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www.emeraldinsight.com/0263-5577.htm

Received 8 July 2010
Revised 18 August 2010
Accepted 8 September 2010

Managing one master data – challenges and preconditions

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Abstract

Purpose – This paper aims to provide a framework of the multidimensional concept of one master data. Preconditions required for successful one master data implementation and usage in large high-tech companies are presented and related current challenges companies have today are identified.

Design/methodology/approach – This paper is qualitative in nature. First, literature was studied to find out the elements of one master data. Second, an interview study was carried out in eight high-tech companies and in three expert companies.

Findings – One master data management framework is the composition of data, processes and information systems. Accordingly, the key challenges related to the data are that the definitions of master data are unclear and overall data quality is poor. Challenges on processes related to managing master data are inadequately defined data ownership, incoherent data management practices and lack of continuous data quality practices. Integrations between applications are fundamental challenge to tackle when constructing an holistic one master data.

Research limitations/implications – Studied companies are vanguards in the area of master data management (MDM), providing good views on topical issues in large companies. This study offers a general view of the topic but not describes special company situations as companies need to adapt the presented concepts for their specific case. Significant implication for future research is that MDM can no more be classified and discussed as only an IT problem but it is a managerial challenge which requires structural changes on mindset how issues are handled.

Practical implications – This paper provides a better understanding over the issues which are impacting on the implementation of one master data. The preconditions of implementing and executing one master data are: an organization wide and defined data model; clear data ownership definitions; pro-active data quality surveillance; data friendly company culture; the clear definitions of roles and responsibilities; organizational structure that supports data processes; clear data process definitions; support from the managerial level; and information systems that utilize the unified data model. The list of preconditions is wide and it also describes the incoherence of current understanding about MDM. This list helps business managers to understand the extent of the concept and to see that master data management is not only an IT issue.

Originality/value – The existing practical research on master data management is limited and, for example, the general challenges have not been reported earlier. This paper offers practical research on one master data. The obtained results illustrates the extent of the topic and the fact that business relevant data management is not only an IT (application) issue but requires understanding of the data, its utilization in organization and supporting practices such as data ownership.

Keywords Communication technologies, Information systems, Data handling

Paper type Research paper

Industrial Management & Data Systems
Vol. 111 No. 1, 2011
pp. 146-162

0263-5577
DOI 10.1108/02635571111099776

1. Introduction

The increasing amount of data is creating challenges to companies' data management practices, causing data quality problems which are very common in today's companies (Lee *et al.*, 2006; Breuer, 2009; Knolmayer and Röthlin, 2006). The life cycle of a typical product involves different phases like design, material acquisition, manufacture, distribution, sale, use, service and termination. Each stage requires different data which need to be managed in an integrated and systematic manner to provide accurate information at the right time to various stakeholders (Yang *et al.*, 2007; Rachuri *et al.*, 2008). Workgroups, such as organization departments, develop data processes in silos which lead to variance in the business concepts and object definitions (Moss, 2007). The need to share information across the organizations and supply chains is driving data from silos to be exposed, unified and shared. This reveals enormous data discrepancies and incompatibilities (Boyd, 2006; Dumas *et al.*, 2005).

Today's technology allows storing more data than a company can manage and different enterprise solutions often lead to further data confusion (Smith and McKeen, 2008). Data errors and inconsistencies cause data quality issues which lead to mistakes, lost opportunities, failed deliveries and invoicing problems. It is estimated that incorrect data in retail business costs alone $40 billion annually and at the organizational level, costs are approximately 10 percent of revenues (Snow, 2008; Batini *et al.*, 2009; Redman, 2001). It is said that the decisions a company makes are no better than the data on which they are based and better data leads to better business decisions (Haug *et al.*, 2009; Dayton, 2007).

Today's business requires that a company's data are managed in a centralized manner. Large companies spend a great deal of resources on combining information from different sources into a unified format (Bernstein and Haas, 2008). Master data management (MDM) is one of the newest trends in the area of data management to solve companies' data issues. It tackles data issues by concentrating on business processes, data quality and, standardization and integration of information systems. Organizations can create or purchase its MDM application but before that decision, the company needs to have an understanding over the MDM in whole (Andreescu and Mircea, 2008; Joshi, 2007). The market for data integration and access software was around $2.5 billion in 2007 and is expected to grow $3.8 billion in 2012 (Bernstein and Haas, 2008).

