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Framework and Research Agenda for Master Data Management in Distributed Environments

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Abstract. Master data is the foundation for relating business transactions with business entities such as customers, products, locations etc. These entities are also referred to as domains in master data literature. The integrity, availability and timeliness of master data in single-, and growingly in multi-domain combinations is crucial in eBusiness transactions over the Internet, or in the cloud for multiple stakeholders. Distributed environments set additional challenges for the management of master data. In this idea paper, we first describe master data, management processes, responsibilities and other contemporary master data management practices aiming to ensure master data quality in different domains. Even though these practical means are of help in improving master data quality and managing master data, they are insufficient to capture the underlying root cause of master data problems. We then look into master data management from the IS theoretical viewpoint and finally propose a research agenda for most critical issues in master data management. We suggest that holistic approaches such as enterprise architecting, stakeholder analysis, or business modeling could serve as coherent frameworks in identifying common and specific master data management research themes for global businesses with networked IT environments.

Keywords: Data Governance, Master Data management, MDM, master data organization, Enterprise Architecture.

Introduction

A recent survey conducted in Finland revealed several shortcomings in master data management (Dahlberg, 2010[1]). This survey and other studies (e.g. Silvola et al, 2011) indicate that master data required to carry out business transactions is spread over multiple systems and databases in an organization and has become more fragmented with each new information system implementation, with obvious side-effects of duplicate data items, redundancy, performance as well as rework in transaction processing and business reporting.

In a recent IBM Global Chief Information Officer Study (2011) the importance of master data management was stressed in face-to-face conversations with more than 3,000 chief information officers worldwide: Over the next three to five years, the CIOs will mainly focus on customer analytics, product/service profitability analysis and master data management. They see that this requires moving beyond traditional relational database management systems into the next generation of integrated data warehouses. Often, the organization becomes aware of the master data challenge when it engages in enterprise architecture work, in large scale IT projects such as an ERP implementation, in major migrations of the organization's core information systems, or when it wants to grow in eBusiness (Dahlberg 2010). Typically, legacy systems consist of numerous partly or totally overlapping master data sets that were developed for some limited or specific purpose. In addition to dominantly used narrow project focus, over the years conducted mergers and acquisitions with uncompleted integrations have added to the fragmentation of systems, databases and coding schemes of master data. For example, in Dahlberg's (2010) survey, one global company had 54 overlapping ERP systems - and respective master data databases - on five continents. Using the tangled web of incoherent master databases and data coding schemes is a call for trouble. It is not rare that an organization's systems have multiple instances of the same customer or product entity, or variants with only slight attribute variations. Multiple entries of the same data, missing, erroneous and conflicting data values cause doubts on the reliability of managerial reporting and business analytics and lead to functional deficiencies in terms of inefficient operations, excess stocks, inability to gain economies of scale, poor customer relationship management etc. When, in these distributed environments, organizations become involved in various kinds of business networks or consider moving their IT to clouds, there is even more urgent need for holistic management of master data.

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[1] Survey consisted of a series of interviews in 10 large organizations with cumulatively over 100 interviewees from senior

With *master data management* (MDM) organizations aim to first improve and then to ensure the quality, consistency and accuracy of the master data. This requires that both technical solutions and organizational processes are managed (Cleven and Wortmann, 2010). Both are demanding, but there are more challenges in the latter (Loshin, 2001, 2008). It appears that in many organizations nobody has responsibility over master data, or they lack the means to execute such a responsibility. The technical solutions and organizational processes are supported with MDM measures such as master data development, master data quality improvement and information architecture. Poor master data management results in missing business and performance objectives, inadequately agreed data ownership (Dyche & Levy, 2006), fragmented data management processes (Mosley, 2008; Dreibelbis et al., 2008) and lack of continuous data quality assurance (Dahlberg, 2010; Silvola et al., 2011).

Even though master data management appears to us as one of the most critical and persistent issues in information system practice at the moment, research on MDM has started only lately (e.g., Google scholar query on articles having words “master data management” in the title provided only 84 hits, and in any part of the article provided 1720 hits), and consequently vagueness characterizes concepts used. At the moment, there are a lot of shortcomings in master data management and hence some studies describe these challenges (e.g. Silvola et al., 2011) and efforts taken to solve them (e.g. Otto and Reichert, 2010). These, and additional practical efforts are represented in a framework of two dimensions – types of data and master data management perspectives to be shown later in the article - to provide a generic background over the phenomenon and approaches used improve master data management.

