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"Why Big Data? Towards a project assessment framework"

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Abstract

Technological evolution and consequent increasing of society and organization information dependency was an important driver to escalation of data volume and variety. At same time, market evolution requires capability to find new paths to improve products/services, client satisfaction and to avoid cost increase associated with it. The relevance of using Big Data for different industries and knowing how to implement it, is something that raises many doubts and discussion. In a Big Data context it is important to evaluate organization needs and understanding if those needs are satisfied with Big Data capabilities, i.e., if they really need Big Data. For that reason, this paper presents a framework, namely BigDAF, capable of measuring a technological/business problem in a Big Data spectrum. This framework aims to help organizations and researchers to understand, not only the meaning of Big Data issue, but also the key factors that determines the necessity of a "Big Data investment". The framework assessment was applied using three case studies.

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1. Introduction

"Big Data set whose size and complexity is beyond the ability of conventional tools of manage, store and analyze data" ¹. As much as any other technology, choosing a Big Data supplier and considering the Big Data complexity of their "issue", are two critical tasks for any organization. Nevertheless, the most important thing to do is to ask ourselves: "Is this a Big Data problem?"; "Do I really need these Big Data tools?" Although Big Data represents a promise for organizations to gain business advantages, produce new insights, make better decisions, and optimize business processes, all the issues should be evaluated. Most organizations, especially European, are not ready for Big Data in a technical and business perspective and do not see significant "value" in Big Data investments². A survey made by International Data Corporation (IDC) revealed that in a short percentage (in Europe) the awareness and readiness were higher among very large companies but even those are still a minority. Also "short-term intentions to increase usage of Big Data technologies were concentrated mainly among very large companies, and in sectors that were already at the vanguard of adoption"². Moreover, they conclude that in most of the cases, Big Data is used as an extension of what already exists. A Big Data project could be seen as a risk investment. The organization must know and be conscience of the reasons to a project be successful or not. Some of the Big Data projects failed because the organization has its focus on technology and their capabilities rather than the business opportunity. They just see Big Data as an extension of the existence capabilities of Business Intelligence technologies making a wrong use of all the capabilities provided by Big Data concept and their tools. A study made by Lavastorm Analytics¹ identified three main reasons why Big Data project fails. Those reasons are: a) Big Data is treated like a project with a known beginning and a known end rather than an agile exploration exercise. Treat a Big Data like a Business Intelligence (BI) project with a set of indicators and pre-defined goals disable the flexible data exploration; b) The return of investment (ROI) hurdle is too high for Big Data initiatives. There needs to be flexibility and agility to fail cheaply and learn from

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mistakes because some organizations keep dealing with Big Data with the same Enterprise Data Warehouse (EDW) paradigm. These attempts are inefficient and very expensive; c) In many cases Big Data projects are not tangled to a business need. They are considered just for scientific purposes with no business goal or metrics. The idea of an exploration exercise is still attached to scientific/innovation purposes. For organizations, explore novel business opportunities and market trends are hard to correlate with their vision, market segmentation and business strategy. The most common error in organizations is using Big Data because it is a tendency or it is fashionable and not because it is really a need. For Enterprises, Big Data means that they need to acquire new resources having some expertise not only in development, implementation and system integration but also specialization on statistic and analytic processes. Many information technologies (IT) executives also see open-source Big Data technologies, such as Hadoop³, as immature or unstable and carrying significant security and retooling risks when compared to proprietary tools. It is proved that Big Data technologies enable the analysis of large amounts of data including detailed tracking and analysis of consumer profiles and behaviors, from non-traditional data sources such as social networking sites, mobile device applications, and sensors. This generates valuable business opportunities for more targeted/personalized services and cross selling. But, could the volume represent all Big Data concept? We only call it Big Data when data meets all those features? Where can we set the frontier between BI and Big Data? Those are the questions that companies need to think about because the possibility of solving current problems with known, cheaper and easier (implementation and utilization) Business Intelligence tools may exclude all Big Data options. On the other hand, being resistant to change may lead the organization into a constant investment on infrastructure with a short scalability or an unsatisfactory return. Identifying what kind of data / projects need a Big Data solution could be the first step to support the decision with an absolute measure. This paper aims to make on little overview of the Big Data concept, help answering to all the issues and presenting a first version of big data project assessment framework (BigDAF). BigDAF is a simple framework that can have powerful impact. It allows a better understanding of the project needs in order to avoid the errors above mentioned. The paper is divided in seven section. After a first introduction, the Big Data and Business Intelligence concepts are presented in section two. The third section presents the Design Science Research, the research methodology used to develop and assess the artefact. The fourth and fifth section present BigDAF, a framework to evaluate the complexity of Big Data projects and a first assessment made. Finally, a set of final considerations are written in sections six and seven.

