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Enterprise Architecture in Practice:
From IT Concept towards Enterprise Architecture Leadership

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Abstract

Information Technology (IT) is essential for current operations, communication and future strategies of modern enterprises (Nolan 2012). Information is needed for human and organizational well-being, growth and survival. Technology is a means to acquire, manage and share information. IT is transforming business, labor and division of work faster and wider than any technology before. Mastering all that technology, information systems (IS) and information requires new thinking, concepts and tools for organizing work (Orlikowski 2007).

Our study explores one of the promising concepts for managing technologies and digitalization as part of a modern enterprise. This concept is called Enterprise Architecture (EA). Currently, EA does not have a standardized definition. Burgess, Ramakrishnan, Salmans and Kappelman (2010, 252) reports 10 different definitions for the concept of EA, which is defined most concisely and at the highest level of abstraction as “all the knowledge about the enterprise”. One source of EA ambiguity relates to its IT roots and highly technical orientation. But, during the last 20 years, the idea of EA and EA management (EAM) has been slowly migrating from technology and IT architectures towards social and administrative innovation for organizing and guiding organizational money expenditure (Luftman & Ben-Zvi 2011, 206), systems development (Makiya 2012, 6), and strategy (Simon, Fischbach & Schoder 2014). Thus EAM is a novel concept promising various benefits but including controversial expectations and complex systemic and social challenges for EAM benefit realization.

We will explore EA development as an emergent IT concept and complex social-technical phenomena. We will start from the IT roots, architectures and business IT alignment towards EAM. From EAM, we will continue using Activity Theory (Vygotsky 1978; Leontiev 1978, 1981; Engeström 1987), Actor-Network Theory (ANT: Latour 1999a; Monteiro 2000), Structuration Theory (Giddens 1984) and sociomateriality (Orlikowski 2007) as ladders for EA leadership. During this theoretical journey we will in-

troduce three frameworks and one external perspective to analyze organization as a socio-material whole divided into layers of IT, EA, EAM and knowledge management.

The empirical part of our study is a reflective practice oriented case study regarding EA development. We are testing our theoretical EA frameworks while analyzing ethnographic field observations from longitudinal EA development in a case enterprise setting during the years 1996-2011. Seven vignettes are bottom-up narratives from EA development, which are analyzed using our theoretical frameworks covering IT layers, EA, EAM and EA knowledge management.

Our EA study indicates that both EAM and EA leadership are promising concepts for improving IT productivity with integrated business, process and IS/IT development. But both EAM and EA leadership require a more systemic understanding of how socio-material structures and practices should be (re)defined and applied in improving organizational knowledge and change management practices. Our EA frameworks could be used for improving management practices towards reflective EA management and leadership practices.

Tiivistelmä

Informaatioteknologia (Information Technology, IT) on kaikkialla ja liiketoimintakriittisesti välttämätön osa yritysten nykytoimintaa, viestintää ja tulevaisuuden strategioita (Nolan 2012). Informaatiota tarvitaan ihmisten ja organisaatioiden hyvinvointiin, kasvuun ja selviytymiseen. IT muuttaa liiketoimintaa, työtä ja työnjakoa nopeammin ja laajemmin kuin mikään aikaisempi tekninen keksintö. Teknologiaa käytetään informaation hankkimiseen, hallintaan ja jakamiseen. Teknologioiden, tietojärjestelmien (Information Systems, IS) ja informaation hallinta vaativat uutta ajattelua, konsepteja ja välineitä työn organisointiin (Orlikowski 2007).

Tämä opinnäytetyö tutkii kokonaisarkkitehtuurin (Enterprise Architecture, EA) mahdollisuuksia hallita teknologioita ja digitalisaatiota osana nykyaikaista liiketoimintaa. EA-käsitteellä ei ole vakiintunutta määritelmää. Burgess, Ramakrishnan, Salmans ja Kappelman (2010, 252) raportoi 10 erilaista tapaa määritellä EA-käsite, joista korkeimman abstraktiotason määritelmä on “kaikki tietämys yrityksestä”. EA-käsitteen moniselitteisyys johtuu osittain informaatioteknologian nopeasta kehityksestä ja hyvin teknisestä näkökulmasta. Viimeisen 20 vuoden aikana kokonaisarkkitehtuurin hallinnan (EA management; EAM) idea on kasvanut tietotekniikasta ja IT-arkkitehtuureista kohti hallinnollista innovaatiota, jolla ohjataan organisaation rahan käyttöä (Luftman & Ben-Zvi 2011, 206), tietojärjestelmien kehitystä (Makiya 2012, 6) ja strategian toteutusta (Simon, Fischbach & Schoder 2014). EAM on uusi käsite, joka lupaa moninaisia hyötyjä, mutta sisältää samalla ristiriitaisia odotuksia ja monimutkaisia systeemisiä ja sosiaalisia haasteita mahdollisten hyötyjen realisoimiseksi.

Tämä työ tarkastelee kokonaisarkkitehtuuria IT-käsitteenä ja monimutkaisena sosioteknisenä ilmiönä. Etenemme EA:n tietoteknisistä juurista, arkkitehtuureista, liiketoiminnan ja tietotekniikan samansuuntaisuuden (alignment) kautta kokonaisarkkitehtuurin hallintaan. Kokonaisarkkitehtuurin hallinnasta jatkamme toiminnan teorian (Vygotsky 1978, Leontiev 1978, 1981; Engeström 1987),

toimijaverkostoteorian (Actor-Network Theory, ANT: Latour 1999a; Monteiro 2000), strukturaatioteorian (Giddens 1984) ja sosiomateriaalisuuden (Orlikowski 2007) avulla kohti kokonaisarkkitehtuurin johtamista (EA leadership). Teoriaosuudessa esittelemme kolme viitekehystä ja näkökulman analysoida organisaation tietotekniikan, kokonaisarkkitehtuurin ja tietämyksen hallinnan sosiomaterialistista kokonaisuutta. Opinnäytetyön kokeellinen osuus on tapaustutkimus kohdeyrityksemme kokonaisarkkitehtuurin kehittymisestä. Teoriaosuuden viitekehyksiä testataan analysoimalla kohdeyrityksen kokonaisarkkitehtuurin kehityksestä tehtyjä etnografisia havaintoja vuosilta 1996-2011. Seitsemän lyhyttä kuvausta (vignettes) kertovat kohdeyrityksen kokonaisarkkitehtuurin kehitystarinoita, joita arvioidaan IT, EA, EAM ja tietämyksen hallinnan näkökulmista. Tämä työ osoittaa kokonaisarkkitehtuurin hallinnan mahdollisuuksia parantaa informaatiotekniikan tuottavuutta integroimalla liiketoiminnan, prosessien ja tietojärjestelmien/tekniikan kehittämistä. Kokonaisarkkitehtuurin hallinta vaatii lisää systeemistä ymmärrystä miten sosiomateriaalisia rakenteita ja käytäntöjä tulisi (uudelleen)määrittää ja sovittaa yrityksen tietämyksen ja muutoksen hallinnan tehostamiseksi. Tutkimuksessa esitettyjä viitekehyksiä voidaan jatkossa käyttää pyrittäessä kohti reflektoivia kokonaisarkkitehtuurin hallinnan ja johtamisen käytäntöjä.

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Harri Kimpimäki

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Central abbreviations

Acronym	Short name	Explanation
ADM	Architecture Development Method	TOGAF based Enterprise Architecture (EA) process model for EA development
ANT	Actor-Network Theory	social theory about human and technical actors and their inter-related networking; (Latour 1999a; Monteiro 2000)
APS	Advanced Planning and Scheduling	supply-chain planning application from Oracle; part of Oracle eBusiness Suite ERP –software package
ASCP	Advanced Supply-chain Planning	supply-chain planning application from Oracle; part of Oracle eBusiness Suite ERP –software package
BA	Business Architecture	a part of EA defining business strategy, governance, organization, and key business processes; Enterprise Business Architecture (EBA)
BI	Business Intelligence	analytical business reporting solution
BPA	Business Process Architecture	the architecture of the business processes and relationships among them
CM	Change Management	concept and practice of planning, preparing, communicating and managing organizational and systemic change
CMMI	Capability Maturity Model Integration	a process improvement training and certification program and service administered and marketed by Carnegie Mellon Software Engineering Institute (SEI)
CRM	Customer Relationship Management	sales and marketing driven practices, processes, systems, application and data for managing customer information, communication and transactions
DW	Datawarehouse	reporting database for analytical reporting purposes, same as EDW at enterprise level and Datamart as domain-specific reporting database
EA	Enterprise Ar-	Enterprise Architecture is the continuous practice of de-

	chitecture	scribing the essential elements of a socio-technical organization, their relationships to each other and to the environment, in order to understand complexity and manage change (Vaknin 2009)
EAF	Enterprise Architecture Framework	conceptual model defining EA components and EA modeling process; e.g. TOGAF, Zachman Framework (ZF)
EAM	Enterprise Architecture Management	organization, processes and systems for managing EA development and EA products
EBA	Enterprise Business Architecture	A part of EA defining business strategy, governance, organization, and key business processes at enterprise level; Business Architecture (BA).
EBS	eBusiness Suite	marketing name for Oracle ERP and business applications
EDW	Enterprise Datawarehouse	enterprise-level reporting database; large storage for enterprise-wide data; Datawarehouse (DW)
EEM	Extended Enterprise Model	applied from Leavitt’s (1965, 1145) organization diamond model containing technology, information, goals, environment and enterprise border, actors and business networks
EIS	Enterprise Information System	logical aggregate enterprise-level composite information system (IS) of all information systems used for social communication; enterprise system (ES) for information processing
ERP	Enterprise Resource Planning	enterprise-level software application for integrated financial and operative transaction processing
ES	Enterprise System	systemic whole for an enterprise; in IS –context meaning the same as EIS for enterprise-level aggregate and logical composite of all information systems within enterprise
ETL	Extract-Transform-Load	reporting solution for transferring data from source systems into intermediate system for transforming (converting, translating, manipulating) data before loading data typically to DW or some other reporting database
GVI	Global Visibility Information	Nokian Tyres’ specific systems, applications and data for managing and sharing product availability information
ICT	Information and Communication Technology	various forms of data and information, which are digitalized, transferred and stored with computers and other data processing devices; information technology, IT
IS	Information System	information systems are technically mediated social interaction systems aimed at creating, sharing and interpreting a wide variety of meanings (Hirschheim, Klein & Lyytinen 1995, 13)
IT	Information Technology	various forms of data and information, which are digitalized, transferred and stored with computers and other data processing devices; information and communication technology, ICT
ITA	IT architecture	IT part of EA defining major systems, technologies and

		their relationships
KM	Knowledge Management	theory and practice of managing human knowledge and tacit knowing
KPI	Key Performance Indicator	aggregate or statistical number or value, which is used for measuring and monitoring system and/or process performance
MDM	Master Data Management	theory, systems, application and processes for managing master data and structures for products/items, customers, suppliers, chart of accounts, bill of materials and other business critical data domains
NR	Nokian Renkaat	a Finnish abbreviation for Nokian Tyres (NT)
NT	Nokian Tyres	an English abbreviation for Nokian Tyres; in Finnish Nokian Renkaat (NR)
STS	Socio-Technical Systems	systems theory stating that human and organizational outcomes could only be understood when social, psychological, environmental, and technological systems are assessed as a whole (e.g. Griffith & Dougherty 2002; Trist & Bamforth 1951)
STS	Science and Technology Studies	Social Studies of Science and Technology (Van House 2003); socio-technical science and studies, which reflect intertwining social and technical development processes
S&OP	Sales and Operations Planning	theory and practice for integrated planning process combining harmonized data structures, demand planning, demand-supply balancing and supply/sourcing processes
WMS	Warehouse Management System	warehouse operations system for managing inbound material receipts, putaway, inventory management, picking and outbound shipping transactions

1 Introduction

Information Technology (IT) is essential for current operations, communications and future strategies of modern enterprises (Nolan 2012). Information is needed for human and organizational well-being, growth and survival. Technology is a means to acquire, manage and share information. Putting information and technology together into social and technical networks creates complex Information Systems (IS), which are changing human life, behavior, communication, societies and social structures everywhere. Ubiquitous IT (Weiser 1993) seems to become a commodity (Carr 2003). The world is seemly becoming flat (Friedman 2005); digitalization (Tilson, Lyytinen & Sørensen 2010) continues while equal IT infrastructure and information becomes available to everyone. But getting things done together and reaching the goals of various forms of social communities in digital worlds is highly dependent on social structuration (Giddens 1984), unequal environments and uneven resources (Walsham 2008), information and IT (Nolan 2012).

The systemic whole of modern enterprise is becoming one of the most complex and fragmented living human systems ever (Colbert 2004), which may also be seen as complex adaptive system (Eidelson 1997). The increasing complexity of IT/IS systems and the rapid changes in business environments and social systems require new concepts and disciplines for leading and managing knowledge (Pearce 2004; Pearce & Manz 2005; Uhl-Bien, Marion & McKelvey 2007), change and organizational learning (Senge 2006), shared IT-business understanding (Ray, Muhanna & Barney 2007), IT-enabled resources (Chen 2012) and IT-infrastructure flexibility (Bhatt, Emdad, Roberts & Grover 2010). All industries have been using IT and digitalization in the search for competitive advantages, new markets, effectiveness, efficiency and survival against increasingly global competition (Luftman 1996). Thus every business and enterprise is based on information and technology, which should be aligned to changing business strategies, goals and operations (Henderson & Venkatraman 1989, 1993). The immaterial part of enterprise has been rapidly growing. The increasing amount of information and technologies has been causing major challenges for managing and organizing both elements. New ways of dealing with materiality are needed if we are to understand contemporary forms of organizing that are increasingly constituted by multiple, emergent, shifting, and interdependent technologies (Orlikowski 2007, 1435). Together business, information and technology are creating something emergent as a complex systemic whole called Enterprise Architecture (EA: Zachman 1987; Richardson, Jackson & Dickson 1990, 386; Rood 1994, 106). EA may be seen to exist irregardless of whether it is deliberately managed (Stettiner & Messerschmidt 2012, 73). Attempts to manage EA are called EA management (EAM: e.g. Radeke 2010), which is the core concept of our study.

The growing complexity of EA may be conceptually divided into Business Architecture (BA: Versteeg & Bouwman 2004) and IT architecture (Zachman 1987) domains. Business Architecture may be seen as business driven structuration of an enterprise, reflecting the leadership style of founders, entrepreneurs, owners and/or CEOs (Levy 2013, 132). Startups may pivot in various ways, e.g. from a sales-driven company to a market-driven company (Moore 2002, 69). from the business-to-business (B2B) to the business-to-consumer (B2C) operations model (Moore 2008; Ries 2011, 174) These kinds of strategic pivots have several effects on business and IT parts of EA, which changes may be managed in small startup-scale without explicit EAM. But in wider enterprise-scale more systematic and systemic approach for EAM may be valid.

EA is a novel concept and ideology which tries to capture both business and IT architecture domains to achieve an integrated approach for maintaining business-IT alignment (Kappelman 2010a, 3; Ulrich & McWhorter 2011, 22). The complexity of modern enterprise is reflected in the ambiguity of EA definitions (Kappelman 2010b, 117). Burgess et al. (2010, 252) reports 10 different definitions for the concept of EA, which is defined at the highest level as “all the knowledge about the enterprise”. One source for EA ambiguity relates to IT roots and highly technical orientation. But, during the last 20 years, the idea of EA and EAM has been slowly migrating from documenting and managing technology and IT architectures (Bernard 2005, 33) towards social and administrative innovation for organizing and guiding organizational money expenditure (Luftman & Ben-Zvi 2011, 206), systems development (Makiya 2012, 6), and strategy (Simon et al. 2014). In 2011, IT executives have ranked increasing EA concerns into their top ten priorities to show the business relevance and value of IT (Luftman & Ben-Zvi 2011, 206).

Academic research has found many potential EAM benefits (Boucharas, van Steenbergen, Jansen & Brinkkemper 2010), which may be realized if EAM is useful for users and shareholders (Ahlemann, Mohan & Schäfczuk 2012b, 241). Lange, Mendling and Recker (2012, 4234) have been exploring EA net benefits as aggregates of EA product and function setup quality, combined to service delivery and cultural aspects of EA use and user satisfaction. Thus EAM seems to be a multi-dimensional organizational decision domain, which includes organization structure and governance models into process, methodology and culture issues (Ahlemann & El Arbi 2012, 39). Bernard (2005, 48) states that organizational structure and culture are important to include in the EA in order to reflect organizational goals, processes, and informal structures, which influence the current and future views of the architecture. But when trying to “see the big picture” of EAM by reassembling the fragments of the whole, we end up splitting, listing and organizing all the pieces of modern enterprises (Senge 2006, 3).

We will investigate EA from a social aspect in theory and practice following Trist and Bamforth’s (1951) idea that social, psychological, environmental, and technological systems should be assessed as a whole. Thus our approach to EAM follows the socio-technical systems (STS) tradition assuming that organizations are “made up of people (the social system) using tools, techniques and knowledge (the technical system) to produce goods or services valued by customers (Griffith & Dougherty 2002, 205). The social perspective to EA theory seems to be quite limited. Mackay (2003) has discussed EA leadership from communication and change management perspectives. Bernard (2005, 49) argues the importance of people and EA as people and social interaction. Bernard (2005, 245) has also elaborated EA as profession and discipline. Ahlemann et al. (2012b) have discussed about human factors and psychological dimensions of EA buy-in for EA stakeholders. Zacarias, Caetano, Magalhaes, Pinto and Tribolet (2007) have added a human perspective to the EA framework. Hobbs (2012) has reviewed EA governance models and various organizational configurations for EAM structuration including centralized, decentralized, center of excellence and hybrid/federated EAM organization models. Makiya (2012) has studied EA assimilation and technology acceptance as diffusion of innovation into U.S. Federal Government organizations. Levy (2013, 57) has studied EA from a Design Science perspective adopting nine genres of human artifact: EA as socio-technical problem solving, product, process/action, intention, planning, communication, user experience, value, professional practice and service (MacKay, Marshall & Hirschheim 2012). More social and organizational EA research has been published quite recently: the role of subcultures in the EA process (Niemietz, De Kinderen & Constantinidis 2013), architectural support activities (Labusch & Winter 2013), EA artifacts as boundary object for enterprise transformation (Abraham 2013).

Our approach to social structures of EA offers sociological integration between business, IT and processes, which we think are major components of EA in practice. Our EA thinking has similarities with Sidorova & Kappelman (2010, 74), who discuss EA from an Actor-Network Theory (ANT) perspective, which we will enhance with other social theories. In our fieldwork, we use ethnographic observation and participation method, which combines culture as the broadest social concept including observations of cultural behavior and cultural knowledge (Fetterman 2010, 16). Our human and sociomaterial perspective to EA shares similarities with social networks (Dreyfus & Iyer 2006) embedded into socially structured reality (Mezzanotte, Dehlinger & Chakraborty 2010) and studies of human behavior (Zacarias et al. 2007). Similarly to Zacarias et al. (2007) adding a human perspective to the EA framework, we are adding a sociomaterial perspective to EAM.

We will use systems thinking to see connections between the parts of EA, trying to see patterns and structures of EAM as a social system (Brynteson 2006, 8) towards EA net benefits. We will use EAM as a higher-level system to aggregate social, material and technical EA parts as sub-systems of the whole EAM. Bernard (2005, 49) maintains that EA is as much about people and social interaction as it is about processes and resource utilization. Visibility to social and material parts of enterprise are needed for efficient and effective EAM communication, coordination and control of complexity and costs for managing change and producing business value (DeBoever, Paras & Westbrock 2010, 157).

Tools and technologies have always been used to enhance human capabilities (Petroski 1992). Technologies has been used as a means for various purposes to achieve human goals and ends, but technology itself can be seen as a goal and end for human activity. Tools are systemic by nature because the making of and using of a tool requires other tools, technologies, skills and knowledge as means, which are combined in the creation and manufacturing process to produce a tool and in the utilization phase to use and to maintain the tool. EAM can be seen as a tool for managing socio-economic complexity and costs of EA. Knowing and caring about existing tools and systems (Sorrentino 2005, 509; Ciborra 1997, 1998) are implicit parts of EA while improving human capabilities and EAM for the organizational goals. Improved knowledge and human capabilities regarding existing technologies have enabled EAM to generate cost savings and cost avoidance (Makiya 2012, 122). EAM seems to promise improvements to communication, coordination and control, but includes challenges in organizational culture for managing knowledge, change and values. Therefore, Activity Theory (Vygotsky 1978; Leontiev 1978, 1981; Engeström 1987) could represent a useful theory for understanding EA in practice. But, at the same time, EAM may be seen as a complex and expensive tool and system to develop and maintain. We argue that in practice EA cultural aspects, organization structures, processes and EA leadership (Lange et. al 2012, 4236) are the most important factors for EAM benefits and business value creation.

At the enterprise level, all the information sources, systems and actors that participate in achieving enterprise level business goals can be seen together as an aggregate enterprise information system (EIS) or enterprise system (ES). When enterprise is seen as EIS, then human systems, information and IT are elementary parts of the operations.

Orlikowski (1992) analyzed IT use in organizations from a structuration perspective, finding four separate types of influence of IT on human actors when they are trying to achieve their work and business goals by using IT. These effects on humans encompass/are analysed as/include IT as a product of human action, IT as a medium of human action, but also IT is setting conditions and constraints for human action, and causing consequences of interaction with IT. Thus both IT infrastructure and tools together create the mostly physical construction of EIS, which are used for business purposes to achieve business goals. In addition to these technologies, information systems also include humans and information, which together are making the social part of EIS. This social part of EIS is the invisible layer and socially constructed system above the material layers of EIS, making EIS fragile to changes in human behavior and systems.

Digitalization, internet technologies, virtualization, outsourcing, mobile computing, cloud computing and social media are rapidly transforming IT, enterprise borders and communication structures, enabling new social interaction, business models and creating an even more complex and dynamic IT foundation. Material IT infrastructure is vanishing into immaterial networks. On the social side, basic IT skills and knowledge are becoming common capabilities for the labor force. EA is promising a systematic and holistic perspective for EIS management covering both technical and social development, use and maintenance of IT/IS (Stettiner & Messerschmidt 2012, 73). New technologies will come and go, and human capability to comprehend the complexity of ever changing technology landscape is challenged continuously. This requires knowing what information and technology already is available and knowing what could be. We think that Actor-Network Theory (ANT: Latour 1999a; Monteiro 2000) could be a useful theory for modelling this continuous systemic discourse between human and technical actors.

Friedman (2005) argues that this continuous IT development is converting the world into a flat communication system and battlefield between nations and enterprises. This flattening effect has been changing global supply chains and EA, which transformation Chattopadhyay (2011) has studied when comparing national and cultural differences in manufacturing organizations. Walsham (2008) argues that the world remains uneven, full of seams, culturally heterogeneous, locally specific, inequitable, and constantly changing domains. If business and IT are managed as separate entities, then the systemic whole of an enterprise will become more complex to manage than ever before. EAM is loose concept and tool promising new solutions and tools for managing the whole “flat world” of EIS from business information and IT perspective, but ethical dimensions, social structuration and culturally heterogeneous perspectives seem to be missing from technology-centric EA concepts.

Thus EA as a tool seems to be more like a next level concept above IT architecture, without any proper tools for capturing social dimensions and diversity of an enterprise. This gap between human intentions, IS development and IT use is generating continuous challenges and complexity for business-IT alignment. This complexity may be minimized, managed and sometimes even prevented, if EA could be enhanced towards integrated EA practices for managing, communicating and coordinating continuous systemic changes with EA management and leadership structures. Makiya's (2012) study in US public sectors shows that an innovative leadership style is the key to advancing EA program assimilation within adopter units. EA leadership seems to be vital for initiating a multi-level behavioral EA management program (Stettiner & Messerschmidt 2012, 57), harvesting cost and managing complexity with EAM (Makiya 2012, 139), as well as investing in EA as a strategic asset (GAO 2003, 25). Thus the IT-driven EA ideology and concepts seem to require social construction and improvements for organizational management practices and social leadership, which could also facilitate corporate strategic management (Simon et al. 2014).

Nolan (2012, 91) argues that now IT is everywhere, but IT strategic leadership remains fragmented and is nowhere. Löhe and Legner (2014, 108) have documented the research gap between EAM and IT management research, with only some practitioner-oriented publications mentioning EAM's application in the IT management context. Huovinen and Makkonen (2004, 5) have argued that business value thinking and leadership skills are required from CIO to produce business value from IT. But EAM seems to be a separate management layer for managing EA without integration to IT management (Löhe & Legner 2014, 101). We think that Nolan's (2012) IT strategic leadership and value-driven CIO (Huovinen & Makkonen 2004) should be integrated into EA leadership including executive communication and change management (Mackay 2003, 255). We maintain that through dialogue and storytelling, EA leadership could shape the evolution of agent interactions and construct the shared meanings that provide the rationale by which the past, the present, and the future of the organization coalesce (Boal & Schultz 2007). EAM should combine technical, social and economic dimensions of EA development, synchronization, coordination and communication between various shareholders and actors inside an enterprise business network. Timing and costs of EAM are practical business issues, which should be visible for covering both theory and praxis of socio-technical EA explorations. Thus EA management organizations and processes should enable EA leadership practices of a learning organization (Senge 2006): systems thinking, personal mastery, mental models, building shared vision and team learning. EA seems to be among top 10 issues of most important/worrisome technologies for IT leaders, but during uncertain economic times organizations may be focusing on more operational and measurable considerations (Kappelman, McLean, Luftman & Johnson 2013).

Richardson et al. (1990, 399) documented so called “sunrise technology”, which refers the a continuing and honest belief of computer professionals to trust that every new technology will perform as the salesperson promised, and the new technology will immediately bring the expected capability. When seeing EA as technology, EA is promised to be an answer and a solution to business needs of better IT management and more flexible, agile and efficient IT infrastructure. Is EA the next sunrise technology for business improvements and better IT management? Could it be so that EA is in the ideological continuum of Taylor’s “scientific management” and Juran’s “statistical quality control (Stacey, Griffin & Shaw 2000; Kappelman 2010c; Salmans 2010, Simons, Kappelman & Zachman 2010, 143)? Ciborra and Hanseth (2000, 4) have presented views to globalization, global infrastructures, organizations and information flows, which are somewhat unpredictable runaway processes, and thus these elements of organizational infrastructure tend to drift (Ciborra & Hanseth 2000). We will accept the concept of drifting, which we will try to understand in EA context as possible outcome of variances in organization cultures, human behavior, values, language, communication and technologies in business networks. Sociomateriality (Orlikowski 2007) seems to be a promising theory for understanding social, immaterial and material imbrications (Leonardi 2011) of modern organizations. Sociomaterialism could improve our understanding of IT capability (Kim, Shin & Kwon 2013) and EA, but includes theoretical (e.g. Scott & Orlikowski 2013) and empirical (De Vaujany, Fomin, Lyytinen & Haefliger 2013) challenges of IT for regulating sociomaterial plurality in organizations.

We will explore EA as an information system and social innovation, which requires EAM for integrating social and technical actors as equal components (like ANT: Latour 1999a; Monteiro 2000) for business network development. Could Giddens’ (1984) structuration theory enhance EA in theory and practice to understand drifting and improve business/IT alignment towards sociomaterially integrated EA management practices and processes? Perhaps we should see this drifting as a social agility and co-development process changing the course of technology instead of fatalistically just dealing with consequences of uncontrollable technological progress (Simon 2010). When we acknowledge EA as a tool for enterprise development, EAM can be seen as an emergent activity system, which could be studied with by using Activity Theory (Vygotsky 1978; Leontiev 1978, 1981; Engeström 1987). These social theories are applied for increasing the social part of EAM as a sociomaterial negotiation processes, which could help to develop socially sustainable work orgnizations (Kira & van Eijnatten 2008) and related competencies (Kira, van Eijnatten & Balkin 2010). We will study how EA development and structuration evolves in practice from IT management towards EA management and leadership for harvesting EA benefits. We argue that EA leadership is needed as a higher-level system and practice to integrate strategic business, process and IT/IS development into business model and network development. This idea and structure of our EA study is illustrated in Figure 1.

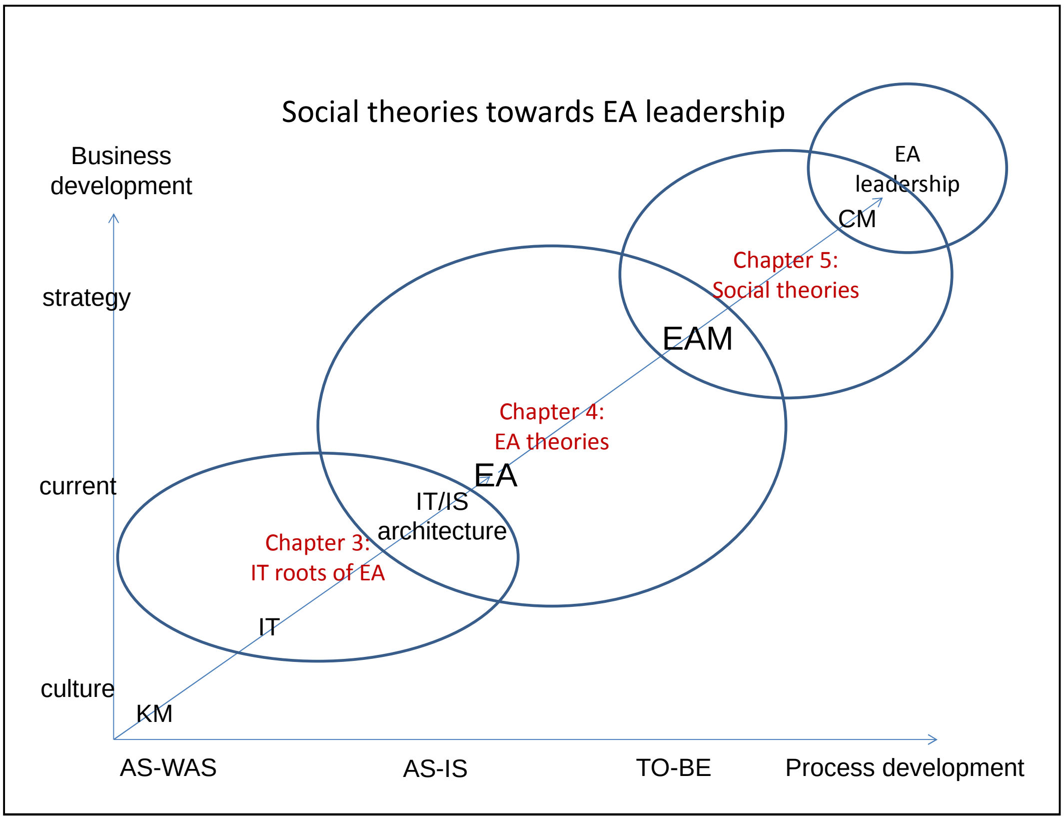

FIGURE 1 EA –study structure from IT concepts towards EA leadership

We argue that EA includes a tendency towards IT architecture and IT-related knowledge management within enterprise borders, which decreases EA potential as change management tool for business and process development capabilities at business network level. Therefore, it is quite understandable that EA projects may have quite a high risk to fail (e.g. Roeleven & Broer 2009, Zink 2009). While organizational goals and IT architectures are continuously changing, it is about time to shift EA language to an enterprise level to EA leadership. By shifting EA language to the enterprise level, we mean that EAM must be redefined and reframed for the human needs of managing changes and complexity, not only at the managerial level but also at the individual actor, actor-network and business-network levels. An EA focus should be reframed from technology, process automation and software into enterprise as a sociomaterial communication system and social network (Dreyfus & Iyer 2006) where information and technology are embedded into socially structured reality (Mezzanotte et al. 2010), soft human behavior (Zacarias et al. 2007), perceived reality for organizational learning and bounded rationality (Simon 1991). We address that we may be seeking EA leadership, which could integrate the development of organizational, structural systems with orgizational culture, behaviour and the levels of organizational consciousness (Cacioppe & Edwards 2005). At the same time we are applying EA leadership as a complex dynamic process that emerges in the interactive “spaces between” people and ideas (Lichtenstein, Uhl-Bien, Marion, Seers, Orton & Schreiber

2006). Thus our EA leadership thinking combines vertical, self- and shared leaderships for managing sociomaterial whole of business, IT and dynamic change (Pearce 2004; Pearce & Manz 2005; Senge 2006; Uhl-Bien et al. 2007; Kappelman 2010a, xlv).

Bernard (2005, 49) maintains that EA is as much about people and social interaction as it is about processes and resource utilization. We argue that more social structuration elements are needed for understanding and creating social and technical prerequisites for efficient and effective EAM processes. Therefore, business and process structuration should be seen as separate dimensions, which IT/IS and EA as communication tools and technologies are trying to integrate together as operational, enterprise-wide whole. Bernard (2005, 45) generalizes that EA is fundamentally an evaluation and depiction of people, processes and resources, but he equates EA to aggregation of strategy, business and technology (ibid., 32). We will combine strategy into business operations but separate processes as sources of automation, operational efficiency and effectiveness (Armistead, Pritchard & Machin 1999). We think that EA management will generate more business value and process benefits, if EA management structures are extended into the EA leadership level, integrating business, process and IT development organizations, as well as processes and capabilities at a strategic level.

Thus EA can be seen as enterprise-level culture and system (Carroll 2003) for achieving enterprise-level goals and business-IT integration. EA leadership should drive integrated strategy, process and IT/IS development, which requires organizational culture for holistic EA management. EAM should develop learning, competencies and structures towards EAM processes and systems for knowledge and change management. Organizational culture (Jeston & Nelis 2008, 1199) can be seen as collective values and beliefs that shape attitudes and behavior according to socially approved norms, organizational history and social interaction. Bernard (2005, 48) defines culture as beliefs, customs, values, structure, normative rules, and material traits of a social organization. Thus culture can be seen as a invisible organizational pattern and an amalgamation of behavior and social interaction. Culture is evident in many aspects of how an organization functions (Bernard 2005, 48). These cultural soft structures are important factors for knowledge and change management towards socially practical EAM and EA leadership structures. According to Bernard (2005, 57), change management is the process of setting expectations and involving stakeholders in how process or activity will be changed so that stakeholders have some control over the change and, therefore, may be more accepting of the change. We accept this definition and argue that EA leadership is about combining strategic changes into process and technology development by setting expectations and involving stakeholders into planning and execution of EA development.

In our study we will explore both the documented and material parts of EA and EAM, as EA-in-theory, combined to social and immaterial parts of EA and EAM in our case enterprise, as EA-in-practice. Objectives of this study are two-fold. First, we will shift EA from IT and technology management towards EA management and leadership practices integrating business, processes and IT/IS development at the business network level. We will explore the theoretical development and social practices that could indicate this shift from IT-oriented EA view towards business, processes and IT/IS development integrating EA maturity and structuration. Our research question for this objective is “How could EA-in-theory be reframed for socially structured EAM practices?”. Second, we will produce EA-frameworks that can be used to improve EAM communication and conceptual EA language for EAM development and use. The need for improving EA communication and language is documented by many researchers (e.g. Kappelman, McGinnis, Pettite & Sidorova 2008 ; Schöenherr 2009 ; Lucke, Krell & Lechner 2010). Kappelman et al. (2008) suggests that there may be room for decomposing EA into a set of simpler inter-related constructs, which we will do by dividing the EA domain into three separate frameworks for IT, EA and EAM. Our research question for this objective is “What sociomaterial elements should be included into EA-in-theory when shifting from IT management towards EA leadership?”. Thus our study has similarities with Morris (2014), who is trying to fill the gaps between PMBOK as a practical project execution guide towards knowledge leadership and shifting academic knowledge and culture towards practice.

This study does not try to define Enterprise Business Architecture (EBA), business architecture (BA), and business process architecture (BPA), nor to define strategy for an enterprise. We acknowledge these business and strategy related definitions as key drivers and content for a business-driven EA system (Boettger 2010). In this study we do not discuss any discrete technology in detail: the technical level of analysis regards social and organizational interaction between business and technology. We acknowledge that our approach is highly motivated by improving social capability and organizational EA understanding for private sector companies. Therefore, our EA study approach may not address values and goals for public sector organizations.

Findings from our empirical EA study indicate that a practical EA management approach integrates business, process and IT development at our case organization, Nokian Tyres, without using any specific EA framework. EA leadership seems to be present, but a more organizational structuration, capability and systematic EA framework as well as processes could improve EA management practices towards a learning organization and according to corporate values. EA management faces some cultural challenges of knowledge management, which relate to minimal documentation culture and documentation language practices. At the same time, EA technologies seem to need further development for managing various practical and social shareholder expectations for business and process development. Business calendar and strategy driven communication could especially improve the setting of priorities for EAM from business benefit and cost management perspectives. Thus more formal EAM processes could improve socio-economic analysis and strategic decision making for EA development investments. These business and process development driven realities could improve EAM from IT-related knowledge and documentation management into integrated business, process and systems development practice for enterprise-wide change management at Nokian Tyres.

Our EA study indicates that EA leadership (DeBoever et al. 2010, 158), strategic management (Ross, Weill & Robertson 2006; Kappelman 2010a; Ahlemann et al. 2012a; Simon et al. 2014), and communication (Mackay 2003; Zeller 2006; Boson et al. 2012) are increasing practices for managing change within business development and knowledge of EAM. The theoretical contribution of our EA study relates to applying social theories in an EA context, drafting three frameworks as instruments to understand and study social construction of EA from technology to EAM and EA leadership practices. Giddens' (1984) Structuration Theory seems to fit well when discussing EA structuration and organizational integration into business, process and IT/IS development. Our IT, EA and EAM –frameworks are introduced and tested using retrospective field data from our case enterprise. But our observations are made from a historic bottom-up exploration of EA development within one case company, thus requiring further research and validation in other enterprises and organizational contexts for broader relevance (Lee & Baskerville 2003, 221).

Kappelman et al. (2008) have stated that in many cases EA is treated as a black box, a tool that is useful in the achievement of a variety of goals. As such, EA can be viewed as a planning tool, or as an organizational blueprint, literature, language and decision (Smolander, Rossi & Purao 2008). Among those who care to look inside the black box of EA, there is a lack of agreement on two issues: the meaning of the word "enterprise" and the meaning of the word "architecture". This observation requires opening the EA black-box for further evaluation of the organizational and conceptual challenges of EA. Thus we start by elaborating the components of EA and enterprise in chapter 2. Then in chapter 3 we will study the IT roots and the evolving use architecture in IT and EA contexts.In chapter 4, we will review the status of EA research and theory development by reviewing ten EA review articles. Social theories for EAM structuration will be discussed in chapter 5. In chapter 6, we will discuss our study settings from theoretical and practical perspectives. Then in chapter 7 we will report our empirical study in the form of 7 vignettes discussing chronological, bottom-up EA development cases from our case organization Nokian Tyres. Empirical findings will be reported in chapter 8; theoretical considerations are discussed in chapter 9; and, finally, implications for EA practice and theory will be discussed in chapter 10.

2 Emergent and evolving components of EA

In 1990 "Enterprise Architecture" was an emergent concept. One of the first journal articles using the exact concept of EA was written by Richardson et al. (1990). They describe the process of establishing a principles-based IT architecture into an organization. They define the concept of "Enterprise Architecture" as follows.

> *"Enterprise Architecture defines and interrelates data, hardware, software, and communication resources, as well as the supporting organization required to maintain the overall physical structure required by the architecture" (Richardson et. al 1990, 386)*

Although it includes circular reasoning, this definition expresses the technical IT layers and organizational support needs for EA. This also shows how EA can almost be seen as a synonym for IT architecture, although the supporting organization was included. Business was not yet visible in this definition. In the same article, these practitioners used the concepts of enterprise information systems architecture, IT architecture, IS architecture and EA almost as interchangeable synonyms. But in an evolving information economy, this dualism between business and IT is no longer valid: when enterprises are shifting their strategies into the future, information becomes a valuable asset for their competitive advantage, not the technology itself. Thus EA has started to shift from technology to business and information domains.

We think that each enterprise has its' EA, which is getting more complex and requires EA management, when an enterprise is growing bigger. Our intention is to make sense of the complex organizational development phenomena called EA, which may be seen as a solution to the alignment challenge of enabling business/IT alignment. The business/IT alignment issue has likely been evolving ever since computers have been used for business purposes. In the 1990s IT was expected to produce more business value as a potential source of competitive advantage and to enable globalization, sothis issue of business/IT alignment received more notice. At the same time Spewak (1992) published his Enterprise Architecture Planning (EAP) methodology as an extension to

Zachman (1987) IS Architecture. Spewak's (ibid.) work, which established the missing process model and concept of Enterprise Architecture into Zachman's framework. At that time, EA as a concept was an emergent structuration artifact and a practical IT management challenge, which Richardson et al. (1990, 386) defined as follows:

> *"EA is a dynamic information technology foundation that provides a direction for the deployment and integration of future technological and managerial development"*

Next we will elaborate the core concepts of technology, system, information and enterprise to define and discuss IT and managerial components of EA as a social activity system.

2.1 Technology

Technology is a core component of EA. We acknowledge that the definition of technology includes many contextual challenges of human understanding, language, meaning and connotations. Our technology definition is applied from Hulin and Roznowski (1985, 47) according to Scott (2003, 231), but we have added knowledge processes into original definition to emphasize knowledge as a separate production component for information intensive work within information economy.

> *Technology refers to the physical combined with the knowledge processes by which the material and the immaterial inputs are transformed into sociomaterial outputs.*

Scott (2003, 22) argues that every organization does work and possesses a technology for doing that work. The technology of an organization is often partially embedded in machines and mechanical equipment but also comprises the technical knowledge and skills of participants. All organizations possess technologies, but organizations vary in the extent to which these technologies are understood, routinized, or efficacious (ibid., 23). Thus technology can be seen as part of the processes and systems, which are used for transforming inputs into outputs. In the early 1980's, academic proposals were initiated for systems thinking in IT (Checkland 1981), applying a system concept from the 1960s (e.g. Churchman 1968). This high-level of abstraction has given mental tools and inspired academia and practitioners, but on the practical level the rapidly evolving business environments and new technologies have been creating more IT chaos than system-thinkers have been able to eliminate. Nevertheless, from an information system perspective, the concept of system is important. In our work we will apply IT systems related definition from Hoogervorst (2004):

> *System is an identifiable bounded set of functionality and/or methodically related elements or principles within a certain operational purpose.*

Scott (2003, 231) argues that Orlikowski (1992, 399) has used the concept of technology narrowed to include only hardware – the equipment, machines and instruments individuals use in productive activities. From a strategic perspective, Mintzberg (1991, 341) further differentiates organization structure into technical systems, which refers to instruments used in the operating core to produce outputs and to technology, which refers to the knowledge base of an organization. Thus Orlikowski's technology and Mintzberg's technical system are quite equal. However, most of the organization theorists seem to embrace the broader view that technology includes not only the material used in performing work but also the skills and knowledge of workers, and even the characteristics of the objects on which work is performed (Scott 2003, 231). Heidegger (1977, 5) defines the concept of technology at two levels: the instrumental definition of technology is a means and the anthropological definition of technology is a human activity. Heidegger (ibid.) continues that modern technology is a means to an end, and therefore the instrumental conception of technology conditions every attempt to bring man into the right relation to technology. Technology-driven systems development may be a Tayloristic approach to put systems first, causing two major problems of rigid business systems and a strong emphasis on planning for static business environments (Ries 2011, 277). The same risks apply to EA, and therefore both IT and EA organizations should include governance structures, which include moral and ethical evaluations of operational means and ends. Thus technology includes material and immaterial as interrelated and intertwining components, which we will study later by using Activity Theory (Vygotsky 1978; Leontiev 1978, 1981; Engeström 1987), Actor-Network Theory (ANT: Latour 1999a; Monteiro 2000), Structuration Theory (Giddens 1984) and sosiomateriality (Orlikowski 2007). We acknowledge that the definition of technology includes contextual challenges of human understanding, language, meaning and connotations, which are inherited to concept of IT. Zhang, Scialdone and Ku (2011) have studied IT artifact in IS research using the following definition for an IT artifact:

> *An IT artifact is an entity/object, or a bundle thereof, intentionally engineered to benefit certain people with certain purposes and goals in certain contexts. It is developed, introduced, adopted, operated, modified, adapted, discarded, and researched within contexts and with various perspectives (Zhang et al. 2011, 3)*

This definition fits well to our study for observing EA, IS and IT life-cycle within an organizational context. Our case enterprise operates in the rubber industry and tyre business, where industrial traditions and culture include technologies which are non-IT artifacts. Therefore, we will study material and social components of technology and IT, which means that we acknowledge the EA potential of increasing visibility to the nature of IT artifact as *intentionally engineered to benefit certain people with certain purposes and goals in certain contexts* (Zhang et al. 2011, 3).

2.2 Information and systems

Our definition of technology is instrumental but somewhat overlapping with information as a separate organization element. On the one hand, technology includes information in intellectual or knowledge processes, as well as in immaterial inputs used for producing work products. While addressing the lack of social perspectives from current EA thinking and literature, we will increase the social layers of information related definitions from Hirschheim, Klein and Lyytinen (1995, 12-15):

- **Invariances** are technical, biological or social codes, which are the basis for communication encoded in some medium, for example alphabets or bit patterns.
- **Data** are invariances with potential meaning to someone who can interpret them; data correspond to stating something (be it true or not).
- **Meaning** is related to human understanding, through meaning we make sense of our feelings, thoughts and the world around us tied to basic human experiences (Dreyfus 1979) and "forms of life" as we know (Wittgenstein 1958).
- **Information** corresponds to speech acts which convey human intentions, which Haberman's Theory of Communicative Action divided into four types: to get someone to accept something as true (assertions about the external world, also called as constativa), to get someone to do something (orders, imperativa), to appeal to others to obey accepted social norms (regulative), and to express how one feels or thinks (expressive). (Dietz & Widdershoven 1992)
- **Knowledge** is a legitimated true and correct claim about a subject.
- **Wisdom** is a certain kind of knowledge, which is based on well-reflected rules and policies for conducting human affairs; it is knowledge about human behavior acquired over a lifetime through the mixture of reflection and experience.

Scott (2003, 95) discusses the importance of information flow as the most critical flow connecting the system elements, but he does not make it explicitly visible. Scott refers to Sage (1981), who argues that gathering, transmission, storage, and retrieval of information are among the most fateful activities of organizations, and design theorists devote much attention to them. Scott (2003, 95) concludes that since individual participants are limited in their capacity to process complex information, organization designers endeavor to construct structures capable of assisting participants to deal with these shortcomings. EA is one example of information systems as structure, which aims to help individuals and organizations to overcome their limited capacity to process complex information regarding their information systems asset. This view of EA as a structure and tool for assisting participants to enhance their information processing capacity is an important perspective on EA as an information system. We may apply the information system definition from Hirschheim et al. (1995, 13):

> *Information systems are technically mediated social interaction systems aimed at creating, sharing and interpreting a wide variety of meanings.*

EA can be seen as an organizational information system about information systems (system of systems), where technology, social structures, participants and information are documented and made visible for organizations to achieve organizational goals. Thus far EA has been merely about technology and information, something about goals but less about social structures, participants and organizational environments. However, EA is also a complex organizational system, where our viewpoint is social and viewpoint selection follows the logic of systems thinking (Hirschheim et al. 1995, 18):

> *No object system is objectively given (Checkland 1981). Rather people have viewpoints which enable them to perceive object systems. These viewpoints are determined by the concept structures that are applied to make sense of the development phenomena.*

We will shortly discuss EA system prerequisites, which are needed for an EA to become an EA system within an organization. This is a somewhat tricky and philosophical topic because now we must think about generic questioning of when an information system is an information system. If EA is an information system regarding information systems for an enterprise, then the systemic EA existence is tied to existence of an enterprise. To formulate a simple ontological question: does EA system exist if nobody knows about it? The same questioning may be addressed in an information system context, whether an information system exists if nobody knows about it. One may ask that is it so that an information system becomes an Information System when somebody observes, invents and knows about it, then informing others about its existence. Then this information system may be private like personal diary, commonplace like a note board, or public like Facebook. There is an existential question that does an information system become an Information System, when somebody observes, invents, knows, informs others and tries to create processes to manage or even develop the Information System. So the key question of this questioning is how much awareness, systemic behavior and/or technology is needed before we can say that EA system or EAM process is initialized. Does it make a difference whether we am thinking about natural, social, socio-technical or technical systems? We must address this question from EAM perspective of when EA system is managed and when we can discuss about EA management.

Monod and Boland (2007, 137) summarize the philosophical questioning of IS research objectivity as follows: *"When we talk about a phenomenon such as IS, an organization or a project, the only thing we can be sure about is that this object of research is in our mind."* But for us it may be useful to go back to basics together with Galliers (2004, 252) and understand the distinction between data, information and knowledge. An individual may get data from a system: data is explicit; one can exploit it, use it, accept it, be efficient with it, and follow old recipes without learning. But when we continue from data to information, according to Galliers (2004, 252), data become informative for a particular purpose to human beings by the way people interpret the world about them through their own individual lenses, and by applying their memory and personal knowledge to each new situation they confront. Galliers (2004, 252) continues that individuals inform themselves in order to undertake some particular task or make a particular decision. Information is, therefore, context dependent and an information system has to include human beings and the act of interpretation for the term to be at all meaningful. Knowledge, on the other hand, is tacit and embedded. It resides within our brains and enables us to make sense of the information we capture. Knowledge is an individual's 'justified belief – a belief that allows them to interpret and take purposive action in the world around them (Polanyi 1962). Thus it seems that it is enough if one individual makes observations about data, invents the system and starts to interpret this data and world around him/her through personal lenses by applying memory and personal knowledge to each new situation he/she confronts. This may be the smallest information system, where some system (natural, social, socio-technical or technical system at organization or virtual/extended enterprise level) sends data that one individual interprets and collects knowledge as justified belief, allowing that individual to make decisions and take purposive action in the world around him/her. Applying a quote from Monod and Boland (2007, 137), we may summarize philosophical questioning of EA and EAM research objectivity as follows: *"When we talk about a phenomenon such as EA, EA management and leadership, the only thing we can be sure about is that this object of research is in our mind."*

If EA is artificially limited to the technical part of EA as an information system without humans, like Mintzberg's (1991, 341) technical system as a production instrument, then EA includes invariances, data and information about enterprise information systems. But if an EA system as information system includes knowledgeable human actors and agents, who can create, process and interpret data into organizational meanings and knowledge, then the EA system services enable executives and development projects to make wise choices and decisions regarding EA (Niemi & Pekkola 2009). In this study, we will emphasize social structures of EA with the concept of EA system services, which means social and technical arrangements for sharing information and creating meanings and knowledge about EA management and leadership. Actors of an enterprise may utilize internal and external information sources and services from and through their social networks to achieve their goals, which tightly integrate all the organization elements to each other. Therefore, we will next shift our definitions towards social content and the organizational layers of EA.

2.3 Organizational contexts of EA

All organizations are open systems, which are dependent on both information and technology from their environments. Organizational borders between internal organization elements and external environments are social agreements enabling interaction and integration between an organization and its' environment. In practice, this segregation between internal technology and the environment is almost impossible, when we think about immaterial part of technology, training, knowledge, information sources and modern IT infrastructure including telecommunication, Internet, mobile services, cloud computing, etc. Thus technology is integral and embedded into organizations in various ways. Scott (2003, 23) explains the relationship between environment, technology and organization as follows:

> *Few organizations create their own technologies; rather, they import them from the environment in the form of mechanical equipment, packaged programs and sets of instructions, and trained workers. Moreover, the environment is the source of the inputs to be processed by the organization, just as it is the "sink" to which all outputs are delivered – as products to be sold, clients restored to function, or waste materials to be eliminated (ibid.)*

This division into technology creating organization and technology using organization is important when trying to understand IT, EA and their roles in different organizations. EAM may be supported with technologies (e.g. Forrester 2013) that some organizations are creating and some organizations are using. In this study, our main focus is on EA development and use, but when redefining EA concepts, we must also include EA technology creating organizations. For our purposes, to improve EA language is vital because EA is also an important commercial concept, and therefore EA creating organizations are actively producing EA literature, which is biased towards selling EA technologies and related EA technology services. From this point, we will explicitly discuss EA technology and EA technology services when we refer to output created by EA technology creating organizations. By EA technology services, we refer to human and informational EA technology activities which aim for EA technology implementation, use and maintenance. But all EA technology creating and using organizations have their own unique EA, which combines their material and social structures.

2.3.1 Organization

All social systems, including organizations, consist of the patterned activities of a number of individuals. Scott (2003, 18) refers to Leavitt's (1965, 1145) organization diamond to identify five major elements of each organization: social structure, participants, goals, technology, and environment. Both Scott (2003) and Leavitt (1965) include arrows and references between organizational elements. Yet they do not make information explicitly visible as one of the most important organization elements of the information age. We argue that information should be added as the sixth organizational element and organizational asset inside Leavitt's model of organization.

The MIT90s framework (Scott Morton 1991, 20) is also based on the Leavitt's (1965, 1145) organization model. But due to the focus on management in the MIT90s framework, its central organizational element is management processes. In the MIT90s framework, social structures are simplified into structure and participants are renamed as individuals and roles. Structure, management processes, individuals and roles together create organizational culture, which is partly embedded into external social and technological environments. Organizational goals are renamed as strategies which emphasize a rational organization view. The MIT90s framework also includes technology, which is located partly as an internal component and partly in an external technological environment. A strategy component is located at the border of the organization, which means that strategy shares some content from external socioeconomic environment. Thus, in our extended model of organization, the borders of an organization are also depicted as dotted lines sharing participants, technology, social structures and goals of an organization with environment.

Figure 2 defines our extended model of organization, which includes Information as an internal core element, four internally and externally shared elements called Social Structures, Goals, Participants and Technology, and one external element called Environment. These elements of organization are abstract, context sensitive, temporal and difficult to define in detail.

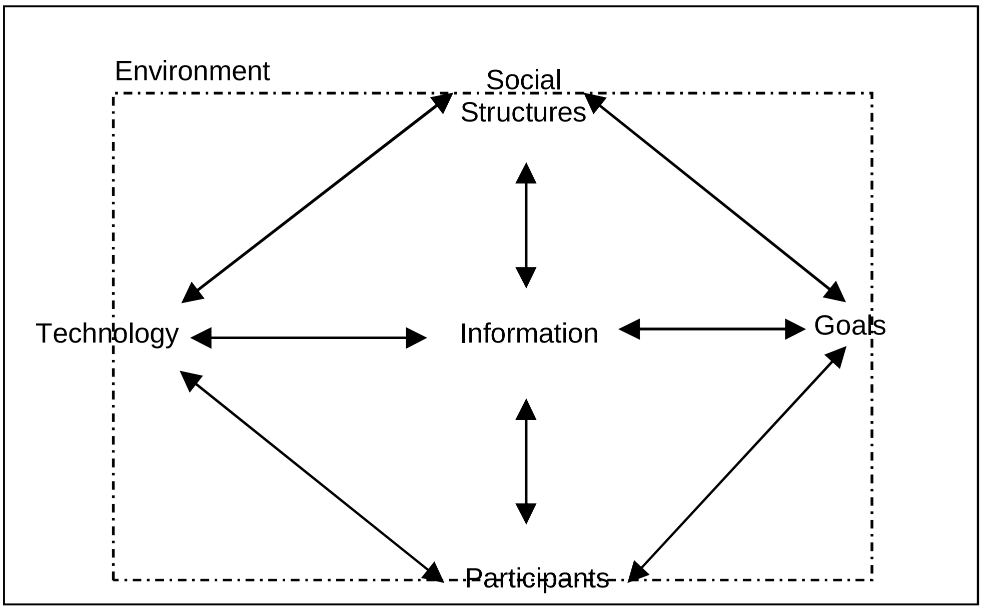

FIGURE 2 Extended organization model (Leavitt 1965; Scott 2003).

