

Exploring the Structural Dimension of Data Warehouse Organizations: Results of a Survey and Implications

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Abstract

Practitioners and researchers in the domain of data warehousing are primarily focussing on technical aspects of data warehouse systems. Organizational issues are often neglected although several studies about critical success factors of data warehouse projects emphasize their importance. Thus, the aim of this paper is to provide deeper insights in organizational issues of data warehousing. The paper focuses on structural aspects of data warehouse organizations by presenting results of an exploratory survey conducted in 2003. The study shows a trend towards organizational challenges, problems in the structural dimension of data warehouse organizations and what kind of documentation about data warehouse departments exists. The findings of the study are discussed and implications for research and practice are highlighted.

Keywords

Data warehousing; Data warehouse organizations; Organizational structures; Process management

1. INTRODUCTION

Since the introduction of the data warehouse concept in the late 1980ies (e.g. Devlin/Murphy 1988), data warehouse systems are now an established component of information systems landscape in most companies. Due to high failure rates of data warehouse projects, several procedure models for building data warehouse systems were published considering their special requirements (e.g. Inmon 1996, Kimball 1996, Gardner 1998, Simon 1998). However, these methodologies were mainly focused on technical issues, like architectural concepts and data modelling. But according to studies about critical success factors of data warehouse projects organizational, political and cultural factors are at least as important as technical ones (Frolick/Lindsey 2003, Hwang et al. 2002, Finnegan/Sammon 1999). In addition, most development methodologies are lacking concepts to ensure long-term evolution and establishment of data warehouse systems (O'Donnell et al. 2002), which are both primarily organizational challenges (Meyer/Winter 2001).

Up to now only few authors have adopted a mainly organizational-driven view on data warehouse systems. Kachur (2000) describes activities and organizational structures for data warehouse management. Adelman/Moss (2000) explain how to design and manage data warehouse systems focusing on project management aspects. In addition, they give an overview of organizational roles involved in a typical data warehouse project. Meyer (2000) and Meyer/Winter (2001) present organizational requirements for data warehousing and the concept of data ownership. A two-dimensional organizational structure for large financial service companies combining infrastructural competencies and content competencies is derived. Auth (2003) develops a process-oriented organizational concept for metadata management providing detailed activity chains and organizational roles.

As shown above the organizational domain of data warehouse systems still lacks attention of data warehouse researchers compared to technical aspects. Therefore this paper aims at providing deeper insights in the current organizational situation of data warehouse departments in practice. The organizational domain of companies can be divided in a structural, human resource, political, and symbolic dimension and each dimension requires different design instruments (Bolman/Deal 2003, Mueller-Stewens 2003). The structural dimension focuses on goals, formal roles and relationships. Structures are created to achieve the company's goals considering technological and environmental factors. Rules, policies, processes, and hierarchies are the design elements of the structural dimension. Drawing from psychology, the human resource dimension takes care about the needs, feelings, prejudices, and limitations of all individuals. The political dimension sees organizations as arenas. Different interest groups cause conflicts while competing for power and resources and the organizational life is

characterised by bargaining, negotiations and compromises. The symbolic dimension abandons the assumptions of rational behaviour and views organizations as some kind of theatres. Rituals, ceremonies and stories are more important than rules or managerial authority (Bolman/Deal 2003).

Many studies on critical success or failure factors of data warehouse projects have been published (e.g. Wixom/Watson 2001, Little/Gibson 1999, Frolick/Lindsey 2003). Most studies comprise technical as well as organizational factors. In the organizational domain issues like management support, sponsorship, user participation, and organizational politics are often mentioned. But these studies do not explicitly distinguish the different organizational dimensions and they only provide a general overview of relevant organizational factors. However, more detailed insights are needed to design and apply appropriate instruments and measures to implement these success factors.

