Data Governance Maturity Model for Micro Financial Organizations in Peru

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Abstract: Micro finance organizations play an important role since they facilitate integration of all social classes to sustained economic growth. Against this background, exponential growth of data, resulting from transactions and operations carried out with these companies on a daily basis, becomes imminent. Appropriate management of this data is therefore necessary because, otherwise, it will result in a competitive disadvantage due to the lack of valuable and quality information for decision-making and process improvement. Data Governance provides a different approach to data management, as seen from the perspective of business assets. In this regard, it is necessary that the organization have the ability to assess the extent to which that management is correct or is generating expected results. This paper proposes a data governance maturity model for micro finance organizations, which frames a series of formal requirements and criteria providing an objective diagnosis. This model was implemented based on the information of a Peruvian micro finance organization. Four domains, out of the seven listed in the model, were evaluated. Finally, after validation of the proposed model, it was evidenced that it serves as a means for identifying the gap between data management and objectives set.

1 INTRODUCTION

Data governance is a trend that allows for proper data management in the organization since information is at present a company asset which offers benefits when used strategically; thus, offering a competitive advantage (Soares, 2010).

On the other hand, organizations play a key role in a country's economic development. In particular, micro finance organizations are the means through which entrepreneurs can access financial services (World Vision, 2014), thereby promoting self-improvement and development pathways for different countries, especially economics low sector, using the concept of micro finance in its financial system (Gestion, 2015).

Given this, as the data volume and complexity grows, organizations have two options: they can succumb to information overload or they can implement data governance in order to take advantage of the organization data huge potential (EY, 2014).

It is vital that these organizations are able to manage their data properly in order to be able to exploit them. According to some Digital Universe studies, only 1% of the global data is analysed and over 80% of the data is not protected (The Guardian, 2014). In addition, IBM studies show that one of the most affected sectors in this gap of data governance is the financial sector, as the cost of each record of lost or stolen data is USD 215, which translates into a loss of USD 3.79 million a year (Ponemon Institute and IBM, 2015). Given this scenario, organizations must be able to assess their data management to prevent such threats and meet the gap be-tween the desired data governance level and its current level.

There are solutions proposed that consist in the development of a maturity model focused on data management. In 2007, Peter, David, Burt and Angela proposed a maturity model of data management consisting of six governance processes and five levels of maturity (Aiken et al., 2007). On the other hand, Marco and Katharina, in 2015, proposed a maturity model for master data management called the master data management maturity model (MD3M), which is characterized by addressing various aspects of governance through five thematic or flexible domains and five levels of maturity (Spruit and Pietzka, 2015).

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Likewise, the Governing Council Data of IBM also addresses the issue of data governance based on best practices and methods used by its members after their performance in various organizations worldwide. As a result, they pose a flexible scheme consisting of five levels of maturity (based on CMM) and eleven domains, which enable organizations to assess current deficiencies in data governance practice and identify opportunities for improvement (IBM, 2007). While there are data governance maturity models, these are generic and do not align to the requirements of the micro finance sector, which has its own characteristics such as the exponential growth of data volume, the criticality of data and regulations and standards to which it is subject (Informatica, 2015).

Given this, the objective of this research study is to demonstrate the advantages and benefits that entails the ability to objectively measure and assess the management carried out in relation to a micro finance sector organization data, in such a way that it ensures integrity, availability and confidentiality of data through a flexible proposal. In this sense, the proposal that arises is the development of a data governance maturity model for micro finance organizations, consisting of fundamental domains covering the most important fronts of data management in the organization. This model serves as a tool to carry out the abovementioned assessment.

This paper is divided into five sections. Section 2 contains information subject matter of the research study, and reviews the literature related to the topic presented in this document. Section 3 discusses the proposal developed during the research period. On the other hand, the result of the validation of the model applied in a study case is in Section 4. Finally, the research conclusions and the conclusions of the model application are presented in Section 5.

2 RELATED WORK

First, Research has been approached from two perspectives: Data Governance Models that provide a frame-work for holistic integration on data management and control in the organization; and Data Governance Maturity Models, which establish evaluation criteria to diagnose data management.

Regarding the Data Governance Models, in 2007, in order to offer the organization, the possibility to unify in one single model the technical and business approach, Kristin (Wende, 2007) proposed a data governance model consisting of 4 domains. The main feature of this model is that it was specifically designed to contribute to the decision-making process of everyday life in organizations. In 2009, Kristin, Boris and Hubert (Weber et al., 2009) observed that organizations failed to address the critical aspects for successful quality data management, limiting to only associating it to IT. Thus, they propose a data governance model that consists of seven parameters with a strategic focus on three decision areas called Strategy, Organization and Information Systems. Its main objective is to obtain an optimal quality data management for the organization, based on the establishment of at least eight major activities for each decision area of the model. In addition, in 2010, Vijay and Carol (Vijay and Brown, 2010) state that organizations manage information technology considering them as corporate assets; however, data is not valued and therefore it is managed in the same way despite the criticality of its importance. In this sense, the authors state that both IT governance and data governance revolve around decision making, which is why in 2010 they proposed a framework for data governance consisting of five domains called DDG, taking the IT governance framework as the main reference. Peter (Malik, 2013), in 2013, proposed a model for data governance based on Big Data due to the exponential growth of information volume experienced by organizations. The proposal includes five key factors and ten principles or best practices for optimum results in data management. On the other hand, in 2014, with the aim of converting the organization data in significant inputs that generate value, Hongwei, Stuart, Yang and Richard (Zhu et al., 2014) propose a data governance model that addresses six categories and five criteria including assessment methods. The latter, unlike other models, allows the organization to anticipate the various ways in which the model can affect while being implemented.

