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Achieving Enterprise Architecture Benefits: What Makes the Difference?

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***Abstract*—Enterprise Architecture (EA) is rapidly becoming an established discipline. However, this does not mean that the practice of EA is already fully standardized. Practitioners as well as researchers report various techniques being used in the EA practice. And although EA has various potential benefits, evidence of real benefits is only just emerging. This paper presents empirical evidence of the relations between EA techniques used and EA benefits perceived, as well as the influence of contextual factors. The evidence is based on the results of a survey (n=293) held among both architects and stakeholders of EA in a wide variety of organizations. Employing multivariate regression analysis we found that the combination of project compliance, EA choices being explicitly linked to business goals and organized knowledge exchange between architects is a strong predictor for EA being perceived as a good instrument. We also established that significant differences exist in EA practice effectiveness between different economic sectors. Government appears to reap less benefits from EA than other sectors. The empirical evidence furthermore shows only a small influence of organizational size and number of architects on EA effectiveness.**

Keywords-Enterprise Architecture; Architectural Practice; Benefits; Contextual Factors

I. INTRODUCTION

Enterprise Architecture (EA) is rapidly becoming an established discipline. As the field is maturing, studies into its practices and benefits are starting to appear. Various benefits of EA are mentioned in the literature [1] [2] [3] [4]. Various techniques used to achieve these benefits are also mentioned [2] [5] [6] [7] [8] [9]. The research on EA techniques and benefits, however, is rather fragmented. A need for hypothesis testing on the direct relation between EA techniques and EA benefits, taking contextual factors into account, has been identified by several authors [2] [3] [10]. This paper aims to contribute to addressing this need by conducting various statistical analyses on empirical data. Thus, we aim to answer the following main research question in this paper:

What EA techniques contribute most to achieving EA benefits and what is the impact of contextual factors on the EA practice?

We divide our main question into the following three research questions:

1. What EA techniques contribute to what EA benefits?
2. To what extent are EA techniques and benefits contingent upon economic sector?
3. To what extent are EA techniques and benefits contingent upon organizational size and number of architects?

This paper is the second in a series of studies based on an extensive set of empirical data derived from a survey among both architects and stakeholders of EA from a broad spectrum of organizations.

In section 2 we present the theoretical background and justification of our research. Section 3 discusses the research approach. In section 4 the research results are presented. In section 5, we discuss conclusions and suggestions for further research.

II. THEORETICAL BACKGROUND

As mentioned in the introduction, various EA techniques and EA benefits are reported by different authors. Benefits of

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EA mentioned in the literature are among others related to providing an enterprise-wide view, managing complexity and costs, integration of applications and data, and business-IT alignment [1] [2] [3] [4] [27]. EA techniques mentioned used to achieve these benefits are for instance in the areas of involving key stakeholders, instituting formal governance, ensuring management support, using instruments like document templates and creating an active community for EA knowledge exchange [2] [6] [7] [8] [9]. The exact relation between all these techniques and benefits is still not fully established, however, as for instance reported by [11] on the basis of an extensive literature review. In addition, the influence of contextual factors has not received much attention yet.

In this paper we test the hypothesis that the extent to which particular EA techniques are used is positively correlated with the extent to which particular EA benefits are experienced by the organization.

In accordance with [3] and [10] we will also take the influence of contextual factors into account. Though there are several indications that the approach to EA an organization takes is dependent on contextual factors, there is still much to be investigated into what these contextual factors are. Reference [12] present three contingency factors, i.e. adoption of advanced architectural design paradigms and modeling capabilities, deployment and monitoring of EA data and services, and organizational penetration of EA. Reference [13] indicate that many organizations feel the need to adapt EA approaches to their situation, but do not provide answers as to what factors cause this need.

We investigate the influence of two types of contextual factors, economic sector and organizational size in terms of number of employees and number of architects. The influence of industry characteristics on various organizational functions or performance has been found before in other areas like human resource management [14], internationalization [15] and diversification, size and divisionalization [16]. The literature on the influence of organizational size is less clear. Studies by [16] indicate that size does not play an important role in organizational performance. Reference [17] mention size of company as a potentially relevant contextual factor, but do not elaborate on this. Reference [9] indicate that when the number of architects becomes large, knowledge integration becomes an issue, which suggests that size may play some role.

In this paper we test the hypotheses that both economic sector and organizational size influence the EA techniques used and the EA benefits experienced.

III. RESEARCH APPROACH

To answer the research questions formulated in the introduction, we used data from a survey study among a wide spectrum of organizations in the Netherlands. The survey was held among all stakeholders of EA, not only architects. This ensured that different perspectives on EA are represented in the response, not only that of the architects developing or applying the EA, but also of other employees being confronted with EA. Besides, both internal employees and external consultants were addressed. Potential respondents were approached primarily by email. As no register exists of the target population, use was made of contacts of some IT providers. In addition the survey was announced on a number of relevant sites and at several practitioner conferences. As our unit of analysis is the employee dealing with EA, more than one respondent per organization was allowed. This allowed for obtaining information from different perspectives (both developers and users of EA) and levels (organization level and project level).