Since the paper is based on an information systems perspective, the structural dimension of data warehouse organizations is regarded as the primary research object. This dimension comprises responsibilities, hierarchies, information and communication flows as well as the assignment of tasks and activities. Thus, the objective of this exploratory study is to foster the understanding of the structural dimension of data warehouse organizations in order to build a starting point for the development of appropriate design instruments and measures. In particular, the paper presents results of a survey concerning current data warehouse trends, organizational problems of the structural dimension and the present state of organizational design in companies. Based on these results implications for research and practice are discussed.

2. DESIGN OF THE SURVEY

The survey was conducted at a practitioner-oriented data warehouse conference arranged by the Institute of Information Management at the University of St. Gallen in the second quarter of 2003. Participants were handed out the questionnaire in conjunction with the conference proceedings. The questionnaire was either returned at the end of the conference or sent back via mail. The population of interest included companies from all economic sectors running a data warehouse system. Prior to distribution, the survey was pilot tested with a small group of experts from research and practice by conducting structured interviews. A number of revisions were iteratively implemented.

In total, responses were received from 66 organizations including 8 insufficiently completed questionnaires. Thus, the usable response rate was 39.7% (58 valid responses of 146 conference attendees). Approximately two third of the participating companies were from banking (32%), insurance (17%) and telecommunication (16%) sector. Accordingly 72% of the participating companies had more than 999 employees and only 16% were SMEs. On average, respondents had about 6.58 years experience in data warehousing and 39 employees were engaged in data warehousing. Further details about the population characteristics are given in the appendix.

As already described above, the survey focuses on the structural dimension of data warehouse organizations. Since the early 1990s there is a trend towards business processes as the primary design objects of the structural dimension of organizations (e.g. Hammer/Champy 1993, Davenport 1993, Oesterle 1995). Therefore this paper applies a process-oriented view called data warehousing to data warehouse systems. In literature no generally accepted definition of the term data warehousing exists, in particular number and naming of the process phases varies. For example Gardner (1998) differentiates the phases planning, design/implementation, and usage/support/enhancement. Vassiliadis et al. (2001) separate the process in the three phases design/implementation, administration, and evolution. In order to reduce complexity for conducting the survey data warehousing is separated in only two main phases 'development' and 'maintenance'. This differentiation was used in all questions concerning the data warehouse process.

The first question of the survey tried to determine whether there is a general trend in data warehouse practice. Therefore the domain of data warehouse systems was divided into technical and organizational aspects and the following question was posed:

Were the past and will the future challenges in data warehousing in your company be of rather technical or organizational nature?

One of the main objectives of the survey was to find out whether problems in the structural dimension of data warehousing exist and what kind of problems are most urgent. Seven typical problems of the structural dimension of organizations were given and the following question was asked in the questionnaire:

Which of the following organizational problems arise in your company in the two phases of data warehousing?

Beside trends and problems the survey also aimed at potential causes of organizational deficiencies. To actively design and manage a company's structural organization and to overcome the organizational problems queried

in the previous question, documents about as-is and to-be processes and structures are required. Therefore a question was posed concerning the extent to which the organization of the data warehouse departments is explicitly documented:

Which of the following documents about the data warehouse organization exist in your company and how do you estimate their degree of completeness?

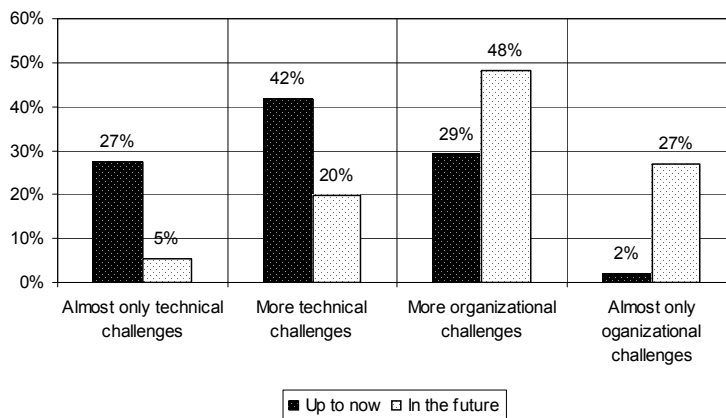
The responses to these three main questions are presented in the next section. Descriptive statistics are used to analyse the data. When appropriate, statistical tests are applied to compute significance levels. ‘*’, ‘**’ and ‘***’ denote significance at the 10%, 5% and 1% level of confidence, respectively.