2. Background

2.1. Big Data

In a simplified definition “Big Data set whose size and complexity is beyond the ability of conventional tools of manage, store and analyze data”¹. On the other hand, it is a set of a new generation of technologies that are capable of store, process and get value from several sources and formats of data in real-time. Essentially, Big Data is designed whit 3v's⁴: a) Volume – Amounts of data in a terabyte scale created by several sources and devices. The amount of data is so huge that dealing with it becomes an important challenge. The data arrives at high velocity, with different formats and needs to be processed almost in real-time; b) Velocity - Data are created at high velocity and needs to be processed (near) real-time. An example of that high velocity is the data created by sensors in monitoring devices; c) Variety - The presence of structured, semi-structured and non-structured (text files, audio, video) data is provided by the use of several sources such as social network, sensors, mobile devices, GPS, and others. This variety is challenging in what concerns the storage, processing and management of data. The relational database management systems (RDBMS) could not be suitable to store all the different types.

These new forms of data creation have been merged in the last few years. The development of mobile/ubiquitous and pervasive computing and the emergence of technologies such as smartphones and tablets, leads the societies into a process of connection even more universal⁵, in such a way that being connected became a preponderant factor for our everyday. In fact, it makes the society more dependent of having the information available anywhere and anytime. In an organizational point of view, the information while an important asset, is generated and stored in amounts of data that round Zettabytes. Organizations collect large volumes of information⁶. We are now facing the “Information Era”, where information became a prized and powerful resource⁷. Most recently, two more Vs (Veracity and Value)⁸ were added to the concept, however they are not considered in BigDAF, at the moment, because their impact is not in the architecture (framework focus) but in the quality of information presented.

2.2. Business Intelligence

Business Intelligence (BI) is described as a set of technologies, applications and tools that creates knowledge and helps in the decision making process. It also includes a life cycle that goes from data acquisition to analysis of results⁹. The BI main objective is to improve the quality and relevance of the information used in the decision-making process by providing useful knowledge through the use of tools and methodologies able to enabling them to make timely and effective decision¹⁰. One of the principal reasons for the adoption of BI technologies in private organizations is obtaining competitive advantages against competitors using privileged information (collected and analyzed by the organization) as leverage. BI can be defined as a set of models, methodologies and tools able to gathering the available data in the organizations to generate new and useful information and knowledge for making complex decisions¹¹. Traditionally BI systems are associated with the use of Data Warehouses (DW). According Vercellis¹² a DW

is basically a form to consolidate information from a variety of data sources. DW is designed to support strategic and tactical decisions. Its main purpose is to provide a coherent picture of the business at a point in time.

2.3. Big Data and Business Opportunities

Big Data can leverage a large panel of opportunities not only in investigation as in science matters¹². Now, more than ever, organizations must look beyond the delivery of the best products or services. “To succeed they must uncover hidden customer, employee, vendor and partner trends and insights. Organizations need to anticipate behavior and then take proactive action and empower the team with intelligent next steps to exceed customer expectations”⁹. Sectors such as health care, agriculture, education, financial and insurance services, manufacturing, retail, energy, public services and administration will be able to improve the relationship organization-person (individual or society) also to their own financial systems. For these sectors, the possibility of collecting profile, behavior and transactions, presents a set of valuable business opportunities for personalized services with better quality. In both online or physical sells, the important thing to do is to design the target customer’s profile and adapt the sales approach¹³. Still, the proliferation of mobile devices and the electronic payment for this kind of products will help the Government monitoring the sector activities. The knowledge created in this context can provide more information about the financial services which this sector needs. Today, all indicators can be tracked and processed and the analytics predictions can be taken more seriously. The medicine administration or treatment can be done in a personalized way, guided by the detailed profile of the patient and with a lower risk margin¹³. Nevertheless, organizations need to be cautious and ensure that this in-depth collection and mining of personal data does not result in privacy and compliance lapses.

