Emerging Technologies: A Catalyst for Sustainable Business Model Innovation

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Abstract: Grand Challenges are global problems requiring coordinated effort from stakeholders at different levels. For-profit businesses, as loci of innovation, can play a pivotal role in advancing Grand Challenges by fostering social impact collaboration. Business Model Innovation is a useful mean to combine the possibilities offered by emerging technologies with the needs of sustainable challenges. Blockchain is widely recognized as an emerging technology, rapidly growing, highly novel and with a prominent impact on different sectors. We adopt a Comparative Case Study in the field of the Voluntary Carbon Market, unregulated markets where organizations can offset their impact by compensating their negative externalities on the environment by buying carbon credits generated through certified mitigation projects following international standards. As climate change is a main Grand Challenges and a threat to humanity, as recognized by the United Nations Sustainable Development Goals, this research aims to explore the role of blockchain as a catalyst for Sustainable Business Model Innovation. This study makes two significant contributions to the field of business model innovation, emerging technologies and Grand Challenges. First, it highlights the importance of Business Model Innovation to address Grand Challenges and overcome their managerial problems, including valuating, coordination, trust, access and reach. Our study presents a novel conceptual model anchored in the Business Model as an activity system view, revealing three actionable characteristics of blockchain that can help to design novel activities configurations able to advance managerial problems encountered by for-profit organizations while advancing effort towards Grand Challenges: asset enabler, trust machine and coordinated and collaborative action enhancer. Second, from a technology-oriented perspective, it offers insights into how an emerging technology can be leveraged to foster complementarity by converging with existing assets and technologies, thereby generating new value. For practice, our findings provide a framework for both startups and established companies to leverage blockchain technologies to create meaningful and lasting impact.

Keywords: Business Model Innovation, Grand Challenges, Emerging Technology, Blockchain, Tokens, DAO.

1. Introduction

Resource scarcity, climate change, inequalities, poverty, inequal access to good health and quality education are among the most urging societal challenges the world is experiencing nowadays. These critical social and environmental issues have been called "Grand challenges" (GCs), which are wicked issues with complex, no clear and unequivocal solution (George, Howard-Grenville, Joshi, & Tihanyi, 2016; Voegtlin, Scherer, Stahl, & Hawn, 2022). In a globalized society, these threats are increasingly influencing public opinion; addressing them effectively requires a collaborative mobilization of governments, businesses and individuals (Grodal & O'Mahony, 2017; Howard-Grenville & Spengler, 2022).

Firms play a central role as a "locus of innovation", and an increasing number of organizations are seeking to achieve both profit, social and environmental impact (Porter & Kramer, 2011).

For this purpose, technology can be a useful tool to conjugate the possibilities offered by new technologies with the needs of the sustainable challenges (Foss & Saebi, 2017; George et al., 2016). This research adopts a technology-oriented perspective to investigate the properties of an emerging technology, blockchain, that has been identified form the literature as highly transformative for its contexts of application (Holotiuk, Pisani, & Moormann, 2019), trying to shed light on how it can generate new sustainable business models. To accomplish this purpose, we conduct an inductive multiple case study (Eisenhardt & Graebner, 2007; Gioia, Corley, & Hamilton, 2013; Yin, 1984) in the field of the Voluntary Carbon Market (VCM) and present a novel conceptual model, anchored in the business model as activity-system view (Zott & Amit, 2010). Our study proposes three blockchain actionable characteristics for sustainable business model innovation: asset enabler, trust machine

and coordinated and collaborative action enhancer. By adopting a technology-perspective towards sustainability, we advance the consolidated work on technology diffusion (Rotolo et al., 2015; Tushman & Anderson, 1986; Utterback & Abernathy, 1975), by "opening the black box" of an emerging technology while understanding how they can affects business models.

2. Literature Review

The most relevant definition of GCs has been done by George and colleagues (2016), that describe them as "*formulations of global problems that can be plausibly addressed through coordinated and collaborative effort*" (George et al., 2016; Howard-Grenville et al., 2019). Namely, GCs call for a coordinated and consistent effort from a wide range of stakeholders from different levels of organizations and society, for alterations in the way economic activities are planned and carried out and for advancements in tools and technology (George et al., 2016).