Even though MDM is one of the most topical issues in information system discipline (Cleven and Wortmann, 2010), there is only limited research on MDM. Some review articles (Tuck, 2008; Dayton, 2007; Smith and McKeen, 2008; Snow, 2008) are written on MDM which tries to define what MDM is but there are almost no practical research articles. Practical research is needed to find out the actual state of MDM practices and challenges in business companies, in order to understand current phenomena and to develop new solutions. Understanding the concept of data management and data governance is not an easy task. Either the data management issues are treated too lightly, which results insufficient resources, or when resources are allocated, the data management project turns to an information technology (IT) project, where money is spent without gaining any benefits. There are companies which have been successful in some MDM sectors and sharing these success stories is important. It is also important to share the challenges which companies have met during their MDM projects.

This paper studies the different elements of one master data, including practical research made in selected case companies. This includes discussing on definitions, processes, data, information systems and challenges related to one master data.

One master data is the subset of "the single version of truth". It means that raw master data from the different applications is unified into one format and shared across the organization. Processes and information systems are developed according to this harmonized one master data view.

The purpose of this paper is to clarify the high level challenges related MDM since it has not been done before in academic publications. Additionally, this study strives for understanding the concept of MDM and its meaning in business context as a whole. Therefore, it is not meaningful to start research on individual challenges and their frequency rates but to understand the phenomena and related challenges in general in practice. The above can be condensed into the following research questions:

RQ1. How to define one master data?

RQ2. What are the challenges related to one master data?

RQ3. What are the preconditions for one master data?

This study addresses the research questions in a qualitative manner both, through literature survey and industry interviews.

2. Literature review on MDM and related concepts

2.1 Master data

Master data describes the business-oriented properties of data objects which are used in the different applications across the organization, together with their associated metadata, attributes, definitions, roles, connections and taxonomies (Loshin, 2009; Dayton, 2007). Master data is the data that has been cleansed, rationalized and integrated into an enterprise-wide system (Berson and Dubov, 2007) and used across multiple business processes. Core entities are parties (organization, customer, prospect, people, citizens, employees, vendors, suppliers or trading partners), places (locations, offices, regional alignments or geographies) and things (accounts, assets, policies, product or services) (White *et al.*, 2006; Moss, 2007). All the company data are not master data but only the subset of elements required for data sharing and standardization; master data objects are the key business elements that matter the most (Loshin, 2009; White *et al.*, 2006).

Often the term "the single version of truth" is mentioned with master data. According to Berson and Dubov (2007), it allows an organization to understand the factors and trends that may have an effect on business. This single version of the truth is one of the requirements to support the transformation of an enterprise from an account centric business to agile customer centric business. Other terms are also used for the same meaning, such as "golden record", "the best record" or "the best version of truth" (Dyche and Levy, 2006).

Scope of MDM is broad and may cover customer data, supplier data, part data, product data, location data and contracts. Many MDM activities focus on customer or product data, but any business data can be master data (Berson and Dubov, 2007). Customer master data is a common starting point for an organization's MDM. Typical data elements are marketed to, sold to and billed to account related addresses, contact names and hierarchies. Product data is more widely scattered across the organization and managing it is a cross-functional responsibility. For example, product master data contains part numbers, descriptions, specifications and stocking codes (Snow, 2008). According to Otto and Huner (2009), master data differ from other types of data in four ways:

(1) Unlike transaction data (e.g. invoices, orders and delivery notes) and inventory data (e.g. stock on hand and account data), master data describes always the basic characteristics (e.g. the age, height and weight) of object from the real world.

(2) Pieces of master data usually remain largely unaltered. For example, as the characteristic features of a certain material are always the same, there is no need to change respective master data. During the life cycle of a product, various attribute values are added over time (e.g. dimensions, weight and replenish times), the basic data remains unaffected.

(3) Instances of master data classes (e.g. customer data) are quite constant with regard to volume, at least when compared to transaction data.

(4) Master data constitutes a reference for transaction data. While a purchase order always involves the respective material and supplier master data, the latter does not need any transaction data in order to exist.

2.2 Master data management

MDM is a set of the best data management practices that organizes key stakeholders, participants and business clients (Loshin, 2009). It is a workflow-driven process where business units and information systems cooperate to harmonize, cleanse, publish and protect mutual information assets that must be shared across the organization (White *et al.*, 2006). The focus of MDM is to create an integrated, accurate, timely and complete set of data needed to manage and grow business (Berson and Dubov, 2007). MDM is a discipline to define and standardize key business data and manage changes to those definitions over time (Dayton, 2007; Moss, 2007). The integrated set of master data is called the master data system of record (SOR) and it is the single location where master data is guaranteed to be valid and up-to-date (White, 2007).