Data governance models analysed have different perspectives; Kristin, Vijay and Carol, and Hongwei, Stuart, Yang and Richard models are approached from a strategic point of view prioritizing decision-making, while the Kristin, Boris and Hubert, and Peter Model focuses on specific features such as Data Quality and Big Data trend.

On the other hand, regarding Data governance maturity models, in 2007, Peter, David, Burt and Angela (Aiken et al., 2007) stated that a data governance assessment within an organization can draw a roadmap for improvement of data management; however, they pointed a lack of a framework to guide such management from an achievement-oriented approach. This drives the

authors to propose a data management maturity model consisting of six governance processes and five maturity levels based on CMMI. In 2007 as well, based on the experience of IBM data governance council members and after understanding the needs of various international organizations with which they worked on data management, they posed a maturity model whose levels are based on the ones proposed by the CMMI. Likewise, they defined eleven categories grouped in four key domains with which all fronts of the organization involved in data governance are covered. This model was applied in the fifty organizations that make up the IBM council revealing their state of maturity (Aiken et al., 2007). In 2009, based on the objective of providing the organization with a roadmap to organize their efforts around critical factors in data management, the Enterprise Content Management Maturity Model (ECM) (ECM, 2009) was proposed, a model consisting of three domains and 5 levels of maturity that have an approach based on the organization management action. A year later, in 2010, DataFlux Company points out that organizations only focus on entering and monitoring data to meet specific needs, however, this leads to the storage of redundant and obsolete data; therefore, they proposed a model that addresses four domains and four levels of maturity (Dataflux Company, 2010). In the same year, Kalido Company (Kalido, 2010) made research on over forty companies with various maturity levels, detecting that the ratio of data-related problems growth is outpacing our ability to detect them. Thus, they pro-posed a model based on three domains, whose maturity levels are based on the evolution of information assets in the organization approach. One year later, in 2011, with the aim to promote and support organizations on how to focus their efforts on data management and materialize them through benefits Oracle Insight Team (Oracle, 2011) proposed a maturity model based on five domains and six maturity levels adapted to CMMI. In 2014, after analysing the behaviour of organizations, the CMMI Institute (CMMI Institute, 2014) said that it is necessary a model that aligns data management with business needs; therefore, it proposes a model with six domains and five maturity levels. On the other hand, after investigating and concluding that quality data assurance arises from the integration of master data, and in the absence of a framework that supports this approach, in 2015, Marco and Katharina (Spruit and Pietzka, 2015) proposed a maturity model called MD3M, which addresses master data management through five flexible themes and five maturity levels also based on CMMI.

Each data governance maturity model studied poses a different approach for its models and maturity levels; however, all of them have the same objective: help the organization identify its real maturity level. Thus, they base themselves on domains, which are the main aspects that must be considered to measure data management and maturity levels, as well as their level of management of each aspect or domain.

3 DATA GOVERNANCE MATURITY MODEL FOR MICRO FINANCIAL ORGANIZATIONS

3.1 Basis

From the literature reviewed, we have selected eight models of data governance maturity, each model provides a context of the aspects considered necessary to be addressed in order to improve data management. These aspects are called domains. Each model defines the level of granularity of their domains, so with the aim of identifying fundamental aspects to implement data governance in an organization, the following common domains are identified from the selected models:

- Principles of data: Focus on data policies, strategies and regulations (Oracle, 2011) (Dataflux Company, 2010) (Kalido, 2010) (ECM, 2009) that determine the desired organizational behaviour (IBM, 2007) (Vijay and Brown, 2010). The overview for setting policies is preventive and requires a high commitment from senior management (CMMI Institute, 2014);
- Data lifecycle: Systematic policy for data collection, retention and disposal (IBM, 2007), supported by analysis and continuous measurement (CMMI Institute, 2014). In addition, it is essential that there is a tool for optimal data storing in the organization (Vijay and Brown, 2010) (Spruit and Pietzka, 2015);
- Data quality: The organization adopts guidelines to maintain the data integrity and define the impact of data categories in the business (Oracle, 2011) (Spruit and Pietzka, 2015). Measurement improvement and quality certification data (IBM, 2007) to pre-vent damage to operational and reputational levels (CMMI Institute, 2014) (Vijay and Brown, 2010);

- Metadata: It describes what data is about and provides a common, single and consistent semantic definition that provides an understanding at a technical and business level (IBM, 2007) (ECM, 2009) (Vijay and Brown, 2010) (Spruit and Pietzka, 2015). Data integration architecture to improve operational efficiency (Oracle, 2011);
- Information Technologies: Technology of organization supports and monitors data, it is also aligned to the business strategy (Kalido, 2010) (ECM, 2009). Infrastructure technology to support BI strategy (Oracle, 2011) (Dataflux Company, 2010);
- Information Security: Enterprise-scale data security architecture to support the integrity, reliability and availability of data (Oracle, 2011). Policies, practices and controls to mitigate the risks (IBM, 2007) (Dataflux Company, 2010) (Spruit and Pietzka, 2015). It addresses the guidelines for assigning value to different data categories and, on that basis; it sets the information access limits (ECM, 2009) (Vijay and Brown, 2010).

