Overview of Data Governance in Business Contexts

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Abstract. Taking into account the amount of information that is currently handled in business contexts, it is mandatory to develop a good data governance program. It guarantees that all the information is available to the company when it needs it, as it needs it and where it needs it. Through this data governance, the main goal is to increase profits, decrease costs, improve knowledge management and interact with customers, suppliers, employees and processes. Besides, this type of programs are not only part of a section in the company, but also they must have a transversal collaboration to all the technology and business teams. During the first stage of this research, it seeks to perform a review of the state of the art on the data governance. It allows to unify criteria through a reference item later, to provide a tool that helps companies to support the information necessities through the development of data governance projects that respond to business needs and strategic decision making.

1. Introduction

Nowadays, organizations are changing all the time. Effective decisions play an important and decisive role in front of competition. It implies a series of attributes of the information quality. It has to be precise, coherent, consistent, available, easy and immediate accessible, but the variety of formats and the volume of data in the business contexts have grown considerably in the last years. It is due to current companies work online worldwide and accumulate a huge amount of information, mainly about their products, goods, services, customers and their behavior. On the other hand, companies add unconventional information from social networks, multimedia, heterogeneous data sources and many of these are unstructured ones.

Consequently, the complexity of the information is meaningful and companies need to find strategies to organize, manage and rule information as an income of the company and can be used as an input that supports business strategies. Data governance is an important variable in strategic management within a corporate government, and it must follow its principles [1]. An efficient data governance can help people of an organization to create a clear mission, increase confidence in the use of the organization's data, establish roles and responsibilities, quantifiable principles and indicators [2]. More and more organizations have realized the growing importance of controlling their data. However, there is a growing focus on data governance aspects to ensure security, high quality and better data management [3]. Nevertheless, there is no single standard or approach for the implementation of data governance programs in organizations nowadays [4][5].

During the initial stage, this research goal is focused on showing a review of the state of the art, which allows an analysis to unify criteria by means of a reference model in order to guide companies in the implementation of data government projects.
2. Main concepts of data governance
The Data Government is the field in charge of treating the data as a company asset. It is about the decision policies so as to improve, protect and take advantage of the data as a business asset. It involves the orchestration of people, processes, and technology and organization policies, to obtain the optimal value of the company's data. The Data Government plays the main role in the alignment of disparate and often conflicting policies that generate anomalies in the master data. It defines who has the right and responsibility for taking decisions about the company data [6][7][8]. There are several meanings of data governance, as follows in Table 1.

| Concept                                                                 | Source |
|------------------------------------------------------------------------|--------|
| It is the set of decisions, processes, standards, policies and technologies required to manage, maintain and exploit some information as a business resource. | [9]    |
| A data governance plan hast to be part of an IT program. It involves processes and controls to ensure that information at the data level is true, accurate, and unique. | [10]   |
| Data governance can be defined as an organizational approach to data management that establishes a set of policies and procedures to include the data entire life cycle. | [11]   |
| Data governance can be seen as a formal orchestration of people, processes and technology to allow an organization to take advantage of data as a business asset. | [12][13] |

Data governance and data management are different, the second one refers to the implementation of the decisions made about architecture level, policies and procedures in order to improve and manage the life cycle of the data in a specific context.

3. Information governance concepts
The information governance is considered as the value driving and it moderates the risk of data exploitation in organizations. An institution can take advantage of information as a competitive asset [14]. The governance of information, mainly, is the set of principles, policies and processes through which an organization guarantees that the information is protected and according to its needs and business goals [15][16][17][18][19][20][21]. Information is an asset of the organization that includes both the data and the context in which data has meaning [14]. Architects, system administrators and data center administrators are key performers in the governance of information; this incorporates processing, infrastructure management and security requirements [17].

4. What it works and what it doesn’t in data governance
The Data Government is not a new concept. Professionals of knowledge and information management have faced the quality and confidentiality of data for most of the computing history. Data doesn’t have not only some value within the application and the users who captures it, but also in the organization. These functions demanding, and cross-architectures of the same data is forcing companies and IT leaders to recognize dependencies and perceptions of data value conflict. Many information managers are betting on data governance to decrease these conflicts [22]. This proposal does not define neither decision dimensions nor a methodological guide for data governance, but it addresses important issues that must be considered when designing and implementing data governance.