The MDM system should enable controlling the data within a single SOR and have the changes replicated across all related systems in an automated and timely fashion (Dayton, 2007). MDM implementation needs a collection of disciplines, policies, procedures, methods, infrastructure and individuals. Individuals should have authority and ownership over the data (Moss, 2007). Different technologies and applications which are used to create and maintain master data are part of MDM system (White, 2007).

MDM is often divided into two sections; operational MDM and analytic MDM. Operational MDM integrate operational applications, such as enterprise resource planning (ERP), customer relationship management (CRM) and supply-chain management, in upstream data flow. Analytic MDM is seen in practices, which reminds data warehousing (DW), such as customer data integration and financial performance management. Together they form the enterprise MDM (Apostol, 2007). The enterprise MDM system is used for maintaining and publishing all the organizations master data. The main components of an enterprise MDM system are MDM applications, a master data store, a master metadata store and a set of master data integration services (White, 2007).

Product data management (PDM) systems are used to manage all product-related data and also product master data. Customer data integration (CDI) systems are used to manage customer master data. The customer in CDI is used as a generic term, which can mean also a client, contact, party, counterparty, patient, subscriber, supplier, prospect, service provider, citizen, guest, legal entity, trust, business entity and other

terms (Berson and Dubov, 2007). Product master data is far more complex than customer master data. According to Boyd (2006), customer name and address data are typically filled with errors that need to be detected and corrected but product information is rich with meaning that must be understood. The truth can exist in manifold and equally correct forms.

2.3 Content and requirements for one master data

According to Loser *et al.* (2004), master data forms the basis for handling business processes and describes business objects, which are represented in different information systems. Smith and McKeen (2008) have defined four prerequisites for successful MDM; developing an enterprise information policy, defining business ownership, data governance and the role of IT systems. Loshin (2009) and Brunner *et al.* (2007) consider creating an enterprise-wide master data model to integrate different master data instances as the most critical aspect. White *et al.* (2006) state that successful MDM depends on data quality, governance, stewardship and change management. MDM needs an appropriate level of organizational commitment. According to Loshin (2009), successful MDM solution requires heavily on following:

- Inventory of data objects use throughout the enterprise.
- Methods for identification of the data object that are candidates for integration into a master data asset.
- Resolution of the definitions, usage scenarios and intentions and the meanings and semantics for these entities, as well as hierarchies and object relationships.
- The ability to seamlessly facilitate standardized information extraction, sharing and delivery.
- A quality-directed migration process, coupled with data survivorship rules for consolidating the "best records" for the master data asset.
- An approach to transparently expose services to enterprise clients for accessing and managing the master data asset.
- A governance framework for managing continued integration of enterprise data into the master data environment.

Technology is a necessary part of MDM, but the most important part of the entire process is to have a logical definition of the entities (Joshi, 2007). The MDM process should affiliate business people to manage the master data and IT staff to support business efforts across the enterprise (Snow, 2008). Data knowledge, e.g. how data have been defined, how they flow, how data change impact on the systems and how to certify the master data, lies within the organizations and its business units. The following steps are identified for the successful MDM process (Joshi, 2007):

- Define the master data flow.
- Identify the sources and consumers of master data.
- Collect business metadata.
- Define the master data model.
- Define the needed functional and operation characteristics of the MDM tool.
- Merge the source data to create a master data list or element.

- Collect and maintain the technical and business rules metadata.
- Publish the master data or modify the consuming applications.

There are many different systems (e.g. ERP, CRM, PDM, CDI and DW) that handle the organization data to ensure that organization's data are unique, coherent, reliable and traceable (Moss, 2007). Each application has a specific functionality, handles the business context of data and rules in its own fashion and stores the definitions of the data. Different data management principles mean information is incoherent in different parts of the organization and leads to complications in exchanging and synchronizing information (Snow, 2008).

MDM integrates methods for managing access to a consistent, unified view of enterprise data objects. MDM should have a business focus instead of technology focus (Loshin, 2009) and too often basic information management principles are forgotten. Different systems with no data management practices result in different silos (Moss, 2007).

2.4 Characteristics of one master data

As a synthesis for the literature review, three main themes related to one master data are identified; data, processes and information systems (Figure 1). Together these three elements form a management framework for successful MDM implementation.

Data include data models, attributes and definitions. One master data is cleansed, rationalized and integrated into one SOR. Data accuracy comes from the excellent data quality over the life cycle. Processes include data ownership definitions and procedures for cleansing, publishing, protecting and sharing of data. The final element of one master data is the information systems. It includes applications and technologies for automated sharing and integration of the data.

