Improving Solution Architecting Practices

Poort, E.R.

2012

7

Successful Architectural Knowledge Sharing: Beware of Emotions

This chapter presents the analysis and key findings of a survey on architectural knowledge sharing. The responses of 97 architects working in the Dutch IT Industry were analyzed by correlating practices and challenges with project size and success. Impact mechanisms between project size, project success, and architectural knowledge sharing practices and challenges were deduced based on reasoning, experience and literature. We find that architects run into numerous and diverse challenges sharing architectural knowledge, but that the only challenges that have a significant impact are the emotional challenges related to interpersonal relationships. Thus, architects should be careful when dealing with emotions in knowledge sharing.

7.1 Introduction

In recent years, architectural knowledge (AK), including architecture design decisions, has become a topic of considerable research interest. Management and sharing of AK are considered to be important practices in good architecting [Lago and van Vliet, 2006, Tyree and Akerman, 2005, Clements and Shaw, 2006, Farenhorst and de Boer, 2009, Ali Babar et al., 2009]. In our quest to improve solution architecting, we decided to look into the relationship between architectural knowledge sharing and challenges in solution delivery projects.

In the beginning of 2008, the members of the Logica Netherlands architecture community of practice were surveyed. The main reason for this survey was to establish a baseline of current practice in architectural knowledge sharing (AKS), and to gain insight into the mechanisms around AKS and related challenges in projects. These ob-

jectives together amount to RQ-2c. The company was interested in these mechanisms because they saw architectural knowledge management as a way to improve IT project performance. The architects were asked about the content, manner, reasons and timing of the AK sharing they did in their latest project; both obtaining and sharing knowledge towards others. They were also asked about the challenges they faced. Furthermore, they were asked to identify various properties of their latest project's context, such as project size and success factors.

Even though the architects surveyed all work for the same IT services company, according to the survey 64% of them is doing so mostly at customers' sites. As a consequence, the survey results represent a mix of AK sharing practices in Logica and in Logica's customer base, which includes major Dutch companies and government institutions.

7.2 Survey Description

The invitation to participate in the survey was sent out by e-mail to 360 members of the Netherlands (NL) Architecture Community of Practice (ACoP) of the company. The ACoP consists of experienced professionals practicing architecture at various levels (business, enterprize, IT, software, and systems architecture) in project or consultancy assignments. The survey was closed after 3 weeks. By that time, 142 responses were collected. 97 respondents had answered the majority of the questions (93 had answered all). The other 45 responses were discarded because no questions about AK sharing had been answered. The survey consisted of 37 questions: 20 directly related to AK sharing, and 17 related to the context in which the AK sharing took place.

7.3 Analysis

The analysis of the 97 valid survey responses was performed in three phases: first, the current state of AK practice and challenges was established by comparing the respondents' answers to the 20 AK related questions. The analysis of four of these questions is presented in §7.3.1: three questions about AK practices and one about challenges in AK sharing. In phase one, we examined the responses by ordering and grouping them.

Second, the relationship between the AK practices and challenges and their context was analyzed by determining significant correlations between the AK-related responses and some of the 17 context-related questions. The two context factors of project success and project size are analyzed systematically in §7.3.2. The result of phase two is a set

of statistically significant correlations between responses to AK related questions, and the size and success of the projects they pertained to.

In the third phase of the analysis, we reasoned and discussed about the results from the first two phases. Based on reasoning, literature and the experience of seasoned architects we deduced causality and impact mechanisms from the correlations, leading to an observed impact model that is presented in §7.3.3. Further discussions are presented in §7.4.

7.3.1 State of AK sharing practice

In this section, the responses to four of the AK related questions are analyzed, presenting the results of phase 1 of the analysis.

The four questions are:

- What type of architectural knowledge have you provided to or acquired from Logica in your latest assignment?
- Why did you share architectural knowledge to your colleagues in Logica?
- When did you share architectural knowledge in your latest assignment?
- What challenges in architectural knowledge sharing did you experience in your latest assignment?

Each question was provided with a set of predefined responses, determined in consultation between two experienced architects and two researchers. There was also the possibility for open text for missing answers. Respondents were asked to signify the applicability of those responses on a 5-point Likert scale. Table 7.1 lists the predefined responses to the questions, sorted by their average response values, which are listed in the third column. Each question is further analyzed in the following subsections. The two rightmost columns in the table list the Spearman's ρ correlations between the responses and the project context factors, which will be analyzed in §7.3.2 below. We will start with the analysis of the responses without taking into account their contexts.

Architectural knowledge types

What type of architectural knowledge have you provided to or acquired from Logica in your latest assignment?

