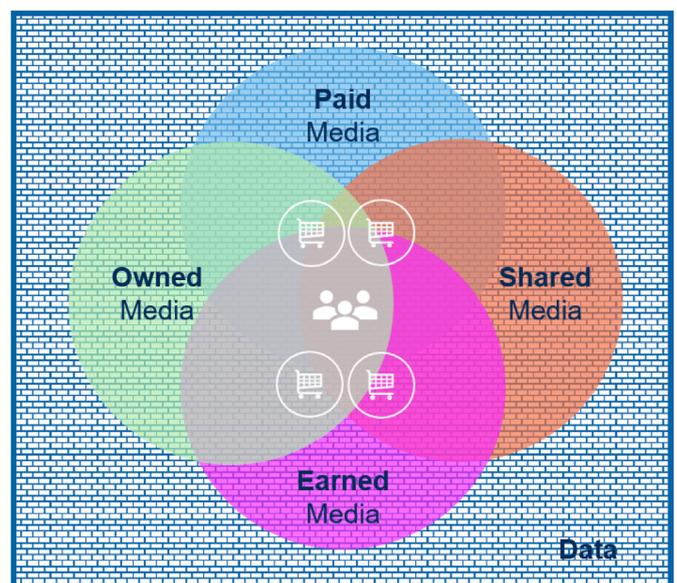


Fig. 1. Extended PESO model (based on Refs. [15,33]).

improve brand positioning and corporate brand image by adopting brand-specific digital currencies and increasing brand storytelling capabilities and (2) authenticate brand communication and therefore improve online brand advertising ROI by reducing need for intermediaries [11]. Pärssinen et al. purely took a stand in the paid media field, by explaining how—back in 2018—BCT applications did not present any evidence to fulfill the requirements online advertising, being scalability, quasi-transparency, power consumption, inability to modify blocks, non-repudiability and quality information, put upon platforms [32]. At the end of their contributions, Pärssinen et al. stated that “[even] though there may be faster development on a smaller scale—for example in the case of individual national online advertising markets—the industry could still be a decade or more away from materializing this potential through a global-scale transformation”. Content & experience is the basic element all the media types in the PESO model are made of [35]. This makes this cluster the most difficult to summarize. For the applications in BCT, scholars have focused on the verification of authenticity and the transferability of content, no matter if text [36,37] or video [38–40]. Their findings can be summarized as revolution-inspiring changes to stale ecosystems of content conception, creation, delivery, interaction and analysis. For the social & relationship cluster, scholars have focused on specific problems that can be solved thanks to BCT, as identified by Saxena et al. [41] and put into perspective by Guidi [42]. Guidi complained about the common trend to use social media and social networks as synonyms. Current BCT applications in this field are not social networks, but social media platforms—therefore focusing on the distribution of the content and not on the interaction between humans. Ahmed et al. tackled the issue of rising amount of false data and fake information in social media [43]. Choi et al. identified issues around privacy and unstructured data collection [44]. Scholars tackled the incentive system of social exchanges and relationships in social media [45,46]. Guidi et al. identified the issue of data islands, also called “walled gardens”, and tried to overcome it by adding a P2P social overlay built by exploiting the real life of the social network's users [47]. This intrusion into real life data is the main beneficial aspect BCT can attempt due to its characteristics presented before. Also, part of the social & relationship category is everything concerning the relationship between customers and brands: This is where loyalty programs come to play. Even though there are publications stating there is limited room for implementation of BCT due to disappearing advantages compared to cloud-solutions [48], there are plenty of scholars mentioning this as one of the most important application fields in marketing [13,49–51]. These last few examples show the focus of academia, when talking about social & relationship, being the result of the exchanges between users: The data. Many publications focus on the transferability of this user data and consumer data highlighting the potentials of data marketplaces from a decentralized point of view. Brandão et al. presented the three layers of data marketplaces being data provision, data rights management and data flow control [52], which in return result in fair, independent and privacy-preserving data ecosystems [53–55]. These B2B trade ecosystems are in contrast to the focus laid upon BCT application in ecommerce: Scholars focused on consumer-to-consumer platforms and their design, showing how BCT can help consumers connect to and transact with each other, share personal data and avoid the centralization of control by large commerce companies [56,57].

Most of the research made on BCT applications in marketing show concepts, name companies and depict the rationale behind them. The research lacks overview on the amount of companies in the different fields/categories/clusters. Only Shrestha et al. tackled this to some extent—based on their suggestion on future research, the authors of this paper aim at including a more comprehensive sample to their analysis and suggest widening it up by taking into consideration other fields in multimedia-related sectors [25].

4. Research method

The authors based the process of this review on some features of the PRISMA statement [19], whereas the overall methodological approach will include the three phases. In the (1) pre-analysis, the authors identified the need for review, defined the proposal of the review and prepared the protocol of the latter. The identification of the need, as well as the definition of the proposal, can be found in sections 1–3. In the (2) analysis phase, the authors located and selected the companies, assessed the quality of the selection, extracted and synthesized the data. These steps will be depicted in this section as well as in section 5. In the (3) post-analysis phase, the authors reviewed the reporting. This review can be found in sections 6 and 7.

4.1. Locating companies

Between May 2020 and September 2020, the authors carried out a systematic review of companies applying BCT in marketing. The authors used the BMTL, which consists of an overview of company logos, as the starting point for the review [17]. The authors created multiple image files out of the BMTL. The image files, each one of them containing one company logo, were looked up with the Google Image Search function to find the name and the website of the company behind it. The authors used this procedure for the four BMTL for 2017, 2018, 2019 Q1 and 2019 Q3 [17] and were able to find the name and the website of every single image depicted on them. Additionally to this procedure, the authors scraped ICO rating websites icobench.com and cryptototem.com, in order to find other companies. The rationale behind this procedure was benefitting from the transparency incentives due to reciprocity expectations of companies in search of investors for their cases.

4.2. Companies' parameters

The elements the authors assessed and/or scraped were firstly the name and the website of the company. These two elements were later defined as the unique identifiers for the deduplication-related comparisons. Then, the authors collected (i) the main description containing a short sentence (max. 75 characters) and a sub description containing a long text about the company (max. 6000 characters). As the third parameter group, the authors checked for (ii) year of creation and year, in which it ceased to exist, and independently carried out this analysis. The authors checked (i) & (ii) according to the information scraped from the website, retrieved from the BMTL itself and from the (social) media presences (e.g. LinkedIn, Instagram, GitHub, Facebook, and Crunchbase) of the companies.