IT management has mostly focused on technology, information and IT parts of the information systems. But enterprise and EA also includes social structures, participants, goals and environments. Thus EAM should also integrate these social and business components into IT management to cover the whole organization, including business-IT integration and social parts of information systems. At the organizational level, this may require new concepts, resources, competencies, roles and social restructuring for organizational EAM capabilities. Despite having the same organizational elements at a high-level, in practice all organizations are different. Each organization can be seen from various viewpoints. Scott (2003) gives three different definitions of organization:

> ***Organization as rational system****: organizations are collectivities oriented to the pursuit of relatively specific goals and exhibiting relatively highly formalized social structures.*
>
> ***Organization as natural system****: organizations are collectivities whose participants are pursuing multiple interests, both disparate and common, but who recognize the value of perpetuating the organization as an important resource. The informal structure of relations that develops among participants is more influential in guiding the behavior of participants than is the formal structure.*
>
> ***Organization as open system****: organizations are congeries of interdependent flows and activities linking shifting coalitions of participants embedded in wider material-resource and institutional environments.*

Thus each organization can be seen from different perspectives, which must have some implications for the EA definition, purpose and content. A rational view to organization emphasizes goals; a natural view focuses on social structures; and an open system is merely interested in organizations dialogue with the environment. In this study, our main focus is on thinking about and analyzing organizations as social, open and rational systems. Therefore, we will not concentrate on the organization as natural system, but replace it with a social view. The difference between the natural and social views to an organization may be quite small but meaningful for our purposes, that is to study more formal social structures of EA than informal ones. Social views to organization can be found from the organization definitions (Katz & Kahn 1966, 16):

- From the rational system and teleological perspective, an organization is a social device for efficiently accomplishing through group means some stated purpose; it is equivalent to the blueprint for the design of the machine which is to be created for some practical purpose.

- From the open system perspective, an organization is an energetic input-output system in which the energy return from the output reactivates the system. Social organizations are open systems in that the input of energies and the conversion of output into further energy input consist of transactions between the organization and its environment.

These various viewpoints to organizations may create EA scoping challenges for EAM efforts. An additional EA scoping challenge may relate to social agreements and differences between organization and enterprise.

2.3.2 Enterprise

In simplest terms, an enterprise is any purposeful activity (GAO 2004). In its customary meaning, the term “enterprise” refers to a (commercial) business organization, and, in its generic use, it refers to intentional and systematic purposeful activities (Hoogervorst 2004, 217). TOGAF 9 architecture framework defines enterprise in more complex terms (The Open Group 2009, 29):

> *Enterprise: The highest level (typically) of description of an organization and typically covers all missions and functions. An enterprise will often span multiple organizations.*

This variance in the definitions of an enterprise from “any purposeful activity” to “descriptions covering missions and functions of multiple organizations” is quite wide. These different viewpoints to enterprise may create EA scoping challenges for EAM and EAM benefit potential realization. Organizations and organizational functions should be studied as building blocks and resource pools for business processes, value chains and an enterprise that could benefit from common EAM approach. When we are shifting our focus from one organization to enterprise, the basic technology and information definitions we made in this sub-chapter does not change. But when more organizations are included as participants of the social system, this will most likely have some implications on social structures and goals. When we apply the concept of culture from the MIT90s framework, then each organization will bring its own organization culture into the systemic whole called an enterprise. These increasing EA challenges for multi-organizational/cultural enterprises and business networks are recognized by Zachman (1996), and cultural language challenges for collaborative EA are discussed by Buckl, Matthes, Roth, Schulz and Schweda (2010b, 46). These findings indicate potential organizational restructuring and/or coordination needs for creating and realizing EAM benefits. Like the concept of architecture, it seems that enterprise is also a challenging concept to define. Rood (1994, 106) described enterprise in an EA context as having the following characteristics:

- Consists of people, information and technologies.
- Performs business functions.
- Has a defined organizational structure that is commonly distributed in multiple locations.
- Responds to internal and external events.

- Has a purpose for its activities.
- Provides specific services and products to its customers.

Rood's (1994) enterprise description includes explicitly and implicitly all organization elements from our extended model of organization. The MIT90s framework includes neither the notion of enterprise nor that of information, but transparent organization boundary and potential organizational changes were implicitly expected because of business turbulence and technological changes (Scott Morton 1991, 5). Enterprise modeling and EA seems to be defined from an inwardly organized perspective of a single organization (Labusch & Winter 2013). We will try to enhance this EA thinking for outwardly organized business culture and network thinking. We think that both Rood (1994) and Scott Morton (1991) have mostly defined organizations from a rational point of view and from an inwardly organized single organization perspective. Therefore, we will further elaborate various multi-organizational structures, which could be reflected in EA definitions and social structures of EAM for business network collaboration.

2.3.3 Markets and hierarchies

According to Child and McGrath (2001, 1136), a conventional theory of organizational design emerged alongside modernist principles of production and manufacture. The increasing information intensity is the fundamental challenge to which new organizational design theories must respond because it challenges the premises upon which a bureaucratic organization's claim to being economical rests – namely the harnessing of efficient combinations of resources in an economy. Child & McGrath (ibid.) have studied this transformation from a material-based economy to an information-based economy, and they have found that these new emergent organizational forms will face the issues of interdependence, disembodiment, velocity and power. Nadler and Tushman (1997, 64) argue that organizational design shapes human behavior and especially information processing, which has become the single most important function within any organization. This indicates further that an organization may not be the most optimal level for EA management efforts.

The challenges of organization design are implicit in and embedded to information flow and, therefore, to the development and use of information systems. A traditional organization chart could be used to visualize operational hierarchic work reporting structures. Markets and hierarchies have been defined as two basic mechanisms for coordinating material and service flows through a value chain (Williamson 1975). In 1987, Malone et al. (p. 485) discussed how IT is reducing the costs of coordination, shifting economic activity coordination from hierarchies to markets, and creating new electronic markets and electronic hierarchies. In hierarchies, the coordination, control and direction of material and service flows through adjacent steps are executed according to managerial supervision. In many cases the hierarchy is simply a firm, while in others it may span between two legally separate firms in a close, perhaps electronically-mediated, sole supplier relationship. Malone et al. (1987, 495) suggested that electronic hierarchies will evolve from stand-alone, linked and shared databases enabling mechanisms for integrating processes across organizational boundaries by allowing continuous sharing of information in easily accessible on-line forms.

Bakos (1991, 295) studied these “electronic marketplaces”, where information systems serve as intermediaries between the buyers and the sellers in a vertical market. Bakos (ibid.) found that electronic market systems reduced buyers search costs in commodity and differentiated markets, reduced intermediation costs, and resulted in indirect but possibly larger gains in allocation efficiency from better-informed buyers. Bakos (1991, 308) concludes that electronic marketplaces ultimately increase the efficiency of inter-organizational transactions, creating numerous possibilities for the strategic use of these systems. Bakos (1998, 42) continued to study the emerging role of electronic marketplaces on the Internet. He argues that Internet-based electronic marketplaces leverage IT to replace traditional markets in matching buyers and sellers, thereby facilitating transactions and offering institutional legal and regulatory infrastructure with increased and reduced transaction costs. This should result in more efficient, “friction-free” markets, which were still in a formative phase at that time. After the 1990’s, digitalization and various forms of eBusiness (B2B) and eCommerce (B2C) have been blurring organizational borders and processes (e.g. Choi & Whinston 2000).

Sowa and Zachman (1992, 596) discuss this division of work between market and hierarchy as follows. According to the organizational dynamics community, *an enterprise will form into a free market structure, if the nature of the transaction between two organization units is simple, well-defined, and universally understood*. This method is like a stock buyer who scans the pool of stockbrokers to find one who will execute a buy within an agreeable time and for a reasonable fee. In contrast, when the intra-organizational transaction is complex, not well-defined, and not universally understood, the enterprise will establish a hierarchy, that is, a regulatory organization that will arbitrarily define the work product, the schedule, and the cost that connects the subordinate organizations. (Sowa and Zachman 1992, 596)

Thus traditional and electronic hierarchies can both be seen as synonyms for enterprise, but enterprise can also include market mechanisms and coordination work between separate legal entities and organizations. According to the ISO15704 (2000) standard, *an enterprise is one or more organizations sharing a definite mission, goals and objectives to offer an output such as a product or a service*. This term includes related concepts such as extended enterprise or virtual organizations, making it applicable to an EA context. But, at the same time, this wide enterprise definition makes architecting and social engineering of EA even more challenging than for one organization. Zachman (1996) does not define enterprise separately, but in the context of Enterprise Architecture he prefers completeness, consistency, coherence and a manageable scope of enterprise instead of jurisdictional scope. This seems to be because of granularity issues: in practice the content of Zachman's EA Framework becomes inconsistent if "the Enterprise" is not self-contained, i.e., an object that functions as a stand-alone organization unit. This cultural language challenge for collaborative EA is discussed by Buckl et al. (2010b, 46). But inspired by the statement of Goethals, Vandenbulcke, Lemahieu, Snoeck, De Backer and Haesen (2004, 335), *"Extended Enterprise is an enterprise and can as such be architected"*; we will continue our exploration of enterprise definitions for EA management for business networks.

2.3.4 Business networks

There are several other forms and levels of co-operation between organizations. Since the 1990s, there have been a variety of innovations in new organizational forms, new paradigms and broad concepts: post-bureaucratic, postmodern, post-entrepreneurial, flexible, federalism, network, virtual, reengineered, knowledge-creating, ambidextrous, high-performance, high-commitment, boundaryless, hybrid, transnational, etc. (Child & McGrath 2001, 1135). Business networks could be seen as flexible and adaptive arrangements with the following features (Vervest, Preiss, Van Heck & Pau 2004a; Vervest, Van Heck, Preiss & Pau 2004b; Vervest, Van Heck, Preiss & Pau 2005, 20):

- Constituting a group of participating businesses – organizational entities or "actors" – that form the nodes.
- Linked via communication networks forming the links between the nodes.
- Having compatible goals,
- Interacting in novel ways,
- Perceived by each participant as increasing its own value,
- Sustainable over time as a network.

Konsynski and Tiwana (2005, 235) maintain that improvisational inter-firm network is created by an interaction between a business practice element and a technical architecture element. These organizing principles shift requirements from business and IT alignment for continuous aligning, realigning and reconfiguring improvisational business network architecture to fit with governance model, practices and strategy changes. Key elements of improvisational inter-firm networks represent socio-technical dualism between governance and architecture, which should be aligned to each other to achieve an efficient, effective and flexible business model presented in Figure 3.

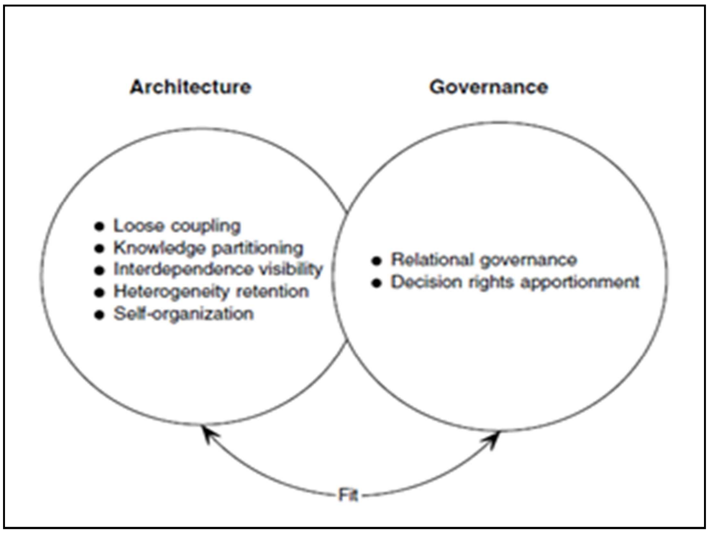

FIGURE 3 Improvisational inter-firm networks (Konsynski & Tiwana 2005).

Complex, large-scale information networks constitute the infrastructure for exchanging knowledge that is important to the achievement of work by individual agents (Braha & Bar-Yam 2004, 2005). Chen, Doumeingts and Vernadat (2008, 648) have studied differences and similarities of virtual and extended enterprises where both forms of enterprises require IT level interoperability or integration. Virtual enterprise seems to be a more temporal and dynamic structure requiring interoperability and loose coupling; meanwhile, extended enterprise seems to be a more stable and tightly integrated whole. Galbraith (2002, 135) discusses virtual corporations that contract out for all activities except those in which it is superior. As a result, a network of independent companies acts together as if it were virtually a single corporation. Thus IT and networks can be used in various ways for improving internal and external communication and information flows, which again enables structural changes and more transparent organizational borders. Information, technology and IT seem to enable business networks using various technologies like Service-Oriented Architecture (SOA), Enterprise Application Integration (EAI), Web Services (WS), and other various Internet-based standards (Van Hillegersberg, Boecke & Van Den Heuvel 2005). These concepts and technologies seem to apply to intentions for agile and collaborative EA (e.g. Buckl, Matthes, Monahov, Roth, Schulz & Schweda 2011; Ambler et al. 2008), but linguistic problems still exist (Berg-Cross 2008a). A combination of service-oriented and enterprise-level architecture has been suggested to complement each other, improving architectural alignment (Haki & Forte 2010) for various forms of business networks.

2.3.5 Extended Enterprise Model (EEM) for EAM

IT has been increasing the variety of organizational forms and structures of both markets and hierarchies. Thus the size, structure, material presence, temporal nature, reach and range of an enterprise have been changing from local to global, from physical to virtual, from permanent to temporary. While the technology and IT parts of an enterprise may be in theory quite generic and global, the systemic and social parts of an enterprise are always remain unique and local. Therefore, enterprise as a social component of EA creates both a need and a challenge for EAM to improve knowledge and change management. We will shift the organization model in Figure 2 for EAM purposes with organizational and informational change forces. Latour's (1999a) Actor-Network Theory (ANT) has been used for evaluating Information Infrastructure (Monteiro 2000) and suggested for providing tools for examining EA from the negotiation, power and politics points of view (Kappelman et al. 2008). Dreyfus and Iyer (2006) have studied EA from a social network perspective, but actor-network theory seems not to have been applied in an EA context. The concepts of ANT seem to be applicable for understanding inter-firm infrastructure and network negotiations, thus we will adapt both concepts of actor and network to redefine our model of organization towards extended enterprise thinking as an outwardly organized business network. These concepts are applied to upgrade "Figure 2 Extended model of organization" towards extended enterprise coverage for future EA development and EA leadership at the business network level.

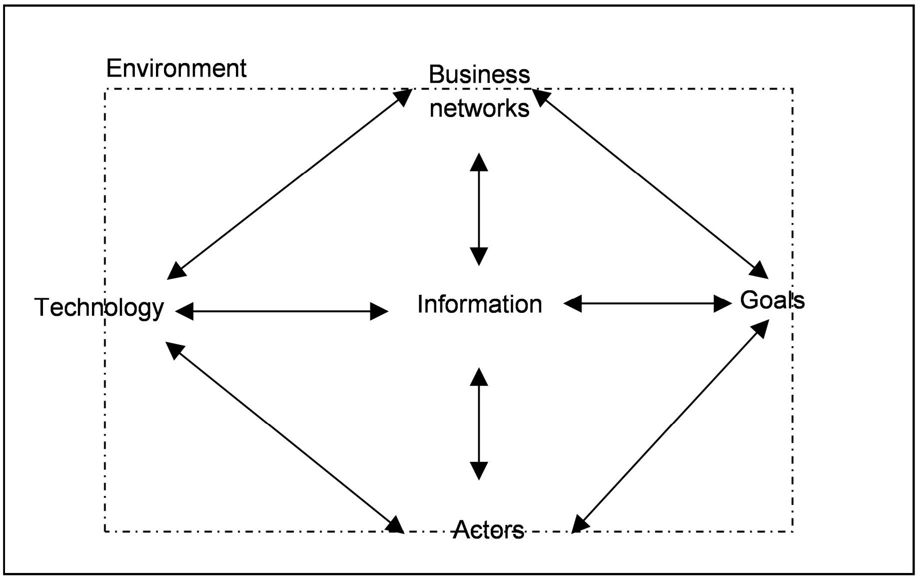

FIGURE 4 Extended Enterprise Model (EEM).

The Extended Enterprise Model (EEM) logically contains the same components as in our model of an extended organization, including technology, information, goals, environment and enterprise border. In this Extended Enterprise Model, the increasing roles of technologies and social complexities of multi-organization spanning enterprises and business networks are enabled by shifting our language from Participants to Actors and replacing Social Structures with Business Networks. Both actors and business networks are important components for developing networked organizational cultures and social structures for EAM development. Now our Extended Enterprise Model puts more emphasis on sharing information and immaterial assets than on physical resources, which makes this enterprise model applicable for information economy and information intensity (Child & McGrath 2001, 1136) as well as information processing purposes (Nadler & Tushman 1997, 64). While information sharing is put in the middle of our EEM figure, all the other components of an enterprise are located at the border of an enterprise: technology, actors, goals and business networks are shared with the environment. Thus our EEM model is applicable for virtual organizations and various forms of business networks. This organizational shift from hierarchies and local operations to extended enterprise has caused challenges for traditional management practices.

2.4 Enterprise-driven EA

New ways of dealing with materiality are needed if we are to understand contemporary forms of organizing that are increasingly constituted by multiple, emergent, shifting, and interdependent technologies (Orlikowski 2007, 1435). In this EA study, we will concentrate on social levels of EA. The social meaning and value of EA could be found in holistic and integrative systems thinking, which recognizes various social realities as social sub-cultures and social architectures for integrating business, processes and IT architectures beyond organizational borders. While thinking about the whole and the parts of EA, IT driven architectures are only one way of dividing enterprise into parts.

More traditional approaches for splitting enterprise as a holistic system into parts are, for example, strategy, business model, organization structure, process map and labor union driven component models. These different views to enterprise present strong social meanings, values and power structures of holistic enterprise as complex social network. Various social systems are continuous sources of social conflicts and complexity, which must be managed as an embedded part of EA. Therefore, social architecture driven EA could be an even more important asset to manage and lead than IT-architecture driven EA. Various combinations of architectures have been used for managing and explaining rationality into IT-driven organizational changes. Therefore, we will next review how various architectures and especially EA has been used for improving IT and enterprise management practices.

3 IT roots of EA

This chapter studies the evolving concept of architecture as the IT roots of EA. Until the mid-1990s, "Enterprise Architecture" was an emergent concept and theory (e.g. Langenberg & Wegmann 2004; Schöenherr 2009; Winter & Aier 2011). Practitioners were tackling the problems of the increasing complexity of enterprises, systems, amounts of information, growing use of IT, and various technologies (e.g. Niederman, Brancheau & Wetherbe 1991, 479; Rood 1994) which had their own information and system architectures (e.g. Dickson & Wetherbe 1985, 122). An early observation from Rood (1994, 106) seems to remain valid: *"Although the concept of an enterprise architecture (EA) has not been well defined and agreed upon, EAs are being developed to support information system development and enterprise reengineering"*.

The concept of Architecture was growing from technology to IT, IS and social layers of an enterprise: practitioners seemed to create architectures for getting a grip on or hiding this IT chaos (e.g. Rechtin 1992; Cook 1996), and meanwhile academia was engineering architecture frameworks to systematize the architecture creation process and outcomes (e.g. Kim & Everest 1994; Bernus & Schmidt 1998). Maier and Rechtin (2002) segregate architecting and engineering clearly from each other:

- Architecting is more an art, inductive process dealing with un-measurable and using non-quantitative tools and guidelines based on practical learning.
- Engineering is more of a science, deductive process dealing with measurable and using analytical tools derived from mathematics and hard science.

Thus the architecting concept fits with our socio-technical EA system and practice-driven EA management approach dealing *with un-measurable and using non-quantitative tools and guidelines based on practical learning*. Hoogervorst (2004, 215) refers to Vitruvius, whose early works from about year 50 BC defined principles of proper design for the city, square and building. While designing Rome, Vitruvius invented "the design principles of proper design", which has been some kind of a mixture of human intuition and “learning by doing” experimentation for finding visual, practical, material and immaterial balance of physical, social and economic process constraints and tools for constructing the products like city, square and buildings. This intuitive definition of architecting may also apply to EA work. Cook (1996, 163) borrows terms for the architecture process from sailing: first take control of the current architecture, then set priorities and chart the course towards future architecture. Architecting seems to be the art of practicing and learning by doing. This observation is a starting point of our EA study to understand EA in practice as an inductive process dealing with un-measurable and using non-quantitative tools and guidelines based on practical learning.

3.1 Architecture definitions

During 20 years of deployment and integration of future technological developments into a dynamic IT foundation, the concept of “Enterprise Architecture” and the related acronym EA have been established into practical and academic language. The concepts of IS, IT and information architecture have been developing since the mid-1980s (e.g. Dickson & Wetherbe 1985, 122), through EA invention (e.g. Rood 1994) and through the EA framework innovations of the 1990s to economically profitable and socially acceptable EA products and processes like TOGAF 9 (The Open Group 2009).

In practice, the loose concept of EA seems to describe, include and explain almost all business and organization related computerization, IT and IS use. When practitioners talk about EA, they most often seem to mean current IT infrastructure or IT architecture with some business components. When academics talk about EA, they most often seem to mean EA frameworks, which are used to document and design AS-IS and future TO-BE EA goals and roadmaps. The status of the discipline of EA, related issues and confusion with core EA concept definitions are documented in EA reviews by, e.g., Achachlouei (2010); Chen et al. (2008); Hoogervorst (2004); Kaisler, Armour and Valivullah (2005); Kappelman et al. (2008); Langenberg and Wegmann (2004); Lemmetti and Pekkola (2012); Pulkkinen (2008); Schelp and Winter (2009); Schöenherr (2009); Stelzer (2010); and Winter, Legner and Fischbach (2014). For our EA study, most of the current EA definitions are quite technical. From the Enterprise Architecture Definition document by Enterprise Architecture Research Forum (2009), we found the following non-technical EA definition:

Enterprise Architecture is the continuous practice of describing the essential elements of a socio-technical organization, their relationships to each other and to the environment, in order to understand complexity and manage change. (Vaknin, 2009)

According to this definition, EA is mostly a social structuration, about which we will next elaborate by studying its' components, relationships and functions from the EA perspective. In EA context the practices of management and leadership have the same differences than in normal organizational operations: management is more about controlling and managing AS-IS matters and things; leadership is more about leading and inspiring people with goals and visions of TO-BE statuses for an enterprise.

In a computer context, the concept of architecture has been used by technology providers as long as computers and related technologies have been designed and constructed. Until the late 1980s, the word "architecture" was used mostly in the sense of system architecture (meaning a computer system's physical structure) or sometimes in a narrower sense of the instruction set of a given family of computers (Kruchten, Obbink & Stafford 2006, 23). As late as 1990, architecture merely meant processor architecture between operating system and hardware layer in an information processing context (Lokki, Haikala, Linnainmaa, Mattila & Susiluoto 1990, 125). From the hardware layer and computer context, the use of the architecture notion has been evolving through software levels into IT usage, systems, organization, process, enterprise and business levels. In IT and EA literature, the concept of architecture has been added to almost every possible thing or artifact humans can imagine and engineer. Thus the current variety of architecture definitions is broad. Some authors define only architecture without explicit IT or enterprise context. Table 1 includes a sample of architecture definitions mostly from the IT & EA context from the year 1990.

TABLE 1 Some definitions of architecture in IT & EA contexts.

Definition of architecture	**Source**
The organizational structure of a system or component.	IEEE (1990)
Integrated structural design of a system, its elements and their relationship depending on givens system requirements.	Bernus and Schmidt (1998,2)
Description (model) of the basic arrangement and connectivity of parts of a system (either a physical or a conceptual object or entity).	ISO15704 (2000)
a) System architectures (sometimes referred to as "type 1" architectures) that that deal with the design of a system, e.g. the computer control system part of an overall enterprise integration system.	ISO15704 (2000) note
b) Enterprise-reference projects (sometimes referred to as "type 2" architectures) that deal with the organization of the development and implementation of a project such as an enterprise integration or other enterprise development programme.	ISO15704 (2000) note
Every system has architecture. In fact, a system could have many architectures. **Architecture is a conception of a system.** There may be many conceptions of a system.	IEEE (2000)
The fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution.	IEEE (2000)
Structural description of an activity.	GAO (2004)
Any socio-technical system.	Braun and Winter (2005)
A formal description of a system, or a detailed plan of the system at component level, to guide its implementation.	ISO/IEC 42010 (2007)
The structure of components, their inter-relationships, and the principles and guidelines governing their	TOGAF 9 (2009,24)

design and evolution over time.	
The structure or structures of a system, which comprise the software elements, the externally visible properties of those elements, and the relationships among them.	Software Engineering Institute (2010c)

In the 1980s, when more IT and IS were introduced into organizations and taken into business critical use, the challenge of managing and changing business organization according to strategic initiatives and business goals became a more complex challenge than ever before. In mid-1980s, the concept of Management Information Systems (MIS) was an important topic. While discussing MIS development and management, Dickson and Wetherbe (1985, 122) expressed the central role of information system architecture, which *should guide long-range development but also allow response to diverse short-range information system demands*. They define information system architecture as follows:

> *Information system architecture refers to the overall structure of information system consisting applications for the various levels of organization (operations, management control, strategic planning), and applications oriented to various management activities (planning, control and decision making). The system structure or architecture also includes databases, model bases and supporting software. (Dickson & Wetherbe 1985, 122)*

Despite being technology oriented and devoid of the exact EA term, this definition captured the idea of enterprise-wide IS architecture and information systems. In 1986 Inmon published a book regarding IS architecture, and then in the following year Zachman (1987) published an article "A Framework for Information Systems Architecture". Both Inmon and Zachman were working with major new technologies: Inmon with relational databases and Zachman with IBM PC and system architectures. Both Inmon and Zachman have inspired many practitioners and academics to enhance systems thinking and models of architectures and frameworks. The concepts of systems and architecture were combined to create structures to growing technology and IT use in organizations (Rechtin 1992, 66):

> *Systems Architecture is the underlying structure of a system, such as communication network, a neural network, a spacecraft, a computer, major software or an organization.*

While the core concept of architecture is difficult to define, the same applies to all applied conceptions of architecture. According to Kruchten et al. (2006, 23), getting agreement on a definition of software architecture was the most difficult task while creating the IEEE1471 (IEEE 2000) standard for software-intensive systems. This lack of consensus regarding the definition of software architecture has regularly provided a source of entertainment at gatherings of software architects (Software Engineering Institute 2010b).

Enterprise, architecture and EA can be understood and defined in various organizational and systemic levels and contexts of IT usage. Perspectives, views and viewpoints into enterprise, architecture and EA may vary from practical and functional black-box perspectives, through constructional change and design perspectives, to theoretical and ontological meta-level perspectives. Definitions may vary in their timing of the articulation. Thus definitions can be categorized into two major categories: one sees architecture as a descriptive concept that factually describes the characteristics of existing AS-IS artifacts, and the other sees architecture as prescriptive concept that defines how TO-BE artifacts should be realized (see e.g. Hoogervorst 2004). Dreyfus and Iyer (2006) have renamed these espoused TO-BE architectures as “Architecture-in-Design”, AS-IS architectures as “Architecture-in-Operation”, and the third category as emergent architectures, which exists because architecture is developed as a result of individual projects. Namba (2005) refers to the transitional, intermediate EIS phase between AS-IS and TO-BE as LIVE-TO-BE EIS architecture. Smolander et al. (2008) have found four views to software architectures, which they call blueprint, literature, language and decision. Thus architectures at various levels of enterprise and technology may involve different scopes and temporal transitions of an enterprise.

3.2 Evolving IT

At the end of 1980s, there were indications that IT should be seen as a dynamic foundation for future business development. Emergent globalization and PC-computing had just started to require and enable increasing computerization and wiring of business. The golden age of mainframes, mini-computers and centralized Data Processing departments was ending. Various forms of client-server-architectures and competing network technologies were distributing computing capacity around the enterprise. Thus IT resources started to require more decentralized services and management of this new emergent and fragmented IT foundation. IT foundation was sometimes called IT infrastructure (e.g. Star & Ruhleder 1996; Star 1999) and managed with IT and system architectures (SA). Information systems were developed using various information system development (ISD) methods and managed with information systems architecture (ISA) and application architecture (AA). Automatic Data Processing (ADP) departments were renamed as IT departments. IT management practices were rapidly evolving and almost everything within the IT domain was architected for emergent global standards and operations. Huovinen and Makkonen (2004, 4) have even called 1980’s as era of IT architectures, when software companies like Microsoft and Oracle started to dominate IT industry.

At the beginning of 1990’s, IT architectures were trying to create control and arrangements of the components that make up the IT systems. In 1991 Keen (1991a, 33) set three often conflicting requirements for effective IT architecture:

- Maximum level of vendor-independence,
- Rationalization of multi-vendor/technology chaos of incompatible elements.
- Adopting standards of leading vendors and electronic trading partners.

In 1991 relational databases and packaged business applications were becoming common and the architectural challenge was visible (Niederman et al. 1991). In SIM surveys, Information Architecture was emergent in 1986 in the 8th place, and already in 1989 Information Architecture *was the first issue to supplant strategic planning as #1 since the initial SIM survey in 1980* (Niederman et al. 1991, 479). This growing challenge of information management was defined and explained with the following remarks (Niederman et al. 1991, 479):

> *Information architecture is a high-level map of the information requirements of an organization. It shows how major classes of information are related to major functions of the organization. Sometimes referred to as an enterprise model, many experts now agree that an information architecture offers the potential to serve as a basis for building a coordinated, responsive, long-lasting set of business applications. Such architecture also provides a view of the business-oriented uses of information from which an effective IT infrastructure can be derived. While the potential benefits of such architecture have been articulated the information architecture is difficult to capture, use, and maintain, due to both the breadth of information requirements and the changing nature of the business environment.*

Thus information architecture and the enterprise model were referred to synonymously. The exact concept of enterprise architecture was not yet recognized by this survey. Important remark in the quotation above is that *an effective IT infrastructure can be derived from the business-oriented uses of information*. IT infrastructure was the only new IS issue ranked for the first time in a 1989 survey. Niederman et al. (1991, 481) defined this growing IS challenge as follows:

> *The technology infrastructure problem is exacerbated by a combination of evolving technology platforms, integration of custom-engineered and packaged application software, and rigidity of existing applications (Zachman, 1987). The emphasis is on networking and open systems to facilitate timely response to changing business conditions. Building an infrastructure that will support existing business applications while remaining responsive to change is a key to long-term enterprise productivity.*

IT infrastructure was defined as technology infrastructure of an enterprise. In the mid-1990s, building a responsive IT infrastructure was ranked as the number one issue: *continuing rapid changes in infrastructure technology and the increasing breadth and depth of applications needing support* (Brancheau, Janz & Wetherbe 1996, 229). In 1992 Nadler (p.5) stated that because the rate of change is increasing, the combination of the great potential of information technology with the great demands of the competitive environment has led to innovations in organizational design. IT has begun to revolutionize organizational design by providing alternatives to hierarchy as the primary means of coordination. Nadler (ibid.) listed new, evolving forms of rethinking organization architecture like autonomous work teams, high-performance work systems, alliances and joint ventures, spinouts, networks, self-design organizations, fuzzy boundaries and teamwork at the top. Thus organizational structures were rapidly changing and IT was used for enabling networked and distributed business operations. While defining the corporation of the 1990s Madnick (1991, 43) discussed the emergent role of flexible IT architecture for enabling integration between disparate parts of the organizations and enabling multiple organizations to work together. Rockart and Short (1991, 197) identified the move towards networked organizations: increased information technology capability is driving the dynamic, global, increasingly competitive business environment, which requires more efficient management of information technology. They defined networks as one part of the firm’s overall system of interrelationships to accomplish work (Rockart & Short 1991, 192). At the same time new emergent business applications called Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) were changing information systems and technologies to support networking and distributed business operations. Huovinen and Makkonen (2004, 4) have even called the 1990’s as era of business applications, when software company called SAP was growing to dominate global business application industry. The role of the Internet was growing, and companies no longer wanted to buy just software: they wanted applications to solve their business problems (Huovinen & Makkonen 2004, 4).

3.3 Evolving organizations

In early 1990, the changes enabled and driven by IT were causing Nadler (1992, 4) to extend organizational design, formal structures and systems with the broader concept called organizational architecture. By organizational architecture Nadler (ibid.) meant a much more inclusive view of design elements of social and work systems, including the formal structure, the design of work practices, the nature of the informal organization or operating style, and the processes for selection, socialization, and development of people. Gerstein (1992, 15) defined organizational architecture as the art of shaping organizational space to meet human needs and aspirations; organizational architects work in the “behavioral space” in which people act. According to Gerstein (ibid.), an organization architect can be seen to design the organization’s information space, which includes the current state of activities, historical pattern of transactions, events and decisions, knowledge and expertise of organization. According to Nadler and Tushman (1997, 9), organizations were competing through their designs, which they called organizational architecture. Organizations in 1990s needed speed, innovation, customer focus, and radically improved productivity to adapt to a rapidly changing business environment. Two structural materials were making this shift possible (Nadler & Tushman 1997, 9):

- IT makes it possible for companies to make timely information available to thousands of people simultaneously no matter where they're located.
- Innovative use of teams relying upon people to use their collective knowledge, judgment, skills and creativity to perform a variety of jobs and functions, rather than just one, in concert with their colleagues.

While chasing more effective IT architecture, organizations were focusing on implementation and delivery more than planning and alignment (Brancheau et at. 1996, 234). Perhaps, executives were chasing for maximal reach (to whom can we connect?) and range (what services can we share?) of IT platforms for fully open systems (Keen 1991b, 180) than actual holistic fits to business needs that were really prioritized. In ranking technology infrastructure so highly, IS and IT executives were trading off the importance of business relationship issues. This emergent gap between business and IT organizations was a growing challenge called business/IT alignment. At that time, in the beginning of 1990s, IT architecture seemed to offer a quite well-abstracted IT management layer for improving business/IT alignment. But soon after that, Internet, globality and mobility of business operations were creating new business possibilities and IT management challenges, which needed new solutions to solve increasing business/IT alignment gaps. Reynolds (2010, 125) explains that *"over time IT architectures matured expanding from physical layer to more abstract logical layer"*.

While IT infrastructure and architectures were creating technology networks and markets, Konsynski and Tiwana (2005, 239) argue that historically Enterprise Architectures have focused on the growth of hierarchies. The move from traditional organizational architectures to spontaneous collaborative networks requires architecting improvisational capability: an organizing logic in which the boundaries of the collaboration network are malleable. These inter-organizational arrangements may be seen in business network architectures as in Van Heck and Vervest (2007).

Next we will shortly review EA relationships to strategic business/IT alignment, IT process development and new technology introductions. These IT domains and process areas are suspects for producing, maintaining and using IT architecture documentation.

3.4 Strategy-driven business-IT alignment challenge

The origin and root-cause for inventing EA may be seen in increasing challenges of business-IT alignment, which EA management aims to improve (Schneider, Schulz & Matthes 2013). The dualism between business and IT is deeply rooted in IT history, when the computer was invented and business organizations were trying to discover how to utilize this new technology in their operations. Initially, IT was something separate from the business. But along with advanced forms of heuristic problem solving (Simon & Newell 1958), electronic data-processing (Mann & Williams 1960), smaller computers (Haines, Heider & Remington 1961), and various forms of automation (Klatzky 1970), the managerial challenge of alignment was everywhere (Anshen 1960).

The increasing use of IT was soon gaining more strategic importance. In 1984 the MIT Sloan School of Management started a major collaborative research program, "The Management in the 1990s", with two basic premises: firstly, the business environment is and will remain turbulent and, secondly, IT will continue its rapid evolution over at least the next decade (Scott Morton 1991, 3). Both premises were right, and the final report presented several valuable findings, including the MIT90s framework (Scott Morton 1991, 20), the IT platform and architecture (Madnick 1991), the IT-induced business reconfiguration with Strategic Alignment Model SAM (Venkatraman 1991), and the Networked Organization (Rockart & Short 1991). But the exact term of Enterprise Architecture was not yet used in these reports. Linking IT and business strategy was already in 1991 a major challenge for global companies (Ives & Jarvenpaa 1991), although some emergent patterns seemed to align IT strategy according to business strategies of multinational, global, international or transnational operating modes (Bartlett & Ghoshal 1989).

In the beginning of the 1990's, Andrews (1991, 47) saw organizations' environments and especially technology as a great opportunity for strategic advantage. According to Andrews (ibid.), technological developments are not only the fastest unfolding but the most far-reaching in extending and contracting opportunities for an established company. They include the discoveries of science, the impact of related product development, the less dramatic machinery and process improvements, and the progress of automation and data processing. Reach and range of IT infrastructure (Weill & Broadbent 1998) was growing beyond the organizational borders since the 1980s, when this strategic alignment model was invented. This change was included in the MIT90s framework, which presented technology at the border of organization boundary closely related to the external technological environment (Scott Morton 1991, 20).

The original idea from Henderson and Venkatraman (1989, 1993) was to see alignment as a means or mechanism to synchronize business and IT development changes. Business-IT alignment refers to applying IT in an appropriate and timely way, in harmony with business strategies, goals and needs (Luftman 2000, 3). Business-IT alignment thinking sees IT as a separate discrete entity in which dualism requires continuous alignment between IT and business. Henderson and Venkatraman (1989) documented this growing challenge in their Strategic Alignment Model (SAM), which had been developed at the end of 1980s during MIT's Management in the 1990s research. This model has been widely used to explain and analyze alignment challenge between business and IT (e.g. Al-Hatmi & Hales 2010; Chan & Reich 2007; Luftman 2000). The literature suggests that firms cannot be competitive if their business and information technology strategies are not aligned (Avison, Jones, Powell & Wilson 2004). Avison et al. (2004, 224-225) have collected the debate about alignment as follows:

> *Strategic alignment has many pseudonyms like fit (Porter 1996), integration (Weill and Broadbent 1998), bridge (Ciborra 1997), harmony (Luftman 1996), fusion (Smaczny 2001) and linkage (Henderson & Venkatraman 1989). However, in all cases, it concerns the integration of strategies relating to the business and IT/IS. There are those who argue that IS alignment is not an issue in its own right. Some researchers like Smaczny (2001) asserts that IS is pervasive in business and not separable from business strategy, and therefore the need for alignment does not arise. Alignment is seen to assist a firm in three ways: by maximizing return on IT investment, by helping to achieve competitive advantage through IS, and by providing direction and flexibility to react to new opportunities.*

Alignment also has counter-arguments (Chan & Reich 2007). One of the issues with this alignment concept may relate to the mess between the concepts of information technology, information systems and information. Kappelman (2010a, 3) states that true alignment begins with the alignment of concepts and ideas of people: from thought to action and physical resources, activities and technologies. If and when IT is embedded into all businesses and organizational operations, this ontology of seeing business and IT as separate entities is no longer valid. On the other hand, while business is more dependent on the ubiquitous IT (Weiser 1993) at all operational levels, this model depicts that business planning, IT management and organizational decision-making requires a higher-level of abstraction for holistic business-IT management, which EA management seems to offer. But when looking at business-IT alignment from an IT perspective, business-IT alignment has been continuously ranked as one of top concerns for IT management (Luftman & Ben-Zvi 2011, 205). Business and IT may be seen as totally separate entities, the two of which may be organizationally combined into a systemic whole by means of IT management processes.

3.5 Process-driven IT management challenges

Because of the increasing IT management challenge, those engaged in practice and academia have been developing new theories, artefacts, constructions and social structures for managing the dualism between business and technology, and improving the division of labor between business and IT operations. While the Strategic Alignment Model (SAM) concentrates on planning and strategic partnership between business and IT, IT Governance (ITG) is trying to tie organization-wide relationships for improving IT management structures, processes and partnership between IT, business and other shareholders. According to IT Governance Institute’s website (ITGI 2011a), “IT governance is an integral part of enterprise governance and consists of the leadership and organizational structures and processes that ensure that the organization's IT sustains and extends the organization's strategies and objectives". Thus IT governance seems to be an elementary part of corporate governance and strategic alignment (De Haes & Van Grembergen 2004).

Cater-Steel, Tan and Toleman (2006, 2) have adopted the multiple process improvement framework from Ratcliffe (2004), showing Cobit as an IT Governance model above IT service management processes and operations:

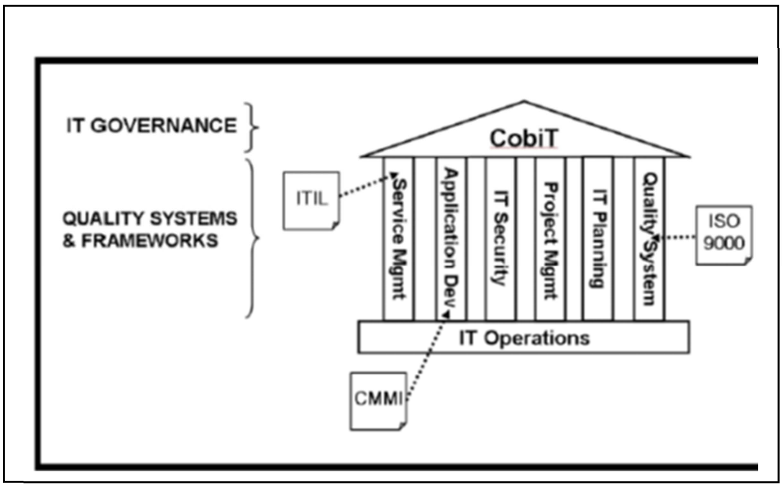

FIGURE 5 Multiple process improvement frameworks (Ratcliffe, 2004).

Some organizations have started with the implementation of IT governance in order to achieve the fusion between business and IT (De Haes & Van Grembergen, 2005). Thus IT governance seems to be a practice-driven concept for implementing business/IT alignment theory into an integrated management system. Relational mechanisms between business and IT seem to be important while initiating IT governance, but when an IT governance framework, structures and processes become embedded into daily operations, the role of relational mechanisms become less important (De Haes & Van Grembergen 2008). Hobbs (2012, 92) lists the enterprise architecture council (EAC), the architecture review board (ARB) and architecture forum as possible EA governance organizations. A focused Delphi study into Belgian financial services organizations validated an Architecture Steering Committee as an effective and relatively easy IT governance structure to implement (De Haes & Van Grembergen, 2008). Hobbs (2012, 93) states an enterprise architecture steering committee is a synonym for enterprise architecture council (EAC), which serves as the principal oversight body for EA. In a global status report regarding governance of Enterprise IT (ITGI 2011b), almost half of the companies studied seem to have structures such as an architecture review board or committee as part of their current or planned governance model.

At this level of discussion, there seems no specific definition whether IT governance research has been related to IT Architecture or Enterprise Architecture. Intuitively, it seems that Cobit and ITIL frameworks are the most common standards applied for IT governance implementation. Perhaps EA and EA management are more common tools for operational IT management, which De Haes and Van Grembergen (2004) defines as being *focused on the effective supply of IT services and products and the management of IT operations*, and IT governance is focused more on strategic questions like *"How does top management get the CIO and IT organization to return some business value to it?"*. One possible reason for this mismatch of architecture and its role in IT governance may be that in practice EA is limited to IT architecture without strong TO-BE coverage of business and process architectures (cf. Lemmetti & Pekkola 2012).

A global status report (ITGI 2011b) regarding Governance of Enterprise IT (GEIT) states that the use of frameworks and structures can help improve the governance of enterprise architecture. Frameworks and standards such as COBIT, ITIL, ISO 27000 series and TOGAF can help improve GEIT, bringing structure and clarity to areas such as service management, information security and enterprise architecture. COBIT provides an overarching framework within which the more focused frameworks and standards can be applied more effectively. Similarly, structures such as an architecture review board can improve the re-use of and synergies between initiatives ensuring that the total cost of ownership is considered, and they can help reduce complexity and increase agility over time. (ITGI 2011b)

More complex IT infrastructures, information systems and wider EIS layers are causing pressures to improve IT services and IT management. Each IT-related layer between business and technology is growing more complex, thereby causing pressures to improve IT service management (ITSM) processes. The response to these pressures for more efficient IT service management processes encompass international standards like ITIL, COBIT, PMBOK, Prince2, ISO/IEC 20000, ISO/IEC38500 and other commercial or practice-driven attempts for more robust and higher quality ITSM practices (c.f. Lankhorst, Iacob and Jonkers 2009, 15). By applying these standards, ICT service vendors are trying to improve their ICT service quality and standardize service delivery processes and language. This development is vital for improving IT management practices; but additional business and process integration elements and structuration are needed for EA management practices. Morris (2014) discusses PMBOK as a practice-driven execution guide without connections to systems life-cycle orientation and social structuration, which could be achieved with EAM practices.

One attempt to integrate various ICT management models into a business-driven ICT standard comes from ICT Standard Forum (2012). By combining ICT management models (ITIL, COBIT, PMBOK, Prince2, ISO/IEC 20000 and ISO/IEC 38500), this ICT Standard divides ICT operations into four different streams: strategy and governance, sourcing and vendor relationships, project management and service management (ICT Standard Forum 2012, 16). ICT operations are integrated with business alignment, defined as “formalized and goal-oriented cooperation between top management, business operations and ICT management with following key objectives (ibid., 30):

- Implement the company strategy and business objectives with the help of ICT.
- Gain commitment from the business and ICT for the common objectives.
- Develop business processes.
- Decide on projects, investments and development initiatives.
- Ensure business continuity and up-to-date information.

An ICT standard, in strategy and governance domain, includes key roles for a CIO, a Chief Architect, Quality and Information Security Managers, and an ICT Controller (ibid., 60). The domain called “Architecture and execution of structural changes” is defined as a component inside the strategy and governance domain expected to drive business development, objectives, measures and communication for business alignment (ibid., 25). The EA component inside this model consists of the EA foundation called the principle level; EA itself is divided into four parts called Business, Information, Application and Technology Architecture. EA governance includes decision forums, processes, operation and steering models, role, responsibilities and mandates (ibid., 69). This model includes a governance model, which is responsible for business alignment. This governance model names the following organizational actors: a board of directors, an executive board and divisional management teams as business governance parties, and an ICT steering group, steering groups for business solutions, a project office and steering groups, a steering group of continual services, and steering groups of vendor relationships (ibid., 34).

The ICT Standard (2012) compiles together international IT standards as a collection of ICT concepts with limited integration between parts of the whole. This practice driven governance model for business alignment seems to recognize major actors for large enterprises which are running IT management with business and IT dualism. Process development is embedded into the project management domain as part of business alignment. These development practices seem to reflect life-cycle and social gaps for IT projects in theory and practice (Morris 2014). Social components like knowledge management, IT human capital and change management are not recognized as explicit management domains. From a social structuration perspective, this ICT standard recognizes business IT leadership as a joint operating field for the CEO, executive boards and board members, who all serve internal stakeholder groups like decision makers, key users and end users, as well as external customers, vendors and opinion leaders (ICT Standard Forum 2012, 64). From a process development perspective, our EA leadership thinking encapsulates EA management as an integrative practice between business, process and IT development, whereas the ICT standard divides EA into IT systems, information and integration challenges, which are separated from process development (ibid., 43). Thus our EA thinking follows the quote from Ross predicting IT to move into the function of EA (Sidorova & Kappelman 2010, 71), a theory which we will elaborate during our study.

Global enterprises like Kone Corporation with strong business process development orientation also recognize business process communities and roles like global process owners, solution owners and business analysts, regional process owners and experts, and local process owners, process specialists, key users, and data managers organized into shared service centers (Hagros 2013). The Kone Way approach for strategy-driven process development and strong system-driven business execution is very similar to our EA leadership approach for integrated strategy, IT and process development. This indicates that strategic business process management (BPM) culture from telecom and ICT industries (Armistead et al. 1999) seems to be adapted to other industries and global corporations. Process improvement techniques seems to offer means to move towards operational excellence, but harvesting IT resource synergies requires superior technical and managerial IT skills to rebuild business process, reshape organizational structure and culture, and respond to environment changes (Chen 2012, 147). The process development approach seems to be a successful change management approach for organizational transformation in information intensive service business (Abraham & Junglas 2011). Thus the business process driven systems development culture and governance model seems to improve IT management getting evidence from both theoretical and practical sources.

IT capabilities and IT management practices are potential sources for improving operational and financial performance of an enterprise (Kim, Shin, Kim & Lee 2011, 287). But understanding social mechanisms of IT business value seems to still be quite preliminary and fragmented. Social mechanisms of managing IT human capital could be seen as a strategic resource and effective IT human resource management (HRM) indicates strategic organizational capability (Ferratt, Agarwal, Brown & Moore 2005, 237). IT human capital theory and practices seem to reflect gaps between an understanding of strategic human resource management as a complex, living-system extension and a resource-based view of a company (Colbert 2004, 341). But an understanding of IT business value seems to be improved through investigating the systemic relationship between IT and organizational factors such as process, structure, culture, power and politics (Cao 2010, 279). For our study, these findings indicate that combining an EA approach with social theory, and especially Giddens' (1984) structuration theory, could improve our understanding about social systems and dimensions of EA for continuous alignment and value management mechanism between business and IT. Huovinen and Makkonen (2004, p.5) have documented this CIO competence shift from business process and strategy thinking towards business value thinking and demonstrating leadership, enabling and creating change within the corporation

3.6 Managing the challenges of IT systems development

In practice IT management simultaneously contains several challenges for developing, maintaining and using systemic combinations of human resources, knowledge, systems, IT and related services. There are various theories, models and ways to slice and dice this kind of systemic complexity. This complexity comes from social interaction between technologies, which may, by definition, include material and immaterial components working together with the external environment. People tend to notice the material and physical components of the technology, but invisible, immaterial, social and knowledge intensive layers of the technology may be easily ignored, thus typically causing problems for the material components of the technology and eventually preventing the whole technology and system from working as designed. Regarding this practical challenge for new technology introduction, Sorrentino (2005, 508) refers to Ciborra's theories regarding care-taking of technologies:

> *The process of introduction and use of technology is never automatic and can never be taken for granted. Rather, it is of a composite nature and is characterized by the simultaneous presence of numerous variables that are of an individual, organizational and cultural character. Within this perspective, the capacity to take on and take care of a new technology or solution, all the while coming to grips with an environment characterized by uncertainty and ambiguity, constitutes ever more frequently the real challenge for organizations. The task lies in managing to absorb technology progressively within everyday work practices up to the point that it becomes internalized by people and hosted by the organisation (Ciborra 2004).*

Because of this fragile nature of new technology introduction and knowledge acquisition, there are various theories, normative process models, methods and life-cycle conceptualizations for technology implementations. The most typical technology and software implementation models are engineering-based sequential waterfall models, but there are also several iterative spiral-models; rapid and agile development models also exist. Generic model from Millerand and Baker (2010, 145) could be used for capturing the recursive and iterative nature of new technology development, and it could serve as an introduction to use during the local implementation model with phases called "Design", "Development", "Deployment" and "Enactment". More IT-specific implementation life-cycle phasing could be adopted from Kwon and Zmud (1987), who have divided IT implementation into phases called "Initiation", "Adoption", "Adaptation", "Acceptance", "Routinization" and "Infusion". This IT implementation phasing has been applied in IT diffusion research (e.g. Cooper & Zmud 1990) and ERP –life cycle studies (e.g. Rajagopal 2002; Somers & Nelson 2004). In an ERP study context, Markus and Tanis (2000, 189) have used an Enterprise System experience cycle with the phases "Project

Chartering", "The project", "Shakedown" and "Onward and Upward"; this model has been applied while studying so-called "best practices" (Kumar, Maheshwari & Kumar 2002) and reasons for failures and successes (Markus, Axline, Petrie & Tanis 2000).

An example from the changing methods for introducing new technology comes from the software and application industry. Most enterprises have changed their application sourcing strategy from make to buy, which has created global application markets for commercial business applications. Yang, Bhuta, Boehm and Port (2005, 54) have studied value-based processes for these business applications to understand how software and system engineering projects could be better planned and controlled to deliver value to stakeholders. They argue that *traditional software process models fail to accommodate many challenges of using business application, however, because their process guidance is overly sequential (as with waterfall-based models) or underdetermined (such as EPIC)*. Their own model for business application implementation includes only three sources of effort called "Assessment", "Tailoring" and "Glue-code development", which are repeated based on an iterative value-based decision-making spiral to produce maximal stakeholder value within predefined schedule and budget. (Yang et al. 2005)

Social mechanisms for managing IT human capital as strategic resource during new technology introductions seem to be quite limited. The complexity associated with the fluctuating demand for IT skills, coupled with the need for highly skilled senior architects and professional developers including inevitable delays in skill acquisition, makes IT human capital management a challenging executive task for new technology introductions (Choi, Nazareth & Jain. 2012, 838). Iterative methods seem to be the current trend for managing knowledge and change during introductions of new technology. However, because technologies are different as well as users and enterprises, there is no silver bullet or right model for introducing new technology. Within an enterprise and business network can be found unique EA, which includes various technologies, knowledge, information assets and IT components. These IT components are a typical domain for IT management, which plans and manages life-cycles for IT components and layers. Each technology and IT layer is different in many ways, which also means that a new technology introduction and life-cycle model for each layer may be different. Because of varying competence and knowledge requirements, each technology and IT layer may have their own management methods and resources.

Typical models for acquiring skills during the introduction of new technology combine three skill augmentation options: training, recruitment, and contracting (Choi et al. 2012, 850). In a practice-driven model, like the ICT Standard, sourcing and vendor relationships are seen as a separate management domain (ICT Standard Forum 2012), but IT human capital is not managed separately as an integrative source for IT business value. But transitions from IT architectures, business/IT alignment, IT management and EA to the EA management level seem to include some discontinuities, which IT technology vendors and techno-centric thinking seems to omit. There may also be many organizational structures, capabilities and cultural issues that may be obstacles or cause delays for business-IT integration.

3.7 IT–framework initialization

To conclude, our attempt to analyze EA by dividing EA into components of enterprise and architecture does not generate any aggregate result. Like in chemistry, splitting water into molecules of H_2O does not generate any social wisdom about value and meaning of water in various forms; we will now give up looking EA meaning and value from its' components. Quoting Rood (1994, 106), we conclude that *while there is no single commonly agreed-upon definition of "architecture" in relation to enterprises or system, the central idea of all architectures is to represent an orderly arrangement of the components that make up the system under question and the relationships or interactions of these concepts*.