Table 7.1: AK related responses, average values and correlations

Architectural knowledge types	**ID**	**avg**	**pr succ ρ**	**pr size ρ**
Standards; principles and guidelines	s_akt_std	2.95	-0.062	0.010
Tools and methods	s_akt_tlsmeth	2.80	-0.096	.213*
Known and proven practices	s_akt_prctc	2.71	0.135	-0.09
Product and vendor knowledge	s_akt_prodkn	2.71	0.187	-.212*
Requirements	s_akt_req	2.71	0.178	-0.079
Design Decisions including alternatives; assumptions; rationale	s_akt_dd	2.69	0.1	-0.011
Business knowledge	s_akt_buskn	2.61	0.082	-0.037
Patterns and tactics	s_akt_ptrn	2.46	0.044	0.023
Reference architectures	s_akt_ra	2.28	0.074	-0.025
Legal knowledge	s_akt_legal	1.79	0.097	0.117
AK Sharing Motivation	**ID**	**avg**	**pr succ ρ**	**pr size ρ**
To build up my professional network	s_akw_bldnetw	3.89	-0.116	0.087
I just like to share my knowledge	s_akw_like	3.84	0.115	-0.075
Personal relation with colleague(s)	s_akw_persrel	3.81	-.230*	0.127
We all work for the same company	s_akw_samecomp	3.77	0.109	-0.151
To enhance my professional reputation	s_akw_reput	3.59	0.042	0.009
To contribute to the company's business goals	s_akw_compbusgls	3.53	0.054	-0.002
I hope the favour will be returned some day	s_akw_return	3.39	-.204*	0.201
I will be recognised as a contributor	s_akw_recog	3.32	0.018	-0.079
I have received useful information from him/her	s_akw_reciproc	3.32	-.223*	0.020
My management expects me to	s_akw_mgtexpect	3.09	.275**	-0.103
This may work in my favour at my next salary review	s_akw_salary	2.69	0.002	-0.009
AK Sharing Timing	**ID**	**avg**	**pr succ ρ**	**pr size ρ**
Whenever needed to solve problems	s_akh_problems	3.48	0.153	-0.019
At the end of the project	s_akh_prjend	3.41	0.027	0.012
When colleagues ask me to do so	s_akh_collask	3.39	0.048	0.000
When management ask me to do so	s_akh_mgtask	2.59	0.177	-0.026
Whenever I have time	s_akh_freetime	2.57	-0.025	0.081
In the evening	s_akh_evening	2.53	0.012	-0.056
Continuously during the project	s_akh_prjcnt	2.34	.205*	-0.159
AK Sharing Challenges	**ID**	**avg**	**pr succ ρ**	**pr size ρ**
Difficulty to achieve common understanding of requirements	s_chl_requnders	3.82	-0.146	0.052
Difficulty to achieve appropriate participation from relevant stakeholders	s_chl_stkhpart	3.66	-0.165	0.036
Diversity in customer culture and business	s_chl_custdiv	3.61	-0.102	0.084
Poor quality of information	s_chl_infqual	3.42	-0.11	0.105
Lack of information	s_chl_inflack	3.31	-0.086	0.169
Inconsistency in information obtained from different sources	s_chl_infincons	3.26	-0.114	0.146
Lack of time	s_chl_time	3.25	0.06	-0.003
Delays in delivery	s_chl_delays	3.24	-0.167	0.152
Difficulty of obtaining the appropriate skills within the project	s_chl_skills	3.24	-0.115	0.138
Conflicts and differences of opinion	s_chl_conflict	3.19	-.214*	0.176
Difficulty to organise effective meetings	s_chl_effmeet	3.09	-0.153	0.211*
Lack of informal communication	s_chl_lackinformal	3.01	-0.204	.261*
Inaccessibility of technical facilities	s_chl_tinacc	2.99	-0.183	.280**
Growing and shrinking of project population	s_chl_growshrink	2.82	-0.117	.357**
Lack of trust between the project locations	s_chl_sitetrust	2.77	-.272**	.265*
Project personnel turnover	s_chl_persto	2.67	-0.116	.307**
No appreciation from (project or competence) management	s_chl_mgtappr	2.60	-0.125	.230*
No willingness to share knowledge	s_chl_nowill	2.39	-.224*	.245*

* Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed).

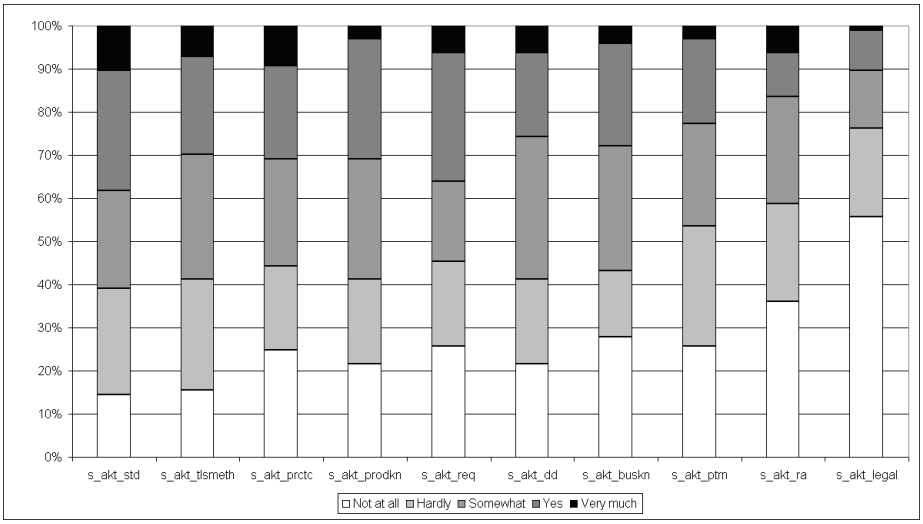


Figure 7.1: Architectural Knowledge Types

The distribution of the response values is visualized in Fig. 7.1.[1] With the exception of reference architectures and legal knowledge, all types of architectural knowledge appear to be shared more or less equally. The least shared type of AK is legal knowledge: over 75% indicate they do not or hardly share it with Logica.

