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ABSTRACT

Realising information technology (IT) decisions and implementations are consistently seen as major challenges of business management faced with increasingly complex IT environments. This article seeks to increase the awareness of the multiple attributive decision making methodology (MADM) in the context of enterprise resource planning (ERP) projects and provides empirical insights based on 209 datasets originating from a primary, national and industry independent survey. The given MADM topics comprise strategic alignment, attributes with associated importance weightings, considered and chosen systems, methodical utilisation, follow-up controlling, and finally MADM relevance in terms of a possible connection between MADM and ERP success. The results in particular show that while the ERP decision problem seems to be structured based on the MADM principle, the minority of decision makers rely on a formal MADM method. The empirically tested measurement model indicates that success according to expectations was achieved at a greater level of magnitude in firms supported by a formal MADM method, especially in terms of financial firm level impact and service quality.

Keywords: multiple attributive decision making, enterprise resource planning, information systems success, empirical survey.

INTRODUCTION

Enterprise resource planning (ERP) systems are comprehensive packaged information systems (IS) comprising several configurable modules that integrate core business activities (finance, human resources, manufacturing and logistics) into one single environment based on an integrated, shared database. They are embedded with „best practices", respectively best ways to do business based on common business practices or academic theory (Kremers & Dissel, 2000). Besides integration, the aim is to enhance decision support, reduce asset bases and costs, receive more accurate and timely information, higher flexibility or increased customer satisfaction. ERP systems are often seen as enabler for extensions such as supply-chain management and customer relationship management (Boubekri, 2001; Willis & Willis-Brown, 2002).

Several authors have proposed ERP research agendas (Esteves & Pastor, 1999). A recent agenda (Al-Mashari, 2002) gives three dimensions: ERP adoption, technical aspects of ERP, and ERP in information systems curricula. This research targets the first dimension proposed, in particular method application and relevance. Literature reports extensively on diverse problems associated with information system (IS) especially ERP system evaluation (Irani, 2002). Those problems can be derived from the difficulty of understanding the complex factors involved in IS, decision making, such as scope and impact of the decision, the concept of value and its multi-dimensional facets, natures of IS, benefits and costs, associated risks, strategy alignment, human and organisational mechanics or political issues. The evaluation of IS investment proposals has been a recognised research area for a long time resulting in a large number of evaluation techniques available today, e.g. (Irani, Sharif, Love, & Kahraman, 2002; Sassone, 1987). Research exists helping to assess the wide spectrum of methodical aids through classifications (Farbey, Land, & Targett, 1992, 1993) or selection aids (Olsen, 1996).

IS decisions have the propensity to operate under multiple, often conflicting criteria. The decision space is discrete, meaning that a limited number of alternatives and attributes need to be assessed. This is the typical setting in which

the discipline of Multiple Attribute Decision Making (MADM) is grounded. In terms of complex IS in particular ERP decisions, their intuitive, simple and cost effective application should help to comprehend the decision making task at hand. They are relatively transparent, allowing others to see the logic of the results and enabling the inclusion of the full range of intangible consequences. Furthermore, by following a MADM based methodology the decision maker should be able to strengthen his decision outcome in terms of justifiability, accountability, and reasonability, which are regularly seen as pre-requisites of complex and risky IS decisions. The amount and depth of methods available in literature seems to be in contrast to the method application in IS appraisal practice. Since IS and their environmental embedding is becoming increasingly complex due to continuously evolving demands on IT related capabilities, the defiance of common grounds of IS decision making remains problematic. This research seeks to increase the awareness of the MADM methodology in ERP projects and to link its application to project success. With respect to ERP projects at various stages of the system's lifecycle, the targets of this research can be summarised as follows:

1. to provide a characterisation of MADM in the given context
2. to give an up to date empirical manifestation of MADM elements, such as method diffusion, attribute selection, etc.
3. to assess if MADM approaches are relevant in terms of promoting ERP success

In the empirical data analysis, this research controls for organisational size and branch of business. The remainder of this article is structured as follows. First, we provide more information on the empirical survey and on the acquired data sample. To avoid redundant information and improve readability, theoretical MADM based considerations were given together with empirical insights in the subsequent section. Thereafter, an ERP success measurement model is given with an empirical validation, followed by an assessment of the effect of MADM on ERP success. Finally, the last section concludes results and sketches on-going research.

