

# Modeling the contribution of enterprise architecture practice to the achievement of business goals

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**Abstract:** Enterprise architecture is a young, but well-accepted discipline in information management. Establishing the effectiveness of an enterprise architecture practice, however, appears difficult. In this paper we introduce an Architecture Effectiveness Model (AEM) to express how enterprise architecture practices are meant to contribute to the business goals of an organization. We developed an AEM for three different organizations. These three instances show that the concept of the AEM is applicable in a variety of organizations. It also shows that the objectives of enterprise architecture are not to be restricted to financial goals. The AEM can be used by organizations to set coherent priorities for their architectural practices and to define KPIs for measuring the effectiveness of these practices.

**Keywords:** Enterprise architecture, organizational effectiveness, cause effect, key performance indicator, design research, architecture effectiveness model.

## 1 Effectiveness of enterprise architecture

Enterprise architecture, the practice of developing and applying a consistent set of rules and models that guide the design and implementation of processes, organizational structures, information flows, and technical infrastructure within an organization [22], is a relatively young, but well-accepted discipline [4, 14]. The discipline is in a stage of development as is evidenced by the many practitioners conferences dedicated to the practice of enterprise architecture, the rapid emergence of books on the topic and the emergence of standardization efforts [10, 18].

Establishing the effectiveness of enterprise architecture, however, appears difficult [10, 16]. The effect of architecture on the business goals is indirect and the difficulty in linking the two may be compared to the difficulty of linking learning and growth efforts to strategic objectives [8]. The wide ranging nature of enterprise architecture makes it difficult to quantify the impact of architecture [10],

though the need for clearly expressing the contribution of architecture to the organization's goals is increasingly felt. Enterprise architecture teams are under constant pressure to demonstrate their value to the organization [23]. The topic of architectural effectiveness also starts to appear on professional conferences [5, 19]. Some statistical evidence of effectiveness is appearing [1]. However, statistical evidence alone does not help an organization to clearly define the contribution of architecture to their business goals. In addition, much effectiveness research concentrates on financial benefits [1, 15]. We will argue that this is too limited a view.

In this paper we present an Architecture Effectiveness Model (AEM) that can be used to model the contribution of the architectural practice to the organization's business goals. The AEM is based on the concept of cause-and-effect. As such we work in the tradition of the balanced scorecard [7, 9, 11, 16] and especially the strategy map [8]. Other applications of the cause-effect model in the field of enterprise architecture are [3] and [12]. Though the cause-effect model can occasionally be encountered in the architecture profession to express the objectives of the architectural practice in a specific organization, extensive research into its use as an instrument to express intended and actual effectiveness of architecture has as yet not been done. Our research is akin to research on the maturity of enterprise architecture [3, 14, 17]. However, we focus on the contribution of architecture to business goals, rather than on how well the architecture processes are performed.

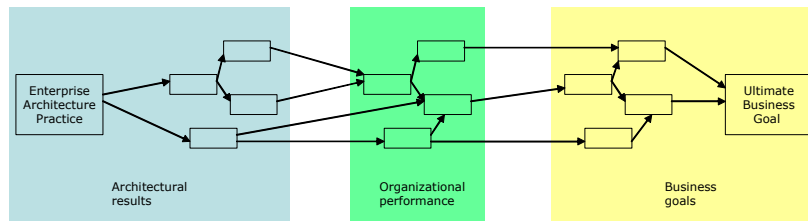
The approach we took in developing the AEM is that of design-science research [6, 21]. We tested the concept of the AEM in three cases. We found that the AEM is applicable as an instrument in all three cases, but that the exact instantiations of the AEM in the three cases varies. It appears that the three cases differ in their objectives of practicing enterprise architecture and that these objectives are not limited to financial gains. In terms of the three domains of business performance of [20], architecture contributes to business performance, or even organizational effectiveness, not only to financial performance.

In section 2 the structure and aim of the AEM is discussed. Its application in three cases is described in section 3. Section 4 compares the three applications. In section 5, we discuss conclusions and suggestions for further research.

