Business architecture for inter-organisational innovation networks:
A case study comparison from South Africa and Germany

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Abstract

The range of inter-organisational innovation networks existing in the global economy today show a wide variance in structure, purpose, location, lifespan and maturity. These differences between network instantiations highlight the need for deeper understanding of the operation of these networks in order to enable efforts to improve network performance. These efforts include strategic management routines for network leadership, as well as the development of appropriate support structures, e.g. information systems architectures.

An important step towards a deeper understanding of inter-organisational innovation networks is to compare the business architectures of network case studies to identify similarities and differences in terms of scope and context, business concepts and underlying system logic. The Zachman framework for enterprise architecture provides an approach to structuring the business architecture of enterprises in a way that allows such comparisons to be drawn. This paper describes the business architecture of two contrasting network case studies from South Africa and Germany within the Zachman framework, and draws some conclusions based on the observed similarities and conclusions.

Keywords

Inter-organisational innovation networks, business architecture, Zachman framework.

1 Introduction

Innovation is widely regarded as a key factor in global economic and social development [Drucker, 1985]. As the global innovation rate accelerates, companies are starting to understand that very few innovation targets are reachable as an isolated organisation. Collaboration is therefore required amongst organisations and this has given rise to the concept of the inter-organisational innovation network [du Preez, Louw, 2008].

This reinforcing tendency towards rather open product development processes is known as the paradigm of Open Innovation [Chesbrough, et al. 2006]. In this context, inter-organisational networks can be seen as the collaboration of legally distinct organisations or/and individuals (like firms, academic institutions or entrepreneurs) with the common aim to enhance their competitive position through innovation. Inter-organisational innovation networks demonstrate an intermediary forms of an organisation falling between the polar models of market and hierarchy

[Grant, Baden-Fuller 2004]. Such networks incorporate competitive (specialisation or efficiency pressure) with typical organisational characteristics (trust or integration of knowledge and information).

The range of inter-organisational innovation networks existing in the global economy today however show a wide variance in structure, purpose, location, lifespan and maturity. These differences between network instantiations highlight the need for deeper understanding of the operation of these networks in order to enable efforts to improve network performance.

This paper focuses on research that provides a deeper understanding of the business architecture of inter-organisational innovation networks via a comparison between two contrasting case studies. The case studies were purposefully chosen to highlight differences in business architecture in terms of member organisations, motivations, geographic context, lifespan and maturity whilst still bearing the trademark similarities that make them typical of inter-organisational innovation networks.

The paper is structured as follows: initially a discussion and motivation of the analysis approach and tools employed is presented in section 2. The two case studies are described and analysed in sections 3 and 4, after which a comparison of the two architecture descriptions is presented and discussed in section 5. Section 6 presents the content and utility of our findings and offers some concluding perspectives on the work done.

2   Analysis approach

Information regarding an organisation's business architecture is normally captured and presented in a series of organisational artefacts or documents. When these artefacts do not explicitly exist or if access to these documents is limited, case study analysis can be done to obtain the appropriate information that would describe the network's architecture.

In order to compare the business architectures of different networks, a reference framework that helps to structure the artefacts describing the enterprise, is needed. The Zachman framework for enterprise architecture provides precisely this mechanism [Zachman, 1987]. It consists of a two-dimensional classification matrix based on the intersection of six basic communication questions with six rows according to reification transformations. The top three rows of the Zachman Framework describe the business architecture of the enterprise, while rows four and five combine to form the information systems architecture. The sixth row represents the functional, real-world enterprise.

The Zachman framework as a tool originates from the enterprise architecture domain and as such its applicability to our research should be motivated, given the academic debate on whether any tools from the enterprise architecture domain are relevant to the network domain. Several prominent academics are of the opinion that the inherent differences between an enterprise and a network in terms of motivation and organisational structure (or lack thereof), to name but two factors, render enterprise architecture frameworks irrelevant to network analysis. The authors of this paper are however of the opinion that, as the Zachman framework is at its most basic implementation an ontology, it can be used to structure information regarding anything, given that the correct scope and methodology is identified and abided by.