3. SURVEY RESULTS

In the following section key findings of the survey are described. First of all the general trend in the data warehouse field is depicted and analysed depending on the maturity of the data warehouse system of the companies. Then common organizational problems in the development and maintenance phase are discussed. Finally the extent to which companies are documenting their data warehouse organization is presented.

3.1 Challenges in Data Warehousing

Up to now challenges in data warehousing were primarily technically dominated. 69% of all respondents indicated that at least the majority of the data warehouse issues they had to cope with in the past had a technical character. 27% of them even answered that almost all challenges were of technical nature. In contrast, only 2% of the companies focused on organizational issues solely. Compared to past challenges the future trend clearly tends towards organizational challenges in data warehousing. 75% of all respondents assume that the majority of data warehouse challenges in the future have an organizational matter and 27% of them expect the organizational domain to be all-dominant. Only a quarter of the questioned companies rates the technical area to be more important than the organizational one. Comparing past and future key aspects of data warehousing a shift from technical to organizational challenges will take place.



Future Challenges	Maturity of data warehouse [years]		
	1 - 4	5 - 8	> 8
Technical challenges	21%	37%	0%
Organizational challenges	79%	62%	100%

Figure 1: Previous and future challenges in data warehousing

To get a deeper insight in future challenges of data warehousing crosstab analysis is used to study the relationship between different data warehouse maturity levels and future trends. The results are shown in the lower table of Figure 1. In order to increase cell count some categories are collapsed. Both technical-oriented and both organizational-oriented categories of the variable ‘future challenges’ are summed up each in a specific category. Furthermore three different maturity levels of data warehouse systems are distinguished. The significance value of chi-square statistic for the crosstab is $p=0.043^{**}$ and therefore indicates a relationship between both variables.

Companies with mature data warehouse system (> 8 years) do not expect any technical challenges in the future. They will mainly concentrate on organizational aspects. In contrast, companies with less experience in data warehousing still see some challenges in the technical area. 37% of the respondents of the segment 5 - 8 years

assume that the majority of challenges will be of technical nature. This is very remarkable as all other segments even the immature one do not rate the technical issues that important. The results from the crosstab analysis may indicate some sort of lifecycle that data warehouse systems undergo (Vassiliadis et al. 2001). So the maturity level of a data warehouse could be utilized as a situational factor in data warehouse procedure models to suggest appropriate measures.

3.2 Organizational Problems

Two organizational main problems in both phases of data warehousing exist (see Figure 2). On average, 37% of the respondents state that problems arise due to interdepartmental cooperation. Reasons for this may be missing service level agreements that clearly specify the output of different organizational units or the varying know-how of people working in different departments. 35% of the survey participants indicate that missing transparency of durations and costs of activities is a major problem in data warehousing. One reason for the importance of the transparency of processes in both phases may be the current economic pressure resulting in cost-cutting measures and higher management attention to control activities. The problems of missing standardization of documents and of activities and processes are rated third and fourth in the category 'major problems'. These problems are tightly connected to difficulties in collaborating with other organizational units as standardization can be used to overcome these organizational interface problems. Standardization may also be helpful to reduce coordination and management costs, e.g. standardized documents assure that all relevant information are handed over to the management and standardized activities facilitate the comparison of different organizational units with the same scope of duties. Organizational problems due to unspecified responsibilities, skills and processes are rated least relevant. It is remarkable that all mentioned problems are judged at least as minor problems by more than 60% of the respondents.