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- None: There is no initiative to improve processes. Data is not valued (Oracle, 2011);
- Initial: Unpredictable process, poorly controlled and reactive (IBM, 2007) (Dataflux Company, 2010). Data management only by IT (Spruit and Pietzka, 2015) (Oracle, 2011);
- Managed: Process characterized for being manageable (IBM, 2007) (Dataflux Company, 2010). There is data management only of certain business units (Spruit and Pietzka, 2015) (Oracle, 2011) (CMMI Institute, 2014);
- Defined: Process characterized for its organization and for being proactive (IBM, 2007) (Dataflux Company, 2010). Business committed to data management (Spruit and Pietzka, 2015) (Oracle, 2011);
- Quantitatively Managed: Process that can be measured quantitatively (IBM, 2007) (Dataflux Company, 2010). Metrics to evaluate data governance (Spruit and Pietzka, 2015) (Oracle, 2011);
- Optimized: It is focused on continuous improvement of processes (IBM, 2007) (Dataflux Company, 2010). Data governance is a process of main business (Spruit and Pietzka, 2015) (Oracle, 2011).

Table 1 show a comparison matrix between of models of data governance maturity and the domains they address. The six previously explained domains address the associated data management basic aspects; however, not all the models refer to them. The MD3M (Spruit and Pietzka, 2015) and DDG (Vijay and Brown, 2010) models have limited approach on data and data management, but they do not address a key aspect like IT strategies for data support. On the other hand, Oracle (Oracle, 2011) and DataFlux (Dataflux Company, 2010) present a more technological approach that starts from the premise of using technological tools to govern data properly without addressing in detail the strategic aspects.

With regard to maturity levels, we can classify models into two groups: those models that have made an adaptation of CMMI levels and others which have chosen to propose their own levels of maturity.

Regarding the models with adapted levels, the DMM and IBM models have chosen not to modify the definition proposed by CMMI established for each level of maturity. While Oracle and MD3M have made an adaptation of CMMI levels adding certain concepts specifically associated with data management. These four models support their choice in that such levels of maturity belong to an already robust and validated international model. There are models that have proposed their own maturity levels such as Kalido, DataFlux, ECM and DDG. The last two are similar because they have approached maturity levels from the initial stage where data governance does not exist yet or is barely known, to a level where initiative data management is based on proactive management. While the first two, DDG and Kalido, differ markedly from those discussed above since they address their maturity levels with approaches based on data management from information centralization. Therefore, as seen in Table 2, maturity levels each model addresses have been standardized in order to compare these approaches and unify the concepts per level.

After studying each model, we have finally detected three points in which each model has decided to address maturity levels: general approach proposed by CMMI; an approach proposed by CMMI adapted to the context of data governance and an approach strictly linked to data management. No model combines these three perspectives, which would enrich the proposal. Finally, each model addresses intervention assessments in different ways.

Table 1: Comparative matrix of models and domains.

Models	Domains					
	Data Principles	Data Lifecycle	Data Quality	Metadata	Information Technology	Information Security
Oracle (Oracle, 2011)	✔		✔	✔	✔	✔
ECM3 (ECM, 2009)	✔			✔	✔	✔
DataFlux (Dataflux Company, 2010)	✔				✔	✔
Kalido (Kalido, 2010)	✔	✔			✔	
DDG (Vijay and Brown, 2010)	✔	✔	✔	✔		✔
IBM (IBM, 2007)	✔	✔	✔	✔		✔
DMM (CMMI Institute, 2014)	✔	✔	✔			
MD3M (Spruit and Pietzka, 2015)		✔	✔	✔		✔

Table 2: Comparative matrix of maturity levels.

Models	Maturity Levels					
Oracle (Oracle, 2011)	None	Initial	Managed	Standardized	Advanced	Optimized
ECM3 (ECM, 2009)	Not managed	Incipient	Formative	Operational	Proactive	
DataFlux (Dataflux Company, 2010)		Undisciplined	Reactive	Proactive	Governed	
Kalido (Kalido, 2010)		Focused on application	Focused on organizational repositories	Focused on policies	Totally governed	
DDG (Vijay and Brown, 2010)		Decentralized	Semi centralized	Centralized	Governed	
IBM (IBM, 2007)		Initial	Managed	Defined	Quantitatively Managed	Optimized
DMM (CMMI Institute, 2014)		Realized	Managed	Defined	Measured	Optimized
MD3M (Spruit and Pietzka, 2015)		Initial	Repetitive	Defined Process	Managed and Measured	Optimized

First, IBM, DataFlux and Kalido models are based solely on the proposed domains and maturity levels; they do not need to disaggregate each domain to perform the assessment. While the other models establish a mechanism of differentiated and detailed assessment.