In our study the Zachman framework is used to structure the architecture information of an inter-organisational network and therefore the resultant architecture description should include all organisational units, motivations, locations, processes, inventory items and timing cycles that reside within the network.

	What	How	Where	Who	When	Why
Scope	List of things important to the business	List of processes the business performs	List of locations in which the business operates	List of organisations important to the business	List of events significant to the business	List of business goals/strategies
Business concepts	Semantic Model	Business Process Model	Business Logistics System	Work Flow Model	Master Schedule	Business Plan
System logic	Logical Data Model	Application Architecture	Distributed Systems Architecture	Human Interface Architecture	Processing Structure	Business Rules

Table 1: Top three rows of the Zachman framework representing business architecture

As our study only aims to analyse the business architecture of two inter-organisational innovation network cases studies, only the top three rows of the Zachman framework were considered (refer to Table 1). The first row identifies the scope of items that are described within the architecture description, while the second row defines these items conceptually. The third row continues this process of reification by representing the underlying logic of the architecture. Cells within the framework matrix are populated with artefacts or models that describe the most primitive elements that comprise the organisation's architecture, with more complex phenomena being described with compound models that combine the primitive elements through horizontal integrations and vertical transformations.

From our study, we found that the information contained in the top two rows of the Zachman framework, i.e. the combination of primitive and possible compound models from these two rows, provides sufficient evidence to identify meaningful similarities and differences between the case studies. Therefore, this paper presents the top row containing lists of things significant to the organisation in table form for both case studies. Furthermore, extracts from the second row concept definitions are presented for items where the concept definition was key to our ability to identify and understand similarities and differences between the networks, either as a primitive element, or as part of a compound model of a more complex phenomenon.

3   Case study 1: The water membrane network

The first case study involves the development of an innovative membrane for water filtration in South Africa. The network involves collaborative relations between engineers from the Water and Membrane Technology Group at the Durban Institute of Technology and scientists from the Institute of Polymer Science at the University of Stellenbosch. The network furthermore involves collaborative relations with the Water Research Commission, the Amatola Water Board in East London, and the Pollution Research Group at the University of Natal in Durban [Kruss, 2006].

In South Africa's rural areas, the water supply at the disposal of local communities is often unfit for human consumption due to high levels of microbial and other contaminants, e.g. cholera. This situation has created an urgent need for the development of a portable, low-cost filtration system to clarify and disinfect water. The local water industry's ability to develop this solution on its own is however constrained by low levels of research and development capacity, which is characterised by limited funding, limited research scope and especially a lack of strategic leadership to encourage technology transfer. A broader collaborative network with local research institutions was therefore necessary to develop the required technologies.

This inter-organisational innovation network performed basic and applied research, and executed a number of phases in the innovation process, idea generation, concept development, prototyping and trials, patenting and initial commercialisation. The network placed emphasis on knowledge transfer between research partners from both the basic and applied sectors of academia, as well

as between research institutions and the local water boards. The structure of the network was flexible, including different partners from both the academic and industry domains as challenges facing the network evolved. Identifying and committing industry partners as long-term network members was however a challenge and failure to do so inhibited the joint venture's capability to deliver a widely adopted innovation.

This network was modelled as an enterprise within the Zachman framework (refer to section 2), and the structured architecture information is presented in Tables 2 and 3. Table 2 presents the complete lists of items significant to the network, thereby outlining the scope of the architecture. Table 3 presents definitions and decompositions for some of these items where the information was deemed critical in enabling comparisons between the case studies (refer to section 5).

	What	How	Where	Who	When	Why
Scope	Technical abilities Technology Innovations Patents Funding	Research Product development Commercia-lisation Network building	Research locations Development locations Partner locations Venture locations	Research entities Partners Intermedia-ries Joint venture Market Government	Research timeframe Innovation life cycle Funding availability Technology maturity Partner confirmation	Profit generation Social development

Table 2: Row 1 business architecture information for the water membrane network case study