	Major problem	Minor problem	No problem
Difficulties in collaborating with other organizational units	36.84%	50.88%	12.28%
No transparency of time and costs of activities	35.34%	47.82%	16.84%
No standardized output documents	29.10%	50.03%	20.87%
No standardized activities and processes	27.68%	44.64%	27.68%
No specified responsibilities	18.58%	48.73%	32.69%
No specified activities and processes	18.00%	55.00%	27.00%
No specified skills and profiles	17.27%	49.09%	33.64%

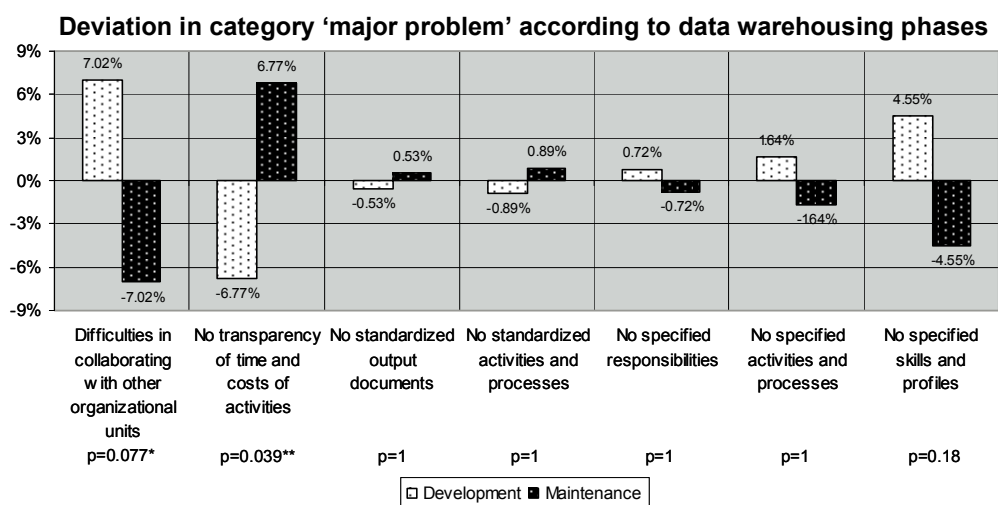


Figure 2: Organizational problems

The lower part of Figure 2 shows the deviations of the answers per data warehousing phase in the category 'major problem'. McNemar test is used to compute the significance values at the bottom of Figure 2 and to indicate whether organizational problems are equally distributed in both data warehousing phases. Significance

values are only computed for the category ‘major problem’ and therefore responses were recoded into dichotomous variables.

In the category ‘major problem’ two statistically significant differences between development and maintenance of data warehouse systems are revealed. The respondents indicate that collaboration problems during development are more pressing than in the maintenance phase (+7%). This difference indicates that during development closer collaborations with more organizational units are taking place. This may originate from the fact that user participation and requirements analysis to understand the user demands are most critical for successful data warehouse development. In contrast, missing transparency of activities is more urgent in the maintenance than in the development phase (+6.8%). This may relate to the fact that commonly inter-company invoicing is used to charge maintenance services and these costs have to be allocated in accordance with the cause of cost. This can be a very challenging task due to a multitude of customers and often undefined causes of cost. In the development phase usually a well-defined project budget and a limited number of customers are given.

3.3 Extent of Organizational Documentation

Besides organizational problems the survey also questioned what kinds of documents about the organization of data warehousing exist in the companies. In the upper part of Figure 3 the responses are summarized. The respondents could rate the degree of completeness of the different kinds of organizational documentation according to the three categories ‘complete’, ‘in parts’ or ‘nonexistent’. The results show that organizational hierarchies of data warehouse departments are very well documented. On average, complete organization charts exist in 71% of the questioned companies. This may relate to the fact that static organizational structures are much easier to document and maintain because they are not as complex as organizational processes and they do not change that frequently. Further documents about organizational units, like descriptions of positions and roles are fully available in 24% of the companies only.

Compared to the static structures, the process organization of data warehousing in companies is not as extensively documented. On average, 33% of the respondents rate their process models as complete and only 21% state that activities are completely described in their companies. Additional documents like definition of terms are even less exhaustively described (17%). About 60% of the survey participants state that the different categories of organizational documents are at least partially available. Around 15% of the companies do not have any documents about their data warehouse organization at all.