It is important for a data governance project success to take into account some topics like catalysts that help to launch a data governance project joined to another: how can a BI project be. An organizational structure for the project has to be led by a CXO of the company, an exclusive project manager, accompanied by a responsible for the business and another IT. It is mandatory to identify the
main risks that can cause the data governance initiative failures and decide how to decrease them: the risks can be aspects such as lack of explicitness about business processes, lack of participation of business representatives, among others. Defining the team in charge of the master data and who are involved in the project is necessary. The government of data should be designed according to the company policies: it means that, if a company decides in a decentralized manner for each field of business, it is suitable to implement a data governance in the same way. Although the government is decentralized, decisions should be taken centrally, but the business data can be taken in a decentralized manner.

5. Data domains
The information architecture, according to [23], describes the principles and guidelines that allow a coherent implementation of information technology solutions: how data and information are ruled and shared in the company, as well as, what it needs to guarantee information confidence. There are several types of data that can be used in each business lines. The data can be structured or unstructured and it can also be viewed from a perspective of how it is stored. In [23] it explains, how to divide business information into 5 domains, according to the use and format of the information within a company. The domains are: metadata, master, operational, unstructured and analytical data.

Metadata is defined as "data on data". It is the information to describe the characteristics of each piece of corporate data and other entities. The master data refers to the data instances that explain the main commercial entities, such as customer and product data. Operational data is also known as transactional data. They are derived from day-to-day business transactions. Unstructured data, also known as content is usually managed by a business content management application. Analytical data is usually derived from the transformation of operational systems to address the specific requirements of decision support applications [23].

6. Reference models
Data governance expresses how the organization manages all the data and information that is transversal to all its processes [24]. It is not a one-time project, but a constant program. The reference models provide a set of tools and guides that help organizations through the implementation of data governance projects to get their business goals.

6.1. Federated enterprise architecture
The information architecture, according to [23], describes the principles and guidelines that allow a coherent implementation of information technology solutions: how data and information are ruled and shared in the company, as well as, what it needs to guarantee information confidence. There are several types of data that can be used in each business lines. The data can be structured or unstructured and it can also be viewed from a perspective of how it is stored. In [23] it explains, how to divide business information into 5 domains, according to the use and format of the information within a company. The domains are: metadata, master, operational, unstructured and analytical data.

6.2. The unified process
Many companies apply a manual procedure to accomplish the instructions for a data governance program. Obviously, all of them will run it differently, especially due to the different goals of the companies. Some of them could focus on data quality, others on customers, and the others on ensuring the privacy of sensitive customer data. Some organizations will adopt a formal Data Governance program, meanwhile others use something lighter and more tactical.

The unified process of data governance shows 14 steps to set up an effective program, from step No. 1 to 9 and 14 are required, the other ones are optional. The company selects one or more of the four optional steps. It means: Government of Master Data, Analytical Government, Security and Privacy Management and the management of the Information Life Cycle. Finally, the unified process
of data governance has to be checked, and the results showed periodically to the executive promoters [6].

6.3. ISO 38500
It proposed an IT governance model [19][20][25], to offer a guidance on behavior in decision-making and responsibility measurements, strategy, acquisitions performance, compliance and behavior of personnel. It explained that organization's leaders should focus on testing the use of current and future IT, guiding the preparation and implementation of the government and establishing a model cycle of evaluation, direction and monitoring. At the same time, ISO believed that IT was also available to data governance.

6.4. IBM Data Governance Council (IBM DG Council)
It explained a data governance element model and it was divided into four levels: support and central domains, contributing factors and results. The results are seen as the key to data governance in this model. The organization could obtain the results and realize the value of the data by means of taking into account the function of the support domain, the central one and the contributing factors. IBM DG Council combined the characteristics of the data with its practices and proposed the data governance maturity model, which divided this model into five levels, including the initial stage, basic, active, quantitative management and permanent optimization [26].

6.5. Information Systems Audit and Control Association (ISACA)
ISACA [26][27] believes that data governance is an important element for IT. He considers data governance as a principles-based methodology for process control. COBIT 5 provides an IT and management framework based on the Top-Down principle and gives the strict distinction between government and management. Besides, COBIT 5 explains key areas of data governance, such as stakeholders, contributing factors, governance and management objects, among others.

