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ENTERPRISE METADATA MANAGEMENT: IDENTIFYING SUCCESS FACTORS FOR IMPLEMENTING MANAGED METADATA ENVIRONMENTS

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Abstract

Managed metadata environments (MME) are being employed in organisations that need to assure a consistent and efficient capture, integration and delivery of enterprise metadata. Initiatives to implement a MME in an organisation may be a daunting endeavour and various information systems have evolved over time to support such environments. The expert study at hand used a multi-round Delphi research method in order to identify critical success factors of these initiatives. Out of the ten critical success factors nominated through the early rounds, nine factors were found to be very-to-extremely important and one factor moderately important. The identified success factors can be used as a basis for implementation frameworks in metadata management initiatives. An effective and efficient metadata management system is one of the key components of data and information management, and can greatly aid organisations' efforts toward improved information quality and governance.

Keywords: Metadata, Metadata management, Managed metadata environment, Information management, Data governance, Critical success factors, Delphi method.

1 INTRODUCTION

Metadata are important, and at the same time enigmatic (Shankaranarayanan & Even 2006), information assets. They represent definitions and descriptions of the content, quality, condition or other characteristics of data (FGDC 1998, p.1). Gartner Research recommends that organisations should "not underestimate the importance of metadata management to the success of the enterprise's ability to create value from information assets, nor the challenges in successfully managing the metadata" (Blechar 2011, p.1).

Having employed a concise metadata taxonomy consisting of *definitional*, *navigational*, *data quality* and *lineage* metadata, Foshay et al. (2007) posit the overall importance of end-user metadata quality in user acceptance of the data warehousing technology. Not only is metadata management crucial in business intelligence and data warehousing (Gabriel et al. 2010; Sen 2004), several other enterprise initiatives, such as data and information governance (Smith 2008; Weber et al. 2009), data quality management (Shankaranarayanan & Cai 2006), and master data management (Blechar & White 2009; Loshin 2008) are also often supported by managed metadata environments. In the past, these environments were typically used to maintain technical metadata (Sen 2004). However, metadata repositories are also required to support efficient business metadata management (Hüner et al. 2011).

Blechar et al. (2010) note that metadata management is not pursued consistently in most organisations, documentation of metadata is insufficient, few organisations have the perseverance to make it successful, and the business value is not realised due to conflicting approaches. The authors identified that *executive mandate and business support*, *technology implementation and operation*, and *organisational maturity* are among the top issues of enterprise metadata management (Vnuk et al. 2011). These issues indicate what hinders metadata management, however, they do not provide a comprehensive guidance for organisations to successfully implement such initiatives.

Although various critical success factors (CSF) for related types of enterprise IS initiatives such as Knowledge Management and Data Warehousing have been proposed in the literature (Davenport et al. 1998; Wixom & Watson 2001), to date, CSFs for implementing metadata repositories and registries to create enterprise-wide managed metadata environments have not been systematically researched.

This exploratory study engages an expert panel to identify a set of CSFs for enterprise metadata management. This set can on the one hand serve practitioners as a guideline to focus their metadata management efforts and on the other hand inform a typological framework that can be used in future research.

The structure of this paper is as follows. Section 2 discusses the concepts of *managed metadata environment* and *CSF*, as well as CSF literature in related fields. Section 3 introduces a three-phase research design based on the Delphi method (Okoli & Pawlowski 2004). The research method is then described in Section 4. Section 5 presents and discusses the study results. The concluding section summarises the paper, its contribution, and future research opportunities.

2 BACKGROUND

2.1 Metadata and managed metadata environments

Metadata can be conceptualised as a data-to-information transition-understanding function (Faucher et al. 2008). Metadata not only have a *descriptive* function of turning *existing* data into information but certain metadata types, such as data models, business rules, data dictionaries and taxonomies, may also have a *prescriptive* function influencing how data and data-related objects are *conceived*. Metadata often represent an important part of enterprise knowledge.