Although this practice-derived framework sums up the MDM phenomenon and approaches applied to remove the consequences of bad quality master data, we argue that a deeper understanding is needed to understand better the root cause of the problems. We then describe and analyze master data management from the IS theoretical viewpoint and propose a research agenda for master data management to address the practical problems. It is necessary to understand the networked, multi-domain use context of data. It appears that master data – and data in general - started to fragment when the number of information systems grew and new systems were predominantly installed with narrow project, technical etc. focus. Consequently, the information systems’ ontology - and its state tracking and reporting characteristics (Wand and Weber 1989, 1993, 2002) over the isolated systems used in new interdependent contexts – will eventually become fragmented. Hence, we propose that enterprise architecting and ontological information architecting could serve as a coherent basis in identifying common and specific master data management research themes for global businesses and networked governments.

The contributions of this paper are twofold. Firstly, the framework presented as the background for the IS theoretical analysis is a step forward in formalizing understanding on master data management issues and master data management concepts. Secondly, the proposed research agenda based on the architecting and ontological analysis of master data management sets a theoretically solid path for future research from the information systems science perspective and bridge the gap between practical master data management problems and their theoretically sounder solutions.

Types of data and processes

The types of data used in organizations can be defined as the categories of transactional data, master data, meta data and reference data (Cleven and Wortmann, 2010). Master data consists of data items that describe the core entities of an organization. They are typically persistent items of independent business domains, the status of which does not change too often. For example, the master data attributes of vendor, product and customer in an organization tend to change little over time. The weight, size and other attributes of a product are typically considered to remain unchanged throughout the lifecycle of a product. Even those master data attributes that change from time to time, such as standard unit price, remain unchanged between the updates. The idea of master data is to enter and maintain data once and to transfer needed attributes to all tasks where such data is needed. The total number of master data records is also usually rather stable when compared to the seasonal and other fluctuations of business transaction volumes.

Typical examples of master data domains are: parties (customers, employees, vendors), places (customer locations, office etc. sites) and things (accounts, contracts, documents products and services) (White et al, 2006; Cleven and Wortmann, 2010), where party is an abstract high level domain and customer is a concrete lower level domain. Most organizations have a limited number lower of level domains, usually around a dozen (Dahlberg, 2010). Each domain may have several data objects. For example, a typical SAP ERP system installation contains approximately 150 master data objects in the domain of Management Accounting (MA) alone, such as currencies and payment terms (Dahlberg, 2010).

In addition to persistency and rather constant volumes, master data is differentiated from transactional data by its independency of the transactional entities, which in turn are most dependent on master data. As an example, consider sales order (transactional data), which cannot exist without customer (master data), product (master data) and payment term (master data) (Cleven and Wortmann, 2010). Since key master data attributes typically act as the identifiers of data queries and the basis of sorting transactional data to perform various aggregations and calculations for reporting, the quality of master data has the highest quality requirements and should therefore be devoted a lot of attention to (Loshin, 2008). Since most business transactions are linked to several master data objects and attributes at the same time, one of the challenges of master data management is the simultaneous management of multiple domains – called multi-domain or domain neutral MDM - as opposed to single domain MDM such as Product Information Management (PIM).

Master data is typically also used across multiple business processes and for reporting purposes. For example sales, delivery logistics, after sales and services, spare parts business, billing, accounts receivable and finance, and management through managerial and analytical reporting may all rely on customer data but have at the same time different needs and priorities. Furthermore, some processes may be cross-functional, for example order to cash, whereas other processes or activities are functional, for example recruiting of employees. Balancing the needs of cross-functional and single function activities is another master data management challenge closely related to the domains of master data.

Master Data Management perspectives

Master data management is defined by Smith and McKeen as: *"Master data management (MDM) is an application-independent process which describes, owns and manages core business data entities. It ensures the consistency and accuracy of these data by providing a single set of guidelines for their management and thereby creates a common view of key company data, which may or may not be held in a common data source"* (2008, pp. 65-66).

Joshi (2007) proposed that the eight steps outlined below should be followed to execute MDM successfully:

- 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

Otto and Reichert (2011) listed the activities of the topmost concerns of MDM shown in Figure 1 and called their figure *"MDM tasks"*. The activities outlined by them concentrate on managing data assets strategically, agreeing upon and maintaing standards and guidelines for design and on handling changes as projects - all this in line with the support from the management.