## 2 The architecture effectiveness model

The goal of our research is to develop an instrument for making explicit the intended and actual contribution of the architectural practice to the organizational goals. As we are dealing with a new solution to a hitherto unsolved problem: the explication of the effectiveness of an enterprise architecture practice, this may be considered a case of design-science research [6]. From our goal we defined requirements, assumptions and specifications for the instrument as recommended by [21]. Examples of the requirements we formulated are (1) *The formulation of the intended contribution of the architectural practice to the business goals must be tuned to the organization.* If the contribution of architecture is stated in general

terms only, it is very difficult to make the connection to what is actually happening in the organization; (2) *The line of reasoning from architecture to business goals must be transparent.* The instrument must be crystal clear as architecture is often considered rather abstract. From the formulated requirements we reasoned that a cause-effect network seemed a suitable design, as such a network allows us to build an explicit link between architectural practice efforts and business goals by means of a number of intermediate steps. The choice for this kind of solution was strengthened by its similar kind of use in the strategy map of [8]. The AEM that resulted relates architectural efforts to business goals by building a cause-effect based network. Figure 1 shows the general structure of an AEM.



**Fig. 1.** The general structure of an Architecture Effectiveness Model

The basic concepts of an AEM are the effect, represented by a rectangle and the cause-effect relation, represented by an arrow between two rectangles. An effect in this context is defined as an intended result. A cause-effect relation represents the purposeful contribution of one effect to another effect.

The AEM is intended to reflect the objectives of architecture for an organization in the next couple of years. It shows what the architecture practice strives for. This implies that it represents a choice: there is not one right model, only a model that is agreed upon within the organization. The instantiation of an AEM differs between organizations. As figure 1 shows, an AEM contains on the left the enterprise architecture practice, the whole of activities, responsibilities and actors involved in the development and application of enterprise architecture within the organization. On the right it contains the ultimate business goal: the primary goal of the organization. The steps in between link the two.

An AEM can be modelled as an acyclic directed graph. It consists of nodes and directed edges. The nodes represent effects that are desirable for the organization. Examples are 'having overview' or 'better project control' or 'reduced costs'. The edges represent the unidirectional relation 'contributes to'. The word 'contributes' is used instead of 'causes' to reflect the fact that the contributing effect need not be the sole factor influencing the resulting effect. Experience with enterprise architecture in many organizations suggests that the effects (the nodes) can be divided into three types. The architectural results are positioned at the left hand of the graph. These are the effects that are fully determined by the architectural practice. The business goal effects are positioned at the right hand of the graph. These are the business results defined by senior management. The enterprise architecture

practice is one of the factors contributing to these goals. In between we find effects in the area of the operations of the organization: the internal processes. We call these effects the organizational performance effects. This division into three types of effects echoes the categories of learning and growth, internal process and customer perspective of the balanced scorecard strategy map [8].

$AEM = (N, E)$  with  $N = (AR \cup OP \cup BG)$  the set of nodes,  
 where  $AR$  = Architectural Result effects;  $OP$  = Organizational Performance effects;  $BG$  = Business Goal effects and  
 $E$  the set of edges on  $N$  (i.e.  $E$  is a subset of  $N \times N$ ) satisfying  
 $OP \times AR \cap E = \emptyset$  and  $BG \times OP \cap E = \emptyset$  and  $BG \times AR \cap E = \emptyset$ .

An AEM has only one source (node with indegree 0), the Enterprise Architecture Practice node, and usually also only one sink (node with outdegree 0), the Ultimate Business Goal, though more than one sink is possible if an organization has multiple purposes. Note that the model does not preclude AR effects to be related directly to BG effects. In an AEM the following key effects may be distinguished.

- *Key step*. A key step is defined as an effect that has both an indegree and an outdegree of a specified minimum  $s$ . In other words, it has at least  $s$  contributing effects and it contributes itself to at least  $s$  other effects. So  $n \in N$  is a key step iff  $\text{indegree}(n) \geq s$  AND  $\text{outdegree}(n) \geq s$ . The exact value of  $s$  is to be determined yet. On the basis of the three cases we have studied so far, we have set  $s$  to 3, for the time being. This seems a reasonable value with respect to the total number of nodes and edges in each of the three cases.
- *Key motivator*. A key motivator is defined as an effect with the largest indegree (i.e. the largest number of contributing effects). So  $n \in N$  is a key motivator iff  $\text{indegree}(n) = \max(\text{indegree}(m)), m \in N$ . It is an effect that is the aim of many other effects. Note that there may be more than one key motivator.
- *Key enabler*. A key enabler is defined as an effect with the largest outdegree (i.e. the largest number of effects it contributes to). So  $n \in N$  is a key enabler iff  $\text{outdegree}(n) = \max(\text{outdegree}(m)), m \in N$ . It is an effect that contributes to many other effects. There also may be more than one key enabler.