4.3. Selecting companies

The authors defined exclusion and inclusion criteria independently. A flowchart of the strategy implemented is presented in Fig. 2. After the selection based on the four BMTL ($n=644$; $BMTL_{id,in}$) and the deduplication due to the presence of the same companies in multiple BMTL editions ($n=317$; $BMTL_{id,ex}$), the ICO rating websites were scraped entirely by using the free version of online web-scraping services offered by import.io ($n=11309$; $ICO_{id,in}$). The authors used the parameters presented in section 4.2 to check whether certain keywords, signaling relevance for the marketing field, were present or not ($ICO_{s,ex2}$). The authors compared the unique identifier of the companies coming from the two ICO rating website sources and deduplicated the entities ($n=5602$; $ICO_{id,ex}$). In the next step, the authors compared the

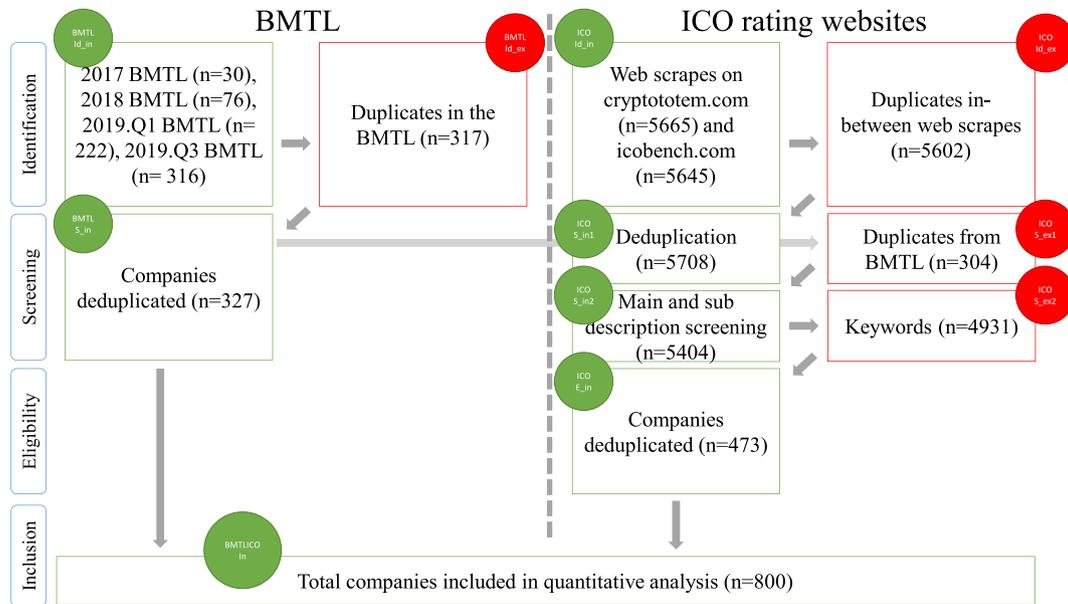


Fig. 2. Flowchart of the search strategy (based on Ref. [21]). BMTL: Blockchain Marketing Technology Landscape.

resulting unique companies ($n=5708$; $ICO_{S_{in1}}$) with the expanded BMTL list and were able to exclude 304 ($ICO_{S_{ex}}$) companies already present in the BMTL from the ICO web-scraping list and deduplicated based on it ($n=5404$; $ICO_{S_{in2}}$). In order to check, whether the companies did not tackle any marketing related subjects as mentioned by business-oriented [16,17,58] and academic [59] marketing technology categorizations and in order to be able to exclude those companies who did not, the authors undertook a content analysis of the main and sub-descriptions ($n=4931$; $ICO_{S_{ex2}}$). All companies meeting the inclusion criteria from the BMTL ($n=327$; $ICO_{S_{in}}$) and the ICO website scrapes ($n=473$; $ICO_{E_{in}}$) were further analyzed. Afterwards, the lists were compared (rate of consensus was approximately 90%), agreed upon for all companies and summarized in a list.

The same thing happened for the categorization of the companies according to the BMTL clusters. The authors applied this procedure for the companies scraped from ICO rating websites. The authors independently analyzed the companies and allocated them to the five clusters of marketing technology application fields (rate of consensus was approximately 95%), agreed upon for all companies and summarized in the aforementioned clusters.

5. Evaluation

Most authors analyze BCT applications in marketing by examining exclusively academic literature [9,23]. In this work, we propose an industry-oriented analysis using an eligibility methodology based on companies sourced on the web. By doing this, the authors are able to convey a clear and comprehensible depiction of the status quo of the BCT application landscape in marketing. In the following subsections, we provide a descriptive analysis of the data set collected and then show in-depth analyses of the clusters mentioned in section 3.

5.1. Overall analysis

As shown in Fig. 2 ($BMTLICO_{In}$), the study analyzes 800 BCT applications in marketing starting and/or ending their existence between January 2017 and July 2020. The descriptive analysis provides insights

Table 1
Entry and exit year of companies.

		2017	2018	2019.Q1	2019.Q3	no exit yet	sum
Out/In		O_1	O_2	O_3	O_4	O_5	
2017	I_1	35	30	4	5	37	111
2018	I_2	–	139	13	23	76	251
2019.Q1	I_3	–	–	1	49	139	189
2019.Q3	I_4	–	–	–	7	90	97
2020.Q1	I_5	–	–	–	–	152	152
sum		35	169	18	84	494	800

regarding the growth of BCT applications in the last years as well as the decline of that very growth.

The timetable starts with 111 companies back in 2017 and ends with 494 companies in July 2020, resulting in a compound annual growth rate (CAGR) of 64.5%¹. Table 1 shows a detailed overview of companies starting (In) and ending (Out) their existence. In the first year of this analysis, 35 ($= I_1 O_1$) of these companies ceased to exist in the same year.

For 2018, the authors recorded 327 ($= \sum_{j=2}^5 \sum_{i=1}^2 I_i O_j$) companies letting the

landscape grow by almost 195%. However, 2018 has been the year with the highest relative immediate decline in the number of companies: Over 55% of the applications appearing to the surface of the industry in that very year, ceased to exist in the same year ($n=139$; $I_2 O_2$). Overall, within 18 months, the BCT in marketing landscape grew by 30%. 2019 has been inspiring for entrepreneurs in the marketing field of BCT: almost 200 companies entered the competition with their projects and offerings. The authors added to Jeffrey Epstein's BMTL 152 ($= I_5 O_5$) companies in the first quarter of 2020 resulting in an overall field of 494 ($= \sum_{i=1}^5 I_i O_5$) companies still active by then, recording again positive growth (16%), though in decline compared to the years before.

