Big Data for Innovation: The Case of Credit Evaluation Using Mobile Data Analyzed by Innovation Ecosystem Lens

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***Abstract*--Despite the high expectations about Big Data (BD) innovation potential, academy lacks studies exploring its implications and the process to achieve the announced benefits. This paper aims to help filling this gap, analyzing the case of an innovative credit assessment model, based on behavioral profiles generated over mobile network data. We ponder about the innovative potential of such huge data sets when applied to purposes differing from the ones they were generated for. To this case theoretical lens, we propose a framework where Innovation Ecosystem concepts are articulated by Contextualist elements. We explore this approach as an alternative to study the phenomenon different dimensions. It was useful to highlight that, despite the potential benefits of the solution as an enabling technology for financial inclusion and new business models in credit area, the ecosystem required for such innovation has critical dependencies delaying its progress. The study also revealed strategies used to break the inertia and create a minimum viable footprint (MVF), as a first step to chase its innovation full goals. It shows that the planning of an incremental path can be a good gimmick to deal with dependencies and enable radical change in complex ecosystems.**

I. INTRODUCTION

The progress of Information and Communication Technologies (ICTs) in recent decades, enabling the development of new applications and their mass adoption, constituted a favorable scenario for generating huge amounts of data, unprecedented in human history [19, 20, 27, 31, 44, 50]. Mobile technologies, cloud-computing, Internet of Things, social networks, and the popularization of the necessary tools to use all these novelties, have boosted the growth of users base between individuals and companies. This, in turn, accelerates the data generation and the perception of new applications possibilities, in a progressive incremental circle [19, 20, 27, 31, 44, 50]. This scenario gave rise to the phenomenon called Big Data (BD).

Between academics and practitioners, enthusiasts suggest that BD can enable innovative solutions in several areas, not only for organizations but also for the public sphere, research, health and society as a whole [44, 50]. Others warn that, although these new technological and informational paradigms are already established in companies and individuals lives, they has not yet been able to perform their full disruptive potential [9, 31]. While recognizing the complexity of the issues involved, which go beyond its technical aspects bringing high level of uncertainty to these innovations, researchers point out the need to find ways to better use this wealth of information, if we want, indeed, to perform the long awaited BD potential [9, 15, 31]. Despite the growing interest aroused by the subject in recent years, empirical studies discussing practical experiences and conceptual models for exploring this issue comprehensively are still lacking [9, 29, 37].

This research aims at contributing to filling such gap by proposing a model to analyze the implementation of an innovation that uses a large data set for purposes other than those for which these data were generated for. In addition, it highlights the implications of new environments created by such application and the process by which they are enabled. To achieve this goal, this study discusses the case of a solution that uses mobile phone network data to compose behavioral profiles, which can be used for credit risk analysis. Based on the experience of using data generated in the context of mobile phones for a financial service, this case demonstrates the complexity of the environment created by the solution, as well as the great potential it offers. As an enabling technology, it can support the expansion of access to credit (especially for citizens excluded from the traditional financial system) and innovative business models in credit market, which could be exploited by their current or new players. For the case analysis, this article proposes a model that uses the concepts of Contextualism [38, 39] to articulate elements of Innovation Ecosystem theory [2, 5] applied to BD phenomenon.

After this introduction, the article will discuss its theoretical basis, presenting the concepts of BD and Innovation Ecosystem, and the proposed conceptual model. Then a section will be devoted to describe the methods used by the study. At this point, the case will be presented under the conceptual lens proposed, followed by the discussion of its results. Finally, the limits of this study and some ideas for future work closes this paper.

II. BIG DATA AND INNOVATION ECOSYSTEM - CONCEPTS AND IDEAS

In this section we will explore the concepts of BD and Innovation Ecosystem, capturing the elements that will be used later to propose a model for the analysis of phenomena involving BD solutions, especially those that occur in complex environments, using data generated in other contexts.

A. Big Data for Innovation

The term 'Big Data' is surrounded by some controversy in academic field. There is no unanimity on the concept it represents, and if it is indeed a new phenomenon or just the evolution of something that already existed, adopting a new name influenced by commercial agenda and players of this market [11, 29]. Far from intending to exhaust this discussion,

we limit ourselves to posit the concepts we adopted in this paper that represent the lens through which we will conduct our theoretical and empirical analysis.

In this research, we consider BD as the phenomenon of processing large volumes of data using new approaches and tools to solve challenges that traditional technologies cannot overcome in time and form needed [15, 20, 31]. This concept is increasingly accepted by researchers because it recognizes not only the question of volume, but also other elements, such as the complexity of data and processing to produce the required results, and the expected response time [11, 15, 37, 47].To show these diverse challenges of the current BD paradigm, the expression '5 *Vs*' has become popular, referring to: Volume (size, amount of data), Velocity (time of response, dealing with data growth and processing dynamics), Variety (diversity of sources and data formats), Value (meanings that can be attributed to data, and value they can add), and Veracity (authenticity, source reputation, and data reliability) [15, 22].

Although there is much excitement around the topic, and the amount of data produced by mankind does not stop growing, researchers warn that the benefits generated by this avalanche of information do not correspond to their full potential [19, 31, 50]. Some areas can already see practical benefits that these solutions can bring to their business, and are advancing faster towards adopting them [31]. Other areas are just adopting these tools to solve their classic problems of data volume and processing performance, which is not to take advantage of the innovative potential of this technological possibility [31].

This scenario suggests that the generation of data is advancing at a faster pace than the ability of using them to produce intelligence and innovation. Reference [14] emphasize that BD in its various applications should seek a triad of expectations expressed by the acronym MAD: Magnetism (ability to attract data on a given topic from different sources, regardless of format, structure and origin); Agility (responsiveness and system adaptation to data evolution); Depth (level of detail considered in the analyzes produced from large data sets and the complexity of processing performed, which may involve sophisticated statistical criteria and machine learning) [14]. In fact, the application of these principles would increase the use of these huge databases, giving room for the intelligence and the innovation that this phenomenon is pursuing. On the other hand, the operationalization of this view is not trivial and involves factors that go beyond technical issues.