3. Research Method

To carry out this investigation, the design science research (DSR) approach was used in the development and validation of the artefact, being in this case a framework. The DSR approach is composed of five main phases: Awareness of problem, Suggestion, Development, Evaluation and Conclusion¹⁴. In this case, the framework can be categorized as a conceptual structure intended to serve as a guide to find the better project type in real problems. The first phase of the process reflects the awareness of the problem, where the knowledge gap, increasing the familiarity around the problem is presented. The following step concerns the solution suggestion. After deepening the knowledge in the area, the result obtained upon completion of the literature review, allows the researcher to overcome the shortcomings of existing knowledge in the initial stage, serving as theoretical support for research. In this phase was possible to observe the non-existence of Big Data assessment frameworks. The next phase was focused in the development of the solution (artifact). The review stage concerns the validation of the artifact. Finally, the conclusion is the last stage and it is the phase the impact of quality and artefact produced is assessed. In order to accomplish this investigation, the DSR approach was undertaken focusing on the seven guidelines provided by Hevner¹⁴: artefact, problem relevance, research rigor, design as a search process, design evaluation, research contributions and research communication. This paper presents a functional framework Big Data complexity level. The framework helps organizations to perceive the problem that they have in hand: if it is a Big Data problem or not in order to avoid making overvalued investments. A project assessment framework is fundamental to improve the decision process. The proposed framework was assessed in a small context using real datasets in order to correctly evaluate its utility and efficacy. To verify the proposed framework, it was assessed in three different contexts by consulting experts in the field. The framework was also verified several times before any conclusions be taken.

4. Big Data Complexity Framework

This paper presents a proposal for a “Big Data Complexity framework” as a way to reach an answer for the main question in this section. The BigDAF aims to help finding a cluster that better defines their “issue” according to the dimensions of the 3v’s and the corresponding complexity level. It is also the base for the calculation that will position the “issue” in a Big Data spectrum. The result will be an absolute measure that could simplify the decision making and help the organizations to better support the decision making. BigDAF assumes a form of matrix (Table 1) with two main features: Complexity Level (CL) and Dimension.

Complexity Level (CL) – Defines a scale of complexity for each dimension. Five levels were defined for this framework, ranging from the less complex dimension (CL1) to the most complex and harder in the scale (CL5). In other words, the more data are collected and processed the complexity increases, in a shorter period of time with complex types of data. In opposite, simplest types of data with large periods of time to collect and process “small” amounts of data, describes projects that are well known by organizations that already implement BI architectures. The complexity levels of each dimension was distributed according to the knowledge about the existent technologies and projects about each theme. A five scale level five was chosen because it allows to have two points for each side (lower and highest complexity) and at the same time, find a neutral point where the complexity is normal. The principles of Likert Scale¹⁵ was followed: 1) The use of short scales can constrain results into closed type of answers such as a simple yes or no; 2) Applying higher scales could lead into a dispersion of results and consequently into inaccurate results.

Dimension – According to earlier investigations, Big Data architecture is defined / depending by three dimensions which are related to each other: Volume: Volume of data collected in a specific period of time; Velocity: Period of time that the data is

collected/refreshed processed and analyzed; Variety: Types of collected data which are directly related to the complexity of process and analysis. The combination of these three dimensions with the respective complexity level it is possible to define a Big Data issue. As above mentioned, you must take into account that the volume is not the volume of the existing data in the organization (historical data) but the amount of data currently collected.

Table 1. Big Data Complexity framework

Dimension/CL	CL1	CL2	CL3	CL4	CL5
Volume	<1000GB	5TB - 50TB	50TB - 500TB	500TB - 2000TB	>2PB
Velocity	Batch	Intra-day	Hourly-refresh	Real-time	Streaming
Variety	Structured Data	Docs: XML; TXT, JSON	Web-log; sensors and device events	Image; social graph feeds; geospatial information	Video; Voice

In order to avoid an inconclusive definition of the issue, an absolute measure by combining the three dimensions in its respective Complex Level (CL) was provided. The proposal consists on the sum of each product between dimension and CL value (1-5). Because some dimensions are more important than others, it was also defined weights (in a total of 100%) for each one. As can be observed and according to the literature review, volume has higher importance to Big Data projects and consequently it was attributed a higher weight (60). Table 2 presents the BigDAF measuring expression.

Table 2. Big Data Complexity Level (calculation)

Dimension/CL	CL1 (1)	CL2 (2)	CL3 (3)	CL4 (4)	CL5 (5)
Volume (60)	$CL = (WVolume * CLx) + (WVelocity * CLx) + (WVariety * CLx)$				
Velocity (10)					
Variety (30)					

The matrix features and their weight distribution were defined based on the literature review performed and on the received specialists’ opinion from the Analytics technologies departments of a multinational organization. The features of the matrix were defined according to the research which made possible to find what was already done for the data processing activities. The features of the matrix were defined according to the research made in the field. Processing 1000GB of structured data in a batch procedure is something that is executed every day and it does not represent difficulties. Nevertheless, the difficulty grows as the volume increases and the several types of data need to be processed faster than ever. With respect to the weights, it was agreed that what is important is not the exact value of each variable, but the scale that separates each one. In our view, this is a possible distribution, however, each organization should adapt and attribute the weights according to the size and capacity of the current infrastructure.