Interrogative	Business concept	Definition and decomposition
Why	Social development	The improvement of living standards in rural communities through the delivery of clean drinking water.
Who	Research entities	Universities, Research groups, Science and technology institutes, Research and Development units, etc. performing basic and applied research.
	Partners	Organisations from both the public and private domain who collaborate with the research entities within the network to bring the innovation to market, motivated by the fact that they will also benefit from the value generated. In the case of this network this is the provincial water boards and industrial enterprises.
	Intermediaries	Governmental organisations that channel government funding and represents a certain industry, but does not pro-actively introduce and commit new members to the network.
	Joint venture	A new enterprise founded by the network as a sustainable entity to commercialise research and own intellectual property. Stakeholders in the network share ownership of this joint venture.
	Market	End-users of the value generated by the innovation network, in this case the rural communities that will receive access to clean drinking water.
	Government	Water supply is the responsibility of the local government or municipalities. These organisations also have access to locations where prototyping can be performed.

How	Research	Knowledge creation in the form of basic and applied research. This process foregoes any possible commercialisation.
	Commercialisation	Process of transforming research to a product or service that is brought to market by a new or existing venture to satisfy a customer demand.
	Network building	Identifying and committing new partners with appropriate competencies and resources to the network, and maintaining and improving existing network relationships and operations.
Where	Customer locations	The end-users are located in a geographically bounded area, creating a regional customer network of water users.
	Research locations	Research is done at various locations where research entities are located, creating a national research network.
What	Technical abilities	Certain technical abilities are required from the researchers in order to bring the technology to the maturity required for commercialisation.
	Patents	Patents are registered in order to safeguard intellectual property developed by the network, and are owned by the joint venture.
	Innovations	The network's innovations decompose into the opportunities, ideas, concepts, projects, products and services that form part of the organisation's efforts to generate new value.
When	Research timeframe	The time required for scientific research to be conducted.
	Technology maturity	The point in time where a technology is deemed to have achieved a sufficient level of maturity for industrial application.
	Partner commitment	The point in time when a new partner commits to being a network member, thereby adding new competencies and resources to the network.

Table 3: Extracts from the row 2 business architecture information for the water membrane network case study

4 Case study 2: Coliquio

The network case study from Germany is concerned with the case of developing and successfully venturing an IT platform for quality management in the health care industry. More particularly, it illustrates a network with an intermediary characteristic. The intermediary role in this case has been taken by the Lake Constance University's Living Lab organisation, the eArchitecture Lab. Aiming at developing IT-supported strategic management architectures, the eArchitecture acted as an intermediary between two entrepreneurs, industrial partners (acting as consultants and technology providers), academic institutions and a focused community in the health care sector. The entrepreneurs planned to venture a technology for management of distributed expert's knowledge exchange that had previously been developed in the eArchitecture Lab.

Following the intrinsic user-centricity of the Living Lab approach, the institutionalised approach of the eArchitecture Lab, the Community of Practice for strategic management architectures (CoPS) activated and coordinated industrial partners as well as lead users and provided the collaboration infrastructure to facilitate lead user participation in product development. The identified lead users not only supported application development but also the development of a business model in later stages and a suitable go-to-market approach. Based on that, CoPS linked the project to the respective community in the health care industry initially based on academic networks to the institute for health care management and science (University of Bayreuth) and a Healthcare Research Institute (Steinbeis University). In this phase the eArchitecture Lab mediated as intermediary the interaction between the relevant health care community concerned

with quality management in health care and Coliquio to support the iterative application developed and venturing of Coliquio.

This intensive collaboration led to Coliquio being awarded with the eHealth innovation prize 2008 funded by the University of Bayreuth. This initialised broad awareness and acceptance of the Coliquio network management approach in the health care community and quickly accelerated the adoption of the Coliquio solution in the target group. By that, the intermediary role of CoPS and the eArchitecture lab faded over time such that a direct and intensive relationship between the venture itself, Coliquio, and the relevant community could be established. This intended developed was the basis for the de-incubation of Coliquio from the eArchitecture infrastructure.

As of today, Coliquio is the only relevant medical expert platform in Germany managing knowledge exchange of over 40 000 medical experts. Based on the established business model, the venture works cash neutral and plans to realise first profits end of 2011.

As was the case with the water membrane network (refer to section 3), this network was modelled as an enterprise within the Zachman framework (refer to section 2), and the structured architecture information is presented in Tables 4 and 5. Table 4 presents the complete lists of items significant to the network, thereby outlining the scope of the architecture. Table 5 presents definitions and decompositions for some of these items where the information was deemed critical in enabling comparisons between the case studies (refer to section 5).