Put into practice the principle of Magnetism, for example, implies the use of data produced in different contexts and for other purposes, involving other players not necessarily related to the application itself. It is a new paradigm of data generation and capture, which brings greater complexity not only technological. More diverse sources of information imply greater plurality of social groups involved, with different interests and assumptions. On the other hand, the radar with no limits in search of interesting information for a particular purpose can lead us to ethical issues, reliability and information security, privacy, and individual and collective rights, which still need to be discussed in all spheres of society [8, 9, 15, 31]. In addition, such analyses, either summarizing data or producing conclusions from them, require not only technological solutions that support this more sophisticated processing, but also robust methodological basis, to ensure accuracy to the whole process, from initial data capture to the production of results. Having more data does not necessarily mean having better data [9]. Rather, the use of large data volumes obtained or handled improperly, from a methodological point of view, can produce wrong answers or even correct answers to wrong questions [9, 13]. Several researchers warn the importance of academic participation in this debate, building theoretical and methodological basis that will support the development in the field of science and practice [8, 9,15]. This is just an example that, besides technology, there are other elements playing a fundamental role in the production of deep and valuable analyses. Getting people ready to deal with this new and complex paradigm is another dimension of this multifaceted issue [12, 27, 31]. In short, the wider use of data can enable new products, services and social solutions of common interest, but all this potential for innovation is facing numerous challenges, therefore finding itself in a scenario of great uncertainty.

Uncertainty is indeed a great challenge for innovations, regardless of involving BD or not. In their study of types of innovation process, reference [48] shows to the impact of uncertainties on the innovation process, which can cause interruptions in its implementation flow in order to resolve technological and market uncertainties, or the combination of both. Several studies have also explored alternatives to identify and address the uncertainties in the innovation environment. Reference [21] proposed a model to analyze the complexity of the environment, identifying its barriers and designing the strategy of innovation development in order to overcome them at each stage until it reaches its full potential, which can lead it to become the dominant design. Reference [55] applied this model to revisit the case of innovation in float glass production process, drawing attention to additional factors such as the importance of corporate support and the fundamental role of an entrepreneurial leadership in disruptive innovation processes.

Knowledge and learning are also a recurring topic among studies related to innovation uncertainty. Reference [28] proposed a model for identifying unforeseen uncertainties as a mechanism to make them recognized uncertainties, and hence manageable. This model, based on decision theory, suggests that the major issues involved in innovation are divided into subgroups that may be assigned to areas of knowledge, allowing the gap mapping of such specific knowledge that could be the source of unknown uncertainties [28]. Reference [30] suggested the "Probe and Learn" process as an interesting approach to discontinuous innovation cases. Reference [46] proposes the Learning Plan model as a framework to map uncertainties, and promote continuous

learning cycles to fill gaps of knowledge that contribute to eliminate them.

The increasing complexity of the innovation environment is also seen as a source of barriers and uncertainties related to the interaction of its players. Reference [1] proposed an analogy with the Ecosystems theory to discuss this environment and its implications [1]. Since the expansion of data usage in BD environments implies the relationship of players from different groups, working under different logics and endowed with different interests, theories that seek to exploit uncertainties generated by the complexity of their environment can bring useful ideas to deal with these impacts, what matters for the purposes of this study.

B. Innovation Ecosystem

The term Ecosystem was originated in biology, and although its concepts have spread more strongly from the '50s, its core ideas were already present in this field in much previous research, such as in the classic Forbes paper "The Lake as a Microcosm" dated 1887 [7]. Basically an ecosystem refers to the set of elements, whether living organisms, non-living materials or energy flows, gathered in an environment where they interact forming a system [7]. Reference [40] emphasizes that, from the 80's, this concept analogy started to be used in various fields of study, leading to more specific theories explored by various authors such as the Industrial Ecosystem [18, 26], Business Ecosystem [23, 34], Digital Business Ecosystem [36, 52], Innovation Ecosystem [1, 56] and Entrepreneurship Ecosystem [25]. While each approach has appropriated the ecosystem theory differently to meet the research demands of its field, in all of them there is a definition of players and the environment where they interact, as well as a clear identification of impacts acting on the micro and macro levels of the system [40]. It suggests that these analogies in different areas share the ambition to produce more holistic analysis that incorporates the vision of the whole and part of the phenomena they observe.

The term Business Ecosystem was proposed to name the complex business environment where organizations and individuals interact, including customers, suppliers, competitors, middlemen, suppliers of complementary products, regulatory agencies and distributors [24, 34, 35]. Every ecosystem needs time for its formation and has a life cycle divided into 4 stages: birth or pioneering, expansion, stability and authority [35]. The interaction between players, either cooperative or competitive, determines the ecosystem development, and the combination of expertise and skills of their participants can generate new business, which is vital in an economic scenario of rapid changes [35]. The ecosystem that does not evolve and renews itself is doomed to death [6]. These ideas about the business environment dialogued with innovation discussions, giving rise to the concept of Innovation Ecosystem.

It can be said that Innovation Ecosystem is a Business Ecosystem oriented towards innovation generation [3]. Therefore, it is highly dynamic to follow the evolution of demands and available conditions to meet them with agility, since time is an important factor for competitiveness in innovation environments [1]. The components of an ecosystem can also vary over time since its participants are not defined by a fixed framework as that of an industry, for example, but by changing conditions of the environment and its participants [1]. The alignment of goals, complementarity of knowledge, trust and harmony between participants are some of the key factors for the success of an innovation ecosystem [6]. For this reason, the composition of this ecosystem is critical, and it is necessary to identify its participants, recognizing the goals, interests and background that guide the performance of each one. It is also worth noting the importance of some kind of leadership that will normally be exercised by elements seeking the financial benefits that innovation can bring or by those who have greater knowledge or resource [6].