Volume is not the only characteristic of Big Data but the most challenging one. It is the one that is more easily recognized from the technology’s or infrastructure’s perspective. The volume is more significant in the choice between Big Data technology and the decision of invest in the increase of the space and process capabilities. Variety comes next, since it represents the challenges for the organizations that have to deal with data types which were never processed, in order to provide value for them. Here we talk about learning new kinds of technologies that “understand” unstructured data and acquire knowledge from data that seems “meaningless”. Finally, Velocity presents the minor weight because the velocity challenge is solved with the increment of process capabilities, like parallelism and hardware investments. Once the weights are distributed it is possible to perform the calculation and map the problem. The equation is a simple sum of the Big Data dimensions, each one multiplied by the CL. BigDAF provides four distinct assessment results:

- **[100-200] - Traditional BI issue** – The Company is facing a problem that could be solved with a relative investment on storage capability and/or simple text processing tools. The period of data refresh and process is not a threat.
- **] 200-300] BI Issue near Big Data challenge** - Defines a problem that might evolve to a Big Data issue. It could be solved, for now, through some advanced analytics tools and a system capable of scheduling tasks (Intra-day, Hourly-refresh). Problems that fit in this class must complement its analysis with expected evaluation and consider the need to advance from the beginning to a Big Data project.
- **] 300-400] Big Data Issue** - Need for investment in Big Data architecture, through a comfortable process skill. Once we reach a Big Data problem, its characteristics (Volume, Velocity and Variety) are not a big issue because Big Data tools are prepared for these conditions.
- **] 400-500] Complex Big Data Issue** – In this case, it is even more urgent to invest in a Big Data project. There is no possibility for the BI to be enough to support such a huge and instantaneous data flow with this complexity. Even the Big Data suppliers have to prove that they are capable of dealing with this problem because not all offers presented on the market will fully serve the customer’s needs

The ranges above presented were defined using the expert knowledge provided by project managers. They gave us an image about the threshold of each range. To better understand of the framework it was assessed a real case of a transportation company that needs to evaluate a logistic improvement initiative:

- **Volume:** >500TB – It will be collect data about traffic, customer profile (for priority definitions), weather conditions, driver profile, real-time GPS information.
- **Velocity:** Information collected and available in real-time.

- **Variety:** Web log and device events, JSON, image, geospatial, and video.

Based in the features above described, the CL is:

$$CL = (60 * 4) + (10 * 4) + (30 * 5) \Leftrightarrow CL = 430$$

According to the result the initiative is defined as a “Complex Big Data Issue”. To the company, the problem is not the volume but mostly the several data format that needs to be collected and analyzed in real-time in order to promote an accurate decision. When combined the three factors BigDAF considers this project a Big Data issue. With this project the company expected a cost reduction and a better quality in the service provided. It is important to note that a good project assessment requires a real-time evaluation. The constant data changes can quickly modify the project type.

5. Framework Assessment

BigDAF was already used to assess project scopes in three distinct areas using real data. At first the project manager / researchers did not have a defined idea about what type of project they are dealing with. However, after apply this framework they can have a most equilibrated idea about the project scope and their complexity. The areas in study was Stock Market¹⁶, Intensive Medicine¹⁷ and Local Government¹⁸.

In the first case a professional was contracted by a multinational organization to make Big Data in stock market. After have some contact with the reality he demonstrated some uncertainty about if the project is or not a Big Data issue. With the goal to clarify the project complexity BigDAF was used. After this, it was possible conclude that at the moment the project is not a Big Data project for now. The frameworks reveal that the organization only wants to make BI in real-time but using a small amount of data. The assessment result was level 2 (BI Issue near Big Data challenge): $(60 * 2) + (10 * 4) + (30 * 4) \Leftrightarrow CL = 280$. As conclusion the organization can use some Big Data components but did not need to invest on it in this first phase. Actually, they are in a test phase and it is a big risk to bet in Big Data, when they did not know if the project will be a success or not.