Data, processes and information systems form a framework, which combines the core entities; parties, places and content into one master data system. "Parties" is the most important entity covering the organization, the roles and responsibilities and data

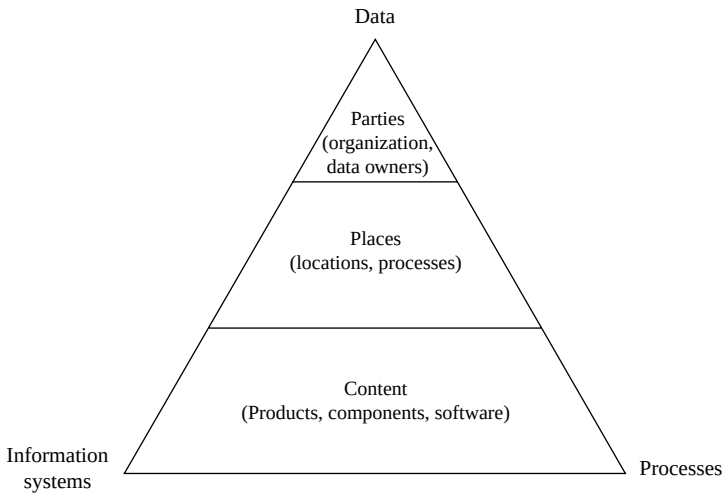

Figure 1.
The concept of one master data

owner's network. The second entity covers the places and processes, which data integrate together. The last entity covers the actual content of master data, such as component, service, software, customer or document.

For example, product master data describes the products in detail, giving each of them their own DNA. These descriptions are then brought to different product related processes, which highlights the importance of compatibility of the different information systems. The data harmonization and one master data have a significant impact on how company's products are understood within the organization and that the people are speaking the same language.

3. Research process

This research is qualitative in nature. MDM was first studied by using existing literature as a key source. The empirical study consists of industrial interviews and case examples. The research process is shown in Figure 2.

At first, a literature review was conducted to gain an accurate understanding about MDM concepts. Based on the literature review, the framework for one master data and the interview framework were created. Eight companies (Table I) were interviewed to find out the challenges related to MDM. Additionally, three expert companies (Table II) were interviewed to find out how these challenges can be solved and what are the benefits in solving them (Section 4.2). The interviews were recorded, extracted and littered. Two researchers analyzed the results individually increasing the validity of analysis. By using inductive logic, the researchers identified high-level challenges and requirements for implementing one master data. The results were then examined through one master data framework (data, processes and information systems) identified from the literature. In Section 4.3, cross-case analyse is performed to analyse what are the preconditions for implementing one master data.

Although master data can contain any business data, this research studies master data mainly from the product point of view. This is justified since the product master data is the most challenging and influential type of master data because of its diversity. The challenges related to product master data are urgent and immediate causing most companies MDM challenges, if they exist at all.

The company interviewees were managers and executives in PDM and MDM field. These interviewees were selected because of their experience and understanding over the MDM (which is good argument for selecting cases, Yin, 2003).

Large companies were selected instead of small ones since the amount of data is greater in large companies and poor data have serious impact on the performance, which can be calculated in euros. Therefore, MDM is a common topic and it has received more attention. Selected companies were pursuing for one master data, which makes them excellent research targets. Also, these companies work in a global environment with global challenges and global customer requests. They have several different applications and information systems for different purposes. Experts' views were asked, since they have the real experience and knowledge on different MDM solutions, but it has not been reported objectively before.

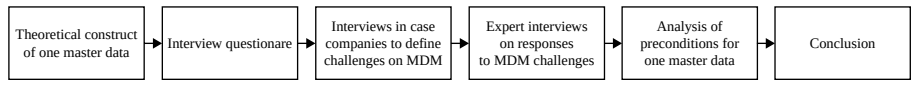

Figure 2.
The research process

Company	Special product characteristics	Operational maturity	Interviewees' responsibility areas/roles
A	Systems products with services, long product life cycle (PLC)	Business merger, unified companies have a long history with well-matured operations	PLM/manager
B	Customer product with warranty service, short PLC	Mature operations, long business history	PDM, data architecture/ manager
C	High volume process product	Mature operations, long business history	PDM, product structures/ data owner
D	Large projects with long PLC	Mature operations, long business history	PDM/manager
E	High volume process product	Mature operations, long business history	PDM/research manager
F	Different service products	Business merger, unified companies have a long history with well-matured operations	PDM, MDM/manager
G	New, immature product with long PLC	Rapidly growing company and business, relatively new company	Applications, products/ application owner, product engineer
H	Customer product with warranty service, short PLC	Mature operations, long business history	Information systems, PDM/ director, manager