Managed metadata environment (MME) consists of "architectural components, people and processes that are required to properly and systematically gather, retain and disseminate meta data throughout the enterprise" (Marco & Jennings 2004). MME tools, such as metadata repositories and registries, are required to support a wide range of capabilities: Full metadata lifecycle, Robust metadata search, analysis and reporting, Easy to use user interface, Robust and extensible metamodel, Integration and Interoperability, etc. (Vnuk et al. 2011). Marco and Jennings (2004) suggest six architectural components to be included in a MME: *Metadata Sourcing Layer, Integration Layer, Repository, Management Layer, Metadata Marts, and Delivery Layer*. Although these components resemble the typical data warehouse architecture, the main difference is that all MME layers operate with metadata instead of data.

This paper assumes the context of the DAMA functional framework (Mosley 2008) whereby metadata management, as one of ten data management functions, covers "planning, implementation and control activities to enable easy access to high quality, integrated meta data" (Mosley 2008, p.11). Although metadata repositories are often seen to support data warehousing and business intelligence initiatives, within the DAMA framework the metadata management function also enables most of the other data and information management functions, such as data architecture management, reference and master data management, document and content management, data quality management and data governance.

Research into successful MME implementations is limited. A recent study suggests that *collaborative management* of business metadata is a success factor supported by two technology-level success factors: ease of metadata use and ease of metadata maintenance (Hüner et al. 2011).

2.2 Critical success factors

The concept of critical success factors (CSFs) was pioneered by Rockart (1979) who defined them as a "limited number of areas, in which results, if they are satisfactory, will assure successful competitive performance for the organization". In short, CSFs have two important properties: 1) They are limited in number, and 2) Their fulfilment indicates successful performance. For the purposes of this study we consider an initiative successful if "it continuously meets predetermined goals, both within a single project scope and over a longer period of time" (Trkman 2010).

Table 1 introduces a selection of CSF research in areas relevant to enterprise metadata management: business intelligence and data warehousing (BI/DWH), knowledge management (KM), and business process management (BPM). While they provide a valuable frame of reference for this study, none of the research has specifically and comprehensively addressed CSFs for MME implementation initiatives.

Area	Source	CSFs
BI (DWH)	Wixom & Watson (2001)	Management support, Champion, Resources (staff, HR training), Team skills, Development technologies, System quality, User participation, High Quality Source systems, Data quality
KM	Davenport et al.(1998)	Link to economic performance or industry value, Technical and organisational infrastructure, Standard, flexible, knowledge structure, Knowledge friendly culture, Clear purpose and language, Change in motivational practices, Multiple channels for knowledge transfer, Senior management support
KM	Wong (2005)	Strategy and purpose, Management leadership and support, HR management, IT, Organizational infrastructure (R&R), Measurement, Motivational aids, (Knowledge sharing) Culture
BPM	Bandara et al. (2005)	Management support (+leadership), Modelling language, Modelling tool, Modelling methodology, Stakeholder participation, Information Resources, Project Management, Modeller expertise
BPM	Trkman (2010)	Strategic alignment, Level of IT investment, Performance measurement, Level of employee's specialization, Organizational changes, Appointment of process owners, Implementation of proposed changes (quick-win strategy), Use of a continuous improvement system, Standardization of processes, Informatization, Automation, Training and empowerment of employees

Table 1. Selected CSF literature in the related fields

3 RESEARCH DESIGN

This interpretive exploratory study aims to investigate the following research question:

Which factors are critical for implementing managed metadata environments successfully?

The resulting set of factors will inform a typology that qualifies toward building the analysis theory type (Gregor 2006). Since the research question and the research scope are not limited to an instance of a MME implementation in a specific organisation, the authors decided to elicit opinions from a group of independent experts with expertise in metadata management. Although the authors borrow the term CSF from Rockart (1979), this setting departs from Rockart's originally devised CSF method as well as from many of its limitations as listed by Cooper (2009, p.12).

