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BENEFITS AND CHALLENGES OF BUSINESS INTELLIGENCE ADOPTION IN SMALL AND MEDIUM-SIZED ENTERPRISES

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Abstract

Leveraging information is a key success factor for companies. Over the last two decades Business Intelligence (BI) has evolved to become a foundational cornerstone of enterprise decision support. However, prior research shows that small and medium-sized enterprises (SMEs), in particular, lag behind in the proliferation of BI. In this exploratory study we examine BI adoption within German SMEs in the state of Saxony (n = 214). We explore perceived benefits and challenges in their efforts to implement BI. By applying cluster analysis to these results we suggest four types of BI SMEs, each with an individual profile concerning potential benefits as well as a certain set of challenges that are to be expected when it comes to adopting BI solutions. Results can create value for enterprises that plan to implement a BI solution, BI consultants as well as BI suppliers.

Keywords: Business Intelligence (BI), exploratory factor analysis, cluster analysis, IT adoption, small and medium-sized enterprises (SMEs).

1 INTRODUCTION

Small and medium-sized enterprises (SMEs) are the spine of the world's economy. More than 95 per cent of the enterprises in most economies belong to the group SME (European Commission 2008; Kotelnikov 2007). Sixty-five percent of the total labour force is employed by about 140 million SMEs in 130 countries (World Bank 2006). Particularly in times of global economic crisis, the vulnerability of the so-called global players seems to become apparent. Since most SMEs support large enterprises or provide specialty or outsourcing capabilities for larger companies (Huin 2004) as well as their adaptive capabilities (Ritchie & Brindley 2005), they also provide the backbone for global economic structures.

Business Intelligence (BI) as a concept provides a means to obtain crucial information to improve strategic decisions and therefore plays an important role in current decision support systems (Inmon 2005). According to Kimball et al. (2008), the data warehouse industry – as the technological basis of BI – has reached full maturity and acceptance in the business world. Additionally, a shift can be observed towards putting the initiative to act into the hands of business users rather than Information Technology (IT). Due to its complexity and – as a consequence – the high costs of implementation and maintenance of BI and data warehouse solutions, the technology itself is used preferably by large enterprises (Levy & Powell 1998; Hwang et al. 2004; Bergeron 2000). To the best of our knowledge, there have not been any analyses focussing on the exploration of major BI benefits and challenges with a special focus on SMEs on the level as covered below. Due to their importance to the global economy and the benefits they could derive from proper utilisation of BI, we concentrate on this special BI target group.

Our research questions are as follows: What are the general benefits perceived by SMEs and what groups of challenges are to be expected when adopting BI? Which patterns characterise types of SMEs that can benefit most from BI and which types of specific obstacles exist for these companies? To answer these questions, we conducted an exploratory factor analysis as well as cluster analysis on a set of companies based in the German state of Saxony. With a subject base of n = 214 we expect our results to be well-founded. Answering our research questions is relevant to both academia and practice. Academics gain a deeper insight into BI characteristics of SMEs and can align their research to better support SMEs in decision making processes. Practitioners benefit from our research by becoming aware of different enterprise types. These types may be used as a basis for developing new BI solutions or adopting current solutions to better fit the company and better support its (strategic) decisions. Overall, our research will help SMEs to better tackle problems with BI systems and specify the benefits that they can expect from these kinds of systems.

2 RELATED WORK

2.1 Information systems success factors in SMEs

SMEs are defined by usage of qualitative and quantitative measures. We took the European Union (EU) definition as our basis. The EU describes an SME as a company that has fewer than 250 employees and has either an annual turnover not exceeding €50 million or an annual balance sheet total not exceeding €43 million (European Union 2003).

Information systems (IS) in SMEs have been addressed by a number of past works. They are mostly based on special IS problems such as Internet adoption (Mehrtens et al. 2001; Dholakia & Kshetri 2004), system integration (Themistocleous & Chen 2004), or IS management (Bhagwat & Sharma 2006). In a more general approach, Lefebvre, Harvey, and Lefebvre (1991) identified four general factors that influence the adoption of a new technology by SMEs: (1) the characteristics of the firm; (2) the competitiveness and management strategies of the firm; (3) the influences of internal and external parties on the adoption decision process; and (4) the characteristics of new technologies

adopted. An important factor in at least three of these four points is the strong influence of the owners (Levy et al. 2002; Lybaert 1998). While larger organisations have specialists for IS (IT department), in SMEs, investment decisions are often made among the owners who might not have deep IS knowledge and experience.