However, not all the models coincide with the assessment mechanisms at a content level, that is why, based on the different aspects each model addresses, it is considered fundamental to consolidate said key areas, components or ideas in a unique concept called assessment criteria, which facilitates maturity assessment for organizations. This can be seen in Table 3.

3.2 Model

The micro finance environment presents peculiarities that have a direct impact on data management, starting from the personalized customer service sought, the very strict regulatory regime to which they are subjected, and the dynamic financial system to which they must adapt. There is a critical issue that characterizes the data manipulated by these organizations, the protection of personal data (Deloitte, 2014), and whose consideration as a separate domain from the Information Security domain is crucial given the context of the proposal (Arnold, 2016).

After analyzing the existing proposals, a model is proposed, as shown in Fig. 1. It allows integration of the seven domains, including the domain of data protection as a separate domain in a single frame of reference aligned to the characteristics of the micro financial sector and whose maturity assessment through level standardization, results simple and objective for micro finance organizations.

In this sense, MMGD offers the organization the ability to be assessed in the financial sector in which it is governed, allowing it to use it as benchmark to learn about their deficiencies regarding competition. In addition, this model is flexible and the organization not only has the possibility to know its overall maturity, but also, according to needs and / or

circumstances, it can measure the maturity level of a given domain independently.

Table 3: Assessment Criteria.

Domain	Criteria
Data Principles	Data Governance Objectives (Vijay and Brown, 2010) (Oracle, 2011) (Kalido, 2010)
	Roles and Responsibilities (Spruit and Pietzka, 2015) (Oracle, 2011) (Dataflux Company, 2010)
	Policies, Principles and Guideline (Vijay and Brown, 2010) (Oracle, 2011) (Dataflux Company, 2010)
	Organizational Culture (Vijay and Brown, 2010) (Dataflux Company, 2010)
	Regulatory Compliance (Vijay and Brown, 2010) (Oracle, 2011)
Data Lifecycle	Data planning (Vijay and Brown, 2010) (Dataflux Company, 2010)
	Data processing (Vijay and Brown, 2010) (Spruit and Pietzka, 2015)
	Data analysis (Vijay and Brown, 2010) (Kalido, 2010)
	Data preservation (Vijay and Brown, 2010) (Kalido, 2010) (Dataflux Company, 2010)
	Data Publication (Vijay and Brown, 2010) (Spruit and Pietzka, 2015)
Metadata	Definition of metadata (Vijay and Brown, 2010) (Spruit and Pietzka, 2015)
	Scope of metadata (Spruit and Pietzka, 2015) (Kalido, 2010)
	Inventory of metadata (Vijay and Brown, 2010) (Oracle, 2011) (Kalido, 2010) (Dataflux Company, 2010)
	Modelling of metadata (Vijay and Brown, 2010) (Spruit and Pietzka, 2015) (Dataflux Company, 2010)
Information Technology	Data Integration and Interoperability (Oracle, 2011)
	Data Warehousing & Business Intelligence (BI) (Oracle, 2011) (Kalido, 2010) (Dataflux Company, 2010)
	Information Technology Governance alignment (Oracle, 2011) (Kalido, 2010)
Information Security	Risk Identification and Information Security planning (Vijay and Brown, 2010) (Oracle, 2011) (Kalido, 2010) (Dataflux Company, 2010)

Domain	Criteria
	Information Security responsibilities (Vijay and Brown, 2010) (Spruit and Pietzka, 2015) (Oracle, 2011)
	Access to network management (Spruit and Pietzka, 2015) (Oracle, 2011) (Dataflux Company, 2010) (Kalido, 2010)
	Internal Audit (Vijay and Brown, 2010)
Data Quality	Definition of data quality (Vijay and Brown, 2010) (Spruit and Pietzka, 2015) (Oracle, 2011)
	Impact on business (Spruit and Pietzka, 2015) (Dataflux Company, 2010)
	Data quality gap (Spruit and Pietzka, 2015) (Oracle, 2011)
	Data quality improvement (Vijay and Brown, 2010) (Spruit and Pietzka, 2015) (Dataflux Company, 2010)

3.2.1 Domains

The data governance maturity model aligned to the micro financial sector comprises seven domains, as shown in Fig. 1. which in turn comprises seventeen assessment criteria.

▪ Data Principles: The focus of this domain lies in the general guidelines of data that exist in the micro finance organization, which will be greatly influenced by the regulatory framework for establishing policy guidelines, standards and strategies under which data management is governed. There are five criteria to consider in assessing this domain: Data Governance Objectives, Organizational Culture, Roles and Responsibilities, Regulatory Compliance, Policies, Principles and Guideline;