Table I.
Company characteristics

Company	Business area	Additional information	Interviewees' expertise
I	Management, IT and outsourcing	One of the largest expert companies in the world	Leading data management expert
J	IT, R&D	Operates mainly in Europe	Good practical experience on PDM and MDM
K	Business management, R&D, PLC	Operates globally in large-scale business programs	Long history with PDM/MDM and world class expertise

Table II.
Characteristics of expert companies

4. Results and analysis

4.1 Challenges of one master data

MDM is a relatively new concept within companies. The benefits of MDM are recognized but the work is still ongoing. The company interviews revealed that MDM is a challenging concept and hard to separate from common data management practices: although the interview questions were about MDM, the interviewees soon started discussing other data management practices confusing the business relevant master data and the other types of data.

However, in the frames of this study, data, processes and IT-systems are identified as the cornerstones of one master data. Results from the company interviews are categorised under these three topics and presented in this section. The company-specific key findings are listed in the tables. The interviews revealed that the companies have the same common challenges although all the interviewees did not mention them.

4.1.1 Data. Table III presents summarized interview results on data-related challenges experienced by the interviews in their companies. The study shows that defining the master data and the data model are common challenges among the interviewed companies. When the master data and the data model are not unambiguously defined, it causes communication problems and data quality issues. Poor data quality is of the biggest challenges in the MDM field. Despite how common the data quality problems are, only Company A has a well defined and continuous data quality program. The interviewees from the Companies B, C, D and E state that quality cost of poor data (e.g. lost business opportunities) are difficult to estimate. More concrete cost calculations can be made in case when wrong data stop production or cause the production of wrong items, as stated the representative from the Company A.

In Company C, they had data control procedures in their old data systems but not in the new systems, since it would have been too expensive to implement. Companies A and B state that the amount of different data is increasing continuously and there is no system that could handle all the data alone. Therefore, different data and information systems need to be developed according to this challenge.

The representative from Company D states that in practice, for any larger company, it is nearly impossible to store data in one location. However, all the changes to product data are made through company's PDM system. They have definitions for the data model but when using standard software, it may be difficult or impossible to use the company's own data model as applications have their own data models.

In Company E, the main challenges related to master data are data maintenance and data storing issues. Since the same master data is used in several applications, it is difficult to be sure which master data is accurate. Sometimes missing data or data saved in wrong places cause problems.

Company G is a relatively new company and just recently started projects to unify and improve its data management practices. Therefore, they had no common data model and people have their own ways to store and share data.

Table III.
Data-related challenges

Company	Challenges: data
A	Data are in different formats and unreliable. Because of this data, consolidation is slow and laborious. The amount of data is increasing which requires continuous data quality and management improvements
B	Defining master data is challenging. Data definitions differ between organizations. The amount of data is increasing which requires continuous data quality and management improvements
C	Local and global data definitions are different which causes data quality issues
D	Difficult to define the master data and data model. Low utilization of common data model. The amount of data is increasing and PLCs are long. This causes data storing issues. Old data are often in incompatible format
E	Master data definitions are missing causing internal communication problems and deteriorates data quality. Sometimes data are saved in wrong place
F	Data are in different formats and unreliable. Several data masters. Master data definition work is ongoing but not ready
G	No common data model. Data are stored in "silos"
H	Difficult to define the master data and data model. Low utilization of common data model

4.1.2 Processes. Table IV presents the summarized interview results on process-related challenges experienced by the interviews in their companies. The results reveal the MDM process definitions are either not finished in the companies or the process definitions are too vague. Vague process definitions are one reason why data maintenance is laborious. Other reasons for laborious data maintenance processes are the enormous and continuously increasing data amounts and different integrations between the applications.

Data ownership is also a common challenge in the selected companies. Definitions for data ownership are lacking or missing completely. Companies' culture is not emphasizing the data ownership and it has a negative strain.

Companies A and B are using centralized data management responsibilities but it is not functioning as planned. Emerging problems are result of inadequate process definitions (e.g. data creation, maintenance and use, compatibility, and different definitions), which cause confusion on responsibilities.