2.2 BI in SMEs

There are already a number of studies on BI success factors. Hwang et al. (2004) identify factors in the dimensions of organisation, environment, and project planning. They find especially strong support for organisational factors. In addition, earlier works discovered the importance of technical issues (Wixom & Watson 2001; Joshi & Curtis 1999; Rudra & Yeo 1999) as well as personnel, educational, and business issues (Rist 1997). However, some results might not be adoptable for the special case of SMEs. For example, Hwang et al. (2004) found the most significant factor to be the support provided by the top management. However, as discussed previously, in SMEs it is often the top management who also decide on IT issues. Therefore, top management support in SMEs is not a question of "success" but of general interest in BI systems.

Existing research suggests that SMEs, while using other types of IS, are modest in the adoption of BI (also known as management information or decision support) systems (Levy & Powell 1998). This is a surprising fact as other works indicate that information use is a crucial factor in the performance of SMEs (Lybaert 1998). However, a possible explanation might be that BI projects often require lots of capital which bigger organisations are more likely to have (Hwang et al. 2004). Bergeron (2000) reports similar findings and suggests that conventional BI systems, which are focused on large organisations, would not meet the needs of SMEs.

In the context of the above mentioned research, a couple of statements according to IT adoption in SME, BI adoption and BI success factors in a specific dimension already exist. What was missing is a link between BI adoption in SMEs with a focus on general BI success factors and general BI challenges as well as enterprise properties. In addition, it might be useful to focus on general possible benefits and problems prior to detailed facts as defined in previous studies, to give executives a first decision support on BI adoption. The results of our research can build a connection between intending BI adoption and the usage of in-depth planning using specific factor dimensions.

3 RESEARCH METHODOLOGY

3.1 Research design

Exploratory factor analysis (EFA) is a popular and powerful tool for reducing variable complexity by summarising relationships in data sets (Thompson 2004). It is: "often used to explain a larger set of *j* measured variables with a smaller set of *k* latent constructs" (Henson & Roberts 2006, p. 394), where the number of underlying constructs causing variances in the data set is not yet known. These constructs or factors derived in the analysis can then be applied as variables in subsequent analyses, thus guiding theory development and evaluation of operational construct validity scores (Gorsuch 1983, p. 350). In case a strong a priori theory exists, confirmatory factor analysis (CFA) should be given the preference. As mentioned in Section 2 there is little prior research (and theory respectively) on BI adoption in SMEs, triggering the use of EFA in our study.

By means of three distinct exploratory factor analyses we aim to identify underlying constructs related to: (1) the perception of *BI benefits*; (2) *challenges* encountered when introducing BI to the organisation; and (3) factors which describe the *business behaviour and inner constitution* of the observed SMEs. The factor analyses were performed in a parallel fashion using the same methods and toolsets following the recommendations for improved practice in using EFA as described by Henson and Roberts (2006).

The Kaiser-Meyer-Olkin measure (KMO) was used to verify overall sampling adequacy of the correlation matrix, following the guidelines proposed by Kaiser and Rice (1974). The decision was validated by applying Measure of Sampling Adequacy (MSA) on each item measured. To extract the factor solutions, Principal Component Analysis (PCA), which is the most frequently used factor extraction method, was applied. The number of factors to retain was determined by using at least two decision rules according to Thompson and Daniel's recommendation (1996, p. 200). Therefore Eigenvalues (EV) > 1 (Kaiser-Guttmann-Criterion; Kaiser & Rice, 1974) and the graphical scree test were applied to determine the number of factors to retain in all three cases. Regarding factor rotation, we applied the orthogonal Varimax method which appeared to fit the data sample well. Orthogonal rotation should be used in preference to oblique rotation if factor intercorrelations allow its application (Henson & Roberts 2006, p. 410). Eigenvalues, factor matrices and the results of the factor analyses are detailed in Section 4.1.

After having extracted the latent variables we applied a cluster analysis to identify heterogeneous groups of enterprises with homogeneous sets of derived factors (Anderberg 1973). Cluster analysis can be seen as a two-fold optimisation problem: the difference between members of the same cluster should be minimal whereas the difference between the clusters themselves (or their centroids) should be maximal. We applied the iterative k-means algorithm with Euclidean Distance (ED) as a proximity measure. ED provides a measure of the similarity of two objects in multidimensional space. The marginal fusion coefficient was used to determine the number of clusters. The course of this analysis is described in detail in Section 4.2.

3.2 Data collection and selection

The sample used was the result of a survey conducted via an online questionnaire covering a broad range of BI topics. We used previous work on BI success as a framework for the development of our SME-focussed items. The questionnaire was validated in two ways (Fowler 2001). First, a revision of the questionnaire was completed by experts from academia. Second, the outcome of the revised questionnaire was evaluated by conducting a pretest. Thus we were able to make sure the items were sensible and nomenclature was properly understood. Additional participant feedback was incorporated in the final version. The survey was conducted from 8 December 2008 to 22 December 2008. For each of the three areas of concern (cf. 3.1) the participants were asked to make judgements concerning 20 items. Properties were scored on a five-point rating scale. Possible responses ranged from 1 ("does not apply") to 5 ("applies completely").