	Complete	In parts	Nonexistent
Definition of terms	17.11%	65.75%	17.14%
Detailed description of activities	21.21%	63.75%	15.04%
Description of positions and roles	23.89%	61.09%	15.02%
Process models	33.33%	54.39%	12.28%
Organization charts	71.05%	21.05%	7.89%

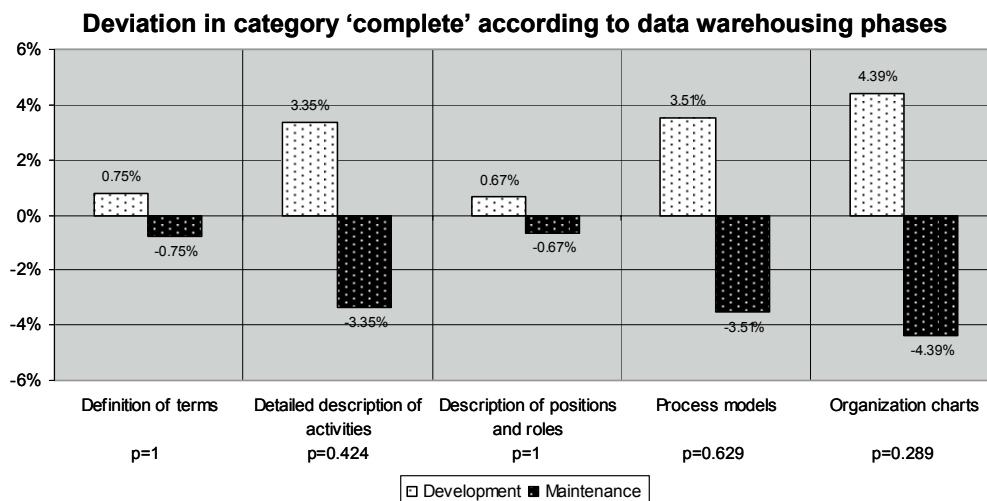


Figure 3: Extent of documentation of data warehouse organizations

The bar chart in Figure 3 shows the deviations of the responses per data warehousing phase in the category 'complete'. Significance values are computed in the same way as for the previous question using McNemar test. At a first glance the chart may indicate that the degree of completeness of organizational documents in the development phase is higher than in the maintenance phase, in particular the description of processes, activities and organization chart. But no statistically significant difference between both phases in the category 'complete' can be found. In general, the results about the extent of documentation of data warehouse organizations may indicate that many companies do not actively design their organizational processes. Without a complete description of as-is or to-be organizations it is difficult to efficiently rearrange organizations, like matching of skills and tasks or streamlining organizational processes.

In the next section implications for research and practice of the results shown above are discussed.

4. DISCUSSION

The results of the survey show a trend in practice towards organizational issues in data warehousing and some major organizational problems. Therefore research in data warehousing should focus on suitable artefacts and instruments to support companies in designing their structural dimension of data warehouse organizations. Such instruments are for example organizational reference models, criteria for evaluating and benchmarking data warehouse organizations, and methods for designing and selecting appropriate data warehouse organizations.

Comparable to the Common Warehouse Metamodel (CWM) - a reference model for metadata in the context of data warehouse systems which was developed by the Object Management Group (OMG) (Poole et al. 2002) - a reference model comprising organizational structures for data warehousing could be developed. An organizational reference model is a 'blue print' including knowledge about best or common practices of a certain domain. It can be used to support companies in deriving company-specific and optimal organizational models, benchmarking their organizational structures or continuously managing and improving their organization (Scheer/Nuettgens 2000, Rosemann 2003). According to both major organizational problems in data warehousing the reference model should focus on organizational interfaces between the different organizational units engaged in data warehousing and on metrics for measuring and monitoring quality, time and costs of processes.