Company C is utilizing centralized data management practices. It reduces overlapping data maintenance work, but sometimes it is hard to find the real data owner, and the maintenance work may be too far from the actual work. Then Company E has no defined processes for data management or data ownership and their main pain points are in data updating, feeding data into systems and data accuracy, especially in the maintenance phase. Despite the adequate data management practices, the Company's E representative considers that the company's actual products are handled well.

In Company D, the data owners are not an individual person but groups of people. The company culture does not support the good data management practices and it results the lack of motivation, which causes the biggest challenges of data ownership. So if people have to complete tasks that do not help them in their work, they may be somewhat lazy with updating the data. For example, the weight of a component is not relevant to the designers but when designing they can easily calculate the weight. The weight may be a very important data for logistics but they cannot get the data by themselves, so it is most efficient if the designer calculates the weight.

Company H has relatively long history with data management practices and they have just finished their second tier PDM project. The long history shows in

Company	Challenges: processes
A	No clear definitions for data ownership. Data maintenance over PLC is unreliable
B	The importance of data is different for each person and this worsens the data quality. No views to data which cover the whole organization
C	Employees are not empowered to take responsibility over data. Data ownership definitions are inadequate. Data maintenance is laborious
D	Partly manual data transfer protocols are laborious. Data are printed and used as hand-outs. This highlights the fact that old data are often used. Motivational problems towards data ownership
E	No process models for data updating. No data ownership practices. Data maintenance is laborious and the process is not defined very well
F	Data maintenance process definitions are inadequate. Attitudes towards data ownership are challenging. Data maintenance is laborious
G	Data management processes are incomplete. Data storing methods are heterogeneous
H	Slow workflow-process. Reserved attitudes towards changes. Manual data transfer is laborious

Table IV. Process-related challenges

well-defined processes. On the other hand, the processes were seen as somewhat slow and attitudes towards new changes were slightly reserved.

4.1.3 Information systems. Table V presents summarized interview results on information system-related challenges, experienced by the interviews in their companies. Every company has several applications which handle the master data such as CRM, PDM and ERP. Challenges arise when the applications are integrated into the same system and when the data are transferred from one system to another. The constant development of IT causes additional challenges when product life cycles (PLCs) are long. For example, the Company D PLCs can be decades. During this period, data formats can change several times which may lead to a situation where the original master data is not available.

The integrations can cause data quality issues. The Company F representative states that data quality can be good in different applications but when the data are transferred through integration, the data quality is decreased. Some data attributes might not transfer at all or they transfer in a wrong data field.

In Company C, there is no actual PDM system since they consider their product is simply enough to be handled with ERP system. They admit, however, that in a ramp-down phase, they could use some PDM systems functionalities to handle the different product versions and variants. Company's ongoing ERP project is implemented from the application point of view, which is causing data problems already (e.g. local systems remains causing silos, different data definitions and wrong/old data may be used).

4.2 Expert responses on challenges

Representatives from three different expert companies were interviewed over how different challenges related to MDM can be solved. For these interviews, two fictional cases were created with similar challenges to these eight other companies. This section summarizes the experts' answers.

The challenges can be divided into three sections, data, processes and information systems (Table VI). The main data related challenges are low data quality and inadequate definitions for master data and data models. The main process-related challenges concerns data ownership and data storing practices. For information systems, the challenges are different applications and integrations between them.

Company	Challenges: information systems
A	Several different PDM systems cause integration problems. Problems in automatic operations between applications
B	Data are stored in different places and several applications are using the same data. Data transfers cause errors
C	ERP project is under work. Different applications which requires manual interface. This causes lots of extra work
D	Many different applications cause integration problems. Applications get old and compatibility to newer applications diminish
E	Several different applications are used but no co-operation between them
F	Several data masters. Integrations in some level poorly done
G	Integration between applications causes problems. All the attribute fields are not transferring correctly
H	Integration between applications is very laborious and requires manual work

Table V.
Information system related challenges

Element of one master data	Challenges	Responses
Data	Master data definitions are unclear	Identify the relevant business data
	Poor data quality	Map the current state of the data
		Create a data model to support company's goals
Processes	Data ownership is not clearly defined	Create a business case for gaining managerial support
	Incoherent data management practices	Start continuous data quality program
	No continuous data quality practices	Model the process for data life cycle
Information systems	Integrations between the applications	Unify the data model
		Minimize the number of different applications and integrations
		Model the data flow

Table VI. Compiled challenges and potential responses of one master data deployment

In these cases, experts suggested very similar solutions. Before starting any MDM program, a business case with costs, timings and benefits should be created. The business case is necessary for achieving support from the higher managerial levels, which is necessary for a successful MDM project. The cooperation between business actions is crucial for understanding the big picture behind MDM. It is necessary to acknowledge the relevant data on what is needed to do business.