METHODOLOGY

This article draws on results of an industry independent empirical survey undertaken in the years 2003 to 2004. The target group was defined as containing Austrian small to medium sized as well as large enterprises (SMEs and LEs). To avoid under-representing the large enterprises in the sample, a stratified and disproportional sample with subgroups according to company size was defined. One thousand Austrian SMEs and LEs were randomly selected from firms listed in a comprehensive, pan-European database containing financial information on 7 million public and private companies in 38 European countries (Bureau-van-Dijk, 2003).

The questionnaire developed for this study was based on a previously undertaken ERP related study (Bernroider & Koch, 2000), on a review of the literature and on recommendations of a panel of ERP experts from two universities in Austria and the UK. Following an empirical design method, the panel was asked to criticise the questionnaire for content validity (Dillman, 1978). According to their suggestions, the questionnaire was revised and used in Pre-Tests applied in the UK and Austria. Responses were examined to optimise the formulation of each question and ensure consistency in the way they were answered. The questionnaire contained a general section assessing the background information on the company especially IT/IS related and performance related questions. The assessed topics were structured in four sections following the ERP system lifecycle: adoption decision, acquisition, implementation, use and maintenance. Companies were contacted through a multi-staged procedure. A cover letter, the hardcopy questionnaire, and a self-addressed stamped return envelope were sent to business management of the 1000 companies. The package explained the purpose of the study, promoted participation in the survey, assured confidentiality, and offered an ERP-related collection of material on CD as well as a summary of the results together with an opportunity to engage in further research activities with our research department. The questionnaire was also provided in an electronic version to further strengthen the participation. Two weeks after the initial mailing, follow up calls were made to all companies that could not be identified as respondents, asking them for their interest in participating and if cooperative for an email address. Short after these calls, reminder/thank you emails were sent out. The next round of contact consisted in reminding 400 randomly selected companies via telephone calls that they had not yet responded, and again giving them the address and logins for the online questionnaire. Finally, 209 valid returns were registered, resulting in an above average response rate of 22%. Some companies could not be contacted, because they had ceased to exist, the address was wrong or could not be found, etc. These neutral dropouts (49 companies) were considered in the calculation of the response rate and therefore did not decrease the return quota. To test for non-response bias, known distributions of variables available through the used corporate database were assessed. The analysis revealed no significant different characteristics between non-respondents and respondents. The data was analysed using a statistical package offering the ability to work on complex samples. It

should be noted that in practice, most scientific papers utilise the default significance tests generated by software packages based on the assumption of simple random sampling even if multi-stage, cluster, or other complex sampling designs were employed (Choudhry & Valliant, 2002; Kish, 1992; Korn & Graubard, 1995). To avoid biased estimates, this work uses a SPSS module called Complex Samples where adjusted tests including chi-square (χ^2) are provided. However, since the range of procedures is limited, analysis was also conducted with the use of sampling weights (Purdon & Pickering, 2001).

Sample Demographics

Table 1 denotes the firm size and branch distribution of the data sample. Following a commission recommendation of the European Communities concerning the definition of micro, small and medium-sized enterprises (EC, 2003), this research classified as SME an enterprises which employs fewer than 250 persons and which has an annual turnover not exceeding EUR 50 million. The branch classification was based on the core codes given in brackets of the North American Industry Classification System (NAICS) which has replaced the U.S. Standard Industrial Classification (SIC) system in 1997 (NAICS-Association, 1997). The number of companies for each category are given in relative and absolute terms. Due to the applied disproportional sampling method, the latter representation can not be used to confirm the relative view. As can be seen, SMEs constitute for 92.8% of all companies in Austria.

Size	Percent	N (unweighted)
Small-to-medium sized Enterprises (SMEs)	92.8	129
Large Enterprises (LEs)	7.2	79
Total	100	208
Branch	**Percent**	**N (unweighted)**
Trade (42,44-45)	22.6	58
Manufacturing (31-33)	21.0	60
Construction (23)	20.5	20
Services (54)	15.7	30
Transportation and Warehousing (48-49)	7.6	8
Information (51)	4.5	8
Health Care and Social Assistance (62)	1.9	4
Management of Comp. and Enterprises (55)	1.4	8
Other	4.8	12
Total	100	208

Table 1: Firm size and branch distribution with NAICS core codes.

ERP diffusion along the system's lifecycle stages is denoted in Table 2. Not surprisingly, ERP has reached the large majority of LEs (76.1%), while less than every fourth SMEs has been confronted with ERP (22.5%). The numbers decrease to 57.1% for LEs and 15.1% for SMEs if only already implemented systems are considered. As expected, the observed differences between SMEs and LEs are highly significant (χ^2, $p<.01$).