AK sharing motivation

Why did you share architectural knowledge to your colleagues in Logica? The distribution of the response values is visualized in Fig. 7.2. These data tell us that most architects are either impartial to or agree with almost all motivation responses.

The only motivation that more architects disagree with (38%) than agree with (17%) is salary. A related finding is the unpopularity of management expectation as a motivator: 65% of respondents are impartial to or disagree with this motivator.

AK sharing timing

When did you share architectural knowledge in your latest assignment?

[1] The figures in this chapter use the codified response IDs of the *ID* column in Table 7.1.

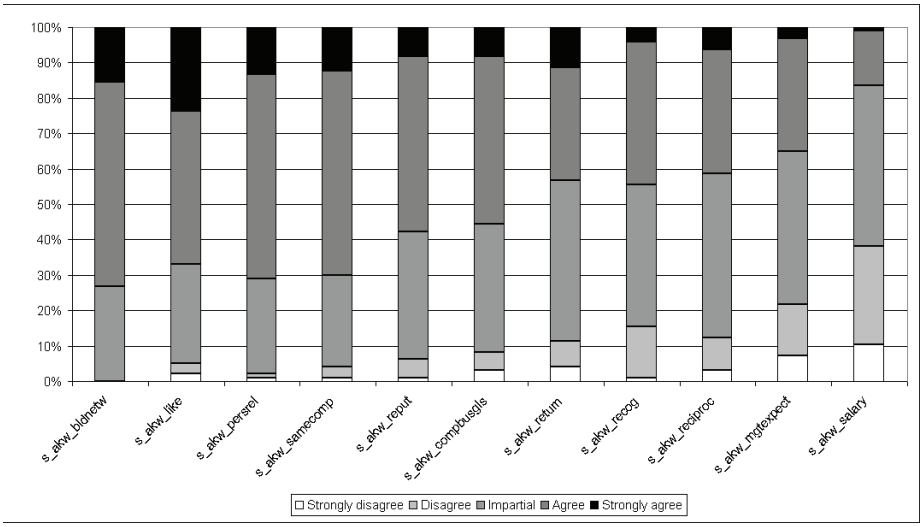


Figure 7.2: AK Sharing Motivation

The distribution of the response values is visualized in Fig. 7.3. By far the most popular times to share AK are when problems occur, at the end of projects and when asked by colleagues (other than managers); these three timings are all used often or very often by over 50% of the architects. Almost 30% of architects indicate they never share AK "when management asks me to do so". We assume this is because in those cases management does not ask - an assumption supported by the observation that there is no lack of willingness to share (see Fig. 7.4). This fortifies our previous observation about management expectation as a motivator.

AK sharing challenges

What challenges in architectural knowledge sharing did you experience in your latest assignment?

The distribution of the response values is visualized in Fig. 7.4. The ordering of the challenges by average response value in Table 7.1 allows an interesting categorization of challenges with descending response values:

- *Difficulty to achieve common understanding of requirements, participation from relevant stakeholders, and diversity in customer culture and business* (s_chl_requnders, s_chl_stkhpart, s_chl_custdiv) are all related to communication issues on

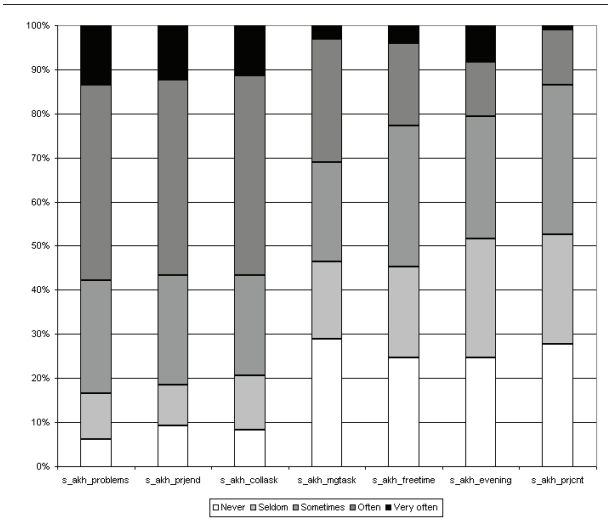


Figure 7.3: AK Sharing Timing

group level (as opposed to personal level); this is the category of challenges that most architects consider relevant in their latest projects.