▪ Data Quality: The definition of this domain within the maturity model results from the importance of accuracy, consistency and data integrity for the organization. In a dynamic financial sector, which in order to develop business strategies based on analytics, poor quality data have an impact on the organization both operationally and strategically. Assessment of this domain revolves around four criteria: Definition of data quality, Impact on business, Data quality gap and Data quality improvement;
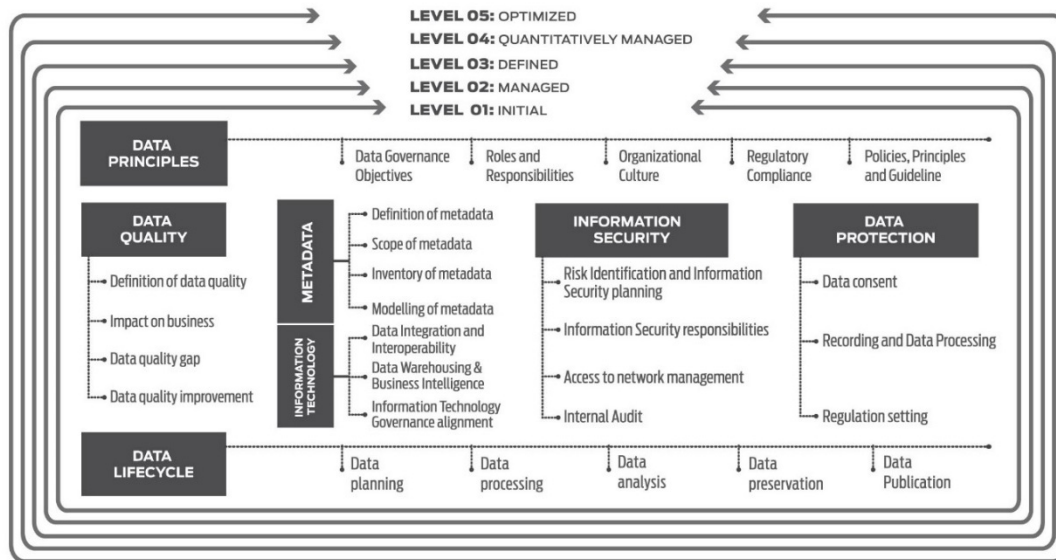
Figure 1: Data Governance Maturity Model for Micro Finance Organizations.

- Metadata: This domain focuses on defining data characteristics within the organization context. In other words, the importance of this domain in the model lies in the ability given to the organization to enable the translation of data content, from the repositories of storage to a business concept up to establishing a language and standard understanding. The evaluation of the domain addresses four criteria: Definition of metadata, Scope of metadata, Inventory of metadata and Modelling of metadata;

- Information Security: Its approach is focused on data accessibility and control according to the needs of use at different levels of the organization. The importance of this lies in the mechanisms and controls in order to ensure confidentiality, integrity and availability of data. This includes both the physical and logical security of information, with which a comprehensive framework of assessment of this domain is provided. According to the regulatory regime, a micro financial organization must comply with regulations associated with risk management and business continuity management. Therefore, four assessment criteria are contemplated: Risk Identification and Information Security planning, Information Security responsibilities, Access to network management and Internal Audit;

- Data Protection: Given the nature of the micro finance sector and as mentioned above, it is necessary to be aligned to specific regulatory compliance for data protection (Law on Protection of Personal Data), which allows you to convert this in a domain apart from the Information Security Domain. In this sense, the assessment of this domain revolves around three fundamental criteria: Data consent, Recording and Data Processing and Regulation setting;

- Information Technology: The domain approach revolves around IT since they support business processes and the information produced during these. In this sense, being a critical resource that supports data volume of micro finance organizations, both at customers' data and transaction level— in its various stages such as collection, processing, storage and distribution—it is necessary to consider it as a key aspect in data management. Three fundamental criteria are considered for each domain assessment: Data Integration and Interoperability, Data Warehousing & Business Intelligence and Information Technology Governance alignment;

- Data Lifecycle: The domain approach focuses on the various stages data goes through. The importance is that this domain addresses a number of processes and mechanisms to optimize the management of data throughout its lifecycle, making it efficient. A micro finance organization stores historical data for analytical or other purposes;

Domain	Assessment Criteria	Level 1 Initial			Nivel 2 Managed			Nivel 3 Defined			Nivel 4 Quantitatively Managed			Nivel 5 Optimized		
		NI	PI	I	NI	PI	I	NI	PI	I	NI	PI	I	NI	PI	I
Data Principles	Data Principles		✓													
	Data Lifecycle					✓										
	Metadata						✓									
	Information Technology								✓							
	Regulatory Compliance						✓									

Indicator	Description	Weight (w)
NI	Not implemented	0.00
PI	Parcially implemented	0.50
I	Implemented	1.00

Figure 2: Assessment Matrix Example.

however, this domain must define when data is outdated for business and debug redundancies at all levels. The assessment criteria considered are five: Data planning, Data processing, Data analysis, Data preservation and Data Publication.

3.2.2 Maturity Levels

The proposal regarding maturity levels is based on the standardization of the previously studied model levels, keeping the focus of the levels established by CMMI and considering as a fundamental aspect the adaptation of each of these levels to the context of data governance in micro finance organizations.

- Initial: There is no formal governance process; data is merely seen as a sub product of applications and processes. The organization has no stable environment that offers support to processes.
- Managed: Standardized processes are in an early stage of business. However, data ownership and administration are defined only in certain business units.
- Defined: It comprises standards, procedures, tools and methods that offer consistency to the whole organization, achieving a good characterization and under-standing of data use in processes.
- Quantitatively managed: Quantitative targets are set in terms of process quality performance and used as criteria during data management, i.e., a statistical analysis is performed on effective data management in the organization.
- Optimized: Process performance continuous improvement based on quantitative understanding of the common causes of process variation and its impact on data, through incremental and innovative

improvements both to processes and to the level of technology supporting data.