The survey was presented as an online survey. To filter out respondents that had no relation to EA, the first question asked the respondents whether they dealt with EA in any way in their jobs. In case of a negative answer, the survey did not continue. EA was described in the survey as “a high-level set of prescriptions, e.g. principles and models. An important function of EA is to ensure that business processes, information, IT et cetera are designed and implemented as coherently as possible”.

The survey existed of three parts. The first part consisted of a number of factual questions like sector and size of the organization, number of architects and focus of EA, i.e. business and information or applications and infrastructure, or both. The second part asked about the extent to which specific EA techniques are used in the organization. The third part of the survey asked about the benefits experienced from EA which might be either benefits for the organization as a whole or benefits for projects and about the actual use of the EA in the sense of whether projects actually conform to the EA and whether the EA prescriptions are clear and precise. The techniques and benefits asked about were gathered from both academic and practitioner publications. The questions regarding EA techniques and EA benefits were mostly presented with a 5-point scale ranging from e.g. Very poor to Very good. Respondents were also allowed the option of choosing a No answer category for questions that concerned aspects not within their scope of experience. The online survey was accessible to respondents from October 2009 till May 2010. A total of 293 valid responses was received, divided more or less equally between creators of EA and users of EA. The responses came from a wide variety of organizations and economic sectors (table I).

The sectors best represented among the respondents are finance and government. This is as expected. The financial sector is a very IT-intensive sector that has been employing enterprise architecture for more than a decade now. The large response from the government sector can be related back to the increasing interest of the Netherlands Government in enterprise architecture which is related to a government-wide e-government program. The use of EA has been propagated by central government for a couple of years now.

All in all the respondents seem to present a good representation of organizations employing EA. This is supported by the fact that the distribution of respondents over economic sector found in our survey is largely similar with distributions found in other surveys in the field of EA like [18] and [19].

TABLE I. DISTRIBUTION OF RESPONDENTS ACROSS ECONOMIC SECTORS (BASED ON ISIC REV. 4)

Economic Sector		Number of respondents	Percentage of respondents
Govern-ment		91	31.1
Finance		89	30.4
Other	Education and research	5	1.7
	Energy & water supply and waste management	15	5.1
	Health and social work	8	2.7
	Trade, transportation, hotel, catering, real estate and other services	30	10.2
	Manufacturing and construction	16	5.5
	Information, communication, entertainment and recreation	36	12.3
	Agriculture	3	1.0
Total		293	100.0

For analysis of the data we used SPSS 17. Apart from simple descriptive statistics, we used a number of statistical techniques. To study whether statistically significant differences exist between economic sectors and between organizations of different size, we used chi-square tests. To build a model of the combination of EA techniques that best predicts EA effectiveness, we used a two-step approach. Firstly, we used ordinal association (using Spearman's rho) to find whether associations exist between individual EA techniques and the various EA benefits. Based partly on the results of this, we next used multivariate logistic regression to build a model of EA techniques combined. In all analyses we applied a significance threshold of p-value = 0.05.

IV. RESEARCH RESULTS

A. EA Techniques Contributing to Achieving EA Benefits

To answer our first research question, "What EA techniques contribute to what EA benefits?", we took a two-step approach. We started with investigating whether associations exist between the EA techniques used on the one hand and the EA benefits perceived on the other hand. We did so by measuring ordinal association (using Spearman's rho), between the EA techniques and each of the EA benefits.

Techniques asked about are whether the EA is formally approved by management (T1), the choices made in the EA are explicitly linked to the business goals of the enterprise as a whole (T2), management propagates the importance of EA (T3), projects are being explicitly assessed on their degree of compliance with EA (T4), knowledge is being exchanged in an organized manner between different types of architects (for instance enterprise, domain, project, software and infrastructure architects) (T5), knowledge is being exchanged in an organized manner between architects and other employees participating in projects that have to conform to EA (for instance project managers, designers, developers, testers, etc.) (T6), assistance is being offered in order to stimulate conformance to EA (for instance enterprise architects or change managers helping a project to make a new design conform the EA) (T7), projects make use of a Project Start Architecture (PSA) (T8), document templates are being used to stimulate conformance to EA (for instance templates that focus attention to the EA by asking for specific information) (T9) and financial rewards and disincentives are being used in order to stimulate conformance to EA (for instance by paying the IT costs of a project when the result is designed and built conform the EA or by imposing penalties in case of deviations from the EA) (T10).

With regard to the organization-wide benefits, respondents were asked whether EA turned out to be a good instrument to accomplish enterprise-wide goals instead of (possibly contradictory) local optimizations (B1), achieve an optimal fit between IT and the business processes it supports (B2), provide insight into the complexity of the organization (B3), control the complexity of the organization (B4), integrate, standardize and/or deduplicate related processes and systems (B5), control costs (B6), enable the organization to respond to changes in the outside world in an agile fashion (B7), co-operate with other organizations effectively and efficiently (B8), depict a clear image of the desired future situation (B9), enable different stakeholders to communicate with each other effectively (B10) and whether EA, in general, turns out to be a good instrument (B11).