The study, instead, follows the Delphi research method (Dalkey 1969; Day & Bobeva 2005; Linstone & Turoff 2002; Okoli & Pawlowski 2004). Using this method the researchers can systematically refine a group opinion of a geographically dispersed panel of participating experts. The main features of the Delphi method include: (1) anonymous reporting of individual comments to reduce effects of dominant individuals, (2) controlled feedback in multiple rounds to reduce noise (3) statistical group response evaluation to minimise the pressure for conformity. The Delphi method does not require a statistically valid sample size and the consensual outcome is unique to the specific panel and context at hand. It is particularly suitable in situations where subjective opinions are to be elicited and the personal contact may be limited due to time and cost constraints. The method has been applied in numerous settings for forecasting, issue identification/prioritisation, and concept/framework development (Okoli & Pawlowski 2004). Recent noteworthy applications include studies to define information science (Zins 2007), and knowledge management system scope and requirements (Nevo & Chan 2007).

The authors devised a three-phase research design shown in Table 2. The first phase (Introduction) includes a round where experts are invited to participate in the study and register their intent to participate (Registration), and the initial round (Round I) that investigates metadata conceptions and issues to establish a common ground for the following Delphi phases. In order to reduce self-selection bias, the invitations in the Registration round are designed to not impose a specific frame or view. This phase also gives an opportunity for the researchers to confirm that participants' level of expertise meets the study requirements. In the second phase (Brainstorming) the experts are asked to nominate critical success factors and provide their rationale (Round II). Finally, in the third phase (Rating), the experts are offered the summary of the individual factors from the nomination phase and are asked to rate their importance (Round III). In the follow-up round the experts are given an opportunity to revise their ratings to improve the level of agreement. Should the agreement improve considerably between the rounds in the rating phase, additional follow-up rounds may be required to ascertain when the study can be terminated.

Phase	**Round**	**Purpose**
1.Introduction	Registration	Confirm participation in the study
	Round I	Establish a shared understanding of key concepts and confirm participants' suitability for the study
2.Brainstorming	Round II	Elicit success factors and their rationale
3.Rating	Round III	Rate importance of factors
	Follow-up	Improve consensus

Table 2. Study phases and rounds

4 RESEARCH METHOD

4.1 Selection of participants

In order to identify suitable expert candidates to be invited to participate in the study, the researchers first reviewed publication records in metadata management and related areas. Since academic and non-academic viewpoints may differ, as reflected in the IS research and practice literature (Lee et al. 1999), the researchers decided to include available academic as well as practice literature (academic journals, conference proceedings, magazine articles, and books) in the search. Several experts referred other possible participants. These referrals were carefully reviewed on the basis of either their publications or other available evidence of their expertise in the field, including conference presentations, and provision of consultancy services.

In regards to the target panel size, Okoli & Pawlowski (2004) recommend a group size of 10-18, whereby the minimum size of 10 will keep the average group error low. To reduce the risk of insufficient panel size, the authors estimated a minimum of 40 experts should be invited to participate in the study, which allows for about 50% response rate in the Registration round and 20% attrition in each subsequent round. A total of 41 expert candidates were invited to participate in the study.

4.2 Study administration

The questionnaires were administered electronically. In order to facilitate participants' response effort the participants were given an option to either answer the study questions off-line and email their responses back to the researchers or answer the questions using an online questionnaire. The online questionnaire was developed in LimeSurvey v1.86 (www.limesurvey.org). All participants except for one opted to use the online web questionnaire method to respond.

4.3 Response rates

Of the 41 invites sent in the Registration round, 21 experts (51%) agreed to participate in the study. The 16 responses submitted in Round I demonstrated sufficient level of expertise by all panel members. Twelve responses were received in Round II. In the rating phase, the panel submitted 13 valid responses in Round III. Two experts did not respond to the final follow-up round, however, for the final results the authors still consider their ratings from Round III as unchanged. The number of responses and attrition rates are summarised in Table 3. When inquired about the drop-out rationale, the experts typically quoted time-related issues. The low attrition rate in the Rating phase further demonstrates that the migration-related selection bias is not significant.