Business model innovation (BMI) is increasingly recognized as a key driver to deliver greater social and environmental sustainability in the industrial system, as it entails holistic changes to how business is conducted on multilevel and multistakeholder dimension (Klein, Spieth, & Heidenreich, 2021). To this extent, Zott and Amit (2010) define the business model as "*a system of activities, as well as the resources and capabilities to perform them, through which a focal firm creates and captures value*". A business model can be described in term of content of activities, their structure (how there are connected) and governance (who perform them). An activity system is also characterized by different dominant logics to achieve value creation: Novelty, efficiency, complementarities and lock-in (Zott & Amit, 2010). BMI regards changes to the key elements of a firm's business model and the architecture of the activity system (Zott, Amit, & Massa, 2011).

Sustainable business model innovation is defined as the incorporation of heterogeneous logic within business, considering the so-called economic, environmental and social "triple bottom line"(Bocken et al., 2014). To this regard, George and colleagues (2021) attempted to distill Grand Challenges into six managerial problems, that undermine firms' efforts to drive sustainable change: problems of knowing, valuating, communicating, coordination and trust, access and reach and institution.

According to recent literature, the use of technologies may enable BMI potentially with a sustainable-oriented purpose (Foss and Saebi, 2017). Emerging technologies, such as fifth generation (5G) cellular technologies, autonomous cars, blockchain, internet of things, and machine learning, have enormous value-creation potential in a broad range of applications (Snihur, Zott, & Amit, 2021; Teece, 2018). Emerging technology–enabled business model innovation simultaneously affects customers, suppliers, strategic partners, and others who participate in the ecosystem, creating new needs for stakeholders, so that novel resource configuration could arise (Amit & Han, 2017; George et al., 2021). Blockchain can be classified as an emerging technology, as it fulfills the characteristics of radical novelty, fast growth, coherence, prominent impact, uncertainty and ambiguity, identified by Rotolo, Hicks and Martin (2015). However, these characteristics are not fundamental technological traits, but rather factors that explain the diffusion and impact of a technology, allowing it to be classified as "emergent" and advancing the consolidated work on technology diffusion (Tushman & Anderson, 1986; Utterback & Abernathy, 1975; Rotolo-et-al, 2015).

It is instead left apart how the inner characteristics of the emerging technology may be used as levers for business model innovation (Foss and Saebi, 2017). Therefore, recognizing the emergent nature of blockchain and the possible consequent implications in terms of BMI and GCs, the research questions investigated in this study is *"How blockchain enables the design of Grand Challenge-oriented business models?".*

3. Methodology

The theoretical background on which the research is based allows to identify the research question at the intersection between GCs, BMI and emerging technologies literatures. The unit of analysis aim of this research are the technological features of blockchain that enable new sources innovation in the business model design elements proposed by Zott & Amit (2010) in their activity-system view, and how they tackle the managerial problems formulated by George and colleagues (2021).

Blockchain impact on sustainable business models is a research field still unexplored, from which new theory can emerge (Eisenhardt, 1989). As a result, it is advantageous to proceed with qualitative research. More specifically, it was chosen to conduct an inductive multiple case study, as more robust if compared to a single case study (Eisenhardt, 1989; Yin, 1984).

3.1 Empirical Setting and Case Sampling

Climate change is currently considered one of the most critical challenges to face in the next years, representing a proper threat for human as species (Pörtner & Roberts, 2022). The primary issue with climate change is the rising concentration of greenhouse gases in the atmosphere, which causes global warming. However, in most industries, there is no penalty for causing air pollution. Carbon markets can be an effective tool for internalizing the negative externalities associated with greenhouse gas emissions. Voluntary Carbon Markets (VCM) are non-regulated markets, in which organizations participate based on self-imposed emissions reduction goals. Here, actors can offset their impact by buying carbon credits that are generated through the development of mitigation projects that follow precise international methodologies and that are verified and certified by external accreditation entities. These projects usually allow the reduction or removal of emission production in the atmosphere (Ieta, 2021).

According to the Taskforce on Scaling Voluntary Carbon Markets, the demand for carbon credits could increase by a factor of 100 by 2050. However, the market is characterized by some problems that prevent it to scale up: measurement technical issues, heterogeneity and illiquidity of carbon credits, greenwashing concerns, opaqueness and fragmentation, entry barriers and lack of regulation (McKinsey, 2021). Practitioners are growing more confident in the use of Blockchain technologies to better collaborate in the fight against climate change and for decarbonizing the global economy. The growing interest in the area is evidenced by the astonishing number of new companies that are beginning to develop novel solutions adopting blockchain for carbon markets (Morgan Stanley, 2022).