For studying these IT layers between technologies and business, we will introduce our IT research framework (IT–framework). Because this IT- framework is generic, allowing for implementation all kinds of new technologies into organizations, the IT–framework for our EA –study includes process or technology life-cycle from "Introduction" to "Retirement". This IT–framework will be used as a research instrument to recognize and elaborate changes between business and technology layers. An IT–framework includes layers called "Business", "Enterprise Architecture/EA", "Enterprise Information System/EIS", "Information System/IS", "Information Technology/IT", "IT Infrastructure" and "Technology". Our IT–framework is illustrated in Figure 6.

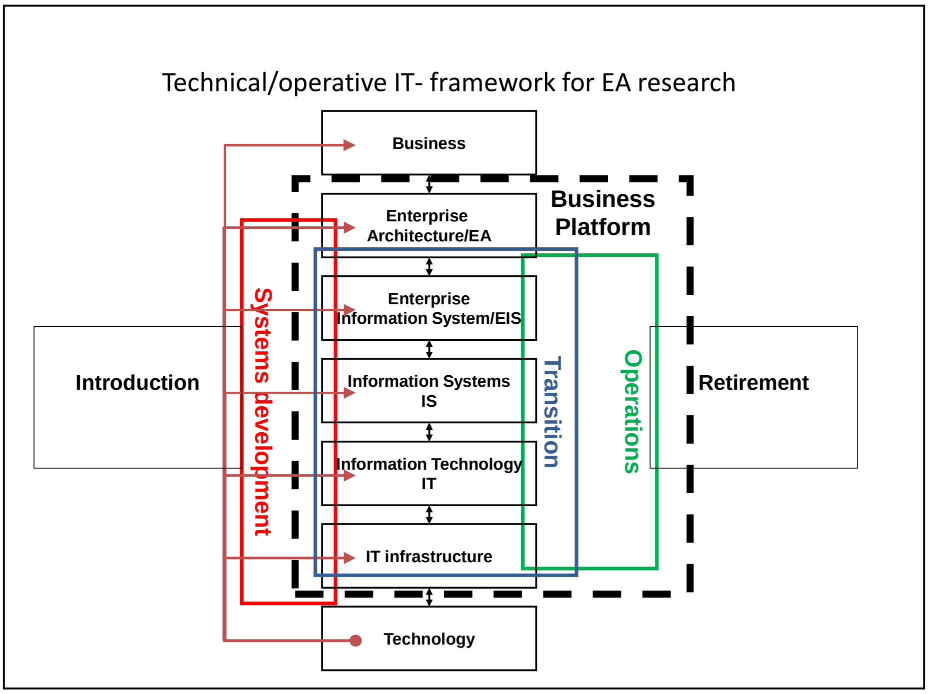

FIGURE 6 IT –framework for EA analysis.

In Figure 6, we initialize our generic model of technology life-cycle and layers between business and technology. We will use this IT–framework while analyzing changes in seven empirical system development vignettes in chapter 6. Inside this IT–framework technology, introductions may occur into one or more layers of an enterprise. After being introduced, some technologies continue into systems development, transition and operations. Technologies, which are in transition and operations, are a major part of EA. Technology usage ends in the retirement phase.

At the bottom of our IT–framework pyramid is the invisible IT-infrastructure, which is embedded into legacy systems inside old-fashion, de-supported IT technology. Aging technologies and knowledge are in the retirement phase. These invisible components of existing EA may cause unexpected discontinuities because IT suppliers may stop developing and supporting installed technologies and/or human resources may not be available for delivering services for aging technologies. Thus knowledge management and infrastructure renewal requires continuous investments for avoiding the pitfalls of unexpected IT infrastructure retirement. Ontologically this IT–framework includes the idea of business and IT dualism. This model emphases new technology introductions and a phased implementation approach where new technology is not yet an integrated part of business-IT integration and not yet inside the organizational IT management scope. This layered IT configuration model also includes similarities with the ISO/OSI model, which has separated 7 layers of IT spanning from professional education to IT organization structures. Recently developed service-oriented models like cloud services have started to question this layered IT development and co-creation model, indicating a transition into service-based architectures, outsourcing and mixed sourcing models and architectures. Despite the availability of the IT service sourcing model, our IT-framework could be used for answering the question of “WHAT?” answering with lists of current and planned social and technical changes that may have effects and cause changes to enterprise operations, business, processes and IT systems.

Next we will review the current status of EA research in more detail. In chapter 5, we will cover social theories, which may help us to redefine and reframe EA from human and organizational perspectives for IT management to develop towards the EA management level. Thus we are seeking for conceptual models for achieving EAM integration between business, process and IT management. After finalizing our conceptual EA instruments in chapter 5, we will establish our study settings in chapter 6. Our EA development domains will be presented as EA vignettes in chapter 7. Findings from our empirical study will be presented in chapter 8, applicability of social theories in EA context are discussed in chapter 9, and contributions are summarized in chapter 10.

4 EA theory meta-review

In this chapter we discuss the EA theory from IT architecture to EAM processes, maturity and benefits. This chapter covers the current status of EA theories by means of a meta-review of 10 academic EA review articles, which we found from academic databases using Google Scholar searches with words “enterprise”, “architecture” and “review”. Our main EA meta-review sources are listed in Table 2.

TABLE 2 Main EA meta-review sources.

EA review author(s)	Year	Title	Reviews/ year
1.Greefhorst, Koning & van Vliet	2006	The many faces of architectural descriptions	1
2.Niemi	2007	EA Stakeholders - a Holistic View	1
3.Schelp & Winter	2009	Language Communities in EA Research	2
4.Schöenherr	2009	Towards a Common Terminology in the Discipline of EA	
5.Bernus & Noran	2010	A Metamodel for EA	6
6.Boucharas, van Steenbergen, Jansen & Brinkkemper	2010	The Contribution of EA to the Achievement of Organizational Goals: A Review of the Evidence	
7.Lucke, Krell & Lechner	2010	Critical Issues in EA – A Literature Review	
8.Radeke	2010	Awaiting Explanation in the Field of EAM	
9.Stelzer	2010	EA Principles: Literature Review and Research Directions	
10.Winter, Buckl, Matthes,& Schweda	2010	119 Investigating the state-of-the art in EAM methods in literature and practice	

The number of EA publications has been increasing since the year 2003 (Langenberg & Wegmann 2004; Schelp & Winter 2009; Schöenherr 2009). This growing EA publication stream has created an opportunity for academic EA review research. The increasing tendency of EA reviews can be seen from publication years in Table 2 above: the EA framework review is from the year 2006; the EA stakeholder review was published in 2007; the EA language and terminology reviews are from the year 2009, and the rest of the 6 EA reviews from the year 2010. This subset of 10 EA review articles gives an overview of EA theory status, which we will describe next while searching for social and organizational findings or references for social theories.

4.1 EA research and development

In our EA meta-review, all ten EA review articles represent the EA research and development community. While discussing EA research and development, we have divided this R&D topic into essentials, standards, frameworks and methods, which we will cover in the next sub-chapters.

4.1.1 Essentials

The essential nature of R&D for EA is information system development (ISD). Thus we must first cover the domains of language and definitions before we can continue to principles, dimensions and stakeholders of the EA domain.

Language

In our EA meta-review, both Schelp & Winter (2009) and Schöenherr (2009) have explicitly studied EA language and definitions. Schelp and Winter (2009) have found seven EA language communities, listed below with the starting year and a short description of their EA research work:

- 2002- The Systemic Enterprise Architecture ‘Methodology’ (SEAM).
- 2003- The ArchiMate project; Dutch research initiative.
- 2003- Business Engineering Framework; University of St.Gallen, Switzerland.
- 2004- Enterprise Application Integration (EAI); Technical University (TU) of Berlin.
- 2004- The Royal Institute of Technology (Kungliga Tekniska Högskolan, KTH); Stockholm, Sweden.
- 2005- The Munich EA meta-model.
- 2007- The Lisbon meta-model.

These seven EA language communities inside the EA R&D community seem to have different definitions and models regarding language/meta-models, procedure models, architectural levels (strategy, organization, integration, software, infrastructure), methodology and explication for the EA life-cycle (Schelp & Winter 2009). While comparing these seven EA language schools on these five different EA dimensions, it seems that St.Gallen’s Business Engineering Framework has the widest EA coverage. But when analyzing the scope of EA language, Schelp and Winter (2009) have found that most groups have their EA language defined (i.e. architectural layers, elements included in models, relationships etc.), some to the extent that a corresponding tool could be developed. From an EA standard and tool perspective, the Dutch ArchiMate project closely follows the IEEE1471 (IEEE 2000) standard in its method to manage and communicate EA issues between the different involved stakeholders. The derived ArchiMate modeling language is clearly defined and is used to develop an EA toolset. (Schelp & Winter 2009)

While the Schelp and Winter (2009) comparison addresses five separate architectural levels of strategy, organization, integration, software, and infrastructure, Schöenherr (2009) also includes information as a separate architecture layer and, instead of software, defines applications and application landscape as a separate architectural layer. Schöenherr (2009) also includes interoperability into the integration layer and opens up the organization layer to contain organizational structures, business processes and a combination of structures and processes. While Schöenherr (2009) adds more detail to EA layers, the confusion of current EA literature is growing more obvious. This is similar to Schöenherr's finding that only 18 of 126 EA articles define the term enterprise to extend their architectural understanding regarding organizational details and requirements. Thus it is not a surprise that both architectural standards and EA frameworks have been under construction to reflect organizational changes (Bernus & Noran 2010). Perhaps this also indicates that architectural standards and EA frameworks have so far been too theoretical and technology-oriented to be practically, efficiently applicable and enterprise-wise capable to model the organizational diversity needed for change management.

4.1.2 Definitions

> *All organizations have an EA, albeit implicit. Whether it needs to be surfaced or articulated, in part or in whole, is dependent on whether there is anything the organization is trying to achieve where an EA approach will help. (Townsend 2009, 52)*

This reference is a conclusion from the EA pilot of Liverpool John Moores University in 2007. This is one subjective view to EA from a high-education context, and seems to be regarding EA use. This quote is a good example that EA seems to be a context-sensitive concept, where both "enterprise" and "architecture" are sensitive in how they are understood and from what viewpoint they are seen. In the EA review articles we examined, this issue with the EA definition was documented by Schöenherr (2009):

> *"There is no doubt about the horrible mess looking at the usage of the term Enterprise Architecture!"*

In our EA review sample, Boucharas et al. (2010), Bernus & Noran (2010) and Schöenherr (2009) do not include an explicit EA definition. So, in spite of Schöenherr (2009) aiming toward a common terminology in the discipline of EA, he does not himself define nor refer to any EA definition in his article. The horrible mess that Schöenherr (2009) has found is explained by Schelp & Winter (2009) as follows:

> *In his comparative study on EA terminology Schöenherr (2009) included both academic and practitioner sources. But most of the practitioner contributions are weak regarding the definition of terminology, lack an explication of an underlying metamodel and/or methodology (Schöenherr 2009). Therefore Schelp & Winter (2009) excluded practitioner contributions from this analysis (with the exception of those showing explicit definitions or by referencing defined terminology sets as defined e.g. in TOGAF, FEAF, or DoDAF). Albeit constituting a distinct EA research framework, the approach of Bernus, Nemes and Schmidt (2003) has been excluded because their EA understanding is too different from the common understanding of the remaining approaches.*

Thus academic and practitioner knowledge about EA seem to use incompatible terminology: academics having seven EA language communities and practitioners' knowledge being context-sensitive. Schelp & Winter (2009) are extending their EA definition from the architecture definition of IEEE1471 (IEEE 2000). Thus *EA can be understood as the fundamental organization of a government agency or a corporation, either as a whole, or together with partners, suppliers and / or customers (`extended enterprise´), or in part (e.g. a division, a department, etc.) as well as [...] the principles governing its design and evolution*. The Architecture definition from IEEE1471 (IEEE 2000) is also referred by Greefhorst et al. (2006) and Radeke (2010). Because Greefhorst et al. (2006) are studying only architecture frameworks and descriptions, they do not define EA in their work. Niemi (2007) accepts stakeholder and stakeholder concern definitions from IEEE1471 but defines his own EA definition *as a collection of all models needed in managing and developing an organization*.

In addition to practitioners, Schelp & Winter (2009) have excluded Bernus et al. (2003) because *their EA understanding is too different from the common one*. Could this be because Bernus and his colleagues have been producing GERAM as a basis of ISO15704 (2000) "Industrial automation systems" while Schelp and Winter (2009) are following EA definitions from IEEE1471 for models describing the architecture of a "software intensive system"? This indicates conceptual differences between hardware and software related architectures.

Radeke (2010) accepts the definition from IEEE1471 (IEEE 2000) for EA to mean an organization's basic structure, which might be captured in terms of descriptive models. Radeke (2010) defines EAM to mean the general process of managing, maintaining, and developing this structure in a holistic and purposeful manner. Thus Radeke (2010) separates the concept of EA as an organization's basic structure from EAM as maintaining EA in a holistic manner. When we accept this conceptual separation between EA and EAM, then the quote of Townsend (2009, 52) could be modified as follows:

> *All organizations have an EA, albeit implicit. Whether it needs to be surfaced or articulated, in part or in whole, is dependent on whether there is anything the organization is trying to achieve where an **EAM** approach could help.*

Lucke et al. (2010) also refer to ISO 42010:2000 when they are defining architecture, but the EA definition they adapt from Lankhorst (2009):

> *Enterprise architecture captures the essentials of the business, IT and its evolution and is defined as a coherent whole of principles, methods, and models that are used in the design and realization of an enterprise's organizational structure, business processes, information systems, and infrastructure.*

Lucke et al. (2010) study critical issues in Enterprise Architecting requiring careful definition of the terms of "architecting" and "enterprise architecting". While Lucke et al. (ibid,) search for the common EA process from EA literature, they are reporting several quite similar EA process models and selecting the TOGAF ADM (The Open Group, 2009) to identify issues related to the EA process. The Lucke at al. (2010) study defines generic, higher-level EAM process models including two phases of EAM Implementation and EAM Usage. But, surprisingly, Lucke et al. (2010) does not anyhow refer to the TOGAF ADM –process model as a possible EAM process implementation.

Stelzer (2010) makes references to architecture definitions of both IEEE1471 and ISO/IEC 42010:2007 before defining enterprise architecture as *the fundamental organization of an enterprise embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution*. Also, Winter, Buckl, Matthes and Schweda (2010) makes an exact reference to the IEEE1471 architecture definition before defining EA as the *coherent and holistic architecture of an enterprise, which comprises both IT and business elements*.

Thus it seems that despite over 20 years of EA research, the definitions and language of EA are still not standardized (cf. Lemmetti & Pekkola 2012). While making the IEEE1471 standard, the basic definition of architecture has been reported to be the most difficult issue (IEEE 2000). Despite the language differences, it seems that the mindset and objectives of different EA research groups and practitioners is the same: defining, managing, maintaining, and developing enterprise structures in a holistic and purposeful manner.

EA principles

This sub-chapter regarding EA principles mainly refers to Stelzer (2010). He reports various interpretations of the concept of EA principle, which are recognized to be pivotal elements of EA. Stelzer (2010, 14) defines *principles as means to achieve certain ends*, which he separates into business, IT or EA goals. In line with TOGAF, Stelzer (2010) separates the two meanings of the architecture: inherent structure/design of the system and its representations. Thus he separates EA design principles from EA representation principles with following definitions (Stelzer 2010, 13-14):

> *Design principles are fundamental propositions guiding the construction and evaluation of architectures, e.g. separation of concerns, modularity, or loose coupling. Representation principles are fundamental propositions for describing and modeling architectures, as well as for evaluating architectural representations. Examples for representation principles are understandability, consistency, and completeness.*

Referring to Lindström's (2006) analytical strategy process from business strategy to IT strategy through architectural principles, Stelzer (2010) follows a logical path from business strategy -> business principles -> architectural principles -> IT governance -> IT strategy generating the illustration of the context of architecture principles in Figure7.

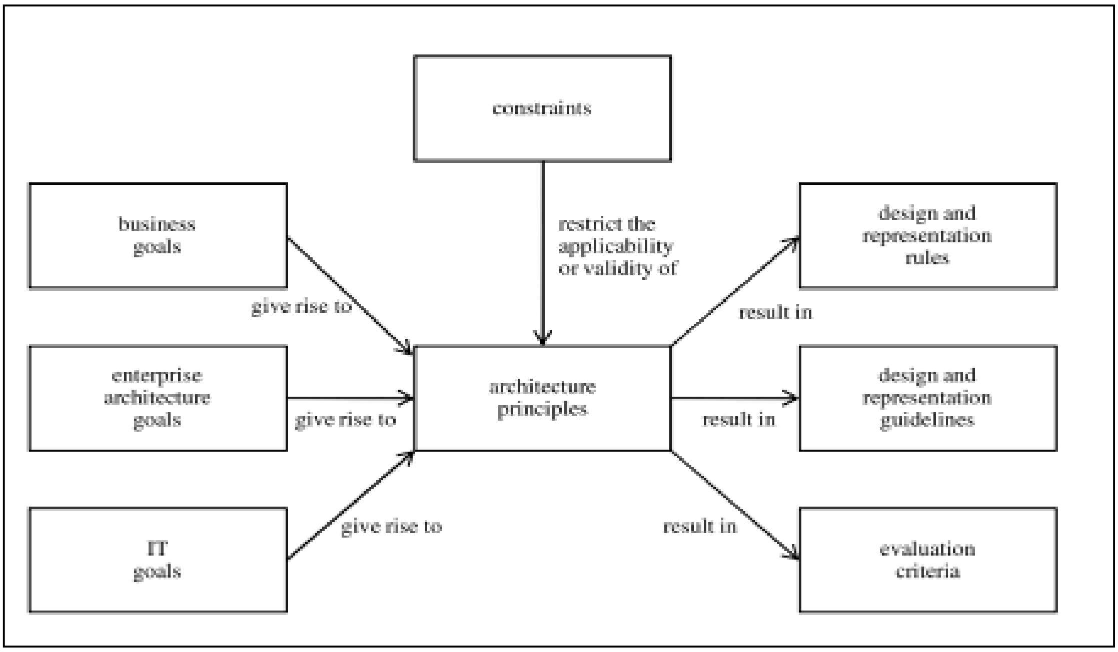

FIGURE 7 Context of Architecture Principles (Stelzer 2010, 14).

Stelzer (2010, 14-15) further continues to present architecture principles as a network of associated principles from business, IT or EA domains. Thus he generates a model of a network of principles where business, IT and EA principles are interrelated to EA related principles from organization, application, software architecture, data and technology/infrastructure. Lindström (2006) compares EA principle examples from EA frameworks: TOGAF, FEAF and TEAF include EA principles, but DoDAF (2010), Zachman (1987, 1996)) and Spewak (1992) do not include the EA principle definition. It would be valuable to bring visibility to this network of principles because this information could increase visibility to original stakeholders and the root cause of some architectural requirements. But if this level of detail regarding EA principles is missing from the EA frameworks, then it may also be missing in a systematic manner from actual EA descriptions, use cases and practice (cf. Lemmetti & Pekkola 2012).

In his review, Stelzer (2010) does not find evidence for making this precise separation of principles: business, IT and EA principles seem often to be mixed. There seems to be no criteria to make differences between EA and IT principles. Several examples of enterprise-specific design principles and generic representation principles were found, but only a few generic EA design principles. This finding strengthens EA as enterprise and context specific domain, but may also indicate a limitation of Stelzer's review (the concept of "standard" was not included in his research) or a common tendency to keep generic EA design principles as implicit constraints (e.g. financial limits) and not to make those as explicit architecture principles. Process and socio-economic goals and constraints should be made more visible parts of architecture principles to capture people and values of enterprise as complex socio-economic systems (Chattopadhyay 2011, 22). Haki and Legner (2013) have distinguished meta-principles from non-principles to clarify EA principles' roles, application and usefulness in practice. But, in spite of the early finding of EA principles by Richardson et al. (1990), both theory and practice of EA principles seem to require further clarification (Winter & Aier 2011). This may relate to contextual and cultural sensitivity of EA principles (Aier 2014).

EA base dimension

Greefhorst et al. (2006) have reviewed 23 architectural frameworks while seeking generic base dimensions for architectural descriptions defined as follows (p.109):

> *An architectural dimension is a criterion to partition an architectural description into a set of segments, where each segment is identified by a unique value within a list of values associated with the dimension.*

Greefhorst et al. (2006, 109) suggest that architectural descriptions should document the dimensions used and the segments they cover in an introductory chapter. Standardizing these dimensions and their segments in particular, in a specific organizational context prevents semantic obscurities and introduces a shared architecture terminology. As a result of their review, Greefhorst et al. (ibid.) have presented commonalities between architecture frameworks as base dimensions as listed in Table 3.

TABLE 3 Proposed architectural base dimensions (Greefhorst et al. 2006, 109).

Dimension	Description
Type of information	The topic of the information *(business, organisation, technical)*
Scope	The extent of the information covered *(industry sector, organisation, domain, system family, system, component*
Detail level	The amount of detail *(high, medium, low)*
Stakeholder	The target audience *(client, end-user, architect, analyst, developer)*
Transformation	The transformation phases that the architecture needs to cover *(current situation, short-term, medium-term, long-term)*
Quality attribute	The quality attribute that is being addressed *(functionality, reliability, usability, efficiency, maintainability, portability*
Meta level	The amount of abstraction *(instance, model, meta-model, meta-meta-model, meta-meta-meta-model*
Nature	The nature of the information *(policy, principle, guideline, description or standard)*
Representation	The way architectural information is represented *(formal, semi-formal, informal)*

For us, these architectural base dimensions offer a wide list to be elaborated and extended for EA base dimensions, which could be used as meta-data for EA documentation and architectural descriptions.

EA stakeholders and concerns

According to Chen et al. (2008), EA at a high level of abstraction is a means of communication with and among stakeholders: it allows representing stakeholders' expectations and concerns in terms of features of an enterprise system rather than documenting detailed requirements on functions, data or resources that will be specified in the later stage.

To achieve a holistic view of EA stakeholders, Niemi (2007) has charted 24 articles from high-quality academic databases. For basic definitions of stakeholder and stakeholder concern, Niemi (ibid.) adapted the IEEE1471 standard as follows: *Stakeholder is an individual, team, or organization with interests in, or concerns relative to, an EA. Concerns are interests related to the development of EA, its use and any other aspects that are important to one or more stakeholders. As seen in Table 4,* Niemi (2007) has compiled the list of EA stakeholder roles grouped as producers, facilitators and users from an EA literature review and focus group interviews.

TABLE 4 Classification of EA stakeholders (Niemi 2007).

Stakeholder	P	F	U	Rationale
Applications Development	●		●	Use architectures in application development. Could also produce architectural descriptions from their work area.
Architect	●	●	●	Carries out planning and development of domain architectures, can also maintain and update them. Use architectures in assuring architectural consistency and completeness.
Architecture Board		●	●	Carries out strategic management and governance of EA and EA work. May also use the product and impacts of EA work in e.g. assessment of EA success.
Architecture Group	●	●	●	Carries out EA planning, development, maintenance and operational management. Use architectures in assuring consistency and completeness of EA.
Board of Directors		●	●	Approves and has the business responsibility of EA work. Use EA work impacts in assessing the success of EA. In higher-maturity EA environments, could use the EA in e.g. decision-making.
Business User		●	●	Use the products of EA work in carrying out their daily work. Could also provide business requirements for EA work.
Competitor / Other Company			●	In special cases, may use the organization's EA and its impacts (if available) in their own EA work, for e.g. benchmarking.
Customer	●	●	●	Compliance between organization's and its customer's EA may be required. Therefore, a two-way relationship between their EA work processes might be needed. Moreover, customers could facilitate EA work with their needs and views, or even directly sponsor EA work.
Development Project Group	●		●	Either carry out architectural planning and development in the project area, or be guided by EA for assuring compliance between project results and EA.
Enterprise	●	●	●	In the enterprise, EA planning, development, management and maintenance are carried out, as well as the EA is used.
Enterprise Architect	●	●	●	Carries out EA planning and development, can also maintain and update domain architectures. Use architectures in assuring architectural consistency and completeness.
Evaluator			●	Use EA in assessment.
ICT Maintenance			●	Use architectures in ICT maintenance.
ICT Operations			●	Use architectures in ICT operations.
ICT Organization	●	●	●	Use architectures in e.g. ICT maintenance and operations. May also produce and maintain architectures. In some organizations, the whole EA-function may be situated under the ICT organization.
Internal Comms.			●	Use products and impacts of EA work in communication.
Investment Board		●	●	May approve investments related to EA work and use products of EA work in assessing investments.
Legislator	●	●	●	Carry out architectural planning, development and facilitation in the form of e.g. reference architectures and standards. Use products and impacts of EA work for feedback.
Manager / Management		●	●	May support and sponsor EA work in their areas of responsibility. In higher-maturity EA environments, could use the EA in e.g. decision-making.
Owner		●		Approves EA work via the board of directors.
Partner	●	●	●	Consultants and other partners may guide or carry out EA planning, development and maintenance in the organization. In the same sense, the organization may provide EA work or work products to partners.
Program Management Office		●	●	May carry out high-level management of projects related to EA, and use products of EA work in e.g. assuring EA compliance of project results.
Project Manager	●		●	Either manage architectural planning and development in the project area, or take into account EA for assuring compliance between project results and EA.
Project Steering Group		●		May require a project to produce architectural descriptions from the project area and thus facilitate EA work.
Public				Typically are not interrelated with EA or EA work.
Research & Design		●	●	Use EA work products for maintaining EA compliance in R&D. Could facilitate EA work with new ideas and research contacts.
Security			●	Use architectures in assuring security.
Sponsor		●	●	Sponsors and supports EA work by e.g. providing resources. Use EA work impacts in assessing the success of EA. Could also use EA in e.g. decision-making.
System Development	●		●	Use architectures in system development. Could also produce architectural descriptions from their work area.

Table key: P = Producer, F = Facilitator, U =User

For our study, this EA stakeholder list gives an initial actor list, which could be applied for analyzing EA communication, structuration and social structures of EA domain. But for our purposes this list may be too detailed. Buckl, Matthes, Schulz and Schweda (2010a) have tried to model a framework between stakeholder concerns, which work indicates semantic and contextual challenges for communicating EA concerns.

4.1.3 Architecture standards

During the last ten years, enterprises, architecture frameworks and other standards have been rapidly evolving. For example, ISO42010 (ISO/IEC 2007) evolved from IEEE1417 (IEEE 2000) in order to set updated guidelines for architecture descriptions of software intensive systems. In the area of standards, ongoing efforts attempt to reconcile and eliminate gaps and overlaps between various related standards (such as ISO15288 – systems lifecycle processes and ISO12207 – software lifecycle processes) using different terminology and levels of abstraction due to historic and other reasons. (Bernus & Noran 2010)

While discussing architecture standards, it is quite difficult to distinguish the border between various architecture domains. Standards seem to give quite neutral ground for defining EA as a socially structured shared object. But as we already have observed, current architectural standards share some common elements but also have some difficulties for finding a common language. Ylimäki & Halttunen (2006) found the definition inadequate and lacking sufficient complexity for applying the Zachman framework as a “de facto” standard for EA method engineering in practice. Chen et al. (2008) listed four approaches to develop standards on enterprise architectures:

- **ISO15704** – Requirements for Enterprise Reference Architecture and Methodologies is produced by the ISO TC184 SC5/WG1 standardization body. The scope of ISO15704 includes any type of manufacturing control mode. GERAM is described in the Annex to ISO15704. From our EA review article, authors Bernus and Noran (2010) have been participating in producing the original EA meta-model called GERAM, which has been used as basis for ISO15704 (2000).
- **EN/ISO I9439** – Enterprise Integration – Framework for Enterprise Modeling has been developed on the basis of a European pre-standard ENV 40003 elaborated at the beginning of the 1990s by CEN TC310/WG1 standardization body. EN/ISO 19439 focuses on model-based and computer executable process monitoring and control. The EN/ISO 19439 is consistent with ISO 15704 and is considered an implementation of the requirements defined in ISO 15704.
- **IEEE1471** standard is concerned with ‘‘Recommended Practice for Architectural Description of Software-Intensive Systems-Description’’. This recommended practice addresses the activities of creation, analysis and sustainment of architectures of software-intensive systems, and the recording of such architectures in terms of architectural descriptions.
- **ISO10746 is** also known as the Open Distributed Processing Reference Model, (RM-ODP), which was a joint initiative of ISO and ITU-T to develop a generic architecture for Open Distributed Processing (ODP).

According to Chen et al. (2008), although considerable effort has been spent to develop standards for enterprise architectures, none of the four approaches presented above has reached a sufficient maturity to be recognized and accepted in industry. There was no collaboration between the three groups (ISO TC184/SC5, ISO/IUT-T and IEEE) elaborating the standards. Even if it seems difficult to merge these standards, it is nevertheless necessary to establish mapping between them in order to achieve certain interoperability between models and systems built using these standards (Chen et al. 2008). Bernus and Noran (2010) describe a possible way forward in the evolution of GERAM and ISO15704 by proposing an enhanced and more formal description of the artifacts involved and their relationships, including some extension to show the relationship to ISO42010. Figure 8 presents the changes in a meta-model created using a UML class diagram with combined AS-IS/TO-BE state of affairs. Therefore, the notes attached to elements are crucial to the understanding of the meta-model as they show whether an element exists in the current version of GERAM 1.6.3 and whether that element is to be added / removed / kept in the next version (GERAM 2.0). The use of UML and specification of all multiplicities assists the formal representation of the relation between artifacts. (Bernus & Noran 2010)

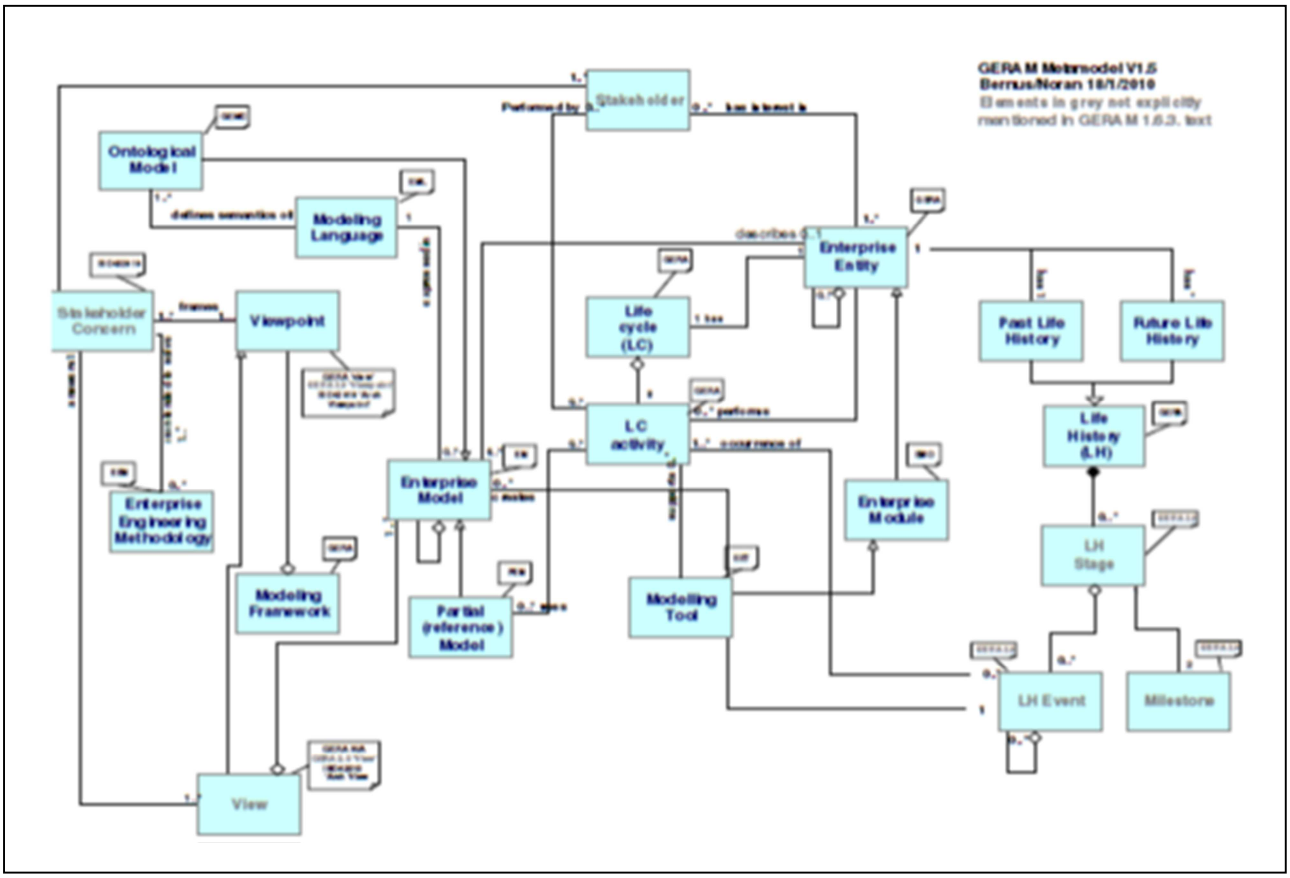

FIGURE 8 GERAM 2.0 (Bernus & Noran 2010, 60).

For our study, the GERAM evolution version seems to include important concepts of stakeholder, stakeholder concern and view. Perhaps these concepts are added to GERAM from software/application architecture frameworks, which mean that both GERAM and our study can really benefit from this framework evolution towards better human and organizational modeling capability. From the previously mentioned architecture standards, ISO15704 and IEEE1471 seem to be defined as generic models for architectural abstraction, whereas ISO10746 and EN/ISO19439 seem to be defined and positioned more in detailed technical IT process levels. Thus this finding is in line with our previous observation regarding EA language differences and explains why Schelp & Winter (2009) found the EA understanding of Bernus et al. (2003) to be different from the other EA language communities. Already, rough comparison between ISO15704 and IEEE1471 makes it clear that ISO15704 and the conceptual model of GERAM are designed to capture enterprise-level architecture models and several frameworks. IEEE1471 is by design system and software-oriented, which makes it more applicable at application-level. This kind of architecture standard comparison is not meaningful for our purposes to find commonalities and attributes for EA as a shared object between EA and IT domains. But as such this EA meta-review has shown the immature status of EA research and theoretical difficulty of EA from an IT standardization perspective.

According to our research question, we should try to avoid these EA technical layers and study EA from social perspectives. For our work and EA communities these standards can give common definitions and thus create shared language for both the EA and IT domain to communicate about EA as a shared boundary object. Also, from the ISD perspective, the EA research practitioners could benefit from EA standardization as a form of more formalized methods for EA development. We accept and apply the role of formalized method into EA System development and maintenance work, as in any ISD work, follows (Fitzgerald, Russo & Stolterman 2002, 90):

- **The rational role of the EA method** may reduce the complexity of EA system work, facilitate EA project management and control, and improve division of labor, systemization of the EA development knowledge and standardization of the EA system development process.
- **The political role of the EA method** may contribute to professionalizing EA work, help to promote the EA team to a more proactive role in strategy formulation; act as comfort, confidence and audit trail factor for decision-making; and finally provision of power-base for EA method champions.

While applying ISD formalization pressures from Fitzgerald et al. (2002, 93) into EA work, the desirability of ISO-certification may increase in some organizations the need for applying EA standards. In other organizations and countries, governmental development activities and legislation have been promoting EA Frameworks as standards for EA development.

4.1.4 EA Frameworks

In this subchapter, we will shortly review EA Frameworks (EAF) as formalized methods for EA development. TOGAF 9 (The Open Group 2009, 7) defines architecture framework as follows:

> *An architecture framework is a foundational structure, or set of structures, which can be used for developing a broad range of different architectures. It should describe a method for designing a target state of the enterprise in terms of a set of building blocks, and for showing how the building blocks fit together. It should contain a set of tools and provide a common vocabulary. It should also include a list of recommended standards and compliant products that can be used to implement the building blocks. (The Open Group 2009, 7)*

Cane and McCarthy (2007, 437) define EAF to "*provide a basis to systematically document and manage the information technology assets of an organization*". Competing architecture frameworks have been developed, adapted and enriched to model and reflect the challenges of changing enterprises (Bernus & Noran 2010). This competition between different enterprise models, EAFs and software/application architecture frameworks has been causing difficulties to achieve a clear understanding of the main purpose and domain covered by each model and framework. In our study, we will utilize the terms model, framework and EAF as synonyms for all attempts at systemic and holistic EA modeling.

The variety of frameworks is broad. Some frameworks contain their own taxonomy/meta-model, creating a common language for architecture descriptions. Some frameworks contain matrix, matrices or cubes for creating, managing and analyzing architectural descriptions. Some frameworks also contain a process model or method for producing architectural descriptions for frameworks. Bernus and Noran (2010, 57) have listed several proposals as early examples of frameworks including Information Systems Framework (Zachman 1987) and GERAM. In the 1990s, there were some early signs of the growing EAF chaos. Later, the competition and comparison between frameworks has become a typical way to develop and study the growing EAF domain. Noran (2003) mapped six EAFs onto GERAM. Tang, Han and Chen (2004) have compared goals, inputs and outcomes of six EAFs. Urbaczewski and Mrdalj (2006) have compared five EAFs by stakeholder views/perspectives, by abstraction level and by System Development Life-Cycle/SDLC phases. Pulkkinen (2008) has used EAF views to compare 16 different EA process models. Greefhorst et al. (2006, 107) reviewed 23 EAFs with the following observations:

- They use different terms for similar aspects, and similar terms for different aspects (for example: the term "business" in IFW vs. TOGAF).
- They often define terms only informally making it difficult to demarcate boundaries clearly (for example: border between conceptual and logical level).

- They often do not name dimensions explicitly, leaving their interpretation up to the reader (an example is the March framework).
- They sometimes do not distinguish clear values within the dimensions, hindering effective communication (an example is the Evernden Eight that leaves the exact content of all dimensions up to the reader).
- They often have slightly different sets of values for particular dimensions (for example the IAF “design phases” vs. Zachman “perspectives” dimension).
- They sometimes have dimensions with values that do not have a clear relationship, which makes it hard to understand the dimension altogether (take for example the “special viewpoints” dimension in IAF).

In our small sample of 10 EA review articles, we can find 28 separate frameworks mentioned. TOGAF seems to be the most popular with 8 references, followed by Zachman with 4 references and C4ISR/DoDAF with 3 references. These three most often cited EAFs in our EA meta-review could be compared as Urbaczewski and Mrdalj (2006) did in their EAF comparison. But, typically, EAF comparisons are snapshots of the current EAF status, which offers neither an indication of the changes or relative position of the products, nor their social structuration for EAM.

In the original Zachman’s (1987) IS Architecture framework, there were six generic models, which were named in building/information system analogy as “Ballpark/scope+ objectives”, “Owner’s representation/model of the business”, “Designer’s representation/model of the information system”, “Builder’s representation/technology model”, “Out-of-the-context representation/detailed description”, “Machine language representation/machine language descriptions” and “Product/information system”. Thus this language had good fit with physical products, computers and technical artifacts. But when Zachman discusses about owner’s representation, he makes an analogy between owner and user (1987, 286), which creates socially quite a gap and trap into this model. Communication-wise there is also another gap and trap that Zachman (1987, 291) reports in conclusions: *IS architecture is relative, it depends on what you are doing, thus there are several, additive and complementary architectures instead of one single architecture*. Socially this framework seems to be somewhat limited, but at the same time leaves plenty of freedom to apply in different contexts and situations (see e.g. Ylimäki & Halttunen 2006).

In the Sowa & Zachman (1992) version of this model, the ISA framework perspectives were named “Planner”, “Owner”, “Designer”, “Builder” and “Subcontractor”. In the textual explanation, the user perspective has vanished, although the owner is expected to live with the daily routines of the business (Sowa & Zachman 1992, 592). The sixth perspective from the original 1987 version called “Product/information system” has been changed to “Functioning System”, which has been omitted for all the actor related perspective descriptions (Sowa & Zachman 1992, 592). Urbaczewski and Mrdalj (2006, 20) have translated the sixth view that was originally called "Product" *from the standpoint of an information system to "user" view and therefore, the functional enterprise*.

Organization-wise DoDAF (2010) V2.0 covers all six roles of planner, owner, designer, builder, subcontractor and user called as worker. DoDAF includes predefined instructions for manager, architect and developer roles. In addition to these, there is also customer perspective included. DoDAF includes these views and flexible viewpoints, which can be modified based on Agency culture and needs. Thus DoDAF may be technically the most advanced EAF while socially this may be quite difficult to follow. In the military context organizational culture is harmonized, and this EAF might be seen as a rule, which must be obeyed. But this EAF is a very domain specific and highly technical approach, which may make DoDAF quite complex to implement.

TOGAF 9 (The Open Group 2009) argues that reason to develop EA is that key people have concerns that need to be addressed by the IT systems within the organization. Such people are commonly referred to as the ''stakeholders'' in the system. The role of the architect is to address these concerns by identifying and refining the requirements that the stakeholders have, developing views of the architecture that show how the concerns and the requirements are going to be addressed and by showing the trade-offs that are going to be made in reconciling the potentially conflicting concerns of different stakeholders. Without the enterprise architecture, it is highly unlikely that all the concerns and requirements will be considered and met. Thus TOGAF 9 seems to enable social structuration elements. But for stakeholder perspectives, TOGAF 9 may need more life-cycle orientation from EA System maintenance and EA domains. Architecture principles could also benefit from stakeholder component, which could add visibility to root-cause analysis and ownership of an architecture principle.

We agree that adding user view to the Zachman Framework (ZF) is an important addition, but we would further extend this with customer view. We argue that user and customer perspectives are relevant extensions for improving social structuration. Because of self-service and e-Business systems, customers are increasingly users of the enterprise systems and thus they should and will benefit for improvements in Enterprise Architectures. In theory, this extension enables more possibilities for users and customers to contribute in EA modeling and thus improves EA coverage from business enterprises to public organizations. Adding users and customers into EA models, moves EA thinking and EAM towards a socio-technical theory stating that human and organizational outcomes could only be understood when social, psychological, environmental, and technological systems are assessed as a whole (Trist & Bamforth 1951; Griffith & Dougherty 2002, 205) Furthermore, if the business model is changing towards customer integration, then the AS-IS version of EA includes employees as internal users and the TO-BE version of EA might need improved communication and analysis from a customer view. Thus customer requirements and expectations as becoming self-service users of a system could be documented into the customer view. Jeston and Nelis (2008, 195) argue that consumers are becoming more demanding with respect to delivery time and customer service, which should be improved by increasing process and systems integration. Adding a consumer view into EA emphasizes a business network view for end-to-end customer processes, which supports our view to change EA development towards external business and process development related change management. Smolander and Rossi (2008) have documented issues with stakeholder conflicts for e-Business system development, which includes challenges for the EA modeling process. In their case study, they found social conflicts from historical inertia, changing markets and changing organization (Smolander & Rossi 2008, 31), which supports our expectations for EA management to include cultural aspects to support knowledge and change management for business and process development.

4.1.5 EA project and processes towards EA management

In this sub-chapter, we will continue our EA meta-review to see what kind of EA project and process support evidence can be found from those academic sources. Three out of ten EA reviews in our EA meta-review discuss EA project and processes: Radeke (2010) and Winter et al. (2010) call it "EA Management", and Lucke et al. (2010) call it "Enterprise Architecting". Lucke et al (2010) selected the TOGAF 9 based Architecture Development Method (ADM) as their EA process model for their study. In TOGAF 9, ADM is illustrated with Figure 9.

FIGURE 9 ADM process model (The Open Group 2009, 54).

ADM includes the same process for both an EA development project and for the following EA maintenance work. The EA use perspective is quite limited in TOGAF. While analyzing existing EA literature using the ADM process model, Lucke et al. (2010) did identify 73 EA issue codes categorized into EA issue hierarchy in Figure 10.

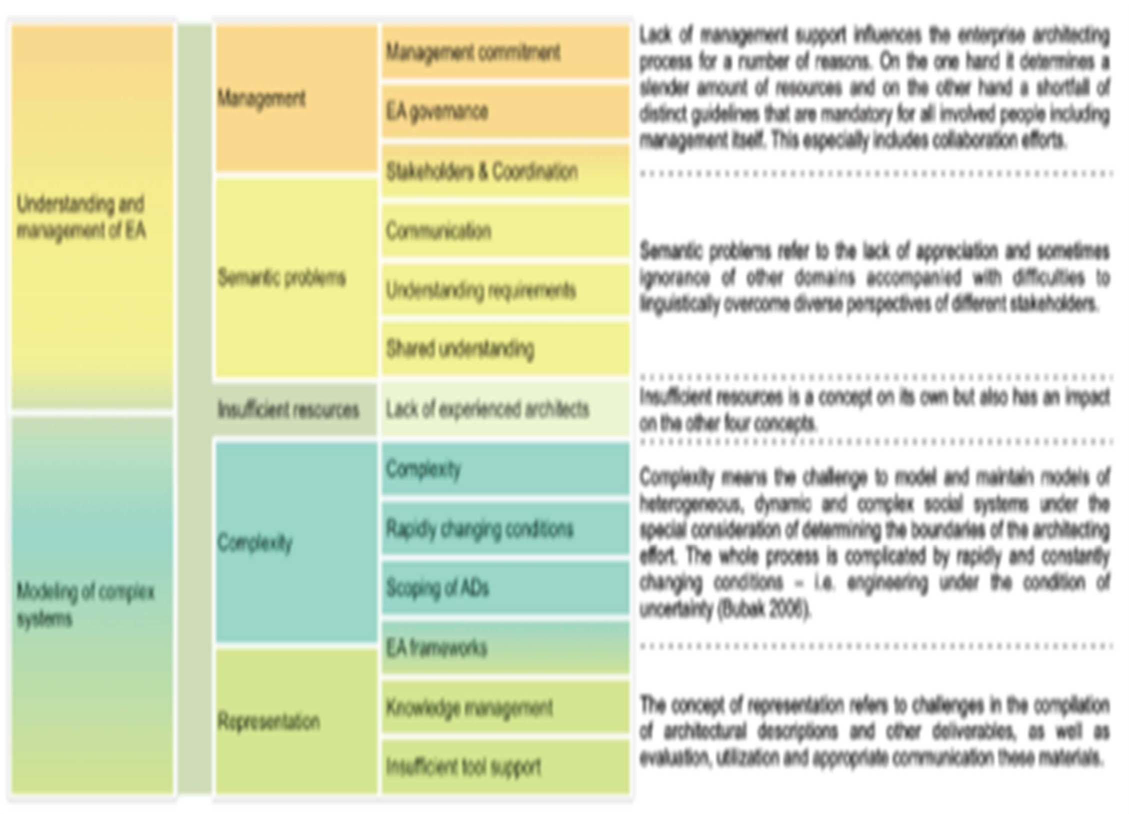

FIGURE 10 Issue hierarchy for Enterprise Architecting (Lucke et al. 2010, 284).

These EA issues seem to be relevant for both the EA project and maintenance phase. EA management can be found as its own issue group, including EA governance, management commitment, stakeholders and coordination. Issues of EA use seem to be related to complexity, representation and semantic problems.

Winter et al. (2010) pursue EAM as a continuous management function that needs to be established similarly to other enterprise-level management functions (cf. Hafner & Winter 2008). Winter et al. (2010) have reviewed several EAM methods to *provide detailed overview focusing on the method constituents of an EAM function, both from the perspective of prominent EAM approaches and as experienced in practice.* Their study seems to mix EAM and EA frameworks. Radeke (2010) defines EAM to mean the general process of managing, maintaining, and developing EA in a holistic and purposeful manner. Radeke (2010, 2) reviewed EAM literature to find EA theories that explain and predict (Gregor 2006, 628: theory type IV) or analyze (Gregor 2006, 628: theory type I) EAM implementation and usage phases. He found only ten articles that are trying to explain and predict, and 32 articles that are trying to analyze these implementation and usage phases of EAM. Radeke's collected findings are presented in Figure 11.

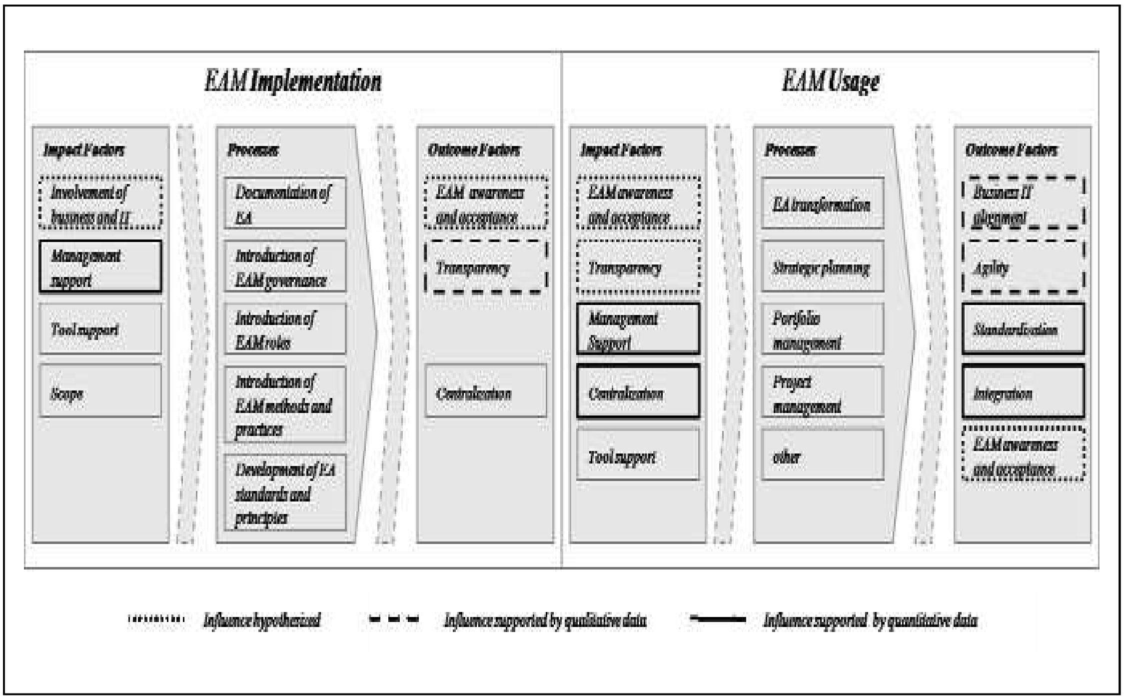

FIGURE 11 Consolidated EAM research contributions (Radeke 2010).

According to Radeke's (2010, 6) results, common processes for EAM implementation seem to be documentation of EA, development of EA standards and principles, and introduction of EA governance, roles, methods and practices. Common processes for EAM usage seem to be EA transformation, strategic planning, portfolio and project management, and some others, such as ICT management, security management or controlling.

When bringing this high-level system thinking into an EAM context, we refer to Lagerström et al. (2011), who have studied EAM's impact on IT success. They define EAM activities with the factors of existence of EAM, amount of time worked with EAM and maturity of EAM. In their study, Lagerström et al. (2011) make operational this factor of EAM existence with the age of the organizational function for EAM: all positive values of EAM function age in years were treated as indicators of EAM existence. Thus EAM as organizational function shows social structuration and organizational commitment to EA management and EA system development work.

4.2 EA use and potential benefits

According to Radeke (2010), common processes for EAM and EA use seem to be EA transformation, strategic planning, portfolio and project management, and some others such as ICT management, security management or controlling. Ross et al. (2006) has documented potential EA management benefits ranging from reduced IT costs, increased IT responsiveness, improved risk management to increased management satisfaction. This indicates that EA management processes could improve business efficiency. But this list continues with enhanced strategic business outcomes like better operational excellence, more customer intimacy, greater product leadership and more strategic agility (Ross et al. 2006). This indicates potential for EA leadership benefits for improving business effectiveness and change management.

Boucharas et al. (2010) have studied the potential benefits of EA. As a result of the systematic EA literature review, they have found 14 eligible studies which revealed the current state of the scientific and practitioner's literature concerning the potential benefits of EA. Their study has found 29 unique contexts within which EA has been found to deliver value, 100 unique benefits of EA, and 3 mechanisms that generate the value of EA. From these findings, Boucharas et al. (2010) have produced an EA Benefit Map, which groups potential benefits into Balanced Scorecard type of benefit categories for financial, customer, internal, and learning & growth perspectives. As the result of their study, Boucharas et al. (2010) observe that the majority of the EA benefits belong to the Learning & Growth (52%) and the Internal (30%) perspectives. The Financial Perspective ranks third (16%), and the Customer Perspective appears extremely underrepresented (2%). From the 52 EA Benefits of the Learning & Growth Perspective, almost two thirds belong to the Information Capital Category (60%), exactly one third to the Organizational Capital Category (33%), and just 8% to the Human Capital Category. From the 30 Internal Perspective EA Benefits, half belong to the Innovation Processes Category, almost all of the other half (47%) to the Operations Management Processes Category, only one belongs to the Customer Management Processes Category (3%), and none to the Regulatory & Social Processes Category. (Boucharas et al. 2010)

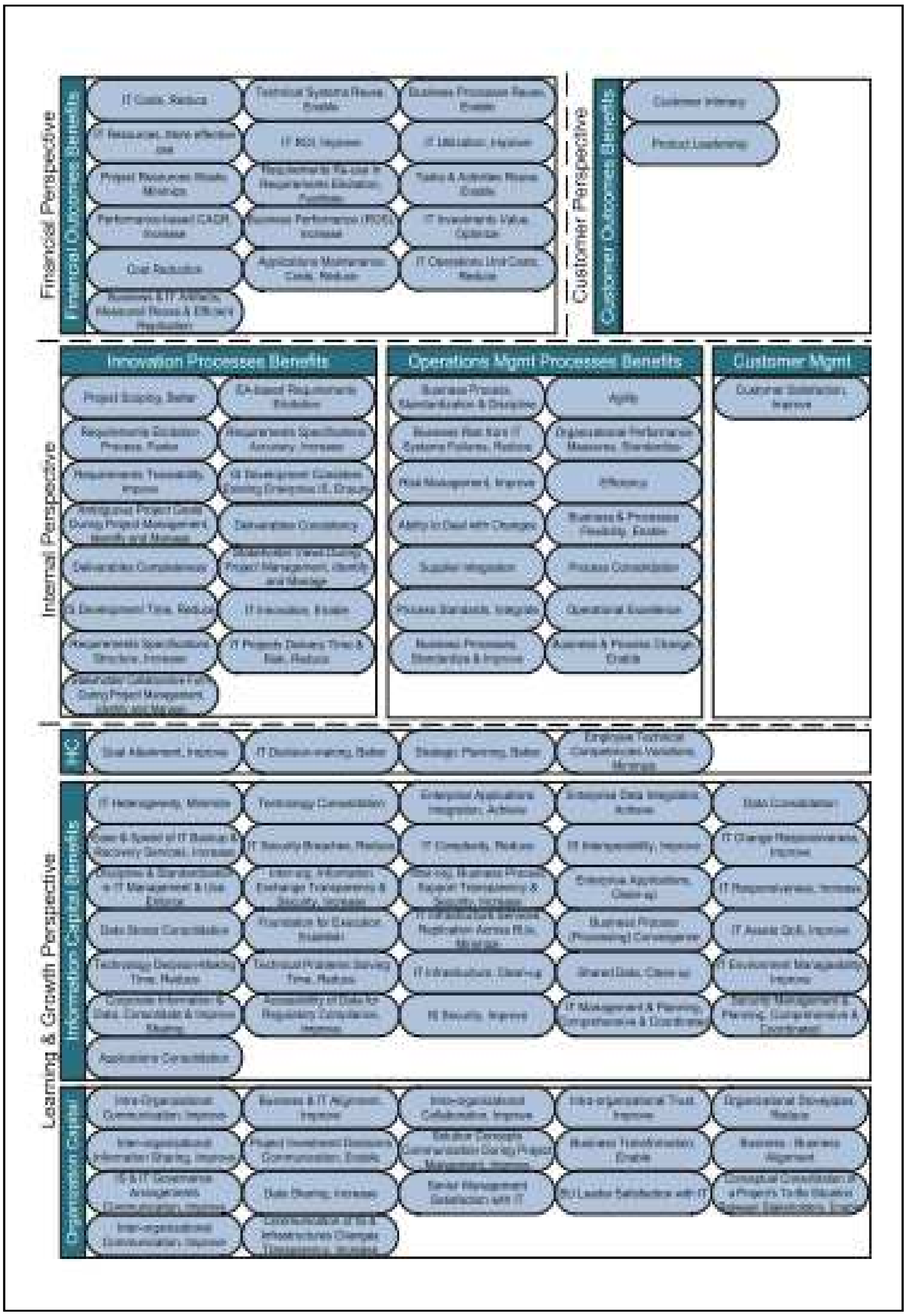

FIGURE 12 EA benefit map for potential EA benefits (Boucharas et al. 2010).