The model as such presents the intended contribution of architecture to the business goals by way of a number of intermediate results. By attaching key performance indicators (KPIs) to the effects, the actual contribution over time can be measured. Regarding the effects as goals, an approach like the Goal Question Method [2] can be adopted to formulate KPIs.

### 3 Three applications of the AEM concept

The AEM concept has been applied in three organizations: a large municipality, a university of professional education and an international financial institution. The

three organizations have in common that they had all been engaged in organization-wide enterprise architecture initiatives for two to three years. The building of the AEM was done by the architects of the organization, assisted by either business strategy documents or opinion leaders. The researcher only fulfilled a moderator role, asking questions and recording results. In each occasion the AEM went through at least two versions. The final version was accepted by the person in charge of the enterprise architecture practice. It was generally felt, however, that the AEM should always remain open to extension from new insights or needs.

The three organizations are of different type, one of them being a commercial profit organization, one an educational institution with a not-for-profit goal, but with some goals of growth and a limited sense of competition, and one a municipality strongly ruled by government regulations. This variation was intentionally sought, as our objective was to test the use of the AEM in different circumstances.

### ***3.1 Case 1: A Municipality***

The first application of the AEM is in a municipality of more than 200,000 citizens. The municipality has about 2200 employees, about 100 of which work in IT. Architecture is the responsibility of the Policies, Standards and Programs team which is positioned within the IT department and consists of seven employees, three of which have the role of enterprise architect.

A preliminary AEM was established in a workshop with eight participants. The lead architect selected the participants from the various architecture stakeholder groups: architects, program managers, controllers, information managers, IS management. Brown paper techniques were used to build the AEM. At the far left of the brown paper a card was put with the text 'enterprise architecture practice'. At the far right a card was put with the text 'coalition charter', as the realization of the coalition charter was the primary goal of the municipality organization. The purpose of the exercise was explained as filling the gap between the two, or in other words, determining what the architectural practice should contribute to realizing the coalition charter. Participants were first asked to write down on cards the results they thought architecture should deliver or contribute to. These were used as a base to build the model together. Starting at the right, the moderating researcher asked if anyone had written down a result that would contribute to realizing the coalition charter. One participant volunteered a card with the text 'customer service' which was added to the brown paper to the left of the 'coalition charter' card. This called forth other cards from other participants. Each card was discussed and after consensus was reached it was added in the right place on the wall. When the flow of cards stagnated attention was turned to the left side of the wall. This time the question was to indicate the results of practicing enterprise architecture. This brought forth a new flow of cards, with architectural results like 'standards', 'common framework' and 'overview'. When the participants felt they had no more cards to add, the group turned to closing the gap between left and

right. This constituted the final stage of building the AEM. After the workshop, the AEM was distributed among the participants for review. A few simplifications were suggested, which were finalized in a second workshop. These simplifications dealt with combining a number of cards into one. For instance, the combination of ‘data consistency’, ‘data integrity’, ‘data reliability’ and ‘data security’ into the one result ‘trusted information’. In figure 2 the final AEM is shown. The colors reflect the three types of effects, blue (grey, dotted line) for architectural results, green (dark grey, solid line) for organizational performance effects and yellow (light grey, stripes) for business goals.