Lifecycle stage of ERP system	All companies		SMEs		LEs	
	%	cum. %	%	cum. %	%	cum. %
Consideration	6.6	6.6	6.6	6.6	6.4	6.4
Evaluation	.5	7.1	.3	6.9	2.0	8.4
Implementation	1.2	8.3	.4	7.3	10.5	18.9
Stabilisation	1.8	10.1	1.8	9.1	2.0	20.9
Usage and maintenance	13.4	23.5	11.4	20.5	39.0	59.9
Extension	2.9	26.4	1.9	22.4	16.1	76
No ERP	73.6	100	77.5	100	23.9	100

Table 2: ERP diffusion along the system's lifecycle.

A MADM BASED VIEW ON ERP PROJECTS

In decision making, multiple attribute based approaches help the decision maker in undertaking preference decisions over a finite set of available alternatives or courses of action characterised by multiple, potentially conflicting attributes (Yoon & Hwang, 1995). Attributes are characteristics, qualities, factors, performance indices and others. They are measurable aspects of alternative choices and the means of the decision objectives' evaluation. The attributes should be clearly and unambiguously defined, and understandable by all individuals engaged in the decisional problem at hand. MADM approaches begin with the task of finding the relevant attributes and alternatives. In the ERP context, this stage should be value-focused, rather than alternative-focused, i.e. begin with identifying and converting goals and values of an organisation which are also the basis for the corporate and business strategies into high-level objectives which can be broken down into sub-objectives for the evaluation of alternatives (Keeney, 1992). Among other advantages, this method provides the basis for achieving the needed alignment between business and IT strategy. In a alternative-focused approach a set of plausible alternatives is defined, then the criteria relevant to assess the alternatives. The study showed that in terms of ERP decisions, in 65% of the cases the decision makers have assessed the strategic goals of their company as a basis for deriving decision making attributes in a value-focused approach. No different situation was perceived between subgroups characterised by organisational size or branch of business.

Table 3 denotes decision making attributes inquired in the ERP study with their mean importance ratings and standard deviations as given by the respondents of the survey differentiated between SMEs and LEs. For both enterprise size classes, the reliability and functionality of the system were the most important attributes in the evaluation process, followed by the support offered by the vendor. The role of ERP systems as technology enabler for business process re-engineering (BPR) is reflected by the high importance ratings of the following criteria. Only then, a number of business related criteria follow, which are concerned with information integration and reduced cycle times. Then again, system related attributes follow. It can be seen, that business related criteria are not seen as the most important aspects of ERP decisions.

Organisational fit, which is consistently seen a major factor for implementation success, has taken a middle position in the importance listing. The attributes concerned with the enablement of specific technologies are rated as least important. Since these requirements would not apply to every company, their low relative importance was anticipated.

The software suppliers considered for the decision process clearly showed the dominant position of SAP in the marketplace. The global contenders BaaN and Oracle show weak representations in Austria. J.D. Edwards and Peoplesoft are seldom considered, hardly ever chosen. It should be noted, that the latter three companies have only recently merged into one. Notable is the strong presence of other, smaller suppliers hinting at the acceptance of more specialised and less complex systems. The situation regarding the solutions chosen is similar, although the advantage of SAP is more pronounced. BaaN and Oracle are the other contenders of larger size while – again – smaller providers have captured a large market share. The given list of other vendors is comprehensive but no single provider gained a notable market share. The notion that the complex solutions provided by the industry leaders do not satisfy the needs of smaller companies is supported.

Both the leading position of SAP and the relatively large cumulative market share for smaller suppliers are in accordance with the findings of a previous study (Bernroider & Koch, 2001), and an European survey of midsize companies (Everdingen *et al.*, 2000). The analysis confirmed the significant influence of organisational size on the selected software package as given in Table 4. In the mean 2.7 different alternatives (min=2, max=5) were considered among the enterprises that passed through a decision making process. The number increased to 3.1 for LEs only, respectively decreased to 2.57 for SMEs only. This information already pertains to the short list of systems that went through an evaluation process, in general after request for proposals were announced.