This illustration displays potential EA benefits found from qualified EA literature. For our purposes, this benefit map should indicate potential sources of EAM synergy for business, process and IT development. Knowledge management related learning and growth perspectives seem to offer not only major benefit potential for EA, but also the internal process perspective includes remarkable possibilities for process and capability development for change management. But benefits from EAM are not evident. Niemi and Pekkola (2009) have adopted IS Success Model from DeLone and McLean (1992; 2003; 2004) for clarifying EA benefit realization process. Lange et al. (2012, 4234) have extended their EA benefit realization model with EA cultural aspects for capturing people and soft aspects of EA, which we call the social dimensions of EA. Lange et al. (2012, 4236) divide EA culture into EA leadership commitment to ensure priority and resources, high awareness of EA among all EA stakeholders and common understanding of EA for both business and IT employees. This research evidence strengthens our understanding about EA leadership as a shared agenda for managing business, process and IT development related knowledge, changes and business transformations.

Applying DeLone and McLean (1992, 61), we can say that EA success, net benefits or EAM effectiveness should be studied as a dependent variable and measured in practice as output from EAM investments. The EA success process has been found to be very complex, but it has been useful in initiating planning principles for practical use of EA concepts and when initiating discussion on EA measurement and improvement (Niemi & Pekkola 2009). EAM benefits seem to require careful EA management and leadership for benefit realization. GAO (2003, 8) requires that at the highest level of EA maturity, an organization tracks and measures EA benefits or return on investment, and adjustments are continuously made to both the EA management process and the EA products. Ballengee (2010a, 50) states that the greatest value of practicing EA comes from the broad-ranging way of thinking throughout the enterprise, not just in IT:

- Knowledge of the business, its value chain, and how value is created.
- Understanding of how information technologies can be applied throughout the value chain.
- Communication between IT and the business using a commonly understood language.
- Awareness of potentially disruptive information technologies impacting the business itself, its customers or suppliers.

Ballengee (2010a, 51) continues that the benefits of the EAM process exceed the benefits of EA products at a strategic level because it closes the cultural and knowledge gaps between business and IT. Ahlemann et al. (2012b, 241) discuss how EAM should be made useful to people by addressing stakeholder needs and developing EAM methodology in participatory development mode with stakeholders. They suggest to show “quick wins” from an EAM initiative and to develop persuasive business cases for selling EAM benefits to the users and stakeholders. Quick wins seems to address EAM at an operational level. Makiya (2012, 173) expects that during EAM introduction financial benefits are hard to demonstrate but that the EA ability to contain both complexity and costs may be worth investing into EA (Makiya 2012, 139). GAO (2003, 25) states that “*The EA is a strategic asset and, as such, should be viewed as an investment in the future*”. Thus business case development requires more tactical and strategic understanding of the business strategy, organizational context, capabilities and EAM maturity. Therefore, we will next review several EA maturity models which may be used for understanding various sources and levels of potential EAM benefits.

4.3 EA maturity models

EA management seems to be an emergent means for improving organizational capability. But as with any capability, EA management also requires practice and wider organizational integration to business and process operations for achievement of the increasing benefits of EA maturity. Salmans (2010, 91) categorizes EA maturity models into three different groups based on their contribution as descriptive, prescriptive or comparative tools.

In our EA meta-review, several papers comment on EA maturity models, but quite surprisingly the benefit-focused paper by Boucharas et al. (2010) did not mention EA maturity at all in their study. Greefhorst et al. (2006) includes EA maturity as a potential source for the base dimension for EA Transformation, a dimension which uses change in time as the criterion and distinguishes the current situation from short-term, medium-term and long-term situations, including the transitions between them. A slightly different way to define the EA Transformation dimension is to not refer to specific moments in time but rather to characteristics of the situation that can exist in time, like the levels in the original Software Engineering Institute's Capability Maturity Model (SEI CMM), the stages of which are called "Initial", "Repeatable", "Defined", "Managed" and "Optimized" (Greefhorst et al. 2006). SEI's (Software Engineering Institute 2011) integrated maturity model CMMI V1.3 is defined as follows:

> *"CMMI is a process improvement approach that provides organizations with the essential elements of effective processes that ultimately improve their performance. CMMI can be used to guide process improvement across a project, a division, or an entire organization. It helps integrate traditionally separate organizational functions, set process improvement goals and priorities, provide guidance for quality processes, and provide a point of reference for appraising current processes."*

According to the Software Engineering Institute (2011) CMMI can be applied to three different areas of interest: product and service acquisition, product and service development, and service establishment, management, and delivery. From these CMMI variants EA system development and use are closest to CMMI service establishment, management and use. Since 1993, CMM (Software Engineering Institute 2010c) has been evolving its' maturity model, which in the current Ver1.3 contains the following capability and maturity levels presented in table 5.

TABLE 5 CMMI maturity levels (Software Engineering Institute 2010a).

Level	*Continuous Representation Capability Levels*	*Staged Representation Maturity Levels*
Level 0	Incomplete	
Level 1	Performed	Initial
Level 2	Managed	Managed
Level 3	Defined	Defined
Level 4		Quantitatively Managed
Level 5		Optimizing

In this CMMI (Software Engineering Institute 2010a, 23), the capability and maturity level comparison difference between columns is explained as follows:

- The continuous representation focuses on process area capability as measured by capability levels applied to an organization's process improvement achievement in individual process areas. These levels are a means for incrementally improving the processes corresponding to a given process area. The four capability levels are numbered 0 through 3.
- The staged representation focuses on overall maturity as measured by maturity levels. Maturity levels apply to an organization's process improvement achievement across multiple process areas. These levels are a means of improving the processes corresponding to a given set of process areas (i.e., maturity level). These five maturity levels are numbered from 1to 5.

This CMMI for Services model contains 24 process areas, and each process area as part of the model can be analyzed using continuous representation capability levels on a scale from 0 to 3 with the corresponding labels "Incomplete", "Performed", "Managed" and "Defined". The overall maturity level for all 24 processes can be analyzed using staged representation of maturity levels on a scale from 1 to 5 with the corresponding labels "Initial", "Managed", "Defined", "Qualitatively Managed" and "Optimizing".

Niemi (2007) discusses that the stakeholders could be classified differently depending on the phase of the EA program: the top management and the board of directors may act as facilitators in the initial phases but begin to use EA as its maturity and quality increases. Radeke's (2010) review regarding contributions to theory for analysis finds Ross (2003) and her colleagues contributions by identifying four architectural maturity stages and associated EAM practices and competencies that are gained when moving from one stage to another, as presented in Figure 13.

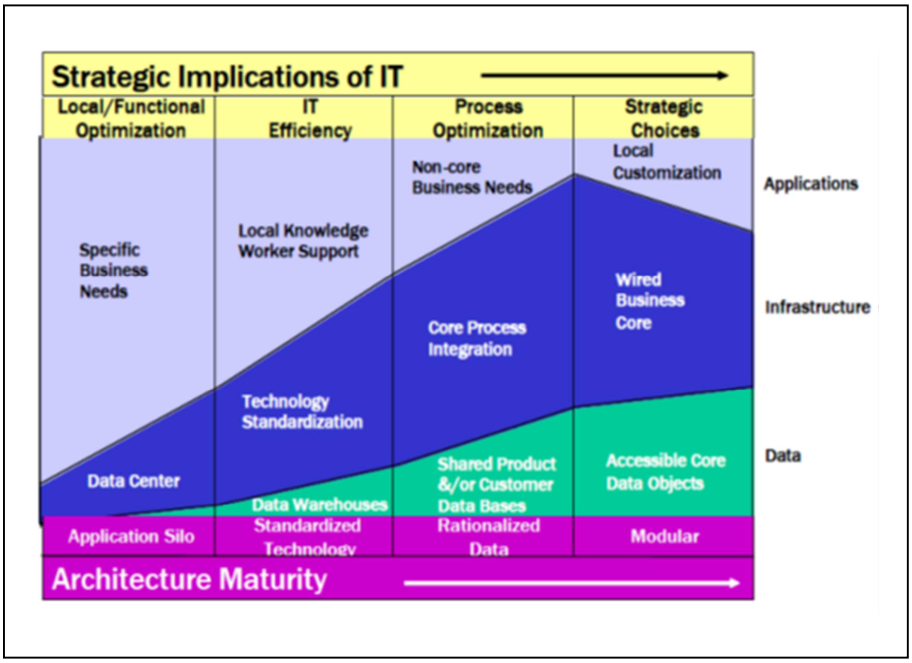

FIGURE 13 Resource allocations across architecture stages (Ross 2003).

In Ross' (2003) 4-stage architecture maturity model, stages are named from EA perspective as application silo, standardized technology, rationalized data and modular. Ross has produced several papers and versions of this 4-stage architecture maturity model, and, along with the studies, these stage-names have been evolving:

- In a 2006 version, Ross calls the architecture maturity stages business silos, standardized technology, optimized core and business modularity. Respective names from the business side for these 4 stages are in this version local/functional optimization, IT efficiency, operational efficiency and strategic agility.
- In seminal book, Ross et al. (2006, 182-186) already indicate the 5th emergent architecture maturity stage called "*Dynamic Venturing*", which means that IT enables seamless merging with partners' systems aiming for ROI from new business ventures and causing organic reconfiguration.

Salmans (2010, 93) calls this model (Ross 2003; Ross et al. 2006) MIT's Center for Information Systems Research model. Riihinen (2006) also has a similar 4 stage EA maturity model, which includes stages called "Autonomy", "Standardization", "Optimization" and "Controlled Flexibility", which evolve from the local, business unit level of EA independence to the enterprise level of shared services and business component – based platform configurations. Based on the evolving management practices, the stages for Ross et al. (2006) could also be called "EA as project practice", "EA as IT practice", "EA as business practice", "EA as strategy" and finally "EA as business transformation". Perko (2008, 82) discusses similarities between software architecture maturity based SEI CMM and other commonly known frameworks for assessing EA maturity:

- NASCIO EA Maturity Model (NASCIO EAMM) developed by the National Association of State Chief Information Officers (NASCIO 2003).
- A framework for Assessing and Improving Enterprise Architecture Management (EAMMF) developed by the U. S. General Accounting Office (GAO 2003).
- IT Architecture Capability Maturity Model (IACMM) developed by the United States Department of Commerce (2003; revised ver. 1.2./2007 available)
- OMB Enterprise Architecture Assessment Framework developed by the United States Office of Management and Budget (OMB 2005).
- Extended Enterprise Architecture Maturity Model (E2AMM) developed by the Institute For Enterprise Architecture Development (IFEAD 2006).

According to Perko (2008, 82), the earlier EA maturity models (NASCIO, EAMM, EAMMF and IACMM) have focused on EA development; thus, their highest 5th stage is EA use, and like in EAMMF the highest EA stage is called *"Leveraging the EA to Manage Change"*. Later EA maturity models seem to have their focus more on EA use, which indicates that like EA frameworks EA maturity models also seem to evolve from a project mode to more standardized business practices. As an example from these EA use oriented maturity models, Perko (2008, 84) presents OMB (2005) EA Assessment Framework, which includes six stages called "Undefined", "Initial", "Managed", "Utilized", "Result-oriented" and "Optimized". Thus it differs from the original 5-stage SEI CMM, which has also been evolving from software development towards a holistic process and quality development model. OMB (2009) EA Assessment Framework has been developing to drive performance improvements that result in the following outcomes:

- Closing agency performance gaps identified via coordinated agency strategic planning and performance management activities;
- Saving money and avoiding cost through collaboration and reuse, productivity enhancements, and elimination of redundancy;
- Strengthening the quality of agency investment portfolios by improving security, inter-operability, reliability, availability, solution development and service delivery time, and overall end-user performance;
- Improving the quality, availability and sharing of data and information government-wide; and
- Increasing the transparency of government operations by increasing the capacity for citizen participation and cross-governmental collaboration.

This indicates continuous improvements and strong benefit orientation inside EAAF development (OMB 2009). Perko's (2008, 86) EA maturity model analysis from service-oriented architecture (SOA) perspective indicates that the 4th stage of Ross et al. (2006) architecture maturity implies full SOA adoption, and at the 5th stage the enterprise is actively transforming itself into a service-oriented enterprise by improving the whole value chain and process performance beyond organizational borders. This finding is in line with Berg-Cross' (2008a) arguments that EA and SOA are complementary by nature: an enterprise-wide EA view can help with business semantics and a wider perspective, which enables increasing benefits from SOA deployment for process improvements, resource sharing and faster system development beyond organizational borders. A combined service-oriented EA (SOEA) framework is suggested and discussed by Haki and Forte (2010). Also MacLennan and Van Belle (2014) have found implications of the benefits of combined EAM and SOA practices.

The GAO (2003) maturity model, called the Enterprise Architecture Management Maturity Framework (EAMMF), presents EAM development stages with an EAMMF matrix of 5 stages and 4 critical success attributes (GAO 2003, 10). While enterprises at stage 1 are becoming aware of the value of an EA, they have not yet established a management foundation to develop EAM. Thus enterprises that do not fulfill EAM evaluation criteria at stage 2 are by default at EAM stage 1 called "Creating EA awareness". The following maturity stages are called (GAO 2003):

- Stage 2: Building the EA management foundation.
- Stage 3: Developing EA products.
- Stage 4: Completing EA products.
- Stage 5: Leveraging the EA to manage change.

Thus these EAMMF stages may be well aligned to our theoretical transition in our EA thinking from technical to social structuration as presented in Figure 5; they may be seen as EA maturity model for our EA study. Organizational EAM maturity in an EAMMF matrix from stage 2 to 5 is evaluated with 4 critical success attributes called "Demonstrates commitment", "Provides capability to meet commitment", "Demonstrates satisfaction of commitment" and "Verifies satisfaction of commitment" to EAM. Each of these attributes has 1-5 so-called "core elements", which are setting increasing organizational requirements when an organization is aiming at a higher stage of EAM maturity. This EAMMF maturity evaluation is very holistic at each maturity stage: if an organization fails in one EAM maturity attribute at a certain stage, its' evaluated EAM maturity is estimated to be at a stage which is totally met. Thus our EA leadership level seems to get theoretical support from EAMMF stage 5, where an organization head is expected to approve the current version of EA (GAO 2003, 24). This is explained in that "*such approval recognizes and endorses the architecture for what it is intended to be: a corporate tool for managing both business and technological change and transformation*". We think that this statement supports our thinking of EAM as a change management tool for business transformation. But when transferring EAM thinking from a public sector organizational context and governmental operations to an agile business development setting, process development and operational EA leadership add more integrated and flexible operations for private sector business development as well as for small and medium size (SME) organizations. EA maturity models indicate that EA system and services can and should be developed in stages. EA changes all the time for various reasons, but increasing benefits from EA initiatives seem to require systematic development of both project and process culture. CMMI seems to offer a generic process and quality development approach, which could also be applied to EA development for EAM. EAMMF supports our thinking of organizational EAM structuration for EA leadership. Ross (2003; 2006) supports our EA thinking about IT development for strategic agility. Ross et al. (2006) indicates seamless business partner integration for new business ventures and reconfigurations at the emergent architecture maturity stage. This supports our thinking of integrative EA leadership for transforming business models, value chain and technological ecosystem at business network level.

4.4 EA risks and social challenges

Every new technology has its' own risks, and the same applies to EA (e.g. Roeleven & Broer 2009, Zink 2009). We acknowledge potential practical risks of EA: over-engineering EA as technology (Jayashetty, Manjunatha & Kashyap 2004; Berg-Cross, 2008b) and underestimating human behavior in terms of change resistance (Mezzanotte et al. 2010). Jayashetty et al. (2004) have defined EA over-engineered: *if its deliverables far exceed the business requirements, thereby making it complex, more expensive, and difficult to maintain (e.g. pyramids of Egypt).* These practitioners are quite right that there is a danger of over-document AS-IS and TO-BE states of EA. Berg-Cross (2008b, 20), as an openly biased researcher for Service Oriented Architecture (SOA), discusses about this EA risk *like Ivory Tower work: an EA team produces nothing more than nice documents and diagrams which don't contribute to the overall benefit of the enterprise; EAs are too abstract and thus can be ignored; or when it starts to get detailed enough to be useful it is too complex and dense and teams get bogged down; it does not adequately represent the SOA model in its products [sic].*

Hauder, Roth, Matthes and Schulz (2013) have found that various organizational and situational EAM challenges, like "ivory tower syndrome", causing disparity in stakeholders' requirements and delivered EA products (Van der Raadt, Schouten & Van Vliet 2008), modeling for modeling's sake (Ambler et al, 2008) leading to produce of an over-sized EA model beyond the demand of any stakeholder (Buckl, Matthes, Neubert & Schweda 2009). Thus EAM seems to include situational and organizational risks of producing too complex models, which are difficult to communicate, understand and maintain. From lean management perspective EAM processes could produce waste, if EA products are not useful for the enterprise. But from knowledge, change and risk management perspectives EAM processes should produce enough documentation to ensure proper communication, coordination and knowledge transfer during systems life-cycle for all stakeholders.

The human aspects and social challenges of EA have been getting more attention in EA research. The role of subcultures seems to act as an intermediary factor, causing communication breakdowns during the Enterprise Architecture process (Niemietz et al. 2013). EAM seems to offer valuable informational support for enterprise transformations but shows weakness regarding information about individual actors, external environment, organizational culture, resistance and rituals (Labusch & Winter 2013), EA artifacts indicate knowledge transfer capability as a boundary object supporting communication and coordination (Abraham 2013).

Both EA and EAM definitions seem to be used as synonyms shifting towards enterprise transformation. EA is positioned as an instrument for coordinating enterprise transformation (Niemietz et al. 2013). Labusch and Winter (2013) discuss EAM support potential for enterprise transformations, i.e. fundamental changes. Hauder et al. (2013) have defined EAM as a means to plan, conduct and coordinate complex organizational transformations. Abraham and Aier (2012) acknowledge the same EAM potential but expect challenges when coordinating transformation between heterogeneous interest groups. Thus EAM theory development indicates a shift towards EA leadership practices of communicating and coordinating enterprise-wide changes.

4.5 EA review conclusion

EA seems to be a quite obscure domain between business and IT. EA can be layered in various ways, and each layer can be investigated from multiple perspectives. At the highest level of abstraction, Ulrich and McWhorter (2011, 55) have defined EA as a combination of Business Architecture (BA) and IT architecture; this composition emphasizes EA as an alignment mechanism between business and IT. According to this line of thinking, EA could be defined as a synonym for business IT alignment. But there seems to be not only several sources for semantic problems, but also a lot of potential benefits and areas of improving organizational performance and IT utilization. After reviewing some of the details of EA, we conclude our EA review with a high-level EA model example from Pereira and Sousa (2004, 1367) showing one example of EA structure, where Business Architecture (BA), Information Systems Architecture (ISA) and Technical Architecture (TA) are included as separate sub-architectures inside the EA structure. In this model, Information Systems Architecture includes Information Architecture (IA) and Application Architecture (AA) as sub-architectures, and part of the Technical Architecture is Product Architecture (PA), illustrated in Figure 14.

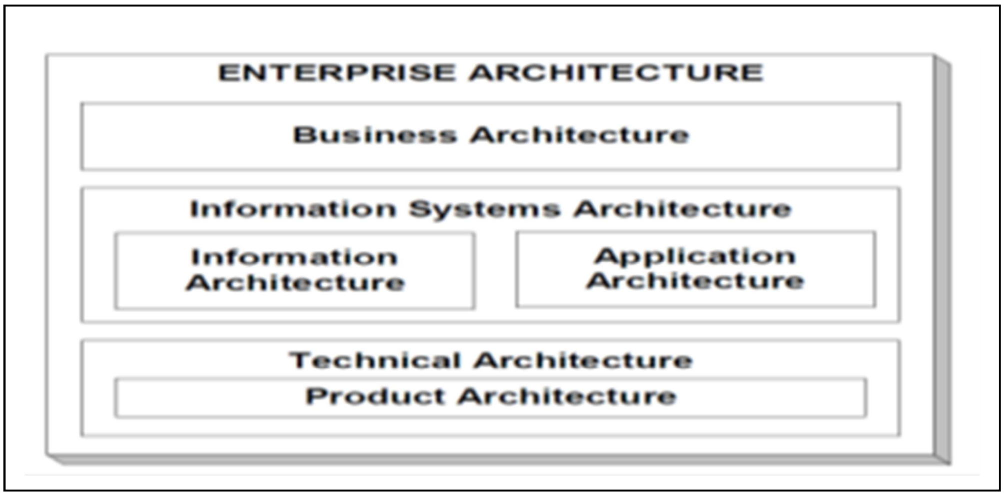

FIGURE 14 EA relationship model (applied from Pereira & Sousa 2004).

This EA relationship model from Pereira and Sousa (2004) is only one example of a potential EA component structure. This and other EA structures are quite controversial. For example, the "Information Architecture" (IA) term can be used separately without the EA context, and then IA itself can constitute a much larger domain than surrounding IS architecture (see e.g. Rosenfeld 2002). As discussed, there are plenty of ways and combinations for creating a EA system or component models. Versteeg and Bouwman (2004) discuss Business and Enterprise Architectures in a synonymous manner. They (Versteeg & Bouwman 2004) maintain that business architecture arranges the responsibilities around the most important business activities and/or the economic activities similar to business processes and process architecture. Applying a model from Pereira and Sousa (2004), we will divide aggregate business architecture into components called organization architecture, actor-network model, process architecture and something we call business model. Also, information systems architecture would benefit from adding conceptual systems architecture and solution architectures as own components into this domain. We think that technical architecture would be better if, instead of product architecture, this domain could be modeled into software, network, hardware and master data architectures. One could argue that these additional components could be subsets of previous higher level components, but for us these are important additions to increase social elements and enterprise-wide components into an EA model. Thus we provide an illustration for discussing enhanced EA components as presented in Figure 15.

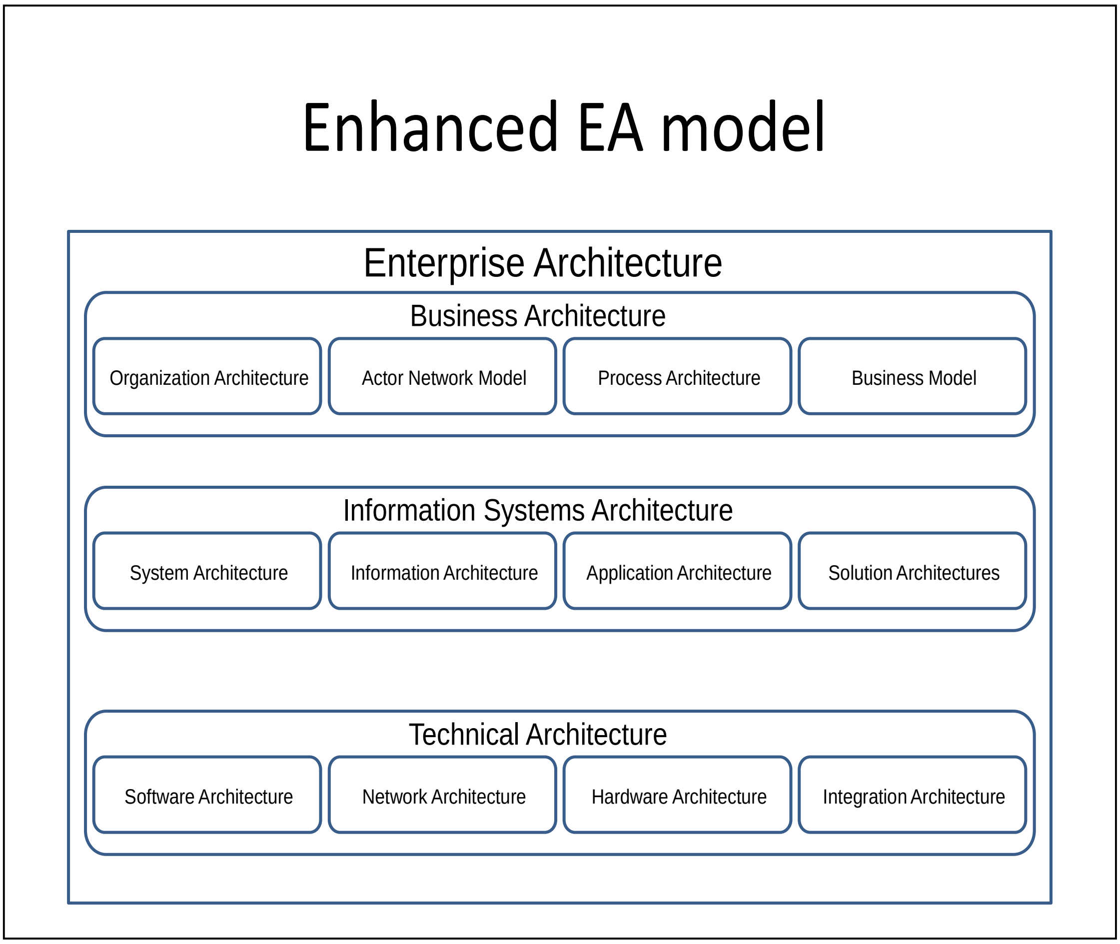

FIGURE 15 Enhanced EA model.

Thus, for us, it seems meaningful to conceptualize an enhanced EA model to contain social, informational and technical components, which are seen to function as a systemic whole. From this model, we can derive our own EA definition for this thesis: *Enterprise Architecture (EA) is a combination of social, informational and technical components, which are seen to function as a systemic whole towards human intentions.* EAM seems to be an emergent social structure leading to EA maturity and business benefits. Integration with business, process and IT/IS development seems to offer increasing benefits for knowledge and change management, but it also requires organizational structures and EA management practices above systematic EA development. Leadership, communication and change management skills from business are seen critical to business process architecture development (Jeston & Nelis 2008, 212), and these competencies would also be beneficial for EAM. Thus EAM seems to require more social structuration above technical EA layers. These social EAM layers will be discussed in the next chapter.

5 Rethinking EAM using social theories

In this chapter we will elaborate social theories towards socially structured EA and EA management. In Figure 1, we initiated our study setting, which states that social theories could improve EA theories for EA management. In this chapter, we will cover some social theories which we think could improve our understanding about social structuration of EA and EA management from the perspective of social theories as illustrated with the EAM star in Figure 16.

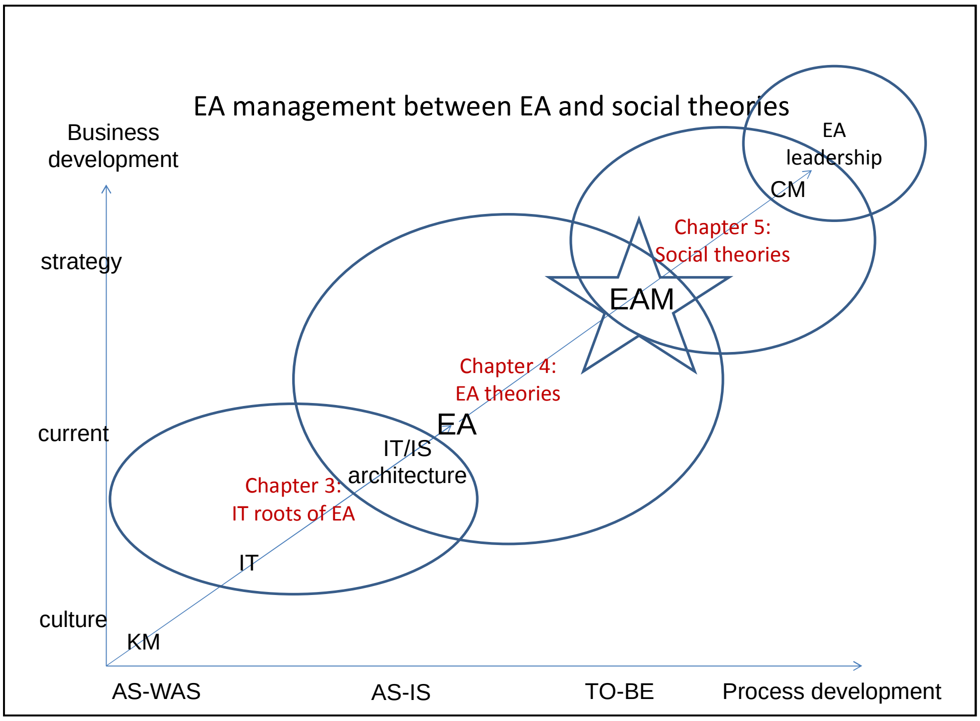

FIGURE 16 EA management between EA and social theories.

We will start from a technical perspective by shortly discussing generic challenges for combining IT/IS research and social theories. Then, in the sub-chapters, we will review prevailing approached for technology management research from IT/IS perspectives, which we will reflect in an EA context structured like Orlikowski (2010b). From technology and IT layers, we will move on to business and process views of EA and EA management. Then we will elaborate major socio-technical and social theories, which we think could inform us about the complex socio-technical phenomena called EA. When integrating IT, business, process and social perspectives of EA, we believe that we have covered sociomaterial theories related to EA management.

The major theoretical and scientific contribution of this chapter and study is accomplished by developing two frameworks: a Sociomaterial/substantial EA research framework (EA–framework) and an Integrative EAM research framework (EAM–framework). After setting theoretical and empirical study settings in chapter 6, these theoretical EA frameworks are tested in a case company setting in chapter 7.

5.1 Generic challenges for IT in social theories

The main problems when trying to understand how IT and social theories have been applied together are actually philosophical. Therefore, the combination of IT and social must be studied more in detail. In this philosophical inquiry into the essence of IT and social theories, we refer to Lee's (2004) concepts and thoughts about scientific thinking about social theory and the philosophy of IS.

Lee (2004, 10) argues that *'information systems' can mean the same as 'information technology', where both terms sometimes simply designate 'the computer'*. Lee (2004, 14) also continues that there is a large segment of information systems research that consists of behavioral studies of how people and organizations do and do not use, adopt, or diffuse information technology, where the studies do not account for the mutually and iteratively transformational interactions between the social system and the technological system. Indeed, in most of these studies the term 'system' or 'information system' appears to be interchangeable with 'information technology'. Thus this terminological confusion between IT and IS makes our inquiry into IT and social theories quite challenging.

Another challenge comes from the definitions of information in an IT/IS context. Typically, IT/IS research is more concerned about technology or systems than the content, structure, meaning or value of information that technology delivers. Zhang et al. (2011) have studied the concept of the IT artefact in IS research. Their study found five core IT artefacts, including hardware, operating and system software, application software, application content and auxiliary artefacts, which were studied from managerial, behavioral, economic and technical perspectives, mostly in an organizational context (Zhang et al. 2011). In this classification, our EA study could be seen as an auxiliary artefact in an organizational context, which we are studying from managerial, behavioral, economic and technical perspectives. But because EA is also a tool for managerial communication, it could also be studied from an informational perspective for strategy execution and change management at enterprise, business network, industry and ecosystem levels. In our case, the company systemic approach to strategy at Nokian Tyres can be seen as part of a business ecosystem that crosses a variety of industries (Moore 1996, 76): rubber, chemistry, manufacturing, tyre, consumables, automotive, transportation and service industries.

EA models contain their own domains for information, which should include high-level descriptions of logical business concepts, entities and relationships in some ER (entity-relationship), object or other data model. Simons et al. (2010, 131) application of Zachman's Framework in practice actually showed that an ER –diagram was the only practical tool for modelling data into the left-most column in Zachman's Framework. The rest of the Zachman's EA schema presented EA as a practical language and communication problem (Simons et al. 2010, 132). But in the IT and application architecture domain, this logical and conceptual business object world is highly fragmented and limited into separate entities and technical domains of structured and non-structured data storages. Boell and Cecez-Kecmanovic (2010) have studied attributes of information from the "knowledge-in-action" perspective in various separate domains of information science, information management, marketing, knowledge management, communication studies, and philosophy. They address the issue that, in contrast to typical hierarchical view of IT/IS layers of data-information-knowledge, the knowledge-in-action view of information sees information not as prerequisite for knowledge but as a specific subset of knowledge. Thus Boell and Cecez-Kecmanovic (2010, 4) suggest that from the sociomaterial perspective the nature of information (unlike data) is both a physical/material and semantic/discursive continuity between layers from technical to social, as presented in Table 6.

TABLE 6 Layers of information (Boell & Cecez-Kecmanovic 2010).

PHYSICAL WORLD LAYER	
physical existence	- information needs a physical carrier
EMPIRIC LAYER	
detectability	- information has to be distinguishable from background noise
SYNTACTIC LAYER	
apprehensible	- representation of information needs to be understood by recipients
SEMANTIC LAYER	
comprehensibility	- information needs to be comprehensible for a recipient
level of detail	- too much or too little detail can hinder information
PRAGMATIC LAYER	
novelty	- information has a novelty character
goal relevance	- information is useful for achieving goals and making decisions
value	- information is valuable to a recipient
time dependency	- temporal context affects the informational character of messages
contingency	- whether something is information or not depends on prior events
SOCIAL WORLD LAYER	
cultural dependency	- cultural context can affect interpretation of messages
subject domain	- domain specific context assumes different knowledge prerequisites
specificity or depth	- required specificity depends on user's sociomaterial practices
matter of trust	- users' trust towards a source affects information

For a broad, novel and technology driven topic like EA, and especially inside the Information Architecture domain, we are facing informational and communicational challenges at all the above listed levels, which are tightly related to each other. We argue that major challenges with EA are related or bound to a social layer, language and communication. We are facing more challenges when discussing social theories, where Lee (2004, 7-10) finds issues and different schools of thought for both terms of 'social' and 'theory'. Lee (ibid.) refers to Schutz (1962), who gives concepts to operationalize and differentiate two different ontologies for theory: one originates from natural science and the other from social science. Schutz (ibid.) conceptualizes subjective meanings as first-level constructs, which are part of the objective reality but exist only in the empirical subject matter of social science, and not in natural science. While a social scientist observes the first-level constructs (the meanings that the subjective matter has of itself, its setting and its history) as objective reality of an organization, the second-level constructs created above the first-level constructs are the generalizations contributing to scientific theories for social science. Natural science and related methodologies operate only with the second-level constructs, but social science must also account for the world of subjective meaning (the first-level constructs). This comparison between social and natural sciences is part of a much wider battle between different schools of thought about the nature of scientific knowledge, which Mingers (2004, 379) divides into three possible positions: naturalist, anti-naturalist and radical views. In this classification, Lee (2004) and Schutz (1962) maintain an anti-naturalist view that the social world is intrinsically different to the natural world, being constituted through language and meaning (Mingers 2004, 379).

Harman (2002) discusses the same existential challenge by analyzing Heidegger's works, and especially "Being and Time" (Heidegger 1962). For Harman (2002), Heidegger's philosophy is a first step towards object-oriented metaphysics, where everything in the universe can be seen as tools, equipment and thus objects. Each discrete tool can be understood at the level of "broken tool", which means tool itself is present-at-hand. For us, this discrete tool, which is present-at-hand, means the same as a second-level object according to Schutz (1962), which can be studied by objective, naturalistic approach. But then Harman (2002) explores the other side of a tool: a working tool as part of the universal tool-system, which operates on subjective, relational level of tool-being and referential contexture. To us this working tool as part of universal tool-system is a subjective first-level construct, which Heidegger calls as *Zuhandenheit* or readiness-to-hand, and Harman (2002, 4) refers to as "tool-being". These two modes for an object as tool and broken tool can be seen as the material and immaterial part of the same object and its' being, which also may be called being -axis. But then when we include time -axis into the same picture, the whole gets much more complicated. Harmon (2002, 88) does not mean chronological time -axis, but following Heidegger's philosophy he divides this time -axis on one end into "in particular" or "in specific", and on the other end into "something at all" or "something in general". Thus we are getting a high-level theory for understanding all objects as broken tools or tools, and along the time -axis from generic to specific. Now when trying to locate EA into this fourfold theory –space divided with being and time -axes, our current EA understanding is mostly in the area of generic, broken tool. But during this chapter, we are studying tool-being of EA: what elements are needed to bring EA from generic, broken tool into specific, socially practical tool-system.

But by calling EA a tool the socio-technical complexity of EA is black-boxed. Latour (1999b, 304) defines black-boxing as *an expression from the sociology of science that refers to the way scientific and technical work is made invisible by its own success*. Collins and Kusch (1998, 181) refer to "closure" and "ship-in-the-bottle" as synonyms for black boxing, while all these concepts are trying to express the process of hiding internal details and the complexity or the system. In this study, we are trying to avoid this black boxing of EA because EA is actually a complex socio-technical communication tool-system consisting of various human and non-human actors as discussed in the previous chapters. The journey for EA from generic theory as broken-tool to specific, valuable communication tool-system may be seen as an example of Latour's (1999b, 195) theory regarding collective exploration of the limits of technology management. According to Latour's theory, the limit of the first collective on humans and non-humans is extended into the next level collective by the process steps called translation, crossover, enrolment, mobilization and displacement. In each crossover of this process, the roles of human and non-human actors are blurring. Latour (ibid., 213) defines the following socio-technical exchange path between social and non-human relations with 11 levels starting from social complexity at the first level, proceeding through social tools as a crossover towards a basic tool kit. Proceeding levels are called social complication, techniques, society, internalized ecology, mega-machine, industry, networks of power, techno-science and political ecology (ibid., 213). These 11 levels may also be seen as an EA maturity path from broken-tool towards specific tool-system. This socio-technical development path may reflect EA development in various organizations and industries towards EA standardization.

Markus and Robey (1988) discuss the logical structure of IS research while dividing IS research into variance and process categories (Mohr 1982), referring to time span of the study. Variance research operates with independent and dependent variables as a snapshot of reality and thus with second-level constructs, which follows the naturalist view that one general approach applies to all science. Process theories operate with a longer time period and recipe of sufficient conditions occurring over time and thus operating with first-level constructs, which maintains the anti-naturalist view that the social world and social science requires different methods than natural science. EA-in-practice is a multi-layer product of multiple social and technological interactions, which requires a longitudinal process study to capture temporal changes and first-level social constructs related to organizational goals and objectives as well as industrial and environmental changes.

But the views of Markus and Robey (1988) do not correspond to the most radical views of Mingers (2004, 380) who argues to deny the possibility of objectivity or scientific knowledge at all, in either the domain of natural or social science. While discussing about the most radical positions Mingers (ibid.) refers to the strong sociology of knowledge programme represented by Foucault's (1980) arguments about socially constructed categorizations, as well as postmodernists like Best and Kellner (1991) who attempt to undermine even the most basic categories of modernist rationality. Barad (2003, 819) refers to Bohr's concept of apparatus and knowledge creation as an intra-actional process, where apparatus is always a productive part of the phenomena produced and enacted in the knowledge creation process. Thus there seems to be wide spectrum of opinions about the kinds of knowledge and generalizations that can be found in the social sciences. In IT, and especially in an IS context, this means that despite the general nature of technology, individual understanding and perceived reality may vary a lot. Therefore, socially practical EA calls for an individual perspective and subjective sensitivity to context, time, space and emergent combinations for temporal innovations of various roles, processes and organizations. For us, socially practical EA could improve IT performativity, if EA processes can produce information and increase knowledge for individuals and groups of stakeholders and shareholders in a neutral manner to enable situational options for social and technical innovations and intra-actions. Thus IT management should proceed towards EA management, which should include technology, business and social processes into a more integrated and holistic EA management system. Improvements in social awareness of EAM as a sociomaterial construction and negotiation process could help to develop socially sustainable work orgnizations (Kira & van Eijnatten 2008) and related competencies (Kira, van Eijnatten & Balkin 2010) towards EA leadership.

Social can also been understood in different ways depending on the ontology of the school of thought. Lee (2004, 9) states that for some researchers any theory about human individuals is a social theory. For other researchers, social theory is not so much about human individuals as it is about shared socially constructed institutions that endure even when the individuals who are momentarily present are replaced by new ones. While reviewing Giddens' contributions to social science, Jones, Orlikowski and Munir (2004, 305) refer to this temporality as integral to social theory, which means that social institutions and daily routines present continuity and repetition, but individuals have an inevitable and irreversible direction. Social ontology positing that individuals determine their own fates through the decisions they make and the actions they take would be better suited for developing a theory of the individual. Giddens (1984) maintains this voluntaristic view of human agency, which posits that despite social structures human agent has always possibility to doing otherwise (Jones et al. 2004, 304). Social ontology positing that individuals are agents of social structures, where the social structures shape what the individuals think and how they act, would be better suited for developing a social theory. Markus and Robey (1988) talk about levels of analysis and they have divided IS research into macro and micro levels, where macro level research is at the group and organization level, and the micro level of analysis may combine mixed research at the individual, group and organization level. This macro level of analysis has similarities with business/IT alignment thinking, and the micro level of analysis has more in common with social theories like Giddens' structuration theory, actor-network theory (ANT) and other socially aware theories, which we will cover in this chapter. For us, EA is a multi-layer concept, which requires research at all levels from individuals to enterprise, network and even industrial levels.

In addition to the logical structure and level of analysis for IT research in social theories, the reason for change has been an almost deterministic factor. Markus and Robey (1988) have named this change initialization factor as causal agency, which can be either technology or organization driven imperative or emergent perspective by nature. Lee (2004, 11) has described this symbiotic process and information system as emergent result. Thus if IT research concentrates only on discrete technology, or social research only on organizational reasons, the results and theoretical contributions may differ. But an information system is not the information technology alone: the system emerges from the mutually transformational interactions between technical and social domains (Lee 2004, 11). EA could be seen as an information system, and thus as a combination of various social and technical information systems. For us, the only objective for socially practical EA is to find a balance between technical and social agencies towards EA management. Therefore, agency is a quite central concept while trying to shift EA in a more socially practical direction.

Human agency and social construction are inherent to Giddens' (1984) structuration theory. But as Jones and Karsten (2009, 594) acknowledge Giddens has an utmost human-centric view of agency with little apparent interest in technology. This perspective almost totally omits the role of technology, which may be seen in Actor-Network Theory (ANT) as an equal actor in the network. But again this perspective of seeing technology as machine agency has generated a wide debate, which Jones and Karsten (2009, 593) state to be found from Rose, Jones and Truex (2005), Latour (2005), Collins and Kusch (1998), Pickering (1993, 1995), Reckwitz (2002), Harman (2002), Orlikowski and Scott (2008), and last but not least from Suchman (2007). Pickering (1993) discusses human and non-human agencies in a symmetrical manner, while recognizing the major difference of human intentionality and goal-orientation, which is missing from non-human actors. Orlikowski (2005) acknowledges the major differences of human and non-human actors by discussing the distinction between human agency and material performativity. Orlikowski and Scott (2008) have been progressing this thinking towards sociomateriality theory, which will be analyzed further from several theoretical and practical perspectives. This concept of sociomateriality is our major conceptual building block of socially practical EA, which means our intention to add sociomaterial thinking to existing EA theories and sociomaterial practices to EA management practices. How could these sociomaterial practices inform EA practices, IT management and thus improve information technology performativity?

The empirical part of this study is a practice oriented attempt to understand how social sciences could enhance IT management towards EA management. While practice theory seems to be constructive theory for studying technology, IT and IS as social phenomena, the concept of practice seems to be quite ill-defined (Awazu & Newell 2010; Corradi, Gherardi & Verzelloni 2008). Reckwitz (2002) defines practice theory to be a loose school of social theories, and (p.249) practice as *routinized type of behavior, which consists of several elements, inter-connected to one another, forms of bodily activities, forms of mental activities, "things" and their use, background knowledge in the form of understanding, know-how, states of emotion and emotional knowledge.* Practice is seen as routinized way in which bodies are moved, objects are handled, subjects are treated, things are described and the world is understood (ibid., 250), which enables practice theory applications into non-human actors like technology, machines and automation. Reckwitz (ibid., 252) discusses practice theory from socio-material perspective while defining combination of social and practice to include social in bodily routines, mental routines and their 'knowledge'. This means that mental routines and their knowledge are integral parts and elements of practices. A 'practice' thus crosses the distinction between the allegedly inside and outside of mind and body. For practice theory, the nature of social structure consists in routinization. Structure is thus nothing that exists solely in the 'head' or in patterns of behavior: One can find it in the routine nature of action. Routinized social practices occur in the sequence of time, in repetition; social order is thus basically social reproduction. For practice theory, then, the 'breaking' and 'shifting' of structures must take place in everyday crises of routines, in constellations of interpretative inter-determinacy and of the inadequacy of knowledge with which the agent, carrying out a practice, is confronted in the face of a 'situation'. (ibid., 255).

Awazu and Newell (2010) have initiated a theoretical lens for practice-oriented ES research by combining various theory sources including the fields of IS, socio-technical science and sociology. Instead of EA, they are studying ES implementation phenomena in practice, where the research setting seems to have many similarities to our EA study. While trying to define practice, they are finding different perspectives from sociology (Bourdieu 1990; Giddens 1984), and from the field of socio-technical science (Lave & Wenger 1991). According to Lave and Wenger (1991, 50), theorizing about social practice, praxis, activity, and the development of human knowing through participation in an ongoing social world is part of a long Marxist tradition in the social sciences. As the controversial name of practice-theory may indicate, theory-building in this field seems to vary a lot. For our EA study purposes, Giddens (1984) Structuration Theory gives us theoretical tools to analyze and understand social structures and their influences on social practice.

Practice theory places the social in practices and treats practices as the smallest unit of social analysis, which can be found in the Structuration Theory by Giddens (1984) and from Actor-Network Theory by Foucault (1980). Both of these "grand social theories" will be discussed later while trying to define and understand what socially practical EA could mean and what kinds of structures and networks should be initiated to make EA practices more social and practical for EA management purposes. Because sociomaterial theories and the shift in sociomaterial thinking seems to be the most promising stream combining social and technical worlds together, we will elaborate this sociomaterial concept and research stream in more details. But before we continue borrowing theories from sociology, we will stop for a while to reflect on some concerns from Truex, Holmström and Keil (2006):

- While considering the fit between selected theory and phenomena of interest, we are finding sociomateriality theory a promising shift in thinking towards a more holistic and socially practical IT/IS/EA understanding.
- The historical context of sociomateriality seems to combine multiple sources of philosophical and sociological thinking, but the actual concept combines the short history of digitalization and techno-scientific research streams since the 1990’s. We do acknowledge origins of sociomateriality for gender studies (Barad, Introna, Suchman), which is even labeled as Feminist STS by Van House (2003). We do acknowledge the socio-marxian roots of Activity Theory and CHAT (e.g. Engeström 1987). But because both gender and labor views have been mostly missing from previous EA research and theories, these elements may be more like balancing ingredients for socially practical EA management.
- Both EA and sociomateriality being novel concepts, and practice theory orientation calling for strong practice exploration, our method of combining case study and action research into a longitudinal research setting could bring to the surface new understanding and social practices for improving EA concepts, IT management and IT/IS performativity.
- Our contribution to cumulative theories for EA and sociomateriality should add value to technology, ICT and business management domains by combining intertwining the technical and social into layered imbrications for more holistic EA, EAM and EA leadership thinking.

After this positive self-reflexive analysis, we will proceed to our attempt to cover the existing understanding about social theories in an IT/IS context, focusing more deeply on sociomaterial theories and practices, and then shifting these theories towards an EA context and practical applicability towards EA management.

5.2 About IT research of EA management

IT, information and technology are the roots of EA. Various IT related architectures have been evolving towards an integrated understanding of EA as a technical artefact. Next we will elaborate on IT research and theories about technology’s role in organizations.

5.2.1 Absent technology

IT seems to be somewhat missing from social and organizational research (Orlikowski & Iacono 2001). Orlikowski and Scott (2008) have found that over 95% of the articles published in top management journals of organization science do not take account the role of technology in organizational life. This is quite surprising because almost all organizations and operations are more or less dependent on technologies at various levels. While reviewing established perspectives on technology in management research, Orlikowski (2010b, 127) calls this attitude towards technology as *absent presence,* where technology is essentially unacknowledged by organizational researchers and thus unaccounted for in their studies. Thus in practice and in many organization theories, technology as a IT architecture is one part of invisible, transparent and opaque infrastructure (Star & Ruhleder 1996; Star 1999).

Zammuto, Griffith, Majchrzak, Dougherty and Faraj (2007) state that the contingency theory debate led to substantial research on the relationship between technology and organizational form and function in the organization science journals Administrative Science Quarterly (ASQ) and the Academy of Management Journal (AMJ) during the 1960s and 1970s; this theme comprised 5.8% (39 out of 664) of the technology-centric journal articles. Furthermore, Zammuto et al. (2007, 759) continues to state that between the years 1996-2005, while IT's penetration of everyday life and the world of organizations increased dramatically, only 2.8% of the research published in four leading organization science journals focused on the relationship between technology and organizational form and function.

Already in 1992 Pinch, Ashmore and Mulkay (p. 265) started defining technology by saying that *technology, unlike science, is everywhere…a part of the fabric of our everyday lives.* Ten years later Latour (2002, 248) repeats the same trope that *technology is everywhere, since the term applies to a regime of enunciation, or, to but it another way, to a mode of existence, a particular form of exploring existence, a particular form of being – in the midst of many others.* These findings that technology is almost absent in leading management research journals depends, of course, on many components of these studies: data, as well as how technology is defined and how data interpretation in classification is carried out. It also seems that scientific interest in organization science does not promote technology in their universe of discourse. Therefore, we must include other sciences and academic literature to enlarge our frame of reference of technology. Our technology definition in the first chapter was as follows:

Technology refers to the physical combined with the knowledge processes by which the material and the immaterial inputs are transformed into sociomaterial outputs.

While this something called technology is at the heart of IT, human understanding about the informational and immaterial part of technology as well as intellectual and knowledge processes makes IT challenging for social theory construction. While trying to understand even simple, discrete technology, we may study the physical nature of technology, which Orlikowski (2000) discusses as a 'technological artefact' having several common pseudonyms like machine, technique, appliance, device or gadget

(Hanseth 2004). Strategy-wise, Galbraith (2002, 17) discusses technology as automation and information technology for redesigning organizations by permitting a wider management span and flattening structures with fewer hierarchical levels. Mintzberg (1991, 331) has elaborated the structuring of organizations into six basic parts of organization (operating core, strategic apex, middle line, techno-structure, support staff and ideology), where techno-structure means analysts and staff for planning and controlling others work. While discussing a technical system, Mintzberg (ibid., 341) means *instruments used in the operating core to produce outputs,* which he distinguished from "technology", referring to the knowledge base of an organization. But, unfortunately, Mintzberg does not elaborate on this "technology as knowledge base" further. Other authors have discussed about technology and knowledge:

- Andrews (1991, 47) defined technology from a strategy and technical development perspective as being the fastest unfolding and the most far-reaching in extending or contracting opportunity for an established company. They include the discoveries of science, the impact of related product development, the less dramatic machinery and process improvements, and the progress of automation and data processing… (Andrews 1991, 47)
- Quinn, Doorley and Paquette (1991, 326) discussed technology in services like styling features, perceived quality, subjective taste and marketing presentations, with these services adding the most value to the intellectual holding companies like Apple and IBM. They noticed operational automation converting manufacturing industries into service networks, and knowledge-based intangibles like technological improvements, styling, quality, marketing, and financing becoming the most value-adding activities for a competitive advantage.

From these various technology-related concepts above, we can see that this concept of technology can be defined, understood and combined in various ways. If technology would be defined like Mintzberg (1991, 341) as knowledge, then Orlikowski and Lacono (2001), Orlikowski and Scott (2008), as well as Zammuto et al. (2007) might have got different results from their journal reviews.

This finding that technology is an invisible and absent part of society and organization research is similar to Barad's (2003) observation that technology does not matter much in most studies of organizational reality. One possible explanation for this absence of materiality in the management literature is that technology is either invisible or irrelevant to researchers trained in social, political, economic and institutional analyses of organizations, and ontological priority is given to human actors and social structures, while technological artefacts (and materiality more generally) tend to disappear into the background and become taken for granted (Orlikowski 2010b, 128). If technology and IT are an invisible part of organization in social and organizational research, adding EA and IT architecture perspectives into social and organizational research could result in a more holistic and systemic view to organizational reality. While humans are orienting toward their own targets and goals, it is easy for them to keep and forgetfully leave technology in a marginal role and as an enabler or constraint, as well as EA as platform for their activities and objectives. Thus technology and EA themselves are not interesting, in contrast to knowledge, information, services and systems, which are enabled by technologies as instruments. However, because EA in most cases has focus and sometimes even seems to equal IT architecture, EA research technology and IT are elementary components of EA, and the enterprise part may be somewhat absent, invisible and embedded into settings. One possible future research topic could be a review of EA Journal publications for finding non-technology focused EA articles to find out how much current EA research is focuses on social and organizational aspects of EA. EA itself is a technological artefact, which would benefit from studies of social structures and EA management practices in organizational life. It is even quite difficult to imagine EA research without technology because the increasing role of IT has triggered the whole concept of EA. Therefore, in EA research and EA management literature the absence of technology is an almost impossible idea. With our study, we are trying to add social components into our EA thinking and achieve more balance between social and technical components of EA for EA management, leadership and change management. Our thinking goes that if we are able to improve the balance of social, technical and sociomaterial components of EA in theory, then in practice this could enable improving EA and IT management practices and IT performativity. In the future, social and organizational research could benefit from EA concepts and technical components of EA related research.