All techniques appeared to be regularly used, except T10, the use of financial incentives. Of the organization-wide benefits only B1, B3, B5, B9, B10 and B11 were widely perceived by the respondents as being contributed to by EA (see [28] for the exact percentages).

Table II shows the associations found between EA techniques and EA benefits. It shows for each EA technique and each EA benefit the strength of the association in terms of Spearman's rho and the significance of the association in terms of the p-value. A strength higher than 0.250 is underlined. An association that is not significant (p-value larger than 0.05) is printed in italics. An association with a p-value larger than 0.01 but smaller than 0.05 is marked with an *. All other associations have a p-value < 0.01.

All EA techniques appear to have significant associations with at least some EA benefits, except for the EA being formally approved (T1). Three techniques show markedly fewer and weaker associations: financial incentives (T10), using a PSA (T8) and using document templates (T9). It seems as if formal techniques are less effective than informal interactive measures. Thus, the EA being formally approved seems to have less impact than management propagating the importance of EA. Likewise, the use of templates to stimulate conformance seems less effective than providing assistance and organized knowledge exchange. The importance of informal aspects was also found by [17]. The business-IT alignment literature, too, stresses the importance of (informal) relationship management [29] [30] [31]. The importance of informal measures may be related to EA still being a relatively young discipline.

TABLE II. ASSOCIATION BETWEEN EA TECHNIQUES AND EA BENEFITS

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
T1	*0.078*	*0.087*	*0.070*	*0.120*	*0.074*	*0.046*	*0.015*	*0.056*	*0.043*	*0.106*	*0.113*
T2	0.407	0.367	0.226	0.283	0.318	0.191	0.267	0.219	0.249	0.213	0.388
T3	0.347	0.302	0.126*	0.307	0.340	0.212	0.285	0.272	0.248	0.178	0.371
T4	0.344	0.285	0.202	0.193	0.330	0.275	0.277	0.210	0.258	0.282	0.401
T5	0.393	0.378	0.190	0.177	0.269	*0.186*	0.264	0.271	0.305	0.307	0.331
T6	0.336	0.349	0.193	0.232	0.297	0.140*	0.338	0.245	0.308	0.251	0.389
T7	0.372	0.236	0.207	0.307	0.249	0.273	0.253	0.199	0.252	0.216	0.333
T8	0.171	*0.087*	0.167	*0.062*	0.122*	0.140*	0.134*	*0.011*	0.140*	0.146*	0.141*
T9	0.143*	0.171	0.151*	*0.110*	0.134*	0.158*	*0.085*	*0.083*	0.132*	0.218	0.227
T10	*0.101*	*0.060*	*-0.006*	*0.116*	*0.061*	0.146*	*0.001*	0.161*	*0.024*	*0.084*	*0.046*

The relatively weak influence of the PSA (a document drafted at the start of a project, translating the EA prescriptions to the specific context of the project (cf. [5])) is remarkable as the use of the PSA as a core EA governance document is widespread among the target population. In light of this widespread use, this outcome certainly warrants further investigation. It may be related to the struggle many organizations experience in precisely defining role and content of the PSA [6].

Measuring ordinal associations as in table II shows the relations of the EA techniques to the EA benefits separately. The next step is to try and build a model combining various techniques, allowing also for the influence of contextual factors. To this end we conducted multivariate regression analysis. As the variables were measured on a five-point ordinal scale, we employed ordinal regression (cf. [20] and [21]). Ordinal regression does not require a normal distribution or identical variance, but it does demand that the effects of the independent variables are constant across all categories of the dependent variable (the test of parallel slopes). Besides the EA techniques we also took into account the frequency of projects conforming to EA and the frequency of EA prescriptions being open to multiple interpretations.

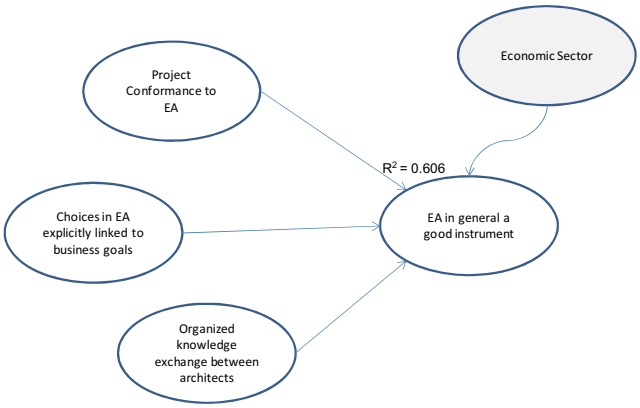

Figure 1. Empirical model for techniques contributing to EA being a good instrument.