In MADM, the alternatives under question in terms of the defined attributes have to be attached with numerical measures reflecting their utility in the dimension under question. Consequently, the decision problem can be expressed by a matrix, where columns contain the attributes considered, the rows denote the competing alternatives and the cross field shows the numerical values for each pair of attribute/alternative. The problem of arriving at quantifications, i.e. one numerical value for each pair, is a major decisional challenge. The definition of scores is often imprecise and the scores assigned are hard to justify. They are often based on preferences and reflect the decision makers own judgement or intuition. Evaluation methods exist that help to find justifiable scores for each pair of alternative and attribute. This study has assessed methods based on salary savings and job profiles (used by

14.6% of the enterprises), some kind of work study assessments (14.1%), and any other method applied for evaluation (6.1%). The numbers indicate that the application of methodologies to support the scoring process is very limited.

Next, the multiple attribute based decision problem needs to be solved by one of the many methods available for this task. Solving the problem can imply the aggregation of utilities into an overall evaluation for each alternative leading to a final ranking. The availability of a wide selection of methods to solve MADM problems generates the paradox that the selection of a MADM method for a given problem has led to a MADM problem itself (Triantaphyllou, 2000). Well known MADM methods comprise the total sum (TS), the simple additive weighting method (SAW) also known as weighted sum model (WSM), the weighted product model (WPM), the outranking approaches, ELECTRE (Benayoun, Roy, & Sussman, 1966) and PROMETHEE (Brans & Vincke, 1985), and the TOPSIS method (Hwang & Yoon, 1981) . In the most used SAW method the overall suitability of each alternative is calculated by averaging the score of each alternative with respect to every attribute with a corresponding importance weighting. Hence, a weight needs to be defined for each attribute, which, again,

	All comp.		SMEs		LEs	
ERP decision making attributes[1]	ME	SD	ME	SD	ME	SD
Systems reliability	4.63	0.79	4.66	0.78	4.55	0.87
Functionality of the system	4.52	0.85	4.54	0.89	4.44	0.82
Vendor support	4.31	0.83	4.41	0.80	4.05	0.91
Business process improvement	4.31	1.05	4.41	1.05	4.03	1.05
Enabler for desired business processes	4.27	1.03	4.42	0.90	3.84	1.30
Integrated and better quality of information	4.23	1.20	4.25	1.26	4.16	1.09
Reduced cycle times	4.22	1.04	4.46	0.71	3.55	1.51
System usability	4.17	0.83	4.29	0.76	3.83	0.98
System flexibility	4.14	0.88	4.31	0.78	3.73	1.02
System interoperability	3.96	1.21	4.34	1.02	3.04	1.19
Improved service levels	3.95	0.99	4.14	0.77	3.43	1.38
Enhanced decision making	3.90	0.98	4.06	0.82	3.49	1.31
Short implementation time	3.89	1.02	4.07	0.82	3.40	1.37
Increased organisational flexibility	3.88	0.99	3.99	0.90	3.55	1.20
Software costs (licenses, maintenance, etc.)	3.86	1.16	3.94	1.14	3.65	1.27
Organisational fit	3.80	1.04	3.93	0.88	3.46	1.38
Increased customer satisfaction	3.74	0.87	3.82	0.77	3.55	1.13
Vendor's financial situation	3.74	1.05	3.81	1.04	3.63	1.13
Y2K readiness	3.51	1.85	3.68	1.87	3.05	1.82
Connectivity	3.46	1.17	3.89	0.87	2.80	1.31
Availability of a industry focused solution	3.44	1.67	3.67	1.65	2.80	1.62
Internationality of Software	3.37	1.38	3.48	1.31	3.06	1.60
EURO currency conversion	3.37	1.68	3.46	1.68	3.11	1.78
Market position of vendor	3.32	0.90	3.36	0.79	3.19	1.22
Vendor reputation	3.22	1.19	3.15	1.17	3.42	1.30
Improved innovation capabilities	3.09	1.26	3.24	1.20	2.61	1.41
Operating system independency	2.98	1.33	3.08	1.27	2.69	1.50
Incorporation of business best practices	2.91	1.15	3.02	1.16	2.63	1.17
E-business enablement	2.78	1.49	2.87	1.52	2.50	1.47
Enabling technology for CRM, SCM, etc.	2.37	1.36	2.18	1.53	2.63	1.12

[1] Rated on a scale between 1 (not important) and 5 (very important), N = max 79, ME=Mean, SD=Standard deviation

Table 3: Inquired decision making attributes with mean importance ratings and standard deviations.

can be a difficult task. In almost every MADM method, weights influence the choice of an alternative Recent

developments in the ERP field work with combinations of DEA and MADM methods to mitigate this problem and further enhance the potentials of MADM (Bernroider & Stix, in print). Table 3 shows the mean weights derived from the sample, which can be seen as common practice importance weightings in ERP decisions. In terms of MADM methods, again only a minority of decision makers in practice apply some kind of MADM method such as the mentioned SAW (41.3% of the cases). TS can be seen as a special case of SAW with equal weights. This compares to 70.9% of the enterprises that captured financial aspects by standard financial investment methods.