We selected 4,960 companies randomly from several Saxon Chambers of Trade and Crafts' databases with regional enterprise contact information. The companies having their headquarters in Germany were contacted individually via email, explaining the research goal and inviting them to take part in the survey, providing a hyperlink to the questionnaire. The invitation contained a request to forward the mail to the managing director or a person with comparable insight into and responsibility for both business and IT strategy.

Of the above enterprises, 995 took part in the survey, which corresponds to a return rate of approximately 20.1 per cent. Due to incomplete (478) or inconsistent (65) data, 543 responses were excluded from further examination. Subsequently a total of 452 questionnaires were considered appropriate, constituting a response rate after cleansing of 9.1 per cent. N = 214 (47.3 per cent) of the participating companies had deployed BI solutions and were further analysed using factor and cluster analysis. The sample size can be regarded as a good fact base for an exploratory analysis (Henson & Roberts 2006, p. 401f.).

Examined enterprises fall into the category of SMEs, distributed as shown in Figure 1. Emphasis lies on enterprises having between 2 and 24 employees (63 per cent), an annual turnover of less than €2 million (66 per cent), and a balance sheet total of less than €2 million (72 per cent). Respondents to the survey were largely managing directors (77 per cent) or senior executive personnel (18 per cent). The sample is evenly distributed across Saxon industry sectors comprising mainly enterprises in services

(25 per cent), manufacturing (23 per cent), and software/IT (14 per cent) industries. The remaining 38 per cent subsume enterprises from 12 other sectors.

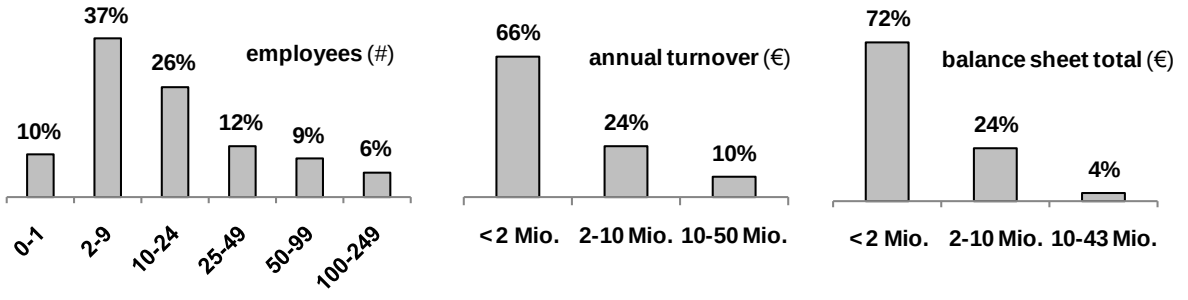

Figure 1: Demographics of participating companies - number of employees, annual turnover, and balance sheet totals

4 DATA ANALYSIS

4.1 Factor analysis

As mentioned in Section 3.1, we conducted three subsequent factor analyses: one to deduce the perceived beneficial factors of BI application in SMEs; one to obtain problem factors or challenges encountered by SMEs applying BI; and one to extract additional qualitative enterprise properties concerning business behaviour of these SMEs in order to characterise them specifically.

Perceived benefits of BI adoption in SMEs. The intention of the first factor analysis was to derive factors describing the perceived benefits of BI adoption in SMEs. The KMO measure amounted to 0.909, indicating a marvellous fit of the correlation matrix (Kaiser & Rice 1974). As each MSA value of the 18 items was higher than 0.60 none of the variables had to be excluded (Cureton & D'Agostino 1983). As shown in Table 3, three factors had EV > 1. As recognisable in Figure 2, the scree plot showed asymptotical decline from factor 4 on. Thus three factors were extracted. An item is assigned to a certain factor if it loads less than –0.5 respectively more than 0.5 on the respective factor. The rotated component matrix is displayed in Table 1.

The three general BI benefit factors can be described as follows:

BI benefit factor 1: Improvements in data support

The first factor encompasses all attributes that are connected to reporting and its improvement. For example, it includes the reduction in the overall effort concerning data analysis and reporting as well as improvements in the reports' quality and a more flexible reaction to new information needs.

BI benefit factor 2: Improvements in decision support

Factor 2 covers the attributes that can be associated with decision support and its improvement. It contains facts about improved business decisions through more precise as well as more current data analyses. In addition, the identification of chances and risks can be improved by using BI systems. Also the improvement in the business results loads onto factor 2.

BI benefit factor 3: Savings

The third factor includes statements which pertain to successes in rationalisation. These include attributes regarding savings in personnel and in costs. By saving personnel and costs, competitive advantages can be achieved indirectly, either by diminishing the cost part in the income and loss statement or by having the possibility of using the saved resources in other areas.