6.6. DAMA-DMBOK2 Framework
DAMA International defines 11 areas of knowledge for most of data management areas: governance, architecture, modeling and design data, Operations and data storage, security, integration and interoperability data, Documents and content, Master Data and Reference, Data Warehouse and Business Intelligence, Metadata and Data Quality. Each area has topics per section and group activities. There is also an additional section of Data Management that contains topics to describe the knowledge requirements for data management professionals. The new area of is integration and interoperability data [28].

6.7. Decision domains
The data governance design, according to [7], defines 5 related decision making domains. These are as follows: data principles, data quality, metadata, security and data life cycle. For each of them, it defines the type of decisions that must be made. It also proposes a set of possible roles in the company that may be responsible for each one.

Data quality. Data quality impacts the company at an operational and strategic level. Poor quality in the data generates operational costs and, strategically, the information is not reliable for taking strategic decisions. The quality of the data refers to its capacity to satisfy the requirements of use within the company. The quality of the data has multiple dimensions such as: precision, timeliness, integrity and credibility, among others, these are relative and should be defined according to the context of data use [7]. Data quality problems are showed in [29]. Despite all the efforts and investments in technology, the departments of the companies identified a lot of problems related to data quality and reliability, at the time of the implementation of analytical projects, which compromises the established deadlines and the investments they made.

Data principles. Data principles establish the link with the business. To align it with the use of the data, its principles set up its measurement as an asset of the company and define which are the specific
policies, standards and appropriate guidelines. Data principles also establish and foster opportunities to share and reuse it. Each one is supported by a fundamental reason and a set of implications [7].

**Metadata.** It is defined as "data on data". It provides a mechanism to obtain a concise and coherent description of the data. It helps to understand the meaning or semantics of the data [7].

**Data access.** Accessing to data is based on the ability of participants to assign a value to different categories. An effective risk analysis by security agents identifies the company necessities and defines policies to ensure confidentiality, integrity and data availability [7].

**Data life cycle.** Being conscious about that all data moves through the stages of the life cycle is mandatory to the design of data governance. By understanding how data is used, and how long it should be retained, organizations can develop methods to allocate usage patterns for optimal storage media in order to decrease the total cost of data storage during their cycle of life [7].

7. **Mature Models of Data Governance**

There is a series of maturity models to improve the planning and implementation of data governance. Each one has strengths and can provide valuable perspectives, current characteristics and form the basis for the subsequent planning of a data governance implementation process. Its review and evaluation must occur at the beginning of the process to establish an understanding of the final state. It is necessary to plan a suitable data governance program. The implementation process is a continuous operational discipline to improve the job as business architecture. The successful implementation of data governance requires a business perspective [30][31][32].

7.1. **The Data Warehousing Institute (TDWI)**

TDWI explains that many of the goals and tasks related to data governance can be reduced to four main imperatives or requirements. They are organized into two organizational imperatives and two technical requirements [32][33].

![Imperatives of data governance](image)

**Figure 1.** Imperatives of data governance. Adapted from [32]

There are two main characteristics in the data governance imperatives classification. First, everyone has stages which develop over time. This advance means development. Second, imperatives as a group imply a sequence of time. For example, it is clear that imperative 1 must create an interdisciplinary team before imperative 2 coordinates the team's objectives with the business initiatives. Figure. 1.
According to imperatives 3 and 4, [32] it explains: The imperative 3 must rule IT systems before imperative 4 begins to use IT systems to automate governance processes. Although these dependencies determine an order to begin the imperatives, they must coexist and interact. The TDWI maturity model is showed in the Figure. 2 and it is described in Chart 2.

**Figure 2.** TWDI maturity model. Adapted from [32]

**Table 2.** Description of stages in the TWDI maturity model

| Maturity stages               | Description                                                                                                                                                                                                 |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Prenatal and childhood stages | In this stage, organizations depend on manual means applied ad hoc as a low-level solution for their business or technological concerns.                                                                   |
| The gulf                     | Leaving this obstacle depends on the organization regularizes the concepts of solution verified in the previous step.                                                                                           |
| Childhood and teenagers stages| In this stage, the organization extends its technological initiatives or practices with it has recently committed. However, growth could arise in a limited context, such as divisions. As a result, growth slows down in the adolescent stage |
| The pit                      | Crossing the abyss successfully requires important global changes, such as business adoption or re-architecture of solutions                                                                                |
| Adult and childhood stages   | In the adult stage, the best practices and the details of technology implementation established and developed in the adolescent stage continue to grow. Silo implementations of the previous stage have been replaced by the wise stage of centralized organizational control and technology integration |