	All comp. (percent)		SMEs (percent)		LEs (percent)	
ERP system	Chosen	Considered	Chosen	Considered	Chosen	Considered
SAP	33.5	46.6	24.3	34.1	59.8	78.8
BaaN	3.0	23.0	2.4	16.6	4.7	37.0
Peoplesoft	0	13.1	0	14.3	0	10.1
J.D.Edwards	0	3.7	0	.6	0	11.7
Oracle	9.5	17.3	12.3	16.4	1.6	19.6
Others	53.9	60.6	61.0	68.3	33.9	41.1
Total	100	-	100	-	100	-

Table 4: Alternatives (ERP systems) considered and chosen.

After achieving a ranking outcome, follow up analysis can provide further insights into the usually non-transparent ranking solution, e.g., validation procedures or further structural analysis especially for equally ranked alternatives. The latter example is elaborated on the basis of a linear optimisation model named profile distance method in the MADM context in (Bernroider & Stix, in print). Through sensitivity analysis, the impact of changing certain values (either attribute measures or weights) on the ranking outcome can be questioned.

A great advantage of following MADM is the grounding that it supplies for controlling requirements for the subsequent stages implementation, and use/maintenance. A well known approach used for controlling based on multiple attributes is the balanced scorecard (BSC) that was first proposed in 1992 (Kaplan & Norton, 1992) and soon after applied (Kaplan & Norton, 1993). The BSC is a well established measurement method which links strategic objectives and performance measures across four different perspectives. Its application promises strategy mapping between each of the perspectives. In terms of ERP controlling, only 3.4% of the enterprise have implemented an instrument to control ERP system operation.

MADM METHODS AND ERP SUCCESS

ERP Success Model Development

In order to produce results that can be compared and validated, this work was based on a widely accepted model for assessing IS success—the Delone and McLean IS success model (DeLone & McLean, 1992) which the authors revised 10 years later (DeLone & McLean, 2003). The model contains the following six IS success categories that were proposed to be interrelated rather than independent: (1) "system quality", (2) "information quality", (3) "use", (4) "user satisfaction", (5) "individual impact", and (6) "organisational impact". In the updated version quality was postulated as three-dimensional construct ("information, systems, and service quality"), each of which should be measured and controlled separately. From the list of ERP decision making criteria applied in the study and performance indicators used in ERP-BSCs (Rosemann & Wiese, 1999), ERP success criteria were extracted and thereafter aligned along the above mentioned success dimensions. Figure 1 constitutes the a priori ERP success model. The focus is placed on assessing net benefits (covered by 11 criteria) which is regarded as most important dimension. The causal explanations incorporated in the model induce that the consequences of IS adoption should finally be recognised through net benefits. Net benefits eventually capture the positive and negative impacts of the system. All given criteria were assessed through a 5-point interval scale where a one accounted for a very negative and a 5 for a very positive valuation according to expectations.

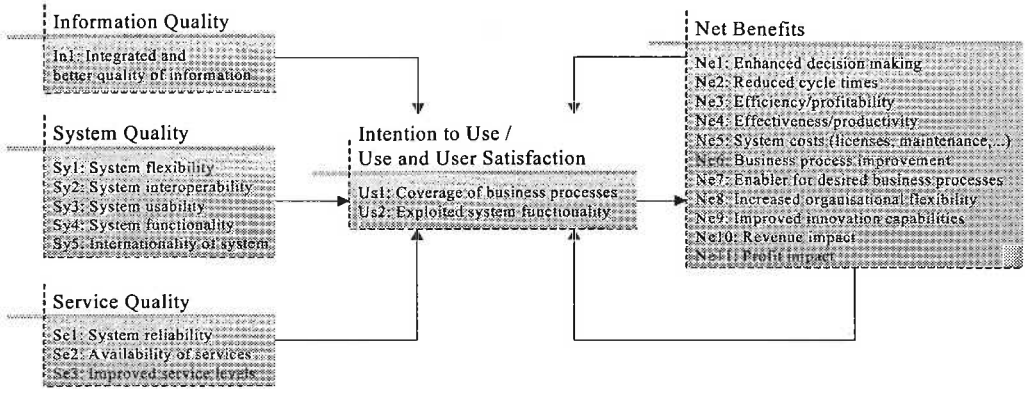

Figure 1: Elementary factors alligned along DeLone and McLeans updated IS success model.