Table 1: Sample selection

Company	Value-chain position	Blockchain protocol	Headquarter Basis	Maturity stage
Company A	Integrated	Polygon	Singapore	Low $ 530.000
Company B	Integrated	Azure Distributed Ledger	Australia	Low $ 1.400.000
Company D	Demand side	Polygon	USA	High $ 14.410.000
Company C	Integrated	Cosmos	USA	High $ 10.500.000

The sampling approach was thus theoretical, as high quality case study research needs to be based on cases chosen for appropriate theoretical reasons, chosen for the likelihood that they will offer theoretical insight (Eisenhardt & Graebner, 2007).

The main source utilized to gather blockchain-based startups for the selection process was Pitchbook, a subscription-based website that delivers data and research covering private capital markets, including venture capital and private equity. Companies were searched including keywords such as “Blockchain” AND “Sustainability” or “Blockchain” AND “Environmental services”. To produce a heterogeneous sample within the "region of homogeneity" subject of our analysis, we considered different cases considering value chain position in the market, adopted blockchain protocol, geographic location and maturity stage, as shown in table 1. Once the initial sample was sufficiently large, it was filtered to select the most notable cases. As a conclusion of the case selection phase, a final sample of 4 blockchain-based startups were extracted and investigated: Company A, Company B, Company C and Company D.

3.2 Data Collection and Analysis

The four cases were subjected to semi-structured interviews with founders and C-levels over two distinct waves. The results of this phase of the research were recorded, for a total of 380 minutes of material, and transcribed, for a total of 107 pages. According Eisenhardt (1989) and Yin (1984), who argue that the use of multiple sources of information improves the overall rigor of a case study, the final outcome of primary data was “triangulated” with secondary sources, coming from the companies’ websites, whitepapers and from third party articles, in order to generate more robust results for the qualitative research.

Following the data collection phase, data analysis was carried out to support the research discussion. Ground theory methodology (Strauss & Corbin, 1998) was adopted to study each case according to an open coding practice, allowing to investigate complex phenomena using labels, thus generating theory from interviews. Collected data allowed the generation of in-vivo codes dataset and the analysis following constant comparative method (Gioia et al., 2013). Subsequently, a comparison of codes from the different cases was carried out to obtain the formulation of first-order concepts. Following the identification of first-order concepts, second-order themes were created to achieve a higher level of abstraction by linking the previously identified concepts to more theoretical constructs. The second-order codes were then aggregated into two major overarching dimensions taken from the two theoretical constructs that underpin the research: (1) *Grand Challenges managerial problems*, based on George and colleagues (2021) work; (2) *Business model design themes* routed in Zott & Amit (2010) seminal work.

With reference to cross-case analysis, we looked for similarities and differences at different abstraction levels (first order concepts, second order themes and overarching dimensions) to compare the differences between the four cases, allowing for novel findings (Eisenhardt, 1989). Finally, a further analysis crossed similarities within first order concept and second order themes of the two overarching dimensions. In this way, the correlation between Grand Challenges managerial problems and design themes was investigated. The final result was graphically represented using coding trees (Gioia et al., 2013).

4. Results

The cross-case analysis, carried out triangulating primary data coming from interviews with secondary data, has been the foundation for the conceptual framework described in figure 1.

According to the findings, blockchain can successfully contribute by addressing the heterogeneity and illiquidity issues of carbon markets (*problem of valuating*) – while allowing to tokenize and fractionalize carbon credits.