- *Poor quality, inconsistency or lack of information* (s_chl_infqual, s_chl_inflack, s_chl_infincons) are about issues with quality or absence of codified AK; this is the second most commonly relevant category of challenges.

- *Lack of time and delays in delivery* (s_chl_time, s_chl_delays) are related to planning; this is the third most commonly relevant category of challenges.

- *Other challenges* all less commonly relevant than the three categories mentioned above, are related to obtaining resources, interpersonal issues, teaming, continuity and management.

In discussions about challenges in knowledge sharing, "knowledge is power" [Bacon, 1597] is often cited as a reason for professionals not to want to share knowledge. In our survey however, *lack of willingness to share knowledge* emerges as the least relevant challenge, which the majority of architects find irrelevant, and which only 18% find relevant. The next least relevant challenge is *lack of management appreciation*, which only 21% find relevant. The unpopularity of this response suggests that, even

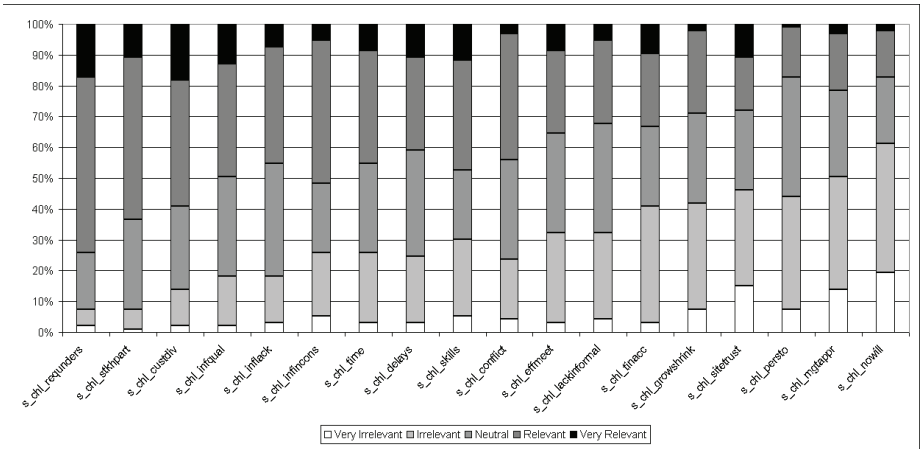


Figure 7.4: AK Sharing Challenges

though we have seen in §7.3.1 that both salary and management expectations are at the bottom of the list of reasons to share AK, architects are not actively discouraged by their management's apparent disinterest. Seeing that only 35% of respondents see management as a motivator (Fig. 7.2) and only 20% see management as a challenge (Fig. 7.4), one might conclude that *architects do not see management as an important factor in architectural knowledge sharing*. As we will see in the rest of this chapter, they might be wrong about this.

7.3.2 AK practices in context

In this section, we analyze the relationship between the AK practices and challenges and their project context, by examining significant correlations between the AK-related responses and some of the context-related questions. The two context factors analyzed here are project success and project size.

The first context factor analyzed is project success, as perceived by the architects. Perceived project success[2] is determined by asking the architects how they rated seven aspects of project success on a 5-point Likert scale from Poor to Excellent. The aspects they rated are: Sticking to budget, Delivery in time, Client satisfaction, Management support, Personnel turnover, Solution quality and Team satisfaction. The combined an-

[2]In this chapter, we use the terms "project success" and "perceived project success" interchangeably, always meaning the success as perceived by the architects and reported in the survey

swers of these seven aspects were subsequently averaged to obtain a quantification of overall project success per case. Cronbach's alpha test for internal consistency [Cronbach, 1951] was used to verify that these seven responses measure the same construct of success ($alpha = 0.82$).

Project size is determined by asking the architects for the number of project members.

Table 7.1 shows the Spearman's ρ correlations between project success and the AK practice related responses in column *pr succ* ρ. Correlations between project size and the AK practice related responses are in column *pr size* ρ.

Correlations with a positive or negative slope of over 0.2 and a significance level of under .05 (indicated by one or two asterisks) are considered significant and discussed here. In the discussion of the correlations, some speculation is presented as to the underlying mechanisms, based on our experience as practicing architects.

Cause and effect

One of the objectives of this survey was to gain insight into mechanisms around architectural knowledge sharing in projects. In other words, we were looking for ways in which architectural knowledge sharing impacts projects and vice versa - questions of cause and effect.

When analyzing correlations like the ones found in this survey, the question of causality between the correlated measurements deserves careful consideration. The mere presence of a correlation by itself does not imply a causal relationship. In order to determine potential causality, we resorted to three additional means: reasoning, literature and the experience of practicing architects in Logica.

The four categories of measurements we are correlating here are:

AKS Practices: the responses related to the type, motivation and timing of architectural knowledge sharing.

AKS Challenges: the responses to the question: *"What challenges in architectural knowledge sharing did you experience in your latest assignment?"*.

Project Success: the perceived success of the respondents' latest project.

Project Size: the size of the respondents' latest project (number of project members).