A major contribution of the concept of ecosystem is that it provides an overview of all players and factors that may influence the success of an innovation, which allows us to view the risks involved more broadly [2]. While traditional approaches focus on execution risks, the innovation ecosystem comprises the risks arising from dependencies, which are generated by the system asymmetries [2]. Reference 2 suggests that the dependencies can be related to co-innovation (other innovations need to succeed) or adoption (need for adoption of other elements to allow end customer innovation adoption). Reference [5] proposes that the dependencies can be linked to technology (unavailable technology or not reachable), information (non-existent content or belonging to other, or the flow of communication is not appropriated), or values (threats or conflicts of values between players). The latter typology best fits the dilemmas of the BD phenomenon where not only technology can bring dependencies, but also information (its property and access), and values involved in the issue (of ethical, legal nature, etc.).

Dependencies can generate delays; in other words, they can slow down or even stops the innovation advance [2]. Therefore, when recognizing them, one should seek strategies to move forward in the innovation implementation. Reference [5] suggests that such alternatives to overcome resistances and difficulties vary according to the system maturity level. They tend to be compliance-centric in the early stages (focus of the strategy is to seek compliance, adapt to the conditions imposed by the environment), then influence-centric (strategy seeks ways to influence the conditions imposed by the environment to change them), and innovation-centric (strategies bring innovative proposals that neutralize the dependencies) when the system reaches higher levels of maturity. For reference [2], such strategies may imply addition, subtraction, split, combination or relocation of product or service components to counteract the effects of dependency that is generating the innovation delay [2]. He also recognizes the importance of these strategies for the development of ecosystem, characterized by 3 stages.

First, the Minimum Viable Footprint (MVF) refers to the minimum configuration of innovation that still represents

customer value [2]. Likewise the first stage of business ecosystem (birth or pioneering), at this stage we seek to facilitate innovation and formation of the ecosystem that will support it over time. It is a stage of intense creative activity and articulation where the work of leaderships is crucial [6]. The second stage, Expansion, refers to the addition of new elements, increasing the value delivered in the previous stage. It can be even the reintegration of components that were subtracted at the beginning, to facilitate innovation, and find favorable conditions at this new stage [2]. The third stage, called Carryover, is where the elements created for this innovation are brought to the generation of new ecosystems [2]. It is noted that the evolution of the ecosystem stage is pushed by strategies that reconfigure the components of innovation in a way more suitable for the ecosystem context at that moment.

C. Big Data by Innovation Ecosystem Lens

After discussing the main elements of Innovation Ecosystems theory in its overall sense, in this section we will reflect on the application of these concepts in a model that contributes to the mapping and analysis of the ecosystem where BD is inserted. As discussed earlier, BD is a phenomenon involving a plurality of players with different interests and objectives, interacting in a complex and changing environment. It lacks tools to increase the understanding of its dynamics in theory and practice, gap this paper aims at dialoguing with.

We will adopt Contextualism [38, 39] to properly integrate the innovation ecosystem concepts described above with the objectives of this model. This approach was already used by other researchers, who proposed the Multilevel Framework, a model that integrates concepts of SST (Social Shaping of Technology) and Technology-as-practice, using Contextualism elements [42]. The application of this same logic will help us to arrange the theoretical elements of innovation ecosystem in a didactic way, illuminating the processual perspective of the object under study. Contextualism proposes that context, process and content are equally important and should be analyzed simultaneously, since they influence each other by mutually constitutive dynamics over time [38, 39]. It is also attempt to connect different levels of analysis (individual or group, for example) [39]. Those ideas are consistent with the Innovation Ecosystem approach and evolutionary dynamics, so it could help to frame them. The chart in Fig. 1 represents how the model articulate the concepts and also indicate the theoretical references of each component.