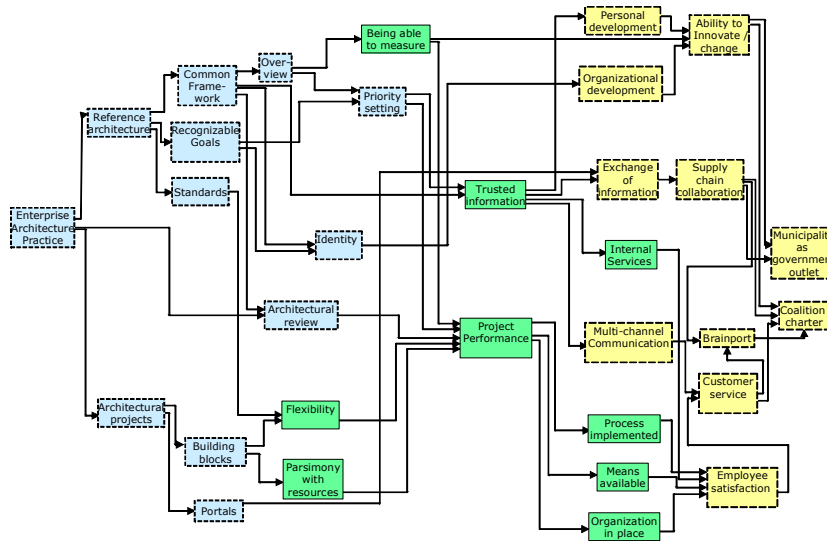


Fig. 2. The AEM of a municipality

Effects like ‘employee satisfaction’, ‘personal development’, ‘organizational development’ and ‘identity’ show a focus on employees and organization. The key nodes are all in the categories of architectural results (‘common framework’) and organizational performance (‘project performance’ and ‘trusted information’). This case was the only one with two end nodes: ‘coalition charter’ and ‘municipality as government outlet’, reflecting the dual character of the municipality in having its own coalition goals as well as being a representative of government.

After it was completed, the AEM was used to define paths from the start node to the end node, in order to set priorities in architecture activities. An example is the path ‘enterprise architecture practice’, contributes to ‘architectural review’ contributes to ‘project performance’ contributes to ‘process implemented’, ‘means available’ and ‘organization in place’ contribute to ‘employee satisfaction’ contributes to ‘customer service’ contributes to ‘coalition charter’. It was decided to define KPIs on this path for the effects ‘project performance’, ‘process implemented’, ‘means available’, ‘organization in place’ and ‘employee satisfaction’.

### ***3.2 Case 2: A University of Professional Education***

The second application of the AEM concerns a university of professional education with more than 16,000 students and about 1500 employees. The university has an IT department of about 50 employees. Architecture is taken care of by the one information architect. The preliminary model was established in a joint effort between the information architect and one of the researchers. The researcher mainly asked questions for elaboration to sharpen the reasoning of the information architect, whereas the information architect built the actual model. In this case too, the building process started at the right, then turned to the left and finally closed the gap. The ultimate business goal for this organization was 'playing its role in society'. Building the preliminary model took six hours. The resultant model was validated by the director of one of the divisions, the Centre of Innovation and Knowledge Distribution, a key stakeholder of enterprise architecture. The architect was also present in this discussion. We explained the purpose and structure of the model. Then we concentrated on the business goals and asked the director if he recognized the goals and if he had any additions. Apart from fine tuning some of the goals, the director made two main additions concerning accreditation and partnering. This worked through in the organizational performance effects by putting more focus on 'exchange of information' and 'quality of information'. Architectural result effects were not changed. The focus in the emergent model was much on supporting the primary processes and facilitating collaboration. Most nodes fall within the category of business goal effects. The key nodes are all in the areas of organizational performance ('exchange of information') and business goals ('aligned process', 'more students'). As with the municipality, financial goals do not occur in the model. Due to space limitations the actual AEM is not included.

### ***3.3 Case 3: A Financial Institution***

The third application concerns a multinational financial institution with more than 60,000 employees. Architecture is positioned within the Operations department (14,000 employees) and consists of both global architects and architects within the various divisions. In all there are about 175 architects.

In this case, the model was discussed and revised by various people in varying constellations. The model was made within the context of an architecture maturity improvement program. The preliminary model was established in a joint effort between the person responsible for the architecture improvement program and the researcher and then refined over a number of seven versions, incorporating input from discussions with various architects, until the final version emerged. In this process each contributor added his own concerns to the model. One person focused on the professionalizing effect of architecture, another introduced effects concerning simplification. These additions concerned architectural result nodes

and organizational performance nodes. The source for the business goal nodes were existing strategic documents. The ultimate business goal in this case was ‘continuity and profit’. Figure 3 contains the final model.