5.2.2 Exogenous technical force

For some people and researchers, technology is an interesting object and exogenous force changing organizations. Orlikowski and Scott (2008, 438) have recognized a separate organizational research stream regarding discrete technologies. They call this research stream as “Research Stream I” characterized by a view of social and technical worlds as discrete, independent entities with inherent characteristics. Orlikowski (2010b, 127) renames this as *exogenous force*, which sees technology as a separate discrete entity, a powerful and relatively autonomous driver of history having determinate impacts on organizational life. In these studies, technology is seen primarily as ‘hardware’ causing determinate organizational changes, which has been in most cases studied by following the prescripts of variance logic (Mohr 1982).

Leonardi and Barley (2010, 3) have found this ideology starting from 1950s, when contingency theorists reported different kinds of production technologies, as independent variables, causing deterministic changes to organization structure, a dependent variable. Leonardi and Barley (ibid., 4) maintain that, at the same time, there already existed socio-technical theorists who thought that social and technical systems influenced each other, and to be effective, organizations needed to optimize both jointly. But these early socio-technical theorists carried out research resembling contingency theory, which repeatedly saw technology as a causal agent causing structural changes. This thinking that technology, IT and organization are separate, discrete entities seems to be still prevailing in theories and organizations. Technological and social worlds seem to be separated in theories which try to align IT into business. Perhaps as a practical and politically correct way to manage business and IT separate from each other, the alignment approach may prevent understanding and achieving transformational benefits from IT and IS investments. Mendonca (2003) refers to the three-era model by Ward and Griffiths (1996), which includes automation and management information systems (MIS) to achieve IT benefits from labor-intensive processes and operational business decision-making. But, at the same time, emergent and context sensitive opportunities for new business models and transitional operational benefits may be omitted because of neither being part of traditional business nor intentional strategy for organizations, which does not see IT as enabling business transformations.

If EA is seen as an external, exogenous force, it would be quite easy to tend towards a positivist approach in EA research, being interested in deriving generalizable laws from statistical empirical work. EA could be also seen as a technology, material mean, external force for changing organization and improving IT management. But, because this view is much too limited in its technical determinism, we will continue to explore t more systemic and socially aware theories of IT design and use as social construction. Introna (2007, 11) argues that the conventional view of technology representing technical means to achieve social ends is too simple to capture a wide area of applicability of IT and the role of technology in modern societies. Latour (2002, 248) argues, even with technology being everywhere,, that without technological detours, the properly human cannot exist (Latour 2002, 252): *without tools and technologies people would live in caves, and without electricity, nuclear power and waste even this material outcome may have not ever existed*. Latour (2002, 24) maintains that technologies and moralities happen to be indissolubly mingled because, in both cases, the question of relation to ends and means is profoundly problematized. Introna (2007, 11) proposes disclosive ethics as a way to make the morality of technology visible.

Thus our approach to create socially practical EA has certain similarities for creating visibility to means and ends, as well as the constraints and affordances of IT and social (re)configurations (Suchman 2007). So, this is a possible implication for further research, that is, whether EA could create visibility to moralities of IT use and development. Walsham (2005b) has raised this important topic, while discussing how ICT could make better world: ICT should not be applied only to economic development but also develop life at the individual, group, organization and society levels. Our intent to improve EA management towards change management includes the same ideology for using EA management as a tool for improving working life from integrated business and process perspectives.

In our EA study, an IT–framework includes technology as an exogenous technical force. This framework presents technology as a separate discrete entity having determinate impacts on organizational life. In our IT-framework, new technology is an exogenous technical force which may be introduced into an organization from various layers of business, EA, EIS, IS, IT or IT infrastructure. In this thinking, EA is a temporal understanding of social and technical configuration, the balance of which is continuously threatened by exogenous technical changes. This view omits social, industrial and business-driven economic changes, which cause continuous flux for existing EA and future organizational needs. In the empirical part of our study, we will evaluate each of our system development vignettes using an IT-framework as a lens to view temporal states of internal EA and exogenous technologies changing this technical and social balance. The last of our seven vignettes is called an EAM vignette, which presents EA as an exogenous technology trying to penetrate into the existing social and technical balance within our case enterprise at Nokian Tyres.

5.2.3 Emergent socio-technical change

Another way of understanding and studying IT sees the systemic nature of information technology and systems. Lee (2004, 14) argues that system thinking is too rare even in IS research, but Orlikowski and Scott (2008, 438) have found this research stream as “Research Stream II”. In this research, humans/organizations and technology are assumed to be interdependent systems that shape each other through ongoing interaction. Thus this idea of IS as a mutually dependent system of social and technical system can be found from socio-technical (ST) systems, ST design school and various process studies. This research stream is searching for emergent perspective (Markus & Robey 1988) viewing technologies and organizations interacting in complex and indeterminist ways, reflecting various cultural, institutional, and temporal influences (Orlikowski 2010a). Orlikowski (2010a, 240) states that contingencies are framed as complex social processes entailing meanings, interests, and history, with multiple meanings depending on the social group that interact with it. This view enhances systems thinking beyond its’ weaknesses regarding human action of participation, culture and politics (Stacey et al. 2000) towards complexity theories, complex adaptive systems (Eidelson 1997), new concepts and disciplines for leading and managing knowledge (Pearce 2004; Pearce & Manz 2005; Uhl-Bien et al. 2007),

This “Research Stream II” is a quite wide classification of research, which acknowledges more systemic and complex interactions between social and technical domains.

Orlikowski (2010b) has continued to analyze technology in management research, and found a separate research stream which sees technology from an emergent process perspective. For these scholars, technology results from the ongoing interaction of human choices, actions, social histories and institutional contexts. The emergent process perspective in management studies has been influenced by the early socio-technical systems school, which argued that social, psychological, environmental and technological systems must be assessed as a whole (e.g. Griffith & Dougherty 2002). Another strong influence on the emergent process perspective came from science and technology scholars' interest in the social shaping and social construction of technology (e.g. Van House 2003). A third influence on the emergent process perspective in management studies has been Giddens' (1984) structuration theory. While this theory does not explicitly consider technology, its focus on the processes of social structuring has informed analysis of the structuring of technologies within organizations (e.g. Jones & Karsten 2008). For example, Barley (1986) studied the implementation of CT scanning technology in two separate hospitals, finding that different groups of users—radiologists and technicians—engaged differently with 'the same technology', occasioning distinct structuring dynamics and contrasting shifts in power relations.

Our EA study follows an emergent process perspective when reporting interpretations of and interactions in EA management to understand how EA enables and constrains business and IT management practices. We have conducted an ethnographic study to follow bottom-up EA development in our case company. We have been participating in the various EA development projects transforming systems, processes and technologies in various ways. We will report our field studies as vignettes, where EAM vignette presents some attempts to introduce EA technology into our case company. Our approach to vignettes is similar to Schön (1983) using a sample of vignettes of practice to document how social and technical systems have been developing in our case company. Our EA–and EAM–framework are used for analyzing structuration and negotiations between development projects, business, IT, users, systems and technologies as situated engagements within the EA sphere of our case company.

5.2.4 Summary of IT research of EA management

While analyzing management research of structuration and social construction, Orlikowski and Scott (2008) have found issues in the conceptual separation between technology, work and organization. Orlikowski (2010b) concludes that exogenous force and emergent process perceive technology and humans as essentially different and separate realities based on an ontology of separateness—an ontology of separate things that need to be joined together (Suchman 2007, 257). Exogenous force and emergent process share a dualistic view of agency that claims that agency is located either in the human or in the material artifact (Introna 2007, 3).

To avoid this separation Orlikowski and Scott (2008) have developed a theory of sociomateriality, which seems to improve and balance our understanding of socio-technical materiality of IT. Awazu and Newell (2010) have recognized the promise of sociomateriality as a practice-based perspective which could give a theoretical lens to study technology, work and organization as a whole social entity. Because sociomateriality seems to improve the social perspective to IT research, we will next study this research concept more in detail before proceeding to socially practical EA management.

Law (2004) argues that this ontology of separateness of human/social and technology/technical has long influenced the social sciences as a legacy of Cartesian dualism of subject and object. This ontology has been challenged with a relational ontology that rejects the notion that the world is composed of individuals and objects with separately attributable properties that ‘exist in and of themselves’ (Law 2004, 42). Relational ontology privileges neither humans nor technologies, nor treats them as separate and distinct realities (Pickering 1995; Knorr Cetina 1997; Schatzki, Knorr Cetina & von Savigny 2002; Barad 2003; Latour 2005; Introna 2007). The social and the technical are ontologically inseparable from the start (Introna 2007, 1), and the starting place comprises configurations of interrelated, reiterated sociomaterial practices (Suchman 2007, 257). In the next sub-chapters, we will review social theories and relational ontology for improving our perspective towards social dimensions and structuration for EA management.

5.3 Review of social theories for EA research

Next, we will shortly review the social theories and major concepts which could be useful while trying to understand EA as social practice, emergent socio-technical process and complex sociomaterial phenomena. Activity theory (Vygotsky 1978; Leontiev 1978, 1981; Engeström 1987) will be used for increasing the human perspective to EA actors, goals and whole EA activity systems. Actor Network Theory (ANT: Latour 1999a; Monteiro 2000) is reviewed to enhance agency for technological artefacts as well. Structuration Theory (Giddens 1984) will introduce EA management and leadership as organizational structuration instruments for managing changes and increasing ICT benefits. These social theories are improving our understanding of EA as emergent socio-technical change, where humans, organizations and technology are assumed to be interdependent systems that shape each other through ongoing interaction (Orlikowski & Scott 2008, 438).

Because we see that theory of EA is in a continuously evolving process towards a technical standard for integrated business, process and IT/IS development, we will apply Millerand and Baker (2010) to understand interactions and dialog between EA technology developers and EA system users, as well as theoretically mixing sociology, information systems (IS), IT, organization, management, and finally Science and Technology Studies (STS). We will review sociological theories to understand human intentions, motivations and agency for social structures and organizational hierarchies. We will evaluate IS research to understand technical agency and determinism in using technology and especially IT as a component for changing human activities, work, organizations and socio-technical structures. We will use STS to improve our understanding of EA as part of social structures and supporting social development and IS use in practice. Thus in the next sub-chapters we are searching for human agency from the sociology and EA technology potential between business, process and IS/IT development and use.

5.3.1 About the social in EA

Latour (2005, 1) explicitly defines that 'the social cannot be construed as a kind of material or domain', because social is everywhere. He finds Gabriel Tarde (1843-1904) as precursor for ANT (Latour 2005, 14) because both are finding the social in everything. While trying to find what is social, Latour (ibid., 159) finds it vanishing, which he explains to designate to two different phenomena: it's at once a *substance*, a kind of stuff, and also a *movement* between non-social elements. *"When it is taken as a solid, it loses its ability to associate; when it's taken as a fluid, the social again disappears because it flashes only briefly, just at the fleeting moment when new associations are sticking the collective together"* (ibid.). We agree with Latour that while the social is a substance, a kind of stuff, it is never material, which validates sociomaterial dualism in our enhanced EA model (Figure 29). Leonardi and Barley (2008, 160) present a list of research, which confirms *general agreement that information technology and organizations both arise at the intersection of social and material phenomena.* In our EA study, we are interested about this other social dimension as movement between non-social elements. We are thinking of EA as this social fluid that disappears into technical, where the social flashes only briefly before vanishing into the collective together. This definition indicates that the time axis may not be the most applicable for analyzing EA as something, which *again disappears because it flashes briefly,* and EA as social fluid.

EA seems to be a means to inform these social processes for an intended collective together called TO-BE, as well as a means to document intermediate states and expected outcomes. But what is this collective together? We agree with Latour and Tarde that the social and society are everywhere, also inside and outside of the enterprise. If enterprise is seen as a network, it is consuming resources and services from the external society, which is an elementary part of its' business infrastructure. Wajcman (2002) has studied how sociologists understand the role of technology in economy and society, while paradigmatic theories are explaining transformation into information society, post-

Fordism, postmodernity and globalization. Wajcman (2002) reviews Giddens, Castells, Habermans and Macuse to understand how they explain this social transformation into network society, and finding the answers that are mainly technologically determined. Walsham (2008) rejects Thomas Friedman's (2005) argument that *ICT-enabled globalization is driving us towards a flat world*. Instead, Walsham (2008) argues that the world remains uneven, full of seams, culturally heterogeneous, locally specific, inequitable, not well-integrated and constantly changing. So if Castells' (1996) vision of that information age at an individual level means the space of flows and timeless time, at enterprise level this requires much EA work to construct a collective together as a TO-BE state integrated into the network society.

In this social construction work, EA seems to offer an artefact that could be used as a boundary object for social coordination and balancing ethical concerns while managing knowledge and changes in work processes and division of labor inside enterprise and networks. From this perspective, socially structured EA could benefit from the activity theory approach.

5.3.2 Activity Theory basics for EA reframing

According to our knowledge, Activity Theory has not been applied to studying EA. Zacarias et al. (2007) have been adding a human perspective to EA modeling by including individual and shared views of humans into the conceptual EA framework. Their work does not directly refer to activity theory, and conceptually their model is more like a mixture of ANT and activity concepts, which we will evaluate in detail. Thus we will adopt the basic concepts of activity theory into the EA context from the human-computer interaction (HCI) research context where mainly Scandinavian researchers have been applying activity theory into HCI context since the mid-1980s. Bertelsen and Bødker (2003) have presented a review of the HCI research stream using activity theory, which includes the following Figures and core concepts that we will apply for reframing EA from human perspective.

Activity-theoretical HCI offers a set of conceptual tool that will enable us to analyze human behavior as a dialectical materialist psychology. Vygotsky (1978) and his Russian colleagues analyzed human activity as having three fundamental characteristics: human subject (S), directed toward a material or ideal object (O, and mediated by artifact (X) also refer to as instruments (we), which can be either technical instruments (tools) or psychological instruments (signs, language, concepts). Vygotsky's (1978) work produced the human activity triangle S-X-O presented in Figure 17/left. A.N. Leontiev (1978, 1981) has continued Vygotsky's theory of social group work as socially mediated activity presenting community (C) as pre-human survival and hunting mechanisms. Leontiev's work produced the socially mediated activity triangle S-C-O presented in Figure 17/right.

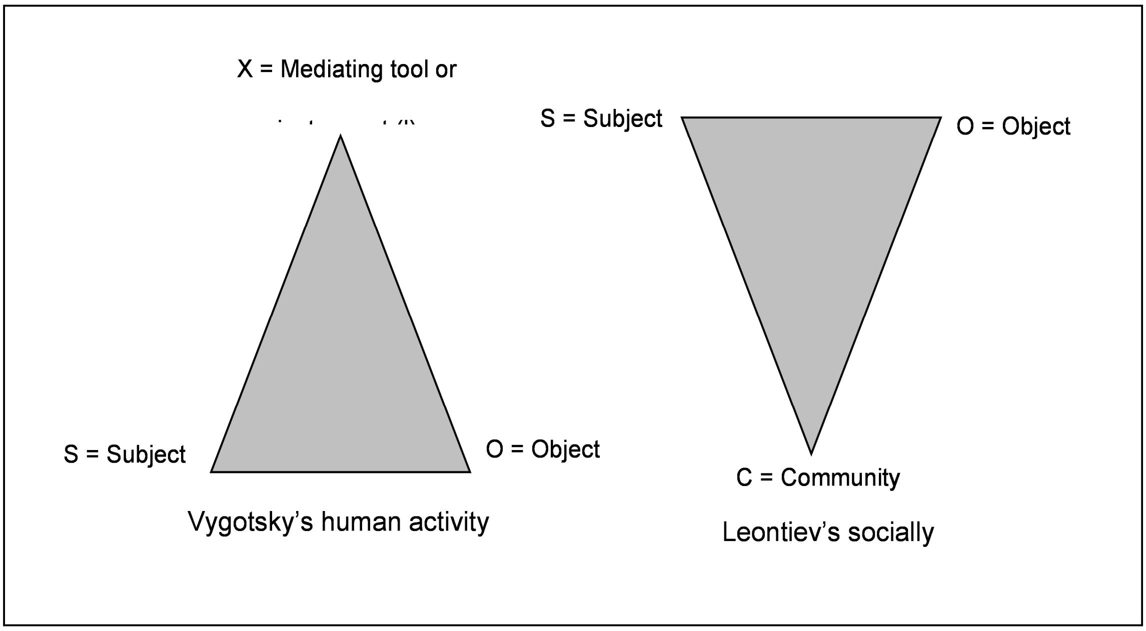

FIGURE 17 Triangles of activity (Bertelsen & Bødker 2003, 300).

According to Leontiev (1978), human activity can be analyzed into a three-level hierarchy of activity, action and operation, which all reflect to the objective world. Activity is directed to satisfy a need through a material or ideal object. Human activity is triggered by conscious or unconscious motive and carried out through actions, realizing objective results. Human actions are triggered by conscious goals and realized through a series of operations, thus goals reflect the objective results of action. Human operations are triggered by the conditions and structure of the action, and performed without conscious thinking. This dynamic relationship among the three levels of human activity can be depicted in Figure 18 (Bertelsen & Bødker 2003, 300):

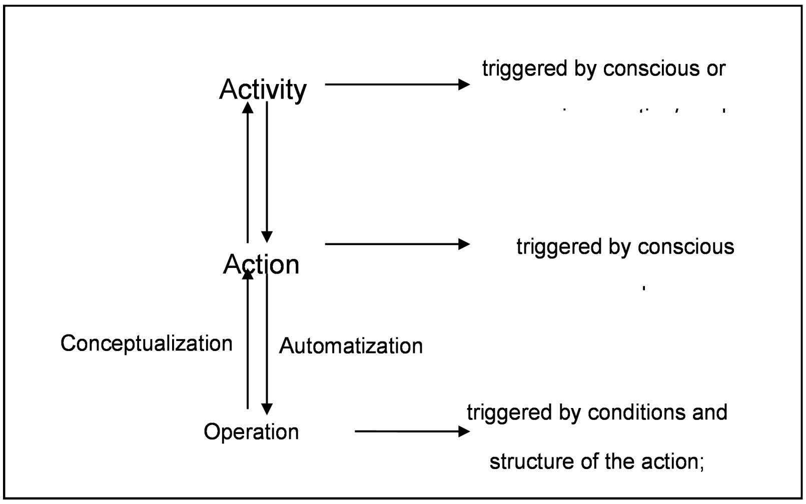

FIGURE 18 Leontiev's three levels of human activity (Bertelsen & Bødker 2003).

Bertelsen and Bødker (2003, 300) argue that these three levels of human activity are not fixed: action can become an operation through automation/internalization, and an operation can become an action through conceptualization in breakdown situations (Bødker 1991). A separately motivated, conscious or unconscious activity in one context can be a conscious and goal oriented operation in another context, or even an automated operation in another context. Engeström (1987) has continued Vygotsky's and Leontiev's triangle model of group work by integrating both triangles and adding community rules and division of labor to capture community culture in an integrated model depicted in Figure 19.

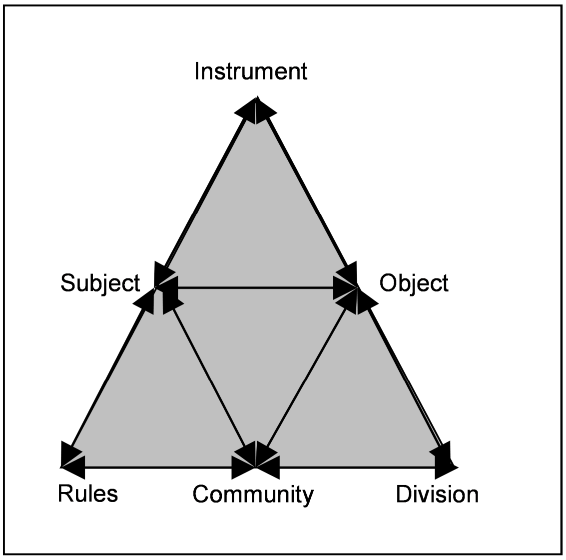

FIGURE 19 Human activity triangle (Engeström 1987; Bertelsen & Bødker 2003).

In this Engeström's (1987) model, social activity can produce not only objects, but also instruments, subjects and rules. The form of the triangle is not important but social structuration and holistic system thinking is:

> *Activity is an intertwined system of subject, object, instrument, rules, community and division of labor. If one corner changes, then the whole system becomes unstable and must develop to obtain renewed stability. (Bertelsen & Bødker 2003, 302)*

Cole (1996) has continued to develop Engeström's work on cultural psychology and produced a cultural historical activity model, CHAT (Daniels & Edwards 2010, 1). CHAT analyses how people and organizations learn to do something new, and how both individuals and organizations change. Thus the key business requirements for EA to support knowledge and change management should be captured by the CHAT model. Human and organizational perspectives are embedded into an EA activity system, where EA and IT services are both sharing the same enterprise-level artifacts presenting various views and viewpoints to EA for an enterprise.

We acknowledge that our attitude is biased towards EA utility and benefits, despite the explicit theory and model for EA benefits being still missing (Kappelman et al. 2008). We think that if EA is made as a socially constructed and collaborative artifact including EA services aiming for knowledge and change management, then this kind of enterprise-level shared object and service should improve net-economics of human-computer interaction, capability and knowledge management toward business goals for the whole activity system. We are not trying to create any EA benefit model to improve this attitude, but our logic of socially structured EA benefits relies on basic assumptions of systems thinking: the whole EA system should benefit net-effects of improved soft and hard empowerment, effectiveness and efficiency of EA utilization, management and development. We aim at collaborative EA thinking where EA is modeled once in independent terms that can be then mapped into the internal enterprise system components of EA management. Explicit EA business value, cost-benefit modeling and cost-calculations for EA are excluded from this study, but we acknowledge EA as a potential tool improving socio-economical visibility for decision-making.

Current enterprise modeling and benefit calculations are still made from an inwardly organized single organization perspective, which we will try to enhance towards outwardly organized business network thinking. We think that the soft and hard benefits of EA management should be recognized already at the single organization level, but net-economics of socially structured EA management could scale and grow to the business network and ecosystem level: more efficient operative control, coordination and communication of EA performance could even be improved by more effective capability, learning, knowledge and change management. Additional soft benefits could come from empowerment: net-effects of socially constructed and collaborative EA management could increase customer-oriented collaboration, co-creation and social innovations at the EA level. Thus the whole EA should be seen more like a roadmap of collaborative EA management, which will increase system complexity and the need for social and organizational perspectives of EA to enable informed decision-making regarding risks and benefits of EA and resource sharing. For example, the Resource-Event-Agent (REA) accounting model by McCarthy (1982, 2003) could enable new thinking for shared EA and EA management resources at the business network level. If EA models could be shared between organizations and business networks, then the REA model could be a capable to model net-economics and accounting of EA benefits at the business network level. We will not use or analyze the REA model in this study, but the same mindset is applied to conceptualize EA management and leadership potential at the business network level.

5.3.3 Giddens' Structuration Theory (ST)

Giddens' (1984) Structuration Theory (ST) is widely used in IS research (Jones & Karsten 2008; Poole & DeSanctis 2004). Giddens' structuration theory is a general theory of social organization concerning the relationship between individuals and society. Rejecting traditional dualistic views that see social phenomena as determined either by objective social structures, which are properties of society as a whole, or by autonomous human agents, Giddens proposes that structure and agency are a mutually constitutive duality. Thus social phenomena are not the product of either structure or agency, but of both. Social structure is not independent of agency, nor is agency independent of structure. Rather, human agents draw on social structures in their actions, and at the same time these actions serve to reproduce social structure.

In the structuration model, Giddens identifies three dimensions of structure: signification, domination and legitimation. Corresponding dimensions of interaction are communication, power, and sanctions. Structural dimensions are linked to interactional dimensions through modalities of interpretive schemes, facilities, and norms. Figure 20 illustrates major dimensions of Giddens' (1984, 29) theory.

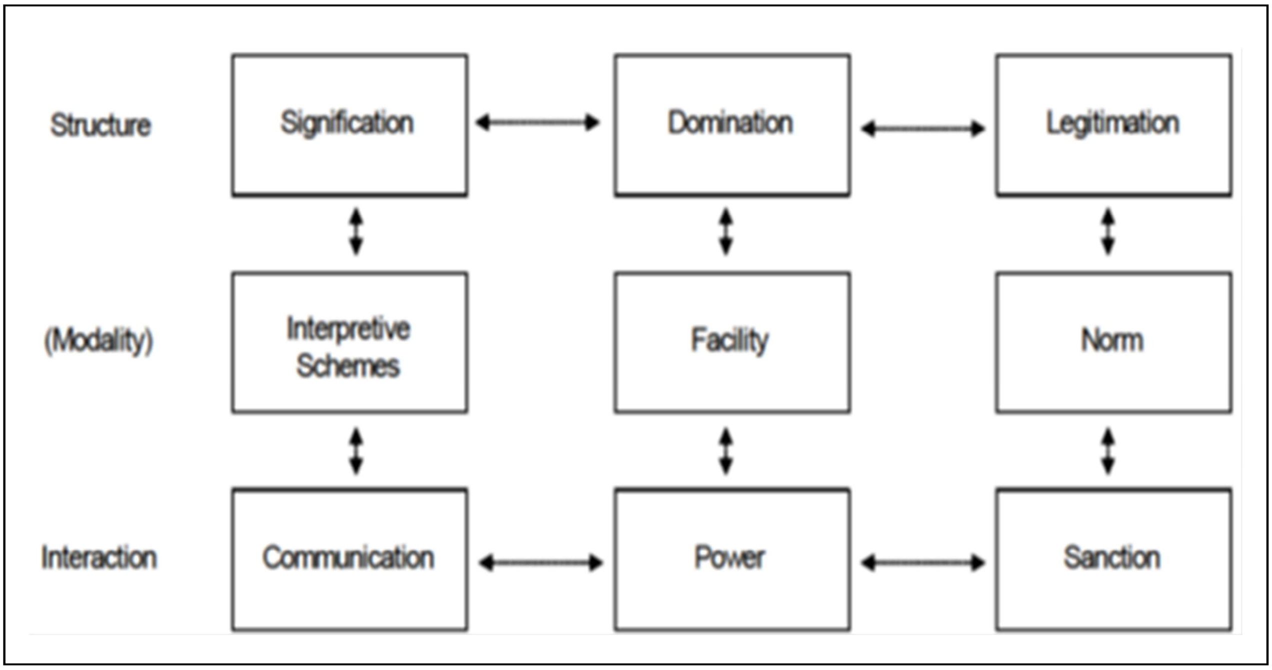

FIGURE 20 The dimensions of the Duality of Structure (Giddens 1984, 29).

Jones & Karsten (2008, 132) argue that Giddens is seeking to distinguish between how the physical world affects action and how social structure influences social practice. Giddens maintains that the rules and resources constituting structure are only in agents' heads. In IS terms, therefore, structure, as defined by Giddens, cannot be inscribed or embedded in technology since to do so would be to give it an existence separate from the practices of social actors and independent of action, thereby turning the duality, which is such a central feature of Giddens' position, into a dualism. Ontologically, a structure that resides in a real, material, artefact would also seem clearly distinct from one that exists only when instantiated in the practices of social actors. In IS terms, therefore, structure, as defined by Giddens, cannot be inscribed or embedded in technology, since to do so would be to give it an existence separate from the practices of social actors and independent of action, thereby turning the duality, which is such a central feature of Giddens' position, into a dualism. Ontologically, a structure that resides in a real, material, artefact would also seem clearly distinct from one that exists only when instantiated in the practices of social actors. Structuration, therefore, sought to avoid such asymmetrical and dualistic treatment of action and structure by conceptualizing the two as a mutually constitutive duality.

Shoib, Nandhakumar and Jones (2006) have analyzed Structuration Theory for sensitizing IS research for social issues. From a temporal perspective, they have noticed that Giddens ties the individual and institutional levels of social practice and highlights the recursive nature of social life at three planes of temporality (Jones 1999b, 111):

- Durée (the temporality of daily experience),
- Heideggerian dasein (the temporality of the life cycle, being-unto-death) and
- Braudel's longue durée (the temporality of institutions).

For our EA study, this indicates that these three different planes of morality are needed when analyzing EA as practice (durée), as system (dasein), and as knowledge (the temporality of institutions). As such, these three different time periods are quite clear, but at the same time are quite difficult to match with EA states of AS-IS and TO-BE. This implies that perhaps we should reconsider how to include temporal aspects and the relative and absolute concepts of time to our EA research frameworks. In our EA, study vignettes may be seen to mainly Braudel's longue durée as the temporality of systemic institutions like slowly moving physical structures (Tomich 2008, 3). EA and EAM could be seen as evolutionary sociomaterial concepts, which may exist and change at different temporal levels, perhaps closer to Heideggerian dasein (the temporality of the life cycle, being-unto-death). This kind of temporal shift occurred in IS history when the acronym ADP for Automatic Data Processing was changed to the concept of IT. We argue that IT and IT management practices could be moving into some more holistic systemic state and structured concept of EA and EAM. Löhe and Legner (2014, 108) have documented that the research gap between EAM and IT management research is only represented in some practitioner-oriented publications mentioning EAM's application in the IT management context. But we argue that because of sociomaterial nature of EA, this kind of temporal changes are complex systemic and subjective changes. Because of this temporal complexity of EA as sociomaterial phenomenon, our practice-driven attempts to also illustrate our vignettes and frameworks are subjective and partial views to complex systemic and temporal changes.

Giddens' structuration theory seems to offer conceptualization that could increase social structuration for EA towards EA management and leadership as an integration mechanism between business, process, IT and EA development. Strategic alignment theory by Henderson and Venkatraman (1989, 1993) emphasizes the dualism and alignment between business and IT, the thinking of which we are trying to eliminate by integration (like Leonardi & Barley 2010, 3). Instead of dualism, we are trying to integrate business and IT with EA, to reframe EA as a shared, co-created EAM structuration object between business, IS/IT and process development domains. Thus we are trying to create a conceptual EA management and leadership instrument for knowledge and change management. Improving communication about IT development and use should enable decreasing and even avoiding unintended changes and drift (Ciborra & Hanseth 2000) of EA without control or connection to enterprise-level business architecture and organizational goals. According to Shoib et al. (2006, 146) in their case study settings, structuration theory would seem relevant to an appreciation of the current situation: the immediate environment and recent experience of the social actors and the broader social and longer-term historical setting. This indication makes structuration theory valuable for understanding social change processes, which should enable social power relationships and possible change resistance. Social structuration towards EAM could integrate IT, business and process development enabling knowledge and change management mechanisms for enterprise and business network development. For these purposes, the EAM structure should include signification, domination and legitimation mechanisms for communication, power and sanction (Giddens 1984, 29).

Leonardi (2011) discusses about structuration theory and human agency to understand how flexible routines and technologies as material agency are intertwining into layered imbrications. Leonardi (2011, 150) states that Giddens' view of agency is developed and deployed in his specific discussions about social structure, which he argues "doesn't have the same kind of existence as a physical structure, nor do its causal effects". Leonardi (2011, 150) explains that while technologies are not within Giddens' sphere of interest, and hence not treated directly in a theory of structuration, this does not mean that they do not exert some form of influence on the social; but their influence is of a different order to that of the social agency/structure relationship with which Giddens is concerned in his work. For our study, Leonardi's (2011) discussions about material agency as social and technical intertwine into layered EA imbrications. This requires time and a longitudinal study to understand how temporal layering and structuration of EA emerge.

For our study, Giddens structuration theory offers conceptual lenses which should reframe EA into social structures for EA management and leadership. If EA management should enable agile change management, then business and IT alignment are not sufficient conceptual instruments for our purposes. Continuous aligning of business and IT needs stronger social structures into EA management and leadership, which we think could be applied from Giddens' theory. While Leonardi (2011, 150) recognizes that a structuration approach provides a useful framework for exploring how people actively structure their environments, it lacks a specific capacity for theorizing the role of technological artefacts. Some proponents of the human agency approach have looked to augment the structuration approach with the concept of "material agency", which they borrow from Actor Network Theory (ANT) discussed in the next sub-chapter.

5.3.4 Actor Network Theory (ANT)

While Giddens' Structuration theory is mostly discusses human agency and dialogue between social structures, Actor Network Theory (ANT) gives agency also to non-humans, animals and even technological artefacts. Thus ANT is pure social theory, while non-humans are getting more value as equal actors with humans. ANT is included into the genre of Science and Technology Studies (STS), which we will discuss later. ANT was originally developed in early 1980 while science research was being done by sociologists Callon and Latour. Harman (2009) presents Latour as a philosopher with the central concepts of actants, irreduction, translation and alliance. Because all these concepts are generic, they apply to technology, IT and EA. Next we will shortly present four Latourian core ANT concepts according to Harman (2009):

- All entities are equal actants, which is a quite close synonym to actor and object. An actor is its relations; all features of an object belong to it; and everything happens only once, at one time, in one place.
- The principle of irreduction means that nothing can be reduced to anything else. But at the same time, anything can be explained to anything else by seeing it in terms of a more fundamental layer of reality.
- By translation, Latour means labor, work or explanation, which is needed to link actors to each other.
- Actants are utterly concrete, but by making alliance with the world an actant comes more real. Actants are without their own inner kernel, and they are always completely deployed in their relations with the world (Harman 2009, 19).

Law has been participating in ANT research since its' early years, and currently he is maintaining the ANT resource collection (Law 2000) as part of Lancaster University website. ANT has been a successful actor in making alliances with various sciences, including organization science, other STS, IT and IS. This may be because of the origins of ANT are related to social structures of science. But ANT has also received severe criticism because of its relativism, its constructivism (Latour 2005, 91), and especially because it includes agency for non-humans as equal with human actors (Bloor 1999).

"I will start by saying that there are four things that do not work with actor-network theory: the word actor, the word network, the word theory and the hyphen!" (Latour 1999a, 15). With this quote, Latour himself agrees that ANT is not a theory, and calls it a crude method to learn from actors without imposing on them *a priori* definition of their world-building capabilities (Latour 1999a). ANT concentrates attention to movement between generic and local, from global to local and back, discrete and local, macro and micro (Latour 1999a, 17). This logic fits to EA technology and local EA system implementation with enactment. ANT argues that entities have no inherent qualities but acquire their form and attributes only through their relations with others in practice. In ANT there are no distinct and separate social or technological elements that might shape, or be shaped by, each other. In ANT, technological artefacts should be treated symmetrically to the humans, and as equivalent participants in a network of humans and non-humans that (temporarily) align or link to achieve particular effects and to create alliance. Sidorova and Kappelman (2010, 72) have reviewed EA through the lens of ANT, which seems to fit well for discussing the political and strategic nature of the EA and IS (Walsham 1997) requirements negotiation process.

ANT has many perils inspiring research in various practices. One of those is Pickering, who has been developing his version of social practice theory called "Mangle of Practice" in his seminal journal article (1993) and book (1995) with the same theme. Pickering (1993) agrees with ANT in his theory by stating that the basic principle of the actor-network approach is the most direct route toward a post-humanist analysis of practice by acknowledging the role for non-human-or material agency. Pickering (1993, 563) maintains that we should think semantically because semiotics teaches us how to think symmetrically about human and nonhuman agents. Semantically, as the actor-network approach insists, there are no differences between human and nonhuman agents: human and nonhuman agency can be continuously transformed into one another. But for Pickering (1995, 565) we humans differ from nonhumans precisely in that our actions have intentions behind them, whereas the performances (behaviors) of quarks, microbes, and machine tools do not.

Leonardi (2011, 150) maintains that the conceptualization of non-human entities, such as technologies, doing things that cannot be reduced to human intentionality is a core tenet of actor-network theory. We think that the ideology of ANT giving agency also for non-human artefacts fits to our thinking of EA as a combination of discrete technical agencies and technical structures; they make alliances to increase their own importance. But, at the same time, there is always the social side of this technological change, which may be called development for those that value and get benefits from technologies. Giddens discussed about the social side of this phenomenon where a human actor is in dialog with social structures, which can be developed and supported by technical structures and that consist of technologies which are developed and supported by human actors. Thus both Giddens' Structuration theory and ANT can be used for explaining EA as socio-technical system: Structuration within social systems, and ANT between socio-technical (sub-) systems.

5.4 Sociomaterial analysis for EA research: EA–framework initialization

After reviewing these major social theories, we are concerned about our instruments for sociomaterial analysis during the empirical EA study. The empirical part of this study contains 7 vignettes from EA development in our case enterprise. Before analyzing these EA vignettes, we would like to create a sociomaterial framework as a practical instrument for each development domain. We agree with Walsham (2005b) about the term of *development as something of concern for all individuals, groups, organizations and societies, and that many different global futures are possible depending on how well we succeed in realizing our development goals and aspirations.* Korpela, Mursu and Soriyan (2001) have covered all levels of analysis from the individual to the societal in their research agenda. The research framework from Korpela et al. (2001) is called “2*4 + history” and has the following structure:

- Covers four integrative social levels of analysis: individual, group/activity, organizational, and societal.
- Each level is divided into two viewpoints: intra (single case) and inter (multiple cases, relational, comparative).
- In addition, the temporal/historical dimension should be applied on all levels and viewpoints.

We apply this framework from Korpela et al. (2001) to our previous enhanced EA model presented in Fig. 19. With this combination, we create the following sociomaterial EA research framework (EA –framework) illustrated in Figure 21. This EA research framework we will use in our vignettes to study EA-in-practice.

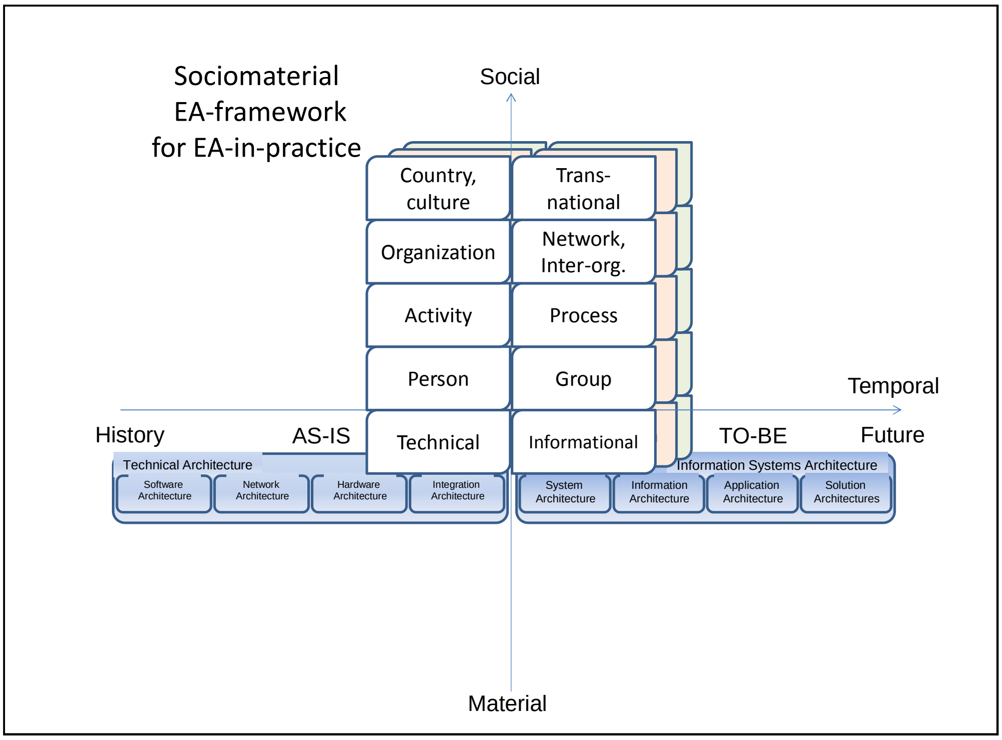

FIGURE 21 Sociomaterial EA research framework (EA–framework).

While studying EA, Giddens’ Structuration Theory could be used as a meta-theory to integrate and explain these social elements together. ANT could be used as a meta-theory to integrate and explain these social, technical and informational actors together. Now this sociomaterial EA research framework (EA–framework) contains elements for social, technical and informational analysis for various future TO-BE states, current status and historical continuum. At social side of the temporal axis is located a framework from Korpela et al. (2001), and at the technical side of the temporal axis are located the material realities, including aggregate presentations for informational and technical domains of EA. Both of these technical IT domains contain a lower level of presentations for Information Systems Architecture and Technical Architecture related sub-architectures, which should enable detailed planning and change management for various business and IT related reconfigurations. But, at the same time, when we acknowledge the emergent value of sociomaterialism in conceptualizing IT capability and subsequently in unraveling the contribution of IT capability toward strengthening business performance (Kim et al. 2013), we do acknowledge the theoretical challenges of sosiomateriality (e.g. Scott & Orlikowski 2013) and the practical challenges of IT for capturing and regulating sociomaterial plurality in organizations (De Vaujany et al. 2013). Despite ambiguity and several challenges, sociomateriality seems to inform IS research in order to reconcile the human/social and the technological dimensions of IS in a coherent way (Kautz & Jensen 2013, 15), and we as reflective practitioners challenge ourselves with sociomateriality while keeping sociomaterial axis as central part of our EA–framework.

Both Structuration Theory and ANT indicated some mismatch in our temporal axis, but we will still keep it untouched for further analysis. However, at the same time, we agree with Shoib et al. (2006) that both Structuration Theory and ANT seems to be applicable theories for sensitizing EA research to social issues. Now our EA–framework is ready for empirical elaboration.

5.5 STS theories for EA research: EAM–framework initialization

Before testing our sociomaterial EA–framework in a case company setting, we will evaluate this framework in theory by reviewing literature from Social Studies of Science and Technology (STS; Van House 2003). The boundaries between science and technology are fluid; the term often used in STS is “technoscience” (Haraway 1997). Wajcman (2008, 813) refers to Haraway’s image of the cyborg, which initiated STS research into biotechnologies potential to transform the relations between the self, the body, and machines. Emergent Technoscience studies biotechnologies ability to modify “nature” and the implications of this for rethinking our standard cultural categories of nature and culture (Wajcman 2008, 813). The same applies to medical, genomic, biomedical, environmental and ubiquitous technologies, as well as nanotechnology, which all are producing scientific results as new technologies and products into our everyday living making boundaries of the social and technical even more confusing. The transition from instrumental technology use seems to continue towards humanizing of technology and IT as part of so-called NBIC (nano, bio, information and cogno-technologies) convergence (Khushf 2004, 125). Because of the previous challenges of defining social and technical, and now this need for rethinking boundaries between social and technical, we also think that the socio-technical axis in our sociomaterial EA framework needs reconsideration.

According to Van House (2003, 4) STS‘s primary concern is the mutual constitution of the technical and the social. She argues that STS might be instructive for information studies as a source of generative understandings of

- Technology-in-use as socio-technical systems, ensembles of materials, machines, people (users, designers, operators, contributors, and others), practices, representations, understandings, categorizations, and other components, interacting with and mutually constituted by one another (Van House 2003, 72).
- Knowledge and knowledge communities, processes, practices, artefacts, and machineries (Van House 2003, 70).

STS could thus inform us and improve our understanding of EA-as-practice in both ways. Because IS research has a design and development focus, we will evaluate if STS's technology-in-use perspectives could improve our EA–framework. IS research tends to have more focus on systems than in information content or knowledge. Therefore, we'll use Van House's (2003) knowledge related theories from STS, which we will further enhance with socio-technical epistemic system theory from Simon (2010) and Longino‘s (2002) tripartite notion of knowledge as content, practices and cognitive agency. Thus we will evaluate whether or not these theories could improve our understanding and language for capturing knowledge-in-action within the EA domain.

Van House (2003, 18) states that technology is always a subject for social shaping or social construction seeing technology as the outcome of social negotiations between a diversity of different agents and stakeholders who are changing the course of technology through negotiations instead of fatalistically just dealing with consequences of uncontrollable technological progress (Simon 2010). According to these research streams, a technological artefact is developed while members of social groups negotiate the form and meaning of the artefact (as a boundary object). There are similarities with applying ANT (Sidorova & Kappelman 2010, 72) by showing that negotiations and different perspectives on the form, meaning and potential usage of an artefact have shaped its final form, helping to open up the black boxes of technology development and innovation. ANT seems to offer a balanced view to social and technological actors during technology development and use for studying social shaping and construction of EA as socio-technical discursive between social and technical forces. EA as a tool could enable more visibility for relevant social groups negotiating possible processes, systems, technologies and scheduling systemic changes from the AS-IS state through intermediate phases towards strategy-driven TO-BE operations.

Our EA study can benefit from Longino's (2002) work and theory of knowledge as content, as practices or procedures, and as a state (Longino 2002, 8). With this three-dimensional concept, Longino is trying to eliminate (de-construct) the dichotomy between rational and social spheres as opposites for each other. Longino (2002, 2) argues that both scientific and everyday knowledge are at the same time integratively social and rational/cognitive as content, as practices and as a state. This same three-level conceptual model can be applied to our EA study, which should see EA-as-knowledge, which again could be divided into EA-as-content, EA-as-practices or EA-as-procedures, and finally EA-as-state. At the philosophical level, this view or thinking EA-as-knowledge could be named an epistemic perspective to EA, which now could include knowledge, information, data, content, process, practices and states as entities on this continuum. Thus knowledge management (KM) is an important part of the EA management structure.

Haraway's (1997, 27) ideas of figuration, seeing all languages as figural and technology as materialized reconfiguration, have inspired Suchman (2007, 1) to rethink human-machine configurations as cultural and material reconfigurations. Instead of sharply separating the human and the machine and discussing issues of agency and responsibility within this dichotomous framework, Suchman (p.283) discusses cutting the network as a foundational move in the creation of sociomaterial assemblages as objects of analysis or intervention. In reconfiguring the human-machine interface, Suchman (p.283) acknowledges that rethinking and reconfiguring boundaries and interfaces between humans and machines requires new more performative and dynamic agential cuts: drawing lines and making boundaries are basic tasks in our daily acting in the world just as much as they are basic tasks for designers of technologies. But agential cuts are never innocent; they have consequences; they include and exclude, and we are to be held accountable for the consequences of our actions even if we cannot foresee them. (Suchman 2007, 285)

From the idea of non-innocent agential cuts (Suchman 2007), we have got our inspiration to rethink, reconfigure and shift motives to do these agential cuts. When we combine this motivational perspective of making agential cuts into the ontological/material substance of EA-as-technology, as well as the epistemological/cognitive processes of EA-as-knowledge, we are (re)thinking ethical/moral dimensions of EA for change. This ethical/moral dimension of EA matches with Barad's (2007, 7) quote from Bohr, who has stated that *moral issues always finally depend on the epistemological one, on the judgment of other people's motives, because if you can't have any knowledge of other people's motives, it's very difficult to come any objective moral judgment of their behavior.* When we exclude some behavioral and social information and entities, knowledge and actors from AS-IS EA models, we include some other information models, technical actors, entities, design elements and change to TO-BE EA models. These changes may cause an intended or unintended lock-in to some vendor or technology, which may be culturally or economically in conflict with existing resources and realities. Actually, now with this ethical/moral dimension of EA, we are achieving a three-dimensional, higher level EA construction, which we will call our integrative EAM research framework (EAM–framework). Logically, this seems to us to be similar to Barad's (2007, 26) philosophical framework, which she defines as follows:

> *"agential realism" as an epistemological-ontological-ethical framework that provides an understanding of the role of human and non-human, material and discursive, and natural and cultural factors in scientific and other social-material practices, thereby moving such considerations beyond the well-worn debates that pit constructivism against realism, agency against structure, and idealism against materialism. (Barad 2007, 26)*

Our intention to shift EA thinking from technological determinism and IT towards an emergent process of socially practical EA and meta-IS really requires reconfigurations and rethinking lines and cuts between enterprise, business, processes and IT. With this integrative EAM research framework (EAM–framework), we are trying to study EA phenomena in a case company setting at the generic level, minimizing ethical insider conflicts (Fetterman 2010, 134) and enterprise as socio-economic entity (Chattopadhyay 2011, 22). We will use this EAM–framework as our research instrument to balance the ethnographer's challenge at the crossroads, which requires intelligent and informed decisions that satisfy the demands of science and morality (Fetterman 2010, 140).

Our EAM–framework tries to capture the ontological substance of EA, including the social and technical, the epistemological/cognitive processes of EA-as-knowledge, and ethical/moral dimensions of EA in practice. But temporal integration of EA models is still limited. Understanding EA-as-complex-phenomena requires cultural and historical views to AS-WAS and current AS-IS situations, creating capabilities, affordances and constraints, and how possible TO-BE architectures could change this existing situation. In our EA study, we have registered this issue with the concept of time and the challenge of understanding various temporal dimensions of being. Barad (2007, 7) quotes Werner Heisenberg's (1927) uncertainty principle saying that there is a necessary limit to what we can simultaneously know about certain pairs of physical quantities, such as the position and momentum of a particle. When we are trying to transfer this ideology into an EA context as an EA uncertainty principle, we argue that there seems to be a necessary limit to what we can simultaneously know about some temporal EA position (history/AS-WAS, current/AS-IS and future/TO-BE) and momentum (speed, affordances, motivations, constraints of movement at certain moment) of the social, sociomaterial and technical. EA is a complex sociomaterial activity system, which we are not able to fully capture and understand within our EA study. If and when we are not able to create an integrative temporal dimension for EA studies, we prefer modeling changes instead of positions. For our EA study, this means that we value more information about temporal changes in the EA domain, than exact information about certain EA positions. This will be our intentional compromise to exclude details of certain temporal statuses of EA, and to concentrate on changes and momentums of the change. Enhancing our EA- framework, we have reconfigured the following integrative EAM research framework (EAM–framework) illustrated in Figure 22. This EAM research framework EAM–framework we will use in our vignettes to study EAM-in-practice.

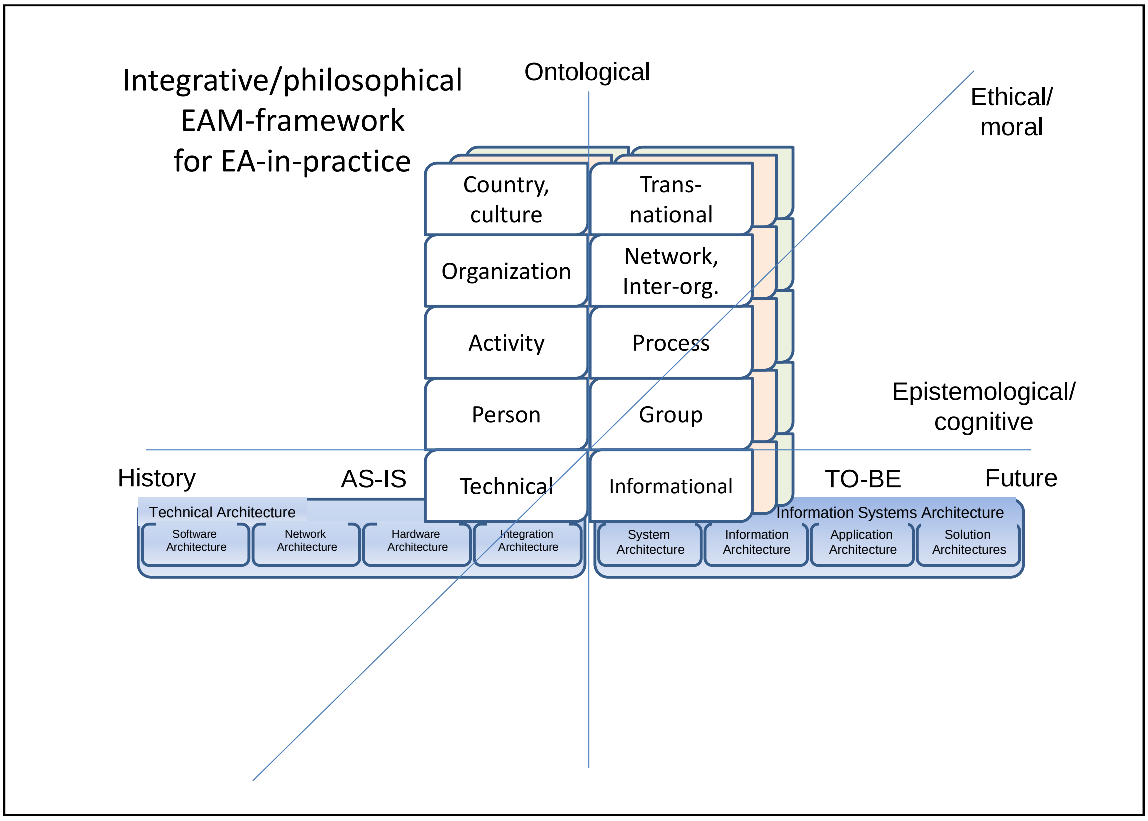

FIGURE 22 Integrative EAM research framework (EAM–framework).

Now we think that our integrative EAM research framework (EAM–framework) acknowledges the ontological/material substance of EA-as-technology. The epistemological dimension of EA-as-knowledge seems to shift to constructionism, which could improve EA as a knowledge management tool and shared boundary artefact for learning-in-practice and learning-by-making together. This shifts our thinking of EA-as-practice at ethical/moral dimensions higher towards shared knowing and knowing together, which Simon (2010) has discussed in her thesis regarding socio-technical epistemic systems. Ethical/moral dimensions of EA-as-practice are also challenged because of technology-enabled social development. This remark from Leonardi and Barley (2008, 164) is related to the epistemic dimension of IT, which enables transforming one type of information into other types of information that can be acquired by no other means. Thus IT is enabling ontological and epistemic shifts, offering social affordances, constraints and workarounds, which will change the nature of the work itself, practices, tasks, roles, responsibilities, and social networks (Leonardi & Barley 2008, 166). For enterprise, these new material reconfigurations offer various possible organizational structures and configurations, which may cause social dynamics and totally new sociomaterial structures. Therefore, we have included the ethical/moral axis into our EAM–framework, which now enables us to sense and evaluate ethical principles and moral consequences of systems development with our case organization setting.

Leonardi (2011) has documented this transformative feature of IT from the case of a computer simulation technology for automotive design to illustrate how perceptions of constraint lead people to change their technologies and how perceptions of affordance lead people to change their routines. By using the metaphor of *imbrication* Leonardi (ibid., 147) suggests how a human agency approach to technology can usefully incorporate notions of material agency into its explanations of organizational change. Leonardi (ibid., 150) is referring to Taylor (2001), Ciborra (2006) and Sassen (2006), who have start characterizing the interweaving of human and material agencies as a process of imbrication, which means to arrange distinct elements in overlapping patterns so that they function interdependently. Ciborra (2006, 1340) refers to Latour's (1999b) term *imbroglio* as an attempt to replace the word 'network' in ANT because the concept of network turns out to be too Cartesian and tidy. The concept of imbrication better captures the reciprocal, self-reinforcing, often non-linear, impacts of one representation upon the other (Ciborra 2006, 1340). This interesting new metaphor of *imbrication* comes from the material process of roof making, and while having a totally material origin, this new language really calls for careful social sensitivity for human intentions and social dynamics. This conceptualization seems to support our aim to understand temporal, layered and inter-twining processes of EA reconfigurations.