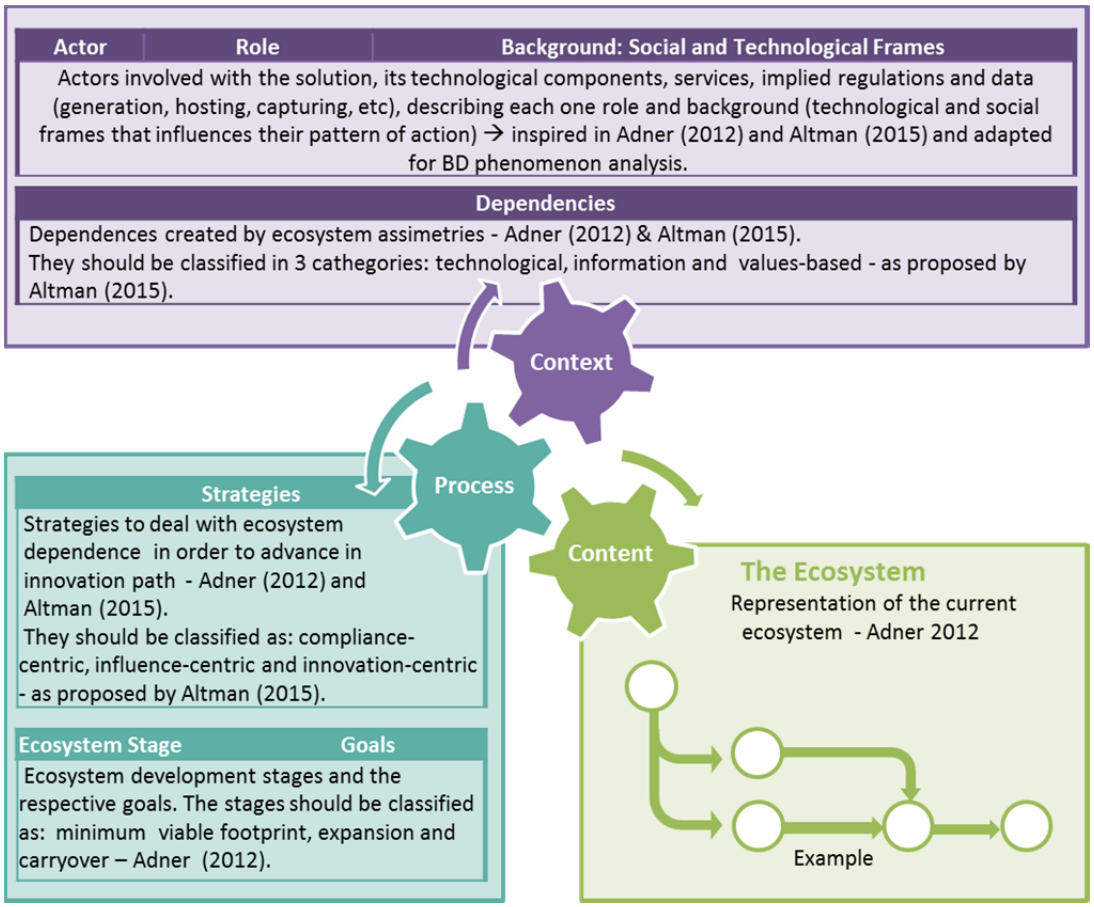

Figure 1: BD Innovation Ecosystem Chart
Source: Author's elaboration

This framework suggests that actors, when playing certain roles influenced by their background, give rise to dependencies. This is the context for the innovation evolution process. Such process consists in advancing over the innovation ecosystem development stages boosted by strategies for dealing with the dependencies. The content resulting from these continuous dynamics is the innovation ecosystem. Those elements (context, process and content) are operationalized in the model as follows:

Context is composed by actors, their roles and the social and technological frames that influence their patterns of action, besides the technological, information or value-based dependencies existing in the scenario under analysis. Those actors could be, for example, the ones involved in: data creation, hosting, flow, ownership or regulation; solution creation, support, financing, hosting and delivery; technological components provision or solution regulation.

Process is represented by the strategies to be adopted to neutralize the dependencies and the way they are put in action in each stage to achieve the goals that will lead to the BD ecosystem evolution.

Content is the BD ecosystem network resulting from these dynamics.

Although the model logic is that, in a given context, there is a process that results in certain content, suggesting a temporal linearity, it is worth noting that this does not happen sequentially, and all these elements interact simultaneously in a recursive process where they influence each other, as proposed by Contextualism [39]. The representation refers to a snapshot of a given moment to analytical and didactical purposes.

III. METHODOLOGY

This work aims at understanding the environment in which an innovation takes place using large databases for purposes other than those for which they were generated, the respective implications and mechanisms by which such applications are enabled. To achieve this purpose, an interpretive research was carried out, based on a single case study analyzed by the theoretical lens of a model that uses elements of Innovation Ecosystem Theory framed by Contextualism components.

The qualitative strategy was more appropriate in this work, since it seeks a deeper understanding of the phenomenon under analysis, its relationships and constitutive dynamics [17]. The interpretative approach is also more appropriate for studies aiming at understanding the construction of a social reality, exploring the meanings produced in its contexts [17, 43], which is aligned with the objectives of this study. Finally, we have chosen to operationalize this research through a case study, appropriate method to address themes in which research and theory are initiatory and/or based on practice, where the experience of players is important, and the context of action is critical [41, 51]. The investigation of a single case, when it is well selected and explored, can be an interesting alternative for emerging theories studies [41, 51], which is our ambition in this paper.

Once the study is positioned, it is important that the research adopts criteria to underpinits quality and strictness, and such criteria should be consistent with the methodological framework chosen. In this research we have adopted the criteria proposed by reference [43]: authenticity (interaction with the empirical material, presence in the field); plausibility (building sound interpretation, a history that makes sense); criticality (engagement with critical interpretation); reflexivity (clear reveal author's personal role, criteria for selecting voices and other data collection, identification of current or confessional contents and personal views); artfulness (mobilizing creativity, art and culture to express the ideas). Enlightened by the principles of plausibility, criticality and artfulness, we have attempted to produce the whole article, its theoretical opinions and empirical content, in a clear and consistent way, bringing critical reflections and offering elements that allow readers to engage in their debate. To highlight the attention throughout the work to meet the criteria of authenticity and reflexivity, procedures for data collection and analysis, as well as the criteria for selecting the case will be described below.

Case Selection.The case of Alpha (codename of the company adopted in this paper to do not reveal its real identity) was chosen in this research because it represents a practical situation in which data generated in a context are used by a solution, whose purpose has nothing to do with those for which data were collected, involving totally different players. This is the situation that we were interested in investigating in this research. Although there are many applications where this occurs, few are based on data held in private domain, since most of them use public domain data that are around the Internet or private data captured by applications with the consent of each of their generators. Intending to open a discussion about the better use of data, this research urged for a case where access to data was not public, and its release process could be observed. Alpha showed great experience with this situation, reporting events occurred in its operations in other countries as well, so that, although the case studied was limited to the operation in Brazil, this view of the global scenario could help us identifying whether its implications would be idiosyncrasies of Brazilian scene or would be aligned with what the company finds in other countries. It seemed to us, finally, the ideal case for our endeavor.

Data Collection. Data were collected through interviews and analyses of public information and material provided by Alpha. Interviews were conducted with the CEO of Alpha in Brazil, responsible for establishing the company in this country. They were held from Sep/15 to Nov/15, totaling 6 hours. The first exploratory interview was conducted as a free conversation where the respondent told the history of the creation of Alpha and its solution, his encounter with the company, the decision to set up an operation in Brazil, and the experience of establishing the company, structure and

local services, as well as an overview of the company worldwide. The second interview was semi-structured and tried to understand more details about the operation of the solution and business in Brazil, particularly exploring the difficulties found in his first attempts to organize the company. In the third interview, semi-structured as well, the theoretical model was already in the pipeline, so its goal was to clarify details required to complete the interpretation of the case through these lens. All interviews were conducted by the first author of this paper and registered in reports produced by her soon after collection, capturing some complete speeches of the interviewee. In parallel to the interviews Alpha has also provided a document reporting a Brazilian case and indicated locations for consultation of material disclosed by the company such as CEO interviews, for example. Material from the company own website and other content found on the Internet about Alpha also helped to understand its history, and served to triangulate information obtained in interviews to minimize the effect of any biases that might exist in the speech of a single respondent.