Phase	**Round**	**Valid Responses**	**Attrition Rate**[+]
Introduction	Registration	21	--
	Round I	16	23.8%
Brainstorming	Round II	12	20.0%
Rating	Round III	13[^]	(8.3%)[^]
	Follow-up	11	15.4%
Notes: [+] Response drop-out rate since previous round; ^ Negative attrition due to one panel member rejoining in Round III with a valid response			

Table 3. Delphi study participation and attrition rates

4.4 Participants' profile

The participants' expertise stemmed from one or more of the following role groups: Academic/Researcher, Data Management Consultant, Data/Metadata Manager, Data/Systems Architect/Developer, and Metadata Management Product Manager/Developer. Geographically, the experts represent primarily North America and Europe, however, experts from Israel and Australia participated as well. Table 4 lists the actual demographic statistics collected from the panel. In the three Experience characteristics (Organization size, Sectors, Industry Sectors) each respondent was able to select multiple categories that applied.

Characteristic	**Frequency**	**%***	**Characteristic**	**Frequency**	**%***
Length of Relevant Expertise			***Experience by Industry Sectors***$^{+}$		
Less than 2 years	0	0.0	Commercial and Professional Services	6	46.2
2 to 5 years	1	7.7			
5 to 10 years	1	7.7	Consumer Products	4	30.8
10 or more years	11	84.6	Consumer Services	4	30.8
Experience by Organization Size^{+}			Energy & Materials	4	30.8
Less than 100 employees	1	7.7	Financials	8	61.5
100-499 employees	4	30.8	Health Care	6	46.2
500 or more employees	11	84.6	Information Technology	5	38.5
Experience by Sectors^{+}			Manufacturing, Construction and Trading of Capital Goods	5	38.5
Education and Academia	6	46.2			
Government	7	53.8	Telecommunication Services	6	46.2
Industry	11	84.6	Transportation	5	38.5
Non-profit	4	30.8	Utilities	2	15.4
Notes: * Percentage of 13 participants in Round III; $^{+}$ Multiple categories allowed to be selected					

Table 4. Expert panel demographic profile

The Length of Relevant Expertise in Table 4 indicates 11 (84.6%) panel members have been involved with metadata management for 10 or more years in total, and the remaining two experts (15.4%) have 2 to 10 years of involvement with metadata management in total. Eleven (84.5%) experts indicated they have experience with large organizations (500 or more employees) and five (38.5%) experts have worked with small and medium-size organizations (less than 500 employees).

The panel's Experience by Sectors demographic shows that all four major sectors of Industry, Education and Academia, Government and Non-profit were represented on the panel with the most common being the Industry sector (quoted by 11 experts) and the least common being the Non-profit sector (quoted by 4 experts). Further, those experts that possess Industry experience were asked to select specific industry sectors that their experience related to. The choice of industry sectors was derived from the sectors and industry groups listed in the Global Industry Classification Standard (MSCI & Standard & Poor's 2010). Finally, based on the data in Table 4, the panel's expertise spans across all industry sectors, notably lead by the Financials sector (8 experts, 61.5%) and trailed by the Utilities sector (2 experts, 15.4%).

The demographic profile presented in Table 4 serves solely for the purposes of demonstrating panel members' expertise and related experience. The Delphi method does not require a statistically valid sample size and the consensual outcome is unique to the specific panel at hand. Therefore, findings of this study are not generalisable to a larger population based on this demographic profile.

4.5 Brainstorming phase

The open-format responses collected from all 12 experts in the brainstorming phase were analysed using the concept mapping method. Although there are multiple methods known as concept mapping, in this paper it is used synonymously with *idea networking* (Metcalfe 2007). First, the researchers

isolated individual idea statements from the success factors and their rationales as nominated by the panel members. Then the researchers linked each individual idea statement to all other similar or related statements. Finally, the resulting network was analysed in UCINET6 for Windows using the Girvan-Newman clustering algorithm (Borgatti et al. 2002) to identify prevailing conceptual themes that represent success factors. The Girvan-Newman clustering algorithm allows for a varying number of clusters to be identified. After evaluating the resulting groupings of statements, the researchers determined that the most appropriate number of clusters, to most accurately represent the variation in themes suggested by participants, was 10. Less than 10 clusters did not allow for the various themes to emerge, and more than 10 clusters resulted in extraneous clusters that did not add insight. Figure 1 shows the final network diagram.