As a first step, characteristics of data warehouse systems which determine their special organizational requirements compared to traditional operational information systems have to be analysed. Relevant characteristics may comprise the following three aspects:

- *High complexity:* The idea behind data warehouse systems is to establish a single data source for all analytical purposes in a company by constructing a single analytical enterprise data model (e.g. Devlin 1997). Therefore almost every operational information system is used as a data source for the data warehouse systems. This results in a vast number of interfaces and dependencies. In addition, nearly all employees of a company use the data warehouse system. Thus, there are a lot of data warehouse stakeholders in companies resulting in a multitude of different interests and responsibilities concerning the data warehouse. An appropriate organization of development and maintenance of data warehouse systems has to cope with this very complex situation, e.g. all the different interests could be coordinated by means of data warehouse steering committees.
- *Highly dynamic environment:* Data warehouse systems are usually confronted with a huge amount of requirements from different departments in a company. Typically the number of requirements exceeds the available resources for their implementation and the time till implementation is often a critical success factor for the data warehouse system. Therefore data warehousing is not a temporary project but a permanent process continuously improving and extending the data warehouse system (Meyer/Winter 2001). This dynamic environment requires special organizational measures, e.g. the flexibility of data warehouse organizations could be ensured by reserve-pool employees.
- *Support of unstructured decision processes:* Data warehouse systems primarily support decision making. This is a management process consisting of the four phases intelligence, design, choice, and review (Simon 1977, Turban/Aronson 2001). Characteristics of this process are its missing structure and the uniqueness of many decisions. Therefore information requirements are difficult to determine and incomplete. Moreover data quality requirements differ from those in operational information systems (Winter/Strauch 2003, English 1999). This results in specific organizational requirements, e.g. data warehousing asks for a special kind of information requirements analysis.

Based on these characteristics special organizational criteria for data warehousing can be developed. They can be used to create and evaluate methods, reference models or other artefacts helping companies to improve the structural dimension of data warehouse organizations. As a starting point, generic organizational processes for IT departments can be adapted according to the organizational requirements of data warehousing. The IT Infrastructure Library (ITIL) for example provides a generic framework and a set of procedures for IT Service Management (Hendriks/Carr 2002).

The results of the survey also have implications for practice. As shown, most companies do not actively design the organizational processes of data warehousing, although Business Process Reengineering (BPR) of core business process was one of the hot topics of the last years. A study of Gartner predicts that the importance of organizational aspects for IT departments will increase over the next few years. One of the main predictions states that “through 2006, 80 percent of infrastructure efficiency improvements will be a direct result of IT infrastructure management processes, with only 20 percent based on the technology (0.9 probability)” (Brittain et al. 2002). This shows that companies and especially data warehouse departments should broaden their scope by including organizational aspects besides technical issues. As a first step, companies should start to completely document their as-is and to-be organizational structures of data warehousing. Based on this documentation further organizational measures could be established, like process optimization, management or benchmarking.

5. SUMMARY AND FUTURE RESEARCH

This exploratory empirical study investigates the structural dimension of data warehouse organizations. It shows a clear trend towards organizational challenges in data warehousing practice. Most data warehouse departments still have to cope with organizational problems. Particularly collaboration with other organizational units and transparency of time and costs of the data warehouse process seem to be severe challenges. In addition, the study reveals that data warehouse organizations are often poorly documented and that the structural dimensions of data warehousing is usually lacking attention. Hence, the structural dimension of data warehouse organizations still seems to be a relevant research topic. Further research efforts should adapt common organizational design instruments to the specific needs of data warehousing and explore human resource, political, and symbolic organizational dimensions to compose a comprehensive view on data warehouse organizations.