Data Analysis. Data collection and analysis was carried out in 4 phases: collection, reduction, display, conclusion (drawing/verifying), as proposed by reference [33]. In this scheme, the authors admit that there may be some interaction between the stages. When reaching the stage of conclusion it is possible to return to the collection to get new data, and again start the analysis cycle of the whole set [33], what happened in this research. During the reduction, which is an interpretative phase of data [33], the information collected in documents and interviews were analyzed and placed into the theoretical model, and the presentation stage was already in progress. In the conclusion, reflections on the result produced were made, raising doubts resolved in a final interview for the composition of the final results presented in this article.

IV. THE CASE OF CREDIT ANALYSIS USING MOBILE NETWORK DATA

A. The Birth of Alpha

In this paper, we will discuss the case of credit analysis using mobile network data performed by the company Alpha. They built a tool based on behavioral analysis algorithm created by a professor from Oxford University, which uses mathematical combinations to generate behavioral profiles from large databases. The idea of using these profiles in credit risk analysis arose from the desire of this professor to apply his study to any practical contribution to social development and from his encounter with an entrepreneur already involved with financial emancipation initiatives. Alpha has emerged from the exchange of experiences between them and aims to collaborate with financial inclusion around the world, providing tools for assessing credit risk using data coming from daily lives of people, regardless their history of operations in the traditional financial system. Considering the high penetration of mobile phones worldwide, the company has decided to use the mobile network data as the basis for the analysis of their tool.

After a proof of concept done in Tanzania, crossing data from a bank and a local mobile phone company, the feasibility of the idea was confirmed and the reliability of the tool was verified by comparing results with bank traditional methods. After raising financial support from investors and bringing together highly qualified professionals (data scientists, programmers, statisticians, etc.), the full solution was developed and presented to the market as an innovative alternative to credit analysis of emerging consumers, as we can see in the speech of its CEO: "Our pitch is to monetize people you have traditionally denied... Banks decline a large percentage of applications. Our score make it possible to quantify tens of millions of people who are currently off the radar screen because of a lack of information. This is a huge new addressable market." True to this purpose, the company, which is not intended to be a financial agent by financing or lending money directly, since its foundation has supported several initiatives of alternative models to provide credit and other financial services throughout the world, providing tools to enable them.

B. A Brief History of Credit Risk Assessment

The non-payment risk assessment is a core theme in credit operations, impacting the selection of clients to whom credit will be granted, and also the interest rates involved in these operations [53]. The academic participation in this debate is old as confirmed by researches of references [49] and [32]. At the end of 60s, with several studies, including the pioneering work of reference [4] proposing a model of discriminant analysis, a series of researches on predictive analysis in this area has begun [10]. Banks and financial institutions have made large investments in creating tools to analyze customers requesting credit in order to identify good and bad payers [53], putting into practice many of these models proposed by the academy.

Typically, conventional credit risk assessment systems uses, among other information, data from previous financial transactions of individuals, their wealth and other collaterals, which limits access to credit for a significant portion of the population that does not have this history. A study carried out in USA with data of 8 million people proposed the use of alternative data (rent, electricity bills and other recurring expenses) for the composition of credit score of individuals [54]. It argues that this tool could help to decrease poverty in the country, since it would fill the gap of information about financial risk of millions of Americans, expanding access to credit in this segment of the population, usually poorer and excluded from the traditional financial system [54].

In Brazil, many of these alternatives for credit granting are linked to microcredit programs aimed at lending small amounts to finance productive activities and small businesses [16]. Despite the consistent expansion of microcredit around the world in recent decades, and the entry of commercial banks in this market from the 90s, microcredit operations are

still concentrated in public banks and public or private initiatives to promote social development [16]. In one hand, banks see an opportunity in this part of the population to compensate the saturation of financial services in their historical market and have developed programs to expand their presence in this new niche. In the other hand, the lack of information recognized by traditional financial systems increases the risk and cost of transaction of commercial banks, discouraging their more aggressive approaches. Meanwhile, initiatives for new arrangements and business models to operate in this market proliferate throughout the world. Driven by broader objectives, these initiatives propose solutions to democratize access to credit and allow the operation of new financing and credit agents, whether companies or individuals working in collaboration. Alpha is tuned in these movements and believes that solutions for risk analysis, which do not depend on traditional historical grounds, owned exclusively by large financial institutions and limited to a portion of the population that already covered by traditional financial system, can help enabling growth and consolidation of these emerging models.

C. Alpha Solution

Alpha solution represents an alternative to fill this gap, since it uses mobile network data to draw the behavioral profile of customers and give them a credit score according to this profile. The customer credit score is defined considering payment probability of similar behavioral profiles. Likewise in traditional predictive systems, this tool applies a model of discriminant analysis, comparing the customer credit score to a database where the rates are associated to risk levels, as shown in Fig. 2. In other words, the reference to classify the risk of the client is his behavioral similarity with the profiles of database associated with high, medium or low risk.