	What	How	Where	Who	When	Why
Scope	Entrepreneurial abilities Technical abilities Demand Technology platforms Innovations Business models Brand Awards Funding	Product development Partner involvement Entrepreneurial support	Incubation locations Customer locations Venture locations Partner locations Development locations	Entrepreneurs Incubator Investors Consultants Lead users Customers Intermediary New venture Opinion leaders	Innovation life cycle Incubation life cycle Partner confirmation Funding availability Market adoption	Profit generation Enterprise development Professional support

Table 4: Row 1 business architecture information for the Coliquio case study

Interrogative	Business concept	Definition and decomposition
Why	Enterprise development	The goal of developing a viable new enterprise. Primarily associated with the entrepreneurs and the incubator.
	Professional support	The goal of exchanging professional knowledge by providing and receiving support. The main driving force motivating lead users and customers to participate in the network.
Who	Entrepreneurs	The individuals with the vision for possible exploitation of a market demand, as well as the drive to generate value via a new venture.
	Incubator	The organisation that lends initial support to young ventures in the form of operational resources and strategic guidance.
	Intermediary	The individual or organisation that facilitates network building by

		introducing and committing new network partners with the required competencies and resources. Contributes a sense of sustainability and trust to the network.
	Investors	Individuals or organisations that invest resources, e.g. financial capital, time and other resources, in the new venture with the expectation to be rewarded for these investments.
	Lead users	Individuals or organisations from the market segment that are involved in early prototype testing and possibly also product development, thereby lending unique insights and ensuring eventual customer satisfaction.
	New venture	The new enterprise that is founded to generate value by bringing the innovation to market.
	Customers	The individuals or organisations whose demands are satisfied by the innovation, in this case the medical professionals that share their knowledge.
How	Network building	Identifying and committing new partners with appropriate competencies and resources to the network, and maintaining and improving existing network relationships and operations.
	Entrepreneurial support	Services provided by the incubator to assist the newly founded venture in the initial phases of its development.
Where	Incubation locations	The locations of the incubator organisation. Its close links to the new enterprise strongly influences the enterprise's own location.
	Customer locations	The locations of the customers, in this case being bounded by national boundaries thereby forming a national network.
What	Entrepreneurial abilities	The entrepreneur's ability to identify an exploitable opportunity in the market, as well as the skills to drive the development of a new venture that aims to exploit the opportunity.
	Technical abilities	Certain technical abilities are required from the network members in order to bring the technology to the maturity required for commercialisation.
	Demand	An unfulfilled need in the market, thereby creating an opportunity for exploitation.
	Business model	A description of the enterprise's underlying logic and value proposition. This is required to convince investors to invest in the enterprise.
	Brand	A marketable corporate identity that is coupled to the enterprise's value proposition. Management and promotion of the brand is key to market adoption and venture growth.
	Award	Recognition for excellence. An award received by a brand can convince customers to adopt the venture's innovation, thereby creating critical mass for further venture growth.
	Innovations	The network's innovations decompose into the opportunities, ideas, concepts, projects, products and services that form part of the organisation's efforts to generate new value.
When	Idea generation	The moment of the initial idea for a possible innovation.
	Incubation life cycle	The sequence of events whereby the incubator organisation helps the new venture to grow toward maturity and self-reliance. Includes initial incubator commitment, business plan maturity, enterprise foundation and eventual deincubation.
	Market adoption	The sequence of events whereby the innovation is adopted by the market, resulting in growth of market segment. In this case these

		events included an initial marketing drive, an award presentation and acceptance as an industry standard.
	Partner commitment	The point in time when a new partner commits to being a network member, thereby adding new competencies and resources to the network.

Table 5: Extracts from the row 2 business architecture information for the Coliquio case study

5 Architecture comparison

The results of the comparison between the two case studies' business architecture descriptions are now presented and discussed in terms of motivation, organisation, processes, location, inventory and timing.

1. From a motivational point of view, the two network case studies both featured a primary goal of profit generation for the network members. The water membrane network however also included a strong social development goal related to the desire to provide access to clean drinking water in rural areas. The Coliquio network featured a goal of providing and receiving professional support, which was especially relevant to the lead users.