Challenges for BI adoption in SMEs. The second factor analysis was conducted aiming at identifying challenges for the adoption of BI in SMEs. KMO was computed and amounted to 0.927,

indicating marvellous appropriateness of the correlation matrix (Kaiser & Rice 1974). Each MSA value of the 20 items was above 0.80, denoting that all items were appropriate for the measurement (Cureton & D'Agostino 1983). As traceable in Table 4, three factors had EV > 1. In contrast, the scree plot showed a sharp elbow after factor 1. It is displayed in Figure 3. To validate the result of the EV > 1 rule we also created two, three and four factor solutions. As the three factor solution matched the EV > 1 rule and appeared to be the most appropriate solution in terms of interpretability, three factors were extracted. The rotated component matrix is shown in Table 2. The three general BI challenge factors can be described as follows:

BI challenge factor 1: Challenges depending on usage

Factor 1 includes statements that are directly or indirectly connected with usage of the BI solution; for example, the handling is too complicated, the processes of the BI report building are too complicated, or personnel using the BI solution are not qualified enough. So if there were training, the users could have a better understanding of how they could work with the system in the correct way.

BI challenge factor 2: Challenges depending on solution and data quality

The second factor covers problems that are connected to the solution and data quality of the BI solution. Software errors, an inadequate security function, contradictory data, low speed of the product, and insufficient support belong to this group.

BI challenge factor 3: Challenges with interfaces

The factor encompasses variables concerning interfaces such as limited data export functionalities and a problematic conflation of data. The two items can cause the need to import/export data manually, which usually takes longer than automatic input/export. In the next step, this can lead to data being not current enough.

Properties of BI adopters among SMEs. To identify certain factors constituting SMEs who have adopted BI solutions, a third factor analysis has been conducted. The KMO criterion delivered a value of 0.809, depicting meritorious qualification for running a factor analysis. MSA values of the single variables also fit the criteria. For commitment of a factor number to be extracted, the eigenvalue greater than one criterion and the scree plot were used again. As recognisable in Table 7 and Figure 4, the first criterion delivers a factor number of six, and the second one a factor number of three. Due to this, factor solutions with three, four, five, and six factors were created and checked with regards to their interpretability. The six factor solution, being the most consistent, was chosen. The rotated component matrix is shown in Table 5.

The following factor names that are given to the factors which satisfy the statements loading up onto them will be used in the cluster analysis of Section 4.2:

Regulation intensity (factor 1): Factor 1 describes how regulated the enterprise is. This covers structural fixing, the level of observance of budgets and the role of employee training. The last area implies that training of employees can help in the regulation and improvement of the skills that are needed for every single job.

Innovativeness and flexibility (factor 2): On the one hand, factor 2 describes how innovative and how open to new ideas the company is. On the other, it includes items that stand for flexibility, which include a flexible reaction to changes in the market environment and individual customising of products. Flexibility might be guaranteed by being settled in a special market niche. Competence within a special area gives the ability to be faster and more flexible in the sense of creating innovative products in comparison to competitors.

Operational collaboration (factor 3): Factor 3 contains items that cover the area of collaboration and contemporary acting. This includes the frequency of making operative decisions, degree of time pressure, the kind of contact with suppliers, customers, and the public and the share of periodic customers. This share might be connected with the degree of time pressure because enterprises may

possibly strive more to avoid losing their periodic customers than winning new clients.

Relative company growth (factor 4): Factor 4 describes the company's growth in comparison to the average company growth using turnover and number of employees as measurements.

Service orientation (factor 5): Factor 5 contains items that belong to topics of service orientation. Service orientation can be measured by using the degree of interest in service delivery as well as the production of goods.

B2B orientation (factor 6): Factor 6 describes the ratio of private clients to business customers. As the item "business clients" has a positive correlation with factor 6, "B2B orientation" was used as the title.

Item description	F1	F2	F3
Overall effort of data analysis is being reduced.	.769	.180	.114
Reports are available faster.	.758	.335	-.061
Overall effort of reporting is being reduced.	.721	.162	.082
Reports are of better quality.	.710	.352	-.046
Staff members have easier access to information.	.672	.109	.208
A more flexible reaction to new information needs can be reached.	.666	.294	.142
Time savings can be achieved.	.628	.287	.246
Data visualisation for end users is being improved.	.603	.268	.137
Business decisions are being eased by more precise data analyses.	.383	.787	-.015
Business decisions are being eased by more current data analyses.	.310	.769	-.040
Identification of chances and risks is being supported to a higher level.	.216	.766	.135
Information security and control is being warranted to a higher level.	.409	.533	-.041
Company results are being improved.	.157	.519	.410
Savings on personnel in non-IT departments can be achieved.	-.057	-.050	.764
Savings on personnel in the IT department can be achieved.	-.095	-.062	.760
Long-term savings concerning IT costs can be achieved.	.374	-.103	.651
Competitive advantages can be achieved.	.140	.420	.573
Cost savings in IT can be achieved.	.292	.331	.552