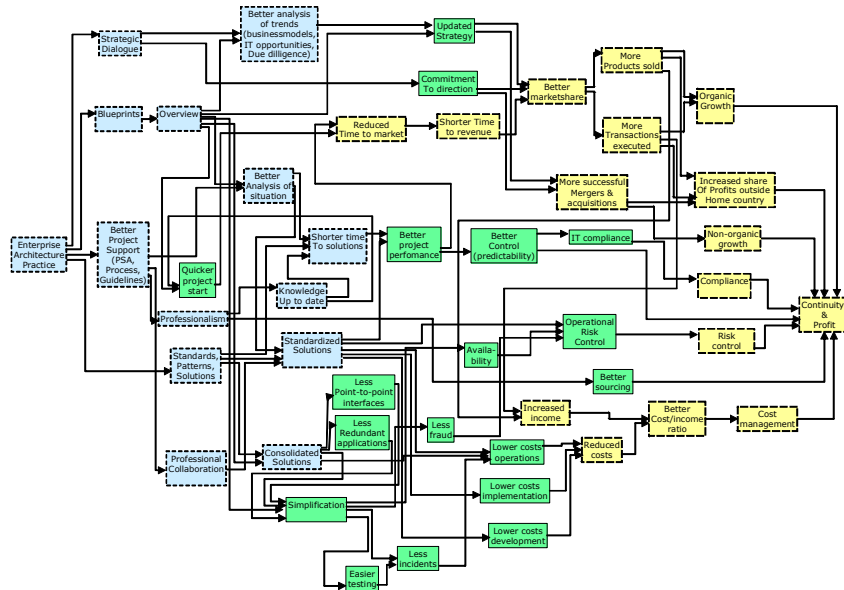


Fig. 3. The AEM of a financial institution

The focus in the financial AEM is on organizational processes and control. The key nodes are in the architectural results area (‘standardized solutions’, ‘overview’) and organizational performance area (‘simplification’). Professionalism and control are two areas that are unique to this case.

#### 4 Discussion

The AEM instrument could be applied to all three cases. In all cases the distinction between architectural results, organizational performance effects and the business goal effects could be established. And though the actual definition of the nodes in these three categories differed, we can identify a common core: nodes like ‘overview’, ‘standards’, ‘flexibility’, ‘exchange of information’, and ‘project performance’ are shared among two or all three of the models. Though the model does not preclude a direct relation between architectural results and business goal effects, the three cases show no such direct link. In the cases, all architectural results are linked to business goals via organizational performance effects. It is a matter for further research to investigate whether this is the case in general.

The differences between the three instantiations reflect the characteristics of the organizations. In terms of the value dimensions of [13], the municipality exhibits a more internal focus than the university which is more externally focussed. On the structure dimension the financial institution exhibits a greater tendency to control than the municipality. Though the number of three is too small to draw any definite conclusions, the cases do indicate that the intended contribution of the enterprise architecture practice to the business goals is partly organization specific and can not be expressed fully in general terms. In only one case financial results play an important role.

Table 1 shows some figures for the three cases. The numbers between brackets show the number of incoming (key motivator) or outgoing (key enabler) edges.

**Table 1.** Statistics of findings of cases

Characteristic	Municipality	Education	Financial
Number of effects	32	48	48
Distribution over EA/OP/BG	12 / 9 / 11	17 / 11 / 20	14 / 18 / 16
Number of relations	52	78	83
Key steps	Project performance	Aligned process	Simplification Standardized solutions
Key motivator	Project performance (5)	More students (5)	Standardized solutions (4)
Key enabler	Common framework (4) Trusted information (4)	Exchange of in- formation (6)	Overview (6)

A number of additional observations can be made. The three cases do not differ greatly in AEM size and the distribution of nodes over the three categories is quite evenly. The cases do differ in key node type: architectural results ('standardized solutions' and 'overview') and organizational performance ('simplification') for the financial institution, organizational performance ('project performance' and 'trusted information') and architectural results ('common framework') for the municipality and business goals ('aligned process' and 'more students') and organizational performance ('exchange of information') for the university. The number of three cases is too small to draw any definite conclusions from these observations, so we will leave that to further research.

Much of the benefit of the AEM lies in the process of building the model. The three cases showed that building the cause-effect chain from the enterprise architecture practice to the primary business goals stimulates the architecture stakeholders to reflect on the real value of architecture for their organization. As the cases also show, the development of an AEM can be done in various settings, varying from a sequence of bilateral exercises to a workshop with up to ten participants. As the AEM is a normative model, essential in the process is the final acceptance of the model by the person responsible for the architectural practice.