There are six possible correlations between these four categories. We are not analyzing correlations between AKS Practices and Challenges. Fig. 7.5 visualizes potential causality arrows for the five remaining possible correlations. In this figure and Fig. 7.8, a causality arrow from A to B symbolizes that A has impact on B, implying

that making changes to A would cause related changes in B. The arrows are based on the following reasoning:

Project Size ↔ Project Success Project size is well known to influence project success in many ways, both in literature [Frederick P. Brooks, 1995, Jones, 2000] and experience, so the primary arrow of causality is from Size to Success.

Project Size ↔ AKS Practices Experience indicates that mechanisms that determine project size are only marginally impacted by architectural knowledge sharing; on the other hand, project size determines factors like organizational and physical distance between project members, which are obvious factors in AKS. We conclude that any correlation found means that project size impacts AKS, and not the other way around.

Project Size ↔ AKS Challenges Like with AKS Practices, project size causes AKS challenges. There are some challenges that may in time conversely influence project size: for example, difficulty to obtain the appropriate skills may either lead to a smaller project because there is no staff available, or to a larger project because the lower skill level is compensated by adding more staff. We conclude that there is a primary causal arrow from project size to AKS challenges, and a potential secondary reverse arrow.

Project Success ↔ AKS Practices Examples of causality in both directions are experienced: e.g., a more successful project may lead to a better atmosphere causing more knowledge to be exchanged, or conversely more knowledge sharing may contribute to a more successful project. We conclude that we cannot a priori attach causality direction to correlations found between project success and AKS practices.

Project Success ↔ AKS Challenges The word *challenge* is used here as a synonym for *obstacle*, which can be defined as *something that makes achieving one's objectives more difficult*. Since the objective here is a successful project, the primary arrow of causality is by definition from Challenge to Success. There is also a possibility of reverse causality here: challenges may be exacerbated or caused by (lack of) project success, e.g. the atmosphere in an unsuccessful project may lead to lack of trust.

The causality arrows between the four categories of measurements as visualized in Fig. 7.5 will be elaborated in §7.3.3, based on correlations measured.

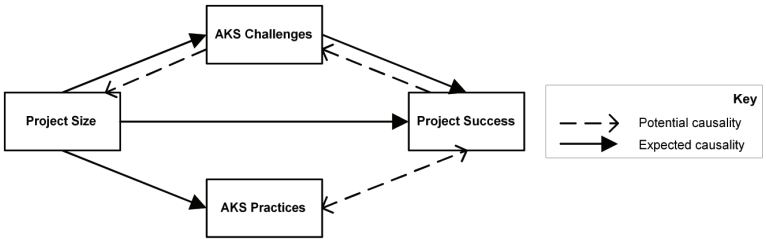


Figure 7.5: Causality as deduced from reasoning, literature and experience

Correlation with project success

We now discuss the correlations between architectural practices and challenges and project success. In column 4 of Table 7.1, we find 8 significant correlations. Summarizing:

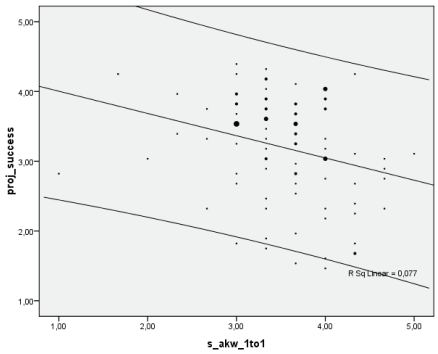
In *more successful* projects, architects tend to:

- be *less* motivated to share AK for interpersonal relationship reasons, but are more motivated by their management's expectations
- face *less* challenges related to interpersonal relationships.

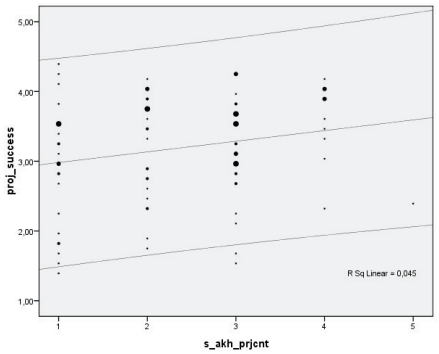
We find no correlation between project success and the type of the architectural knowledge shared.

- Motivation: *Personal relation with colleagues, or because I have received or hope to receive information from the other* (s_akw_persrel, s_akw_return, s_akw_reciproc): remarkably, all motivation responses that are related to one-to-one relationships between colleagues show a significant negative correlation with project success. Fig. 7.6(a) visualizes this relationship, showing a clearly downward slanting cluster: the x-axis represents the individual architects' average mark given to these three responses.[3] There are many possible explanations, but in view of our findings about AK sharing challenges a few items further down, the most plausible one appears to be related to trust. Problems in projects tend to reduce trust, which might cause architects to place more value on interpersonal motives.