After investigating a number of models, the model with T2, choices in EA are explicitly linked to business goals, and T5, knowledge exchange between various types of architects, together with project compliance, appeared to yield a good fit, giving a Nagelkerke R^2 of 0.595. We applied the logit link function and combined the last two categories of the variable project conformance. We tested for the assumption of parallel lines, which was not violated (p-value of 0.774). Checking for the influence of contextual factors, we found that if we controlled for economic sector the strength of the prediction increases still a little to a Nagelkerke R^2 of 0.606 (Fig. 1). The resulting model shows that a combination of project conformance with EA choices being explicitly linked to business goals and organized knowledge exchange between architects, strongly predicts EA being perceived as a good instrument.

The details of the model are given in Fig. 2. According to [22], for each variable at least one category must be significant. As the Sig. column shows, this is the case, with most variables having more than one significant category.

We might summarize the results by stating that the benefits of EA are most likely to be reaped if projects conform to an EA that is well-aligned: the architectural choices made in the EA are explicitly linked to the business goals (which may be seen as a form of business IT alignment) and the different viewpoints on the EA are shared by the architects developing and using it (internal consistency). It is the combination of quality of the EA with good governance that leads to effectiveness. The results also indicate that economic sector plays a role. This aspect is further investigated in the next section.

Thus, in answer to our first research question, "What EA techniques contribute to what EA benefits?" we might state that

- Informal techniques contribute more to the achievement of EA benefits than formal techniques
- The PSA, though extensively used, is not a prime contributor to EA benefits
- The combination of projects conforming, choices in EA being linked to business goals and organized knowledge exchange between architects is a strong predictor of EA being perceived as a good instrument.

		Estimate	Std. Error	Wald	df	Sig.
Threshold	[EAGoodInstrument= 1]	-25.952	3759.290	.000	1	.994
	[EAGoodInstrument = 2]	-6.565	.832	62.309	1	.000
	[EAGoodInstrument = 3]	-3.872	.741	27.265	1	.000
	[EAGoodInstrument = 4]	.377	.653	.333	1	.564
Location	[LinkBussGoals=2]	-2.677	.821	10.624	1	.001
	[LinkBussGoals =3]	-1.680	.544	9.544	1	.002
	[LinkBussGoals =4]	-.944	.483	3.817	1	.051
	[LinkBussGoals =5]	0[a]	.	.	0	.
	[KnowlExchArch=1]	-38.882	9090.909	.000	1	.997
	[KnowlExchArch =2]	-1.430	.717	3.975	1	.046
	[KnowlExchArch =3]	-1.548	.636	5.927	1	.015
	[KnowlExchArch =4]	-1.056	.607	3.025	1	.082
	[KnowlExchArch =5]	0[a]	.	.	0	.
	[ProjectsConform=2]	-2.641	.588	20.202	1	.000
	[ProjectsConform =3]	-1.434	.345	17.309	1	.000
	[ProjectsConform =4]	0[a]	.	.	0	.
	[Sector=1]	-.791	.374	4.471	1	.034
	[Sector=2]	-.328	.344	.906	1	.341
	[Sector=3]	0[a]	.	.	0	.

[a] This parameter is set to zero because it is redundant.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	304.354			
Final	141.371	162.983	11	.000

Link function: Logit.

Pseudo R-Square

Cox and Snell	.530
Nagelkerke	.606
McFadden	.364

Link function: Logit.

Figure 2. Ordinal regression model linking various factors to EA being a good instrument.

B. The Influence of Economic Sector in EA Practice and Effectiveness

To answer our second research question, "To what extent are EA techniques and benefits contingent upon economic sector?", we divided the respondents into three categories of economic sector: government, finance and all other sectors (see table I). Next, we employed chi-square tests to see whether statistically significant differences exist between these three groups with regard to EA techniques used and EA benefits perceived. The results of these tests are summarized in tables III and IV. Of the eleven enterprise-wide EA benefits, seven were found to show significant differences between the sectors. Table III shows the percentages of respondents for each sector giving *Good* or *Very Good* as answer to the question whether EA is a good instrument to achieve specific benefits. The table also shows the number of non-responses and the p-value of a Pearson chi-square test with 2 degrees of freedom. In the table we included only the factors that exhibit a significant difference ($p < 0.05$).

As can be read from table III, the respondents in government on the whole perceive less benefits from EA than in the other groups: for all EA benefits that show significant difference between sectors, the percentages *Good* or *Very good* are lowest in government. Somehow, government seems to experience difficulties in reaping the benefits from EA. This difference between government and the other economic sectors in benefits perceived cannot be fully explained by differences in the use of EA techniques (table IV).

Table IV shows the percentages of respondents for each sector giving Frequently or Always as answer to the question whether specific EA techniques are being used in their organization. The table shows that government does not differ that much from the other non-financial sectors with respect to EA techniques used.