Table 1: Perceived benefits of BI adoption - rotated component matrix

Item description	F1	F2	F3
Handling of the deployed solution is too complicated.	.761	.188	.162
Processes of BI report building are too complicated.	.702	.220	.180
Created reports are too complex.	.637	.389	.100
Data is poorly structured.	.622	.322	.287
Key performance indicators are not defined unitarily in the enterprise.	.609	.236	.304
Layout capabilities do not cover business needs.	.601	.299	.137
BI staff are not qualified enough.	.574	.421	.015
Efficiency is difficult to determine.	.555	.149	.344
BI project was affected by disagreements in requirements.	.542	.417	.118
Software errors (e.g. bugs, crashes, etc.) occurred frequently.	.320	.680	-.032
Security function of the BI solution is inadequate.	.174	.663	.160
Query performance is not adequate.	.261	.649	.243
Data is often contradictory.	.456	.555	.114
New requirements cannot be implemented quickly enough.	.123	.553	.405
Support of the BI solution (quality of support) is inadequate.	.430	.528	.056
Range of BI functionalities does not match business needs.	.432	.510	.357
Data is not current enough.	.183	.503	.510
Data exporting functionality is too limited.	.099	.169	.803
Conflation of data from different sources is problematic.	.482	-.030	.647
Data is not current enough	.183	.503	.510

Table 2: Challenges for BI adoption - rotated component matrix

Factor	Eigenvalue	Percentage of variance	Cumulated Percentage
1	7.655	38.274	38.274
2	2.388	11.942	50.216
3	1.313	6.565	56.781
4	0.990	4.948	61.729
5	0.848	4.239	65.968
6	0.749	3.747	69.715
7	0.708	3.540	73.255
8	0.635	3.175	76.430
9	0.612	3.060	79.490
10	0.565	2.824	82.313
11	0.496	2.479	84.792
12	0.439	2.193	86.985
13	0.427	2.133	89.118
14	0.380	1.900	91.018
15	0.368	1.842	92.860
16	0.331	1.655	94.514
17	0.307	1.533	96.047
18	0.282	1.411	97.458
19	0.270	1.349	98.807
20	0.239	1.193	100

Table 3: BI benefits - measures

Factor	Eigenvalue	Percentage of variance	Cumulated Percentage
1	8.512	42.562	42.562
2	1.193	5.967	48.529
3	1.065	5.325	53.854
4	0.988	4.938	58.793
5	0.912	4.558	63.350
6	0.852	4.262	67.612
7	0.718	3.589	71.201
8	0.696	3.482	74.683
9	0.617	3.083	77.767
10	0.564	2.821	80.588
11	0.536	2.678	83.266
12	0.478	2.388	85.654
13	0.474	2.372	88.026
14	0.443	2.216	90.242
15	0.406	2.032	92.275
16	0.369	1.847	94.121
17	0.354	1.771	95.893
18	0.305	1.527	97.419
19	0.262	1.312	98.731
20	0.254	1.269	100

Table 4: BI challenges - measures

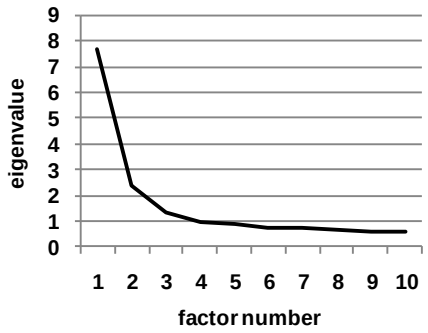

Figure 2: BI benefits - scree plot

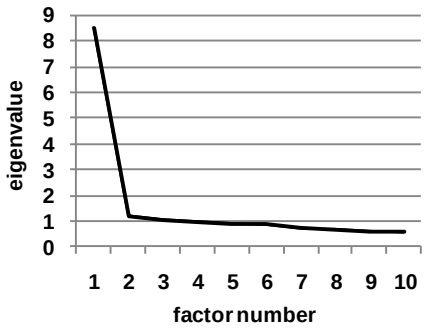

Figure 3: BI challenges - scree plot

4.2 Cluster Analysis

A cluster analysis was employed to find internal homogeneous and external heterogeneous groups of enterprises concerning their qualitative properties, BI utility factors and BI problem factors. Thereby, the iterative algorithm k-means and the proximity measure ED were applied. To determine the optimal number of clusters to be created, the measurement Fusion Coefficient (FC) was employed (Toms et al. 2001). As the analysis included a large number of enterprises, the FC was also large. For this reason the scree plot did not show an elbow. This is why the distance between adjacent cluster FCs (ΔFC) was drawn on the ordinate of the scree plot as a modification of the FC. The values are displayed in Table 8 and Figure 5. An elbow in cluster number 4 indicates that four clusters are the optimum. For this reason, four clusters were extracted.

