On the Role of Information Technology Systems Architects

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ABSTRACT

Information Systems in large organizations are seldom built from scratch. They have to be built taking into account different existing aspects like customers, organization's business, and its current Information Technology (IT) infrastructure, among others. IT architects are the professionals who take all these aspects into account when designing an information system. Despite their importance, the work of these professionals is barely understood. This research aims to fill this gap by describing a qualitative study we conducted with IT architects. We use semi-structured interviews for data collection and analyzed our data using grounded theory methods. Our results suggest that there are different IT architect roles in every company and that the activities performed by them are highly interconnected and these interconnections are fundamental for the information diffusion and collaboration in projects.

Keywords

IT architecture, software architecture, architect roles, collaboration.

INTRODUCTION

In large-scale companies, software is seldom built from the scratch; instead, it is embedded in a large ecosystem that includes other information technology (IT) systems, organizational standards to be followed, businesses goals it needs to achieve, among other factors. There are many aspects that need to be considered during software development, some of them are even conflicting. IT architects are the professionals who take all these aspects into account when designing a new information system (IS). While requirements analysts are responsible for understanding and eliciting clients'/users' desires and software developers are responsible for the development of a particular software system, the IT architects are the professionals in between these two groups, who take all the aforementioned aspects and the work from analysts and developers into account when designing an IT system. IT architects define the components that make up the information system of the entire organization, instead of the components of a single information system. They establish how acquired products and systems developed in-house are going to be integrated to compose the overall information system of the organization [7]. Despite their importance, there are just a few studies that consider the work of IT architects [12] and associations that seek to better develop the study of IT architectures and the career of the IT architects (e.g., [1] and [2]). Their work has not been sufficiently explored in empirical studies either, with the exception of the work of software architects described in [3][4][15].

This paper goes a step further previous research by describing a qualitative study conducted with IT architects. This research aimed to understand how IT architects deal with all the several aspects that influence their daily work in order to properly design tools that support their activities. We used semi-structured interviews [16] for data collection and grounded theory methods [5] for data analysis. We conducted 27 interviews with 22 interviewees from 9 different companies. Consistent with results from the literature, our results suggest that there are 3 different types of IT architects who perform similar roles in the organizational ecosystem at different "points" in the organization. Moreover, those architects work as "bridges" between customers and software developers, translating organizational constraints and business requirements into technical aspects that, ultimately, can be implemented by these developers. This means that their activities are highly interconnected.

The rest of the paper is organized as follows. The next section presents background information about the different IT architects types. The following two sections describe the setting of the study and the research methods used respectively.

Then, the next section presents our findings, which is followed by a discussion. Finally, the last section presents our conclusions and suggestions for future work.

IT ARCHITECT ROLES

IASA [6] defines IT architecture as "the art or science of designing and delivering valuable technology strategies". This definition emphasizes that IT architecture is not focused in delivering solutions or projects in a particular timeframe. Instead, it defines the components that make up the overall information system of an organization in order to meet business needs [7]. The role responsible for developing the IT architecture is the IT architect, who defines strategies to solve customer's business problems or needs through the application of information technology [8].

There are many different aspects that an IT architect needs to be able to handle. Some authors [9][10][11] argue that this role is considered "ambiguous and murky" because it interacts with many different types of stakeholders and each stakeholder expects the architect to work in a different way. In order to reduce this ambiguity many companies establish different types of architects, that are also called IT architects roles [11]. In this sense, IASA and The Open Group suggest different disciplines or specializations of IT architecture [6][8]. The idea is simple: every IT architect should have the same basic knowledge and then acquire a higher level of proficiency in one IT architecture discipline or specialization. Examples will be presented below.