In Fig. 3, the authors present the cohort analysis based on the years the companies entered the landscape. Up until 2020, the class of 2018 is performing the worst, by having only 45% of the companies still active after 12 months, whereas the cohorts of 2017, as well as 2019.Q1 both did not get under the 68% mark after the same amount of time. After 24 months, though, both the classes of 2017 and 2018 were floating around the 40% mark. Compared to the companies entering the landscape in 2018, the second year of existence was fatal to companies, which started

¹ CAGR computed as $(V_t/V_0)^{(1/t)}$, whereas V_t is the end value, V_0 the end value and t the amount of time passed between V_t and V_0 [78].

How many companies are still existing after 6, 12, 24, 30 and 36 months after appearing?

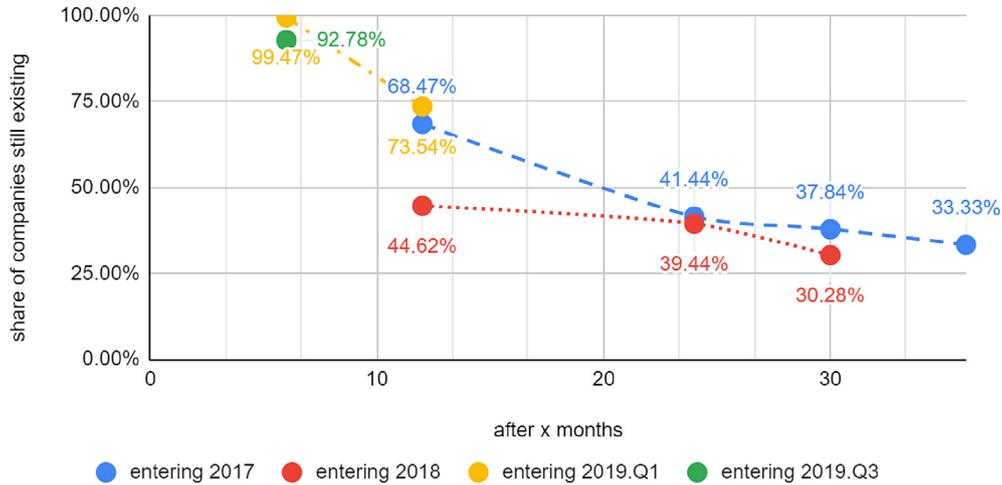


Fig. 3. Cohort analysis.

their activities in 2017. Interestingly enough, the twelve months of 2018 were apparently the ones costing the life of most companies (169, 51.7% of all the companies listed at that time), significantly less companies ceased to exist in 2019 (102, 24% of all the companies listed at that time).

5.2. Marketing technology clusters

The marketing technology landscape delivers an extraordinary overview of the offerings that lie within marketing and its technological developments. For this paper, the authors focused on the BMTL of Never Stop Marketing, which was inspired by Scott Brinker's marketing technology landscape [16,17]. After our systematic review, the five clusters

pre-defined by both experts (advertising, content, social, ecommerce and data) contained more companies in 2020.Q1 compared to 2017, resulting in an overall CAGR of 64.5%.

The overview delivered by Fig. 4 does not leave any open room for interpretation: Companies applying BCT to the field of advertising grew the most. The CAGR of 79.5% confirms this fact. A thorough analysis of the data set shows that companies trying to revolutionize programmatic advertising are driving this huge rise in applications (12 in 2017; 72 in 2020.Q1). Their share grew from 63% in 2017 to 65% in 2020.Q1, which again depicts the focus BCT has had in advertising. The second category in this ranking is applications in ecommerce, where the authors computed a CAGR of 78.9%. In opposite to the field of advertising, there

How many companies exist in the different clusters?

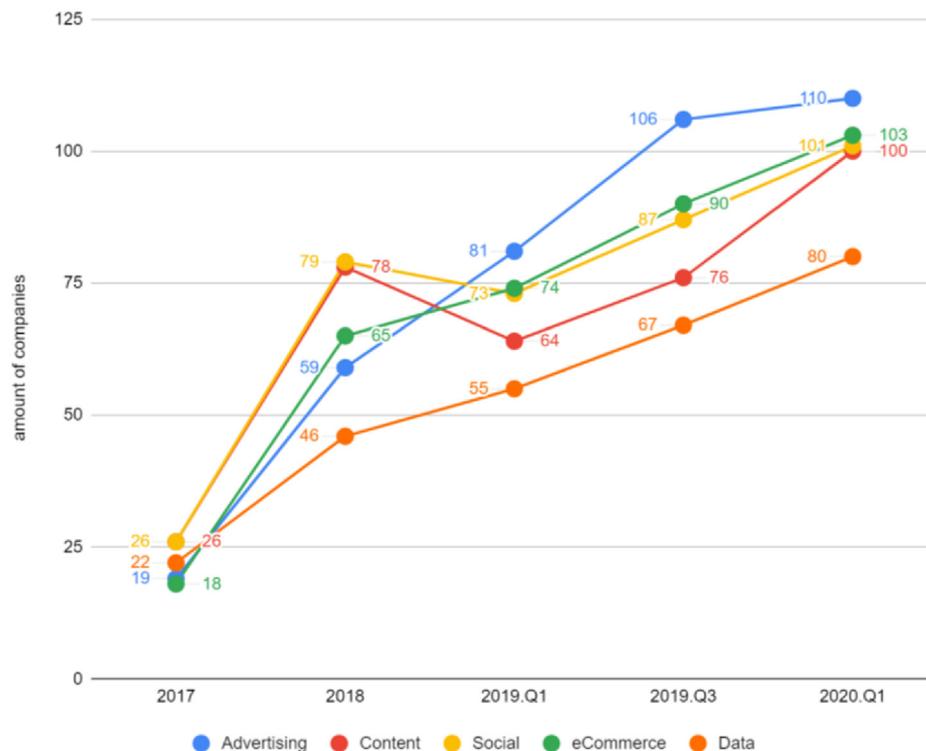


Fig. 4. Category clusters.

is not a specific subsection driving this growth. The least growing field is the one of retail (11 in 2017; CAGR of 54.2%). The other three fields (social, content and data) registered less compound annual growth with CAGR of 57.2%, 56.7% and 53.8% respectively. However, these clusters have to cope with an increased lump risk, due to the focus of entrepreneurs and engineers on one specific field within the respective cluster: For the content cluster, it is rewarding contributors, which back in 2017 made out 42%, in 2020.Q1 it declined to 36%, of all the companies in this cluster.