5.6 External knowledge-sharing perspective initialization

New transformative technologies and organizational arrangements are causing pressures for the understanding epistemic dimensions of EA-as-knowledge and sociomaterial actors converting knowledge and cognitive structures. But these changes are especially challenging the change management dimension of EA-as-practice for sharing human intentions and goals triggering changes to social structures, networks, cultures and even regional and global division of labor within EA activity system.

Regarding this practice-related movement between various perspectives Østerlund and Carlile (2005, 92) argue that while making a sidestep they call the 'substantialist view', practice theories create a dynamic *theory of relational thinking*, which prove helpful in breaking down problematic dichotomies imposed by non-relational theories like objectivism and subjectivism, and at the same time focuses on interactions or relations that capture recursive dynamics of a given relation and everyday practice as the locus for the production and reproduction of relations. Their approach to create an analytical framework for capturing this relational thinking from practice theories, and then to apply their framework in knowledge sharing theories, has many analogies with our EA study principles. Their study is done by comparing four different knowledge sharing theories with seven relational attributes, which we will try to use as an external knowledge-sharing perspective to our EA vignettes.

The external knowledge-sharing perspective from Østerlund and Carlile (2005, 92) offers a practical lens to knowledge sharing theories having many analogies with our EA study principles. Their study is done by comparing four different knowledge sharing theories with seven relational attributes, which we will now try to use as an External perspective for knowledge-sharing. Thus, we are trying to use these seven attributes of “difference”, “dependencies”, “change”, “power”, “blurring category boundaries”, “empirical units (active units, temporal organizations, kinds of activities)” and “historically constituted or emergent structures” as perspectives to epistemological dynamics of system related knowledge-sharing within our case enterprise context.

We are using these knowledge-sharing attributes in triangulating each EA vignette from a knowledge management and transfer perspective. This perspective forces us to analyze each EA vignette, our EA observations and our own understanding of the socio-material changes as well as the organizational structuration with lenses by Østerlund and Carlile (2005, 92).

5.7 Summary of social theories for EAM

In this chapter, we have elaborated social theories for socially structured EA as EA management and leadership practice. In the next chapter 6, we will present theoretical, methodological and practical considerations of our EA study setting and our case enterprise. Then, the following chapter 7 presents seven system development cases as vignettes, which we will analyze using our IT-, EA- and EAM–frameworks and external knowledge-sharing perspective (Østerlund & Carlile 2005, 92).

6. Practice-driven EA research setting

This chapter introduces theoretical, methodological and practical considerations as well as the organizational background of this empirical study of EA in our case enterprise setting. In practice, this EA study utilizes observations regarding business, IS and IT development initiatives from our fieldwork in a case enterprise between the years 1996-2011. These observations are our empirical data from over 15 years at Nokian Tyres. During these years, the author has been acting in various roles between business, IS and IT development. In this study, we will analyze, explain and reflect on these field-work observations and experiences using our EA frameworks from previous chapters. While doing so, we will test our EA frameworks for understanding EA-as-complex soci-omaterial phenomena, and to reframe substantial EA theory in a more socially practical direction.

First, the theoretical and practical study settings and their connections to scientific the-ories will be presented. After that, we will review industrial and enterprise level busi-ness development for our case enterprise. This part of the study presents industrial history and company cultures of this enterprise. When our EA research setting is pre-sented, the empirical EA research flow goes in a bottom-up approach presenting our seven EA vignettes and empirical findings. But before exploring our seven EA vignettes in our case enterprise, we will explain and elaborate our theoretical and organizational research settings to analyze EA-in-practice.

6.1 Theoretical concerns about study settings and strategy

Our study can be classified as qualitative research on information systems (IS). Quali-tative research methods were developed in the social sciences to enable researchers to study social and cultural phenomena and designed to help researchers understand people and the social and the cultural contexts within which they live (Myers 1997).

Both definitions are a good match to study EA as a complex sociomaterial phenomenon.

Dobson (1999, 2001) presents three alternative approaches for theory use in an interpretive case study, which he calls “No theory – Grounded Theory”, “Single Theory – Authentic Theory Use”, and “Multiple Theory – Theory as Scaffold”. Because we perceive EA as complex and multi-faceted social and organizational phenomena, some theoretical triangulation is needed. Therefore, our study applies multiple theories, which enable multiple views and more rich perspectives to increase the relevance of the findings and implications. From Dobson’s (1999, 2001) critical realist perspective and context-dependent framework for theory selection for longitudinal case research, we can find evidence in our study for selecting a pluralist approach, which recognizes both structure and agency, micro and macro, as well as the individualist and collective ideals. Thus we agree with Orlikowski and Baroudi (1991, 1) that in IS research *much can be gained if a plurality of research perspectives is effectively employed to investigate information systems phenomena*, while applying interpretive and the critical perspectives into complexity of EA-in-practice. Plurality of research perspectives in this study includes various forms of Engaged scholarship.

6.1.1 Tackling theory-practice gap with Engaged IS scholarship

Our study process started with strong practice-driven orientation, which called for an active and collaborative research approach. Mathiassen and Nielsen (2008, 4) present a collaborative research approach called Engaged scholarship by Van de Ven (2007) who argues that academic and professional knowledge represent different but related domains. Mathiassen and Nielsen (2008, 4) refer widely to Van de Ven (2007, 2), stating that *much of the published research by professional schools and IS scholars “is not contributing in intended ways to either science or practice”,* but resulting in a theory-practice gap between professional disciplines and practicing professionals, a gap which engaged scholarship is trying to tackle. Thus there seems to be need for new, more collaborative research practices, and engaged scholarship tries to respond to this need as *a participative form of research for obtaining the different perspectives of key stakeholders (researchers, users, clients, sponsors, and practitioners) in studying complex problems”* by four different forms (Van de Ven 2007, 9)

1. Informed basic research to describe, explain, or predict a social phenomenon;
2. Collaborative basic research like informed basic research, but it entails a greater sharing of power and participation between researchers and stakeholders;
3. Design and evaluation research focuses on normative knowledge related to design and evaluation of policies, programs, and models for solving practical problems within a profession; and,

4. Action research applies to intervention to address a client problem while at the same time contributing to academic knowledge.

During our EA study, we have been changing our approach from informed basic research and collaboration to action research. Perhaps this can be explained by the long study period which included more intensive attempts to change the existing processes. But there also were periods that included more intensive IS development work, when EA study was done more in an informed basic research mode.

Mathiassen and Nielsen (2008, 6) have found a simpler way to classify forms of engaged IS scholarship based on underlying knowledge interests (Mathiassen 2002):

1. Practice research: understanding IS practices to inform or advise stakeholders.
2. Design research: designing various forms of artefacts to support stakeholders engaged in IS practices.
3. Action research: changing IS practices through problem solving in response to specific client needs.

This classification above seems more natural for starting engaged IS scholarship for an author such as a Ph.D. student. But the same answer applies with this scale as with Van de Ven (2007): during our study, the author has been changing roles and research approaches from practice research to action research. While doing practice research, the author has been able to understand business requirements and various options for changing EA towards expected TO-BE objectives. While doing design research, the author has been producing various “big pictures” to illustrate, communicate, and support decision-making by explaining various options of changes for stakeholders. Sometimes, the author has been doing action research by trying to solve EA related issues at business, EA, EIS, IS or IT levels because all these different problem solving layers have been available for our problem solving process as an IS manager working for our case enterprise.

But when applying an action research method, there is a danger that situation specific problem solving leads to a solution architecture, which may conflict with the holistic EA goals. We think that this issue is typically a hidden trap for action research cases for engaged IS scholars: academic help is requested and accepted in a case company when practitioners are facing bigger problems than they can solve, which leads to solutions that are optimizing some component in the equation, most often the one that is in a comfort zone for the researcher. But in the long run this solution (architecture) may not be optimal for the whole system and enterprise (architecture). The author’s active EA study phase in our case enterprise (re)started in a similar situation at the end of 2006, when our case enterprise had major problems in its logistics center because of a newly installed Warehouse Management System (WMS). This event triggered the author’s explorative and practice-driven EA research flow into our case enterprise. But before going into details of the WMS vignette, we will elaborate further our research setting and theoretical challenges.

6.1.2 Mainly Interpretive epistemology, but…

When we are analyzing and explaining our philosophical perspectives and *underlying epistemology as assumptions about knowledge and how it can be obtained* (Myers 1997, 4), we are getting more confused how positivist, interpretive and critical approaches are mixed in our study. Our subjective study regarding IT and EA as meta-IS presents primarily interpretive epistemology because of aiming to *understand phenomena through the meanings that people assign to them (Myers 1997, 2)* and *producing an understanding of the context of the IS, and the process whereby the information system influences and is influenced by the context* (Walsham 1993, 4-5). Our research question can be seen as an attempt to enhance technology-driven EA thinking with a wider social context and organizational sensitivity. Myers (1997, 2) discusses interpretive research *focusing on the full complexity of human sense making as the situation emerges*, a definition which has much resemblance with our attitude towards understanding EA as emergent and evolving complex sociomaterial phenomena.

When we are reflecting on a technical/operative EA study framework for the IT (IT–framework) layer, our vignettes present some elements from Yin’s (1981) implicitly positivist stance to case study, as well as positivist engineering driven components from objectively given technology. While setting the ground and foundations for our substantial EA study for IT side, we may have precursors from the objectivist tradition, which assumes that an object possesses objective properties, which we are subjectively and dis-connectively perceiving (Greiffenhagen & Sharrock 2008, 77). Bunge (1993, 209) states that an account of a fact (or group of facts) is objective if and only if (a) it makes no reference to the observer and (b) it is reasonably true (or true to a sufficient approximation) - otherwise it is *subjective*. Bunge (ibid.) continues to define that objectivism or realism is a philosophical doctrine with the view that, except in the arts, we should strive to eliminate all subjective elements from our views about reality. Thus while reporting on our EA study of the IT layer using our IT–framework, we are triangulating our observations and IT/IS related data sources, aiming at a reasonably true account of a fact and striving to exclude our own feelings and desires in our pictures of the external world. While reporting our observations from IT/IS domain, our study can be classified as "descriptive" positivist work (Orlikowski & Baroudi 1991, 5) because we are not attempting to create theoretical grounding or interpretation of the phenomena; rather, we are presenting what we believe to be a straightforward "objective" and "factual" account of events to illustrate some issue of interest to the IS community. We do acknowledge ontological challenges but try to document and study EA development with an idiographic attempt to understand a phenomenon in its context (Franz & Robey 1984).

On the other hand, when we are reflecting our perspective to the substantial EA layer, and while we are analyzing our EA observations with our sociomaterial/managerial EA study framework (EA–framework), we are explaining EA-in-practice mainly from the interpretive perspective. Thus our substantial EA study is intentionally moved away from the objective worldview towards a subjective mindset. Bunge (1993, 210) defines *subjectivism as a philosophical view that the world, far from existing on its own, is a creation of the knowing subject*. Perhaps we could define this part of our EA study as our first-order descriptions of this EA as phenomena about which subjective observations and documented sensory-data from perceived reality should be treated as EA data. At least this thinking is in line with Greiffenhagen and Sharrock (2008, 87) who suggest that *social practice theory does not want to ignore individuals' (first-order) descriptions, but 'their description[s] must be addressed as data, not as part of the analysis'*. This interpretive part of our study is in accordance with Orlikowski and Baroudi (1991, 13), who have defined the interpretive worldview of IS research as follows: *The world is not conceived of as a fixed constitution of objects, but rather as "an emergent social process-as an extension of human consciousness and subjective experience" (Burrell & Morgan 1979, 253).*

On the other hand and the next level, we are reflecting our ontological, epistemic and ethical approach in this EA study. While elaborating on the second-order conceptualizations of EA, we find many similarities with critical research. Myers (1997) maintains that *critical researchers assume that social reality is historically constituted and that it is produced and reproduced by people: although people can consciously act to change their social and economic circumstances, critical researchers recognize that their ability to do so is constrained by various forms of social, cultural and political domination.* Thus from this EA study we can find a social critique of the current theory of EA being a technology driven construct echoing technical determinism, which could be made visible and balanced by reframing EA as a sociomaterial epistemic system. Stahl (2008, 137) presents that *research is critical, when it is motivated by the intention to change social realities and promote emancipation*. Orlikowski and Baroudi (1991, 19) argue that *critical perspective is concerned with critiquing existing social systems and revealing any contradictions and conflicts that may inhere within their structures.* These critical research elements can mainly be found in the ethical dimension of our integrative/philosophical EA research framework (EAM–framework) and when explaining how ontological, epistemic and ethical dimensions of EA are in tight intra-action with each other. But again, these indications of having elements from critical theory seem to shift our EA study towards a generic and objectivist approach, which may occur by *adopting an external or transcendent viewpoint and therefore seem to exclude actors' personal* *or individual experience* (Østerlund & Carlile 2005, 92) with external knowledge-sharing perspective elaboration. But, at this point of analysis, we confess our limits to capture the social and technical fluidly. Thus we accept and adapt the interpretive research approach, which admits that a researcher can never assume a value-neutral stance, and is always implicated in the phenomena being studied, and researchers' prior assumptions, beliefs, values, and interests always intervene to shape their investigations (Orlikowski & Baroudi 1991, 15).

6.1.3 Integrative EA process study at a mixed level of analysis

While analyzing causal structure of research on IT and organizational change, Markus and Robey (1988, 584) have divided research streams based on causal agency, logical structure and level of analysis. Regarding causal agency their classification contains technological imperative, organizational imperative and emergent perspective. We argue that our study goes beyond that classical division towards an integrative perspective of IT and organizational change. Regarding the logical structure, Markus & Robey (1988, 590) refer to Mohr (1982) while dividing research streams into variance or process research. With this dichotomy, our study presents a clearly longitudinal process research category, the feature of which we will shortly elaborate in the section below. Based on the level of analysis, Markus and Robey (1988) have divided research streams into three different categories concerning individuals, organizations, or society. In this respect, our study can be classified as mixed-level, but there may be a slight tendency to include more micro-level explanations because an empirical study is executed by one individual and inside one enterprise spanning between many separate organizations. Actually, this matches well with Markus and Robey (1988, 584) because in their classification model mixed is a sub-category for the micro-level of analysis.

Markus and Robey (1988, 592) promote process research to study behavioral patterns of social phenomena: process theories are useful precisely because, while recognizing and accepting the complexity of causal relationships, they do not abandon the goals of generalizability and prediction (p. 593). We agree with them. Therefore, this EA study is a longitudinal process study where the author as a practitioner and researcher has been involved deeply in the EA processes and flow, collecting fine-grained, rich and thick data from EA process directly (Langley 1999, 691). This study is longitudinal in order to follow and document EA development with a bottom-up approach. Our EA vignettes have occurred between the years 1996-2011. The ERP vignette is included to create a background for other vignettes, which have occurred between the years 2006-2011. These seven vignettes are our primary data source, and samples of knowing in practice, which the author is trying to document and analyze as a reflective practitioner (Heiskanen & Newman 1997; Schön 1983).

To conclude the review of our theoretical setting for this EA study, it seems that, following Østerlund and Carlile (2005), this work could also be defined as dynamic practice theory of relational thinking on EA. Next, we will shortly describe and explain principles of our research method and design elements in theory and practice.

6.2 Methodological concerns

When we were starting to realize how complex socio-technical phenomena EA-in-practice is, at the same time, we initiated planning process of understanding and capturing it in a holistic manner. For us, it emerged that the most natural way to EA understanding was a longitudinal dive into the EA process itself, but methods of data collection were needed for study execution. Transition from a research strategy to a method selection seems to be quite obscure:

> *Research method is a strategy of inquiry, which moves from the underlying philosophical assumptions to research design and data collection. The choice of research method influences the way in which the researcher collects data (Myers 1997. 6).*

Walsham (1995b, 77) emphasizes the importance of selecting role of the researcher as outside observer or involved researcher enacted through participant observation or action research. During our EA data inquiry from case enterprise, our role has been varying from outside observer to employee, giving us even more of an inside view but also presenting more ethical challenges than those an involved researcher may face. The author's role has been that of an involved researcher changing from participant observation to action research. First, we will elaborate on the participatory design setting for our study approach.

Participatory design

Bødker and Pekkola (2010, 45) argue that participatory design (PD) is a long-lived tradition of systems design with active user participation; its roots can be tracked in the work of Kristen Nygaard and Olav-Terje Bergo with the Norwegian Iron and Metal Workers Union in the 1970s. The early years of PD seems to have had a highly political focus, which Kyng (2010, 52) states had the ideal of workplace democracy and Trade Unions safeguarding user interest. But recently these political trends seem to have changed towards partnerships, where PD researchers have promoted user involvement for better systems for all. In our study, we share the same ideal, which Kyng (ibid.) establishes to be a challenge for future PD practices: to design better EA systems for users and for organizations. We argue that this requires more human orientation and a wider social participation than EA design and development so far.

The author's engagement in our case enterprise has given direct access to confidential insider information sources. All peers, team members, vendors, IS and business development partners have been at some level aware about the author's double-role as ICT professional and Ph.D. student, but the subject of this study has not been explicit nor understood by most. During longitudinal fieldwork, the author's role as engaged IS scholar has been irrelevant for our practical, everyday contributions. But at the same time, the author has documented daily observations with a working diary and field notes, which are used as primary, first-order data for this study. The author has also recorded his own thinking regarding EA and conducted some interviews during fieldwork, the materials of which are used as second-order data to support diary and memories about our attempts to understand and develop EA in the case enterprise. The author has enjoyed great moments with bosses and peers while discussing and reflecting on the challenges in EA development and management. These moments were really attempts to combine scientific and practical knowledge of EA and to eliminate the theory-practice gap between professional disciplines and practicing professionals (Van de Ven 2007, 2) in the spirit of participatory design.

The main study approaches in our empirical fieldwork include case study and ethnography, but some action research features may be also found, at least implicitly. Next, we will explain how the case method has been our primary research method in this EA study and, after that, how we have applied ethnography and action research in our data collection.

Case study

In early the 1980s, the case study method was in crisis because of strong criticism regarding the lagging rigor of the results (Yin 1981). Yin (1981, 59) argued that the distinguishing characteristic of the case study is that it attempts to examine*:*

- a contemporary phenomenon in its real-life context, especially when
- the boundaries between phenomenon and context are not clearly evident.

For us EA is both a contemporary phenomenon and its' boundaries with context are not clear; therefore, the case study method seems to be the most applicable strategy of inquiry for EA as a complex sociomaterial phenomena. Dooley (2002, 335) argues that *case study research is one method that excels at bringing us to an understanding of a complex issue and can add strength to what is already known through previous research*. Therefore, case study research seems to be a good fit for our intentions to add our knowledge regarding the EA domain.

But the term "case study" has multiple meanings: it can be used to describe a unit of analysis or to describe a research method (Myers 1997). In our EA study, we have applied case study in both meanings: whole qualitative data is collected from one case enterprise, where vignettes are cases from development initiatives that are building layers of EA within our case enterprise. Because of these multiple meanings of the "case study" concept, we have decided to call these units of analysis *vignettes* (like Orlikowski 2006), which refer to personal, subjective experiences similar to Simonsen's (2009) understanding of some events and activities, which are these development initiatives from our case enterprise. While analyzing and reporting each vignette, we are trying to follow the conceptual definition of a *good case* by Dooley (2002, 337):

> *A good case is generally taken from real life and includes the following components: setting, individuals involved, the events, the problems, and the conflicts. Because cases reflect real-life situations, cases must represent good and bad practices, failures as well as successes.*

While analyzing each vignette, the author's personal, subjective experiences and understanding of these events are supported with working diaries, project plans, meeting memos, presentations and other available development documentation. During vignettes, we explain how this case enterprise is successfully developing implicit EA in practice without following any explicit EA method or framework.

Thus our EA study is a case study at several levels. Technology-wise our vignettes present various practices and technologies with several organizational levels and varying results and outcomes. In our study, we try to be neutral and avoid Dooley's (2002) style to value some practice good or bad, or outcomes as failures or success. Because we are not trying to create an inductive theory from vignette data like in Grounded Theory, our study process does not follow theory-building process like Eisenhardt (1989, 533). Our process is more like an iterative and interpretive process, which follows ideas from Walsham (1993; 1995a; 2006). Walsham (1995a, 376) argues that *interpretive methods of research adopt the position that our knowledge of reality is a social construction of human actors*, the ideology of which we have followed when comparing existing EA theory and our understanding of EA practices in our case enterprise. Our study is very similar in logic with Walsham (1998), where case studies are used as micro-studies and Giddens' (1984) Structuration Theory as macro-theory. Results of Walsham's (1998) study have major resemblance to our study: the macro-theory is applied to generalize results from micro-studies, and micro-studies are used to create an IT dimension to the high-level macro-theory. Walsham (1998, 1081) offers a starting point for the investigation of IT and social transformation across multiple levels of analysis by saying that

> *"If we try to generalize from these micro-studies, we need concepts and theories which transcend the particular case settings, and linking the micro-studies with macro-theory is one approach to this problem of generalization". (Walsham 1998, 1088)*

In a similar manner our EA study uses vignettes and a case enterprise setting to present micro-studies regarding dialog between EA AS-IS, development projects, IT and business towards EA TO-BE goals. Our frameworks and theories from the social sciences are used to transcend these case study settings for reframing EA for more social practices. Thus our case study approach could be defined to use a single-case approach to richly describe the existence of EA phenomenon and enable emergent theory building, and vignettes are used as a multiple-case approach for validating emergent theory with ethnographic field study (Eisenhardt & Graebner 2007).

Ethnography

Myers (1997) argues that ethnographic research comes from the discipline of social and cultural anthropology where an ethnographer is required to spend a significant amount of time in the field. In a 1999 tutorial article regarding ethnographic research, Myers (1999, 1) argues further that

> *Ethnographic research is one of the most in-depth research methods possible. Because the researcher is at a research site for a long time - and sees what people are doing as well as what they say they are doing – an ethnographer obtains a deep understanding of the people, the organization, and the broader context within which they work. Ethnographic research is thus suited to providing information systems researchers with rich insights into the human, social, and organizational aspects of information systems. (Myers 1999, 1)*

The ethnographer participates in the daily routines of this setting, develops ongoing relations with the people in it, and observes all the while what is going on (Emerson, Fretz & Shaw 2011, 1). The ethnographer adopts a cultural lens to interpret observed behavior, ensuring that behaviors are placed in a culturally relevant and meaningful context (Fetterman 2010, 1). Thus in an organizational setting it seems obvious that ethnography could be a quite good match for studying technology (Prasad 1997), enterprise and EA-in-practice. Shoib et al. (2006, 143) have selected ethnography as the main data collection approach for their qualitative study for ANT and Structuration Theory in IS research because ethnography has an *emphasis on meanings, detail, understanding and openness, while a multi-data approach is compatible with social constructionism, assumptions and interest in multiple perspectives, context, social processes, everyday life (Schwandt 1994) and Information Systems in context (Myers 1997).* Our study has similarities with the Shoib et al. (2006) study, which makes ethnography a likely classification for our fieldwork. Furthermore, while we are studying EA-in-practice, ethnography is argued to be applicable, especially for practice-based theorizing about knowledge in practice (Carlile 2002), and *ethnography is the key methodology with which to observe social and situated practices and simultaneously to participate in them* (Corradi et al. 2008, 23). The ethnographer seeks a deeper immersion in others' worlds in order to grasp what they experience as meaningful and important (Emerson et al. 2011, 3). The ethnographer enters the field with an open mind, not an empty head (Fetterman 2010, 1). Our situation was very valid because of a long relationship with our case company. In our research, the setting of learning-by-doing and experiencing (Emerson et al. 2011, 3) various enterprise structures, cultures and sub-cultures of EA-in-practice were a major part of the participation and systems development work. The most important element of fieldwork was being there, to observe, to ask seemingly stupid but insightful questions, and to write down what is seen and heard (Fetterman 2010, 9).

But there are also some concerns, which are related to the classification of our EA study. Myers (1999, 4) defines the main difference between a case study research and ethnographic research is the extent to which the researcher immerses himself or herself in the life of the social group under study. According to Myers (1999, 4) in a case study, the primary source of data are interviews, supplemented by documentary evidence such as annual reports, minutes of meetings and so forth. But in ethnography, these data sources are supplemented by data collected through participant observation. This definition relates to another concern. Schein (1987) argues that an ethnographer explicitly aims not to change the culture of the system being studied nor to help or influence it instead, taking up a role as an unobtrusive participant observer. In this sense, our EA study approach differs from ethnography in that the author's implicit approach and some actions as a practitioner were trying to change case enterprise and its' operations into more intentional EA practices and management. Thus our EA study approach has some features from Action Research, which Myers (1997, 6) defines according to Rapoport (1970, 499):

> *Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework (Rapoport, 1970, 499).*

The author's fieldwork included more collaboration and active EA development approach than ethnography seems to include. But according to Emerson et al. (2011, 3), some ethnographers seek to do field research by doing and becoming – to the extent possible – whatever it is about which they are interested in learning. This approach applies well to our fieldwork execution. Myers (1997) comments regarding these collaborative features in action research indicate possible ethical dilemmas on attempts to change the subject under study, which is an issue on which we will elaborate later. Lallé (2003) also refers to Rapoport (1970), while arguing that action research seeks to contribute to both practical problem solving and the advancement of social science theory. While Lallé (2003, 1099) compares scientific observation to action research, action science and intervention research, we can find many principles of action research matching to our fieldwork activities, but there are also some similarities with action science and intervention research. Coghlan (2003, 452) defines action research as an approach to research that is based on a collaborative problem-solving relationship between researcher and client, which aims at both solving a problem and generating new knowledge. Similar to Simonsen (2009, 115), our study combines action research and ethnographically informed practice studies, aligning with Walsham's (1995b, 77) argument, that *even if researchers view themselves as outside observers, they are in some sense conducting action research by influencing what is happening in the domain of action, if only by the sharing of concepts and interpretations with the personnel in the field site.*

Our methods for this EA study seem to be quite challenging to categorize. We think that this is mainly because our data inquiry of this study has lasted over 15 years, and author's role has been varying from outside observer to employee, giving us a more practice-biased, a longer and a more internal view than a standard research setting assumes. Fetterman (2011, 8) argues that classical ethnography requires at least 6 months to over 2 years exploratory fieldwork, which may be seen to be fulfilled with 4,5 years of intensive participation in our case enterprise setting. Despite these methodological challenges with our fieldwork, we maintain that our EA study can be defined as a qualitative, interpretive, longitudinal in-depth case study combining features of action research and ethnography. Our approach to vignettes as kinds of EA documentation samples of knowing in practice is trying to combine academic theories and practical knowing of the reflective practitioner (Heiskanen & Newman 1997; Schön 1983). Our EA research strategy combined Engaged IS scholarship in various forms and Participatory Design attempts, the combination of which was quite a good fit in a practice-oriented enterprise culture, which we will presented next in the form of a historical review of our case enterprise.

6.3 Industrial history of the case enterprise

6.3.1 Roots in Finnish rubber industry

Rubber plants and trees have an ancient history (Palo-oja & Willberg 1998, 17), and the origins of rubber products falls somewhere around the year 1850, when rubber arrived as a miracle raw-material for various purposes (ibid., 41). First, rubber products were mainly shoes, galoshes, and various rubber clothes, which came to Finland from Russia and Sweden (ibid., 42). Instructions for rubber maintenance began to emerge during the 1880's (ibid., 41). At the end of 1890's, the first Finnish rubber companies and domestic production started, which was challenging and resource-consuming because of the lack of know-how about rubber technology (ibid., 43). The early years for rubber products in Finland seem to be not that well-known because Laurila (2011, 9) maintains that the use of rubber products started in Finland the 1890's. But Laurila (ibid.) also brings an interesting political perspective to the birth of the rubber industry because for Finland, being part of Russia at that time, a strong domestic rubber industry – as well as other industries - would have meant resistance to Russian authorities and their will for national unity. At the same time in 1880, industrial calculation was taking its’ first steps when the Hollerith punched-card machine was invented in the United States (Paju 2008, 67).

One of the first Finnish rubber production companies, Suomen Gummitehdas, was initiated in Helsinki in 1898 to produce mainly galoshes (Palo-oja & Willberg 1998, 43). Because of the heavy cost structure and environmental issues in the middle of the Finnish capital (ibid., 45), the factory of Suomen Gummitehdas was moved to Nokia (ibid., 47), but the head office stayed in Helsinki (Laurila 2011, 10). The first 15 years were a difficult learning phase with investment in facilities, process and product know-how of rubber products, but finally in 1914 a factory was profitable and production was growing (Palo-oja & Willberg 1998, 48). According to Laurila (2011, 10) in 1914 the company was able to pay stock dividend, and diversify production from galoshes to technical rubber products. At the same time, bicycles were gaining popularity and the first cars came into the Finnish market, a trend noticed by Eduard Polon, who was managing director of Suomen Gummitehdas (Palo-oja & Willberg 1998, 50). The first idea about tyre production was invented, but then the First World War and related political turbulence and raw material shortages caused some delays for increasing rubber production for new product groups (ibid., 50). But after the war a long high season started. Finland gained independent in 1917, Russians left the Finnish market and Suomen Gummitehdas gained a leading market position in Finland (Laurila 2011, 10). The company bought the majority of Oy Nokia Ab in 1919, and increasing demand and economic growth enabled investments into new production technology, better quality and new products (Palo-oja & Willberg 1998, 50; Laurila 2011, 10).

Laurila (2011, 17) states that during the first years of the rubber factory, the production shop-floor was more like a handicraft workshop than an actual factory. The main products were galoshes, and there was no division of labor: each worker did galoshes from start to end, and every worker was expected to complete a given amount of galoshes per workday (ibid., 17). Supervisors monitored this work and knew every worker at a personal level (ibid.). The company culture at that time was heavily affected by the technical director Antti Antero, who had been heading production since the beginning until the end of 1930’s (Palo-oja & Willberg 1998, 50) and had a major role as a rational and ambitious developer of the Finnish rubber industry (Laurila 2011, 10). His guiding principle was that engineers do not need their own rooms or tables: their place is on the shop-floor taking care that production runs smoothly (Palo-oja & Willberg 1998, 50). The same attitude is still prevailing in the rubber factory culture.

The major milestones in the history of Suomen Gummitehdas are related to plans for diversification from rubber foot-ware and technical rubber products into the tyre business (Laurila 2011, 10-11). In 1924, the company started to produce both inner tubes and tyres for bicycles (Palo-oja 1998, 130). The nature of the work at the rubber factory started to change in the 1920's (Laurila 2011, 18). Production operations were mechanized, production grew, diversified, and the factory got its own research laboratory. While the amount of workers was increasing, requirements for their own trade union contract intensified. Personal agreements with directors were more difficult to make than in early years. In the spring of 1928, frustration about working conditions at the rubber factory in Nokia burst out in a strike, which was one of the biggest industrial conflicts in Finland and lasted almost one year. Management of the rubber factory at Nokia started to hire new workers in order to continue production. The strike ended in March 1929 with a loss of employees, and then during the 1930's trade union activity almost vanished. (Laurila 2011, 18)

New technology played a central role in the modern, development driven culture in the young republic of Finland (Paju 2008, 67). Suominen (2003) has tracked the role of new technology as part of the increasing national identity and independent development of Finnish industry in 1920's. This admiration for new technology produced concepts like "Machine Brains" and "Machine People", discussed in public newspapers. This machine materialized in 1923 when the Statistical Center of Finland introduced the first Hollerith- punched-card machine in Finland (Paju 2008, 67). Rubber must have been one of the new technologies of that time, but when Laurila (2011, 18) writes that *the nature of the work at rubber factory started to change in 1920's and production operations were mechanized*, we assume that so-called punched-card machines were introduced at the rubber factory, at least in the research laboratory by some means of analog calculation machines. During the first 50 years, the rubber industry seems to have grown from an artisan culture towards industrial manufacturing processes.

6.3.2 Tyre business in Hakkapeliitta Spirit

The first pioneer years of tyre production were a challenging time for solving technical issues, collecting know-how, improving quality and organizing sales (Palo-oja 1998, 131). In 1931, it was decided to start car tyre production: the first car tyres were produced in 1932 (Palo-oja 1998, 131; Laurila 2011, 15). During the next year, in 1933, more technological knowledge was acquired via a field trip to the States, and after a series of trials, car tyre production was ramping-up to the commercial phase with additional investments to production machinery (Palo-oja 1998, 133) and marketing of the first Finnish car tyre called "Kesäpinta" (ibid., 130). Because of the issues with snow and road conditions during the winter time in Finland, the first winter tyre was developed in 1934, called "Kelirengas", which evolved into the Hakkapeliitta product family and brand (Palo-oja 1998, 133; Laurila 2011, 15). The sales of car tyres was started in 1934 into the Finnish market through hardware stores, but then also car dealers, car service and tyres service centers started to sell tyres (Laurila 2011, 11). Export started in the end of 1930's, first to Estonia (Palo-oja 1998, 133). In a quote from the early years of tyre sales, there is an echo from both the car and IT industry, when director August Kelhu quotes Henry Ford: "If somebody doesn't buy our lousy product, we can never make you a better one" (Palo-oja 1998, 131). Thus a minimum viable product was released and the startup could start learning from its customers (Ries 2011, 77).

The Winter War began in 1939 and therefore the Finnish Trust Committee for Rubber Industry was established to share limited raw materials in an equal manner (Laurila 2011, 12). In 1940, the so-called "Tammikuun kihlaus" (Engagement of January) started a new period in Finnish Trade Union and labor market activity (ibid., 18): this was the beginning of the modern negotiation system, where employers' associations and labor unions together agreed on terms of employment (ibid., 19). Wartime was an exceptional time without negotiations, but then during peacetime Trade Union activity restarted and this negotiation system was established, and the first agreement for terms of employment in the rubber industry was achieved in August 1947 (ibid.). The Second World War caused major challenges for tyre development and production, but at the same time created opportunities for developing heavy tyres for military purposes as well as opportunities for repairing, retreading, and developing domestic tyre building machines and equipment (Palo-oja 1998, 137). The Finnish rubber industry survived and adjusted to peace without major issues, and major factories continued their operations without breaks (Palo-oja & Willberg 1998, 61-62). After the war, operations in rubber factories were rationalized, factories were enlarged and modernized, and rubber products were mainly marketed to the domestic market, with only minor amounts exported to Nordic countries (ibid.). Production of technical rubber products, tyres and foot-ware were increasing, and their shares of the Finnish rubber industry were approximately equal for the whole of the 1950's (ibid.).

Because of war and raw material shortages in the 1940's, tyre production was not able to fulfil tyre demand in Finland (Palo-oja 1998, 137). During and after the war, domestic production was protected with licensing, customs and other legal protectionism. In 1950's, the fleet of cars in Finland was growing rapidly. Even after investments into new tyre production capacity at Nokia factory, Suomen Gummitehdas was able to provide only 60% of this demand (ibid.). In 1956, a general strike also hit the rubber industry (Laurila 2011, 19) and opening of Finnish tyre markets changed the market situation dramatically (Palo-oja 1998, 137). Rapidly this existing capacity gap in the Finnish tyre market was filled by imported tyre brands, which caused increasing competition in the domestic market (ibid.). An economic recession eliminated those benefits workers achieved during a general strike, and unemployment was increasing also in the rubber industry (Laurila 2011, 19). In 1959, Suomen Gummitehdas Osakeyhtiö changed its name into Suomen Kumitehdas Osakeyhtiö (Palo-oja & Willberg 1998, 62), invested into marketing and started to head to international markets with product brands like the Nokia Superstrada, Finnmiler and Finnspeed (ibid., 69; Palo-oja 1998, 138).

During the 1950's, punched-card machines were common; the Finnish Punched-card Association (later the Finnish Association of IT) was established in 1953. IBM Finland was actively promoting their technologies when the first generations of arithmetic computing machines were coming to Finnish organizations (Paju 2008, 40). Finland, somewhat patriotically, attempted to create its own computing industry and centralized National computing center (Åberg 2010, 16), which was about to produce the first Finnish computer ESKO in 1956. For various reasons, this attempt was delayed and ESKO was finalized in 1960 (Paju 2008, 478). During this delay in 1958, the Finnish national savings bank Postisäästöpankki bought the first actual computer, an IBM 650 called "Ensi", to the Finnish market and established its own computing center (Åberg 2010, 16). At the same time, in 1958, one of the new parts of Nokia group, Suomen Kaapelitehdas, was starting to seek new business opportunities from computing (Paju 2008, 399), which led to establishing their own computing center already in 1958 (Åberg 2010, 16). In 1960, Suomen Kaapelitehdas invested in their own mainframe computers like the English-made Elliott for scientific-technical purposes and the German-made Siemens for administrative computing (Paju 2008, 460). The early years of Finnish computing involved active co-operation with academic research and industrial development. This interaction created the seeds of the computer business for the Nokia group. At the same time, when "Elliot" was used for scientific-technical purposes, and "Siemens" technology for administrative computing, this created separation between engineering and administrative computing and organizations.

So, moving into the1960's both the emergent computer industry and the already more traditional tyre industry were battlefields of Finnish national interests and international importers of new technologies (Palo-oja 1998, 137). The Finnish tyre market had a totally new situation with tight competition, which required more investments in marketing, branding, quality improvements and strict pricing and sales efforts (ibid.). At the end of 1950's, the economic recession in Finland ended, and investments of Suomen Kumitehdas to internationalization yielded results, when tyre exports to Sweden were started (ibid.). This meant a really fast growing period for tyre production, which was now six times bigger than in 1950's. In 1961, Finland made an agreement with the European Free Trade Area (EFTA) about opening of European markets, which still increased competition and required even more investments into product development, tight product quality and pricing policies. These product development investments resulted in the Finnish innovation of studded winter tyre, and the first time tyre sales passed footwear sales in 1963 (ibid.). More tyre production capacity was needed in 1965, when the Finnish Government started to promote use of products "Made in Finland", and most of the Finnish vehicles and machinery were equipped with Finnish

Tyres (ibid., 138). Later on, this trend also led to close co-operation with Swedish car producers. In the 1970’s, the radial tyre NR 20 was accepted as the OEM tyre to Saab 99 produced in Finland (ibid., 141).

The high season in the 1960’s enabled new legislation regarding shortened working weeks and longer vacations. Also, the rubber industry changed to a 5 days working week in 1969 (Laurila 2011, 19). Despite improving working conditions, the 1960’s and 1970’s were turbulent times at Nokia: the labor situation varied especially at the footware factory, and inside the Trade Union internal power struggles between left-wing parties caused continuous walk-outs and strikes. Agreement on terms of work started to also include occupational safety and health related topics (ibid.). Labor disputes were common in the beginning of 1970’s, but the situation settled down in the mid-1970’s (ibid., 42).

From Laurila (2011, 13), we can find the important roots of the still prevailing rubber company culture and professional pride, which was initiated during the pioneering years of the rubber industry. During the first years, professional skills were learnt while working. Rubber factories were recruiting professionals from Germany and Sweden, and these masters did the training and orientation programme for others (ibid.). The rubber industry has been a stable employer, and the careers of rubber professionals have been long (ibid., 84). This practice was in use until the 1990’s because formal training had not been available for the rubber industry (ibid., 13). By tradition, rubber workers became qualified professionals while doing their work (ibid., 84). Laurila (ibid.) quotes employment manager Korpela from Nokian Tyres: “The *rubber industry has had its’ own culture in which the employee either adapts and stays for a long time or quits*”.

6.3.3 From Nokia group towards winter and forest

A restructuring of the Finnish rubber industry occurred in 1967 when he Suomen Kumitehdas Oy, Suomen Kaapelitehdas Oy and Oy Nokia Ab merged together (Palo-oja & Willberg 1998, 67). Nokia group was founded, including paper, rubber and cable industries (Laurila 2011, 28). It was said that the new company got the name Oy Nokia Ab from the wood processing industry, leaders from the cable factory and money from rubber industry (Palo-oja & Willberg 1998, 67). The new organization of Nokia Rubber centralized financials, export and business planning, but factories remained decentralized according to rationality of each division (ibid., 68). Devaluation of the Finnish currency, the mark, further improved the competitiveness of tyres for export (Palo-oja 1998, 139), which enabled increasing exports at the end of the 1960’s to England and in 1970’s to Canada (Palo-oja & Willberg 1998, 67). Because of increasing demand, the tyre factory at Nokia was enlarged several times, and yet again in 1968, which meant more capacity, better production processes, more automation and conditions for building radial tyres (Palo-oja 1998, 139). When the first radial tyres were produced in

1970, demand was growing faster than expected (ibid., 141). This meant growing sales and new capacity enlargements for both car tyres and heavy tyres. The oil crisis started in 1973 to slow down production (Laurila 2011, 39). To get more room for radial tyre production in Nokia factory in 1974, with the help of regional support policy and authorities, bicycle tube and tyre production was started in Lieksa, near the eastern border of Finland (Palo-oja 1998, 141; Laurila 2011, 45). The continuing oil crisis caused an increase in raw material prices, and a decrease in car sales, which dropped domestic tyre markets by 25% and caused lay-offs in tyre production (Palo-oja 1998, 143).

In the mid-1970's, the economic situation was improving, and industrial as well as agricultural growth increased demand for heavy tyres (Palo-oja 1998, 143), but already in 1977 demand for heavy tyres in the forest industry was decreasing (Laurila 2011, 43). At the end of the 1970's, the bicycling trend caused capacity enlargements for the bicycling tyre factory and the movement of light cross-ply tyre production from Nokia to Lieksa (Palo-oja 1998, 143). An Interesting remark from Laurila (2011, 42) indicates an emergent trend of personal computerization: Apple Computer and Microsoft were established in 1976. Investments into winter tyre R&D resulted in 1979 in the launch of Hakkapeliitta NR 09 winter tyre (Palo-oja 1998, 145), which was tested in 1982 by a leading Finnish consumer technology journal with the quote: "The best winter tyre ever" (Palo-oja 1998, 143).

During the 1980's, increasing imports, competition, over-capacity in the tyre industry and the economic situation were causing pressures for improving sales and productivity (Palo-oja & Willberg 1998, 71; Palo-oja 1998, 144). The car industry was in crisis, which was reflected in the tyre industry and especially heavily in technical rubber products (Palo-oja & Willberg 1998, 71). An interesting remark from Laurila (2011, 53) indicates the increasing trend of home computerization: the Commodore 64 was launched to the Finnish market in 1983. In the mid-1980's, many changes were done in the Nokia group, and following the computing trend, major changes caused investments in the computer business, computers and computing in planning, production and marketing (Palo-oja & Willberg 1998, 71). These investments into computers included a remarkable change in R&D technology, when computing, CAD and CAM technology started to be used for improving productivity in tyre development (Palo-oja 1998, 144). International collaboration was started for each division of the Nokia Rubber industry, and in 1986 Nokia tried to acquire tyre know-how from Sumimoto Rubber Industry with Japanese-European co-operation regarding Dunlop-factories. This co-operation between Nokia and Sumimoto's SP Tyres UK Ltd. was organized into a new company called Nokia Renkaat Oy (Palo-oja & Willberg 1998, 71; Palo-oja 1998, 145). New products failed, and the Hakkapeliitta NR 09 winter tyre remained as a leading car tyre product from 1979 until 1987, when Nokia Tyres celebrated production of the 5 millionth NR 09 (Palo-oja 1998, 145).

In 1987, Nokia Rubber industries continued international operations and released a plan regarding Nokia Rubber Corporation (Laurila 2011, 57). At the same time, in a difficult economic situation, Nokia Rubber industries tried to streamline operations, eliminate unprofitable products and improve customer service, but tyre sales did not meet its' targets (Palo-oja 1998, 145). In 1987, Oy Nokia Ab tried to clarify its' operations, organization and accountability with decentralizing common operations to profit centers (Palo-oja & Willberg 1998, 71). Laurila (2011, 61) describes the year 1987 as a "crazy year" for Nokia group: emergent problems occurred in leadership responsibilities, TV production and the telecommunication business, the stock price was swinging, and finally exports to the Soviet Union were declining before collapsing in 1991. The first company tyre outlets, Larsen & Lund AS and Wullum Dekk AS, were acquired in 1987 from Norway. These companies were merged to a company called Vianor in 1995 (Nokian Renkaat 2002, 18).

New managing director Lasse Kurkilahti started his job in February 1988 at Nokia Renkaat in order to find an international strategy and operational role for tyre production inside Nokia group (Palo-oja 1998, 145). The turning point in the history of Nokia group was in December 1988, when general director Kairamo committed suicide and the company changed its' strategy for the mobile phone business and started selling away other industries (Laurila 2011, 61). For the Nokia Rubber industry, a major clarification occurred when the parent company Oy Nokia Ab in 1989 sold away foot-ware and technical rubber products (Palo-oja 1998, 145). Restructuring of the Finnish rubber industry meant birth for new, independent companies with new, factory-driven company cultures. During the Nokia group period, business was led by central administration, which was located in Helsinki, but now power was given to factories and their owners, who were now responsible for operations and finance. Thus decision-making was now moved close to production. (Laurila 2011, 63-64)

Deep economic recession continued with high unemployment and remarkable political changes were transforming the Soviet Union and Eastern parts of Europe in the beginning of 1990's (Palo-oja 1998, 148). With the lead of the Kurkilahti tyre business, strategy was sharpened into winter tyres for cars and heavy tyres for forest machinery, both product groups of which were now getting target markets in the global snow-belt (ibid., 145; Laurila 2011, 64). Continuous product development and co-operation at the Japanese-European level resulted in new product families in all product segments (Palo-oja 1998, 145). A major devaluation of the Finnish mark and global recovery enabled an export-driven economic recovery for the whole Finnish economy, as well as for the tyre business of Nokia. In 1994, both car and machinery sales were growing again, which caused tyre sales to grow in all segments (ibid.).

Laurila (2011, 64) argues that the practical management style of Kurkilahti changed company culture from strikes to discussion and practical issue resolution. The same practical approach for issue resolution Kurkilahti applied when he was leading the Finnish Rubber Industry Association (ibid., 68). During his first year at Nokia Tyres, Kurkilahti changed the factory into a modern and training-oriented organization. Improved discussion with directors and workers enabled development of operations and production, which changed the factory and improved the image of the company. (ibid., 64)

6.3.4 Growing to Russia with Vianor way

Then, in 1995, it was again time for major changes in the tyre factory. The parent company Oy Nokia Ab was heading into new challenges with the mobile phone business. The tyre business was listed on the Helsinki stock exchange with the name Nokian Renkaat Oy (Nokian Tyres Plc.). At the same time, the company decided to invest in new "high performance" tyres and retread manufacturing technology enabling higher quality and price-level product categories. A new winter tyre testing center was built in Ivalo, and continuous investments in product development and marketing were increasing productivity and sales, which for the first time I 1995 exceeded the one million Finnish mark. In the 1996 annual report, Kurkilahti stated that the "long-time strategy focused on Northern conditions and with a wide selection of other products is giving direction to the company's steady growth and development". Operations-wise this development included continuous product development, specialization, continuous learning for personnel, quality and efficiency thinking, and increasing company awareness at a global scale. (Palo-oja 1998, 148-149)

In 1998, Nokian Tyres was recognized as a leading Nordic tyre manufacturer developing, producing and marketing car and van tyres, heavy tyres, bicycle tyres, inner tubes and retreading materials. Palo-oja (1998, 149) concluded that Nokian Tyres is about the 30th biggest company of the approximately 135 tyre producers in the world, and revenue-wise 10th biggest in Europe, as well as the leading manufacture in winter and forest machinery tyres in the Nordics. Nokian Tyres exports to 48 countries, the most important being in volume-wise Sweden, Russia, Norway, Canada, Germany and England. (ibid.)

During the year 2000, Gran replaced Kurkilahti, first in Nokian Tyres and then also as chairman of the Finnish Rubber Industry Association (Laurila 2011, 77). Rantalaiho was selected as managing director for the Finnish Rubber Industry Association, and Rantalaiho's period started with changing daily routines with email usage and launch of the first home-pages as an information channel for the association (ibid., 75-76). After almost 10 years of creative pause, Nokian Tyres continued growing its tyre chain: in 1998, Galaxie AB and Däckshopep Auto-Service i Malmö AB were acquired from Sweden; in 1998, Freibi Riepas SIA from Latvia; in 1999, Isko Oyj from Finland and Isko AS from Estonia; and, in 2000, Rengasmestarit-Kumi-Helenius –ryhmä from Finland (Nokian Renkaat 2002, 18). In September 2000, Gran led the branding and merger of tyre outlets into Vianor –tyre service chain (Mansikkaoja 2011). In 2002, a new logistics center was built at Nokia. In 2003, Nokia Corporation sold its' ownership in Nokian Tyres and Bridgestone became the biggest owner of the company. At the same time, Gran initiated various attempts to start operations in Russia. Operations in Russia started during 2003. The Russian factory investment project was successful and tyre production started during the summer of 2005 (Nokian Tyres 2006). Figure 23 presents the project timeline for the Vsevolovsk factory as presented for investors in 2006.

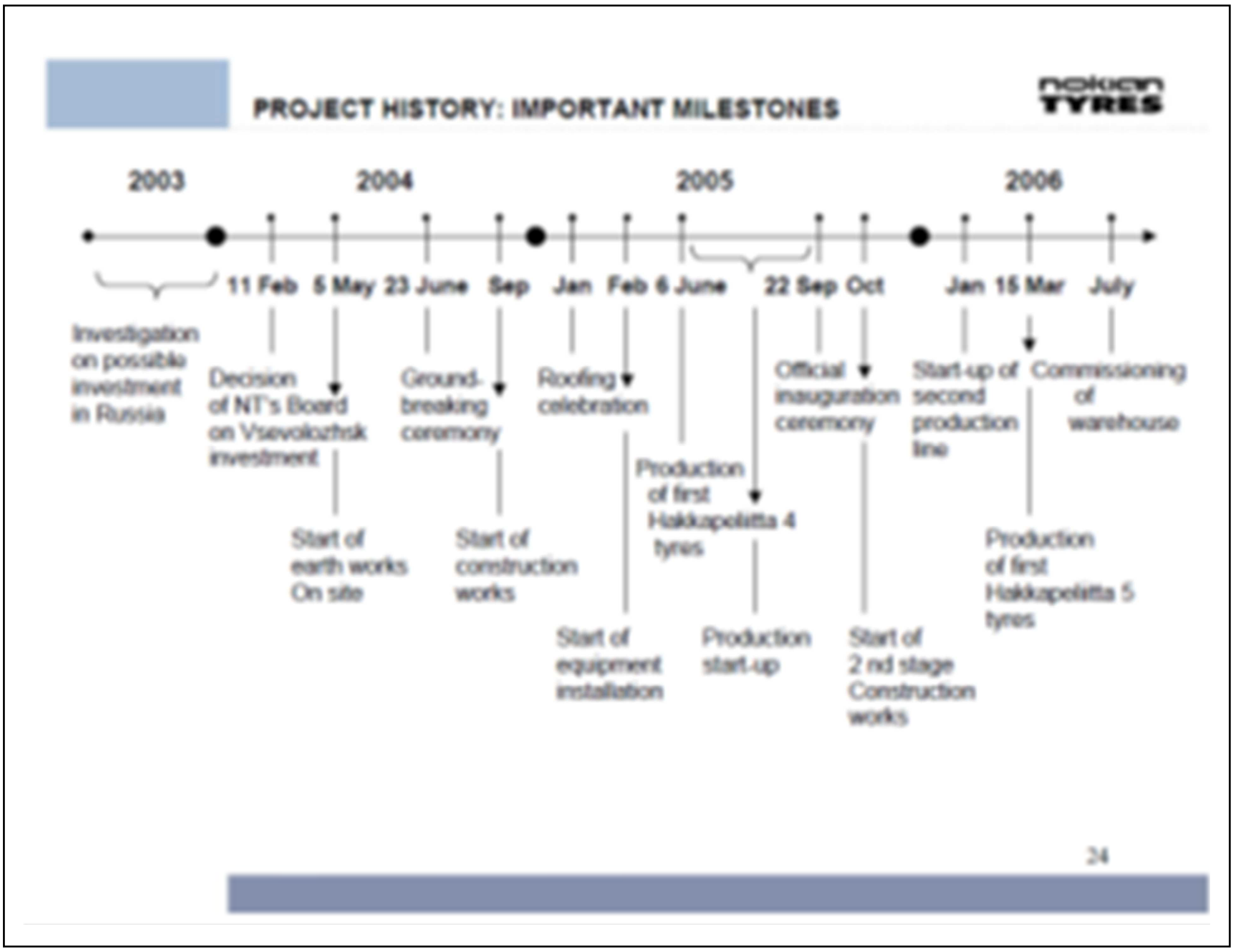

FIGURE 23 Russian factory investment of Nokian Tyres (2006, slide 24).

A long period of growth in the tyre business ended in 2008 when the global economic recession also forced the Finnish rubber industry to give employee notices (Laurila 2011, 91). At the end of 2009, Nokian Tyres returned to a growth track, which seems to continue. Laurila (2011, 109) presents Nokian Tyres in 2011 as follows:

> *Nokian Tyres develops and produces car tyres, heavy tyres and truck tyres for demanding Nordic conditions. Core products are winter tyres for cars and tyres for forest machinery. The company is in selected demanding product segments the market leader in its' main markets in the Nordics and in Russia. Tyres with the Nokian –brand are sold in over 50 countries. The company has factories in Nokia, Finland, and near St. Petersburg, in Russia. In the Nokian Tyres group also belongs the Vi-*

anor –tyre chain, which operates as a wholesaler and retailer in the main markets of Nokian Tyres. Vianor –tyre chain includes over 800 outlets in over 20 countries. Success factors for Nokian Tyres are specialization, expertise and innovativeness. Nokian Tyres employs globally about 3500 professionals. (Laurila 2011, 109)

6.3.5 Current and future visions for the tyre business

In 1998, Laurila (p. 151) reviewed the future of the rubber industry, and Juopperi (1998, 153) evaluated R&D visions for the tyre industry. Laurila (1998, 151) saw that the development of the rubber industry has been slow, and the same core processes have been used for already 100 years. He expected that most developing parts of the process will be in process control and automation, including internal efficiency of the process equipment. Laurila (1998, 151) saw the future of the rubber factory as follows:

Products are planned with a computer, which calculates the optimal recipe based on given product requirements. Data is transferred directly to the process. Raw material handling in the warehouse, weighing, mixing, handling of the mixed batches and quality control are done automatically and human labor is needed mostly in a supervisory role. Because of the wide variety of rubber products, some of the products will still need plenty of manual work; some products may be done by automation.

Both Laurila (1998) and Juopperi (1998) saw that environmental thinking will cause changes in raw materials and chemicals. Laurila (1998, 151) took a product life-cycle view when estimating that in the rubber industry less harmful chemicals will replace the current chemicals, raw material processing will be done with more nature-friendly methods, and recycling will increase the usage of process waste as well as end-product re-use. Juopperi (1998, 153) took the car industry view when estimating that global requirements for protection of the environment and especially the need for decreasing noise and exhaust gas levels will guide future development of cars and tyres. According to Juopperi (ibid.), major challenges for the tyre industry are to maintain and even improve tyre safety and economic features, while searching for still more easily and silently rolling tyres, which is also important for efficiency of electronic vehicles. Juopperi (ibid.) concludes that in collaboration car and tyre industries may create an even cleaner traffic environment without compromising driving speed, flexibility of traffic, driving comfort or safety.