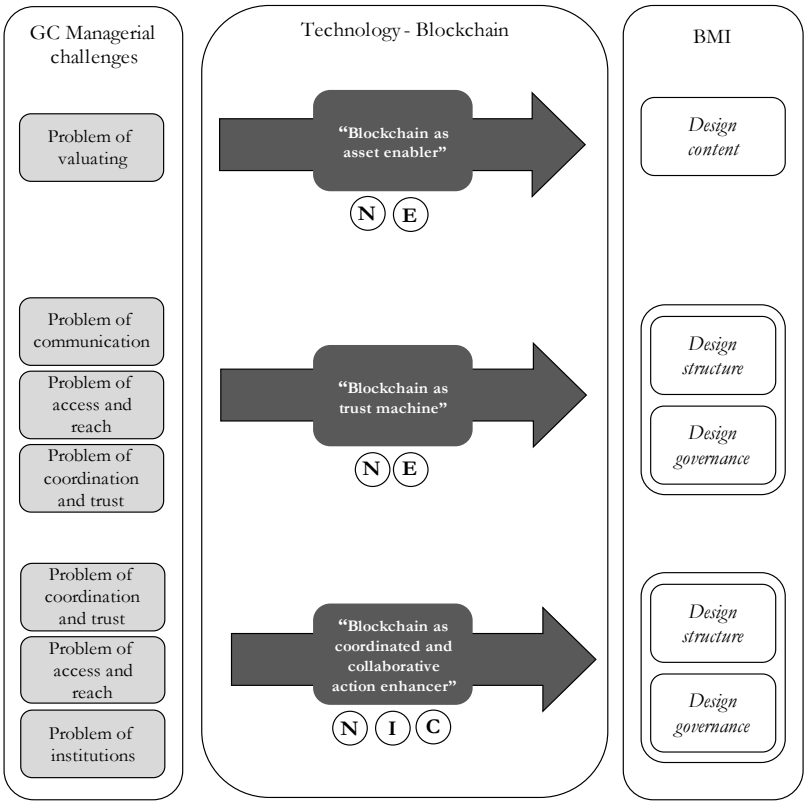
Carbon credit baskets aggregate credits from comparable carbon offsetting initiatives, boosting the homogeneity of the supply of carbon credits. Increased liquidity results in correct price discovery for each credit class. Concerning *problem of communicating*, blockchain may be a reliable mean to fight greenwashing as in the distributed ledger, all the transactions are immutably recorded in the ledger. All the startups evaluated addressed the opaqueness and fragmentation issues of voluntary carbon markets (*problem of coordination and trust*). Blockchain, due to its peer-to-peer nature, might promote higher degrees of disintermediation within the activity-system towards carbon credit brokers, traders, and merchants thus lowering transaction costs. Blockchain makes also possible to establish new roles or coordination mechanisms. For example, new methodologies can be proposed with open innovation approaches and validated through decentralized governance mechanisms, as in Company C, or peer-to-peer lending mechanisms enabled, as in Company A.

As a result, blockchain can help by providing the tools for removing entry barriers (*problem of access and reach*) both in the demand side and in the supply side. Finally, blockchain may fill institutional void or failures (*problem of institutions*), serving as a global distributed platform infrastructure for transacting carbon credits, without heavy reliance on trust intermediaries.

Regarding the design themes overarching dimension (Zott and Amit, 2010), the cross-case analysis suggests that blockchain promotes *novelty* mostly through tokens. It is critical to distinguish between governance tokens, which reflect the DAO's governance and consensus mechanism, and utility tokens, which represent on-chain carbon credit revival. Governance tokens enable new forms of decentralized governance, resulting in new forms of organizations (DAOs), where token holders can take part in the decision-making process. As such, tokenization may enhance the *efficiency* of carbon markets, demonstrating a strong association between value creation sources. The distributed ledger and the use of smart contracts to automate trustless transactions are also tied to efficiency. The improved openness and accountability of the decentralized ledger aid in the decrease of information asymmetry. Finally, transaction costs are drastically reduced by the possibility of decreasing the of reliance on intermediaries on both the demand and supply side.

Concerning the value source of *complementarity*, two main insights emerge. First, the application of blockchain is empowered with the usage of a combination of other emerging technologies (i.e., Sensors and satellites) to innovate the measurement, reporting and verification process. Second, it has been founded that blockchain enabled activity systems exhibit composability, enabling new organizational models (i.e., Decentralized Autonomous Organizations) that encourage open-source and cooperation logics. Finally, regarding the *lock-in* design theme, the use of governance tokens and the development of DAOs allow investors to become more closely associated with the businesses, allowing them to take part in decision-making and share in the profits.

Figure 1: Conceptual Framework.



5. Discussion and Conclusions

According to George and colleagues (2016) "*Grand Challenges are formulations of global problems that can be plausibly addressed through coordinated and collaborative effort"*. This study contributes to the call by Bocken, Heidenreich, Spieth, Tucci and Zott (2022), who asked researchers to investigate business model innovation as a mean to address Grand Challenges. By drawing on the case of voluntary carbon market, we get to explore how blockchain can contribute to the improvement of sustainable issues. In particular, our contribution is twofold.