This area describes applications, which incentivize content production by rewarding content providers. Loyalty applications represent the lump in the social cluster. In 2020.Q1, 42.5% of the companies came out of this sub-category (30% in 2017). Applications in this area try to implement BCT in loyalty and referral programs. For the data cluster, it is the audience, which back in 2017 made out 86% of all the companies in this cluster and in the last overview in 2020.Q1 it was 80%. Companies in this area work to analyze audiences and bolster the existing prospect data of the customers with additional insights pulled and correlated with other services.

6. Applications

In the previous chapter, the authors aimed at highlighting the focus practitioners are setting in their entrepreneurial activities. In this chapter, the authors will present selected applications, cluster by cluster, and relate them to the findings of section 5 by depicting cases within the fastest growing sub-categories.

6.1. Advertising

The internet has become an efficient communication tool, which connects brands with potential customers. This connection has been served with different ecosystems, which changed in the last few years [60]. With the introduction of cookies, user logs could be stored via browsers and thus provide a basis for targeted digital marketing [61], which has been mentioned by Google to phase out support on Google Chrome leading to an outcry for solutions to save online advertising from advertisers' and publishers' point of view. The companies found in this field address either the BCT application areas of paying for performance, paying for attention or managing performance systems transparently [62].

The first example is (or better: "was") adChain², which allowed for risk mitigation associated with the potentially devastating impact of click fraud, by implementing a more precise and controllable digital advertising ecosystem reinforced. adChain did so by leveraging the comprehensive analysis of qualifications, credibility and information of the actors within the ecosystem [33]. adChain, which ceased to exist in 2019.Q3, has set standards: After exiting the landscape of BCT applications in advertising by the end of 2019, the field of programmatic advertising—including supply chain transparency, payment transparency, fraud prevention and consumer rewarding—remained the fastest growing sub-section of application in the advertising cluster of BCT companies. The Brave Browser³ enables a form of monetizing websites independent of both ad networks and the user tracking that accompanies the current digital advertising ecosystem. Users maintain some form of credits or currencies for making micropayment to websites they use [63]. The users, in return, are paid for watching advertising, as advertisers reward the users' attention. Another market for advertisement and media planning is the NYIAX⁴ (New York Interactive Advertising Exchange), that was launched by NASDAQ, promoting a transparent marketplace where a matching engine ensures a fair exchange of future

premium advertising inventory as guaranteed contracts [9,33]. The CAGR of almost 80% in this category is a signal of exuberance as well as of needs in terms of a closer look into how the new applications respect the requirements of online advertising as depicted by Pärssinen et al. [32].

6.2. Content & experience

In the content delivery ecosystem, publishers, retailers, and providers of digital assets can deny the fair share of the sale or royalty to original authors of digital assets (e.g. digital books and documents, audible content, motion pictures, etc.). The original author of the digital asset may end up receiving a meager amount as their royalty share. A lack of trust therefore exists between author and publisher in settling the payments and sales share as the author might not be involved directly in the sales of digital assets [64]. As stated in section 3, BCT can help with the verifiability of authenticity of the transferability of digital assets as content, by setting the right incentives to do so. DTube⁵ is a video platform comparable to YouTube, where users can watch and upload videos and can earn rewards through their content (uploading videos, which other users watch) and interactions (comments and upvotes of other users' videos) [65]. LBRY⁶ is an open-source protocol that is based on a distributed network of hosts and focuses on the decentralized distribution and discovery of media content addressing both media publishers and consumers. Rewarding of content publishers is an intrinsic property of the LBRY protocol. Based on their own LBC token, users automatically pay for consumed media content. The verification of authenticity and the transferability of content is in the focus of the applications, just as it is in the academic contributions. As mentioned in the previous section, though, business applications are moving fast (CAGR 56.7%) and might benefit from the latest developments around content verification and monetization with Non-Fungible Tokens (NFT) in the space of arts, fashion but also web based content as memes and gifs [66,67].

6.3. Social & relationships

As Guidi states, "current Online Social Networks are based on centralized platforms" suffering from certain problems including "scalability, dependence on a provider, and privacy" [42]. Current solutions are social media platforms, and not social networks, focusing on the content produced on the platforms and not on the interconnection between the humans on them. As for content & experience, this field focuses on the incentivization of valuable content, the verifiability of authenticity, the absence of censorship as well as the absence of a single point of failure. In this chapter, we depict one example of platform that is focusing on the interconnection of the humans on the platform, by adding the sub-categories of loyalty, referrals and advocacy programs. By creating and sharing content, replying to, upvoting and/or downvoting that very content, users on SteemIt⁷ can earn rewards—by the end of August 2018, SteemIt had issued over 40 million USD worth of rewards to its users [42,45]. Users of SteemIt compete to become one of the witnesses, the operators of the platform elected by the users through a consensus mechanism called Delegated Proof of Stake. It is suggested by the same authors that the whole platform is being misused by bots, deviating from the original intended goal of rewarding high-quality content [45]. This fact has already been debunked by scholars, publishing a way to identify those bots, trying therefore to counterattack this fraudulent activity [68]. Keybase⁸ is one of those players already tackling this potential issue by checking the integrity of social media users' signature chains and identifying malicious rollbacks [33]. Enabling

² <https://medium.com/@AdChain>.

³ <https://brave.com/>.

⁴ <https://www.nyiix.com/>.

⁵ <https://d.tube/>.

⁶ <https://lbry.com/>.

⁷ <https://steemit.com/>.

⁸ <https://keybase.io/>.

individuals to prove rightfulness can justify promotional expenditure resulting in big wins for marketers. Another big win for marketers can be exploited by binding the customer to the brand. From a consumer's point of view, the use of BCT can lead to increased interaction with a brand because loyalty points can be redeemed more easily, which can lead to greater customer satisfaction: Customers store all their loyalty points in a single wallet and are awarded for their loyalty in real time [69]. Loyyal⁹ is one of these solutions, offering easily exchangeable loyalty incentives across different markets by using tokens to support and verify their value [11].