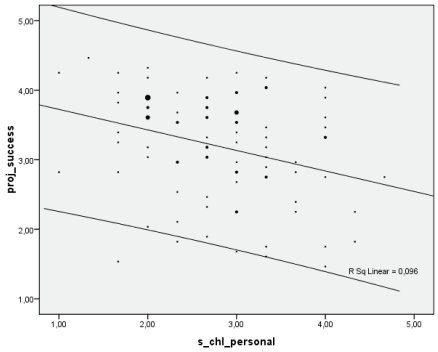
[3]The lines in the scatter plots in this section represent linear regression fit lines and their 95% confidence interval



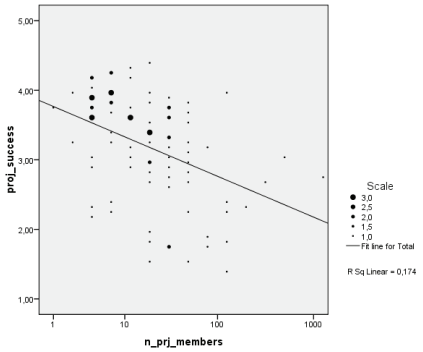
(a) Motivation: interpersonal relationships



(b) Continuous AKS



(c) Interpersonal challenges



(d) Project Size vs Success

Figure 7.6: Various AKS parameters plotted against project success

- Motivation: *My management expects me to* (s_akw_mgtexpect): even though management expectations are considered one of the least important motivations for sharing AK by the architects, it is the only motivation that has a positive correlation with project success. The explanation may also be related to trust levels: architects working on successful projects have more confidence in their management, and hence are more inspired or motivated by them.
- Timing: *Continuously during the project* (s_akh_prjcnt): the only AK sharing timing response that has a correlation with project success. However, visual inspection of Fig. 7.6(b) suggests that this is a spurious effect.
- Challenges: *Conflicts and differences of opinion, Lack of trust between the project locations,* and *No willingness to share knowledge* (s_chl_conflict, s_chl_sitetrust and s_chl_nowill). Since there is by definition a causality between AKS challenges and project success, we *expect* to find correlations. Remarkably, only three challenges are significantly correlated with project success. These three challenges, all with a very clear negative correlation, have in common that they are related to interpersonal relationships and emotion: conflicts, trust and willingness. We have plotted the correlation between project success and the individual architects' average mark given to these three responses related to interpersonal challenges in Fig. 7.6(c). As for the other challenges, finding *no* correlation indicates one of two things: either the challenge is so insignificant that the correlation is too small to be measured in a sample this size, or the challenge is somehow overcome or neutralized.

From these correlations, we can draw the following conclusion: the only significant AKS challenges that are not overcome or insignificant in projects, are those related to emotion and interpersonal relationships. In less successful projects, there is less trust and willingness to share AK, and more conflict. This appears be unrelated to the type of AK shared. There is, however, a significant correlation with architects' motivation to share architectural knowledge: in more successful projects, they are more motivated by management and less by interpersonal relationships between colleagues.

Correlation with project size

We proceed to discuss the correlations between architectural practices and challenges and project size, as documented in column 5 of Table 7.1. We find 10 significant correlations. Summarizing:

In *larger projects*, architects tend to:

- face significantly *more* challenges of multiple kinds

- share *more* knowledge about tools and methods, but *less* about products and vendors.

Project size has no effect on AK sharing motivation or timing.

- *Information related to tools and methods* (s_akt_tlsmeth) is shared slightly more by architects in larger projects than by architects in smaller projects. This is likely due to the fact that there are simply more developers to educate on tools and methods.

- *knowledge related to products and vendors* (s_akt_prodkn) architects in some smaller projects tend to share more. We suspect that this is due to the fact that in larger projects, decisions about products and vendors are often made on a higher (management) level, whereas smaller project architects are more likely to be involved in these decisions, and hence have to share more knowledge related to products and vendors.

- *AKS challenges* Table 7.1 shows that out of the 18 types of challenges surveyed, 8 are significantly correlated to project size. We have also calculated the aggregated AKS challenge level as the average of each architect's challenge-related responses. It turns out this aggregated AKS challenge level is correlated to project size with a correlation coefficient of 0.356 at a 0.001 significance level. The eight challenges at the bottom of Table 7.1 are the only ones that are also individually correlated to project size. Apparently, some challenges are universal, and others are considered less relevant in smaller projects, bringing down their average response value. We have illustrated this by plotting the average response values of both the seven least commonly relevant and the eleven most commonly relevant challenges against project size in Fig. 7.7. The figure confirms that there is indeed a clear upward trend, and that it is steeper for the less commonly relevant challenges.

  Based on the fact that larger projects are likely to include more distinct departments or locations, and the well-known issue of tension between departments, we would expect larger projects to suffer more from emotion-related challenges. We do indeed find correlations between project size and lack of both willingness (.245) and trust (.244), but no significant correlation with the challenge of conflicts and differences of opinion.