In the second case study^{19,20} the results were clear. The research team developed streaming data system which collects every day a considerable amount of data²¹. They are inducing data mining models using online learning and all the processing and transforming tasks are performed in real-time²². At the moment they have a project in a small scale, however after using BigDAF they understood that they have a Big Data problem. Consequently, the machines are slower and they cannot answer on-time to the request made. Using BigDAF this project was considered as a Big Data Issue: $(60 * 3) + (10 * 5) + (30 * 3) \Leftrightarrow CL = 320$. After obtain this result, the research team met and designed a Big Data plan to their project. Finally, in the last case the local government representatives used the BigDAF to understand if the project that they are starting in the Business Intelligence field can be or not considered a Big Data project. After analyze the data complexity and the project goals it was possible conclude that the project is a normal BI project and did not need to invest in Big Data frameworks. The project was classified with the first level - Traditional BI issue: $(60 * 1) + (10 * 5) + (30 * 3) \Leftrightarrow CL = 200$.

In both cases the managers / researchers mentioned the importance of having a simple framework able to help them to understand which type of project they have in hands. According them, the results were very promising and they are strong associated to the environment, i.e., can represent very well the project reality. After using BigDAF they redefined the project needs and expectations.

6. Discussion

It is true that both approaches (BI and Big Data) are limited when they have to perform the opposite task, i.e., Big Data technologies are not ideal to deal with the structures and traditional volumes and the BI/Data Warehousing technologies are not even capable of dealing with large amounts of unstructured data. After mapping this problem in the BigDAF, organizations will be able to take a better decision for its investment avoiding an unsuccessful case. The main idea is not dictate what should leaders choose but make them think over and finding a balance between the necessity of keeping up with the technologic and market trends and their realistic present and future needs. If organizations are resistant to changes, they do not have to exclude all the investments made until now in data processing and data analysis. In fact, Big Data architecture is capable of integrating and extending the traditional BI for the analysis of more complex data, it will provide new capabilities:

- The conventional BI for the mainstream business allows the users to do ad-hoc queries and reports. Now, it is possible to complement that effort with a Big Data analytics environment, optimized to handle a flow of unstructured data.
- BI tools help the analysts to filter and analyze according to the business requirement.
- Big Data can operate from the business requirements and the context of the problem.
- The Existing ETL process for loading data warehouse can be improved by the power of Hadoop.

In case of the Big Data Complexity Framework does not map your problem in a complex Big Data range, this options could represent a step forward for the business into this new “information Era” without a huge investment or radical changes. As observed in the three case studies, the managers / researchers had a different idea about the project scope. By using the BigDAF they are able to better understand if their project is a simple BI project or a most complex project, where their success depends the use of Big Data. We are not imposing BigDAF as a universal framework. It is a new resource that can be used by the organizations in order to improve the decision process. It did not gives an absolute truth but an overview of the problem type.

7. Conclusion and Future Work

This is an ongoing project and this paper is presenting the first results achieved. The Big Data concept has evolved by the ability to provide value to organizations that include this “technology” in their decision making process. Exploring the Big Data market, it was possible to understand why does everybody talk and want to be part this new era. It could represent an all new perspective to perform business because information is now the most important resource of a company. There is a lot of organizations still have doubts about what really defines Big Data and where are the boundaries of a project of this kind (as can be proved by the case studies). For that reason, Big Data Project Assessment framework (BigDAF) was presented in paper. BigDAF aims helping organizations to classify their Big Data project according to dimension, volume, velocity and variety. Looking at the framework a management / research team will be decide based on precisely measure and understanding the real challenging that they are facing. With the application / use of BigDAF it is expected a better understanding of what is a Big Data project and when the organization need or not to invest in Big Data technologies. The major goal is helping the organizations and research teams to frame their projects / works and achieve their goals with the right costs and tools. As results it is possible obtain new knowledge about the type of project, future needs and what is the right path to follow. Consequently, BigDAF will prevent unnecessary costs and even “bad investments”. Each dimension tells something different about the problem and the business choices should considering all three dimensions. BigDAF looks for the three dimensions as a whole. It gives a global overview of the problem to the decision maker. It helps him to understand if only one of the dimension is really significant to be a Big Data project or not.

BigDAF should be seen as a decision support tool or a guideline able of better identifying the project features. Using BigDAF is possible to overcome wrong choices. A note that BigDAF should carefully use and the project type should be constantly revised. Although it creates an easier understandable scale, collapsing all the dimension in a 100-500 should not avoid the process of analyzing the dimensions in separate. It only gives a different overview of the problem. This framework is also helpful to the decision-makers which demonstrates to be confused about their problem is a BI or Big Data issue. The framework should be applied to evaluate whether a project requires big data approach or not. In the future a study will be applied to several decision makers in order to understand how helpful they found this framework. In the future this framework also will be applied to biggest problems and their features and constructs will be improved. It is the first step to create a global framework able to help in the decision process. Finally the other 2 Vs also will be analyzed in order to understand how they can be added to BigDAF.

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