2. In terms of organisation there were marked differences between the networks, the most obvious being the presence of an incubator in the Coliquio network. This organisation played an important role in guiding the new venture towards self-reliance and a level of success that was never achieved in the water membrane network.

   The next major difference between the two case studies was the presence of entrepreneurs in the Coliquio case who drove the network toward their vision for their innovation. In the water membrane network, researchers who believed in the potential of their technologies had to double as entrepreneurs without necessarily having the required skill set to do so. The Coliquio network's greater ability to attract investors is one result of this difference.

   Furthermore, the Coliquio network exhibited a more user-centric approach to innovation and as such included more active role players from the user domain, e.g. lead users and customers. The water membrane network's market was mostly uninvolved in the network, as they were passive consumers of the access to clean drinking water.

   An important similarity between the case studies was the formation of a new or joint venture to bring the network's innovation to the market. It is clear that this brings a strong sense of purpose and trust to an inter-organisational innovation network.

   The presence of an intermediary in both case studies is a further similarity and in both cases this organisation contributed initial funding, as well as links to potential network partners.

3. As far as processes are concerned, there were some expected similarities between the networks, especially the focus on the product development and network building. As has however already been mentioned, the presence of a pro-active intermediary in the Coliquio network had a great effect on the success of network building.

   A major process difference between the networks was the focus on research and commercialisation in the water membrane network. This was to be expected, given the fact that some technologies still need to be developed for the network's innovation to be successful, while in the Coliquio network's case some already mature technologies only needed to be adapted.

   Another difference was the presence of an entrepreneurial support process in the Coliquio network, introduced by the incubator.

4. In terms of location there were obvious differences, with the water membrane network being located at the southern tip of Africa and the Coliquio network operating in Germany. We however found that from an architectural point of view these differences were not identifiable in terms of primitive location elements, but rather manifested themselves as compound architecture elements that combine a number of the primitive elements from different interrogative perspectives. One example of this would be the way in which the density of possible external competencies and resources that are at the network's disposal could vary based on geographical context, thereby combining process (partner involvement), organisational (which new partners) and inventorial (which new skills and resources) elements.

   The architecture of both networks included the locations where development took place, as well as where partners and the new venture were located. The Coliquio network's architecture did however have to allow for the location of the incubator organisation, and this had a direct impact on the location of its venture.

   The way in which the locations of the respective networks' customer locations factored into the architecture also differed. The water membrane network's end users were located within a regional area bounded by the municipal area of the water board that was a network member. Although not considered in this analysis, this meant that the technology logically specified at an increased level of reification in the architecture (the third row of the Zachman framework) could cater for a less distributed customer base. The local water board's infrastructure of common water points further enhanced this notion. The Coliquio network's customers on the other hand were distributed all across Germany and therefore a technological setup that could deliver the innovation's value in a far more distributed fashion was required.

5. Regarding network inventory, both networks logically exhibited an architecture in which the availability of technologies, innovations and funding were deemed significant. In both cases, the network's innovation as inventory item could be broken down into an opportunity, idea, concepts, prototypes, projects and at least one resulting product or service.

   Both networks required certain technical abilities to develop their innovations and in both cases new organisations with the required competencies were approached and became network members.

   In the case of the Coliquio network, a strong entrepreneurial ability was required to identify the demand in the market and to sense the opportunity for innovation. In the water membrane network's scenario the market demand is a commonly known fact in South Africa and entrepreneurial ability did not significantly factor into the network's architecture.

   Several additional inventory items characterised the Coliquio network's architecture, including a business model to attract investors, a recognisable brand and an award to lend prestige to the venture.

   The water membrane network's architecture included a patent as an inventory item, which was directly linked to and owned by the joint venture.

6. The innovation life cycle played an important role in the timing perspective of both networks' business architecture and in both cases it could be broken down into the phases of idea generation, concept development, prototyping and implementation.

   An important difference between the case studies was however the role the incubation life cycle played in the Coliquio network. This life cycle included key timing events like the incubator's initial commitment to the network, the formation of a business plan, the foundation of the venture and the eventual deincubation from the incubator.