3.2.3 Assessment

Reflects the level of maturity regarding data governance in the micro finance organization, i.e., it relates the two first components mentioned through a matrix that serves for assessing, as seen in Fig. 2. This assessment, by the scores obtained, shows the representation at a results level of the application of the model in the organization. It allows for interpretation and identification of those results to establish a roadmap for improvement in the micro finance organization. Assessment takes into account evaluation, considering the premise that each of the domains presents a significant impact on the sector—according to the analysis of two important and prestigious consulting firms like KPMG and EY, which address themes of each of the domains of the model as critical factors and high impact for data governance in the financial sector (KPMG, 2014) (EY, 2011).To carry out this evaluation, in the first place, it is fundamental to have a teamwork of four to six people who we will call evaluators, and who must have at least one of the following profiles in the organization: Business architect of data, data architect, data modeler or Information security official.

After defining the evaluation team, the organization is eligible to apply the data governance model, using the respective equations seen in Fig 3., in two ways. The first option is that the organization applies the maturity model considering the seven domains. This means that the final assessment, i.e., the model score is the average of the score of each of the existing criteria for each of the seven domains.

This is the common scenario in which a micro finance organization is interested in knowing its real condition and thus, it requires to be assessed

$$Score_{Criterio} = \frac{\sum_{k=1}^{k} w.n}{k} \qquad (1)$$

$$Score_{Dominio} = \frac{\sum_{k_1=1}^{k_1} Score_{Criterio}}{k_1} \qquad (2)$$

$$Score_{Modelo} = \frac{\sum_{k_2=1}^{k_2} Score_{Criterio}}{k_2} \qquad (3)$$

w: Peso del indicador de implementación
n: Nivel de madurez
k: Cantidad de evaluadores
k_1: Cantidad de criterios del dominio
k_2: Cantidad de criterios del modelo

Figure 3: Equations of Maturity Score.

holistically to identify the different aspects of improvement. The second option is that the assessment is performed only at a specific domain(s) level; for instance, in a scenario where the organization had suffered multiple cyberattacks and is only interested in focusing on the Information Security domain. If that is the case, the model presents flexibility in its application and the Assessment permits reflecting only the score of maturity for such domain, which is called domain score.

Finally, in both model application cases, the organization is able to interpret the scores of each result based on Table 4, which permits concluding at what maturity level it is regarding its data governance and management.

Table 4: Score Equivalences

Score	Maturity Level
0 > Score <= 1	Level 1: Inicial
1 > Score <= 2	Level 2: Managed
2 > Score <= 3	Level 3: Defined
3 > Score <= 4	Level 4: Quantitavely Managed
4 > Score <= 5	Level 5: Optimized

4 VALIDATION

In this stage, the validation process has four steps: Planning, Application Model, Diagnostic and the Analysis of the Results. In planning the validation process, we address two fundamental aspects: scope of validation and micro finance and work team for the case study. With regard to the scope of validation,

only 4 of the model domains have been considered: Data Principles, Metadata, Data Quality and Information Technology due to the limitations in terms of time and resources. On the other hand, as per the case study, we worked with a micro-finance we will call ABC micro finance organization to protect its information. ABC micro finance organization aims to promote sustainable and inclusive economic and social development for economically disadvantaged people through the use of responsible finance. The organization is as a leader in the sector in Peru and has over half a million customers in its portfolio, about three thousand employees and approximately 153 offices in the country.

In addition, for this validation process, we worked collaboratively with the micro finance organization, which offered us a team of four people with the following profiles: Data Architect, Information Security Analyst, Data Manager and Quality Data Analyst to support us with data collection for the corresponding evaluation.

Table 5: Maturity Score of Domains.

Domain	Score
Data Principles	2.86
Data Lifecycle	2.55
Metadata	3.46
Information Technologies	2.47

Table 6: Maturity Score of Evaluation Criteria.

Domain	Criteria	Score
Data Principles	Data Governance Objectives	4.45
	Roles and Responsibilities	3.25
	Policies, Principles and Guideline	2.45
	Organizational Culture	1.45
	Regulatory Compliance	2.70
Data Lifecycle	Data planning	3.25
	Data processing	1.70
	Data analysis	1.45
	Data preservation	4.10
	Data Publication	2.25
Metadata	Definition of metadata	2.25
	Scope of metadata	3.45
	Inventory of metadata	3.70
	Modelling of metadata	4.45

Table 6: Maturity Score of Evaluation Criteria (Cont.).

Domain	Criteria	Score
Information Technology	Data Integration and Interoperability	2.45
	Data Warehousing & Business Intelligence (BI)	3.25
	Information Technology Governance alignment	1.70

Once the planning stage is consolidated, the application of the model consists in each of the four members of the team making the corresponding evaluation, as shown in Table 5, in order to obtain the weighting of each criterion or domain of the proposed model; i.e., at the end of the model application we must have four evaluations independent from each other.

The purpose of this is to have the four perspectives and be able to objectively define the diagnosis of maturity for the organization.