**7.2. Analytical Business Maturity Model**

[34] It takes a different approach according to the TDWI. It shows the analytical business maturity model, with five levels of maturity and explains that it allows organizations to specify current and objective maturity levels and what it needs to be achieved in each phase. The stages are the following: ad hoc, foundational, competitive, differentiating and breaking, see Figure. 3.
In the ad hoc stage, the company is generally behind other companies in the corresponding information area. It is an initial phase, the company begins to develop the capacity to gather information in its functional areas. Different from basic reports, information is not available, or it spends time. Human efforts are usually required to gather the necessary information in order to take daily business decisions.

In the fundamental stage, the company cannot gather the key information yet and is still behind most of its competitors. Information is constantly not available to take business decisions and some human effort is still required to get it. On the contrary, the competitive scenario represents companies whose capacities in gathering information is online, like most of similar companies. This level of maturity is also the starting point to establish a certain consistency in the main business metrics in the company.

In the differentiating stage, a company whose commercial strategies are carried out through the use of information is considered better than most other companies in its sector. Management has the ability to be adapted to commercial changes. Business leaders and users have the opportunity to get the main information and the respective metrics so as to take effective decisions.

Finally, when a company is in the breaking stage, it is generally considered as the best in executing key business strategies. The information is used in the company for multidimensional decision and key indicators of predictive performance are used to model the results.

7.3. DataFlux Maturity Model
This is another model of data governance maturity. According to this one, the organization progresses in the sequence from stage one to stage four, the value increases and simultaneously the risk associated with "incorrect data" decreases. Table 3. Tony Fisher, president and general manager DataFlux explains that the term "data governance" can be lost in different conversations such as big data governance, data and knowledge management, data assets and information assets. DataFlux has improved its maturity model to highlight a business to manage data as a business asset and achieve the necessary levels of data quality [35][36][37][38][39].

7.4. Gartner Maturity Model
Gartner's maturity model, see Table 3, explains that business information management is not a project itself. It is a long-term program that evolves over time. Gartner developed the maturity model to provide information and guidance to organizations that take information management seriously as a strategic asset [30][16].
**Table 3. DataFlux data governance maturity model**

| Level                | Characteristics                                                                 |
|----------------------|---------------------------------------------------------------------------------|
| Level 1: Undisciplined| There are redundant and duplicate data, sources and divergent records at this stage. The main problem is that poor data and information will lead to wrong decisions and missed opportunities. |
| Level 2: Reactive    | This is the beginning of data governance. The improvements are experienced at the departmental level. The company recognizes the value of a unified vision of information. It thinks of Master Data Management (MDM). The IT and business groups collaborate in this stage. In this phase, culture is also preparing to change. |
| Level 3: Proactive   | The information is unified in the company. Business needs to manage IT projects. It has a sophisticated data strategy and framework. Employees have realized that information is a key asset of the company. |
| Level 4: Ruled       |                                                                                                                                 |

**Table 4. Gartner maturity model**

| Level                | Characteristics                                                                 |
|----------------------|---------------------------------------------------------------------------------|
| Inconsistent         | • Strategic decisions are made without adequate information.                     |
|                      | • Lack of information architecture, principles, rules and procedures to share information. |
|                      | • Lack of control of information, privacy, security and responsibility.          |
| Consistent           | • Identifying the value of information.                                           |
|                      | • Realizing the risks associated with the lack of adequate management of information and the exchange of information. |
|                      | • Companies realize the value of information as an organizational asset.          |
| Reactive             | • Information is shared in multifunctional projects.                              |
|                      | • Measurements are taken to exchange data among departments.                     |
| Proactive            | • The roles and structure of the government are structured.                       |
|                      | • Data governance is incorporated to the systems development methodology.       |
| Managed              | • Policies are developed to achieve coherence and are accepted throughout the organization. |
|                      | • A government organization has been established to address concerns related to the management and exchange of multifunctional information |
| Effectiveness        | • Senior management considers that a competitive advantage is obtained by adequately improvement information assets. |
|                      | • The strategies of the management of business information are linked to the objectives of productivity and risk management. |