Akenine investigated several companies and mapped the many architect roles he found to the artifacts these architects produce. Based on this mapping, Akenine suggests four different architect roles. In this paper, we will use the roles definition described in [9] as follows:

• Enterprise architect: this architect works to support the organization's business strategy with IT solutions and information. (S)He is responsible for the overall organization IT strategy and ensures that the IT architecture is cost effective. This architect must possess a deep knowledge in business, IT, enterprise architecture, business modeling, governance, project management and economy, as well as leadership and negotiation skills;

• Business architect: this architect focuses on the organizational business needs and understands in details how the organization works. (S)He has deep knowledge of the business, process modeling and requirements analysis. Although (s)he has an organizational focus, (s)he is also active in ongoing projects, working to ensure that projects deliver benefits to the organization's business [9];

• Solution architect: this architect focuses on the ongoing projects and works designing IT solutions based on requirements from the organization business. They are responsible for balancing functional and non-functional requirements, defining priorities and trade-offs. Their goal is the success of the *current* project. They have broad and general technical knowledge, and competencies in infrastructure, data models, service orientation, and enterprise architecture [9]; and

• Software architect: this architect also focuses on the ongoing project. While solutions architects have a wider focus in policies, regulations, and reuse of existing assets, software architects have a deeper knowledge in technology. Software architects must have deep knowledge in programming languages, frameworks, standards and technical modeling [9].

SETTINGS

Our research aims to understand how software development organizations develop their IT architecture activities, focusing in the roles that perform them. In order to address such an open question, we adopted a qualitative approach. Thus, we visited 8 different IT organizations (briefly described in Table 1) where we conducted interviews with professional architects and other related roles.

METHODS

Our research was conducted as a qualitative study. We used semistructured interviews [16] for data collection and grounded theory [5] methods for data analysis. Our initial research question focused on understanding how the researched organizations perform their IT architectural activities. To try to answer this question we interviewed employees who worked on IT architecture activities. Our focus was on architects, but we also interviewed other roles in order to acquire a broader knowledge of the IT activities. This allowed us to gather information about activities that were performed by roles not directly labeled as architects, as discussed later.

Company	Country
A	Multinational headquartered in the USA. Research in Brazil subsidiary
B	Multinational headquartered in the USA. Research in Brazil subsidiary
C	Brazil
D	Brazil
E	Multinational headquartered in the USA. Research in Brazil subsidiary (head office of Latin America)
F	Brazil
G	Brazil
H	Multinational headquartered in the USA. Research in Brazil subsidiary
I	Brazil

Table 1. Summary of studied companies

We conducted 4 iterations of data collection, always intertwined with data analysis. Based on the results of each data analysis iteration, we planned and conducted the next data collection iteration. In total, we conducted 27 interviews with 22 different informants. Interviews lasted from 23 minutes to 1 hour and 27 minutes. Overall, we have 19 hours of interviews.

During our data analysis, we noticed one recurrent aspect: the presence of different roles participating in the architecture activities and the frequent interaction among them. We then researched in the literature and found the IASA study described in the previous section. Then, we established a parallel between IASA's roles and our own research, once we realized that we could find similar architectural roles in every researched company. More than that: we identified a recurrent relationship of these architectural roles with aspects of information diffusion, communication and coordination during the IT development process. The studied companies not only have different architecture roles, but they are organized in a way that supports the development of the information systems these companies create. These architecture roles play an important function by "translating" requirements from the organization and from the customers into aspects that can be implemented by software developers.

FINDINGS

The Architecture Roles in Practice

IASA suggests a division of the IT architecture activities among different architecture roles [8][9]. Our results, aligned with this approach, suggest that some of the observed organizations have different roles formally defined and institutionalized, while in others organizations these roles are informal. Furthermore, in some organizations these roles are *not* called architects, despite performing architecture-related activities. Figure 1 presents this division in roles. Each architect role receives information from different stakeholders, performs his/her own work using the available information and then passes different information along to the next architect.

In our study we did not identified IASA business architects in the studied organizations. We found that when companies have an enterprise architect, (s)he also performs business architecture activities. When enterprise architects are not present, solutions architects perform business architecture activities, in addition to their own activities.