In order to analyse the construct validity, the 21 items were included in an exploratory factor analysis. The model was partially validated. Of the original 21 variables (without the single variable pertaining to information quality), seven were dropped. With the remaining 14 variables factor analysis concluded with a more interpretable and parsimonious outcome comprising the factors net benefits (NB), system quality (SY), firm level financial impact (FI), and service quality (SE). All items loaded as anticipated and explained 73.7 percent of model variance. As suggested by the authors of the original success model, a finer granularity of net benefits can be appropriate in many settings. In the context of this study, ERP can lead to notable consequences in terms of revenue and profits (e.g. in a negative perception (Scott, 1999) concerning the FoxMeyer Drugs case). DeLone and McLean have only recently incorporated these elements into their updated IS Success Model. In terms of the empirical classification, firm level financial impact is denoted by the third factor. The dimension "intention to use/use and user satisfaction" was omitted from the final model. This exclusion from the consolidated measurement model was also observed in another empirical study postulating that satisfaction is not a dimension of success in the context of enterprise systems (Gable, Sedera, & Chan, 2003).

Besides the items given so far, the survey instrument considered measures of overall IT/IS/ERP success with regard to the following statements: (A) "Is ERP in general aiding your organisation to gain a competitive edge", (B) "Efficiency of IT/IS supported processes", (C) "IT/IS impacts on goal achievement", and (D) "IT/IS reliability". While (A) was assessed by a binary scale (No or Yes), the other statements referred to scales from 1 (very negative) to 5 (very positive). With the objective of further analysing the content, construct, and criterion validity of the factor solution, the following composite measure of overall success was computed: (DA) dimension average as the average of the four success dimensions in the factor analysis model. Table 5 shows the results of correlating the variables (A-D) with the four dimensions and their average.

		A		B		C		D	
Dimensions		Corr	p	Corr	p	Corr	p	Corr	p
NB	Net benefits	.36	.05	-	-	.69	.00	.60	.01
SY	System quality	.49	.01	.51	.03	.40	.10	.42	.08
FI	Financial impact	-	-	-	-	-	-	-	-
SE	Service quality	-	-	.43	.08	-	-	-	-
DA	Dimension average	.52	.05	.78	.00	.60	.01	.47	.05

Table 5: Correlations between general success criteria (A-D) and dimensions of factor solution.

It can be assumed that the extent to which each dimension or their average correlates with the criterion scores (here denoted as A to D) is evidence of their criterion validity assuming that the chosen measures are valid. The dimension average (DA) yields the largest correlation with all the criteria supporting the view that the dimensions are additive. Hence, when combined the criterions yield a stronger overall measure of success than given by any single dimension.

The Effect of MADM on ERP Success

The relevance of methods is captured by analysing their effect on ERP success as defined in the previous section. As already stated, in the survey business management had to assess whether any ranking and scoring technique in the sense of MADM was applied. This variable was used to segment the cases in two groups to consequently test its effects on ERP success. The first part of this section focuses on the following six variables to capture ERP success: the factor values (for each of the four factors) generated after factor analysis for every company, on the average of each dimension which was validated as strong overall measure of success, and on the information quality dimension reflected by the single variable (IN) left out in factor analysis. The last part uses an empirical classification based on the aggregate ERP success measure for cross-tabulation analysis.

With respect to four of the six measures, the mean values are higher among companies that were engaged in a MADM approach. A high factor value for a specific firm means that the elementary variables of the corresponding factor were also high. The situation achieved in terms of system quality (SY), financial impact (FI), service quality (SE), and the dimension average (DA) was more favourable among companies that showed more methodological expertise. Information quality (IN) achieved the same level for both groups of enterprises. In terms of firm level financial impact (FI), the mean value is higher among companies where no MADM ranking and scoring method was applied. Two-sample unpaired t tests revealed different means for financial impact ($p=.01$) and the dimension average ($p=.07$) while the absolute size of the difference is .99 and .36, respectively. Thus, differences are observable, but it is unclear if these differences are scientifically important. Follow up rank correlation analysis (Spearman) between each success dimension and the MADM method variable showed similar results: Financial impact ($corr=.58$, $p<.01$), the dimension average ($corr=.33$, $p=.08$), and for this test also service quality ($corr=.35$, $p=.06$) correlate with MADM method application indicating that method usage as assessed in this study promotes success.