An AEM can not only be used to show the intended contribution of the enterprise architecture practice to the business goals. It can be taken one step further in defining key performance indicators to measure this contribution over time. From

the model we can select effects we wish to measure. Criteria for selecting these effects are the importance of the effect in the organization, the extent of influence of architecture on the effect and the feasibility of measuring KPIs for the effect. A good practice is to select two or more effects that are directly linked, at least one that is largely determined by the architecture practice and at least one that lies in the organizational performance or business goal area. In this way progress in an architectural result is linked to progress in an organizational result. In any AEM, many paths can be chosen from the start node to the end node. Each path represents a line of reasoning connecting the architecture practice to the business goals. By choosing KPIs on one path, a coherent priority setting is achieved.

## 5 Evaluation and conclusions

We evaluated the design of the AEM against the seven guidelines formulated by [6]. Table 2 summarizes the results of this evaluation.

**Table 2.** Applying the guidelines of Hevner et al. 2004 to the AEM

Guideline 1: design as an artifact	Our research delivered a construct, a model and a method as described in sections 2 and 3.
Guideline 2: problem relevance	The AEM definitely seems to fulfill a need, as expressed in section 1 of this paper.
Guideline 3: design evaluation	The AEM is applied in three types of cases (external validity). Construct validity is striven for by using multiple participants in building the model. Reliability is achieved by describing the process by which the different AEMs were built. Internal validity is not applicable as the case studies were exploratory in nature [24].
Guideline 4: research contributions	The contribution is mainly to the design foundation in that it presents a novel way of making explicit the contribution of enterprise architecture to the business goals.
Guideline 5: research rigor	The approach is in the tradition of the balanced scorecard.
Guideline 6: design as a search process	Requirements were defined excluding certain approaches as described in section 2.
Guideline 7: communication of research	This paper to the research community.

There are some limitations to our research so far. The AEM has been applied to a municipality, a professional university and a financial institution. From these applications some interesting similarities and differences can be derived. However, the number of three cases is very limited. We intend to extend the number of

AEMs in the future which will make it possible to analyze a larger sample. Also the three applications differed somewhat in the actual manner the AEM was built. Though in all cases the approach of starting at the right, moving to the left and then closing the gap was followed, this was done in a workshop setting in one case, in a face-to-face meeting with an information architect in the second case, and in a number of consecutive sessions with varying participants in the third case. These differences sprang from practical reasons mainly. As an anonymous reviewer pointed out to us, it might be interesting to investigate whether a standard implementation model could be developed.

It must be borne in mind that architecture is not the only factor contributing to the organizational performance and business goals. In practice this means that actual KPIs have to be closely investigated to explain their actual values. But this is good practice for any KPI measurements.

In this paper we presented an instrument for modeling the contribution of the enterprise architecture practice to the organizational goals, the AEM. We tested the AEM in three very different organizations. The AEM appeared applicable to all three organizations, resulting in instantiations that clearly reflect the characteristics of the organization and provide a transparent connection between the enterprise architecture practice and the ultimate business goal. The AEM presents a novel way of making explicit the contribution of enterprise architecture to the business goals and as such enables further research into the effectiveness of enterprise architecture. It fills a gap that up till now existed between the architecture practice and the area of achieving business goals.

The three cases show that not every organization is focused on financial goals. Our conclusion is that the focus of much research on financial results is therefore excluding whole categories of use of enterprise architecture in organizations. In our view a purely financial approach to architecture effectiveness is too restrictive.

The AEM shows similarities with the balanced scorecard (BSC) strategy map in that it links organizational efforts to organizational objectives by a cause-effect relation. The BSC perspectives of customer and internal process are recognizable in the business goal effects and organizational performance effects, respectively. The architectural result effects are comparable to the learning and growth perspective. In organizations that have implemented the BSC, the AEM can be linked to the strategy map. If no BSC is implemented, the AEM might be a first step in doing so. As architects are usually very knowledgeable about the organization, they are likely candidates to initiate such an initiative.

The AEM adds to the existing research on architecture maturity [3, 14, 17] by focusing on the contribution of architecture to the business goals (effectiveness), rather than on how well the architecture processes are performed (maturity). It would be interesting to relate maturity and effectiveness. The hypothesis being that a greater maturity should lead to a greater effectiveness. We intend to perform a longitudinal study to investigate precisely this relation.

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