The definition stage of the diagnosis arises from the consolidation of the four evaluations in a single matrix that allows us to distinguish the level of maturity per evaluation criterion. This consolidation is made based on the corresponding formulas for detecting scores of criteria, domain and model which helped us detect that the level of maturity of the organization is currently 2.84, i.e., the organization is at Level Three Defined. Likewise, in Tables 5 and 6, we can observe the score on a disaggregated basis by domain and evaluation criteria.

Finally, once we have the diagnosis of the organization, we can start the analysis stage of results that allows to provide feedback about data management for the micro financial organization. Analysing the results, we can identify relevant aspects, as seen in Fig, 5., the domain with the best performance and what it represents, the greater positive change compared with the overall score is the Metadata domain. On the other hand, Information Technologies is the domain that has the lowest score, this means that the organization should focus on improving this aspect.

Also, a higher level of detail can be seen in Fig. 6., the representation of the maturity level score for all criteria evaluated in the organization, from this perspective the criteria of organizational culture and alignment to IT governance are the ones that reflect less maturity, and conversely, the criteria with the highest score of maturity are data governance and data modelling. Finally, given these results, the organization must choose to establish a management to start improving the governance of its data, in Fig. 6, it can see the score for each criterion identified, those with a low level of maturity, which means they must have a high priority of short-term management.

The data governance maturity model for micro finance organizations differs from existing models based on three aspects. First, it offers a comprehensive panorama regarding environment domains, i.e., it consolidates the main domains or general aspects to consider regarding data governance. Second, it provides the organization with a consistent standardization of existing concepts for maturity levels, based on a robust model as CMMI, but aligned with data governance context. Finally, the model is aligned to the characteristics governing the micro finance sector at present. Even though it is true that there are proposals to evaluate data governance in an organization, these are general and not aligned with the particular requirements of a specific category or segment.
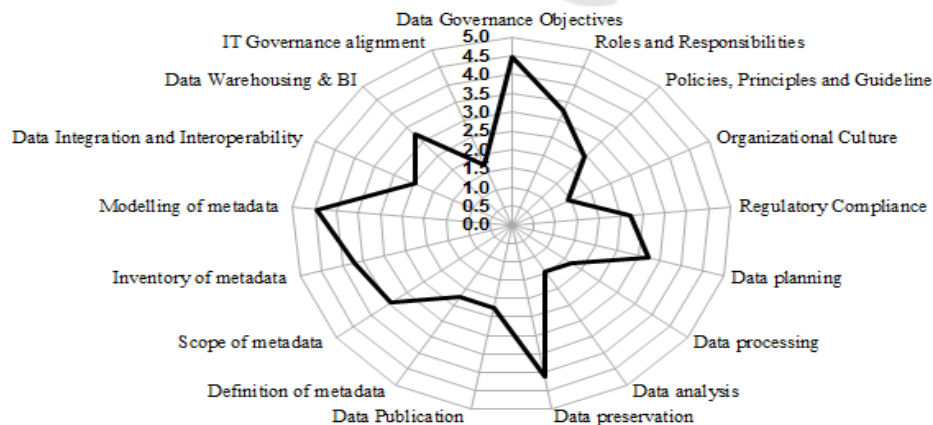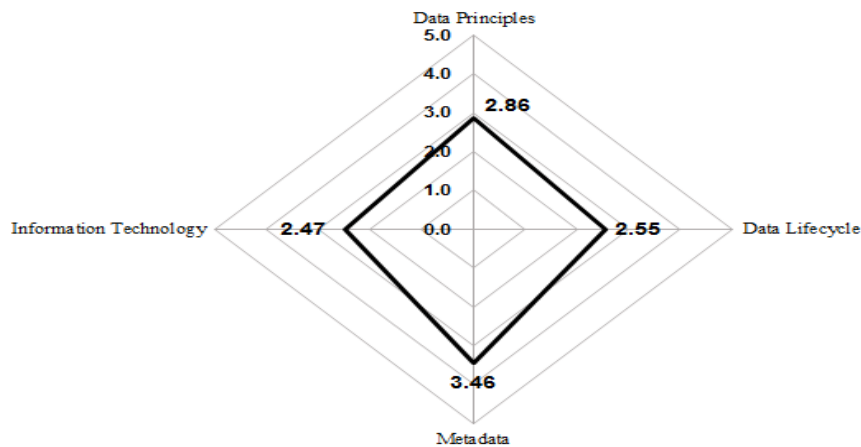

Figure 5: Representation of the score per domain.

Figure 6: Representation of the score per assessment criteria.

5 CONCLUSIONS

In this paper, we have analysed the existing data governance maturity models, identifying its weaknesses and strengths, and from there, we proposed a consistent model of data governance maturity, which is based on the integration of domains, the standardization of maturity levels, the consolidation of evaluation criteria, and the alignment of the micro finance sector.

The data governance maturity model for micro finance organizations comprises seven domains, seventeen evaluation criteria and five maturity levels. Each of these components has been addressed considering the study case sector. In addition, this model was complemented with what we call Assessment, which is defined as the representation at the level of results of the model application in the micro finance organization.

The application of the model permitted the micro finance organization to evaluate its maturity level, taking into account its sector in an objective and easy manner since it only requires commitment of its team in order to know the real state of its management and thus, subsequently, be able to set priorities to manage action plans regarding the diagnosis of the maturity obtained.