First, we provide a theoretical contribution to the BMI and GCs literatures by studying business model innovation as a means of addressing Grand Challenges. Building on the business model construct proposed by Zott & Amit (2010) in their activity-system view, our framework (fig.1) illustrates three features that characterize blockchain as enabler of novel forms of design content, structure and governance; specifically, blockchain acts as *asset enabler*, as *trust machine* and as *coordinated and collaborative action enhancer*.

Blockchain acts as an *asset enabler* as it adds the fundamental attribute of "ownership" to the internet we use today, allowing new asset classes to emerge: Governance tokens, which are built natively on-chain, govern the consensus mechanism of blockchain protocols and projects, as well as offering new kinds of stake, rights, and participation (F. Glaser, 2017); Tokenized assets, that are digital twins of current real assets that are represented and transferrable on the distributed ledger (Gan, Tsoukalas, & Netessine, 2021; George et al., 2021).Tokens may serve as a new source of *design content*, as they entail new activities related to the design of tokens, such as defining the conditions under which participants can earn new tokens for contributing resources to the network, or defining the rights associated with token ownership (Catalini & Gans, 2020; Forman et al., 2019; F. Glaser, 2017). For sustainable development, tokens can contribute to the problem of valuation, as they might change the manner of how we assess and value ecological and social assets. Accordingly, individual may gain access to asset classes and risks that may have been otherwise beyond their capacity, as it is possible to slice or group data into compact packets to create wider fractionalization and distribution of risk and ownership (Santos, Pache, & Birkholz, 2015).

Blockchain as *trust machine* property is linked to the nature of its distributed ledger and consensus mechanism. Smart contracts enable multiple parties who do not trust one another to engage in exchanges of value when

certain conditions are met (Catalini & Gans, 2020; Forman et al., 2019; Murray, Kuban, Josefy, & Anderson, 2021). Our study suggests that blockchain technology enhance trust and transparency by reducing costs and time for validating trading partners, freeing actors to trade in a large-scale decentralized fashion, without the need for a trustworthy intermediary (Bailey & Bakos, 1997; Malone, Yates, & Benjamin, 1987; Zott et al., 2011). Thus, our research suggest blockchain may enable new forms of *design structure and governance*, by the mean of an increased efficiency in the activity system.

Trust is important in many areas of sustainability, especially where there is an exchange of goods or services that have a social or ecological impact; these must be transparently communicated to the stakeholders and no mechanisms of opportunistic behaviours due to information asymmetries should arise (George, 2021). In these situations, pure commercial transactions can fail, while blockchain allows these transactions to happen despite the existing obstacles, such as by lowering costs or providing novel means of access (Santos et al., 2015).

Blockchain as a "*coordinated and collaborative action enhancer"* owes its name to the definition of GCs provided by George and colleagues (2016), according to whom solving grand challenges requires "*coordinated and collaborative effort*". Blockchain protocols pave the way for new paradigms of distributed governance and open-source collaboration mechanisms, such as decentralized autonomous organizations (DAOs). Namely, new forms of *structure* and *governance* within activity systems may be driven by complementarity and lock-in value logics. GCs lack centralized control over their participants, and some researchers claim that current organizational structures are inappropriate (Ferraro et al., 2015; Howard-Grenville & Spengler, 2022). Decentralized governance enabled by blockchain technology can serve as a mechanism for achieving structural alignment in addressing Grand Challenges. This is consistent with Adner (2017), definition of "ecosystem-as-a-structure," which characterizes ecosystems as the structural alignment of multiple partners who must interact to realize a central value proposition. A social or environmental challenge may represent the focal value proposition the set of partners collectively tackle with their effort.

Our research also contributes from a technology-oriented perspective, by "opening the black box" of an emerging technology. Blockchain fulfills the characteristics of an emerging technology described by Rotolo and colleagues' (2015): radical novelty, fast growth, coherence, uncertainty & ambiguity, prominent impact. However, these features are mainly related to the characteristics leading to the wider diffusion and adoption of the technology itself, advancing the consolidated work on technology diffusion (Tushman & Anderson, 1986; Utterback & Abernathy, 1975), by understanding how they may be used as levers for business model innovation (Foss and Saebi, 2017). Our analysis also revealed that blockchain adoption is related to other technologies exploitation. Building upon Teece's (2018) argument on technological convergence, we observe that the composability within different Blockchain protocols, as well as their integration with other consolidated and emerging technologies (i.e., third-party information sources, called oracles, including remote sensing and satellites) play a crucial role in unlocking the emerging technology's full potential.

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