6.4. Ecommerce

BCT enables ecommerce platforms to offer an efficient payment system, decentralized control to prevent the domination of big companies, an anti-fraud system, less transaction processing charges and overall efficient ecommerce platforms [70]. It creates an environment of trust and credibility in trade transactions by tracking and distributing consumer records as well as enabling everyone to see the progress of business transactions [56]. One kind of peer-to-peer electronic platform that has attracted significant media attention is OpenBazaar¹⁰ [71]. The same authors—by daily crawling the marketplace over approximately 14 months—found out that the activity on the platform is “orders of magnitude smaller than on centralized anonymous marketplaces”, with a strong focus on narcotics [71]. It is therefore no surprise that the only publication citing the work of the two authors is a contribution commissioned by the Air Force Research Laboratory on Online Crime [72]. The two authors recognize, reasons for this lack of traction can be due to a higher learning curve for users compared to centralized alternatives [71]. This learning curve might flatten in the future due to the current run and focus by the mainstream on cryptocurrencies [73].

6.5. Data

As stated in section 3, marketplaces for data exchange are closely connected to the sub-chapter 6.4. It does not matter, whether it is about a marketplace for IoT data (like mobius¹¹ [74]), or using data for prediction markets in logarithmic market scoring rules (like augur¹² [75]). Wibson,¹³ a BCT based data market for individuals selling safe and anonymous way information in a trusted environment, allows sellers and buyers to transact with data of personal information and directly maintaining anonymity as required [52]. Individuals can connect to data sources (e.g. Facebook, Amazon, Google), the monitor offers from data buyers and sells their personal data. Businesses can buy personal data directly from consumers, paying—and therefore rewarding the consumers—using the business-specific currency (tokens). Consumers receive payment for sharing access to their data when the transaction is confirmed. The Sovrin¹⁴ Foundation shifts its focus from the transaction to the storage of personal data, standardizing, creating and offering an infrastructure for Self-Sovereign identities (SSI). An SSI has been described as “a digital representation of the individuals characteristics, description and identifiers where no government, or organization, can violate” the individual's “right to choose” its “level of privacy or celebrity” with its “identity attributes” [76]. Sovrin's goal is to provide users with full control over all aspects of their digital identity, even their choice to sell their data, highlighting the opportunities of the portability of the data itself. Datum,¹⁵ in return, focuses again on the monetization of data,

which is stored on BCT. Again, its focus lies upon the aim of giving back data ownership to the data producers and let them decide whether they want to share their personal data or not [53].

7. Open issues and future trends

Although being a simple functional aspect of implementation [21], BCT and its applications have grown and will continue to grow as we speak, due to its potential global effect on economics and society [13]. In this paper, the authors show the impact it has had on entrepreneurs and their activities: The CAGR of 64.5% over the last three years depicts the efforts put in this field by entrepreneurs worldwide. In this social construction of reality, our motivation relied upon the curiosity in the cases presented. The observations made in the growing number of the BMTL up until 2019.Q3 lead to a review beyond the companies proposed by Never Stop Marketing [17]. The authors aggregated the applications into clusters and aimed at learning from the aggregated cases and their descriptions. By doing so, the authors discovered multiple gaps and different research fields to direct themselves to, which is increasingly important in a field like BCT research, where the practitioners' are somehow moving faster and more intense than academia does. That very same procedure, though, contained pitfalls: A justified point of criticism is the fact that it is not possible to guarantee the completeness of the list of companies retrieved. If, for example, the descriptions on the ICO websites and the categorization of the BMTL are incorrect, it is possible that single applications may not have been included or may even have been misplaced. It is also possible that several BCT projects are not listed on ICO platforms. As Oliveira et al. stated, practitioners might need additional decision-aids in order to design their tokens according to their business models, which can lead to disregarding the need for an ICO in the first place [24]. These cases need an alternative research procedure from other quantitative methods as web-scraping of BCT organizations websites [25], additional crypto market analysis websites and (de-) centralized exchange platforms to a qualitative approach as interviews with BCT experts [31], or systematic reviews of academic publications [9]. The allocation of the applications to the different clusters and sub-categories came with certain difficulties: Many applications did not contain enough information to render them allocable. Multiple applications might even be active in different clusters. Scholars could address this issue by creating a deductive categorization and therefore create an endemic allocation. In this contribution, the authors did not focus at all on financial data of the companies that were identified: The value of their coin, their profits, and their margins were not analyzed. These data points—if possible—should be included by scholars in future.

On another note, entrepreneurs' and developers' key takeaways from this paper should be the emergence of five research propositions, whose investigation should help them in identifying their next steps in the ideation and creation of BCT applications in marketing. In the descriptions of the companies, the authors learned that their provision of rationale for the use of BCT differ significantly, as well as the type of BCT they use. We thus propose:

rp1: What are the requirements and motivation demanding BCT in marketing?

The authors have superficial information about the amount of companies, which exist, or ceased to exist, in marketing between 2017 and 2020. Though it is still unclear, which procedures the companies chose to design, test and/or employ BCT. We thus propose:

rp2: What are the requirements design, test and employment approaches aimed at meeting?

For the use cases enlisted by the authors, the main BCT characteristics presented in section 2 are not weighted equally. At some point, the negative consequences of, e.g. consensus (e.g. the energy consumption),

⁹ <https://loyyal.com/>.

¹⁰ <https://openbazaar.org/>.

¹¹ <https://www.mobius-software.com/>.

¹² <https://augur.net/>.

¹³ <https://wibson.io/>.

¹⁴ <https://sovrin.org/>.

¹⁵ <https://datum.org/>.

might outweigh the positive consequences (e.g. minimization of necessary trust). We thus propose:

rp3: Who are the entities subject to trust, immutability, transparency, programmability, decentralization and consensus evaluation?

Research on the topics suggested in rp3 encompass not only BCT use cases, but also other branches as information science (trust, programmability, decentralization, consensus), jurisprudence (trust, transparency, decentralization), psychology (trust, transparency, consensus) and engineering (programmability). We thus propose:

rp4: What are the strengths and limitations of employing BCT in marketing-related systems?

On a more detailed note, the authors depicted in sections 5 and 6 the intra-group differences in developments of BCT applications in marketing. This is counterintuitive taking into consideration the centralization effect of “the winner takes it all” aspects of marketing technology and its network effects already affecting the mining process, too [77], though it reflects the growth in applications shown by Scott Brinker in his Landscape [16]. We thus propose:

rp5: What are the features and functionalities provided by the BCT that are relevant and necessary to differentiate from other applications?

BCT is still in its infancy, but it is crawling its way towards the cookie jar. The authors provided future directions for researchers on and development of tools to systematically generate knowledge and improve the application of BCT and the work of practitioners in marketing.