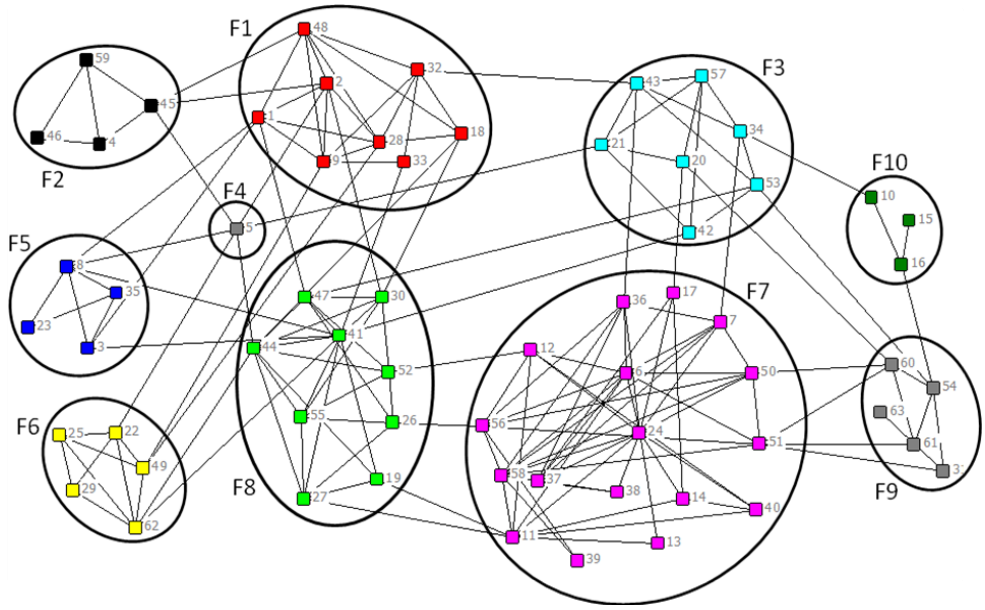

Figure 1. The network diagram and the emerging factors F1-F10

Due to the space limitation the authors do not include the individual 63 numbered idea statements as shown in Figure 1. The identified factors F1 to F10 and sample statements are included in Section 5. The researchers followed up with the panel members to elicit comments on the proposed groupings. The panel members, when presented with the opportunity, raised no amendments or objections.

4.6 Rating phase

The factors identified in the brainstorming phase were presented back to the experts in Round III. The panel members were asked to rate each factor's importance on the Likert-type scale from 1 (not important) to 5 (extremely important). The individual factor ratings were collected from 13 experts. Multiple statistics, such as median, 25th and 75th percentiles, as well as mean and standard deviation were calculated across the panel for each factor. In order to measure the level of overall agreement, the authors calculated Kendall's coefficient of concordance (W). Since this non-parametric statistic uses rankings instead of ratings, all ratings were first converted into rankings, allowing for ties.

A follow-up round was conducted to ascertain if the overall agreement on the importance of individual success factors could be improved and to what extent. The panel's median ratings were distributed to each panel member along with their own ratings in the form of a radar-type chart to highlight the differences from the panel. Each expert was invited to review their ratings.

5 RESULTS AND DISCUSSION

5.1 The success factors

The success factors presented in Table 5 are the outcome of the Delphi brainstorming phase.

