

2012

# ENTERPRISE ARCHITECTURE AS A MEANS FOR COORDINATION – AN EMPIRICAL STUDY ON ACTUAL AND POTENTIAL PRACTICE

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## Recommended Citation

Abraham, Ralf; Aier, Stephan; and Labusch, Nils, "ENTERPRISE ARCHITECTURE AS A MEANS FOR COORDINATION – AN EMPIRICAL STUDY ON ACTUAL AND POTENTIAL PRACTICE" (2012). *MCIS 2012 Proceedings*. 33.

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# ENTERPRISE ARCHITECTURE AS A MEANS FOR COORDINATION – AN EMPIRICAL STUDY ON ACTUAL AND POTENTIAL PRACTICE

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## Abstract

*Enterprise architecture management (EAM) is considered a means to guide the alignment of business- and IT-related concerns from an enterprise-wide perspective. Our goal in this paper is to understand by which means EAM supports this coordination task today and potentially in the future. We designed a questionnaire and conducted an empirical study (n=95) with participants from the field of EAM. Based on common coordination mechanisms from literature, we analyze (1) the relation between coordination mechanism and their current EAM support, (2) to what degree participants are aware of opportunities of EAM supporting coordination mechanisms, and (3) what the perceived gap between potential and realized EAM coordination support is. An exploratory factor analysis leads to three factors that represent coordination mechanisms in enterprises. Using these factors, we group participating enterprises in three different clusters: (1) non-coordinators, (2) dominators and (3) negotiators. We find that a similar awareness of opportunities exists in all three clusters, yet there are gaps in the realization of EAM coordination support: non-coordinators show the lowest realization, negotiators the highest. Based on this clustering, we provide implications on further EAM development options.*

*Keywords: enterprise architecture management, coordination mechanisms, empirical study*

# 1 INTRODUCTION

Enterprise architecture (EA) describes the fundamental structures of an enterprise (e.g. company, government agency) and the principles guiding its evolution in a business-to-IT view (ISO/IEC/IEEE, 2011). Enterprise architecture management (EAM) is concerned with the establishment and development of EA in order to consistently respond to business and IT goals, opportunities, and necessities. As such, the notion of EAM goes beyond EA modeling and includes as one of its main goals to establish and continuously maintain alignment between business and IT aspects.

The task of alignment can be considered as a problem of managing the simultaneous development of business processes and information systems. Therefore, alignment can be seen as a coordination task, following the notion of coordination as “managing dependencies between activities” (Malone & Crowston, 1994). Activities that need to be coordinated may be related to changes in value propositions or business processes up to changes of the supporting information systems and IT infrastructures. The involved activities will typically touch upon several additional aspects of the enterprise, such as human resourcing, finance, or reporting structures (Rouse, 2005).

While EAM is seen by many scholars as a means to support coordination (Lankhorst, 2005; Ross et al., 2006; Pulkkinen et al., 2007; Op’t Land et al., 2009), the issue of coordination between different organizational units and stakeholders is still seen as one of the most important issues to be addressed by future EAM research (Niemi, 2007; Lucke et al., 2010). While acknowledging that coordination is a core management task and therefore supported by a variety of disciplines in an enterprise, we aim at investigating the specific kind of coordination support that EAM can provide. Building on foundational work on coordination, we aim to discuss how EAM currently supports individual coordination mechanisms, and where there are discrepancies between actual and desired support. We summarize these efforts in the following research question:

*RQ: How can enterprise architecture management (EAM) support coordination?*

In order to gain a broad perspective on this question we conducted a questionnaire-based survey with 95 enterprise architects. In the paper at hand, we proceed as follows. In section two we briefly discuss the foundations of EAM. In section three we present the research design, including a summary of coordination mechanisms we identified based on a literature review on coordination. In section four we present our results, followed by a discussion in section five. The paper ends with a conclusion.

# 2 BACKGROUND

EAM has developed into an accepted practice in enterprises (Winter & Fischer, 2007). During the recent decade, the development has been strongly driven by practitioners (e.g., the TOGAF Framework (The Open Group, 2011)) and design oriented researchers (Mykhashchuk et al., 2011).