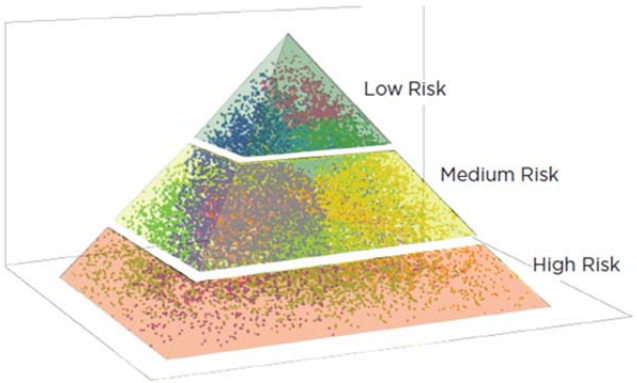

Figure 2 – Multi-dimensional behavioral cluster model for predictive credit risk analysis
Source: Alpha documentation

Concerning individuals privacy, the tool does not access information from the content of calls or text messages sent and received by users. Data used are restricted to the records captured by the mobile network known as Call Detail Record (CDR). Such data, typically used by telephone companies for ticketing and invoicing, are stored in online databases for a specified period of time and then archived, due to their huge volume. Data contained in the CDRs may vary among carriers, but basically they contain information such as, for example, number of origin and destination of calls, date and call start time, call duration and the means by which the call was started and stopped. Alpha tool does not copy such data to its database, only reads them for definition of the behaviors they indicate. These behaviors are stored in the Alpha solution database with no individual identification (such as phone number or location data).

D. The Case - Alpha in Brazil

Believing in the Brazilian market potential for this type of solution and glimpsing the benefits it could bring to local development, Alpha has opened an office in Brazil. This experience will be the particular case we will look at in this article from a conceptual lens proposed herein. Using this framework, we have mapped the context and process by which a new ecosystem was formed, as a resulting content of this dynamic. We present this mapping below.

Context

The initial context found by Alpha in Brazil was as promising as challenging. According to data collected by the company, almost half of adult population did not have a bank account, while mobile phones reached a much larger contingent. It confirmed their thesis that many citizens who do not participate in the conventional financial system might benefit from their solution, since many of them would be mobile phone users.

The market of mobile phones in Brazil is mostly concentrated in 4 major telephone companies. Such companies, owners of large structures, are attentive to the possibilities of new services to their customers, since this market is extremely competitive. However, they operate in an environment regulated by government agencies that determine and monitor compliance with service and market standards. Their huge and growing base of mobile phone users generates an also huge and growing volume of data from the network operation (the CDRs). This information is used primarily for ticketing and invoicing, with few initiatives of companies to use it for intelligence, usually limited to internal demands. Although having adhered rapidly and strongly to the use of mobile phones, users are unaware of more technical details about its operation network and mostly ignore the existence and content of CDRs. On the other hand, they are increasingly concerned and attentive to issues of privacy and information security, adopting a more demanding attitude towards telephone companies and regulators.

Alpha also found a highly computerized financial system led by major banks, which have invested heavily in developing their systems that process and store large amounts of information about their customers and transactions. Those applications also have tools for risk analysis based on the

latest technology and statistical models widely recognized in this field. Operating in an environment where information is a very valuable asset, they have strict standards of information control and security. The regulation of this market is performed by a group of public instances that seek to organize the operation and services provided to the society, also considering legal, macroeconomic and security issues.

To accomplish its goal of contributing to credit/financial inclusion, Alpha should offer a solution for companies that can propose any kind of credit (loans or financings, for example), especially for this part of the population that would not be qualified by traditional risk assessment systems.

Although Alpha is convinced that its tool does not present risks to the privacy of individuals or information security of the companies involved, the lack of information and a clear legislation that legally bear this kind of activity bring some issues to the game. It inhibit the interest of mobile phone companies to give access to information for the profiles generation. It also discourage banks to support Alpha in the validation of credit scores based on their historical knowledge in the Brazilian scenario, that Alpha is unaware, at this point. With little certainty about the real benefits that this solution can bring to business, and many concerns and risks on the horizon, these players do not release access to information that Alpha needs to operate its solution. The restriction of data access and difference in the mindset of players involved, coming from different business scenarios, become critical dependencies for the future of Alpha solution, a situation the company had already faced in its entry into other countries. The table 1 below summarizes the described context.

TABLE 1: ALPHA CASE CONTEXT

Context

Actor	Role	Background: Social and technological frames
Mobile Companies	Capture and host CDR data	Forward thinking; Poor vision about potential of CDR; Sensible to telecom regulation pressures and public opinion.
Mobile User	Generate data and is the data owner	Unaware about CDR content; Sensible to personal content privacy; Ignore the way behavior profile can be captured from data.
Telecom Regulator - Government	Define rules and monitor compliance of Telecom providers	Responsible for rules and procedures to be followed by telecom providers to regulate the market and to protect people privacy; Sensible to public opinion; Regulation of commercial use of people information.
Banks	Capture and host financial records of client's transactions Operate in the credit market (financing, loan)	Conservative; Sensible to finance regulation pressures and public opinion; Strongly concerned about information security and data evasion; Attached to existing credit analysis model; Owner of a huge ammount of financial historical data; Proprietary systems user.
Financial Regulator - Government	Define rules and monitor compliance of Banks and Financial Companies	Responsible for rules and procedures to be followed by financial services providers to regulate the market and to protect people privacy; Sensible to public opinion and to political and macro economy conditions; Regulation of commercial use of people information.
Credit provider	Operate in the credit market (financing, lending, etc)	Diverse background: could be a big store financing for its clients, a financial service provider, a bank or any other entity which will provide credit for someone.
Alpha	Provide the credit risk evaluation based on data provided by Telcos and Banks	Forward thinking, high tech and knowledge based; Clear vision about potential of CDR; Commited with the creation of alternatives for development based on BD inteligence.

Dependencies	
Technological	None
Information	Bank: restrictions to grant access to Alpha solution to read information to calibrate the scores; Mobile Companies: restrictions to grant access to Alpha solution to read information to create the behavior profiles.
Values-based	Bank: uncertainty about the repercussion of such partnership on clients opinion; uncertainty about the effects of the adoption of such kind of solution in credit market; uncertainty about legal aspects of such operation. Mobile Companies: uncertainty about the repercussion of such partnership on clients opinion; not benefited by the effects of the adoption of such kind of solution in credit market; uncertainty about legal aspects of such operation.