Table 6 shows the factor characteristics as well as the factors' average values (in parentheses) for each cluster; ">" indicates enterprise characteristics that are above average and "<" indicates enterprise characteristics which are below average. Thus it is not possible to classify the average factor values as "good" and "bad" but only as "above" and "below" average. Apropos of BI utility and problem factors it is, on the other hand, possible to say that a value is "good" or "bad". Utility factors that are above

average as well as problem factors that are below average are classified with "+" for "good". Utility/problem factors which are below or above average are classified with "–" for "bad".

Item description	F 1	F 2	F 3	F 4	F 5	F 6
Corporate departments are structured clearly.	.733	.006	.112	.028	.022	.027
The enterprise aims at ensuring high compliance of the processes.	.728	.152	.121	.210	-.125	.002
The enterprise aims at rigorous compliance with the cost budgets.	.647	.189	.055	-.265	.032	.125
Advanced training of employees plays an important role.	.545	.205	.048	.277	.309	-.225
Innovation plays an important role in the enterprise.	.263	.627	.081	.226	.139	.145
The enterprise is positioned in a special market niche.	-.089	.610	.020	.159	-.296	.014
The enterprise customises the products individually.	.152	.576	.287	-.046	.166	.090
Involvement with novelties of all sorts is of importance.	.391	.536	.232	.077	.252	.087
The enterprise reacts flexibly to changes in the market.	.331	.523	.244	.159	-.133	.029
Operative (short-term) decisions are to be dealt with frequently.	.005	.189	.828	-.096	-.036	-.084
Time pressure is part of everyday life in the company.	.052	.208	.675	.225	-.028	.129
Contact with suppliers and customers is based on a personal level.	.203	.234	.583	-.079	.202	.071
Share of periodic customers is high.	.278	-.190	.562	.246	.123	.222
Number of employees has been rising within the last five years.	.049	.117	.000	.841	-.104	.095
Turnover has been rising within the last five years.	.052	.181	.131	.764	-.046	.230
Production of goods is of large interest to the company.	.092	.142	.084	.154	-.823	.057
Service delivery is of large interest to the company.	.146	.247	.320	.009	.718	-.032
The customer segment "private clients" is of primary interest.	.024	.016	.023	-.213	.158	-.823
The customer segment "business clients" is of primary interest.	.179	.218	.242	.238	-.003	.674

Table 5: Results of the factor analysis for enterprise properties - rotated component matrix

Factor	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Regulation intensity	< (-.195)	< (-.363)	> (.204)	>> (.502)
Innovativeness and flexibility	> (.051)	< (-.111)	< (-.091)	> (.146)
Operational collaboration	< (-.049)	>> (.523)	< (-.379)	> (.303)
Relative company growth	>> (.567)	< (-.015)	< (-.006)	> (.327)
Service orientation	< (-.046)	> (.231)	>> (.571)	<< (-.533)
B2B orientation	<< (-.898)	< (.088)	>> (.526)	< (-.042)
Improvements in data support	- (-.477)	-- (-.726)	+ (.133)	+ (.411)
Improvements in decision support	- (-.433)	++ (.642)	-- (-.511)	+ (.456)
Savings	++ (.757)	-- (-.778)	-- (-.558)	+ (.418)
Challenges depending on usage	-- (.535)	+ (-.041)	+ (-.372)	- (.078)
Challenges depending on solution and data quality	--- (1.026)	++ (-.547)	+ (-.183)	+ (-.166)
Challenges with interfaces	- (.202)	--- (1.321)	+ (-.088)	++ (-.536)

Table 6: Result of the cluster analysis (factor characteristics and arithmetic means of factor scores for each cluster)

Factor	Eigenvalue	Percentage of variance	Cumulated Percentage
1	4.768	23.838	23.838
2	2.245	11.226	35.064
3	1.603	8.017	43.081
4	1.217	6.085	49.166
5	1.179	5.893	55.059
6	1.072	5.358	60.417
7	0.914	4.568	64.985
8	0.796	3.982	68.967
9	0.745	3.726	72.693
10	0.720	3.602	76.295
11	0.634	3.172	79.467
12	0.584	2.920	82.387
13	0.556	2.778	85.166
14	0.545	2.725	87.890
15	0.489	2.443	90.333
16	0.464	2.322	92.655
17	0.417	2.084	94.739
18	0.401	2.004	96.743
19	0.353	1.764	98.506
20	0.299	1.494	100