During recent years, aspects of EAM that facilitate coordination gained attention by the research community. For example, a discussion about EA *principles* emerged (see e.g. Proper & Greefhorst, 2010; Stelzer, 2010; Aier et al., 2011; Winter & Aier, 2011). EA principles allow for coordination by providing guidelines and rules that help actors to take decisions leading the enterprise in the same direction of action (The Open Group, 2011). Principles may be defined based on knowledge, experience and opinions of all sorts of people in an organization. This mixture of people is also the target audience of the principles (Proper & Greefhorst, 2010). In such a case, principles allow for a group-controlled and consensus-oriented coordination approach. The reduction of design freedom by the provision of principles is sometimes regarded as the essence of architecture (Dietz & Hoogervorst, 2008). Another coordination approach is EA *planning* (Pulkkinen et al., 2007), which produces to-be models of future EA states.

Still, coordination between different units and stakeholders in an enterprise is seen as one of the most critical issues that EAM needs to address in the future (Niemi, 2007; Lucke et al., 2010). In order to systematically assess the current and possible future coordination support provided by EAM we strive for a more abstract perspective on coordination which we consider necessary in order to identify directions to further develop the coordination capabilities of EAM.

### 3 RESEARCH DESIGN

#### 3.1 Overall Design

In order to address our research question, we conducted a questionnaire-based survey. The rationale for choosing this instrument is to get a broad view on coordination in the field, covering a larger number of organizations. The relations we are especially interested in are illustrated in figure 1.

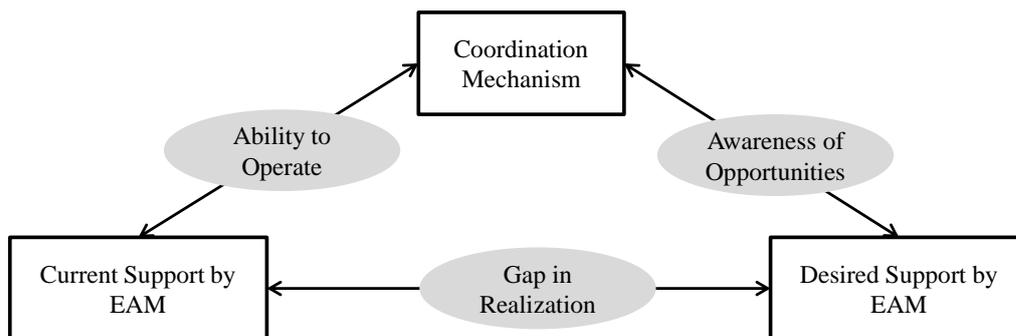


Figure 1. Relations between Coordination Mechanism and EAM Support

First, we are interested in prevalent *coordination mechanisms* and clusters of enterprises concerning these mechanisms. Second, concerning the support of EAM we are interested in the *current* and *desired support by EAM* within these enterprise clusters. The relation between the prevalent coordination mechanism and the current support by EAM we consider to be the *ability to operate*. The relation between the prevalent coordination mechanism and the desired support concerning the coordination mechanism we consider to be the *awareness of opportunities*. Between the current and the desired support of coordination by EAM there might be a *gap in realization*.

#### 3.2 Foundations of Coordination

In their work on coordination theory, Malone and Crowston describe coordination as the “act of working together harmoniously” (Malone & Crowston, 1990) and as “managing dependencies between activities” (Malone & Crowston, 1994). Coordination is found to be a key process in various fields, ranging from the management of shared resources in computer science to coordinating activities in an organizational context.

Coordination can be achieved through different mechanisms. Several scholars such as March and Simon (1958), Thompson (1967) and Mintzberg (1983) have identified coordination mechanisms in organizations and provided classification systems for these mechanisms. Martinez and Jarillo (1989) provide an extensive review of the literature on coordination mechanisms in multinational corporations. Their work is still considered relevant regarding the classification of coordination mechanisms (Schmid & Kretschmer, 2009). Martinez and Jarillo (1989) synthesize two primary classes of coordination mechanisms: (1) *structural* and (2) *informal mechanisms*. Since coordination mechanisms are regarded as tools to achieve integration of organizational units, they are not limited to multinational corporations, but may be found in all kinds of organizations. Table 1 provides an overview of this classification. A detailed discussion may be found in Martinez and Jarillo (1989).

Structural mechanisms	Informal mechanisms
(1) Departmentalization or grouping of organizational units	(6) Lateral or cross-departmental relations
(2) Centralization or decentralization of decision making	(7) Informal communication
(3) Formalization and standardization	(8) Socialization
(4) Planning	
(5) Output and behaviour control	

Table 1. Overview of coordination mechanisms (see Martinez and Jarillo (1989)).