Figure 1 represents a generic structure. We noticed a common aspect in all studied companies: there are always actors performing solutions and software architects activities. More interestingly, each organization "adapts" this model to its reality. Despite the adaptation, we observed that the way companies organize the roles can be classified in 3 different groups according to roles definition, namely: "defined roles", "partially defined roles", and "non defined roles". Each group is summarized in Table 2, which presents how each company maps these IASA roles into their own roles. For example, in Company E, in the "defined roles" group (column 1), the role equivalent to IASA enterprise architect (column 3) is called Functional Responsible (column 4). Companies B and H do not appear in Table 2 because we could not get as much information as we would like from them: we, initially conducted only one interview in each company, but could not gather additional data due to commitments from our interviewees.

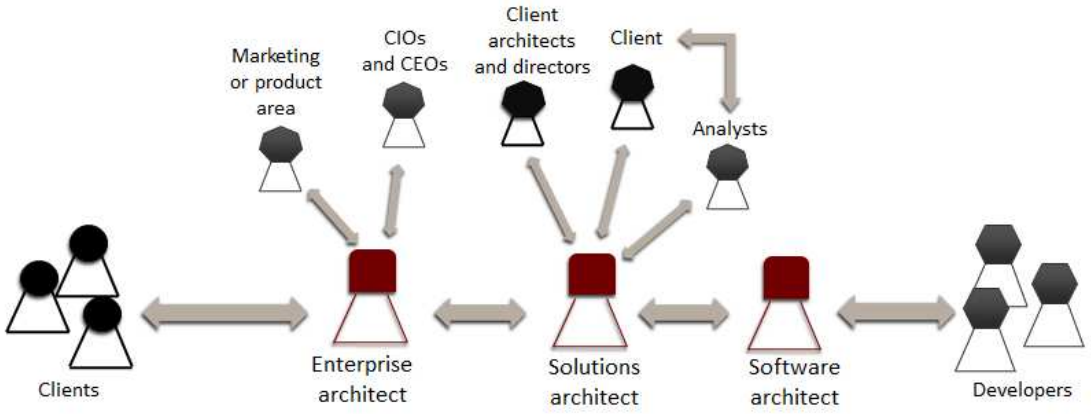

Figure 1. Architect roles and their main interactions generic structure

Group	Company	IASA Role	Role Name
Defined Roles	A	Enterprise Architect	Enterprise Architect
		Solution Architect	Solution Architect
		Software Architect	Technical Architect
	E	Enterprise Architect	Functional Responsible
		Solution Architect	Technical Responsible
		Software Architect	Team or Technical Leader
Partially defined roles	C	Enterprise Architect	-
		Solution Architect	Software Architect
		Software Architect	Designer
	D	Enterprise Architect	-
		Solution Architect	Software Architect
		Software Architect	Senior Developer
	I	Enterprise Architect	-
		Solution Architect	Software Architect
		Software Architect	Technical Leader
Non defined roles	F	Enterprise Architect	-
		Solution Architect	Software Architect
		Software Architect	Software Architect
	G	Enterprise Architect	-
		Solution Architect	Software Architect
		Software Architect	Software Architect

Table 2. Mapping from architect roles to the roles adopted in the studied organizations

In the "Defined roles" group there are well-defined roles for the enterprise, solution and software architects, who perform activities similar to these three IASA architect roles. Moreover, it is also possible to identify some typical activities of an IASA business architect among the activities that the enterprise architect performs. The two companies in this group are both multinational organizations that work with Distributed Software Development (DSD).

In the "Partially defined roles" group (Companies C, D and I), the solution architect role is defined by the organization, but they receive different names in different organizations, although perform similar activities, especially those related to the overall solution architecture definition. In this group, it is also possible to identify some activities from IASA enterprise

architect, but with no role dedicated to it: the actor playing the solution architect role is the same actor who performs the enterprise architecture activities, in addition to solution architecture's activities.

The "Non defined roles" group comprises Companies G and F. In this group we did not identify organizational architecture activities clearly differentiated among the architect roles. Solutions and software architecture activities are well identified, but they are interchangeable among the roles: they are not performed by a defined role in every project. The person (or more than one person) in the architecture team who better understands the project solution architecture takes this job. The others automatically perform software architect activities. Another characteristic of this group is that the architects have few, if any, contact with customers. Instead, the analysts are responsible for this activity. So, if architects need to discuss something about requirements, they have to talk to the analysts.