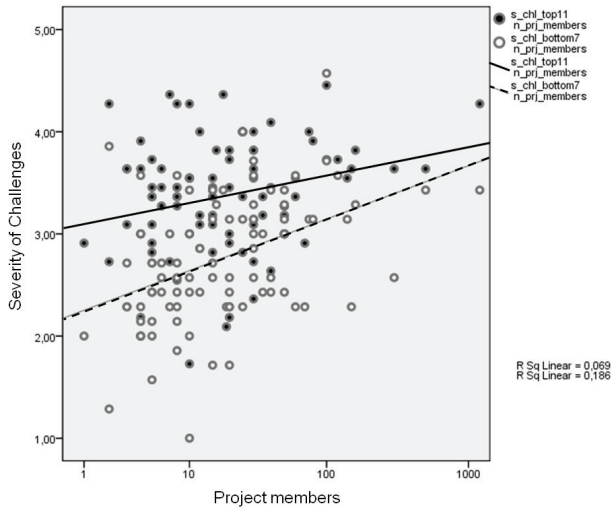


Figure 7.7: AKS Challenges versus project size

7.3.3 Refined model of causality

We now use the correlations observed in the previous section to obtain a more detailed picture of causality. Fig. 7.8 shows the causality arrows between the four categories of measurements as explained in §7.3.2 and visualized in Fig. 7.5, but the AKS category boxes have been replaced with more specific subcategories corresponding to the responses that showed correlations. Additional symbols show whether correlations are positive or negative. Specifically, we have:

- replaced the generic box *AKS Challenges* with a box *Less common AKS Challenges*, representing the seven least common AKS challenges that have significant positive correlations with project size
- created a box *Interpersonal challenges* inside the *Less common AKS Challenges* box, representing the three challenges related to willingness, trust and conflict that are negatively correlated with project success
- replaced the generic *AKS Practices* box with four specific boxes representing the practices that we have found to be correlated with either project size or project success

- added + and - symbols to the causality arrows representing the sign of the observed correlations.

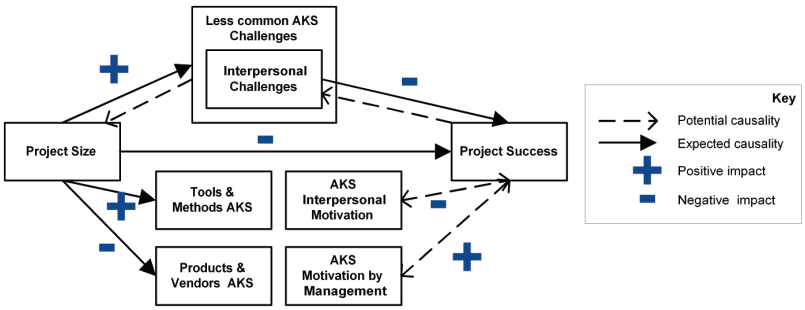


Figure 7.8: Causality as observed

There is one correlation that we had not discussed yet: that between project size and perceived project success. Fig. 7.6(d) displays a very clear correlation between project size and perceived project success. Perceived project success and project size show a negative Spearman's ρ correlation coefficient of -0.453, with a significance of 0.000. This is in line with results found by [Jones, 2000], and conversely provides some additional validation that our input data behave according to known properties of IT projects. [Frederick P. Brooks, 1995] gives a clear explanation of one of the mechanisms that cause this correlation. Surprisingly, a more recent survey [Emam and Koru, 2008] does not find this correlation.

Fig. 7.8 summarizes in one picture the combined mechanisms in the interplay between AKS and project size and success. We see how project size impacts some challenges, and which challenges impact project success. We also see that project size impacts the type of knowledge shared, and we observe a relationship between AKS motivation and project success, a relationship with an as yet undetermined arrow of causality.

7.4 Discussion and Related Work

In this section, we further discuss the results found above and threats to validity, and we relate them to additional related material found in literature. Please refer to §4.2.1 for a discussion of the project success construct and related work, which also applies to this chapter.

7.4.1 Threats to validity

These results are based on a survey of architects in one IT services company in one country. This limitation is somewhat softened by the fact that 64% of respondents work mostly at customers' sites, but the results are certainly influenced by cultural aspects of both the Logica company and the Netherlands location. It would be very interesting to repeat the survey in other companies and locations.

The ordering of the responses in Table 7.1 and the response value distribution bar charts is based on average response values. The meaning of the average number itself is not clear, since the Likert-scale is not equidistant. An alternative ordering quantity would be the percentile responses of e.g. the two most positive Likert values. This would have the advantage of being able to say exactly what the ordering quantity means, but the disadvantage of ignoring the information inherent in the detailed distribution of responses. Visual inspection of the bar charts shows that, with the exception of Fig. 7.1, the order of the responses would not be that much different, specifically in those cases where we have based reasoning on the response ordering. As an example: the "seven least commonly relevant challenges" in Fig. 7.4 that we have discussed above would also be the seven bottom-most challenges if ordered by percentile of respondents answering "Relevant" or "Very Relevant".

There is a weakness in the four questions analyzed in §7.3.1, in that they all appear to have slightly different scopes for AK sharing: two of the questions are about sharing towards or from Logica, one is explicitly about sharing with colleagues, and two are explicitly from the perspective of the originator. These scope differences are ignored in the analysis, since they cannot be remedied without redoing the survey.