The next step is to create a solid picture of the current status of the data. Proper measurement procedures should be created to find out that the data are correct and correspond with the agreed specifications. Data should be modelled in a way that supports the company's goals. An expert from the Company I states that things are usually better in companies which measures the data quality but in many cases this is forgotten.

The number of different data storages and applications should be minimized. Although one master data system is the ultimate goal of MDM, it is not often realistically the best option since the integrations are expensive and unreliable. Instead of one system, companies should model the process on how the master data is created, stored, used and maintained in different systems.

The data quality is one of the key elements in MDM. The poor data quality is often the result of the inadequate data ownership model. Companies should define the data responsibilities and ownerships. The data ownership should last over the PLC. An expert from Company K states that data ownership reflects directly to data quality and data ownership can be further developed with training and knowledge.

It was said that exact answer or practical solutions are hard to give without knowing the real business situation. The challenges in companies are common in high-level but the detailed solutions may differ due to different business environments.

4.3 Preconditions for one master data

The most common challenge related to the data is the inadequate data model definitions (Table VII). Inadequate data model definitions then cause problems when companies are trying to unify or integrate data into one system. If the company cannot define one

data model, then they probably cannot integrate different data formats into one system. In some cases (Companies B and C), data definitions exist but they differ inside the organization. This may cause communication problems and misunderstandings, which may lead to loss of business opportunities. The effect is similar to low data quality.

From the data quality point of view, most of the case companies were in a passive or reactive state (Figure 3). When data quality problems emerge, the company moves to a reactive or active state and tries to fix the problem and then returns to the passive state to wait for the next emerging problem. In general, companies have inadequate data quality surveillance. Data quality is monitored in projects but there is no data quality surveillance at the operational level. Only Company A has clear data quality practices.

Even thought it has been clear for companies to measure processes and its performance through defined metrics, the master data quality metrics are still on its early stage. Metrics are mainly used in projects to measure the quality stage of data conversions, but not in daily operations. By implementing metrics for master data quality, companies can take a major step towards one master data. Old management wisdom says "you can't manage what you can't measure". This is also true for data quality.

The data quality should be considered when processes are being developed. The company should then decide what kind of data quality they want and then design

Preconditions for one master data	Description
Data model	Common definition on data model to be used across the organization
Data ownership	Clear data ownership definitions
Data quality	Pro-active data quality surveillance
Culture	Data friendly company culture
Roles and responsibilities	Clear definitions for roles and responsibilities
Organizational structure	Organizational structure built support data processes
Processes	Clear definitions for processes
Managerial support	Business case and support from the managerial level
Information systems	Unified data model

Table VII.
Preconditions for one master data

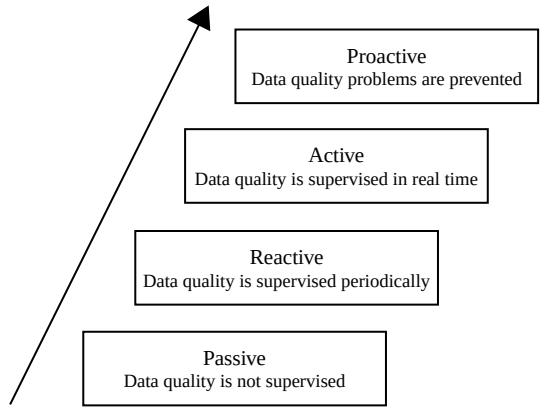

Figure 3.
The data quality activity levels

the processes according to this decision. The aim is not the 100 percent quality but good enough. It has to come from the company strategy and process performance targets. In general, MDM aims for proactive data quality, which means preventive data quality practices.

Information systems related challenges were similar in every company. Different applications were used to manage different master data (e.g. customer master data and product master data) which is a normal practice. Challenges arise when the data are transferred between the applications, for example, data transfer between CRM and ERP systems or PDM and ERP systems. The data model and format might be incompatible and integrations poorly implemented. As a result, the quality of data diminishes. Integration projects are good places to introduce data measurement practices and each integration should be considered as an opportunity to implement data quality improvements. As experts suggested, companies should not strive to one master data application but to unify the data model to be used in company applications: so regardless of IT solutions, the definitions of master data should be uniform through the enterprise. One of the biggest challenges in MDM implementation is that the projects are lead by IT. Because of that, the business units do not implement the data ownership and changes are made in systems without understanding the whole process and the business environment. MDM is not about having an exquisite tool to handle the master data but MDM can be piloted also in a smaller scale. For example, customer data is a common place to start MD implementation. At first, processes, roles and responsibilities should be placed. This helps the organization to understand the common data management practices which ease the wider utilization of MDM.