Source: Prepared by the authors

Process

Cornered by the constraints created by the context dependencies, Alpha innovative solution could not come alive entirely. Confident in the its solution quality and business potential in Brazil, Alpha has adopted a compliance-centric strategy to face those obstacles, relocating its operations to meet internal demands of companies. While keeping opened to serve companies of any segment, its main focus is on banks and mobile carriers. This approach, besides enabling business that can sustain its operation financially, will also contribute to the formation of this new ecosystem, constituting its first stage or MVF. Its objectives, at this stage, are related to the disclosure of its tool by other players and legitimacy built. By creating real cases, they can show their application potential, demonstrating how the tool operates and access data to generate trust among those involved (with special attention to banks and mobile phone companies). Performing business clearly allowed by legislation, they also aim to conquer credibility.

In this perspective, Alpha's main example is the service provided to a company which is a joint venture between a bank and a mobile phone carrier to finance the purchase of products of the latter. For legal reasons, the bank cannot share customers financial information with the mobile company and the mobile company cannot share customer information with the bank either. Alpha solution accesses data from the mobile company and generates behavioral models that allow the indication of financial risk of customer credit supply, and the respective propensity to mobile services, directing commercial actions. In this case, Alpha helps a joint operation to meet the legal requirements of the two segments (financial and telecom). It also provides the bank and mobile company the experience of operating its solution and realizing the robustness of its security and privacy mechanisms. This is done through its relationship with the joint venture party, which is the company that actually hired Alpha services. With the same purpose, Alpha also has other projects in telecom companies and other segments, always focused on reading business information of the company to meet its own internal demands.

Alpha has not abandoned its original purposes of financial inclusion, which continue on its business horizon. While working in the existing business in this first stage already consolidated, Alpha plans actions for the expansion stage in order to enhance its performance, advancing gradually toward these purposes. Its primary goals for this next stage are linked to obtain formal authorizations for data access and partnership with companies interested in offering credit to people who are outside the banking system and in designing new types of credit. The table 2 below summarizes the described process.

TABLE 2: ALPHA CASE PROCESS

Process		
Strategies		
Compliance-centric	Embrace an opportunity of providing the solution for a business where a bank and a mobile company work together and share interests and responsibilities over credit evaluation.	
	Look for business opportunities in mobile, banks and other segments to provide the solution for projects to develop intelligence from their big data sets for the company own purposes to disseminate the solution and also get financial support to Alpha's existence.	
Ecosystem Stage		**Goal**
Min. Viable Footprint	- Partnership with a company (joint-venture between a bank and a mobile company) who finance mobile products for consumers; - Projects with Mobile companies to help them get intelligence from their raw data (like CDR) for their own operation; - Projects with banks and other companies who needs to map behavioral profiles from their big data sets.	- Generate a consistent business implementation cases to show the solution power in real life; - Provide partners in Telecom and Bank the confidence about how the solution works and how it deals with data privacy and protection; - Generate a business case clearly covered by legal regulations of both mobile and bank segments in Brazil, with no doubts or legislation gaps.
Expansion	Under planning and construction	- Have a formal authorization for mobile data access to compose the behavior profiles; - Provide the solution to credit providers interested in dealing with unbanked population; - Provide the solution to companies interested in creating new credit services models.
Carryover	To be planned	To be planned

Source: Prepared by the authors

Content

By adopting this strategy, Alpha has simplified its ecosystem, performing activities that exercise the use of its solution, but limited to work with data provided by its contracting parties. Even when it uses information from the bank and mobile phone company it makes it on demand of a joint venture company. Such company negotiates the access with banks and mobile operators and monitors the application of Alpha tool, being the actual user of the information produced as well, an operation that complies with the existing legal provisions. Thus, although the bank and mobile company are part of this ecosystem, they have no direct relationship with Alpha, whose business relationship is only with the joint venture enterprise. So, the plurality of participants still exists, but the complexity of Alpha relationships became similar to that observed in the case of direct services to companies with internal data and for internal purposes. It is, therefore, the MVF of Alpha's Ecosystem, constituting the content of our framework in this case, analyzed at this point in time. The Fig. 3 below illustrate the described content.

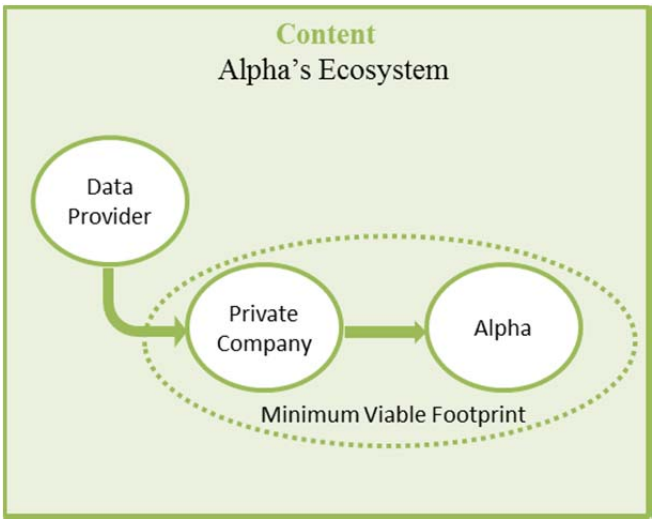

Figure 3: Alpha's Ecosystem
Source: prepared by the authors

V. DISCUSSION

The growth in the volume of data generated by humankind and the advance of technologies to store, transmit and process them raise the enthusiasm of those who envision the great potential of BD phenomenon for companies and society as a whole. Although, researchers and practitioners warn about the realization of these benefits in practice, pointing out the various challenges surrounding these solutions implementation, which go beyond technical dimensions [9, 15, 19, 27, 31, 44, 50]. Despite the great wave of interest in this subject, heavily emphasized in recent years, the academy still lacks empirical studies that deepen our understanding about multiple issues involved [9, 29, 37]. This work aims at helping to fill this gap, presenting a theoretical alternative to explore this phenomenon and applying it to a real case. Besides exercising the proposed model in a practical case, this reflection allows us to discuss implementation aspects of a BD solution, also collaborating to the knowledge of this emerging phenomenon.