Laurila (2011, 100) quotes Professor of Elastomer Technology, Jyrki Vuorinen, from Tampere University of Technology: "*From an engineering perspective, rubber is a very technical material, which has unique features and in many use cases does not have a substitute*". Rubber is a flexible raw material, which is easy to mix into other materials like plastics, metals and metal composites (Laurila 2011, 87) to make compounds and new applications (ibid., 101) where nanotechnology creates new possibilities (ibid., 87). Vuorinen sees that in the future the Finnish rubber industry needs cost-efficient structures, a high-level of automation, know-how and information intensive materials, which are difficult to copy. With this recipe, Vuorinen believes that the rubber business and knowledge can survive in Finland, even if products may be produced elsewhere: "*Specialities must be understood, and adapt to a changing world; it is dangerous to strive for being the best in historical things, you must stay sensitive for listening to future needs*". (Laurila 2011, 101)

So far, Finnish rubber factories have been small and flexible, even the factory of Nokian Tyres at Nokia is on a global-scale a small and specialized production unit (Laurila 2011, 102). Gran as chairman of the Finnish Industry and managing director of Nokian Tyres lists *flexibility, cultural acceptance for hard work, high education level and the close key markets of Sweden, Germany and Russia as strengths for the rubber industry in Finland* (ibid.). For Gran, Finnish tyre production is not an absolute value itself: production in Finland must be profitable and a value-adding property, which also requires high knowledge and know-how for tyre factory operations. Gran continues that "*Role of the tyre factory at Nokia has changed: it is more like a development and competence center than a mass volume production unit. This means that a tyre factory at Nokia is a development center for technology, products and processes. Not only for tyre production processes, but also for development of marketing, logistics, financials and IT processes.*" (ibid.)

Global industrial competition has been changing the role of the Finnish rubber industry and factories from fulfilling generic needs of the domestic market to high-quality component and special product manufacturing with distributed production locations and customer relationship management processes (Laurila 2011, 103). Nokian Tyres is an example of a company whose sales has been shifting to export: in the 1970-1980's the domestic market made up about 90 % of the tyre sales, but in 2011 the share of domestic sales is below 15 % (ibid., 102). Internationalization belongs to survival strategies of the Finnish rubber industry, a trend which requires development of knowledge management, training and process renewal to shift from a local to an international and even a global scale for competing against globally operating corporations in highly specialized product segments (ibid., 103). Nokian Tyres has been re-inventing the wheel for demanding winter conditions for 80 years, and new environmental demands and implications of climate changes still seem to create new possibilities for safety improvements (Virtanen 2014, A17). Economic results from year 2013 are still excellent (Lähteenmäki 2014, 51). But now in 2014 when Russia takes Crimea from Ukraine (Yaffa 2014), the valuation of ruble (Pesonen 2014, 25)) and Nokian Tyres is challenged by economic decline and conflict between EU and Russia (Kullas 2014, 50).

6.4 EA research setting summary

Our case enterprise Nokian Tyres combines various company cultures along its long value chain, from rubber procurement to tyre sales and services. The factory culture includes the industrial handcraft roots of the Finnish rubber industry, an active labor union culture and high adoption of modern production technologies. The R&D culture promotes innovation, test wins in technology magazines and continuous improvement as part of Nokia factory culture. The tyre sales culture combines attitudes of multi-national sales operations of Nokia group into passionate customer service and logistics around the snow-belt. The tyre service chain combines consumer-orientation, branding, retail and franchising operations into service business innovations like the tyre hotel and fleet services for car rental companies.

Each sales company has their own strong local company culture, which has been validated by promoting entrepreneurship and inventiveness as core company values. Russian operations have been very successful and developed under strong Russian management, which have created local operating models and a Russian company culture. At the same time, Finnish administration and HQ operations have been kept very efficient, which has given an organizational mandate for local companies to develop their own operations and systems. But the most important result is that the tyre business has been very productive, profitable and growing well despite local and global economic challenges and high competition. Kurkilahti, Gran and the management director of Russian operations, Pantiukhov, have shown EA leadership in practice without explicit EA management products, processes and structuration with strong business architecture focus. Mansikkaoja has been developing corporate information systems since 1995 in cooperation with various vendors and teams from Nokian Tyres, Vianor and country organizations. Thus EA-in-practice has been reflected more in embedded systems development work, including various IT technologies and architectures growing from a local to regional and global business scales.

This organizational setting has created an interesting foundation for observing EA challenges for business and systems development in our case enterprise. Next we will proceed to report seven different vignettes regarding systems related development projects and bottom-up EA challenges of the growing tyre business at Nokian Tyres.

7 EA vignettes

In chapter 6 we presented theoretical and organizational EA research settings for our study. In this chapter, our EA study flow proceeds to the empirical part, presenting our seven EA vignettes which present how EA has evolved in everyday life at Nokian Tyres. These EA vignettes are thematic narratives from our ethnographic field notes representing some aspect, perspective or slice of the world studied (Emerson et al. 2011, 202). In these seven EA vignettes, we will report several development projects, which include various changes at multiple operational and technical levels. In the proceeding sections each EA vignette has a similar kind of structure:

1. **Intro:** each EA vignette starts with a short narrative that tries to explain drivers for the project from a business perspective, including market changes, business strategy and industrial settings. The introduction explains objectives for development and changes, which may be part of some programme, project, business change or some other development initiative towards continuous improvement.
2. **Information Technology/IT:** the vignette proceeds into IT changes elaborating technical requirements, capabilities, actors, affordances, constraints and other related changes, which are presented by using our Technical/operative EA research framework for IT (IT–framework). We will analyze the content of each vignette as our EA data in a positivist mode, where the IT–framework is used as an instrument for initializing settings and technical foundation for discussing substantial EA content at higher levels of abstraction.
3. **Enterprise Architecture/EA:** from a technical IT layer, we will then switch our perspective to the substantial EA layer, where we are using a Sociomaterial/managerial EA research framework (EA–framework) to analyze how each project changes EA AS-IS towards some TO-BE status, and how EA work is done in practice (EA-in-practice). We will elaborate substantially on the EA layer and analyze our observations as first-

order EA data with our Sociomaterial/managerial EA–framework instrument. During this elaboration. we explain EA-in-practice mainly from interpretive perspective.

4. **Enterprise Architecture Management/EAM:** the vignette proceeds to the next level, where we reflect on our ontological, epistemic and ethical approach to changes with the second-order conceptualizations of EA data with our Integrative/philosophical EA research framework (EAM–framework). In this elaboration, we will use the EAM–framework as an instrument to explain how ontological, epistemic and ethical dimensions of EA management could help to analyze and manage expected changes and reframe EA-as-practice. This part of each vignette may include elements from critical theory.
5. **Knowledge Management/KM:** each EA vignette is analyzed with external knowledge-sharing perspective (external knowledge-sharing perspective) regarding topics of knowledge management and transfer (Østerlund and Carlile 2005, 92). Thus we will return to an interpretive and positivist mode by using an external knowledge-sharing perspective and instrument to analyze knowledge sharing and social restructuring for each vignette.
6. **Summary:** each EA vignette concludes with a short reflective summary analysis, implications and findings from the frameworks applied to EA management as a knowledge management tool for business and process development.

EA vignettes are presented in a chronological order to enable understanding about these imbrications are layered above each other. Thus each vignette explores EA development from a bottom-up approach. Each vignette may be seen as a separate building block for constructing and telling the story (Emerson et al. 2011, 203) of EA development in our case company. Figure 28 illustrates the timing and layering of our seven vignettes.

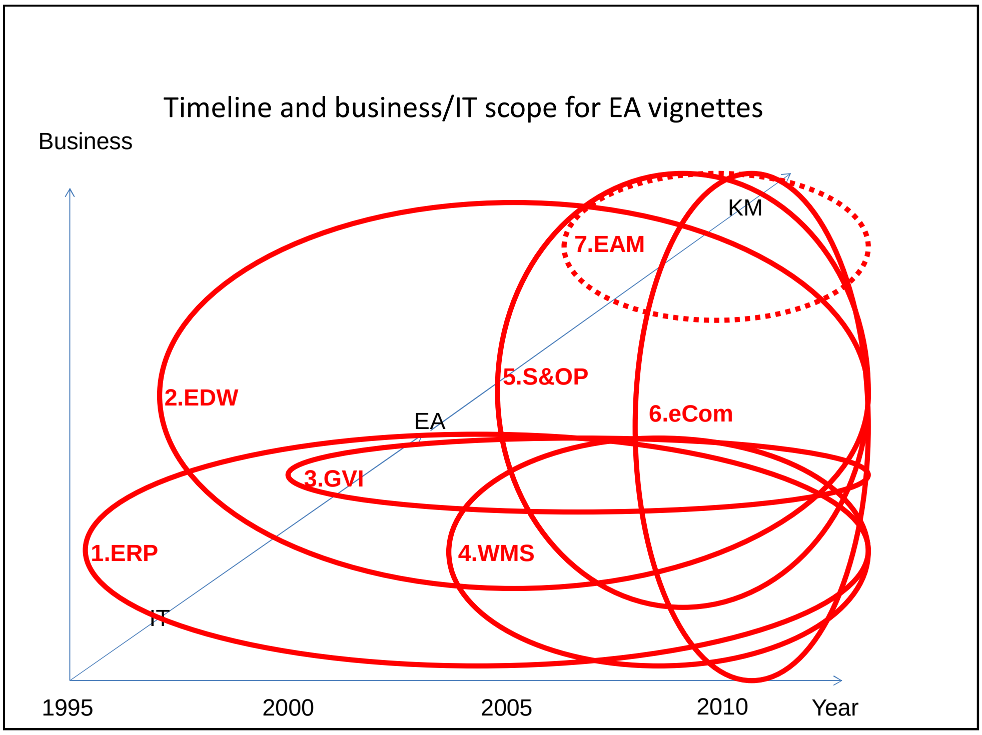

FIGURE 24 Timeline and business/IT scope of EA vignettes.

The first vignette regarding ERP development has the major technical and social structuration effects on the other vignettes and EA at Nokian Tyres. EA vignettes from 2 to 6 are presented, explained and analyzed as enhancements to ERP system. Thus corresponding EA vignettes can be understood better, if the ERP vignette is read first before vignettes 2-6. The ERP vignette includes reasoning and references for related vignettes 2-6, which can be seen as separate but highly dependent on the same operations, processes, information flows, ERP systems, transactional data sources and company cultures.

Logically, vignette 7 is different from vignettes 1-6. Therefore, vignette 7 is depicted with a dotted line in Figure 28 to illustrate the vague nature of this EAM system development. Because of its implicit nature, non-systematic processes and limited social structuration of EAM at Nokian Tyres, this EA vignette is reported as vignette 7 of this study. Before reading these vignettes, it is important to understand that the ethnographer is a human instrument striding into a culture and social situation to explore its terrain, to collect and analyze data, which can be subjective and misleading (Fetterman 2010, 33). Therefore, these vignettes can be seen as partial observations of the complex and multi-faceted operational changes.

But first we will start our empirical study report with an ERP system development history, which relates and presents major EA restructuration and IT architecture changes at Nokian Tyres.

7.1 Enterprise Resource Planning/ERP vignette

7.1.1 ERP introduction

The tyre business was supported since 1996 with the own ERP system implementation as a part of the business changes and operational separation from Nokia group. Because of the functional organization model of Nokia group, processes and information systems at Nokian Tyres were department-specific and inefficient for process development. In particular, order-to-cash –process development was seen as critical for improving tyre sales and customer service, but custom-developed legacy systems were not integrated and system platforms were quite old. Therefore the promise of international ERP software applications were attempted and seemed to offer an integrated business platform for tyre sales and process development.

ERP (Enterprise Resource Planning) is commonly defined as *commercial software packages that enable the integration of transactions-oriented data and business processes throughout an organization* (Davenport 1998; Markus & Tannis 2000). Systems-wise this idea of integrated ERP software was a major change because most of the legacy systems were departmental, separate customized applications for Nokia Renkaat rubber industry and Nokia factory. Some older applications were running on DPS6-servers by Honeywell and Groupe Bull. An operating system for these DPS6-servers was called GCOS - General Comprehensive Operating System. Some newer applications were running on various unix-servers. PCs were used as terminals for DPS6- and unix-based applications, but also some native PC-applications were in use for admin and office work. Data center services have been produced from data centers at Nokian Tyres for all companies belonging to Nokia group. After restructuring of the Nokia group and Nokian Tyres' separation from Nokia group, organizations in the Nokia group continued as external customers to buy administrative data center services from Nokian Tyres data center.

While preparing for ERP system investment, Nokian Tyres was heading towards international operations and tight competition in tyre markets, which made the "make or buy" decision quite natural in changing the application strategy from customized solutions into "ready- made" ERP software applications. In 1998, Davenport (p. 121) warned about the promise of Enterprise Systems, which appear to be "*a dream come true*" when offering an off-the-shelf promise to solve business integration problems, but may possible turn into nightmares. During 11/1994-2/1995, the CEO Kurkilahti and the management team, including the IT department, bought an ERP pre-study from Enator. The ERP pre-study results indicated issues with the concept of sales order, a gap between sales orders and production plans, fuzziness between the sales budget and Excel-data files, and a lack of planning and simulation possibilities. These reasons for initiating ERP –investment at Nokian Tyres is similar to the top five reasons for ERP adoption from Bradford and Richtermeyer (2002, 15): integrating disparate business units, replacing obsolete systems, the need to stay competitive, inefficient business processes and poor organizational performance. Our own ERP system was an important departure from the Nokia group legacy systems and operational culture.

Mansikkaoja was hired in 3/1995 from Gap Programator/Gap Gemini to head the IT department and to lead the ERP project at Nokian Tyres. After documented process simulation rehearsals in 8-9/1995, the Investment Board of Nokian Tyres accepted replacement investments for the DPS6 –servers with initial hardware costs of 0,5 meur (at that time 3 million Finnish Marks) and ERP –project initialization with the project name Rento (Renkaiden Toiminnanohjaus) with an initial sum of software costs of 0,67 meur (4 million Finnish Marks). Requests for Quotation were sent in January 1996 for major international ERP vendors who had just arrived in the Finnish market. The most remarkable quotes came from 3 different service vendors offering, namely, SAP –based solutions, CA offering ManManX, and Oracle offering Oracle Applications. The service vendor and software selections were made during the spring 1996, ending in 6/1996 with a signed contract with Oracle Finland as a service vendor for Oracle Applications –based ERP-solution. The server platform selection resulted in a signed contract with Digital and included new Alpha-processor based unix-clusters with Tru64-operating systems, which were then replacing old DPS6-servers. (Mansikkaoja 2011)

A new ERP system implementation project started with the joint Nokian Tyres and Oracle Finland team, during the summer of 1996, using the Oracle Applications release 10.6 for manufacturing modules, Oracle Manufacturing. The bicycle tyre factory at Lieksa was not in the scope of this project because directors were planning to sell this business away. The Vianor –tyre service chain was not yet part of the business portfolio, but Isko as a major customer caused some specific business requirements. Order-to-Invoice, Demand-to-Build and Inventory-to-Replenishment processes for the car tyre, heavy tyre and re-treading businesses at Nokian Tyres rubber factory and main inventory at Nokia were inside the first phase scope of this ERP implementation.

The ERP project was a major event for learning new technology at many levels: the release of 10.6 was just launched in 1995. This version included new graphical user interface and client-server technology for Windows-based PC-workstations. The project team from Oracle Finland as the service vendor was doing one of the first ERP implementation projects with Oracle Manufacturing in Finland, and the whole project team was experienced with Oracle-database technology but not with Oracle Manufacturing. The Oracle Application Implementation Method (AIM) as a project method was also new for the whole project team, but this kind of learning-by-doing was quite typical for the tyre industry and part of the company culture. The strict waterfall logic of AIM was applied in quite a creative and practical manner in keeping with the informal discussion culture at the Nokia factory. One additional challenge for the ERP project came from the phased implementation approach: the legacy financial system from Nokia group was required to continue as a Finance system, but Oracle Applications required setups and implementation of a Financials module. The challenges to legacy Finance systems from Nokia group posed by this module sequencing and integration were learnt during the solution analysis phase. This caused new resource and capability requirements, causing additional costs for the design and build phases of the project.

Process simulations and TO-BE process documentation were created when preparing the ERP software selection. Yet there was not any practical process re-design or any change management activities before the ERP implementation project. Oracle's AIM templates with Visio-process pictures supported process-driven ERP implementation. At the software level, all Oracle Manufacturing R10.6 modules supported request sets for sequenced batch procedures; order cycles were defined and applied for the Order-to-Fulfilment process; workflows were available for the Procure-to-Pay –process; and the Oracle Alert module was event, calendar or schedule-based process initiation. But during the ERP design and development phase of the ERP –project, organization units were not willing to change their AS-IS practices and procedure logic into integrated business processes. This change resistance caused hundreds of customizations into ERP functionality, but enabled implementation of Oracle Manufacturing software into the tyre factory at Nokia. The ERP project team produced user instructions and end-user training materials, which included process documents for technical ERP usage. From Nokian Tyres' business side, there were no attempts at maintaining actual business process descriptions or implement change management activities to change business operations from a functional mode towards a process orientation. With some over-run in schedule and budget, Nokian Tyres managed to reconcile the technological imperatives of the enterprise system (Davenport 1998, 122), which were mostly solved with customizing the ERP package to keep current business practices unchanged,

The author joined the ERP –project team in the beginning of 1997, when project needed more resources to finalize development before it was due to go-live on the 1st of May, 1997. One more rescheduling was still needed, and the new ERP system went live in June 1997. Purchasing and MRP –modules, go-live phase were delayed until March 1998. This ERP project has been an important milestone for EIS development and the history of Oracle at Nokian Tyres.

TABLE 7 Oracle at Nokian Tyres (Kimpimäki 2008, applied from Mansikkaoja).

▪ ->'96:	Few small Oracle databases
▪ 1996:	Contract (Manufacturing)
▪ 1997:	Manufacturing 10.6SC (INV,OE,AR,WIP,BOM)
▪ 1998:	Manufacturing (PO,AP,MS/MRP,CAP,COST) R10.7SC
▪ 1999:	Financials, DW+OFA, R11, Multiorg
▪ 2000:	Roll outs: Norway, Sweden
▪ 2001:	DW&Discoverer EURO
▪ 2002	**Integration solution (9iAS, Interconnect, "case Oulu")**
▪ 2003-2004	FINA Switzerland & Germany & Vianor AB & Vianor AS
▪ 2005	R11i, FINA Nokian Heavy Tyres Ltd.
▪ 2006	WMS in Nokia, Russia1
▪ 2007	**Integration platform/GVI, SOA Suite in production 24.9.07** global single instance => multi-instance; Aris/BPA Suite
----------	----------
▪ 2008	MDM / R12, Planning, Russia2, Central Europe / R12, …

Because the Oracle Purchasing -module had only limited support for factory maintenance operations, service and investment procurement, Nokian Tyres implemented in 1997 a local Oracle-technology based maintenance application called Arttu for its' factory maintenance and investment procurement purposes, replacing the old DPS6-based system. Oracle Applications did not include the Finnish Payroll –application, but Nokian Tyres needed new a Payroll –application to replace its old DPS6-based systems for the hourly-based labor payroll and monthly salary calculation and payment. The new Payroll application was found from the Finnish media industry, where Enator had developed an Oracle-technology based HR and Payroll -application framework called Henkari. Both Arttu and Henkari were quite easily modified for Nokian Tyres, which had now in a span of 2 years replaced its' old DPS6-platform and customized applications with quite modern, client-server software applications running on Oracle-technology, Tru64-unix and Digital Alpha –servers. This server platform change ended the sales of administrative data center services to external companies of Nokia group.

The ERP project implemented Oracle Manufacturing and Logistics applications in 1997, which were upgraded in 1998. During the upgrade, the author worked at Nokian Tyres' ICT team responsible for the upgrade project and improving EDI and MRP solutions. After that, the ERP system was further upgraded to release 11.0.3, including integrated Oracle Financials to finally replace the legacy Finance system from Nokia group. Oracle Multi-org setup was done to enable single-instance deployment for sales companies. The strategy for corporate reporting was changed from customized Oracle Reports –development into the Datawarehouse approach. Corporate-level reporting data was collected to a centralized Enterprise Datawarehouse (EDW), where Oracle Discoverer was used as an ad-hoc –reporting tool and Oracle Financial Analyzer (OFA) as an analytical reporting tool. This development we will explore in the EDW vignette. The ERP solution for Nokian Tyres group was ready for the year 2000 and rollouts to international operations. ERP supported only Latin letters because the ERP system-wise small Russian operations were separate and Cyrillic letters were not needed at that time. ERP investment was now about 3 meur, including the slightly increased hardware costs and the remarkably higher software costs ending up at 2.46 meur. (Mansikkaoja 2011)

Yang et al. (2005) calls these kinds of acquisition processes the “requirements-first waterfall model”, which they suggest to avoid because *committing to requirements before performing design and glue-ware integration analysis will likely create architectural mismatch problems, often causing factor-of-four schedule overruns and factor-of-five budget overruns*. Also, at Nokian Tyres the price for the corporate ERP system was higher than expected. During the year 2000, these ERP investments were leveraged in rollouts to Nokian Däck in Sweden and Nokian Dekk in Norway. In 2001, a proposed ERP upgrade project was postponed because of cash-flow reasons. Only necessary improvements were made to manage the Euro as a currency unit and the corporate-level reporting currency was converted to Euros.

In 2002, the role of the Vianor tyre service chain was changed. Vianor’s processes and systems were integrated tighter with the parent company operations. The new logistics center operations at Nokia were designed to serve Vianor and Finnish tyre retail as a central inventory. Forklifts were equipped with mobile terminals and barcode scanners, which were connected to a wireless network and a customized inventory solution for efficient inventory operations. The development of this system we will elaborate on in detail in the WMS vignette.

The development of the ERP system continued between the years 2003-2004 in sales companies and with the integration of add-on systems in the parent company. A sales strategy change required tighter integration between Nokian sales companies and Vianor –tyre service chain. The Swedish operations applied Vianor system architecture: the local sales company Nokian Däck replaced Oracle’s sales and logistics modules with the lighter ERP system Maestro, which was a legacy ERP system from acquired Isko –tyre chain and also the current ERP system for Vianor –tyre chain in Finland. Norwegian operations, processes and systems were similar to Finland. Nokian Dekk continued running sales, financials accounting, procurement, import, warehousing and wholesale processes with the Oracle ERP solution. Norwegian Vianor used the Maestro ERP system, which was integrated to the local sales company to create inventory visibility and a locally efficient order fulfilment process. In each Nordic country, Oracle

Purchasing and Payables –modules were enhanced with a Basware IP –purchase invoice processing application with country-specific Basware instance and integration solutions.

At the same time, Vianor integration in the Nordic region was increasing, Nokian Tyres' strategy was heading east to Russian markets. At first, a joint-venture sales company was established in Russia. These operations needed a separate, local, and legally acceptable ERP solution for the Russian tyre business. A corporate ERP solution was a little bit heavy and lacked support for the Cyrillic character set. Thus the Russian ERP selection for tyre sales ended up being the local-driven Microsoft Navision implementation, which was already successfully utilized by Russian tyre business by competitors. In a similar manner, other Nokian Tyres' sales companies have selected their local ERP solutions, which were typically locally implemented light ERP packages like AccPac for Nokian Tyres in the States, and 1C as "de facto" ERP for former Soviet countries Ukraine and Kazakhstan.

For growing Central European (CE) operations and sales companies, there was no available localized system template for rollout purposes. In Germany and Switzerland, the first ERP implementation ended in a Swedish hybrid-model, where Vianor systems were used as tyre sales system and Oracle ERP as a back-office financials system. Several small ERP systems have come into Nokian Tyres EA through acquisitions: Nokian Tyres in Czech used an ERP system called Aconto (http://www.aconto.cz/) and, as Vianor –tyre chain has also started growing through acquisitions in Northern America, ERP system called MaddenCo (http://www.maddenco.com/) and ASA Tire Systems (http://www.asatire.com/) were added. This growth of business and systems integration has enabled a Global Visibility and integration (GVI) solution, which we will explore in more in detail later in the GVI vignette.

Strategy wise, the combined tyre sales and service chain concept for Nokian Tyres was very successful around the northern snow-belt. EA-wise, this global expansion of sales operations increased EA fragmentation with several locally implemented systems and processes causing challenges for small corporate IT and ERP support teams. During the last 10 years, business requirements have changed. Operational growth from the tyre factory at Nokia to international tyre sales and service chain required structural changes to corporate operations and processes. In 2004, with the decision to in a Russian factory, the growth of business volumes and international operations caused pressures for renewing the ERP solution for the parent company and the Nokia factory. Because of growing tyre volumes in 2002, the opened logistics center at Nokia was already becoming too small and new investment was planned in order to double the space of the warehouse. The central European automotive business and tyre culture especially started to experience increased awareness of tyre age, which caused pressures for adding First-In-First-Out/FIFO-logic to warehousing processes. This development track is explored later in WMS vignette.

The heavy tyre business was prepared for sales, which led to starting the incorporation of Nokian Heavy Tyres (Raskaat Renkaat Oy) into its own legal entity for financial reporting, but operationally and system-wise Heavy Tyres continued using the parent company resources. The quickly expanding logistics needed improvement to supply chain planning and execution, which will be explored more in the S&OP vignette. The global availability of information was critical for decreasing inventory levels without a decrease in customer service levels. With a new factory and Vianor expansion, Russian operations were fast growing beyond Navision ERP, which was implemented for sales company purposes without support for manufacturing operations. These reasons led to an upgrade decision for the parent company ERP to the latest Oracle ERP – release, which was at that moment called Oracle eBusiness Suite (eBS) 11i9. Thus, in 2004, the parent company started the previously postponed ERP system upgrade project, including new application modules for warehousing processes with the WMS – application (Warehouse Management System) and supply chain planning with the Advanced Planning and Scheduling (APS) module.

In 2006, the parent company started an Oracle ERP implementation project for the Russian operations RIMP-project, which was aiming to include operational support for the soon to start Russian factory and companies to the same ERP solution and instance with Nokia factory. The Finnish ICT service vendor Tieto-Enator helped the Nokian Tyres ICT-organization with the ERP upgrade project at Nokia factory. Oracle Consulting, including experts from Finland and offshore resources from Oracle SSI India, ran an EBS –rollout project to the Russian operations and supported with new ERP modules for the Finnish operations. The Russian ERP development will be explained later in an eCommerce vignette.

While investing in a new ERP release and implementation projects, data centers at Nokia factory and Alpha/Tru64 clusters and technology from 1990’s were growing old. The older “server room A” was totally over-loaded already, and the newer “server room Q” was in somewhat better shape. However, because there were no immediate reasons to increase the facility or platform costs for upgrade projects, both server rooms continued as earlier; but the electricity supply and cooling capacity were causing severe service constraints for ERP and IT systems.

As a result of 10 years of business growth and the growing complexity of the ICT landscape, the following picture of “Nokian Tyres – IT concepts” was presented in a 2006 corporate strategy workshop as part of the IT strategy for the year 2011. At the bottom of Figure 25 are listed all companies in Nokian Tyres and their expected ERP systems in 2011. Above ERP systems are reporting and integration layers, which share business information services for different user groups and purposes.

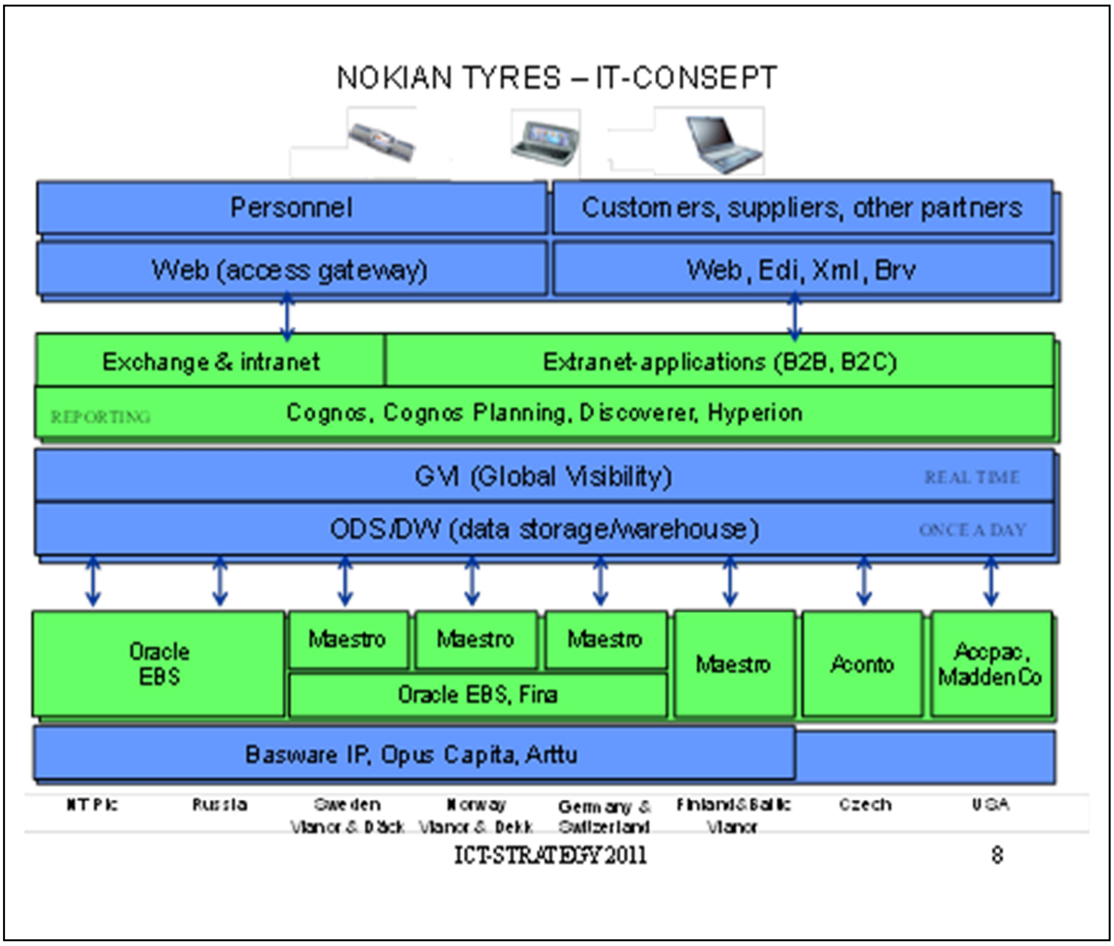

FIGURE 25 Nokian Tyres – IT concepts (Savolainen 2006, slide 8).

7.1.2 ERP/IT–framework -elaboration

When trying to analyze the system lifecycle for ERP development at Nokian Tyres we face various problems with the multiple layers of ERP technology. Our Technical/operative EA study framework for the IT (IT–framework) layer includes an idea that the introduction of technology may occur at one or several layers of the system. At the same time, this means that discrete technical innovations and the introduction of technology may and most likely occurs in different moments in different layers of our IT–framework model. The moment of introduction and the lead-time from introduction to actual changes may be quite difficult to track at different layers between business and technology. Also, the systemic nature of ERP technology and the iterative nature of human behavior and learning at each layer from business to technology make this ERP lifecycle even more difficult to define. This technology lifecycle challenge was found at Nokian Tyres, where the business layer tried to continue operations and AS-IS processes despite major changes in the corporate IT and ERP technology level.

This lifecycle challenge applies to ERP applications, which have been evolving from internal financial applications towards enterprise-wide logistics, Human Resources (HR), Customer Relationship Management (CRM) and eBusiness and eCommerce applications. In 1998, Davenport (p. 122) listed ERP modules from SAP to enable data integration between Financials, Human Resources, Operations and Logistics, as well as Sales and Marketing. Another lifecycle challenge comes from the immaterial nature of software combined to the marketing culture of IT technology. This means that technology vendors typically start marketing their new technologies as products early in the idea phase to generate demand and create markets before the actual product or technology exists at any level. In the software industry, this phenomenon is sometimes called “promiseware”, which means that lead-time from a conceptual idea to technical innovation as immaterial semi-finished product still requires plenty of time and effort before this idea can be realized as a materialized technical artifact.

ERP as concept, technology and product have been evolving rapidly from the year 1995 to 2007. The same applies to business, operations and ERP systems of Nokian Tyres. At the same time, our case enterprise has grown from a small Finnish tyre company into a mid-size international tyre business enterprise. Revenue-wise, this growth of Nokian Tyres has meant almost 5,5 times scaling from about 0,187 meur (Nokian Renkaat 2002, 44) in 1995 to 1,025 meur in 2007 (Nokian Tyres 2008, 4). Personnel-wise, the growth of Nokian Tyres has been about 2,5 times scaling from 1350 persons (Nokian Renkaat 2002, 44) in 1995 to 3462 persons in 2007 (Nokian Tyres 2008, 4). ERP technology-wise, we could simplify that Nokian Tyres as a parent company has used two ERP technologies: old DPS6 –technology based applications, which were not yet called as ERP, and Oracle Applications since 1997. If we look at Nokian Tyres as a case enterprise from the group level, various local ERP systems in sales companies and several ERP –versions and instances in Vianor –tyre chain should also be included in the EA scope. If we look at Nokian Tyres parent company and its Oracle Application history at ERP version level for the system called “MaFi”, then we can aggregate ERP versions inside Nokian Tyres into 5 different major releases of Oracle Applications: R10.6/1997, R10.7/1998, R11.0.3/1999, R11i9/2005 and R12/2012. But, in practice, there were much more minor ERP releases because technical and functional issues of complex and highly integrated Oracle applications needed software and configuration bug-fixes, which Oracle Support organization normally calls “patches”. Because of the various and partly parallel development project procedures, and these bug-fixes from Oracle Support, in practice each Oracle ERP –instance has needed at least 3 different copies: one instance for development projects, one instance for system testing and training, and one instance for production. Ideally, one more ERP instance was also needed for ERP production testing purposes, which was software-wise a replica from the production ERP-instance with as fresh data as possible. These 3-4 ERP instances were needed for developing, testing and running production at the Nokian factory. If integrations between various ERP systems are included, ERP system lifecycle is yet more complex.

Before 2007, ERP –system strategy at Nokian Tyres aimed at a single ERP –system called in Oracle-language as the “Global Single Instance”. In 2006, Russian operations and the factory at Vsevolovsk were not able to accept Finnish processes and procedures inside “MaFi” for “local legal reasons”. Nokian Tyres was compelled to change their ERP –system strategy for multiple ERP -instances. As a result, the ERP-system architecture and corporate-wide EA soon became much more complex than before the year 2007. At the same time that the corporate level Oracle ERP -master data system was running its own Oracle ERP-instance “MAD” at the Oracle R12 –version level, Russian operations were using their own Oracle ERP-instance “ROP” at Oracle 11i10 –version level, and Central European operations were using their own Oracle ERP-instance “GOM” at Oracle R12 –version level. In addition to these transactional ERP systems, the advanced supply-chain planning module Oracle APS was running in a separate production instance called “Global Planning” (GPL), which had one replica instance for testing purposes. While each of these separate ERP –systems “MaFi”, “MAD”, “ROP” and “GOM” had their own 3 sets for development, testing and production purposes, system integration testing needed careful planning and coordination for maintaining synchronized and complete sets of 4 transactional ERP-instances, a corporate datawarehouse DW-instance and an advanced supply-chain planning instance. EA –wise this meant that each system had 2-4 AS-IS versions, which were integrated to each other in various ways using database links, a transactional integration layer and ETL –batch processing.

These different ERP –versions with separate ERP –instances are each unique sets of software, setups and data, which makes detailed ERP system documentation maintenance, change management, communication, coordination and training quite challenging. Depending on the ERP governance model, responsibilities and time-space -proximity between the network of ERP developers, support organizations and users, the ERP –management task is more simple if an enterprise is able to support its’ business with one, global single ERP –instance. But if the business operating model or some other structural reasons are leading to usage of several ERP technologies, then the ERP management challenge and complexity increases, also indicating the need for mirroring the business side structuration to ERP development and service organization. In practice, this was also the result in Nokia Tyres group, where ERP development and service organizations were quite widely separated: Nokian Tyres with Oracle-based ERP and Vianor with Maestro-based ERP had their own ERP development and service organizations. There were some critical and totally overloaded shared resources working with both Oracle and Maestro ERP –systems that were supporting hybrid solutions in the sales companies of Sweden, Switzerland and Germany.

When evaluating the Oracle ERP –solution of Nokian Tyres with an IT–framework model, the Oracle Applications technology stack can include new technical components to all layers in every new major release. Even if, technically, some old discrete technology component from Oracle like a database, SQL*Net –protocol, Forms or Reports would have been certifies and compatible with a new application release, Oracle Support was aging and support for old technology expired faster than Nokian Tyres was willing to make upgrades to ERP systems. In practice, this meant that major ERP upgrades at Nokian Tyres from R10.7 to R11.0.3 and from R11.0.3 to R11i9 included new technical components to all layers of the three-tier application architecture: database, application and user interface. The risk of using some old version of a well-functioning component like the database 9i or 10g release as part of the ERP configuration was that Oracle Support did not promise to deliver new bug-fixes if the customer would find a new critical issue from this non-supported component. But of course all existing patches were available to fix all known issues, and extended support could be bought if needed. Because Nokian Tyres and service vendors had many technically talented resources, the risk of running a non-supported database version as part of the ERP configuration was quite minimal. Thus major technical IT components were upgraded normally as part of the ERP upgrade projects.

ERP upgrade projects, new application module introductions and new solution configurations tended to change all layers, from business to servers and even to PC clients. This made upgrade projects demanding from a testing perspective. Especially, because Nokian Tyres has developed some 500+ customizations, which were suspected to be changed in every major upgrade. In some cases, a new ERP release enabled eliminating old customizations, but normally schedules for projects were so tight with so little testing resources, that it was easier to select a technical path to migrate old customizations into a new technology and application release than to start a business path for reconfiguring business processes and learning new application configurations.The ERP system development could benefit from IT–framework analysis while elaborating systemic dependencies and change effects between different EA layers and socio-technical imbrications. Our IT–framework phases of technology life-cycle from introduction to retirement are quite generic for highly systemic ERP technologies, which would benefit for much richer ERP –lifecycle models (e.g. Millerand & Baker 2010; Rajagopal 2002; Somers & Nelson 2004; Markus & Tanis 2000). This IT–framework being generic for all technologies, we do not modify this framework in this phase of our study. Thus we present this vignette and findings with IT–framework illustration in Figure 26.

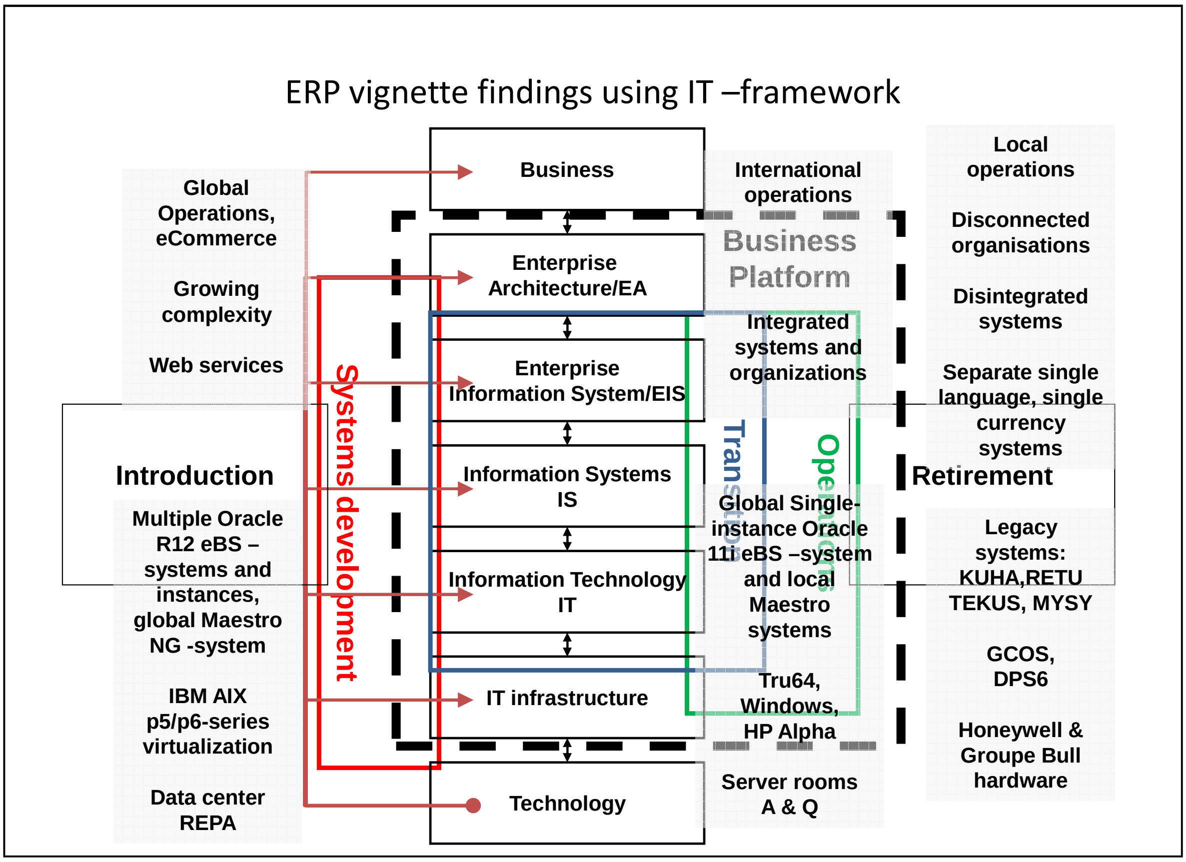

FIGURE 26 ERP vignette findings using IT –framework.

This illustration of the ERP technology into the IT–framework –model seems to work quite well for putting emphasis on the major technological and operational changes. But there also seems an obvious danger of achieving too complex of presentations, if too much detail is embedded into the IT–framework –picture.

7.1.3 ERP/EA–framework -elaboration

When reflecting on our perspective to the substantial EA layer at Nokia Tyres, three important themes must be discussed regarding ERP development. The first one is more a sociomaterial feature regarding minimal documentation culture. The second one is more a managerial feature regarding seasonal business culture, which combines annual the business calendar and scheduling of ERP development project phases according to seasonal business peaks. The third and perhaps the most important is sensitivity to organizational sub-cultures.

Nokian Tyres may be a quite typical rubber industry organization with a company culture that highly values new technologies, which are merely learnt by using those in practice. Thus the most valuable knowledge has been the practical know-how of doing rubber compounds and tyres by running production technology. This procedure and practical method of learning-by-doing is highly valued, and has been an excellent method for improving production processes and tyre products, but not in documenting information systems and maintaining up-to-date processes or procedure documentation about working methods. The physical end-product itself, the tyre, has included all the needed information in material form printed with rubber in the sidewalls of the tyre: physical measures, load index, speed index, factory code, country of origin, manufacturing month, etc. Thus the physical and material end-product itself has been the only documentation, which is delivered to the end-customer. In the tyre industry, product recipes are more like valuable, industrial secrets, and the user guide or mounting instructions are not part of the end-product, which may explain why the tyre industry has not valued documentation culture. Written documentation has not been an important product either for tyre service culture. In some cases during author's career at Nokian Tyres, analysis of AS-IS processes and operational history can only be read from system source code files. In some cases, if source code files have not been available, historical documents have been requested from the original system vendor or transactional information flow has been analyzed from the database and system log files. But this minimal documentation culture may be a more generic issue in many modern organizations, which Sidorova and Kappelman (2010, 77) have described as a lack of up-to-date high-level conceptual IS designs. They elaborate this situation as actor-network behavior for eliminating non-value-adding activity and visibility to as-built systems not consistent with as-designed systems (ibid.). Minimizing documentation for avoiding costs of non-value-adding work seems to have some match with field notes and participant observation in our case company. Thus this minimal documentation culture may be seen as a common industrial practice, lean management and part of the common sense of not paying for extensive paper works at the technical documentation level. But on an ethical and professional level, minimal documentation practice is not a preferred means to save money, if it causes person dependency and delays in issue resolution, knowledge transfer and systems development.

Scheduling challenges for ERP development at Nokian Tyres come from the seasonality of the tyre business: from the end of September to the beginning of December, the factory and the whole supply chain is running at full capacity to maximize winter season sales. A similar kind of seasonal peak occurs in March-April for the summer season. Thus new development projects must be planned against the annual corporate calendar in which the ends of each quarter and seasons are the busiest times on the business side, while monthly period and quarter closings are the busiest times on the financial reporting side. Typically, the ERP design phase can be done before season and testing after the season. Normally, training periods should be scheduled just before go-live dates, which are best done in the beginning of January, May or August. On the factory shopfloor, the best go-live period is after mid-summer, when normal production is stopped for summer vacations and annual maintenance breaks. At the warehouse, inventory levels are at a minimum in July and in January, when seasons and Q2 and Q4 are over.

Inside the long value-chain of Nokian Tyres, there are many departments, organizations or ERP user-groups that have their own sub-cultures, procedures and practices, which can somewhat value different matters and behavior than the original rubber industry or factory culture. If both the minimal documentation culture and the seasonal business culture could be seen as generic tendencies in Nokian Tyres' tyre business, then there are also local differences between different organizational sub-cultures. The original rubber industry culture may be perhaps best found from raw material procurement of natural rubber, factory maintenance and perhaps also from the rubber mixing department. But in younger and more international departments like IT, logistics and the Vianor tyre chain, working cultures may be somewhat different, which is again reflected back to the documentation culture and seasonal business culture of each employee group.

Krumbholz and Maiden (2001) have studied ERP –package implementations in different organizational and national cultures. They have found slight evidence that ERP implementation problems may be more associated to organizational culture than to national culture. Our observations from Nokian Tyres indicates that careful social analyses with the web of users and key stakeholders is needed for every ERP development initiative because individuals and personal behavior combined to competencies are critical for managing and communicating changes between technology and people. With generic technology like ERP, developers can't always satisfy all user groups and personal preferences, and therefore some social engineering is required to balance the limitation of technical engineering.Another important differentiator between sub-cultures comes from international differences inside Nokian Tyres operating countries. The major markets of Finland, Russia, Sweden and the States have some differences regarding human behavior, manners, practices and national calendars, which have effects on business values and national business requirements, and also in documentation and seasonal business culture. Seasonal business culture is a combination of corporate business calendar, national calendar and environmental differences regarding weather, climate and seasonal changes. These country-level differences should be considered carefully when planning ERP –projects, localizations, change management and implementation approaches in different countries.

A few practical examples from the ERP development environment in Nokian Tyres indicates that values and capabilities of the managing director are a major differentiator, at least in small country organizations. Normally managing directors as users and stakeholders expect numbers, dates and practical business communication during ERP development. But the managing director of Nokian Tyres Ukraine had a multi-media and web developer background, resulting in unique expectations about how ERP and technical development should be communicated and managed in Nokian Tyres' operations in Ukraine. Typically, German speaking Central-European users and organizations are expected to be formal and precise, "sehr pünktlich", but the managing director of Nokian Tyres Switzerland was Italian, a former heavy-weight boxing champion, which affected his unique expectations and affected in his personal business management and communication style, as well as in his organization. When these kinds of different personal preferences during the ERP system development are noticed in all phases of the projects, local business, sales and change management including customer communication can be planned and executed without major discontinuities. A summary of the EA–framework finding regarding ERP development is presented in Figure 27.

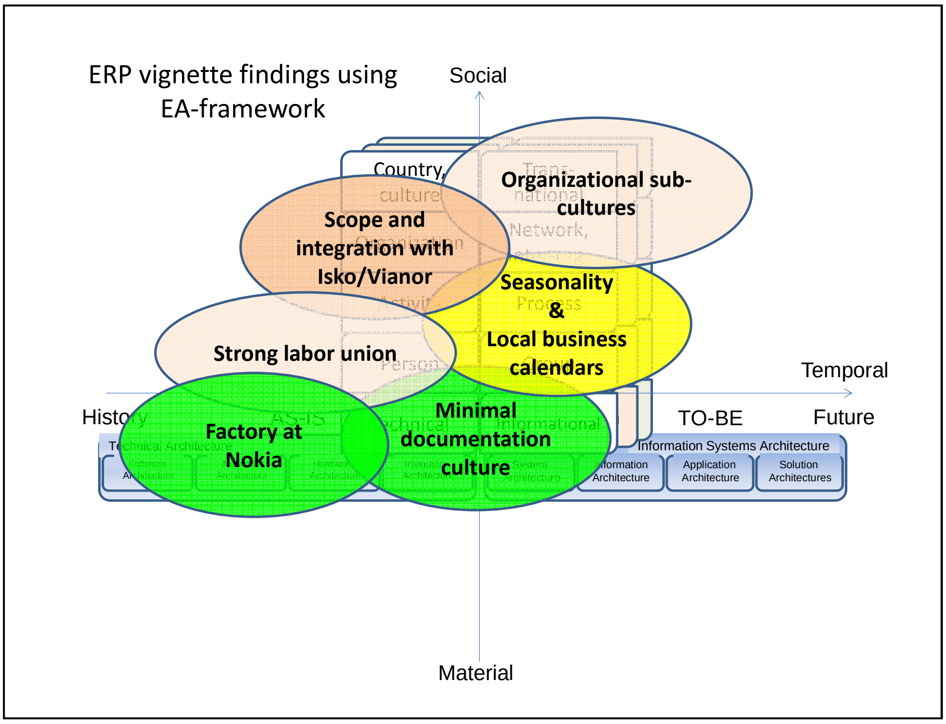

FIGURE 27 ERP vignette findings using EA–framework.

7.1.4 ERP/EAM–framework -elaboration

When reflecting on our ontological, epistemic and ethical approach to ERP development in our case enterprise, we will try to elaborate on the second-order conceptualizations of the minimal documentation culture, seasonal business culture and sensitivity for organizational sub-cultures.

We will start from the epistemic perspective, which relates tightly to the minimal documentation culture. Perhaps this remark is culturally tied to the nature of rubber and how the knowledge of rubber as a raw material and the use of rubber products have been tied to technical and economic well-being of the rubber industry. This minimal documentation culture has perhaps protected owners of the rubber trees and factories from competitors and replacements. This special character of the rubber and tyre industry may have been acting as an “invisible” protection and structuration element, which does produces neither value nor other kinds of information and knowledge than what is “printed” on the product, i.e. the tyre itself and that knowledge acquired by people in the “learning-by-doing” mode in the production process. If so, then that portion of tacit knowledge has been larger in the rubber industry than some other, more information intensive and documentation-centric industries. This generates a situation, where the product, process and system knowledge is quite tightly embedded in the individuals, who have developed the current business and systems. Of course, ERP and other related IT systems have been documented at some level during investment projects, but typically during the years various changes in processes, technologies, integrations and business configurations are not maintained to system documentation. This decreases the value of the original documentation and makes business development slower and more dependent on the knowledge of the original system developers. Perhaps the company culture and the HR-programme called Hakkapeliitta Spirit (Nokian Renkaat 2004, 5) could be used for improving business documentation culture, sharing information and eliminating the risks of tacit knowledge and person dependent business operations. These investments in documentation culture could result in improvement possibilities of HR development, business systems, processes and product knowledge. The documentation culture could be embedded into the Hakkapeliitta Spirit component “Team Spirit”, which could be converted from “The will to Fight” into sharing and caring of the community, communications and knowledge management. The sales and marketing driven “Trust the Natives” culture (Nokian Renkaat 2007, 16) has supported a strong R&D spirit of northern conditions combined with country organizations, leadership and entrepreneurship. This sales approach has produced strong country organization leaders with good sales teams and market positions around the snow-belt; this strateg has produced continuous growth and profit (Happonen 2014, A12; Manager Magazine 2005, 2007, 2008, 2009, 2010, 2011; Raeste 2014, B10).

The minimal documentation culture may be a common industrial practice and part of the practical common sense of not paying for extensive paper work at the technical documentation level (Sidorova & Kappelman 2010, 77). This practice may also be explained as part of the automotive-industry and lean management culture, if extensive documentation is seen as waste. But from the system development perspective and on an ethical and professional levels, minimal documentation practice is not a preferred means to save money, if it causes person dependency, service constraints and delays in issue resolution and systems development. The wide organizational scope of ERP systems in particular requires documentation, which supports the organizational integration, communication and learning. Thus the need for technical documentation is limited to IT support and development, but on an operative and process development level ERP system documentation is vital. Drawing a line between technical and operational documentation may sometimes be difficult. The same applies to determining the optimal amount of documentation required for ERP system life-cycle services and development.

From the EAM perspective, ERP systems are perhaps the one of the most challenging parts of Enterprise Information Systems because ERP systems have wide coverage of the business processes and information. Davenport, Harris and Cantrell (2004, 25) have studied how enterprise systems can be used for continuous improving of business performance, and they have found the factors most associated with achieving value from enterprise systems were integration, process optimization, and use of enterprise-systems data in decision making. At Nokian Tyres, ERP –data has been used in decision making, but the potential of ERP systems in improving organizational integration and process optimization has not been leveraged. If improvements in EA management could be reflected in the process thinking and redesign for internal process efficiency, then moral and ethical considerations of EAM work should improve the communication of process automation and organizational re-arrangements.

The limited harmonization of business processes also decreases the value of ERP –data, which applies both to master data, for example customers, and to transactional data, for example forecasts and sales orders. But when Nokian Tyres group has more than one ERP system and a separate B2B CRM system, the role of the customer master data becomes more critical. Even with one flexible ERP system like Oracle ERP, customer data can be entered in several ways like in Finnish and Norwegian operations. When running a separate CRM system and several ERP systems like Oracle and Maestro, each having their own customer data model, the complexity and various customer data combinations creates multiple sources of errors and confusion into enterprise datawarehouse and reporting. Thus the need for common customer master data system and processes raises above normal IS borders to EIS level, where common data should be located, including standard terms and conditions for payment, deliveries, commodity codes for customs clearance, internal customer and supplier data for inter-company transactions to enable analytical reporting, netting, credit checks and consistent elimination of internal sales from enterprise-level reporting services. Thus ontologically and ethically business entities such as common lists of values for standard terms and conditions, customers, suppliers, products, global contracts, pricelists and reporting structures should be managed and maintained at the higher level of abstraction, system and processes than what one single ERP system can manage. At least strict and documented group-wide rules for master data maintenance and processes should exist, if there is no centralized master data system, which could enforce consistent rules for master data maintenance. Ethically, the need for master data is even more important when we think of the customer service level for the most important international customers, who should be managed and served in a consistent manner in each country and from each sales channel they are using. Development of an enterprise-wide centralized customer master data system would decrease operational flexibility and local improvisations in customer facing operations, but this should improve global visibility and data for decision-making, which should benefit internal efficiency and external effectiveness at a global level.