Most companies had some kind of problems related to data ownership; the ownership definitions were inadequate or the attitudes towards data ownership were negative. When data ownership issues are not clear, the data quality suffers. Data ownership is about taking responsibilities over data at the enterprise level and not just ensuring that the data are right when they are created. The idea of data ownership has to come from the higher managerial level. It is needed to create organizational culture where responsibilities are taken.

Despite the different organizational structures between the companies, the organization departments are working in silos. For example, process technology companies (Companies C and E) are viewing data management issues at the factory case basis. This causes difficulties in version management, traceability, data use and maintenance, since the data are managed in silos separately. The results from the Companies C and E also reveal that their industry's MDM practices are still at early level of maturity and more definitions and standards are needed. In general, organizational structures affects on MDM projects. Clear processes, roles and responsibilities are needed to implement data ownership. Together culture, roles and responsibilities define how the data owner network is implemented.

MDM projects cannot be implemented at the lowest organizational level but they need support from the higher managerial level. The managerial support shows, for example, in resources which are pointed to MDM projects. This emphasis is on the importance of creating the business case before the MDM project has started. However, this is not an easy task. MDM projects tend to be expensive and long, and the benefits may be difficult to point.

In practice, often the executive level does not understand the importance of data management and projects are failing because of limited resources and too strict time limits. It takes time to get acquainted with the company data. First, it is needed to understand the data value for business, processes and best practices. At best, there are people who have understanding over the data, process and information systems. Building this kind of competence takes time.

The results of this study are necessary to point out executive managers how wide the MDM challenges are. The challenges and preconditions are so manifold that each company should map their own environment to find out how these challenges are related to their businesses and what their challenge proportions are. One object of this study was to raise overall awareness of the MDM, and point out if MDM in not understood on as a whole, it causes misunderstandings and wrong actions. For example, often data remains hidden in the background of processes and information system resulting difficulties when calculating the cost of the data.

5. Conclusions

Earlier research in the area of MDM is limited. This study combines earlier studies as a definition for one master data. One master data contains the data, processes and information systems (Figure 1). These elements bond different master data types together into a unified format to be utilized in different applications across the organization.

The challenges related to the implementation of one master data were studied in practice. Although issues may sound trivial in theory, the study shows that challenges are similar in all the case companies at practical level. This point out the problematic of MDM: the companies are not taking the challenges seriously enough. The founded preconditions are not actualising in case companies and even two fulfilled preconditions would be a major step towards company wide one master data. Preconditions for one master data implementation (Table VII) shows that the problems are not technology based but organizational and process based, even though MDM projects are commonly lead by IT. Implementing one master data requires that the whole organization is willing to change towards more transparent processes.

The main data related challenges originated from the inadequate definitions of master data and the data model. Companies had difficulties in defining what the master data is, and to the create data model, which could be used across the organizations. The process-related challenges concerned data ownership issues and deriving data quality issues. Companies did not have proper data ownership definitions and the employees' attitudes were reserved towards the data ownership. Challenges related to information systems resulted from several different applications, which were used to handle master data. Implementing integrations between the applications is expensive and unreliable.

The preconditions for implementing one master data require that cornerstones, data, processes and information systems are managed as a whole. Implementation and definitions need to go hand in hand. In many cases, the definition part is done well, but implementation and practices are different. Company wide data model needs to be created to be used in different applications. The MDM project needs executive support and the company's culture needs to be data friendly, meaning employees are empowered to take responsibility over data. The management role is to ensure that MDM processes are used as they should be. Defined data ownerships together with active data quality control

ensure good data quality. The number of different applications should be minimized and the process on how master data is created, stored, used and maintained should be modelled when companies are starting their MDM project.

This research provides a better understanding over the issues which are affecting on the implementation of one master data. The precondition list of one master data implementation is wide helping business managers to understand the concept of MDM as a whole. The preconditions point out that MDM is not only an IT issue but there are problems in employees' attitudes.

Selected companies offered a good view for MDM practices in large and global companies. However, smaller companies working in smaller markets may have different needs towards their data management systems so more varied case selection may have provided somewhat different results. The potential for future research are vast. For example, comparing the significance and importance of the identified challenges with a larger survey or presenting the case examples of implementing practices in defined areas of preconditions. Additionally, each item on the precondition list can be further studied as an individual factor.

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