The presented framework uses Contextualism elements (context, process and content) from references [38] and [39] to articulate concepts of innovation ecosystem theory from references [2] and [5]. This articulation was useful to display the mapping of various aspects of the ecosystem involved in the implementation of a BD solution and the process by which it was built, giving a didactic contribution to the analysis of this type of phenomenon in a broader and more integrated perspective. By gathering information about the context (actors and dependencies) and the process of evolution (strategies to overcome delays and the goals of each ecosystem development stage), the model can also be applied to ongoing cases as well. It highlights the understanding of the scenario in an integrated manner and allows forethought about potential dependencies and appropriate strategies to address them, which may collaborate with the progress of theory and practice. It is worth mentioning the contributions of this model for this study, where it helped to guide the data collect in the field, the presentation of results, and the construction of a dynamic and processual view of the case. The model was, in short, satisfactory for the purposes of this research.

Regarding the object of this study, using this conceptual lens helped to visualize the complexity of the environment for the implementation of solutions using data generated in other contexts and for other purposes. Using data created in the environment of mobile phones to compose behavioral profiles for credit risk analysis gave rise to a new ecosystem, complex and marked by uncertainties and asymmetries. Financial and mobile phone players come from different ecosystems governed by different mindsets, interests and rules. To be integrated into this new ecosystem, they take on new roles, but keep their roles, responsibilities and interests in their original ecosystems, with which they are not sure this new experience is fully consistent and compatible. The lack of practical experiences with the application use also creates some level of uncertainty about its operation and ability to ensure information security, which is highly critical to its business and customers, indeed, regulated by laws in their original ecosystems. The benefits the solution generates for these players are unclear, and, apparently, they do not contribute significantly to their core business, further discouraging their support and participation.

On the other hand, in this type of intelligence solution, having access to quality data is as critical as the technology itself, which increases the significance of those who hold power over data access, generating an asymmetry and, consequently, high levels of dependency on the ecosystem. Although this research has not enough data to assure, we can infer the possibility of this same situation be found in other

cases where data generated in a particular context are used for purposes other than those for which they were created, and by players that do not belong to its original environment. The asymmetry of forces favors players who may grant access to data, but they may be subjected to various pressures, and thus more sensitive to the uncertainties posed by innovation and their emerging ecosystem. Just as in this case, not always these players will reap the greatest benefits from this new use of data, that is, they can be viewing the risks to their original ecosystems and the uncertainties of their participation in the new ecosystem, with no clear benefits for their own business. Even if there are social or macro environmental benefits that interests them, the price may still seem too high.

To reference [2], in highly complex environments, such the one in this case, building an incremental path may be the best alternative to the implementation of a radical innovation. In this context, a strategy that reduces the system complexity and allows the solution to be exercised, even if not for its full ambitions, can enable the initial formation of this ecosystem. Adopting the strategy of offering the solution to meet internal demands of some companies, including the joint venture of a bank and a mobile company, Alpha was able to generate its MVF, initiating the formation of this new ecosystem. Similar to the Minimum Viable Product (MVP) [45], the MVF aims at facilitating innovation in a simplest ecosystem configuration, even if it is not enough to achieve its real goals or to deliver the planned value in its entirety. In the MVF case, the focus is not on the product or production process simplification, but on simplifying the dynamics and relations of the environment in which it is inserted. Thus, this reconfiguration can affect any characteristics of the product or service, its market position or any other element of its value proposition that reduce the level of dependencies on its ecosystem.

To fulfills its role in the innovation development cycle, the MVF must consist of a simple ecosystem, whose value is clearly perceived by players involved and expandable. In doing so, after the consolidation of this early stage, it helps to leverage the next steps towards the reintegration of the elements necessary to the innovation achieves its full goals [2]. The MVF of Alpha meets these requirements and additionally helps to legitimize Alpha before players who are important for the expansion stage. As warned by authors who are followers of ecosystem theory analogies in various areas [6], the formation of a new ecosystem requires time and the enlivening of some leadership. Usually, this position is hold by those most interested in the benefits that will be generated by the new ecosystem. The identification of this leadership is not trivial in situations like this, where the benefits are still uncertain and beneficiaries are scattered. By starring in the MVF, Alpha reinforces its position before other players, gaining strength and legitimacy to tackle the barriers to progress over the next stages of expansion.

The construction of a MVF is, therefore, a powerful tool to enable innovation, since it is designed to deliver the necessary elements to leverage the next stages of innovation ecosystem development. Even though this initial step does not realize the full ambitions of the innovation, it should open a path to begin walking toward it. So, a clear view of the context and process by which this path takes place is vital to ensure that it follows in the right direction. By discussing a model that applies this view to analyze the implementation of a BD solution in a complex environment, this study may contribute to the development of BD at theory and practice. If we agree that the use of data in broader perspectives, fully exercising the magnetism principle, can be an alternative to reach the high benefits announced by BD enthusiasts, preparing the room to facilitate solutions in increasingly complex ecosystems, as the one we describe in this paper, can be of great value.

VI. LIMITS AND OPPORTUNITIES FOR FUTURE RESEARCH

The results presented herein are limited to the experience of the case investigated in this study. Its plausibility increases the likelihood that they can be transferred to other contexts, what can be explored in future studies. Another opportunity for the advancement of this research is monitoring the next stages of the development of Alpha ecosystem, which is part of our plans. The application of the model proposed in this study in other cases, especially the ones which have completed their development cycle, and cases involving other business areas, can also help the evolution and consolidation of this framework as an applicable tool for academic and practical fields.

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