Companies F and G have some similarities between them. They call themselves software factories and have just one customer: Company F is the IT division of a credit card solutions organization, while Company G is a regional branch of a state-run organization created to support a very large local customer. Both of them usually work in one project at time. Their architecture team is composed of four architects simply called software architects. So in each project, there is one architect who creates and works on the overall architectural solution, working as a solution architect, while the others assume the software architecture activities, working closer to developers and developing critical components. According to our informants, this arrangement emerged during their daily activities.

The Interdependencies among Architect Roles and other Stakeholders

The Influence of Stakeholders and the Context in the work of IT Architects

The division in architecture roles represents a way not only to distribute the technical activities related to IT architecture among different roles, but also to distribute the communication activities related to these technical aspects. Each architect interacts mainly with a specific group of stakeholders (Figure 1), as Interviewee 1 from Company A summarizes in the following quote:

> "What changes is the stakeholders' 'level' with who each interacts. The enterprise architect talks more with CIOs and CEOs. The solution architect will talk with an architect from the other side [company] or with directors from the other side. And the technical architect interacts more with [software] developers. (…) And they communicate among each other". – Interviewee 1, Company A.

This quote illustrates that each architect role is influenced by different groups of stakeholders. This benefits the organization because, once an IT architect role interacts with a smaller group of stakeholders, (s)he can better address their interests in architecture (s)he is developing.

Besides the influence of different stakeholders, the "context" in which new products are being built is also something that IT architects need to consider in their daily work. For example, Interviewee 8, who works as an enterprise architect, describes how this "context" influences his work when argues that his role is more necessary in the beginning of projects:

> "He has more time to study new technologies, and to know Company E's structure, to know other products (…) and he talks much more to make proposals, to perform analysis (…). He is not there to define the interaction with external products from the company, he is there to thoroughly detail what needs to be done in the project: 'we are going to use this component', 'there is already a free software product that makes this feature, we just need to adapt it or extend it', etc." – Interviewee 8, Company E.

The same influence of the "context" is observed in the software architect role of Company C. This role is responsible to propose the overall solution, but (s)he do not worry about specifications or diagrams: this is the responsibility of the designer, who works closely to developers and focuses in more low-level architecture aspects. The following quote also presents some characteristics of IASA enterprise architect, namely investment and commercial relationships.

> "The [solution] architect has a more separated function: he gets the overall project idea, what the project is going to be. He defines that, he understands which level of investment is going to be made in the project, and it does not depend on the analyst, it depends of the commercial relation. We receive some information by the time the contract is made: this customer is adopting Microsoft as platform, and they are already buying this and that, and they are already setting up an environment... Meaning that we already know some information and the analyst did not start to work yet, but we already know. So it is more with that information that we work. So, this person designs, based on all these ideas, how the system concept is going to be and plans what I said: a concept view, then a logic view and so on. He

> does not hold himself in development. He defines how the pieces of the puzzles are going to be connected, which is the more suitable product for each situation." – Interviewee 4, Company C.

These quotes exemplify that IT architecture activities are not exclusively related to technical issues, they are influenced by the "context" and by the stakeholders who interact with each IT architect role.

Architect Roles and their Interdependencies

In addition to interacting with specific stakeholders, IT architects interact among themselves. Their activities are interconnected; they depend on each other's work in different ways. They receive information from different groups of stakeholders, perform their own work using this and additional information they seek, and then pass a different type of information along to the next architect. For instance, enterprise architects develop the architectural principles [9] that are going to guide all projects in the organization. In order to do that, they interact with stakeholders (e.g., the CEO and CIO) receiving information necessary for their activity. These architectural principles are important to solution architects, because they need to follow them to produce the architecture of each specific project. In other words, solution architects need to consider and obey these principles to produce an architecture in conformance with the organization's architectural principles. This is exemplified in the following quote:

> "This person [enterprise architect] talks about requirements, but in an open way, nothing really defined. The requirements are like 'I think we need to increase product scalability' and (s)he does not say what in scalability we are going to increase, or how we are going to do it (…). But (s)he elaborates [the requirements] together with the customers (…) and (s)he says 'It is important to have a greater scalability' and then the people 'below' him/her [the solution and software architects] can understand what we are going to increase [an activity from the solution architects] and how we are going to do it, which is the technical architect [i.e., the IASA software architect] part, where I work. So, this is the difference: the enterprise architect works at the higher level and (s)he looks basically to how the industry is, and with that (s)he is going to propose and seek solutions, pointing directions... So (s)he sees market tendencies and says 'everybody today is working with VMWare; virtualization is important, so we must increase virtualization support', then the person here [the solution architect] is going to say 'yes, this is true, there is a large amount of clients that demand it' and we go in this direction. Then, the other person [the software architect] refines the focus. This is the division according to the scope: the enterprise architect is broader and less specific, while the technical architect [the IASA software architect] is the lower level and is focused in the specific product; (s)he is going to see how this product attend the directions that the higher level person [the enterprise architect] points. (…) It must exist an alignment between these two dimensions (…)." – Interviewee 1, Company A.

Meanwhile, the solution architect designs the overall solution and then, this is divided in order to be developed. Each "part" of the architecture is refined by one software architect that works closely aligned with software developers. The quote below illustrates how the solution architect influences software architect's work:

> "He [the solution architect] is not going to model a system, he is a person who wants to know where it came from, where it goes, where it fits in the world, why my customer is or is not going to use it, which are the high level use cases. He is hanging out with the customers, saying where the possibilities are, and he just says to us 'this is what needs to be done'." – Interviewee 1, Company A.

These interdependencies among the different architect roles show that, although they divide their activities, they still have to interact and collaborate with each other. Their work is divided, but not detached. In fact, the information flows across the different organization teams and stakeholders: each architect addresses the interests of some groups of stakeholders, perform his/her work and pass the (modified) information along to the other architect. In the end, the final product addresses the interests of all stakeholders groups.

Architect Roles and Collaboration

In addition to having to manage the dependencies between their artifacts, it is also important to highlight that the different architects work closely together. That is to say that the description of the work performed by the different architect roles does not represent a waterfall model, a hierarchy; but instead, different architect roles collaborate along the project. This situation is clearly illustrated in the following quote:

> "In a solution developed to a [external] customer, the enterprise architect will be involved. As we [technical architects] are closer to the development team, we are responsible for developing products that have a lifeline. So, since this lifeline was created, there is a parallelism among the 3 architects [enterprise, solution and technical], because there is someone looking for marketing tendencies, there is another one taking care of the portfolio of that specific situation,

> and a third one that is worried about developing everything accorded with the "superior" architect [the enterprise architect]. So, there is a parallelism [in the tasks], but the three [architects] are working together and have contact points" – Interviewee 1, Company A.

So, despite the fact that each architect role has his/her specific activities, these activities are interdependent [18].

DISCUSSION

Grinter [4] performed a study where she argues that software architects act as boundary spanners to help create and maintain the common knowledge every development project needs. Boundary Spanners are social actors who interact with many kinds of stakeholders and, through these interactions spread knowledge and information about the project, helping its coordination [4][17]. Our research extends her work by considering the overall IT context. In this scenario, every IT architect needs to work as a boundary spanner. In fact, the different architect roles we identified work collaboratively to perform their tasks. As previously discussed, once architecture activities are divided, the associated interactions are divided too. Each role interacts with different groups of stakeholder and among themselves. Through these interactions, they help in the coordination of the project and the diffusion of knowledge, working as a group of boundary spanners.

This is also related to the research conducted by Unphon and Diitrich [15], where they identified that usually the architecture exists implicitly in discussions during the development; there is no huge effort in architecture documentation in the companies they studied. They report that the architect acts as a "walking architecture": (s)he communicates the architecture to developers and, in turn, communicate problems to the right stakeholders [15]. In short, software architecture practices emphasize communication rather than documentation. Our research extends their work, since in every company we studied we noticed this preference for communication rather than documentation not only to software architecture issues, but to IT architecture in general. Companies have several "walking architectures", instead of a single one.