7.5. IBM Data Governance Maturity Model

Data governance has reached such importance that IBM has created a data governance Council. One of the proposals of this council is a data governance maturity model based on the Capacity Maturity Model (CMM) of the Software Engineering Institute [26][40]. The Maturity Model of the Data Governance Council defines a set of domains that comprise data governance. The revision of these domains is a first step to understand the IBM Maturity Model. The 11 domains reside within four main groups: Outcomes, Enablers, Central Disciplines and Support Disciplines. The interactions among these groups are showed in the Figure No.4.
IBM developed the maturity model (Figure 5). The maturity model is the "criteria" for evaluating and measuring progress within each of the 11 domains [30].

**Figure 4.** Elements of an effective data governance. Adapted from [41]

**Figure 5.** Maturity model of the IBM Data Governance Council. Adapted from [42]

### 7.6. Oracle Data Governance Maturity Model

Oracle is well known for its emphasis on a well-designed underlying data architecture. Oracle has data management experience with the government policies about data. It is showed in [37]. Effective data governance must correctly align people, processes and technology to convert data into strategic information and knowledge assets [30].

It is necessary to rule the data applied in a wide variety of heterogeneous applications and business intelligence systems. Most data quality problems start in these segmented applications. The origin of this data makes it difficult to manage and creates challenges for data governance [30].

Oracle considers that a data governance maturity model help the company determine where it is according to the evolution of its data governance discipline and identify the short-term steps required to move to the next level, see Table 5. Each step has key performance indicators, measurable on real investment to assume the cost [30].
Table 5. Oracle data governance maturity model

| Stage | Level    | Characteristics                                                                                                                                 |
|-------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Marginal | This stage describes an organization that has understood the data governance needs. They will expand the scope of ongoing data quality initiatives and add data management capabilities. This stage is featured by data governance initiatives at the division or department level with functioning data governance teams. It socializes the successes achieved at this level and helps to increase the progress requirement. Teams should be organized in the company and interdisciplinary conflicts have to be solved. Master Data Management solutions must be implemented. |
| 2     | Balanced | Companies are applying the best data governance practices. The data management policies are automatically executed by the Master Data Management engines and the feedback loops that report the results to the committees. |
| 3     | Best practices | This stage integrates the quality data tested in the applications and business intelligence tools in every business process to achieve the transformational state for the company |
| 4     | Transformational | 8. Big Data Government Most of large organizations have multiple application and format data. The mobile revolution is experiencing today. It has completely changed the way they capture data and build intelligent systems. Large data tends to be operational in nature and is featured by "3 Vs", large volumes, high speed and a variety of formats such as structured, unstructured and semi-structured [34][43][44][45]. The figure. 6 shows the three dimensions of Big Data. These three dimensions and related characteristics are a useful lens to understand the nature of the data and how they can be understood. Therefore, challenges of Big Data are different and are featured by a combination of the "3 Vs" that make the information and knowledge of the business difficult to obtain. In addition, when large-scale data is processed and stored, other dimensions such as government, ethics, security and policies take part of it [12][45][46][47][48][49][50]. |

Figure 6. Big data growth dimensions and related characteristics. Adapted from [42]
9. Conclusions

Reference models, data domains, what it works and what it does not, should be taken into account as a necessary tool when planning and executing a business data governance strategy or program. These reference models are useful to organize concepts and establish a perspective about a data governance initiative in order to fit and respond to business necessities and strategies.

A comprehensive data governance strategy should not only include a reference model, but also maturity models, business processes and, the organizational context and culture. Maturity models should be used as a measure of the evolution in data governance by means of the data and information recognition with one more asset of the company or organization.

The quality of the data depends directly on a comprehensive strategy of data governance and without it, the objectives, strategies, business indicators cannot be defined, understood, communicated and measured properly.

There are several reference and maturity models as proposals for planning and executing data governance programs. They are different based on their characteristics but complementary at the same time. Each proposal addresses the issue from different perspectives and equally important issues. Consequently, if someone wants to be part of this type of program, it is necessary to review each of the proposals, analyze and determine which of the proposals is the most appropriate or choose another one according to the company needs.

According to the previous work, the opportunity to propose a data governance model for a specific context is identified in order to facilitate the planning, execution and evolution of a data governance program in high-level educational institutions.

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