Table 7: SME properties - measures

Cluster	FC	ΔFC
1	2443.23	167.69
2	2275.54	134.19
3	2141.35	106.12
4	2035.23	82.96
5	1952.26	75.93
6	1876.33	71.82
7	1804.51	71.43
8	1733.08	55.36
9	1677.73	49.70
10	1628.03	48.74
11	1579.29	48.58
12	1530.71	47.85
13	1482.86	41.26
14	1441.60	41.10
15	1400.50	34.06
16	1366.44	29.78
17	1336.65	29.66
18	1306.99	29.60
19	1277.39	27.50
20	1249.90	26.88

Table 8: SME cluster - measures

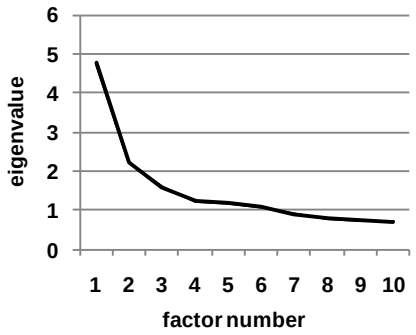

Figure 4: SME properties - scree plot

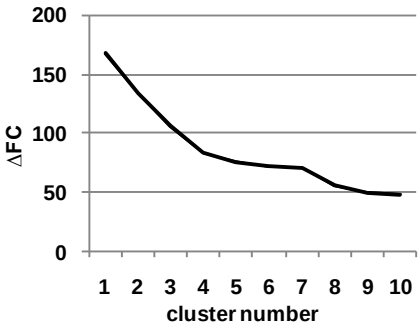

Figure 5: SME cluster - scree plot

Cluster 1: Rapidly growing B2C companies

Cluster 1 covers 19 per cent of the enterprises and is marked by a high company growth and a low orientation toward business customers. The corporations of this type can achieve high savings by launching BI solutions but are faced with problems in the area of solution and data quality.

Cluster 2: Lightly regulated companies with focus on collaboration

Cluster 2 involves 14 per cent of the companies. The degree of operational collaboration is high on average. Companies of type 2 have a focal point in reaching large improvements in decision support. Improvements in data support and savings are below average. Except for challenges concerning the integration of multiple interfaces, challenges for the adoption of BI range below average.

Cluster 3: Service-oriented B2B-companies

Cluster 3 comprises 33 per cent of the enterprises. They have a high service orientation and a high degree of B2B orientation. BI utility factors as well as BI problem factors are low.

Cluster 4: High-regulated product-oriented companies

Cluster 4 covers the largest share of enterprises: 35 per cent. Characteristics are a high degree of regulation intensity as well as a low service orientation. Each utility factor is above average. Expect problems that are conditional on usage, problems are low.

5 CONCLUSIONS AND FUTURE RESEARCH

The goal of the presented study was to identify general BI benefit factors, challenges, and organisational factors with a special focus on SMEs. Improvements in data support, decision support, and savings (e.g. costs, personnel) were identified as general BI benefit factors. BI challenges are related to usage, solution and data quality and interfaces. Using cluster analysis, we extracted four types of BI adopters among SMEs. One group (cluster 4) shows benefit factors that are above average throughout and faces only minor challenges overall. Another group (cluster 3) indicates low benefits. The two remaining clusters, 1 and 2, have a focal point in BI benefit but also face more or less pronounced BI challenges. For this reason, the cost-benefit ratio should be investigated individually.

Although the findings are both original and significant, there are some limitations of note in the research. The focus on the state of Saxony drives the question of whether the results could be generalised. While Saxony is located in the centre of the EU and therefore has similar conditions to the rest of the continent, the special history of Eastern Germany with its mostly very young companies might lead to special findings. Therefore, the study could be repeated on a regular basis with a broader participant base (Germany, the EU, the world).

The results of the study can create value for three groups: enterprises that plan to launch a BI solution, BI consultants, and BI suppliers. Prior to the launch of BI, enterprises are able to draw conclusions about their BI benefit and challenge characteristics by calculating the cluster that fits best with their company properties. BI consultants can see the challenges which their clients may possibly have to tackle prior to and during BI implementation according to their individual enterprise properties. Therefore, they are able to shape the process of the BI launch individually. Finally, by applying the results of the cluster analysis, BI suppliers now have the possibility of customising product marketing by identifying the enterprise characteristics, checking the fits with each single cluster, and deducing the individual BI benefit characteristics of their target clients.

References

Anderberg, M.R. (1973). Cluster Analysis for Applications. Monographs and Textbooks on Probability and Mathematical Statistics, Academic Press, Inc., New York.