The next objective was to segment enterprises into groups with similar perceptions of ERP success based on the dimension average variable (DA) as aggregate measure. The SPSS quick cluster procedure was used to group the cases efficiently into three clusters (Hartigan, 1975). Cross tabular analysis showed that the proportion of enterprises that used MADM ranking and scoring increases strictly monotonically from the cluster with the lowest mean in terms of the aggregate success variable to the highest.

CONCLUSION

This article firstly supplied an overview of ERP diffusion considering the stages of the system's lifecycle. The main goal was to outline MADM in the context of ERP projects and to provide empirical insights into the relevance in particular of methods. Therefore, the data originating from a primary, national and industry independent survey was presented following an MADM approach beginning with the identification of goals and values of the organisation. The first empirical perception was that the majority of companies (65%) were following a value-focused approach characterised by considering the organisation's strategic goals in defining decision making attributes, thereby being compliant with a pre-condition for strategic alignment. The given list of decision making attributes in this article together with associated importance weightings reflecting common business practice should assist decision makers in practice to validate their attribute selection. The complexity of the decision problem is reflected through the limited number of alternatives that undergo a detailed evaluation process. In the mean around three different ERP system alternatives are forwarded into an in-depth system evaluation. SAP being the market leader only achieves to be considered predominantly among LEs. Concerning SMEs, the most considered category seen in their system's short list are smaller or more specialised providers. The given list of small/specialised vendors was comprehensive, but no single provider achieved a dominating share neither in terms of considered nor chosen systems. The notion that more complex solutions provided by the industry leaders do not satisfy the needs of smaller companies is supported. Methodical aids apart from standard financial investment techniques, and simple ranking and scoring techniques are seldom utilised. However, the application of the latter type has already reached nearly every second enterprise (including SMEs). A main advantage of multiple attribute based analysis – the possibility of transferring a subset with additional measures into an instrument for ERP controlling purposes – is hardly ever implemented.

The second part of this article was concerned with analysing the contribution of MADM approaches towards the success of the ERP project. Therefore, first an a priori ERP success model was defined, which was transformed into an empirically tested model for subsequent analysis of ERP success. The results showed that various dimensions of ERP success as captured by this article showed significant dependencies on the usage of a MADM method. Success according to the expectations of business management was achieved at a greater level of magnitude in MADM supported firms in terms of financial firm level impact, service quality, and the combined view of all dimensions (which was validated as strong overall success measure). Cross tabular analysis with empirically clustered firms by

ERP success confirms a positive relationship between success and MADM method adoption. It can be noted that the relevance of MADM was only assessed in terms of their effect on ERP success. Other aspects such as the gains achieved in terms of justifiability, accountability, or reasonability which provide further arguments for their application were not considered.

To summarise, this paper provides new empirical founded evidence supporting the view that MADM is a common and relevant approach applicable to ERP system appraisals. However, business management still fails to recognise the full spectrum of methodologies and methods available in this context, in particular, support by evaluation methods and follow-up analysis and applications such as structural analysis of system alternatives for evaluating organisational fit, or multiple attributive ERP controlling. Future research will deal with these topics, i.e., with new methodical developments on the basis of MADM to support IS projects.

REFERENCES

Al-Mashari, M. (2002). Enterprise resource planning (ERP) systems: a research agenda. Industrial Management & Data Systems, 102(3), 166-170.

Benayoun, R., Roy, B., & Sussman, N. (1966). Manual de Reference du Programme Electre. Note de Synthese et Formation, 25.

Bernroider, E. W. N., & Koch, S. (2000). The decision making process concerning investments in ERP software - results of an empirical study in Austrian organizations. Wirtschaftsinformatik, 42(4), 329-338.

Bernroider, E. W. N., & Koch, S. (2001). ERP selection process in midsize and large organizations. Business Process Management Journal, 7(3), 251-257.

Bernroider, E. W. N., & Stix, V. (in print). Profile distance method - a multi-attribute decision making approach for information system investments. Decision Support Systems.

Boubekri, N. (2001). Technology enablers for supply chain management. Integrated Manufacturing Systems, 12(6), 394-399.