A final threat is caused by our approach of doing multiple statistical tests, and deriving our model from significant statistical results found in those tests. This approach implies a risk of introducing spurious statistical results in the model. We have mitigated this risk by using reasoning, experience and literature, but it would be interesting to further validate the model by using it to predict results in other surveys.

7.4.2 Architectural knowledge sharing

Over the last years, much has been published on the topic of architectural knowledge sharing. The GRIFFIN project [Farenhorst and de Boer, 2009, Clerc, 2011, Ali Babar et al., 2009] and six SHARK workshops [SHARK, 2009] on SHAring and Reusing architectural Knowledge have been especially productive. [Farenhorst and de Boer, 2009] reports on challenges to sharing architectural knowledge: they examine these challenges in an IT company, but perform only a qualitative analysis. The authors deduce a number of issues resulting from a lack of architectural knowledge sharing,

but do not directly relate the challenges to project success.

7.4.3 Motivation and emotion

An interesting finding about motivation in this survey is the observed shift in motivation source from colleagues to management in more successful projects. Could there be an either/or effect, in the sense that the 1-on-1 motivation by colleagues and motivation by management are somehow mutually exclusive? In that case, one would expect a negative correlation between these two motivation sources, which we did not measure (Spearman's $\rho = 0.107$ with a two-tailed significance of 0.295). We conclude that the mechanisms causing these shifts are independent. The finding does, however, cause one to wonder about architects' apparent indifference to management expectations as either a motivator or a challenge. The well-known Chaos Reports [Standish Group, 1994] already showed empirical evidence for management attention being a key project success factor.

Markus already identified the importance of being aware of one's motivation long before the term *architect* was used in the context of system design: "Self-examination of interests, motives, payoffs, and power bases will lend much to the implementor's ability to understand other people's reactions to the systems the implementor is designing..." [Markus, 1983]. In literature, motivation is reported to have the single largest impact on developer productivity [Boehm, 1981, McConnell, 1996]. Moreover, in system development, the architecture represents the system's earliest design decisions with the highest impact on success [Bass et al., 2003]. Combining these facts, it is only to be expected that the motivation to share architectural knowledge is correlated with project success. Our results not only point to the importance of motivation and its source, but also shed some light on the mechanisms through which motivation and emotion impact project success through architectural knowledge management.

Finally, some words on the topic of *emotion*, a term that we introduced in §7.3.2 as the common element between the three only challenges that have a significant negative correlation with project success: *Conflicts and differences of opinion, Lack of trust between the project locations* and *No willingness to share knowledge*. During the analysis, we often wondered how it was possible that we did not find any significant correlation between the *other* challenges in AKS and Project Success. Consider, for example, the most commonly encountered challenge: *Difficulty to achieve common understanding of requirements*. How can a project be successful without common understanding of requirements? As stated above, the only plausible explanation is that all of these other challenges are apparently neutralized. With neutralize we mean that if these challenges occur, there are other factors that prevent them from having a significant impact on project success. In the case of our example, these could be compen-

sating activities to promote the common understanding of requirements, such as client meetings. In the end, the only challenges that are not neutralized are those related to lack of trust, willingness, conflicts and differences of opinion: all issues in interpersonal relationships that have a strong negative emotional connotation. Apparently, it is harder for architects to neutralize challenges when such negative emotions are involved. This is a phenomenon that practicing architects often observe in real life, and it should be no surprise, given that architects are human beings. The significant finding here is that these emotional challenges are not neutralized where all other challenges are, and hence they merit extra attention, leading to the warning in our title: *Beware of Emotions*.

We conclude:

FOR ARCHITECTS, TO UNDERSTAND THEIR MOTIVATION AND DEAL WITH EMOTIONS ARE CRUCIAL KNOWLEDGE SHARING SKILLS.

7.5 Conclusions

We set out on this survey with two goals, which were both achieved: to establish the current state of architectural knowledge sharing in Logica and its customers, and to gain insight into the mechanisms around architectural knowledge sharing in projects. In order to gain this insight, we looked at architects' responses to four questions about AK sharing, and the correlations between these responses and their latest projects' success and size, and we reasoned about impact mechanisms and causality.

The analysis revealed the following mechanisms:

- Architects face many challenges sharing architectural knowledge in projects;
- these challenges are more numerous and diverse in larger projects than in smaller ones.
- The most common of these challenges are related to group level communication issues, the quality of codified knowledge and planning issues;
- however, these common challenges are not correlated with project success, so apparently they are generally neutralized somehow.
- The only challenges that *are* correlated with project success are the ones related to interpersonal relationships: conflicts, trust and willingness to share knowledge.
- Architects' motivation to share knowledge is more personal in less successful projects.

- Architects do not see management as an important factor in architectural knowledge sharing, but those architects that are motivated by management tend to work in more successful projects.

Our final conclusion is that *dealing with emotions* is a crucial factor in how architectural knowledge sharing leads to successful projects. It is important for architects to understand their motivation, and they should carefully deal with emotions when sharing knowledge.