Bhagwat , R. and Sharma, M. K. (2006). Management of information system in Indian SMEs: An exploratory study. International Journal of Enterprise Network Management, 1(1), 99–125.

Bergeron, B. (2000). Regional business intelligence: the view from Canada. Journal of Information Science, 26(3), 153–160.

Cureton, B. and D'Agostino, R. (1983). Factor Analysis: An Applied Approach. Lawrence Erlbaum Associates, Hillsdale, NJ.

Dholakia, R.R. and Kshetri, N. (2004). Factors impacting the adoption of the Internet among SMEs. Small Business Economics, 23(4), 311–322.

European Commission (2008). Enterprises by size class – overview of SMEs in the EU. Eurostat Statistics in Focus, retrieved from: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-08-031/EN/KS-SF-08-031-EN.PDF.

European Union (2003). Commission recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises. Official Journal of the European Union, L124, 36–41.

Fowler, J.F. (2001). Survey Research Methods (Applied Social Research). 3rd ed., Sage Publications, Thousand Oaks, CA.

Gorsuch, R.L. (1983). Factor Analysis. 2nd ed., Lawrence Edition, Hillsdale, NJ.

Henson, R.K. and Roberts, J.K. (2006). Use of exploratory factor analysis in published research: common errors and some comment on improved practice. Educational and Psychological Measurement, 66(3), 393–416.
Huin, S.F. (2004). Managing Deployment of ERP systems in SMEs using multi-agents. International Journal of Project Management 22(6), 511–517.
Hwang, H.-G., Ku, C.-Y., Yen, D.V., and Cheng, C.-C. (2004). Critical factors influencing the adoption of data warehouse technology: A study of the banking industry in Taiwan. Decision Support Systems, 37(1), 1–21.
Inmon, W.H. (2005). Building the Data Warehouse. 4th ed., Wiley & Sons, Indianapolis.
Joshi, K. and Curtis, M. (1999). Issues in building a successful data warehouse. Information Strategy: The Executive's Journal, 15(2), 28–35.
Kaiser, H.F. and Rice, J. (1974). Little Jiffy, Mark IV. Educational and Psychological Measurement, 34(1), 111–117.
Kimball, R., Ross, M., Thornthwaite, W., Mundy, J., and Becker, B. (2008). The Data Warehouse Lifecycle Toolkit. 2nd ed., Wiley & Sons, Indianapolis.
Kotelnikov, V. (2007). Small and Medium Enterprises and ICT. Asia-Pacific Development Information Programme, e-Primers for the Information Economy, Society and Polity.
Lefebvre, L., Harvey, J., and Lefebvre, E. (1991). Technological experience and the technology adoption decisions in small manufacturing firms. R&D Management 21(3), 241–249.
Levy, M. and Powell, P. (1998). SME flexibility and the role of information systems. Small Business Economics, 11(2), 183–196.
Levy, M., Powell, P. and Yetton, P. (2002). The dynamics of SME information systems. Small Business Economics, 19(4), 341–354.
Lybaert, N. (1998). The information use in a SME: Its importance and some elements of influence. Small Business Economics, 10(2), 171–191.
Mehrtens, J., Cragg, P.B., and Mills, A.M. (2001). A model of Internet adoption by SMEs. Information & Management, 39(3), 165–176.
Rist, R. (1997). Challenges faced by the data warehousing pioneers. Journal of Data Warehousing, 2(1).
Ritchie, B. and Brindley, C. (2005). ICT adoption by SMEs: Implications for relationships and management. New Technology, Work and Employment, 20(3), 205–217.
Rudra, A. and Yeo, E. (1999). Key issues in achieving data quality and consistency in data warehousing among large organizations in Australia. Proceedings of the 32nd Hawaii International Conference on System Sciences, January 5–8 , pp. 7012–7019.
Themistocleous, M. and Chen, H. (2004). Investigating the integration of SMEs' information systems: An exploratory case study. International Journal of Information Technology and Management, 3(2–4), 208–234.
Thompson, B. (2004). Exploratory and Confirmatory Factor Analysis: Understanding Concepts and Applications. American Psychological Association, Washington, DC.
Thompson, B., and Daniel, L.G. (1996). Factor analytic evidence for the construct validity of scores: A historical overview and some guidelines. Educational and Psychological Measurement, 56(2), 197–208.
Toms, M.L., Cummings-Hill, M.A., Curry, D.G., and Cone, S.M. (2001). Using cluster analysis for deriving menu structures for automotive mobile multimedia applications. SAE Technical Paper Series 2001-01-0359, Warrendale, PA.
Wixom, B. and Watson, H. J. (2001). An empirical investigation of the factors affecting data warehousing success. MIS Quarterly, 25(1), 17–41.
World Bank (2006). Micro, Small and Medium Enterprises. International Financial Corporation Report.