Author contributions

Valerio Stallone: Conceptualization, methodology, validation, formal analysis, investigation, resources, data curation, writing (original draft), visualization, project administration; **Martin Wetzels:** Methodology, software, supervision; **Michael Klaas:** Resources, writing-reviewing and editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- [1] MSI, Research Priorities 2020–2022, 2019. Available online, https://www.msi.org/wp-content/uploads/2020/06/MSI_RP20-22.pdf. (Accessed 3 November 2020).
- [2] G. Ishmaev, The ethical limits of blockchain-enabled markets for private IoT data, *Philos. Technol.* 33 (2020) 411–432, <https://doi.org/10.1007/s13347-019-00361-y>.
- [3] K. Werbach, Trust, but verify: why the blockchain needs the law, *Berk. Technol. Law J.* 33 (2018) 489, <https://doi.org/10.2139/ssrn.2844409>.
- [4] J. Lake, Hey, you stole my avatar!: virtual reality and its risks to identity protection, *Emory Law J.* 69 (2019) 833–879.
- [5] M.L. Wu, K. Wang, X.Q. Cai, et al., A comprehensive survey of blockchain: from theory to IoT applications and beyond, *IEEE Internet Things J.* 6 (5) (2019) 8114–8154, <https://doi.org/10.1109/JIOT.2019.2922538>.
- [6] R. Alt, *Electronic Markets on blockchain markets*, *Electron. Mark.* (2020) 181–188. Springer.
- [7] D. Tapscott, A. Tapscott, *Blockchain Revolution: How the Technology behind Bitcoin Is Changing Money, Business, and the World*, Penguin, 2016.
- [8] Edelman, *Edelman Trust Barometer*, 2020. Available online, https://www.edelman.com/sites/g/files/aatuss191/files/2019-05/2019_Edelman_Trust_Barometer_Women_and_Trust_Report.pdf. (Accessed 6 July 2020).
- [9] I. Antoniadis, S. Kontsas, K. Spinthiropoulos, *Blockchain applications in marketing*, in: 7th ICCMI 2019 International Conference on Contemporary Marketing Issues, 2019.
- [10] C.R. Harvey, C. Moorman, M. Toledo, How blockchain can help marketers build better relationships with their customers, Available online, <https://hbr.org/2018/10/how-blockchain-can-help-marketers-build-better-relationships-with-their-customers>, 2018. (Accessed 6 July 2019).
- [11] A. Boukis, Exploring the implications of blockchain technology for brand–consumer relationships: a future research agenda, *J. Prod. Brand Manag.* 29 (2019) 307–320, <https://doi.org/10.1108/JPBM-03-2018-1780>.
- [12] M. Holler, L. Barth, R. Fuchs, Trustworthy product lifecycle management using blockchain technology—experience from the automotive ecosystem., *The Case Studies*, in: J. Stark (Ed.), *Product Lifecycle Management Volume 4*, Springer, Cham, 2019, pp. 13–19.
- [13] M.R. Gleim, J.L. Stevens, Blockchain: a game changer for marketers? *Market. Lett.* 32 (2021) 123–128, <https://doi.org/10.1007/s11002-021-09557-9>.
- [14] N. Saurabh, C. Rubia, A. Palanisamy, et al., The ARTICONF approach to decentralized car-sharing, *Blockchain Res. Appl.* (2021), 100013, <https://doi.org/10.1016/j.bcr.2021.100013>.
- [15] A. Ertemel, Implications of blockchain technology on marketing, *J. Int. Trade Logist. Law* 4 (2) (2018) 35–44.
- [16] Chief Marketing Technologist Blog, *chiefmartec.com*, Marketing technology landscape supergraphic (2020): martech 5000—really 8,000, but who’s counting?, Available online, <https://chiefmartec.com/2020/04/marketing-technology-landscape-2020-martech-5000/>, 2020. (Accessed 11 November 2020).
- [17] Never Stop Marketing, *Blockchain Marketing Technology Landscape*, 2019. Available online, <https://www.neverstopmarketing.com/wp-content/uploads/2019/02/NSM-Brave-Blockchain-Landscape-Final-2-17-19.pdf>. (Accessed 23 June 2019).
- [18] H. Treiblmaier, Toward more rigorous blockchain research: recommendations for writing blockchain case studies, *Front. Blockchain* 2 (2019) 1–31, <https://doi.org/10.3389/fbloc.2019.00003>.
- [19] D. Moher, A. Liberati, J. Tetzlaff, et al., Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement, *PLoS Med.* 6 (2009), e1000097, <https://doi.org/10.1371/journal.pmed.1000097>.
- [20] P. Rosenberger, Satoshi Nakamoto, in: *Bitcoin and Blockchain*, Springer Berlin Heidelberg, Berlin, Heidelberg, 2018, pp. 25–34.
- [21] D. Drescher, *Blockchain Basics: A Non-technical Introduction in 25 Steps*, first ed., Apress, Berkeley, CA, 2017.
- [22] N.K. Ostern, Blockchain in the IS research discipline: a discussion of terminology and concepts, *Electron. Mark.* 30 (2020) 195–210, <https://doi.org/10.1007/s12525-019-00387-2>.
- [23] F. Casino, T.K. Dasaklis, C. Patsakis, A systematic literature review of blockchain-based applications: current status, classification and open issues, *Telematics Inf.* 36 (2019) 55–81, <https://doi.org/10.1016/j.tele.2018.11.006>.
- [24] L. Oliveira, L. Zavolokina, I. Bauer, et al., To token or not to token: tools for understanding blockchain tokens, in: *ICIS 2018 Proceedings*, 2018, pp. 1–17. San Francisco, CA, USA.
- [25] B. Shrestha, M.N. Halgamuge, H. Treiblmaier, Using blockchain for online multimedia management: characteristics of existing platforms, in: *Blockchain and Distributed Ledger Technology Use Cases*, Springer, Cham, 2020, pp. 289–303.
- [26] D. Boreiko, G. Vidusso, New blockchain intermediaries: do ico rating websites do their job well? *J. Altern. Investments* 21 (2019) 67–79, <https://doi.org/10.3905/jai.2019.21.4.067>.
- [27] Y. Li, T. Marier-Bienvenue, A. Perron-Brault, et al., Blockchain technology in business organizations: a scoping review, in: *Proceedings of the 51st Hawaii International Conference on System Sciences*, Big Island, HI, USA, 2018, pp. 4474–4483.
- [28] I. Konstantinidis, G. Siaminos, C. Timplalexis, et al., Blockchain for business applications: a systematic literature review, in: *Lecture Notes in Business Information Processing*, Springer, 2018, pp. 384–399.
- [29] L. Ismail, H. Materwala, A review of blockchain architecture and consensus protocols: use cases, challenges, and solutions, *Symmetry (Basel)* 11 (2019), <https://doi.org/10.3390/sym11101198>, 1198.
- [30] W. Chen, Z. Xu, S. Shi, et al., A survey of blockchain applications in different domains, in: *Proceedings of the 2018 International Conference on Blockchain Technology and Application - ICBTA 2018*, ACM Press, New York, NY, USA, 2018, pp. 17–21.
- [31] J. Scherf, *Blockchain im Marketing*, vol. 1, neopubli GmbH, Berlin, Germany, 2020.
- [32] M. Pärssinen, M. Kotila, R. Cuevas, et al., Is blockchain ready to revolutionize online advertising? *IEEE Access* 6 (2018) 54884–54899, <https://doi.org/10.1109/ACCESS.2018.2872694>.
- [33] A. Rejeb, J.G. Keogh, H. Treiblmaier, How blockchain technology can benefit marketing: six pending research areas, *Front. Blockchain* 3 (2020), <https://doi.org/10.3389/fbloc.2020.00003>, 3.
- [34] C.R. Harvey, C. Moorman, M. Castillo Toledo, How blockchain will change marketing as we know it, *SSRN* (2018), <https://doi.org/10.2139/ssrn.3257511>.
- [35] J. Macnamara, M. Lwin, A. Adi, et al., “PESO” media strategy shifts to “SOEP”: opportunities and ethical dilemmas, *Publ. Relat. Rev.* 42 (2016) 377–385, <https://doi.org/10.1016/j.pubrev.2016.03.001>.
- [36] J. Li, A. Grintsvayg, J. Kauffman, et al., LBRY: a blockchain-based decentralized digital content marketplace, in: S.M. Danish, M. Müller, M. Kuperberg (Eds.), *2020 IEEE International Conference on Decentralized Applications and Infrastructures, IEEE, Piscataway, NJ, USA, 2020*, pp. 42–51.
- [37] I. Tarkhanov, D. Fomin-Nilov, M. Fomin, Application of public blockchain to control the immutability of data in online scientific periodicals, *Library Hi Tech.* 37 (4) (2019) 829–844, <https://doi.org/10.1108/LHT-12-2018-0186>.