TABLE III. DIFFERENCES IN ORGANIZATIONAL BENEFITS PERCEIVED BETWEEN ECONOMIC SECTORS

Perceived benefits for the organization	**Govern-ment: (very) good**	**Finan-cials: (very) good**	**Other: (very) good**	**NR**	**p-value**
B1. Accomplish enterprise-wide goals, instead of (possibly conflicting) local optimizations	**41.0**	62.4	54.2	18	0.020
B2. Achieve an optimal fit between IT and the business processes it supports	**27.7**	47.0	51.4	22	0.003
B3. Provides insight into the complexity of the organization	**63.2**	78.2	79.8	10	0.018
B5. Integrate, standardize and/or undouble related processes and systems	**44.0**	58.6	62.3	16	0.034
B6. Control costs	**3.9**	17.1	17.6	32	0.014
B7. Enable the organization to respond to changes in the outside world in an agile fashion	**17.3**	34.1	24.5	28	0.045
B11. EA, in general, turns out to be a good instrument	**47.7**	65.1	68.5	13	0.008

TABLE IV. DIFFERENCES IN TECHNIQUES USED BETWEEN ECONOMIC SECTORS

Techniques	Government: Freq./ always	Financials: Freq./ always	Other: Freq./ always	NR	p-value
T4. Projects are being explicitly assessed on their degree of compliance with EA	46.2	**73.0**	58.7	4	0.001
T8. Projects make use of a PSA (Project Start Architecture)	47.1	**85.1**	41.0	14	0.000
T9. Document templates are being used to stimulate conformance to EA.	37.6	**65.9**	47.2	12	0.001

This suggests that other factors play a role. These factors may be related to project compliance, as government does score significantly lower on this aspect (table V). This is consistent with the predictive power of project conformance with regard to EA being a good instrument as discussed in the previous section. The fact that in government projects comply with the EA less frequently than in the other sectors requires further investigation. One of the causes may be the fact that the architectural prescriptions in government are more open to interpretation, as table V also shows. This might be connected to the political context in which government has to operate that may easily create uncertainty, diversity and regular changes of direction.

Table IV also shows that the financial sector scores higher on the more structural, formal techniques: assessing projects on compliance, using document templates to stimulate conformance and making use of the PSA. This might be related to the fact that the financial sector is especially subject to strict regulations and compliance rules, necessitating a formal governance. As far as project compliance is concerned, however, the financial sector is on a par with the other, non-government sectors (table V). This suggests that these structural techniques alone are not decisive in achieving project conformance. This conclusion is supported by the fact that the category of 'other' sectors reports less frequently formal approval of the EA (69.2% versus 84.3% in government and 87.4% in finance), while still reporting comparable compliance percentages as the financial sector. It may be the case that the need for formal techniques is situation dependent.

Taken together, the results of the comparison between sectors suggest that a differentiation in EA approach might be in order, where different sectors may require different approaches. Of course, this needs further investigation. It is worthwhile to investigate whether these differences can be related to underlying factors like organizational culture. This latter conjecture is supported by earlier studies [23] [24] [25].

TABLE V. DIFFERENCES IN USE OF EA BETWEEN ECONOMIC SECTORS

Use of EA	Government: Freq./ always	Financials: Freq./ always	Other: Freq./ always	NR	p-value
Projects that are required to conform to EA turn out to actually conform to the architectural principles, models and other prescriptions	**50.8**	71.6	70.0	56	0.015
Principles, models and other architectural prescriptions turn out to be open to multiple interpretations	**41.8**	31.0	**21.0**	30	0.011

Thus, in answer to our second research question, "To what extent are EA techniques and benefits contingent upon economic sector?" we find that

- Government on the whole perceives less benefits from EA than the other sectors
- In Government projects less frequently comply with EA than in the other sectors
- Finance makes more use of structural, formal techniques than the other sectors

We may conclude that indeed differences exist between economic sectors.

C. *The Influence of Organizational Size on EA Practice and Effectiveness*

To answer our third research question, "To what extent are EA techniques and benefits contingent upon organizational size and number of architects?", we conducted chi-square tests with respect to number of employees and number of architects. With regard to number of architects we distinguish between architects developing EA, i.e. enterprise and domain architects and architects applying EA in projects, i.e. project and software architects. For reasons of brevity, we will henceforth refer to the first group as enterprise architects and the second group as project architects.

As is to be expected the number of architects is related to the size of the organization. To test this hypothesis we performed chi-square tests on number of employees versus number of enterprise architects (Fig. 3) and on number of employees versus number of project architects (Fig. 4). The tables show the actual count as well as the count that would have been expected if number of employees and number of architects were totally unrelated. Both tests yielded a p-value of 0.000.

Not surprisingly, the majority of organizations have up to 5 enterprise architects. In addition, a substantial portion of organizations with more than 2000 employees have between 6 and 20 enterprise architects. More than 20 enterprise architects is rare. As is to be expected, the numbers of project architects are on the whole higher than the number of enterprise architects and increasing with organizational size (Fig. 4).