REFERENCES

Soares, S. (2010). The IBM Data Governance Unified Process: Driving Business Value with IBM Software and Best Practices.1st edition. Ketchum: MC Press.

World Vision (2014). Economic Development. [Online]. Available at: http://m.worldvision.org/content/economic-development?&origin=www.worldvision.org%2Four-impact%2Feconomic-development [Accessed 16 July 2016].

EY (2014). Big Data Changing the way businesses compete and operate. [Online]. Available at: http://www.ey.com/Publication/vwLUAssets/EY_-_Big_data:_changing_the_way_businesses_operate/%24FILE/EY-Insights-on-GRC-Big-data.pdf [Accessed 19 July 2016].

The Guardian (2014). New Digital Universe Study Reveals Big Data Gap. [Online]. Available at: http://www.emc.com/about/news/press/2012/20121211-01.htm [Accessed 20 July 2016].

Ponemon Institute and IBM. (2015). The cost of data breach study: Global Analysis. [Online]. Available at: http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?subtype=WH&infotype=SA&htmlfid=SEW03053WWEN&attachment=SEW03053WWEN.PDF [Accessed 22 July 2016].

Aiken, P., Allen, D., Parker, B., and Mattia, A. (2007). Measuring Data Management Practice Maturity. IEEE Computer Society, 42, pp. 43-50.

Spruit, M. and Pietzka, K. (2015). MD3M: The master data management maturity model. Computers in Human Behavior, 51, pp. 1068-1076.

IBM (2007). Data Governance Council Maturity Model: Building a roadmap for effective data governance. [Online]. Available at: https://www-935.ibm.com/services/uk/cio/pdf/leverage_wp_data_gov_council_maturity_model.pdf [Accessed 24 July 2016].

Informatica (2015). Transforming financial institutions through data governance. [Online]. Available at: https://now.informatica.com/en_transforming-financial-institutions-through-data-governance_white-paper_2882.html#fbid=gt6PYccHzOO [Accessed 26 July 2016].

Wende. K. (2007). A model for data governance – organizing accountabilities for Data Quality Management. ACIS Proceedings, 19, pp. 417-425.

Weber, K., Otto, B. and Osterle, H. (2009). One size does not fill all: A contingency approach to data governance. ACM Journal of Data and Information Quality, 1(4), pp. 1-27.

Vijay K. and Brown, C. (2010). Designing Data Governance. Communication of the ACM, 53, pp. 148-152.

Malik, P. (2015). Governing Big Data: Principles and practices. IBM Research Journal, 57(3), pp.1-20.

Zhu, H., Madnick, S., Lee, Y., Wang, R. (2014). Data and Information Quality Research: Its Evolution and Future. Computing Han book: Information Systems and Information Technology, 3, pp. 16.1-16.20.

Gestion (2015). Microfinance and its decentralization role. [Online]. Available at: http://gestion.pe/mercados/ microfinancieras-y-su-rol-descentralizador-2138997 [Accessed 22 July 2016].

Deloitte. (2014). Personal Data Protection Law: Practical Approach. [Online]. Available at: https://www2.deloitte.com/content/dam/Deloitte/pe/Docum ents/risk/ley_n29733_la_experiencia_implementacion.pdf [Accessed 20 March 2016].

Arnold, M. (2016). Insurance broker warns on financial groups' cyber-attack cover. Financial Times. [Online]. Available at: https://www.ft.com/content/93b7eabc-1bb4-11e6-8fa5- 44094f6d9c46 [Accessed 20 April 2016].

KPMG (2014). Governing Strategies for managing data lifecycles. [Online]. Available at: https://www.kpmg.com/ ES/es/ActualidadyNovedades/ArticulosyPublicaciones/Do cuments/frontiers-finance-governance-strategies-managing-data-lifecicle.pdf [Accessed 18 June 2016]

EY (2011). Data Loss Prevention Keeping your sensitive data out of public domain. [Online]. Available at: http://www.ey.com/Publication/vwLUAssets/EY_Data_Lo ss_Prevention/$FILE/EY_Data_Loss_Prevention.pdf [Accessed 18 June 2016].

Oracle (2011). Enterprise Information Management: Best Practices in Data Governance. [Online]. Available at: http://www.oracle.com/technetwork/articles/entarch/oea-best-practices-data-gov-400760.pdf [Accessed 16 June 2016].

DataFlux Company (2010). Data Governance Maturity Model. [Online]. Available at: http://www.fstech.co.uk/fst/ whitepapers/The_Data_Governance_Maturity_Model.pdf [Accessed 10 June 2016].

CMMI Institute (2014). Data Governance Maturity Model. [Online]. Available at: http://www.fstech.co.uk/fst/ whitepapers/The_Data_Governance_Maturity_Model.pdf [Accessed 9 June 2016].

Kalido (2010). Kalido Data Governance Maturity Model. [Online]. Available at: http://docplayer.net/2788287-Kalido-data-governance-maturity-model.html [Accessed 15 June 2016].

ECM (2009). Enterprise Content Management Maturity Model - ECM3. [Online]. Available at: http://mike2. openmethodology.org/wiki/ECM_Maturity_Model_(ecm3)#_note-ftn3 [Accessed 12 June 2016].