The numerical order of the mechanisms from 1 through 8 indicates both a *rising effort in implementation* and an increasing *complexity level of strategies* they are able to support: While simple strategies can be coordinated using structural mechanisms only, more complex strategies demand the additional use of informal mechanisms of coordination. Informal coordination mechanisms are more costly, but at the same time capable of supporting more complex strategies than structural coordination mechanisms.

### 3.3 Questionnaire Design and Data Set

The participants were enterprise architects, consultants and further experts concerned with EAM. More than half of the participants (53.7%) belong to the group of corporate users. Consultants and vendors account for 37.9%. The remainder of the participant stated belonging to some other group. Consultants and other experts were specifically instructed to answer the questionnaire from the perspective of the customer project they were most knowledgeable about. We conducted the survey during an event held in Switzerland in late 2011. The questionnaire was administered in German language. The parts of the questionnaire that are reported in this paper have been translated to English. Participants of the survey were mostly employed in mid-level management positions in their respective organizations. We collected 95 questionnaires which the participants filled in during the event. The researchers were present at the event in order to provide assistance if questions were not understood properly.

For general information on the involved enterprises, we asked respondents about the size and industries of their organizations. We adopted the categorizations provided by Eurostat (2008) and the European Commission (2005). The majority of questionnaires were filled in by participants working for large enterprises: 38 questionnaires indicate an enterprise size between 1000 and 4999 employees, 37 a size of over 5000 employees. Regarding industries, enterprises from the insurance industry (25), information and communication systems industry (ICT; 21) financial services industry (20) form the dominant parts.

Besides general information on the participants and their organizations (such as experience with EA, personal role, industry or enterprise size and structure), the questionnaire contained statements covering the presence of individual coordination mechanisms in the organization. Respondents were also asked about current and desired EA support for these mechanisms. In each case, answers were given on a 5-point Likert scale (Likert, 1932) ranging from no agreement (1) to full agreement (5).

## 4 RESULTS

In this section, we will present the results of our survey. We identify several clusters of enterprises in respect to the coordination mechanisms used, and discuss how EAM may support these.

### 4.1 Coordination Mechanisms

In order to identify the underlying dimensions of the coordination mechanisms used, we applied an exploratory *factor analysis* using principal component analysis. The goal of this analysis method is to extract a number of latent factors from the variables in the data set. Missing values have been excluded pair-wise from the factor analysis. This resulted in the exclusion of 3 cases, leaving 92 cases. The data

set at hand met two important quality criteria that determine its suitability for factor analysis: First, the percentage of non-diagonal elements of the anti-image covariance matrix that are non-zero ( $>0.09$ ) has to be below a threshold of 25% (Dziuban & Shirkey, 1974). This holds true for our data set. Second, the Kaiser-Mayer-Olkin criterion for measuring sampling adequacy is 0.760, which defines the intercorrelation of the factors as “middling” (Kaiser & Rice, 1974). This is also considered in the acceptable range. We therefore consider our data set suitable for a factor analysis.

We used Varimax rotation with Kaiser normalization for the factor analysis. Item 1.11, concerning the control of compliance with formal hierarchies and standards has been dropped because it did not contribute to the factor identification. This has led to 3 factors for the remaining 10 items, which account for 63.5 percent of the total variance.

The 10 items and the corresponding factor loadings are presented in table 2. For each item, the factor it is assigned to is marked in grey.

Item ID	Item Description	Factor		
		1	2	3
1.1	Existence of a communication-fostering corporate culture	.846	-.129	.139
1.2	Strong identification with the values and goals of our company	.761	.004	.157
1.3	Participation in company-wide meetings (e.g. by supervisors)	.570	-.128	.351
1.4	Heavy use of planning tools such as strategic planning or budgeting	.547	.132	.060
1.5	High degree of discretion in relation to work granted by supervisors	.541	-.496	.052
1.6	Reliance on formal rules and standards	.055	.881	-.058
1.7	Strict adherence to formal hierarchies and official channels	-.024	.840	-.029
1.8	Designated liaison roles to other departments, independent of the hierarchy	.008	-.122	.893
1.9	Strong contact with other organizational units, even outside the official organizational structure	.342	.250	.696
1.10	Provision of cross-departmental teams to tackle tasks and challenges	.390	-.395	.631
	<i>Cronbach's Alpha</i>	.733	.766	.715