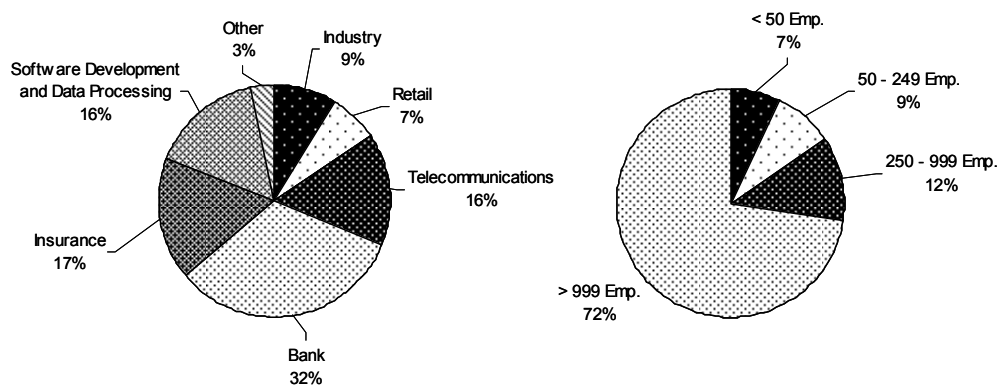
REFERENCES

- Adelman, S. & Moss, L. (2000) *Data Warehouse Project Management*, Boston: Addison-Wesley.
- Auth, G. (2003) *Prozessorientierte Organisation des Metadatenmanagements für Data-Warehouse-Systeme*, Doctoral Thesis, University of St. Gallen, Bamberg: Difo-Druck (in German).
- Bolman, L.G. & Deal, T.E. (2003) *Reframing Organizations: Artistry, Choice, and Leadership*, San Francisco: Jossey-Bass.
- Brittain, K., Adams, P., Curtis, D., & Nicolett, M. (2002) *Use Organization and Process to Do More With Less in 2003* (Gartner Research Note SPA-18-6241), URL <http://www.gartner.com>, Accessed 5 Apr 2003.
- Davenport, T.H. (1993) *Process Innovation: Reengineering Work through Information Technology*, Boston: Harvard Business School Press.
- Devlin, B. (1997) *Data Warehouse: from Architecture to Implementation*, Reading: Addison-Wesley.
- Devlin, B. & Murphy, P. (1988) *An Architecture for a Business and Information System*, IBM Systems Journal, 27 (1), 60-80.
- English, L.P. (1999) *Improving Data Warehouse and Business Information Quality: Methods for Reducing Costs and Increasing Profits*, New York: Wiley.
- Finnegan, P. & Sammon, D. (1999) *Foundations of an Organisational Prerequisites Model for Data Warehousing*, Proceedings of the 7th European Conference on Information Systems (ECIS 1999), Copenhagen, June.
- Frolick, M.N. & Lindsey, K. (2003) *Critical Factors for Data Warehouse Failure*, Journal of Data Warehousing, 8 (1).
- Gardner, S.R. (1998) *Building the Data Warehouse*, Communications of the ACM, 41 (9), 52-60.
- Hammer, M. & Champy, J. (1993) *Reengineering the Corporation: A Manifesto for Business Revolution*, New York: Harper Business.