	Response Percentage
Application management for a master data management software	47.4 %
Business user support	73.7 %
Development and maintenance of the master data strategy	89.5 %
Development and maintenance of standards and guidelines	84.2 %
Master data lifecycle activities (e.g. creation, maintenance, deactivation)	57.9 %
Measurement and reporting of master data quality	78.9 %
Project support	84.2 %
Training of users	73.7 %
Other	10.5 %

Figure 1. MDM Tasks by Otto and Reichert (2011)

As a whole, master data management appears to break down into many perspectives. Dahlberg (2010) has identified the following five perspectives, which are used to improve MDM and master data quality:

Management perspective: This perspective addresses the governance and management aspects of master data. For example, Dahlberg (2010) classified 28 master data governance and management issues classified into seven managerial task categories by adapting Gartner Group's (2006) "Seven Building Block Model for Enterprise Information Management". Categories, shown also in Figure 2 in the Framework section, are: MDM objectives, MDM road-map, MDM governance, MDM organization, MDM processes, MDM infrastructure and MDM reporting.

Information architecture perspective: Ability to use and manage master data requires that master data is modeled. A standard data modeling approach with the overall model, conceptual model, logical model and physical model levels could probably be applied as master data appears similar enough to other types of data. Since same master data entities are used in multiple processes and/or organizational functions it is also necessary to model the data flows of master data to cover the inheritance of this data. When a new master data record is created some of the data attributes could be controlled against accepted reference data values. For example, the country of a customer could be selected from a drop list of countries. The creation of some other data attributes could be controlled with reference data rules. Reference data management controls and meta data related to master data needs also to be modeled and managed (Cleven and Wortmann, 2010).

Master data quality perspective: The consequences of badly executed MDM typically appear as the poor quality of data. Bad data appears as duplicates, missing attribute values and data value conflicts. Improvements of master data quality require that data is analyzed and cleaned up in a planned way. Migration and harmonization may also be used to improve data quality. When quality-improving changes are made to master data, it is necessary to secure the continuity of data, for example via audit trail and data inheritance checks. One mean to accomplish this is to use so called delta file approach. Setting up rules and other controls to ensure the quality of master data is another data quality management measure. Furthermore, it is necessary to manage the information security of master data. The challenge lies in the organizational and managerial aspects of master data quality.

Technology management perspective: Ideally a specific master data item, such as a customer, is entered and maintained only once and made available to all SOA components / WEB services, legacy applications and other IT components, which use that data. At the moment, very few organizations, however, appear to have clarity on which of their alternative databases serves as the master database – even when the database has a MDM module label on it.

Development Process perspective: The development of master data management could be run as traditional projects or with agile development methods. The development of master data management impacts all layers of enterprise and information architecture as well as organizational processes.

The Framework Combining Data Types and MDM Perspectives

When we combine the categories of types of data and the types of processes where master data is used with MDM perspectives, the result is Figure 2.

Process & data domains➔ MDM Perspective 🡻	Processes (and activities) – MD is used in		Master Data Domains	
	Cross-functional processes (e.g. order to cash, procure to pay, manufacture to delivery)	Functional processes and activities (e.g. sales, procurement, accounting,…)	Multi-domain / domain neutral (e.g. customer & sold product & account, vendor, purchased item & account)	Domain specific (e.g. customers, products, vendors, accounting keys, location, document IDs,…)
Management •Objectives •Road-map •Governance •Organizing •Processes •Infrastructure •Reporting				
Information architecture •Data models (overall to physical) •Data flow model •Controls and rules against reference data, meta data				
Master Data quality •Data analysis, clean up, migration •Delta file, continuity •Control & Rule implementation •MD Information security management				
Technology •MDM applications, modules, databases •Analysis, reporting and dash board tools •Workflow and productivity tools				
Development Process •Development approach •Management perspective •Information architecture perspective •Data quality perspective •Technology perspective				

Figure 2. Master data framework combining types of data and processes and MDM perspectives

The columns of the two-dimensional framework categorize the number of involved master data domains into single and multi-domain categories and functions where master data is used into single-function and multi-function process categories. The rows of the framework describe the various MDM perspectives on how to manage and improve the quality of master data in practice. Thus the framework summarizes and organizes research findings and approached discussed above and provides a holistic description of master data management as a whole. For practitioners it can serve as a starting point in defining the master data management activities. Both the columns and the rows of the framework describe *what* master data is and *how* the quality of master data could be improved with various MDM activities. However, it is not able to explain *why* the quality of master data has become poor and thus how to prevent that happening again. In other words, the framework describes what means in various contexts one could adopt to remove the symptoms of master data problems but does not explain what are the underlying reasons for those problems. Thus, in order to dig into the root causes, in the next chapter we turn to theoretical research on IS, especially viewing master data problems from ontological viewpoint.