Table 2. Factor results

To test the reliability of the factor scale, we calculated Cronbach's Alpha for each factor. Values above 0.7 indicate adequate reliability, which holds true for our data set. It must be noted, however, that the values for some factors are only slightly larger than the 0.7 threshold, e.g. 0.715 for factor 3. In order to assign items to factors, factor loadings must not be below 0.3 to 0.4 (Hair Jr et al., 2006). For an unambiguous assignment of an item to a factor, loadings of at least 0.5 are generally seen as the minimum threshold. This is the case for our data set, with all items assigned to their respective factors by a loading of more than 0.5. We identified the following three factors:

*Factor 1* is represented by 5 items that indicate intensive communication to reach common objectives. It could be characterized as *coordination by all-embracing decision making*. While discussing and defining goals with “all” stakeholders concerned using communication and planning instruments, employees are given high discretion in achieving these goals. An organizational environment fostering communication and identification with enterprise goals is associated with this factor. The factor is explaining approx. 34% of the variance in the dataset.

*Factor 2* is represented by 2 items and forms an antipole to the two other factors. We call this factor *coordination by vertical structure*. Items in this factor describe strict communication channels in forms of organizational hierarchy and high regulation of the work done. In contrast, items defining structured or unstructured communication have very low loadings for this factor. The factor is explaining approx. 18% of the variance in the dataset.

*Factor 3* is represented by 3 items. We consider the factor as *coordination by horizontal structure*. The factor is located in between of the two extremes represented by factors 1 and 2. Coordination is supported by communication, yet communication occurs in a more institutionalized way (e.g., via

boards or task forces) than in the case of factor 1. Items in this component tend to provide more guidance on the communication channels involved or the responsibilities for communication. This factor is more closely related to factor 1 than to factor 2, as can be seen by the item loadings. Two items in this factor and one item in factor 1 also have loadings of more than 0.3 for the respective other factor, while no items of either factor 1 or factor 3 have strong cross-loadings on factor 2. Overall, the factor is explaining approx. 11% of the variance in the dataset.

In order to distinguish groups of respondents that rely on similar mechanisms of coordination, we performed a *cluster analysis*. We built on the three factors identified by our exploratory factor analysis. We chose a hierarchical clustering algorithm because these algorithms do not include any ex-ante assumptions on the eventual number of clusters (Hair Jr et al., 2011). Instead, all possible clustering results are presented to the researcher. We used the “average within-group linkage” clustering algorithm and selected “squared Euclidean distance” as the distance measure. Using the agglomeration schedule and dendrogram proposed by the algorithm, we identified three clusters. Due to missing values, 3 cases had to be excluded, so the clustering was performed on the remaining 92 cases.

In order to analyze and compare the clusters, we identified their centroids, by considering the mean factor values within each cluster. This led to the following net diagram shown in figure 2.

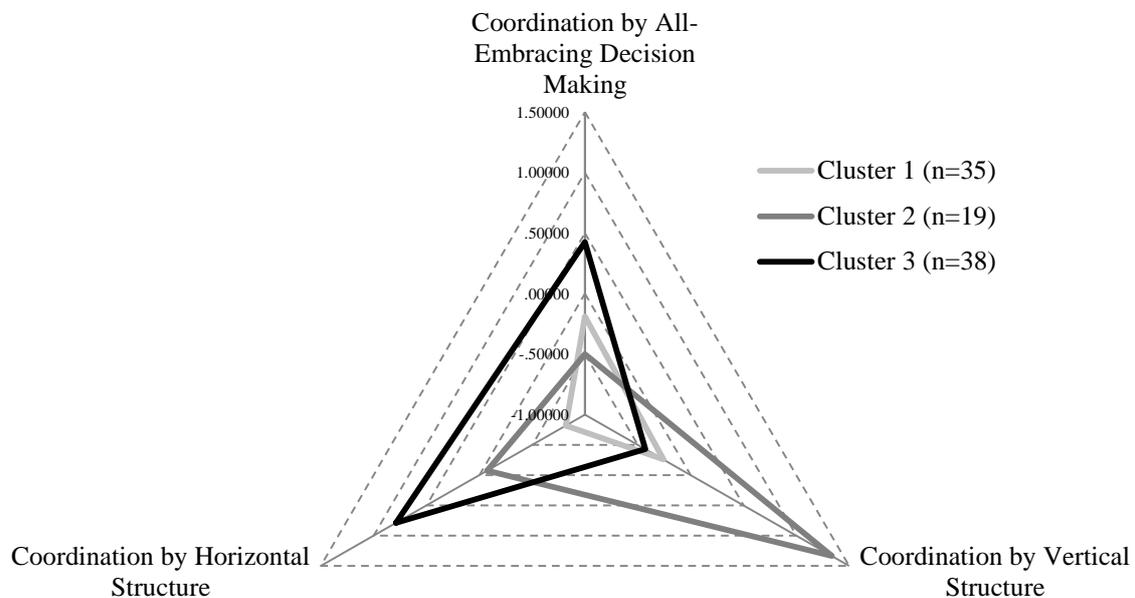


Figure 2. Net diagram of identified clusters

We identified three clusters by applying the described method. These clusters are differentiated in the intensity the factor scores occur.