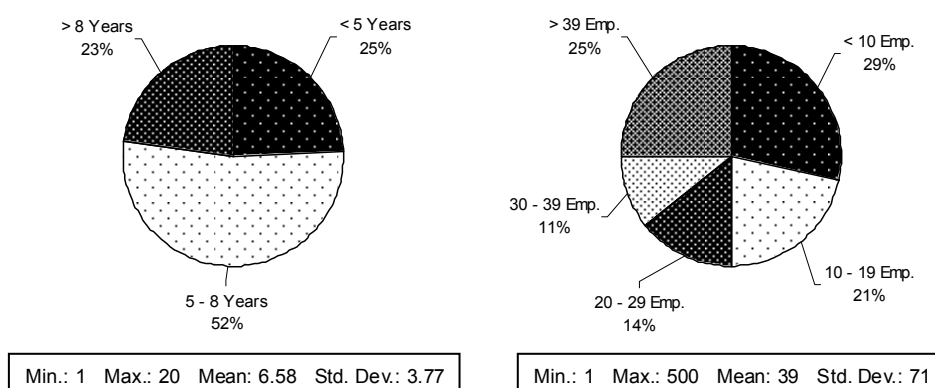
- Hendriks, L. & Carr, M. (2002) ITIL: best practice in IT Service Management, in J. van Bon (Ed.), *The Guide to IT Service Management Volume I* (pp. 131-150), London: Addison-Wesley.
- Hwang, H.-G., Kua, C.-Y., Yenb, D. C., & Chenga, C.-C. (2002) Critical factors influencing the adoption of data warehouse technology: a study of the banking industry in Taiwan, *Decision Support Systems*, In Press, Corrected Proof.
- Inmon, W.H. (1996) *Building the Data Warehouse*, Second Edition, New York: John Wiley & Sons.
- Kachur, R. (2000) *Data Warehouse Management Handbook*, Paramus: Prentice Hall.
- Kimball, R. (1996) *The Data Warehouse Toolkit: Practical Techniques for Building Dimensional Data Warehouses*, New York: John Wiley & Sons.
- Little, R. & Gibson, M. (1999) Identification of Factors Affecting the Implementation of Data Warehousing, *Proceedings of the 32nd Annual Hawaii International Conference on System Sciences (HICSS-32)*, Maui, Hawaii.
- Meyer, M. (2000) *Organisatorische Gestaltung des unternehmensweiten Data Warehousing: Konzeption der Rollen, Verantwortlichkeiten und Prozesse am Beispiel einer Schweizer Universalbank*, Doctoral Thesis, University of St. Gallen, Bamberg: Difo-Druck (in German).
- Meyer, M. & Winter, R. (2001) Organization of Data Warehousing in Large Service Companies: A Matrix Approach Based on Data Ownership and Competence Centers, *Journal of Data Warehousing*, 6 (4).
- Mueller-Stewens, G. (2003) Die Organisation als Gegenstand von Veränderungsprozessen, in H. Oesterle & R. Winter (Eds.), *Business Engineering: Auf dem Weg zum Unternehmen des Informationszeitalters* (pp. 133-145), Berlin: Springer (in German).
- O'Donnell, P., Arnott, D., & Gibson, M. (2002) Data warehousing development methodologies: A comparative analysis, Working Paper, Melbourne, Australia: Decision Support Systems Laboratory, Monash University.
- Oesterle, H. (1995) *Business in the Information Age: Heading for new Processes*, Berlin: Springer.
- Poole, J., Chang, D., Tolbert, D., & Mellor, D. (2002) *Common Warehouse Metamodel: An Introduction to the Standard for Data Warehouse Integration*, New York: John Wiley & Sons.
- Rosemann, M. (2003) Preparation of Process Modeling, in J. Becker, M. Kugeler, & M. Rosemann (Eds.), *Process Management: A Guide for the Design of Business Processes* (pp. 41-78), Berlin: Springer.
- Scheer, A.-W. & Nuettgens, M. (2000) ARIS Architecture and Reference Models for Business Process Management, in W. van der Aalst, J. Desel, & A. Oberweis (Eds.), *Business Process Management: Models, Techniques, and Empirical Studies* (pp. 376-389), LNCS 1806, Berlin: Springer.
- Simon, H.A. (1977) *The New Science of Management Decision*, Englewood Cliffs: Prentice Hall.
- Simon, A. (1998) *90 Days to the Data Mart*, New York: John Wiley & Sons.
- Turban, E. & Aronson, J.E. (2001) *Decision Support Systems and Intelligent Systems*, Sixth Edition, Upper Saddle River: Prentice Hall.
- Vassiliadis, P., Quix, C., Vassiliou, Y., & Jarke, M. (2001) Data Warehouse Process Management, *Information Systems*, 2001 (26), 205-236.
- Winter, R. & Strauch, B. (2003) A Method for Demand-driven Information Requirements Analysis in Data Warehousing Projects, *Journal of Data Warehousing*, 8 (1), 38-47.
- Wixom, B.H. & Watson, H.J. (2001) An Empirical Investigation of the Factors Affecting Data Warehouse Success, *MIS Quarterly*, 25 (1), 17-41.

APPENDIX 1

Company Characteristics: Economic sector and number of employees



Data Warehouse Characteristics: Maturity and number of employees engaged in data warehousing



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