- [38] H.R. Hasan, K. Salah, Combating deepfake videos using blockchain and Smart contracts, *IEEE Access* 7 (2019) 41596–41606, <https://doi.org/10.1109/ACCESS.2019.2905689>.
- [39] N. Barman, G.C. D, M.G. Martini, Blockchain for video streaming: opportunities, challenges, and open issues, *Computer* 53 (7) (2020) 45–56, <https://doi.org/10.1109/mc.2020.2989051>.
- [40] W. Hao, J. Zeng, X. Dai, et al., Towards a trust-enhanced blockchain P2P topology for enabling fast and reliable broadcast, *IEEE Trans. Netw. Serv. Manag.* 17 (2) (2020) 904–917, <https://doi.org/10.1109/TNSM.2020.2980303>.
- [41] S. Saxena, B. Bhushan, D. Yadav, Blockchain-powered social media analytics in supply chain management, *SSRN* (2020), <https://doi.org/10.2139/ssrn.3598906>.
- [42] B. Guidi, When blockchain meets online social networks, *Pervasive Mob. Comput.* 62 (2020), <https://doi.org/10.1016/j.pmcj.2020.101131>, 101131.
- [43] J. Ahmed, S. Yildirim, M. Nowostawski, et al., Towards blockchain-based GDPR-compliant online social networks: challenges, opportunities and way forward, in: *Advances in Intelligent Systems and Computing*, Springer, Cham, France, 2020, pp. 113–129.
- [44] T.M. Choi, S. Guo, S. Luo, When blockchain meets social-media: will the result benefit social media analytics for supply chain operations management? *Transp. Res. Part E Logist. Transp. Rev.* 135 (2020) <https://doi.org/10.1016/j.tre.2020.101860>, 101860.
- [45] C. Li, B. Palanisamy, Incentivized blockchain-based social media platforms: a case study of steemit, in: *Proceedings of the 10th ACM Conference on Web Science - WebSci '19*, ACM Press, New York, NY, USA, 2019, pp. 145–154.
- [46] R. Zhang, J. Park, R.F. Ciriello, The differential effects of cryptocurrency incentives in blockchain social networks, in: *Pre-ICIS Workshop on Blockchain and Smart Contract (SIGBPS2019)*, Munich, Germany, 2019, pp. 1–5.
- [47] B. Guidi, K.G. Kapanova, K. Koidl, et al., The contextual ego network P2P overlay for the next generation social networks, *Mobile Network. Appl.* 25 (2020) 1062–1074, <https://doi.org/10.1007/s11036-020-01525-3>.
- [48] V. Stallone, A. Collenberg, A. Ruedlinger, et al., The application of blockchain technology in loyalty programs, in: P. Isaias (Ed.), *IADIS International Conference WWW/Internet*, 2020, pp. 11–18.
- [49] M. Agrawal, D. Amin, H. Dalvi, et al., Blockchain-based universal loyalty platform, in: *International Conference on Advances in Computing, Communication and Control (ICAC3)*, 20–21 Dec 2019, Mumbai, India, IEEE, Piscataway, NJ, USA, 2019, pp. 1–6, 2019.
- [50] D. Agrawal, N. Natalia, G. Gopalakrishnan, et al., Loyalty points on the blockchain, *Business and Management Studies* 4 (3) (2018) 80–92, <https://doi.org/10.2139/ssrn.3246395>.
- [51] J. Choi, Modeling the intergrated customer loyalty program on blockchain technology by using credit card, *Int. J. Futur. Revolut. Comput. Sci. Commun. Eng.* 4 (2) (2018) 388–391.
- [52] A. Brandão, H.S. Mamede, R. Gonçalves, Trusted data's marketplace, in: Á. Rocha, H. Adeli, L. Reis (Eds.), *New Knowledge in Information Systems and Technologies. WorldCIST'19 2019. Advances in Intelligent Systems and Computing* 930, Springer, Cham, France, 2019, pp. 515–527.
- [53] P. Sharma, S. Lawrenz, A. Rausch, Towards trustworthy and independent data marketplaces, in: *ICBCT'20: Proceedings of the 2020 The 2nd International Conference on Blockchain Technology*, 12–14 Mar 2020, Hilo, HI, USA, Association for Computing Machinery, New York, NY, USA, 2020, pp. 39–45.
- [54] M. Travizano, C. Sarraute, M. Dolata, et al., Wibson: a case study of a decentralized, privacy-preserving data marketplace, in: *Blockchain and Distributed Ledger Technology Use Cases*, Springer, Cham, France, 2020, pp. 149–170.
- [55] W. Dai, C. Dai, K.K.R. Choo, et al., SDTE: a secure blockchain-based data trading ecosystem, *IEEE Trans. Inf. Forensics Secur.* 15 (2020) 725–737, <https://doi.org/10.1109/TIFS.2019.2928256>.
- [56] S.M. Shorman, M. Allaymounq, O. Hamid, Developing the E-commerce model a consumer to consumer using blockchain network technique, *Int. J. Manag. Inf. Technol.* 11 (2019), <https://doi.org/10.2139/ssrn.3407739>.
- [57] A.K. Shrestha, S. Joshi, J. Vassileva, Customer data sharing platform: a blockchain-based shopping cart, 2020 *IEEE International Conference on Blockchain and Cryptocurrency (ICBC)*, 2–6 May 2020, Toronto, ON, Canada (2020) 1–3, <https://doi.org/10.1109/ICBC48266.2020.9169421>, 2020.