NumberOfEnterpriseArchitects * Size Crosstabulation

			Size			
			< 2000	2000-5000	> 5000	Total
NumberOfEnterpriseArchitects	<5	Count	65	43	32	140
		Expected Count	40.6	37.4	62.0	140.0
		% within SizeGroup	85.5%	61.4%	27.6%	53.4%
	6-20	Count	11	24	52	87
		Expected Count	25.2	23.2	38.5	87.0
		% within SizeGroup	14.5%	34.3%	44.8%	33.2%
	21-50	Count	0	2	19	21
		Expected Count	6.1	5.6	9.3	21.0
		% within SizeGroup	.0%	2.9%	16.4%	8.0%
	>50	Count	0	1	13	14
		Expected Count	4.1	3.7	6.2	14.0
		% within SizeGroup	.0%	1.4%	11.2%	5.3%
Total		Count	76	70	116	262
		Expected Count	76,0	70.0	116.0	262.0
		% within SizeGroup	100.0%	100.0%	100.0%	100.0%

Figure 3. Relation between organizational size and number of enterprise architects

To investigate the influence of number of employees, number of enterprise architects and number of project architects on EA practice and effectiveness, we again performed chi-square tests. Though we found some significant differences, we could not detect any strong patterns. Respondents from organizations of up to 2000 employees report less frequently the use of document templates (35.1% versus more than 50% for the other categories), respondents from organizations of 2000 to 5000 employees report more frequently that assistance is being offered in projects (57.3% versus less than 40%) and that projects having to conform to EA get initialized slower (65.6% versus less than 50%), and respondents from organizations of more than 5000 employees report more frequently that EA leads to standardization (63.6% versus around 50%).

NumberOfProjectArchitects * Size Crosstabulation

			Size			
			< 2000	2000-5000	> 5000	Total
NumberOfProjectArchitects	<5	Count	40	16	10	66
		Expected Count	18.9	17.9	29.2	66.0
		% within SizeGroup	55.6%	23.5%	9.0%	26.3%
	6-20	Count	26	33	27	86
		Expected Count	24.7	23.3	38.0	86.0
		% within SizeGroup	36.1%	48.5%	24.3%	34.3%
	21-50	Count	3	15	28	46
		Expected Count	13.2	12.5	20.3	46.0
		% within SizeGroup	4.2%	22.1%	25.2%	18.3%
	>50	Count	3	4	46	53
		Expected Count	15.2	14.4	23.4	53.0
		% within SizeGroup	4.2%	5.9%	41.4%	21.1%
Total		Count	72	68	111	251
		Expected Count	72.0	68.0	111.0	251.0
		% within SizeGroup	100.0%	100.0%	100.0%	100.0%

Figure 4. Relation between organizational size and number of project architects

TABLE VI. DIFFERENCES IN BENEFITS BETWEEN NUMBERS OF PROJECT ARCHITECTS

Number of project architects	**<5**	**6-20**	**21-50**	**>50**		
Perceived benefits for the organization	**(very) good**	**(very) good**	**(very) good**	**(very) good**	**NAR**	**p-value**
Achieve an optimal fit between IT and the business processes it supports	**52.5**	43.2	26.1	50.0	59	0.037
Provides insight into the complexity of the organization	**85.9**	66.3	83.0	80.8	47	0.020
Perceived benefits for projects	**(much) more often**	**(much) more often**	**(much) more often**	**(much) more often**	**NAR**	**p-value**
Deliver the desired functionality more often than projects that do not have to conform to EA	**66.7**	39.4	36.7	46.7	128	0.031
Perceived benefits for projects	**(much) quicker**	**(much) quicker**	**(much) quicker**	**(much) quicker**	**NAR**	**p-value**
Projects that have to conform to EA turn out to get initialized faster than projects that do not have to conform to EA.	**17.6**	2.8	15.0	14.3	95	0.041

Looking at the differences with regard to number of architects it is interesting to establish that the percentage of respondents from organizations with up to five project architects reporting benefits is slighter higher than of organizations with more project architects (table VI). This may be due to many factors like for instance the effect that with an increasing number of project architects the chance increases that they are not sufficiently educated (as they are frequently recruited from the population of analysts and designers that are not educated in EA), that they are more inclined to take over project work or that mutual alignment is more difficult.

Another difference that emerged from the data is that with an increase of architects an increase in the use of document templates is associated. This can be explained by the fact that document templates can function as a means of communication and alignment between architects (boundary objects, cf. [9]), which is of course needed more when the number of architects increases. This is in line with the finding mentioned earlier that smaller organizations make less use of document templates.

On the whole, however, we can state that, though there are a few significant differences, the relation between organizational structure and EA practice does not exhibit very strong patterns with regard to size of organization and number of architects.

Thus, in answer to our third and final research question, "To what extent are EA techniques and benefits contingent upon organizational size and number of architects?" we might conclude that

- An increase in employees and/or architects strengthens the need for the use of boundary objects like document templates
- The increase of number of project architects associated with larger size organizations does not necessarily lead to greater effectiveness

All in all not much evidence for a strong influence of size is found.