In this context, our research extends existing literature and highlights the importance of the architect to the collaboration. More than that: all architects roles should act as boundary spanners, once they interact with many different types of stakeholders. Architect roles are fundamental for collaboration: they interact with different stakeholders and interact among themselves, translating and transforming information in this process. Thereby, they can guide the collaboration flow in the project.

CONCLUSIONS AND FUTURE WORK

In this paper, we report from a study conducted with IT architects aiming to understand their work in practice. We noticed that the studied organizations divide the IT architecture activities among different architect roles. These roles act as boundary spanners in the organization, each one dealing with specific set of stakeholders and providing information for another role, i.e., facilitating information diffusion in the organization. Our research highlights the importance of the interconnections among architect roles. Furthermore, any approach aiming to support architecture activities needs to provide support for the interconnections and collaborations among the different architect roles.

In our future work we hope to better understand how these different architect roles coordinate their work and based on that we plan to suggest computational mechanisms (tools) to better support the cooperation and collaboration among them.

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REFERENCES

1. IASA, http://www.iasaglobal.org/iasa/default.asp.
2. The Open Group, http://www.opengroup.org/.
3. Smolander, K. (2002) Four metaphors of architecture in software organizations: finding out the meaning of architecture in practice, *In Proceedings of the First International Symposium in Empirical Software Engineering*, Nara, Japan, IEEE Press.

4. Grinter, R. E. (1999) System Architecture: Product Designing and Social Engineering, *In Work Activities Coordination and Collaboration*, San Francisco, CA, USA, ACM Press.
5. Strauss, A. and Corbin J. (1998) Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory, Thousand Oaks, CA, SAGE publications.
6. Wilt, J. (2010) IASA's Five Pillars of IT Architecture, *Microsoft tech.ed 2010*, Available in: <http://www.msteched.com/2010/Europe/ARC204>, Access in November 16, 2010.
7. The Open Group (2004) Business Executive's Guide to IT Architecture Have you thought, Available in: <http://www.opengroup.org/bookstore/catalog/w043.htm>, Access in November 15, 2010.
8. The Open Group (2008) Information Technology Architect Certification Program – Conformance Requirements (Multi-level), England, Available in: <http://www.opengroup.org/itac>, Access in November 15, 2010.
9. Akenine, D. (2008) A Study of Architect Roles by IASA Sweden, *The Architecture Journal – The Role of an Architect*, vol 15, pp. 22-25.
10. Hofstader, J. (2008) We don't need no architects! *The Architecture Journal – The Role of an Architect*, journal 15, pp. 2-6.
11. Unde, A. (2008) Becoming an Architect in a System Integrator, *The Architecture Journal – The Role of an Architect*, vol 15, pp. 7-9.
12. Penker M. and Eriksson H. (2000) Business Modeling with UML: Business Patterns at Work, John Wiley & Sons, Inc. New York, NY, USA.
13. The Open Group (2009) TOGAF Version 9 - The Open Group Architecture Framework, Available in <http://www.opengroup.org/togaf/>, Access in February 20, 2011.
14. Schekkerman, J. (2009) Enterprise Architecture Tool Selection Guide, Available in: <http://www.enterprise-architecture.info/EA_Tools.htm>, Access in February 20, 2011.
15. Unphon, H., Dittrich, Y. (2010) Software architecture awareness in long-term software product evolution, *The Journal of Systems and Software*, 83 2211–2226.
16. Jorgensen, D. L. (1989) Participant Observation: A Methodology for Human Studies, Thousand Oaks, CA, SAGE publications.
17. Ovaska, P., Rossi, M., and Marttiin, P. (2003) Architecture as a coordination tool in multi-site software development. *Software Process: Improvement and Practice*, 8(4): 233-247.
18. Thompson, J. D. (1967): Organizations in Action. New York: McGraw-Hill.