- [58] Gartner, *The Digital Marketing Transit Map*, 2020. Available online, <https://www.gartner.com/en/marketing/research/the-digital-marketing-transit-map>. (Accessed 19 November 2020).
- [59] D. Jayaram, A.K. Manrai, L.A. Manrai, Effective use of marketing technology in Eastern Europe: web analytics, social media, customer analytics, digital campaigns and mobile applications, *J. Econ. Financ. Adm. Sci.* 20 (39) (2015) 118–132, <https://doi.org/10.1016/j.jefas.2015.07.001>.
- [60] N. Gusic, V. Stallone, The digital advertising ecosystem - status quo, challenges and trends, in: P. Kommers, B. Bontchev, P. Isaias (Eds.), *IADIS International Conference E-Society 2020*, 2–4 Apr 2020, virtual conference, IADIS Press, 2020, pp. 36–42.
- [61] C. Alaimo, J. Kallinikos, *Objects, Metrics and Practices: an Inquiry into the Programmatic Advertising Ecosystem. Living with Monsters? Social Implications of Algorithmic Phenomena, Hybrid Agency, and the Performativity of Technology* vol 543, Springer, Cham, France, 2018, pp. 110–123.
- [62] C.F. Durach, T. Blesik, M. Düring, et al., Blockchain applications in supply chain transactions, *J. Bus. Logist.* 42 (1) (2020) 7–24, <https://doi.org/10.1111/jbl.12238>.
- [63] S. Eskandari, A. Leoutsarakos, T. Mursch, et al., A first look at browser-based cryptojacking, in: *Proceedings - 3rd IEEE European Symposium on Security and Privacy Workshops, EURO S and PW 2018*, 23–27 Apr 2018, London, UK, IEEE, Piscataway, NJ, USA, 2018, pp. 58–66.
- [64] N. Nizamuddin, H. Hasan, K. Salah, et al., Blockchain-based framework for protecting author royalty of digital assets, *Arabian J. Sci. Eng.* 44 (4) (2019) 3849–3866, <https://doi.org/10.1007/s13369-018-03715-4>.
- [65] T. Kollmann, S. Hensellek, K. de Cruppe, et al., Toward a renaissance of cooperatives fostered by Blockchain on electronic marketplaces: a theory-driven case study approach, *Electron. Mark.* 30 (2020) 273–284, <https://doi.org/10.1007/s12525-019-00369-4>.
- [66] F. Regner, N. Urbach, A. Schweizer, NFTs in practice – non-fungible tokens as core component of a blockchain-based event ticketing application, in: *ICIS 2019 Proceedings*, Munich, Germany, 2019, pp. 1–17.
- [67] A. Newitz, Who wants to be an animated gif millionaire? *New Sci.* 249 (3326) (2021) [https://doi.org/10.1016/s0262-4079\(21\)00467-x](https://doi.org/10.1016/s0262-4079(21)00467-x).
- [68] T. Kim, H. Shin, H.J. Hwang, et al., Posting bot detection on blockchain-based social media platform using machine learning techniques, in: *15th International Conference on Web and Social Media*, 2020.
- [69] V. Stallone, A. Collenberg, A. Ruedlinger, et al., The application of blockchain technology in loyalty programs, in: *IADIS International Conference WWW/Internet 2020*, 2020, pp. 11–18.
- [70] H.P. Bulsara, P.S. Vaghela, Blockchain technology for e-commerce industry, *Int. J. Adv. Sci. Technol.* 29 (5) (2020) 3793–3798.
- [71] J.E. Arps, N. Christin, Open market or ghost town? The curious case of OpenBazaar, in: J. Bonnaeu, N. Heninger (Eds.), *Financial Cryptography and Data Security. FC 2020. Lecture Notes in Computer Science*, vol 12059, Springer, Cham, France, 2020, pp. 561–577.
- [72] N. Christin, *A Queryable Platform for Online Crime Repositories*, 2020. Available online, <https://apps.dtic.mil/sti/citations/AD1100866>. (Accessed 29 November 2020).
- [73] R. White, Y. Marinakis, N. Islam, S. Walsh, Is Bitcoin a currency, a technology-based product, or something else? *Technological Forecasting and Social Change* 151 (2020) 119877, <https://doi.org/10.1016/j.techfore.2019.119877>.
- [74] O.R. Kabi, V.N.L. Franqueira, Blockchain-based distributed marketplace, in: *Lecture Notes in Business Information Processing*, Springer, 2019, pp. 197–210.
- [75] A. Carvalho, A permissioned blockchain-based implementation of LMSR prediction markets, *Decis. Support Syst.* 130 (2020), 113228, <https://doi.org/10.1016/j.dss.2019.113228>.
- [76] A. Satybaldy, M. Nowostawski, J. Ellingsen, Self-sovereign identity systems: evaluation framework, in: *IFIP Advances in Information and Communication Technology*, Springer, 2020, pp. 447–461.
- [77] N. Leonardos, S. Leonardos, G. Piliouras, *Oceanic Games: Centralization Risks and Incentives in Blockchain Mining. Mathematical Research for Blockchain Economy*, Springer, Cham, France, 2020, pp. 183–199.
- [78] M.J.P. Anson, F.J. Fabozzi, F.J. Jones, *The Handbook of Traditional and Alternative Investment Vehicles*, John Wiley & Sons, Inc., Hoboken, NJ, USA, 2010.