V. CONCLUSIONS AND FURTHER RESEARCH

In this paper we investigated the question of what EA techniques contribute to what EA benefits and what is the impact of contextual factors on the EA practice. Analyzing the data of a survey study (n=293) utilizing various statistical techniques we found a number of interesting relations.

First of all, we found that the techniques strongest associated with EA benefits are choices in EA being explicitly linked to business goals, management propagation of architecture, assessment of projects on compliance with the EA, organized knowledge exchange among architects, organized knowledge exchange between architects and stakeholders and assistance being offered to projects. Formal approval of the EA, use of a PSA, use of document templates and use of financial incentives show much weaker associations or no significant association at all. It appears as if interactive measures are more effective than formal techniques. This may be related to the fact that EA is still a relatively young field where architects still have to prove their value to the organization.

Employing multivariate regression analysis we found that the combination of project compliance, EA choices being explicitly linked to business goals and organized knowledge exchange between architects is a strong predictor for EA being perceived as a good instrument. We conclude that EA effectiveness is best achieved by projects complying with an architecture that shows internal consistency and alignment between the various aspects of the organization.

We found a number of significant differences between economic sectors. Especially, respondents from government experience more difficulties in reaping the benefits of EA than respondents from the other sectors. Also, in government less projects comply with EA. The financial sector is distinguished from the other sectors by the more frequent use of structural, formal EA techniques. This may be related to the strict regulations the financial sector is subject to.

Finally, we found that organizational size and number of architects do not make a large difference for EA techniques

used and EA benefits perceived. The few significant differences we found do not exhibit any strong patterns, though it is food for thought that an increase in number of project architects is slightly negatively associated with experiencing EA benefits.

There are some limitations to our research. Firstly, the survey asked for perceptions of the use of EA techniques and the benefits EA engenders. However, asking for perceptions in surveys is an established approach and has been found to lead to reliable results [26]. Besides, responses represented different perspectives, both from EA developers and EA users, and from both an organization level and a project level. Secondly, the scope of the survey was limited to the Netherlands. In particular the results concerning the differences between economic sector may not be directly transferable to other countries. The fact that differences exist, however, is in our opinion also relevant outside the scope of the Netherlands.

Our research has several implications for practice. First of all, it provides an indication of what EA techniques to focus on, in order to reap the benefits of EA. In addition, the relatively weak contribution of the use of the PSA to EA benefits merits a fresh reflection on the way this instrument is deployed in practice at the moment. The results concerning the difference between economic sector suggest that a variation in approach to EA according to economic sector is appropriate.

An interesting avenue for further research suggested by our results is the further investigation of the differences between economic sectors. How these differences can be explained and to what extent these differences are related to cultural differences are research questions that merit further study. The results concerning the influence of number of project architects on EA benefits indicates it may be worthwhile to investigate whether there is an optimum in number of architects, related to organizational size.

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REFERENCES

[1] J.M. Morganwalp and A.P. Sage, "Enterprise architecture measures of effectiveness," International Journal of Technology, Policy and Management,vol. 4, nr. 1, 2004, pp. 81-94.

[2] W.F. Boh, and D. Yellin, "Using enterprise architecture standards in managing information technology," Journal of Management Information Systems, vol. 23, nr. 3, 2007, pp. 163-207.

[3] E. Niemi, "Enterprise architecture benefits: perceptions from literature and practice," Proceedings of the 7th IBIMA Conference on Internet & Information Systems in the Digital Age, 2006, Brescia, Italy.

[4] S. Gregor, D. Hart, and N. Martin, "Enterprise architectures: enablers of business strategy and IS/IT Alignment in government," Information Technology & People, vol. 20, nr. 2, 2007, pp. 96-120.

[5] R. Wagter, M. van den Berg, J. Luijpers, and M. van Steenbergen, Dynamic enterprise architecture: how to make it work, Hoboken, New Jersey: John Wiley & Sons, 2005.

[6] R.M. Foorthuis and S. Brinkkemper, "Best practices for business and systems analysis in projects conforming to enterprise architecture," Enterprise Modelling and Information Systems Architectures, vol. 3, nr. 1, 2008, pp. 36-47.

[7] R. Slot, G. Dedene, and R. Maes, "Business value of solution architecture," Advances in Enterprise Engineering II (E. Proper, F. Harmsen, and J.L.G. Dietz, Eds.), LNBIP (28), 2009, pp. 84-108, Berlin: Springer.

[8] A. Nakakawa, P. van Bommel, and H.A. Proper, "Challenges of involving stakeholders when creating enterprise architecture," 5th SIKS/BENAIS Conference on Enterprise Information Systems, 2010, pp. 43-55.

[9] M. van Steenbergen and S. Brinkkemper, "The architectural dilemma: division of work versus knowledge integration," Proceedings of the Third International Workshop on Business/IT Alignment and Interoperability (BUSITAL'09) (H. Weigand, H. Werthner, and G. Gal, Eds.), 2009, pp. 46-60, Amsterdam, the Netherlands.