	Factor summary and sample expert statements
F1: Value proposition	Promotion and education about the purpose and various aspects of metadata that will ensure a clear value justification of metadata management, best articulated in a solid business case.
	"Unless you have a clear idea of why and how your metadata is needed you cannot establish a well balanced goal. A lot of time a project is technology-driven, [...]"
F2: Management support and sponsorship	Committed senior management, ready to support the initiative with adequate organizational resources and funding.
	"Without active senior [management] support there will be no funding for meta data [management] and no reason for resources to participate"
F3: Metadata strategy	Clear high-level direction for the metadata management initiative that meets long-term business and technical stakeholders' expectations across the organization. Metadata strategy should consider organizational alignment, metadata architecture, phased implementation strategy, level of commitment to interoperability through standards, etc.
	"Develop meta data strategy before embarking on evaluating, purchasing and installing complex management products." *"Decide the level of standardization and interoperability commitment."*
F4: Project champion	Pivotal role requiring business competence and the authority to steer and drive the project, ideally with a good overview of strategic as well as technical requirements.
	"There have to be 'flag wavers' – leaders in the effort."
F5: Team composition	Project team with metadata expertise and appropriately balanced capabilities, including external consultants as required, with provision for required training.
	"People with appropriate skills to analyse the customers' needs and translate into meta-data environment"
F6: Scope management	Clearly defined project scope that is agreed by all stakeholders and whose modifications are subject to a change control process. Given the comprehensive scope covered by most metadata initiatives, a pilot project and iterative implementation approach should be adopted to effectively manage stakeholder expectations and project delivery.
	"Scoping metadata - Metadata is infinite in types and expectations can be falsely set."
F7: Technology selection	A robust and flexible technical framework that supports the organization's metadata strategy and requirements. Typical capabilities include metadata capture, storage, update, versioning and delivery through a metadata repository or registry featuring a wide range of metadata types, formats and sources; easy-to-use, customizable interface for business and technical users; robust search, analysis and reporting facilities, etc.
	"The tools need to be very agile. Every department, project, group and individual needs customized views of their own metadata that are all driven from a shared database."

F8: User involvement	Active engagement and participation, of not only technical but in particular business users, through audience-targeted language and feedback mechanisms, towards better buy-in, requirements assessment and understanding, usability testing as well as operations.
	"Design and enhancement must be built on user experience. User and user tasks are different, both for metadata creators and for metadata users, both for human and agents. Unfortunately this is a factor being ignored by many cases."
F9: Data governance and metadata quality	Effective policies and processes established to ensure high metadata quality. Ongoing compliance, and motivation to contribute to content quality, will enhance trust in the managed metadata environment which is essential for user acceptance.
	"Metadata are like any other data. High-quality results from well-defined and managed processes."
F10: Performance measurement	Evaluation of the managed metadata environment, in terms of content usage and its effect on operations and business performance.
	"Many factors in administrative item management [...] need to be constantly improved including who is using what items and how clear the semantics are."

Table 5. Summary of the success factors and selected sample panel member statements

5.2 Success factor ratings

Summary statistics for the final panel ratings of importance of success factors can be found in Table 6. The authors propose that the median factor ratings of very to extremely important signify critical success factors.

Factor	Mean	Std.Dev.	25th Percentile	Median	75th Percentile
F1: Value proposition	4.38	0.87	4	5	5
F2: Management support and sponsorship	4.69	0.48	4	5	5
F3: Metadata strategy	4.38	0.65	4	4	5
F4: Project champion	4.69	0.63	5	5	5
F5: Team composition	4.00	0.00	4	4	4
F6: Scope management	4.15	0.69	4	4	5
F7: Technology selection	3.54	0.88	3	3	4
F8: User involvement	4.46	0.52	4	4	5
F9: Data governance and metadata quality	4.46	0.52	4	4	5
F10: Performance measurement	3.85	0.55	4	4	4

Table 6. Final panel statistics for importance ratings by individual factors in the Follow-up round

5.3 Agreement assessment

Coefficient	Round III	Follow-up round
Kendall's coefficient of concordance (W)	0.24	0.33

Table 7. Panel's overall consensus coefficients

Schmidt (1997) suggests that weak agreement exists for $W<0.3$, moderate agreement for $W=0.5$ and strong agreement for $W>0.7$. In round III the coefficient of concordance indicated a weak agreement as is shown in Table 7. The follow-up round improved the panel's consensus only marginally to below-moderate levels and hence the authors decided the study could be terminated at that stage. On reflection, the disadvantage of Kendall W is that it treats all data as rankings whereby a certain

statistical power is lost if the assumption of interval-level data could have been made instead. The standard deviation across the rated factors presented in Table 6 is low and the interquartile range is minimal which indicates a satisfactory agreement for the purposes of the study.

5.4 Discussion

The *Value proposition*, *Management support and sponsorship*, and *Project champion* lead the median importance ratings as extremely important. The factor *Technology selection* trails the set of factors as the only moderately important factor, which suggests that although still important, the tools and technology may have advanced sufficiently enough to meet standard metadata management requirements. More detailed recommendations for the technology selection criteria can be found in Vnuk et al. (2011).