IS theoretical explanation of MDM problems

In the light of literature reviewed, MDM appears to be a topic of its own (Smith & McKeen, 2008; Otto & Reichert, 2010) like master data is ideally separate from the transactional data and other concerns of an IS (Cleven and Wortmann, 2010). Yet, any data set or database serves a bigger whole, information systems representing and tracking the behaviour of a purposeful real-world system.

The definition of an information system (Iivari et al., 1998) underlines that this real-world system is typically a human activity system, representing vested interests and dynamic interplay of the socially constructed concepts about the stakeholders and their behaviour for the purpose which the IS is to serve. This can be also considered from a more realist stance (Iivari et al., 1998): An IS describes facts, especially the relevant facts of the technical system derived from the stationary and stable real-world. It is evident that the present way of looking into master data management and master data quality builds on the realist stance, and at the same time omits largely the idealist, or constructivist interpretation. We believe to have a good reason to claim that this is the root cause for those master data problems we have depicted in previous sections. That is, efforts to model and solve master data quality and master data management problems are done as if these problems were stemming from a stable, predictable, uniform and causal world, when the actual problems are more deeply and profoundly related to the fundamental changes in the real world and our perceptions and representations of it.

In master data managment practice, the realist stance could lead to harmonization efforts in the name of rationality where the resulting compromise satisfies nobody and cannot be used, because it is not applicable in multiple-domains – granularity is not fine enough for the various purposes. For example, a company could try to harmonize processes and master data used in them to the extent that it serves none of the actual processes and data use situations. Similarly adopting only the extreme reflective stance could lead to a situation where master data is systematically overruled. For example, the unit price of a product inherited from master data could always be overruled by users when used, which will make that data useless as master data.

As Goldkuhl and Lyytinen stated already in (1982), *"...information systems can be viewed as "technical systems with social implications" or "social systems only technically implemented"*. Both views are valid, eventhough the contemporary IS researchers distinguish themselves from the rest of the computing and engineering researcher community with the previous statement, as they emphasize the socially constructed nature of the organizatonal complexities including information systems (Iivari et al., 1998).

We illustrate our argumentation in more detail with the help of the ontological description of the structure of an IS (Wand & Weber, 1989) and its requirements for an information systems methodology, including the subset of databases. According to this approach any IS methodology must represent the ontology of the system with a minumum set of constructs and to map and track the state changes for various purposes of the real world system (Wand & Weber, 1993), including the reporting requirement for various stakeholders of an IS for their anticipated and ad-hoc purposes. In master data contexts, this means that the various user needs of master data in relation to other data types as well as other relevant characteritics of the real world are understood. Only then is an IS development model fulfilling its role properly, that is, it has the necessary representational means for expressing the ontology of the domain completely and clearly but also without overloading constructs and extra constructs which result in redundancy. The goodness of this representational model does not exist in vacuum, but must be able to serve first the 'needs' of the state-tracking model, against which the states of the real world are reflected in the IS, and secondly, the 'needs' of the reporting, where the states of an information system can be reported for the stakeholders to reflect the corresponding state changes of the real world. The first requirement refers to creating and maintaining all the attributes of master data. Correspondigly, the second requirement describes how the relevant attributes of master data are inherited to the various use situations. These two principles are able to capture both the holistic nature of master data management and the specific use situations of this data, but seldom applied in practice. It is more common to separate the concerns of reporting from that of state-tracking using, e.g., OLAP[2], an approach not necessarily helping in the master data problems.

Some of the master data problems described in the previous chapters can be restated according to the architectural and ontological IS theoretical explanation as follows:

- There are cases where the ***constructs of the ontology are incomplete*** because some fundamental concepts are missing. A real case example of this problem is a company that had multiple identities for its vendors, with each new bank contact creating a new vendor record (Dahlberg, 2010). The data model or its implementation did not contain sufficient structure to capture this feature of multiple identities in each vendor data.
- The ***constructs of the ontology are overloaded*** because planned and implemented concepts cannot distinguish the subtle differences of meanings in the real world constructs. For example, a customer may have multiple roles depending on who is in contact with the customer. If the attributes of customer master data are not able to capture these different roles, the content of the data could reflect the most typical role or could lead to duplicates.
- The ***constructs of the ontology are redundant***, or become redundant, e.g., when information system instances are connected to serve wider geographical activities or entire global business. For example, it is not uncommon that the same product has two different codes in two different markets, or ZIP, ZIP+4 and ZCTA codes being 'about' the same (which they are not, the former being for deliveries, the last for statistics and analysis). This might just reflect differences in local coding practices forced by local authorities or voluntarily followed by all parties in that local market. Very few data items have globally standardized codes. In this kind of a situation, merging the instances with simultaneous harmonization is not a working option.
- ***Mappings are incomplete, or cannot reflect changes in the real world***, because the real world is not or is no longer steady and stable, but is in constant turmoil, at the same time as master data does not change accordingly, is not managed properly or meta data does not reflect changes in a systematic manner. For example, standard unit price is a typical product master data attribute. Standard unit price is often checked at certain intervals and may include a rough fixed cost element. Should the environment change suddenly, so that the fixed cost element changes significantly or prices fluctuate constantly, these practices become insuffient to cope with the real world, especially in OLAP environments, where both the transactional and analytic databases master data must be update in sync with each other.
- ***Reporting needs are unanticipated or not taken into account*** in the original design of master data coding, data repositories, information systems etc. There can be several reasons for this. Necessary classification codes were not

[2] Online Analytical Processing

considered or registered and hence are not connected to transactional data. The design methodology could also have been inappropriate. For example, aims to make public master data repositories available to open use with simultaneous protection of privacy data may lead to a dead-end.

- ***Forced limitations on ontological clarity and increasing construct redundancy*** This may happen if the constructs cannot be designed freely, but must follow socially constructed conventions, standards and regulations limiting the ontological clarity and increasing construct redundancy. Things are almost, but not quite the same, to put it colloquially.

Fundamentally, the separation of master data concerns from the real world social systems in master data management practices – as summarized in Figure 2 in the previous section - leads to the dilemma of not describing master data in the the real world context, but rather trying to improve the management of 'socially implemented technical systems' not as 'technical systems socially implemented', the way they should be managed.

We think building on the foundations of a good information systems design will serve as a solid basis for proposing a research agenda in the area of master data management. As a whole we propose a more strategic approach into the design and active maintenance of the master data. We urge that in the requirements crafting and design of master data constructs as well as in the problem solving of current challenges researchers and practitioneers should not just look at the logical technical designs, but also at the foreseeable changes in socially constructed concepts and at the effects of such changes.

In this context, master data management means those structures, process and mechanisms, which are needed to ensure the quality of designs, state-tracking and reporting requirements collected from many socially relevant sources, i.e., from all the stakeholders of the purposeful systems with related interpretations on the master data ontology and its various uses. This calls for a more holistic approach for master data management, such as enterprise architecting, business modeling, or stakeholder analysis as starting points.

Research Agenda for Master Data Management

We started this article by looking at various types of data and processes where master data is used. We then discussed the current meaning of master data management and its various perspectives, which are used to improve master data quality and MDM. We noticed that MDM practices are good to describe current status but insufficient to understand the underlying nature and root causes of the master data management problems. The necessary depth of analysis was found from the IS theoretical viewpoint, especially from the ontological structure of information systems. In summary motivated by discussion above, we suggest that holistic approaches are needed to serve as coherent frameworks in identifying common and specific master data management research themes for global businesses in networked enviroments. We furthermore propose, as our Research Agenda, to apply the architectural and ontological IS theoretical perspective to investigate the practical master data management issues covered in Figure 2. Below we offer some selected example research questions for future research:

- How should interoperability requirements (e.g., the same person represented with more than one unique identifiers in a number of databases) be derived from stakeholder analysis, business process modeling and enterprise architecting? This is to tackle the problems of *incomplete design, redundancy, and overloading of the ontology*.
- How could security, access rights, and integrity be ensured, especially for reporting? What kinds of consents are needed to use and combine master data from various sources? What kinds of opt-in or opt-out arrangements are relevant? This is to handle the problem of *unanticipated reporting requirements and forced limitations*.
- Who owns and is responsible for maintaining the distributed master data: data ownership is a major business issue but has not been considered in MDM practices properly. What are the means to accomplish the ownership issues in the design and to secure the participation of all relevant stakeholders? Here we go beyond the original use of ontological limitations. *The mappings are found incomplete* since they should reflect the social construction of the system in its real-world use context.
- How to adapt IT governance principles and build best practices for MDM? How could MDM fit the Evaluate, Direct and Monitor (EDM) presented in ISO/IEC 38500 IT Governance model and the Plan, Do, Check and Act - cycles (PDCA) common to project management and development activities, so that the business management and IT asset management concerns are separate and clear enough? What project management practices are relevant for MDM? Who should bear the responsibility for master data management improvement efforts: business or IT? How does the allocation of development responsibilities impact the outcomes of such development? This is also *beyond the original concerns* of IS ontological design, but reflects the other set of concepts with its interplay of the real-world master data management in practice.
- How should we treat master data in clouds, outsourcing and off-shoring? What are the best ways to to map 'good' designs, business needs and the views of the stakeholders including privacy and security? This final category of