The point at which funding for the networks' innovative activities became available was also crucial in both cases. Both architectures furthermore largely governed by the confirmation of new network members contributing certain competencies or resources, and the lack of sustainable industry partners proved to be a major hurdle in the development of the joint venture in the water membrane network.

This resulted in the fact that only the Coliquio network's venture ever reached a point of market adoption, a sequence of events which was strongly influenced by the presentation of an award.

6 Findings and Conclusion

The purpose of this study was to arrive at a deeper understanding of the business architecture of inter-organisational innovation networks in order to enable further research into ways of improving these networks. The comparison of two business architecture descriptions presented in the previous section lead us to the following key points that we deem to be valuable insights toward our goal.

1. The network's combined pool of goals and motivations are not necessarily coherent and strategically aligned, but rather tends to be a heterogeneous composite of that of the network partners. This could potentially have a ripple effect on the network's capability to effectively execute certain processes, manage its inventory or effectively work according to a shared schedule.

2. The innovation life cycle is an important timing sequence that governs the development of the network's architecture. It determines which competencies and resources are required at certain points in time and therefore influences which partners, processes and inventory items are required in the network's architecture. An example of this would be the development of a formalised business plan as a network inventory item at an advanced point in the network's life cycle.

3. An inter-organisational innovation network that has an entrepreneurial focus and motivation will benefit from a different architecture than a network focussed on research commercialisation.

   Inter-organisational innovation networks with a dominantly entrepreneurial motivation may benefit from specific entrepreneurial skills as part of the network architecture, particularly during the early phases of the innovation life cycle. In these phases the level of uncertainty concerning the economic outcome of the innovation is high and requires at least visionary thinking and conviction of individuals (entrepreneurial characteristics) to drive further developments and to convince potential new partners. Without such an ambition towards risk-taking, innovation will be inhibited. In the case of networks where the motivation includes a stronger element of research commercialisation, some partners may be more ideologically driven and technology maturity may be lower at the time of network inception. This network configuration would initially benefit from a different architecture, although it might develop toward a more entrepreneurial architecture at a later stage when more entrepreneurially-minded partners are added to the network.

4. A pro-active intermediary is required to identify the appropriate partners that may contribute specific competencies or resources to the network throughout the innovation life cycle, e.g. the addition of an incubator at the point where a new venture is founded. The intermediary is also required to focus the network members' heterogeneous pool of goals toward a homogeneous set of goals at certain points in the innovation life cycle.

5. A network's geographical context (i.e. whether it is principally located in e.g. South Africa or Germany) does not have a direct impact on the type of architecture it would benefit from. This could be attributed to the way in which inter-organisational innovation

networks deliberately cross organisational as well as regional and international boundaries. Geographical context could however influence the density of possible external competencies and resources that might be at the network's disposal. The importance of a well-connected and pro-active intermediary is therefore highlighted once again as a possible mechanism to combat any possible inhibiting effect that geographical context could have on the network's performance.

Our method of describing the business architecture of these complex organisations within the Zachman framework was validated by the way in which we were able to describe complicated network phenomena in terms of primitive architectural elements. This in itself is a valuable outcome of this study, illustrating that the Zachman framework is a viable option for structuring architecture information on inter-organisational innovation networks.

One limitation of this approach that we can however foresee is that it would be easy to confuse the scope of the organisation that is being modelled within the framework. Great care should therefore be taken to establish and maintain the correct scope of analysis when describing a network's architecture within the Zachman framework. Another limitation of the approach might be that a complete business architecture description within the reference framework is required to develop a meaningful information systems architecture to support the network (refer to section 2). Developing such a complete description could be a resource-intensive and intricate process.

We see utility in our findings therein that the influence of the innovation life cycle on the architecture of inter-organisational innovation networks was highlighted. These observations are a promising avenue for possible future research into how to strategically manage such a network's architecture as it progresses through the phases of the innovation life cycle. Such further research would place a governing focus on the timing perspective of the business architecture and then attempt to optimise the other architectural perspectives (i.e. motivation, role players, processes, inventory and locations) according to the timing perspective's development.

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Comment [HG1]: To be expanded