Brans, J. P., & Vincke, P. (1985). A Preference Ranking Organisation Method: (The PROMETHEE Method for Multiple Criteria Decision-Making). Management Science, 31(6), 647-656.

Bureau-van-Dijk, E. P. (2003). Amadeus. Retrieved January

Choudhry, G. H., & Valliant, R. (2002). WesVar: Software for complex survey data analysis. Paper presented at the Statistics Canada Symposium.

DeLone, W. D., & McLean, E. R. (2003). The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. Journal of Management Information Systems, 19(4), 9-30.

DeLone , W. H., & McLean, E. R. (1992). Information Systems Success: The Quest for the Dependent Variable. Information Systems Research, 3(1), 60-95.

Dillman, D. A. (1978). Mail and telephone surveys: the Total Design method. New York: John Wiley and Sons.

EC. (2003). Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises. Official Journal of the European Union, 46(L 124), 36-41.

Esteves, J., & Pastor, J. (1999). An ERP Lifecycle-based Research Agenda. Paper presented at the International Workshop on Enterprise Management Resource and Planning Systems (EMRPS), Venice, Italy.

Farbey, B., Land, F., & Targett, D. (1992). Evaluating investments in IT. Journal of Information Technology, 7, 109-122.

Farbey, B., Land, F., & Targett, D. (1993). How to assess your {IT} investment: A study of methods and practice.

Oxford: Butterworth-Heinmann.

Gable, G. G., Sedera, D., & Chan, T. (2003). Enterprise Systems Success: A Measurement Model. Paper presented at the Twenty-Fourth International Conference on Information Systems, Seattle, Washington.

Hartigan, J. A. (1975). Clustering algorithms. New York: John Wiley & Sons Inc.

Hwang, C. L., & Yoon, K. P. (1981). Multiple Attribute Decision Making: Methods and Applications. New York: Springer.

Irani, Z. (2002). Information systems evaluation: navigating through the problem domain. Information & Management, 40(1), 11-24.

Irani, Z., Sharif, A., Love, P. E. D., & Kahraman, C. (2002). Applying concepts of fuzzy cognitive mapping to model: The IT/IS investment evaluation process. International Journal of Production Economics, 75(1-2), 199-211.

Kaplan, R. S., & Norton, D. P. (1992). The Balanced Scorecard – measures that drive performance. Harvard Business Review, 71-79.

Kaplan, R. S., & Norton, D. P. (1993). Putting the Balanced Scorecard to Work. Harvard Business Review, 134-147.

Keeney, R. L. (1992). Value-Focused Thinking: A Path to Creative Decisionmaking. Cambridge, MA: Harvard University Press.

Kish, L. (1992). Weighting for unequal Pi. Journal of Official Statistics(8), 183-200.

Korn, E. L., & Graubard, B. I. (1995). Examples of differing weighted and unweighted estimates from a sample survey. The American Statistican(49), 291-295.

Kremers, M., & Dissel, H. V. (2000). ERP System Migrations. Communications of ACM, 43(4), 53-56.

NAICS-Association. (1997). NAICS - North American Industry Classification System. Retrieved 12 January, 2003, from http://www.naics.com/index.html

Olsen, D. L. (1996). Decision aids for selection problems. New York: Springer.

Purdon, S., & Pickering, K. (2001). The use of sampling weights in the analysis of the 1998 Workplace Employee Relations Survey: National Centre for Social Research.

Rosemann, M., & Wiese, J. (1999). Measuring the Performance of ERP Software – a Balanced Scorecard Approach. Paper presented at the Australasian Conference on Information Systems.

Sassone, P. G. (1987). Cost-Benefit Methodology for Office Systems. ACM Transactions on Information Systems, 5(3), 273-289.

Scott, J. E. (1999). The FoxMeyer Drugs' Bankruptcy: Was it a failure of ERP? Paper presented at the Fifth Americas Conference on Information Systems, Milwaukee, Wisconsin.

Triantaphyllou, E. (2000). Multi-Criteria Decision Making Methods: A Comparative Study. London: Kluwer Academic Publishers.

Willis, T. H., & Willis-Brown, A. H. (2002). Extending the value of ERP. Industrial Management & Data Systems, 102(1), 35-38.

Yoon, K. P., & Hwang, C.-L. (1995). Multiple Attribute Decision Making: An Introduction. Thousand Oaks, CA: Sage Publications.