[10] L. Kappelman, A. Pettite, T. McGinnis, and A. Sidorova, "Enterprise architecture: charting the territory for academic research," Proceedings of the 14th Americas Conference on Information Systems, 2008.

[11] V. Boucharas, M. van Steenbergen, S. Jansen, and S. Brinkkemper, "The contribution of enterprise architecture to the achievement of organizational goals: a review of the evidence," Proceedings of the 5th International Workshop on Trends in Enterprise Architecture Research (E. Proper, M.M. Lankhorst, M. Schönherr, J. Barjis, and S. Overbeek, Eds.), LNBIP 70, Springer, Berlin Heidelberg, 2010, pp. 1-15.

[12] C. Riege and S. Aier, "A contingency approach to enterprise architecture method engineering," ICSOC 2008, LNCS 5472, Springer-Verlag, Berlin Heidelberg, 2009, pp. 388/399.

[13] K. Winter, S. Buckl, F. Matthes, and C.M. Schweda, "Investigating the state-of-the-art in enterprise management methods in literature and practice," MCIS 2010 Proceedings, paper 90.

[14] D.K. Datta, J.P. Guthrie, and P.M. Wright, "Human resource management and labor productivity: does industry matter?," Academy of Management Journal, vol. 48, nr. 1, 2005, pp. 135-145.

[15] H. Boter and C. Holmquist, "Industry characteristics and internationalization processes in small firms," Journal of Business Venturing, vol. 11, 1996, pp. 471-487.

[16] B.W. Keats and M.A. Hitt, "A causal model of linkages among environment dimensions, macro organizational characteristics, and performance," The Academy of Management Journal, vol. 31, nr. 3, 1988, pp. 570-598.

[17] S. Aier and J. Schelp, "A reassessment of enterprise architecture implementation," ICSOC/ServiceWave 2009 (A. Dan, F. Gittler, and F. Toumani (Eds.), LNCS 6275, Springer-Verlag, Berlin Heidelberg, 2010, pp. 35-47.

[18] T. Bucher, R. Fisher, S. Kurpjuweit, and R. Winter, "Enterprise architecture analysis and application, an exploratory study," Proceedings of TEAR 2006, EDOC Workshop, URL: http://tear2006.telin.nl

[19] T. Obitz and M. Babu K., "Enterprise architecture expands its role in strategic business transformation," Infosys Enterprise Architecture Survey 2008/2009.

[20] C.K. Chen and J. Hughes Jr., "Using ordinal regression model to analyze student satisfaction questionnaires, IR Applications, vol. 1, 2004, pp. 1-13.

[21] D. Weisburd and C. Britt, "Multivariate regression with multiple category nominal or ordinal measures: extending the

basic logistic regression model," Statistics in Criminal Justice, 3rd Edition, 2007, pp. 579-606. Springer, New York.

[22] G.D. Garson, "Ordinal Regression (Statnotes from North Carolina State University)", 2010, URL: http://faculty.chass.ncsu.edu/garson/PA765/ordinalreg.htm.

[23] G.G. Gordon, "Industry determinants of organizational culture," The Academy of Management Review, vol. 16, nr. 2, 1991, pp. 396-415.

[24] J.A. Chatman and K.A. Jehn, "Assessing the relationship between industry characteristics and organizational culture: how different can you be?," The Academy of Management Journal, vol. 37, nr. 3, 1994, pp. 522-553.

[25] R. Parker and L. Bradley, "Organisational culture in the public sector: evidence from six organisations," The International Journal of Public Sector Management, vol. 13, nr. 2, 2000, pp. 125-141.

[26] T.D. Wall, J. Michie, M. Patterson, S.J. Wood, M. Sheehan, C.W. Glegg, and M. West, "On the validity of subjective measures of company performance," Personnel Psychology, vol. 57, nr. 1, 2004, pp. 95-118.

[27] M. Lankhorst et al., Enterprise Architecture at Work. Modelling, communication and analysis, Berlin: Springer, 2005.

[28] R. Foorthuis, M. van Steenbergen, N. Mushkudiani, W. Bruls, S. Brinkkemper and R. Bos, "On course, but not there yet: Enterprise Architecture conformance and benefits in systems development," Proceedings of the Thirty First International Conference on Information Systems (ICIS), St. Louis, Missouri, USA, 2010, pp.1-19.

[29] Q. Hu and C.D. Huang, "Aligning IT with firm business strategies using the balanced scorecard system," Proceedings of the 38th Hawaii International Conference on System Sciences, 2005.

[30] Y.E. Chan, "Why haven't we mastered alignment?: the importance of the informal organization structure," MIS Quaterly Executive, vol.1, nr.2, 2002, pp.97-112.

[31] B.H. Reich and I. Benbasat, "Factors that influence the social dimension of alignment between business and information technology objectives," MIS Quaterly, vol. 24, nr. 1, 2000, pp. 81-113.