*Cluster 1* has overall small means for all three factors. Coordination by horizontal structure is almost non-existent, the other two factors roughly exist to the same weak extent. The enterprises in this cluster seem to employ a pragmatic, hands-on approach, coordinating only as much as necessary or possible. To emphasize the overall low level of coordination, we further address this cluster as *non-coordinators*.

*Cluster 2* has a high preference for coordination by vertical structure. Enterprises located in this cluster have strict hierarchies and strongly restrict freedom in decision making by applying rules and standards. Communication tends to be guided by the horizontal structure, e.g. by defining committees and official channels of communication. We further address this cluster as *dominators*.

*Cluster 3* includes enterprises that have formal coordination up to a certain extent, but focus more on coordinating driven by communication – either in a more structured (coordination by horizontal structure) or informal (coordination by all-embracing decision making) way. These enterprises are characterized by seeking broad consensus on planned goals and some commonly defined rules, yet they grant a high degree of discretion related to execution. We further address this cluster as *negotiators*.

While clusters two and three can in some way be considered antipoles, cluster one represents enterprises with coordination mechanisms established on a low level.

#### 4.2 Desired & Current Coordination Support by EAM

We asked about EAM supporting coordination in another section of the questionnaire. As in the previous block, the items are designed to represent the coordination mechanisms identified in section 3.2. Values are given on a Likert scale ranging from 1 (no agreement) to 5 (full agreement). A graphical representation is given in figure 3.

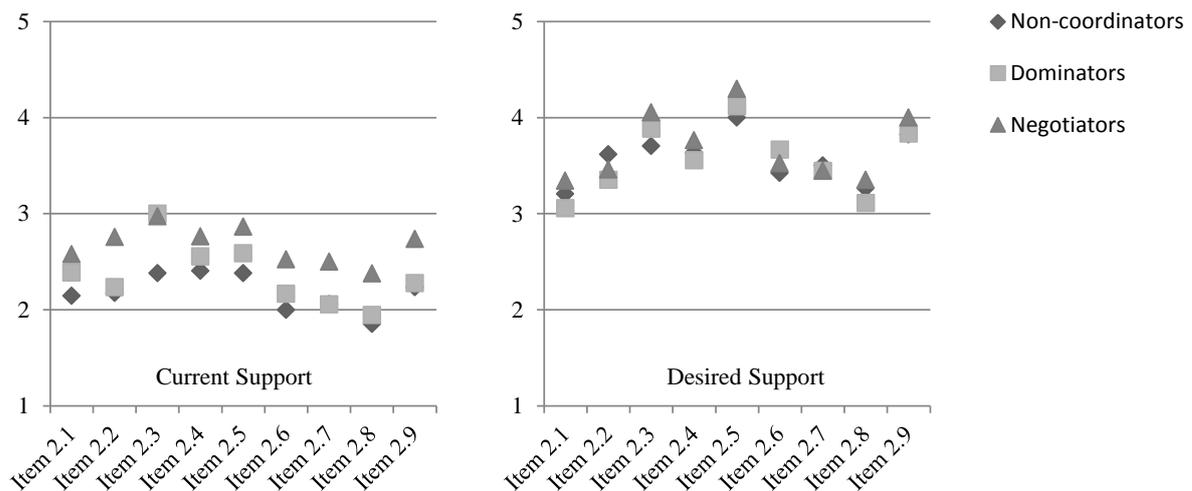


Figure 3. Means of and difference between current and desired EAM coordination support

Concerning data across all three clusters, the biggest difference between current and desired EAM support concerns its use as a planning instrument (item 2.5).

Regarding individual clusters, *negotiators* show the highest values for both current and desired EAM coordination support, whereas the difference between current and desired support is the lowest among all three clusters. This cluster appears to group the most ambitious enterprises with respect to EAM's role in assisting coordination that have already achieved a certain degree of maturity.

The *dominators* are characterized by medium to high values regarding current EAM support of structural coordination mechanisms (items 2.1; 2.3), but comparatively low values regarding EAM support of informal mechanisms like assisting horizontally structured communication (items 2.7; 2.8) or fostering networking (items 2.6; 2.9). However, the difference between current and desired EAM support with respect to informal coordination mechanisms is among the highest for this cluster.