activities reflect *the changing environment*: at the time of its invention, the ontologically driven design principles were applied in one organization unit environment.

To summarize, above we sketch a research agenda, where some new research issues are proposed to reflect the changing business design constructs and approaches on the ontological requirements of the good design (the two first bullets points). The three latter areas of MDM research are reflecting the issues emerged with the expansion of real-world beyond the original domain of ontological design, which was within one organization and within pre-defined sets of primary internal users of isolated information systems. Compared to the distributed environment, where the concerns of privacy, security and unanticipated data use are the primary concerns, but not properly modeled or managed, we think these issues are a high priority in Master Data Management research agenda of the 21st century.

References

Cleven, A., Wortmann, F., (2010). Uncovering four strategies to approach master data management. Proceedings of the 43rd Hawaii International Conference on System Sciences - 2010.

Dahlberg, T., (2010). The Final Report of "Master Data Management Benchmark Best Practicess Research Project". Aalto University School of Economics and Solteq Oyj. Helsinki 2010.

Dreibelbis, A., Hechler, E., Milman, I., Oberhofer, M., van Run, P., Wolfson, D., (2008). Enterprise Master Data Management: An SOA Approach to Managing Core Information. IBM Press.

Dyche, J., Levy, E., (2006). Customer Data Integration: Reaching a Single Version of the Truth. John Wiley & Sons.

Goldkuhl, G, Lyytinen, K. (1982). A language action view of information systems, International Conference on Information Systems, 1982.

IBM (2011). The Essential CIO: Insights from the Global Chief Information Officer Study, a White Paper submitted by IBM at IDGconnect.com

Iivari, J., Hirschheimm R., Kleinm H.K., (1998). A Paradigmatic Analysis Contrasting Information Systems Development Approaches and Methodologies. Information Systems Research, Vol. 9, No. 2. 164-193.

Joshi, A., (2007). MDM governance: a unified team approach. Cutter IT Journal, Vol. 20, No. 9. 30-35.

Loshin, D., (2001). Enterprise Knowledge Management: The Data Quality Approach. Morgan Kauffman.

Loshin, D., (2008). Master Data Management. Morgan Kauffman.

Mosley, M., (2008). DAMA-DMBOK Functional Framework, v 3.02. Dama International.

Otto, B., Reichert, A., (2010). Organizing Master Data Management: Findings from an Expert Survey. In Bryant, B. R., Haddad, H. M., & Wainwright, R. L. (Eds.), Proceedings of *SAC'10*, March 22-26, 2010, Sierre, Switzerland. 106-110.

Wand, Y., Weber R., (1989). An ontological evaluation of systems analysis and design methods. In: Falkenberg ED, Lindgreen P (1989) (eds). Information system concepts: an in-depth analysis. North- Holland, Amsterdam. 79–107.

Wand Y., Weber R., (1993). On the ontological expressiveness of information systems analysis and design grammars. Information Systems Journal, 3(4). 217-237.

Wand Y., Weber R., (2002). Research Commentary: Information Systems and Conceptual Modeling – A Research Agenda. Information Systems Research, 13 (4). 364-376.

Silvola, R., Jaaskelainen, O., Kropsu-Vehkapera, H., & Haapasalo, H. (2011). Managing one master data – challenges and preconditions. Industrial Management & Data Systems, 111(1). 146-162.

Smith, H.A., McKeen, J.D., (2008). Developments in Practice XXX: Master Data Management: Salvation Or Snake Oil?, Communications of the Association for Information Systems, 23(4).

White, A., Newman, D., Logan, D., Radcliffe, J. (2006). Mastering Master Data Management. Gartner Research, ID Number: G00136958.