When comparing the emerged success factors to the ones mentioned in Table 1, *Value proposition*, *Metadata strategy* and *Data governance and metadata quality* do not appear strongly in the other related fields. The authors hypothesise that the value proposition, unlike in other initiatives, is more important for metadata management because of the indirectness of metadata management benefits. The emergence of *Metadata strategy* and *Data governance and metadata quality* demonstrates that these critical success factors are unique to this type of information management initiative.

The authors ordered the factors F1 to F10 to enable better navigation. The first few factors can be seen as relating to the strategic-level issues for the initiative, whereas the last couple deal with operational-level issues of maintaining high metadata quality and motivation to contribute to content on an ongoing basis. The authors also note that some of the identified factors have inter-dependencies. For example, *Value proposition* has an effect on *Management support*. The *Project champion*'s role is critical to the other factors as well and could be considered for inclusion in the *Management support* factor.

Unlike Hüner et al.'s (2011) study, collaborative management did not emerge as a separate critical success factor. However, success factors supporting collaborative management, namely Ease of use and Low metadata maintenance effort (Hüner et al. 2011), can be related to the *Technology selection* factor. The *Data governance and metadata quality* factor is also relevant in this regard as it calls for defined processes and motivation to contribute to metadata quality. The collaborative processes (Hüner et al. 2011) should be considered as a means to address the business metadata maintenance.

While the results are specific to the expert panel at hand and should not be generalised to a wider population, the authors do not think that adding experts to the panel would dramatically change the set of proposed factors. The current set of factors derived from the responses of 12 experts is comprehensive. This is reinforced by the fact that in the rating phase a 13th expert rejoined the panel and did not introduce any new factors.

6 SUMMARY AND FUTURE RESEARCH

This exploratory study investigated critical success factors for implementing enterprise managed metadata environments. Employing the Delphi enquiry method, a panel of experts elaborated ten factors that indicate successful implementation of metadata environment that were grouped into three levels. Clear *value proposition,* committed *management support and sponsorship,* and a well-defined *metadata strategy* aligned with long-term business and technical direction were identified as the critical components of success on the strategic level. On the project level, critical success factors include a competent *project champion,* a balanced *team composition,* effective *scope management,* and active *user involvement,* whereby appropriate *technology selection* was found moderately important. Finally, on the operational level, *information governance* ensuring high metadata quality, and *performance measurement* complete the set of critical success factors. These findings represent a novel contribution to knowledge in the area of enterprise metadata management.

Organisations can use the proposed success factors to frame and focus their metadata management initiatives. In this paper, each factor bears a label and a concise description of what is involved but it can be further augmented to include best practice recommendations and serve as practical guidelines.

The set of CSFs provides a common language that can facilitate communication, especially with the senior management. Such communication may indirectly have a positive impact on winning their support for the initiative. The CSFs can also be developed into an assessment tool to evaluate the current metadata management practices.

Among the proposed CSFs, organisations are more likely to find it challenging to fully address some aspects of *value proposition* (e.g. benefit quantification), *scope management* (complexity and size) and *metadata quality* (e.g. maintenance and motivation). Although *technology selection* has been identified as non-critical, organisations should not underestimate the evaluation of requirements, such as ease of use, as well as availability of advanced features and long term vendor support.

The proposed set of success factors can also inform a typological framework that can be evaluated in future research. Although the identified set of success factors in this study shows overlaps with the sets of CSFs previously suggested in other IS initiatives, such as KM, the MME-specific aspects are apparent when it comes to the detailed descriptions of most of the factors.

Methodologically, the study's choice of concept mapping, as a tool for analysis of the Delphi panel's responses and their clustering, proved effective and represents an innovative approach in such a setting. Among other benefits, the authors especially appreciate the network visualisation feature that facilitates communication and presentation of analysis results.

One of the features as well as limitations of the study at hand is the inclusion of experts' views only. Although their expertise is based on long-term experience with multiple cases of metadata management systems, the study does not examine individual cases or end-user views. The authors therefore plan to evaluate and enhance the findings through a series of case studies exploring how organisations implement and practice metadata management.

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