In the *non-coordinators* cluster, values for both current and desired EAM coordination support tend to be the lowest among all three clusters. An exception is item 2.2 (desired support for decentralized decision-making), which is a highly desired support in this cluster. This may be indicative of the autonomous nature of enterprises in this cluster and the overall low presence of coordination mechanisms.

## 5 DISCUSSION

From the cluster analysis we learn that there is a gap between our clusters about the extent to which they currently support coordination by means of EAM. Hence, we conclude that enterprises have a differing *ability to operate* with their EAM approach in general. Overall, the *negotiators* show the strongest current implementation values of EAM coordination support. On the other hand, the *non-coordinators* show the smallest values, which indicates an overall lesser degree of EAM support for coordination mechanisms in this cluster, be they more structural or more informal.

Based on this perception of the current state, it is remarkable that the differences in the desired support of coordination are less strong – the three clusters show rather similar values here. Thus, an *awareness of opportunities* concerning EA and coordination exists in almost all enterprises. However, the *gap in realization* is apparent to a different extent in the three clusters. Regarding the high level of desired support across all three clusters, it must be kept in mind that the questionnaire was filled out by EA experts who are likely to have higher expectations towards EA than non-experts.

Coordinating on an enterprise level is often associated with a loss of autonomy for individual domains and organizational units in the enterprise. Possible benefits from enterprise-wide coordination need to be put in relation to the accompanying risk: high implementation efforts and possible organizational resistance. Specific stakeholders may perceive enterprise-wide coordination and the goal of global optimization as sub-optimizing their domains (Asfaw et al., 2009), and may consequently not be willing to support or it. Depending on the power structures, they might even fight it. Related to the organizational structure, enterprise-level approaches concerning coordination may be considered fruitful by people in charge of organization-wide tasks, but be resisted by the strong majority of stakeholders that are concerned with a well-defined subset of the overall organization. For example, in an organization with a strong divisional structure of autonomous units, enterprise architects associated with an enterprise-level shared service unit may see coordination potential, but face considerable resistance in convincing divisional managers.

Enterprises that rely on structural coordination mechanisms like the use of standards and guidelines to coordinate can be supported by EAM principles. However, setting principles and promoting use of and compliance with them, demands horizontal mechanisms of governance and coordination, i.e. mechanisms based on institutionalized communication like committees and task forces (Boh & Yellin, 2007). By providing enterprise-level transparency, EAM may assist in establishing horizontal coordination mechanisms that eventually positively affect definition and use of principles. Stimulating coordination in a guided way may form the foundation for further networks of personal communication and dialogue.

Ultimately, general findings concerning antecedents for EAM success in general also hold true for the scenario of coordination support in particular. Namely, these antecedents are transparency on the as-is state of the enterprise, horizontal governance structures and top-management support for the EAM function (Radeke, 2011).

## 6 SUMMARY & LIMITATIONS

Our initially asked research question was how EAM can support coordination in enterprises. To address that question, we focused on the support of specific coordination mechanisms by EAM. Analyzing empirical data, we identified three factors that determine the mix of coordination mechanisms used – coordination by all-embracing decision making, coordination by vertical structure and coordination by horizontal structure. Based on these factors, we identified three clusters of enterprises (namely non-coordinators, dominators and negotiators). All clusters have a gap between realized EAM support and the desired EAM support for coordination in common. While the extent of realized EAM (thus, the ability to operate) differs between the clusters, they share a similar awareness of opportunities.

The empirical study we conducted provides two contributions to EAM practice and research: (1) Identifying the mix of coordination mechanisms in enterprises as a contingency factor for EAM coordination support, and (2) clustering enterprises with respect to prevalent coordination mechanisms to draw implications for the EAM approach to be used.

While offering an initial idea on EAM coordination support based on empirical data, the current work is based on a very aggregate view of coordination mechanisms and EAM methods and models supporting these. This constitutes an important limitation of our work: While providing a first overview, the high level of abstraction clearly limits a detailed mapping of individual coordination mechanisms (e.g., planning) to concrete EAM deliverables (e.g., dependency models, principles with a certain granularity).

As future work, we therefore suggest gathering both qualitative and quantitative data on individual coordination mechanisms and their support by specific EAM deliverables.

## Acknowledgement

*This work has been supported by the Swiss National Science Foundation (SNSF).*

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