At the enterprise-level, ontological balance should be found between social, material and technical details. This is a major challenge for EA work and practices, which are originally IT-biased and thus go into too much detail of the technology domain. Especially in an ERP context, if EA modeling is done at a detailed level, there is a big danger that the EA work is not efficient, effective and beneficial at the enterprise and business level. Thus social and material structures of business and environment should be included in more detail than in an IT-biased architecture model, and the IT domain and technologies should be modeled at a more aggregate level concentrating on information flow and content between different actors in current and future business networks. This ontological balancing between social, material and technical issues is a challenging task, but critical for EA to be beneficial at the enterprise-level in an ERP context. A summary of the EAM–framework elaboration regarding ERP development is presented in Figure 28.

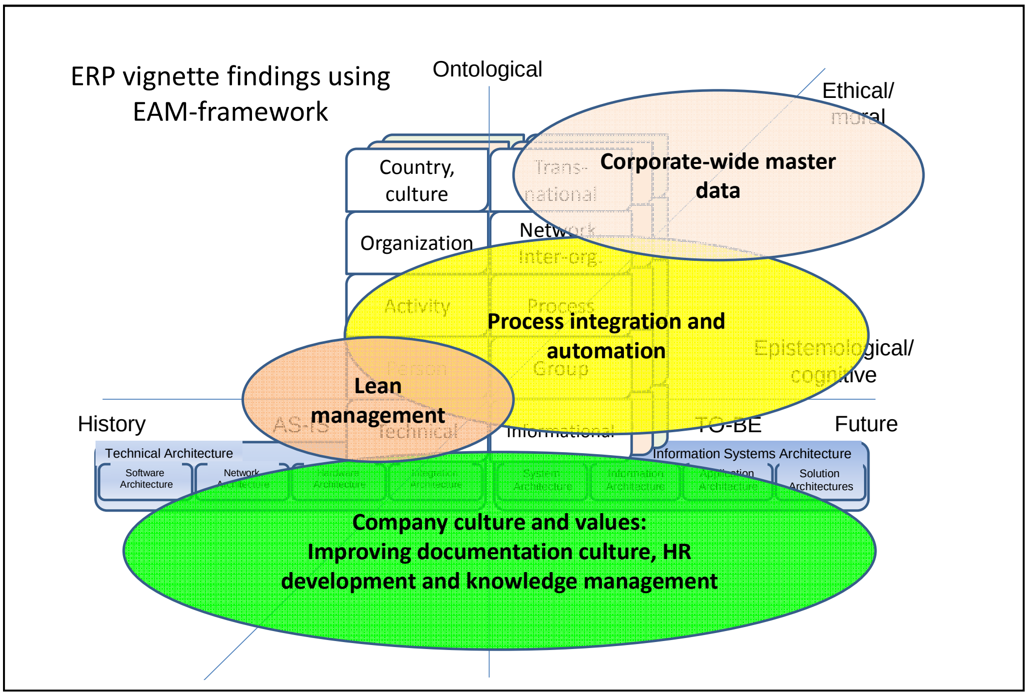

FIGURE 28 ERP vignette findings using EAM–framework.

This illustration of ERP findings using an EAM–framework research framework shows the EAM potential for eliminating social EA challenges at Nokian Tyres. Considering the it again critically, this EAM–framework –framework includes the same problem as the EA–framework model in that it is too loose for detailed EAM analysis, but at the same time the EAM–framework enables discussions of quite invisible and controversial cultural issues and possible organizational goals. The prevailing Lean Management –principle from the automotive industry could be used for explaining several management practices that have worked fine while having only one factory. Our EAM study implies that the more complex business environment may need new management practices and improvements into an ERP system and process development for managing changes and knowledge management between various organizational units.

7.1.5 ERP/external knowledge-sharing perspective -elaboration

Each IS system has its' own system and social architecture, which is a subset of EA. At Nokian Tyres, the ERP –system covers a major part of the corporate-wide EA. Thus ERP –knowledge-sharing practices are an important part of the EA knowledge-sharing. At Nokian Tyres' organization, ERP knowledge-owners are those long-timers who have learnt the ERP system during implementation, development or upgrade projects. In the ICT department are working technical specialists who can help with technical issues, and system specialists, who can help with system configuration and integration issues, but deep ERP –related business knowledge is typically owned by veteran super-users who work either in business or an ICT organization. System Managers are supervisors or knowledge specialists in an ICT department having the wider responsibility of inter-related business systems and work coordination between internal and external resources. Business Managers are supervisors for end-users and super-users, or business specialists at operational departments having wider responsibility of inter-related business processes, performance and results. A super-users' role and knowledge-sharing at Nokian Tyres have had similarities with modes of inertia, reinvention and improvised learning documented by Boudreau and Robey (2005, 9).

ERP -systems are documented somewhat during the development projects, a process which normally produces technical user guides. Newcomers get their user access rights to ERP -systems from the ICT department, and normally their peers or supervisor give end-user –training and instructions as part of the orientation to work. Then, newcomers improve their ERP –system knowledge through learning-by-doing. If someone is competent and motivated to improve his or her ERP-system knowledge beyond the standard end-user, willingness to participate in ERP –development in projects, system testing or as super-users offers new social structuration possibilities for ERP development organizations. Two super-user persons from Nokian Tyres' organization have switched their working careers to ERP service vendors, which show how systems related knowledge transfer may initiate organizational restructuring and personal career development. Beside ERP-related project trainings, there is no separate ERP –training available, but training events are arranged on on-demand –bases. During the author's empirical work at Nokian Tyres, two really capable super-users retired: one from the Finance department, and the other from the Procurement department. Both retired super-users have acquired their ERP –system knowledge since the ERP –project 1995. In both cases, within one year, their departments asked for special training events to increase generic ERP –knowledge for all the remaining persons. These training sessions were given in an in-class mode and training materials were produced and saved in document management systems.

For ERP-related knowledge-sharing practices, there has been a long-term discussion stream regarding community of practice initiation for ERP –super-users. But with a small set of people, who participate in daily business work, end-user training, support and development projects, there has not been enough resources to establish this ERP -super-user network. Super-users were in a central role in their business and knowledge area between business, ERP and ICT, thus having quite a lot of informal power and influence inside the organization. On the other hand, super-users have more work and responsibilities in daily problem solving and issue resolution than their peers, which meant also longer working days and sometimes support calls during nights and weekends. For the ICT –organization, ERP –super-users were valuable persons because normally they knew better the daily tricks and workarounds than technical specialists. Even more important, ERP –super-users could discuss and elaborate business and process changes combining business and ERP –language. Some ERP –super-users adapted terms and concepts directly from the ERP –system into their daily discussion with their peers. Thus daily business discussions and dialog regarding business process development, changes and issues were interweaving ERP-terms and concepts into normal language. At the Nokia factory, this was easy to observe, because normal, daily business communication was done in Finnish with a Tampere –area accent, which then contained some Oracle ERP –based American English words like "enter", "demand", "book", "schedule", "ATO" (from Assemble-to-Order"), "BOM" (from Bill-of-Materials), which were pronounced with a strong Finnish/Tampere-accent. But this kind of dialog and knowledge-sharing, which combined language from tyre business processes and ERP –system terms and concepts, was an efficient way of communicating and coordinating both issue resolution and change management. Thus ERP system knowledge and tyre business knowledge were combined to each other, creating new levels of and structures of social communication for organizational influence and unofficial power structure over official organization hierarchy.

A systemic ERP knowledge-base creation was initiated as part of the ERP support practices and service contract with Tieto-Enator application support. This service vendor and service desk system were replaced with distributed service management and its own service desk system, which was implemented together with Solita using Jira –application from Atlassian. A Jira-based service desk was first initiated in ERP development projects, and the old ERP –knowledge-base was migrated to Jira. Later this Jira-based service desk system was also introduced to other systems and in daily support tasks and issue resolution between all Nokian Tyres central organizations and country-organizations. In Russian operations the same Jira –based service desk was also utilized for customer responses and claims management to enable dialogue between outsourced call center operations, internal customer service and other operational departments. The Russian HR operations utilized the same service desk system also in HR development projects and in managing Russian processes for personnel initiatives.

Thus this Jira-based service desk system was a central actor and facilitator in ERP –knowledge management beyond organizational borders. System-wise issues with ERP –knowledge sharing in Jira-based service desk were quite technical, which makes this system less compatible with daily ERP-support services. Another issue comes from flexible and informal service request processes at Nokian Tyres, which creates various individual, local and temporal routines for entering ERP –knowledge into a system with local languages and varying terms. Because of limitations with other content management systems, ERP –knowledge sharing with a Jira-based service desk also contains a plenty of attached documents. Thus Jira creates a flexible way for file sharing between ERP developers and service operations, but various practices in document creation procedures, non-standard terms and local languages complicates the search for knowledge.

Yet another issue with ERP knowledge and data structuration comes from the ICT –organizational border between an IT –technology team and the IS team: for some historical reasons ICT –organization at Nokian Tyres has been separated into the “hardware team” and “software team”. The hardware team was responsible for development and support of data centers, non-unix server platforms, networks, printers, all terminal devices and office applications. The software team was responsible for software tools, and business application administration, development and use. For various reasons, the “hardware team” did not use the Jira-based system in its’ operations and daily practices, which eliminated most of the hardware, data center, printer and terminal related knowledge from the Jira –knowledge base. Regarding ERP –knowledge this ICT-organizational structure between “hardware team” and “software team” did not affect that much because “software team” was responsible for ERP-systems technology layers between unix-operating system and end-user services excluding physical terminals and printers. But especially in ERP –performance issue resolution cases this organizational structure caused problems in service request processing and knowledge sharing, because network, storage and physical hardware related information and knowledge did not properly accumulate in the Jira-based ERP-knowledge-base. Even with some limitations, the Jira-based service desk application and data storage created a valuable immaterial asset for Nokian Tyres and its' ERP development beyond enterprise borders.

When coming back to attributes in external perspectives from Østerlund and Carlile (2005, 92), the difference in ERP-knowledge can be made between newcomers, end-users, super-users, business managers, system managers, system specialists and technical specialists. These knowledge categories and boundaries between knowledge categories were historically constituted during the ERP –system development. Memberships in each knowledge category stemmed from a combination of professional education, working career, organizational position and history with the ERP –system. Emergent practices for knowledge-sharing and temporal blurring of knowledge categories occurred quite naturally at Nokian Tyres because the company culture also promoted a "learning-by-doing" attitude in ERP development. The organizational hierarchy was also quite low and informal, which promoted daily dialog and emergent movements between different knowledge categories and between all layers of the business and technology stack beyond ERP –system borders.

Our knowledge-sharing perspective model seems to be a challenging instrument for analyzing social structures for both system specific and EA –wide knowledge management and transfer. Within each technology comes embedded some design-driven social architecture, which should be somehow applied during the technology introduction into existing organization structures. System-related knowledge transfer initiates opportunities for social restructuring while creating new roles, knowledge and responsibilities, and eliminating ones. Thus knowledge is a fluid mixture of social and material, the position, momentum and flow of which is difficult to analyze in and between ERP development and whole EA activity system.

7.1.6 ERP summary

This ERP vignette has created foundations for the other vignettes, which will follow in their own sub-chapters. The ERP system at Nokian Tyres is a central part of EA and IT architecture, but the process and business architectures are not visible from the ERP system. The IT management for an ERP system is quite strong and well-balanced between business and process management. But both business and process development can be seen as separate social domains, which are not integrated into an ERP system and the IT management process. Therefore, in Figure 29 we will position the ERP vignette as the IT management foundation without holistic EA, business or process development attempts towards EA management. Analysis of the social architecture and organizational structure needs deeper analysis in the ERP system roles, responsibilities and division of labor.

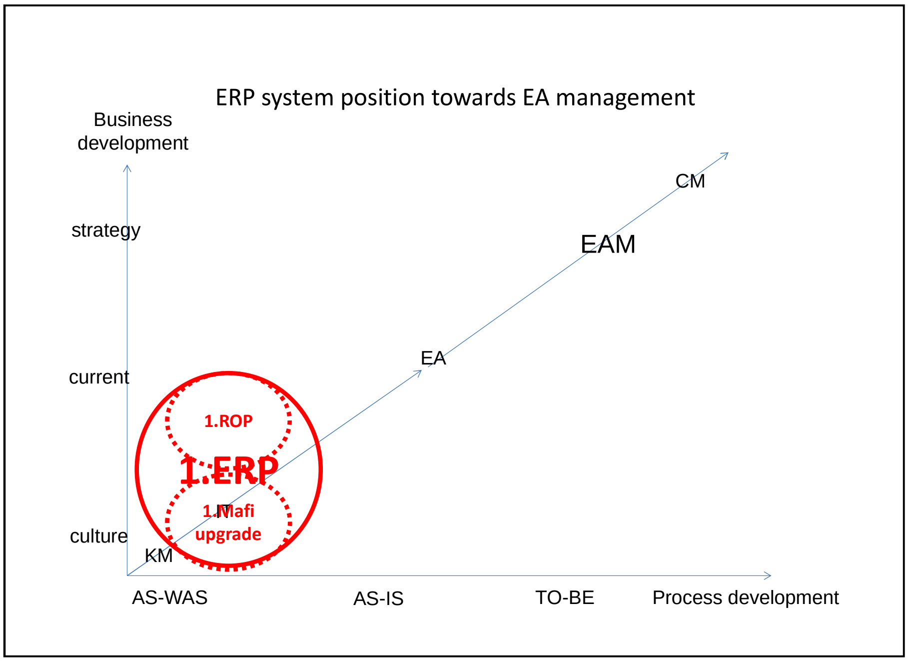

FIGURE 29 ERP system position towards EAM maturity

7.2 Enterprise Datawarehouse/EDW vignette

7.2.1 EDW introduction

This vignette includes observations regarding Enterprise Datawarehouse (EDW) and reporting solutions, which together contain the majority of the internal Business Intelligence (BI) data and solutions at Nokian Tyres. During the ERP –project, it was already obvious that informational business needs were much larger and multi-faceted than standard ERP queries and reports were capable to deliver. Despite limited reporting functionality, Oracle Manufacturing modules were taken into use with some modified Oracle Reports –based printouts directly from operational ERP –instances, which caused immediately some performance issues. As explained already in the ERP –vignette, in 1999 the corporate reporting approach was changed from customized Oracle Reports –development to an EDW approach: corporate-level reporting data was collected to a centralized Enterprise Datawarehouse (EDW), where Oracle Discoverer was used as an ad-hoc –reporting tool and the Oracle Financial Analyzer (OFA) as an analytical reporting tool. After ERP –rollouts to Sweden and Norway in the year 2000, and the Vianor –tyre chain launch in 09/2000, corporate reporting system architecture was illustrated with Figure 30.

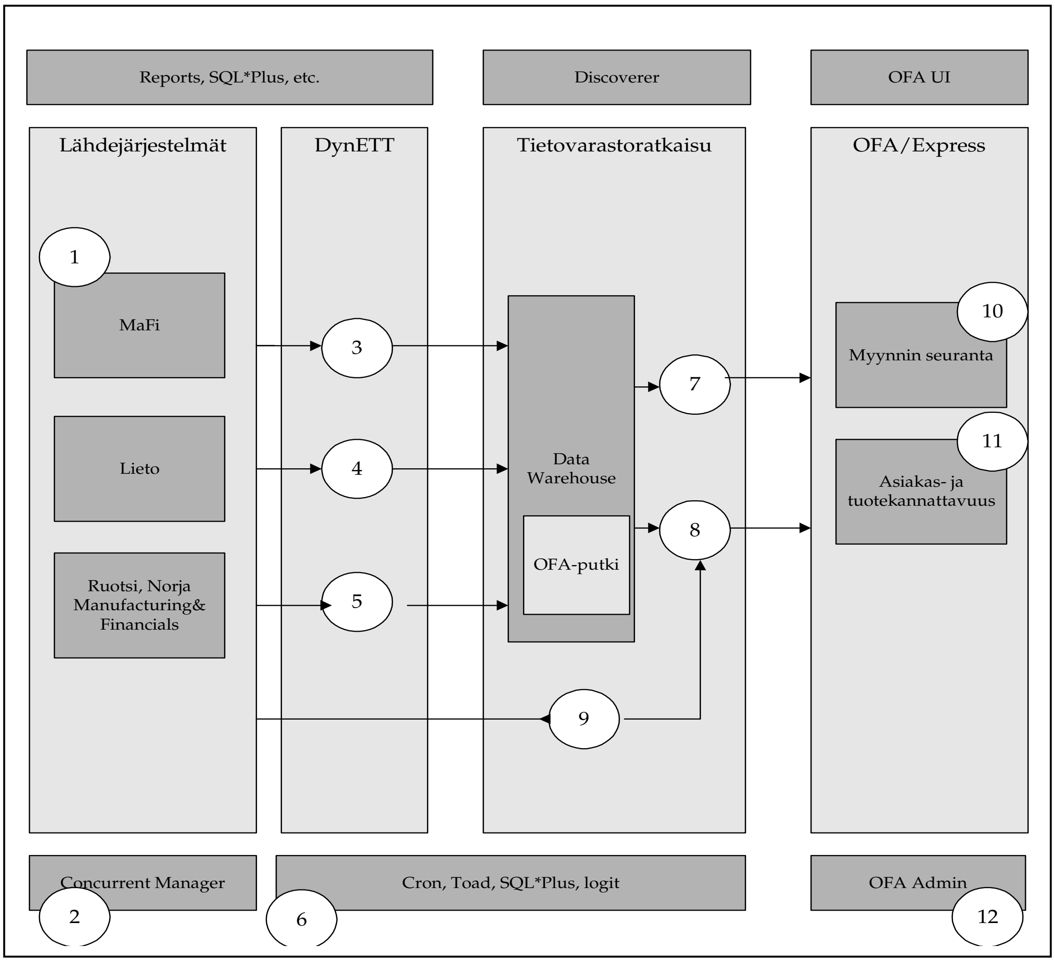

FIGURE 30 Reporting systems for Nokian Tyres (Kimpimäki & Ranta 2002, 3).

In Figure 30, in the left-side box number one, various ERP –systems are acting as source systems for transactional data. The second phase in this reporting data flow was the Oracle ERP-based Concurrent Manager –batch runs, which were scheduled batch process data collections. Phases 3-5 were target system specific pre-processing runs executed with so called DynETT, which were separately collecting reported dimensions and factual transaction data for the Discoverer-based ad hoc –reporting and OFA –based analytical reporting. Box number 6 below DynETT- data processing phases presents the technical admin tools for executing and monitoring this reporting data flow. The top-most box above phases 1-6 present user interface tools for these reporting phases. These information processing steps were enriching transactional data for managerial and business reporting purposes. The EDW –dimensions and factual data are updated during phases 1-6 into Nokian Tyres' EDW –solution for ad-hoc Discoverer –reporting. The Analytical OFA –reporting data and dimensions are still processed in phases 7-9. Then, in phase 10, the sales follow-up reporting cube is updated daily, and, in phase 11 customer and product profitability, the reporting cube is updated on a monthly basis. Phase 12 is reserved for OFA Admin –procedures for maintaining Express –databases for OFA –applications. The top-most box in the upper right corner was at that time OFA user interface layers. This EDW –architecture for corporate reporting enabled business-driven reporting views for product and customer profitability monitoring. Enterprise-wide information architecture has been an important part of this EDW –solution, which has been very flexible for capturing integrated profit calculations from factory costs through different sales channels, Vianor and local sales companies.

In 2002, the ETL -data-loads to EDW and ad-hoc queries with Discoverer were working, but OFA was not technically capable to manage actual sales and invoicing data in analytical cubes with fragmented data sets. OFA was by design meant for analyzing smaller and more compact financial accounting data sets from General Ledger (GL). Oracle would have also had a similar kind of software product called Oracle Sales Analyzer (OSA), which was by design meant for analyzing fragmented sales data. Thus OSA –reporting might have been a better solution for Nokian Tyres. But Nokian Tyres decided to replace OFA with Cognos –reporting tools, which were already used in the Vianor –tyre chain reporting. Nokian Tyres' financial specialists together with Solita reporting technology specialists have continued to develop EDW and Cognos –reporting solutions according to changing business needs. Thus both EDW and Cognos –reporting tools were standardized as enterprise-level BI solutions for Nokian Tyres.

The EDW –solution has been developed for managerial reporting purposes. Each operating unit has been developing their own set of reports with common tools. Corporate-level financial reporting at Nokian Tyres has been collecting source data from various accounting systems and sub-ledgers at the legal entity level. Accounting data has been collected with Excel-workbooks into Hyperion Financials, where data has been processed into corporate-level financial reports. Thus EDW has been lacking so-called "Fina DW" for financial reporting. In 2008, the Russian ERP project RIMP2 wanted to develop the local DW solution for financial reporting, but during the planning phase Mansikkaoja negotiated with the Russians to join a corporate-level EDW –reporting platform. Because the corporate EDW-solution was lacking structures for financial reporting, the RIMP2 project designed their own data model and structures with ETL-scripts, which were centrally developed by the Solita team as an embedded part of EDW structures. This development during 2008-2009 produced Russian specific Fina DW implementation into corporate EDW. This caused quite heavy new data loads and performance issues in the EDW –solution. In 2010, a new EDW design and development was started from the financials reporting perspective, the development of which was heading towards a totally new BI solution at the corporate-level.

The increasing variety in reporting source ERP –systems and data models has been causing more complexity with the EDW –system, but with continuous investment in EDW –development, the EDW -reporting solution has been kept aligned with business growth. By trial and error, Nokian Tyres has developed modern corporate-level EDW and analytical reporting platforms, which have enabled the whole enterprise to analyze its customer and product profitability in a manner that enabled it to develop as one of the most profitable companies in the European automotive industry (Manager Magazine 2005, 2007, 2008, 2009, 2010, 2011). Nokian Tyres has been able to utilize this analytical reporting platform and profitability data with long-term success. Profitability has been an important company value, which requires a strong product demand and pricing position as well as strict cost control at all organizational levels. In this respect, the EDW and enterprise level BI-systems have been business-wise in line with the interests of the owners and executives.

7.2.2 EDW/IT–framework elaboration

The EDW –system development has been an attempt at business driven data integration to utilize new reporting technologies and EDW for improving business analytics in decision-making. Technology-wise, this EDW –system is real EIS, but business-wise this system contains several applications and business views for different business purposes at Nokian Tyres and Vianor –tyre chain. Business functions have been developing this EDW –system directly with external technology and service vendors, and Nokian Tyres ICT –department has been acting in a coordinating role for development, maintenance, support services and data center services. Thus common platforms have been utilized, but data models and reporting procedures have wide variation between different business units. The EDW –solution contains several discrete IT technologies which have been updated and changed during the EDW –system development in several phases. The only major technical issue has been with OFA for sales reporting. Replacing OFA with Cognos –tools and technologies has improved business ownership and created new analytical domains as Cognos cubes for various analytical business reporting purposes. At Nokian Tyres' side the use of Oracle, Discoverer –technology has been fragmented into three separate and unsupported versions called Discoverer Client, Desktop and Viewer, which Oracle would like to replace with the more modern Oracle BI –tools acquired from Siebel. At Vianor –side Cognos –tools are widely used for analytical and financial reporting, which indicates a possibility to harmonize reporting tools at the enterprise-level using Cognos –technologies.

In 2007, two separate external studies were bought to evaluate harmonization of reporting technology with either Oracle or Cognos BI –tools. At that point in time, there were major discontinuities and uncertainties visible in both offerings. One pilot implementation of Oracle BI –tools has been deployed to the mixing department at Nokia factory, but this solution has not yet been taken into use at the Vsevolozhsk factory. One trial project with Qlik Tech –presales tested the Qlik View –technology combined to Google Maps -based geo-data services to create a more visual sales analytics application, but this solution was not taken into use at all. This pre-study project showed that issues with master data processes, systems and maintenance, as well as incompatibilities with the source ERP systems, data models and flows created major obstacles and internal inefficiencies for benefitting from advanced analytics and visualization. Instead of adding more reporting tools into Nokian Tyres' reporting solution stack, one might think that it would be more efficient to deploy one reporting technology for the whole enterprise-level business reporting purposes. But for different end-user needs and preferences, varying from simple aggregate listings to complex analytical computations, it is more important that data sets and models are consistent between different reporting tools. EDW -analysis is illustrated with an IT–framework in Figure 31.

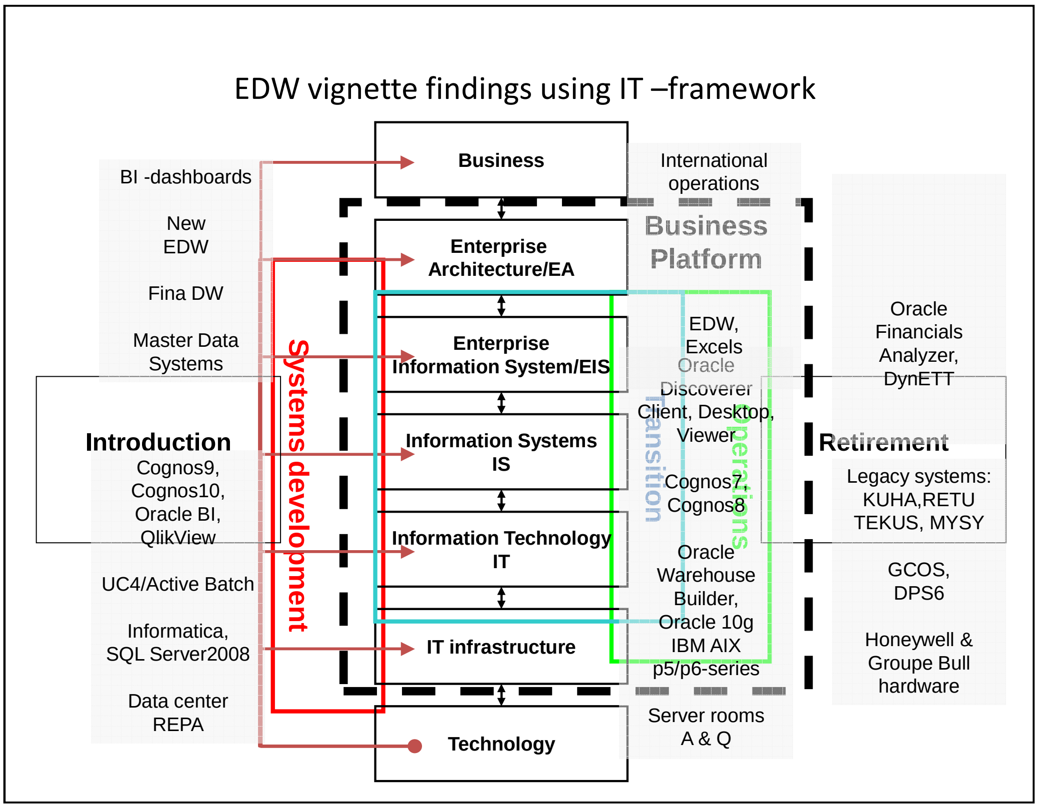

FIGURE 31 EDW vignette findings using IT –framework.

Our IT –framework seems to fit for EDW –analysis from a technology perspective. From the data model and organization perspective, the IT–framework seems to be too limited for presenting diverse operational and organizational reporting solutions. Technology-wise, this illustration omits various modules and versions of reporting tools and databases.

7.2.3 EDW/EA–framework elaboration

Various organizational sub-cultures can be found inside EDW –system development. EDW –development has been an important tool for sales organizations, controllers, cost accounting and business developers, but for support functions like financial accounting, procurement, HR and ICT this EDW -system has been less useful. For sales and logistics organizations, the EDW –system offered a somewhat fragmented but holistic view to the enterprise-level business situation over a fragmented ERP system landscape. Because of the limited business interest in anything other than raw material procurement, operational functions for sales companies like tyre, service and transportation procurement have not been properly included in ERP –solutions or EDW –data sources. External Business Intelligence/BI has been kept as a separate function with its own BI –systems. This EDW –solution included only internal costing, pricing and volume data for current countries and customers. Thus country and market specific external BI data is mostly missing from the EDW data and fragmented into other information channels like the intranet and a separate BI-portal. Organizational separation between Vianor ERP –developers and EDW –system owners has been causing communication gaps, which at worst has caused EDW –data load failures after Maestro ERP –version changes. Russian specific EDW –development, various organization and country-specific ERP systems and versions, as well as a separate CRM system with its own customer data model has caused complex ETL –structures and layers, which has caused delays and complexity into the EDW –system development. An extreme example of this complexity emerged when new a business request for adding a zip code in the EDW customer data resulted in estimates of 2 weeks work and additional calendar delays because of external resource constraints.

Limited EDW –system management services and capability has been causing technical complexity and fragility in the EDW –system. EDW –user groups like production planning, logistics, customer service and sales have been developing plenty of their own Oracle Discoverer views to EDW –data. This end-user driven application development is supported with the Discoverer Desktop –version and the concept of “End-User Layer (EUL)”, which both enable modifications to EDW –data views with functions and filtering. Thus some advanced end-users have been able to create and share their own reporting views for wider user-groups. This end-user –driven reporting development has been increasing the relevance and value of EDW –reporting, but at the same time this has been an additional source for data errors and challenges for managing EDW –system changes. End-user –driven report development has also caused challenges for data access right management because some pricing and profitability related information should not be visible for all end-users.

One of the core ideologies behind the business profitability has been the optimization of business management resources. Resources for business execution have been big enough to enable local services and opportunistic growth. This individualistic behavior has been explicitly supported by the company culture, which includes highly valued components of entrepreneurship and inventiveness (Nokian Renkaat 2004, 5). The strategic leadership level has been strong because of visionary leaders like Kurkilahti, Gran and Pantiukhov. But at the tactical, regional and corporate level this optimization of business management resources has caused resource limitations for process, data and system harmonization. For country organizations and business units, this situation has enabled a wide variety of operational improvisation and inventiveness, which could also be seen as limited corporate support structures and services. Limited system management services can be partly eliminated by utilizing more modern BI –technologies, but without more harmonized business reporting processes and BI governance structuration, an EDW system is has difficulties responding to changing business requirements. This implies a need for improving social structuration with integrated business, process and information architecture management. On the other hand, the strong Vianor Way –process culture has included the same EDW as an integrated part of the business analytics and BI –solution with much smaller margins from the service business. Thus the same generic technologies as IT architecture have been applied to different business architectures and process cultures inside the same corporation. This indicates major differences in the EA leadership and management practices despite sharing the same IT architecture and technologies. At a holistic enterprise level, these IT and BI system level weaknesses are balanced by the social and industrial intelligence of top management. Gran is a highly valued for his leadership style and business merits, which have been described as “analytical thinking combined to excellent execution, balanced and determined risk taking and geographical business refocusing” (Rope 2013, 130). Thus social competencies combined to enterprise-wide analytics and BI systems have enabled profitable business operations (Manager Magazine 2005, 2007, 2008, 2009, 2010, 2011), even during the economic recession and with global price competition (Happonen 2014, A12; Raeste 2014, B10).

The minimal documentation culture is causing inefficiency also to EDW development and information use. EDW development has been person and vendor dependent, which has enabled efficient EDW development, but knowledge management and sharing have been more at the technical level. Therefore, new information intensive analytics, such as a customer classification process or a new analytical reporting development, like geographical customer analytics, are quite slow and dependent on original EDW data specialists and developers. This implies the need for improving EA management with more documented and integrated IT, processes and information architectures. These EDW development findings are presented in Figure 32.

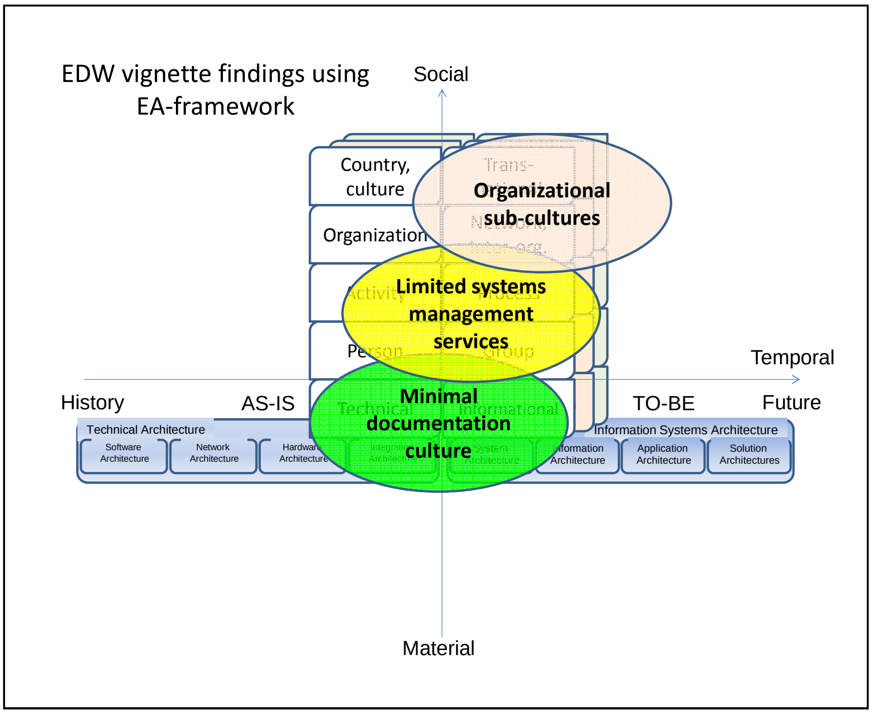

FIGURE 32 EDW vignette findings using EA–framework.

This illustration of EDW findings using an EA–framework -framework is quite similar to an ERP illustration reflecting the social EA challenges at Nokian Tyres. At a substantial EA level, our analysis for the EDW vignette seems to result in similar, organization culture driven results. The minimal documentation culture is causing challenges at technical, process and business levels. Limited system management services are causing EA challenges to the business and process levels, which is reflected as complexity in the technical system level. Organizational sub-cultures are also causing behavioral and informational variety at the business level, which is causing complexity and knowledge management challenges into process and technical levels. EA-wise, the major difference between ERP and EDW vignettes is related to the orientation to development: the ERP vignette is driving development from a technology driven perspective, The EDW vignette is driving development from a business driven perspective. But our EA–framework instrument does not seem to be sensitive to whether EA development is technology or business driven.

7.2.4 EDW/EAM–framework elaboration

EDW system quality and services are highly dependent on data sources, where master data management (MDM) is a combination of business entity data and reporting structures. MDM issues are a combination of mixed processes, unclear data ownership, lacking corporate-level MDM tools and differences in transactional systems. Thus reporting processes are quite fragile for new data entries, which are not consistent or defined according to existing reporting structures. A new MDM –solution development was started in 2011 to tackle these reporting issues as part of a new EDW solution. More important than MDM tools, business and process architectures should be defined and maintained for improving master data management, processes and data quality. Reporting service vendors create technical documentation about their reporting implementations, but due to the minimal documentation culture, business process level documentation and data flow visualizations are quite minimal. This causes issues in knowledge sharing practices and daily operations of support services, which we will elaborate on further in this chapter. IT infrastructure related fragmentation in information logistics generates long and fragile data loading sequences in which issues with loading schedules and data quality are causing complex relationships and problems with EDW –service levels.

At a technical level, the current system fragmentation is causing various reporting process related issues. Because of using scheduling at an operating system level and technical scripting tools for data processing, issue monitoring and resolution requires highly technical competence and knowledge about definitions of business and data integration. With this kind of fragmented information logistics structure, Nokian Tyres is facing challenges when global growth is narrowing data processing schedules for successful data publishing and if reporting services aim at a 24*7 –service level. To tackle this kind of scheduling and service-level challenges in global data flows, Nokian Tyres has started evaluating new data flow processing technologies like UC4 and Active Batch, which are promising to improve scheduling of batch processes and data loads for more robust reporting processes using global production and reporting calendars.

User access right management is quite a challenge for an ICT –department because the flexible EDW –system development without formal role-based data access right definitions creates unclear situations in access-right allowance. EDW-system infrastructure includes a possibility for defining a virtual private database for sensitive data, which could be useful for costing and pricing related details, but there are no clear rules or mechanism to define what is included in sensitive data and who is authorized to access it. This indicates a need for increasing more formal labor roles and responsibilities into organizational job descriptions and process definitions, which could enable visibility for an ICT –department in access-right management. HR process and system integration is needed to improve consistent role-based access right management processes. EAM–framework elaboration regarding EDW development is presented in Figure 33.

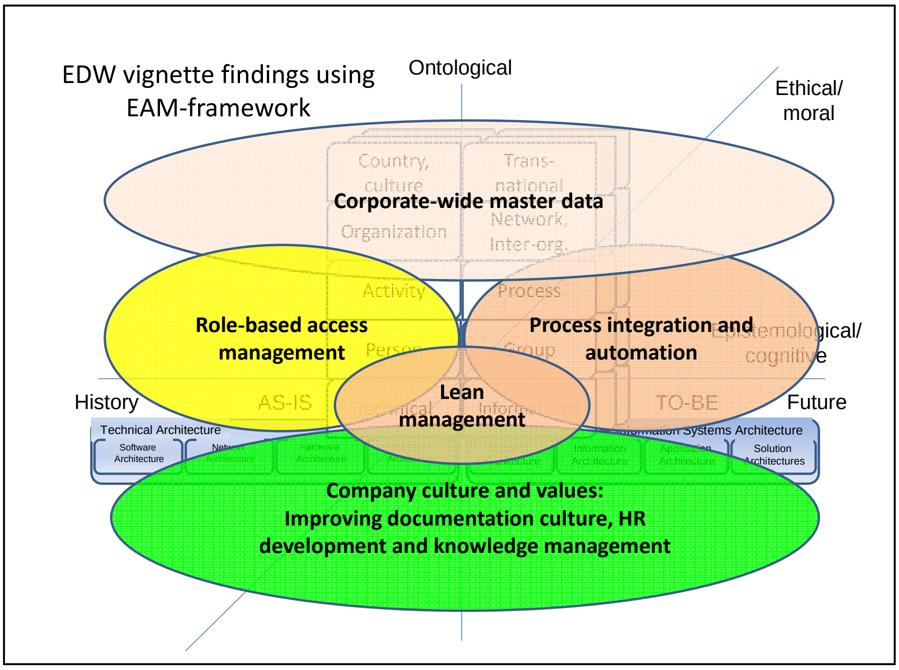

FIGURE 33 EDW vignette findings using EAM–framework.

EDW -development at Nokian Tyres seems to reflect both the benefits and challenges of the company culture. Flexible, practical and business-driven EDW-development has generated valuable data storage and information sources for profitable tyre business growth. But at the same time, minimal documentation culture, limited system management services, missing master data practices and fragmented IT infrastructure for information logistics and monitoring are causing issues for EDW –data quality and service levels. These issues could be tackled with improved EA management with business and process architecture governance, processes, documentation and communication.

7.2.5 EDW/external knowledge-sharing perspective elaboration

From the external knowledge sharing perspective (Østerlund & Carlile 2005, 92), the EDW-knowledge seems to be structured between business developers, end-user developers, super-users, users, ICT coordinators, system developers and support service specialists. EDW-knowledge owners can be acting in different roles in different business areas, and each actor may be acting in one or many roles depending on the business areas to which he or she belongs. Typically each business function is having one EDW –super-user whose role is quite central in EDW –development and support services. This again varies based on technical knowledge, business understanding and personal motivation factors related to EDW –system development. Employment duration and participation in IS development projects are also quite important differentiators in EDW –knowledge because most of the EDW –knowledge typically is created, transferred and adapted during IS –development projects. This again may be related to minimal documentation culture, which applies to some extent also to EDW –system documentation.

These findings indicate that the practical EA approach for managing business information and process definitions together with information and integration architecture could improve knowledge sharing about the whole of business information and data structures. Thus business architecture and process architecture development should be integrated into EA management processes to ensure integrated and consistent EA development and use for business and financial reporting purposes.

7.2.6 EDW summary

The EDW system is an important part of business and information architecture at Nokian Tyres. In practice, the EDW system was an important component for business and data integration, but process integration, IT management and EDW system documentation were not fully integrated into EDW management and development. Therefore, in Figure 34 we are positioning the EDW system as a business-driven EA component without tight integration to IT or EA management practices.

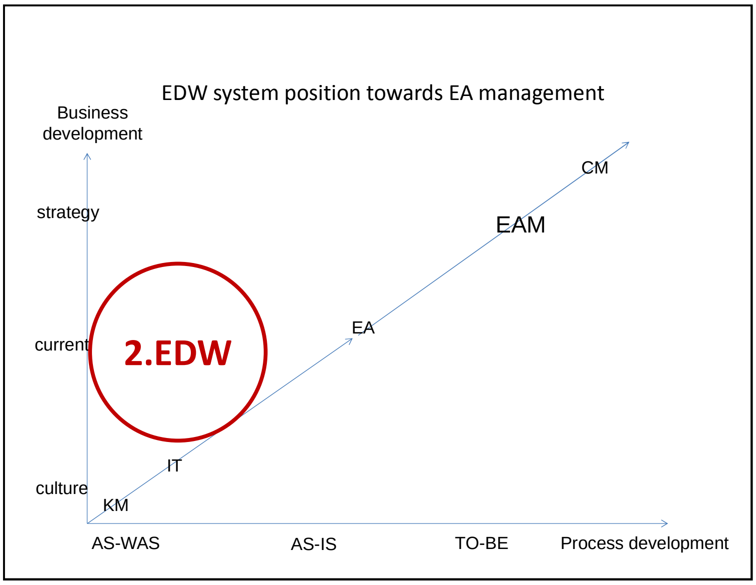

FIGURE 34 EDW system position towards EAM maturity

Thus EDW system seems to have limited process management involvement. In the next GVI vignette we will elaborate on the integration platform for business process development.

7.3 Global Visibility/GVI vignette

This vignette is about value chain integration, which could also be called eBusiness – development or business-to-business/B2B –integration. At Nokian Tyres, the major tool for enterprise-wide process integration is called GVI, which is explored in this section.

7.3.1 GVI introduction

Before the year 2002, Vianor –tyre chain has been operating quite independently from the parent company. In 2001, it was decided to increase enterprise-wide internal and operational supply chain integration for Vianor growth, which led to development of so-called the "Global Visibility (GVI)" solution. In a corporate annual report 2003, this development was mentioned with following the reasoning: "*To ensure competitive position in all delivery channels, Nokian Tyres makes remarkable investments into transparent logistic processes (GVI, Global Visibility –system)*" (Nokian Renkaat 2004, 33). In this GVI vignette, we will discuss the technical GVI –solution in combination with B2B-integrations because the tyre availability information through the GVI –system to B2B – customer triggers Order-to-Cash –process execution using a web portal, email or a phone. The ideal technical architecture was similar to RosettaNet for the electronic device industry, but the tyre business did not have any similar industrial standardization approach. Luckily, the selected GVI approach was flexible enough for adopting various B2B and even B2C integration development needs for the tyre business.

This enterprise-wide solution for internal integration between Nokian Tyres operations and Vianor operations was first piloted to create tyre inventory visibility between 3 local Vianor outlets in Oulu and tyre availability in the factory warehouse at Nokia. The GVI-solution enabled tyre deliveries or pickup from the nearest Vianor outlet(s) using local and central inventories as a supply source. The solution was built as a fully customized extension to the EDW-reporting data, which meant that availability data was not "real-time", only from the "last night", but close enough for improving availability information inside Vianor –tyre chain and adding sales inside Nokian Tyres at the group level. In addition to availability information, the GVI –solution was further extended to automate intercompany transactions for order-to-fulfilment process between Vianor and Nokian Tyres. This development included xml-based advanced shipment notice (ASN) for Vianor deliveries and receipts against shipping notice at Vianor outlets.

Another advanced extension of the same integration solution was the so called web-based "Extranet", which was used for manual tyre availability inquiry and as a sales order entry system for both Nokian Tyres and Vianor customers. This "Extranet" was used as shared resource for the tyre dealer B2B –order portal: based on customer profiles, the same system was "Nokian Extranet" in green parent company colors or "Vianor Extranet" in orange tyre chain colors. The extranet solution has been developed in close co-operation with the Swedish sales company and sales team for the car-dealer business (CDB), which had more sophisticated business requirements because of the Swedish automotive market and deeper industrial eBusiness/B2B –integration development needs. Simple functional innovations in the extranet user experience like "Alter Ego" –function enabled extranet super users to simulate the customer view and support tyre dealers with their tyre purchase orders without technical specialist support.

In 2007, this integration platform was upgraded to new servers and a new platform. The system was re-branded as the "Nokian/Vianor Store", but in daily business language "Extranet" was still the prevailing concept. This versatile integration solution was used in internal value chain integration between the parent company and all sales companies and in external value chain integration between major Nokian authorized tyre dealers during the 2000's. Before 2011, the major issues with this integration solution were related to "non-real time" availability information without planned inventory levels, and to some constraints in Store –functionality and process integration with countries using non-Oracle ERP as their local ERP-system. During 2011, "Nokian/Vianor Store" rollouts to US, Canada and Russia would have required deeper integration into local retail cultures and operating models, which caused increasing requirements for additional retail features and replacing "Store" with more modern B2B –portal solutions. A typical retail feature in the tyre business is selling 4 tyres as one set of tyres, which is normal tyre-user need, thus enabling sales of 4-times multiples was needed for improving tyre sales integration and the efficiency for tyre retail business. This need for selling of 4-times multiples of tyres was needed in tyre availability queries and pricing with discounts and sales margin calculations. These tyre sales process supporting features were needed to improve he GVI-based value chain integrations, efficiency and effectiveness for retail/B2B customers as well as B2C/tyre consumer sales.

7.3.2 GVI/IT–framework elaboration

Development of the GVI –system was a business driven process integration attempt to utilize new integration technologies and EDW data for improving customer service for the Vianor –tyre chain and other key B2B –customers. The GVI –system was consequently built as internal co-operation between Logistics and ICT departments of Nokian Tyres with the full custom development approach, new technology introductions and transitions into operations running smoothly and bringing business benefits from the beginning. Competence-wise, the GVI/Extranet -integration solution was initiated in 2002, together with Oracle Finland, local service vendor Solita and Nokian Tyres' own ICT-team. Technology-wise GVI -application was developed with the (at that time) quite new Java-programming language and Oracle InterConnect, which was part of Oracle 9i

Application Server –technology. Oracle InterConnect was working as expected, but the only issue was with really huge integration messages, which were consuming working memory from the integration server and halting the integration platform. Oracle Consulting developed a concept called Java-splitter, which was used for splitting huge messages into smaller pieces, and after implementing this Java-based extension Oracle InterConnect has worked fine for Nokian Tyres' integration purposes. Thus Oracle's Java-based integration platform was well fitted to ERP –platform and service vendor competencies combining ERP, EDW and integration platform technology knowledge.

In the year 2007, software development tools were also upgraded to the Oracle 10g SOA Suite –technology. Oracle Portal –tools were totally eliminated from the "Store" –solution and replaced with a Java –user interface framework. Oracle InterConnect was somewhat replaced with the Oracle Enterprise Serial Bus (ESB), which was the technology back-end promising Service Oriented Architecture (SOA) development. After this technology change, integration development started to utilize Oracle ESB as a primary integration development technology, which was used in both internal and external integration development. With Oracle ESB –technology, deployment of Nokian Tyres was buying more technology life-time and extending the technology support period for its' business critical GVI –solution. But soon, when Oracle acquired BEA Technologies, Oracle's integration technology development started to utilize a new Oracle Serial Bus (OSB) as part of its integration technology tools. It seemed obvious that Oracle ESB –technology will be replaced with BEA –based OSB –technology, which was not a positive signal for companies like Nokian Tyres, who has been investing its limited resources into development of ESB –technology based integration. During 10 years of integration development, Nokian Tyres has created a wide business integration rhizome around GVI and Oracle integration technologies. Each integration technology, can be seen as a separate, discrete IT technology, which is then embedded as an integral part of various business processes, enterprise-wide information systems like GVI and Store, and some other smaller scale information systems. For its customers, Nokian Tyres has been a flexible and active partner in developing integration solutions, which has, in terms of integration architecture, generated a complex and effective business integration solution. This integration capability is based on a strong internal system competence combined to flexible and talented suppliers, which together creates efficient sociomaterial structuration for integrating systems and tyre availability into retail and automotive ecosystems. The GVI development situation is illustrated with the IT–framework in Figure 35.

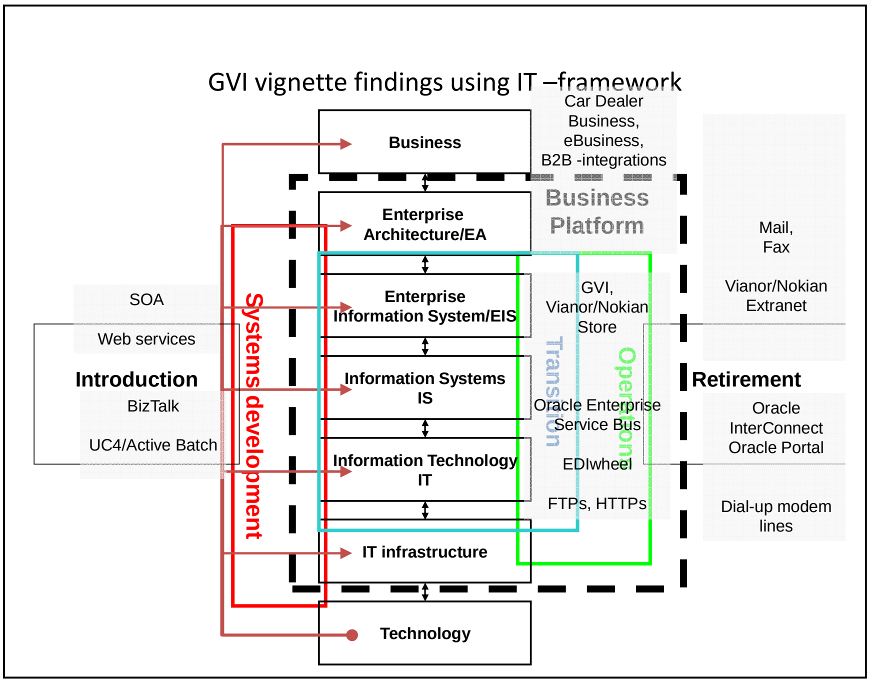

FIGURE 35 GVI vignette findings using IT –framework.

7.3.3 GVI/EA–framework elaboration

Business and corporate development was successfully promoting GVI –based integrations between Nokian Tyres group companies, systems and various business partners like Vianor –tyre chain, the Car Dealer Business (CDB) and the forest machinery/OEM customers of Nokian Heavy Tyres. The logistics department of Nokian Tyres was actively utilizing GVI-based process integration for improving information and process flows for more efficient logistic processes and customer self-service. The ICT –department and integration solution developers of Nokian Tyres were actively improving existing solutions and developing new components and solutions for increasing systems and eBusiness –integrations. Oracle SSI developed WMS –integration and inter-company integrations between separate Oracle ERP –instances. Local Oracle –technology partners Solita and Attido were developing integrations between applications and business partners. The same GVI –integration framework and platforms were used for value chain integration between customers like Ford, GM, VW, Toyota and Volvo, who were harmonizing supply chain integrations for their authorized brand dealers. In practice, this means that Nokian Tyres publishes its electronic product catalog and daily availability information for the information broker system, which is further integrated to car dealer’s point-of-sales/POS and ERP –systems. Each car brand seems to have their own processes and integration message variants, but Clifford-Thames (CT) as an information broker and EDIwheel as a common integration message format for the tyre business seem to a have bigger market share than other competing actors. Nokian Tyres' integration solution was developed to include both CT –processes and EDIwheel -standards, which can be used for several B2B –integration purposes.

The issues regarding GVI development are related to the minimal documentation culture and the limited system management resources. Integration service vendors are creating technical documentation about their integration implementations, but as a result of the minimal documentation culture and limited system management services, business process level documentation and operative customer service related GVI – and integration instructions are quite minimal. This causes issues in knowledge sharing practices and operations support services, which we will elaborate on further in the following sub-section. These GVI development findings are presented with an EA–framework illustration in Figure 36.

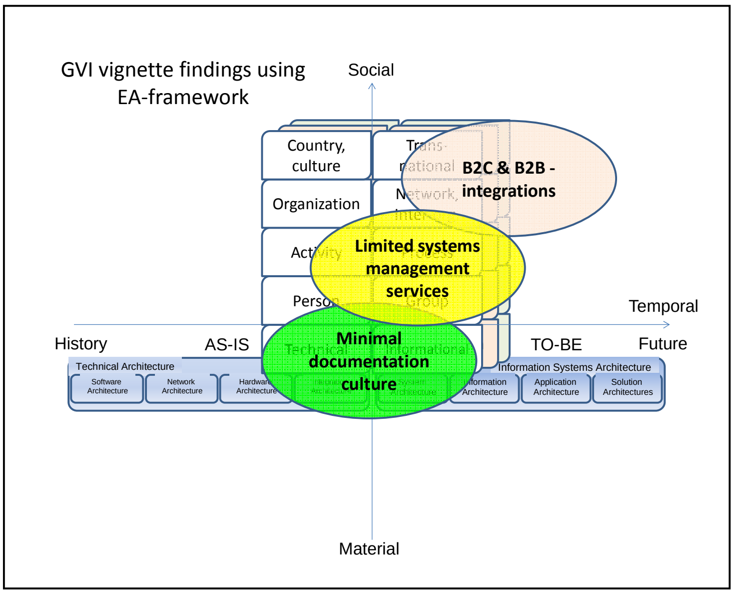

FIGURE 36 GVI vignette findings using EA–framework.

This illustration of GVI findings using an EA–framework research framework repeats an issue regarding minimal documentation culture and the limited system management services, but also includes opportunities for increasing B2B and even B2C integrations.

7.3.4 GVI/EAM–framework elaboration

When reflecting on our ontological, epistemic and ethical understandings of GVI development, we are finding this a valuable, efficient and effective example of corporate company culture at Nokian Tyres. In a practical and informal manner, the customer, sales, logistics, ICT and technology service providers are together developing joint solutions and information flows for efficient business communication and tyre services. IT infrastructure related fragmentation in information logistics creates issues in the transportation layer and protocols, or, in other words, limited tools for supporting standardized and secure File Transfer Protocol/FTP-services. Because of using operating system level scheduling and scripting tools for file transfer execution and a highly technical FTP –service definition and execution tool for integration file transfers, business and process level operations monitoring requires highly technical competence and knowledge about business integration definitions. With this kind of fragmented information logistics structure, Nokian Tyres gets locked in to development organizations and developers. This causes possible support issues with B2B-integrations, which are by nature expected to be run at a 24*7 –service level. To tackle this kind of scheduling and service-level challenges with business integrations, Nokian Tyres has started evaluating new data flow processing technologies. More harmonized processes and advanced integration tools could create opportunities for improving process-integration and automation with B2B –customers and suppliers. EAM–framework elaboration regarding GVI development is presented in Figure 37.

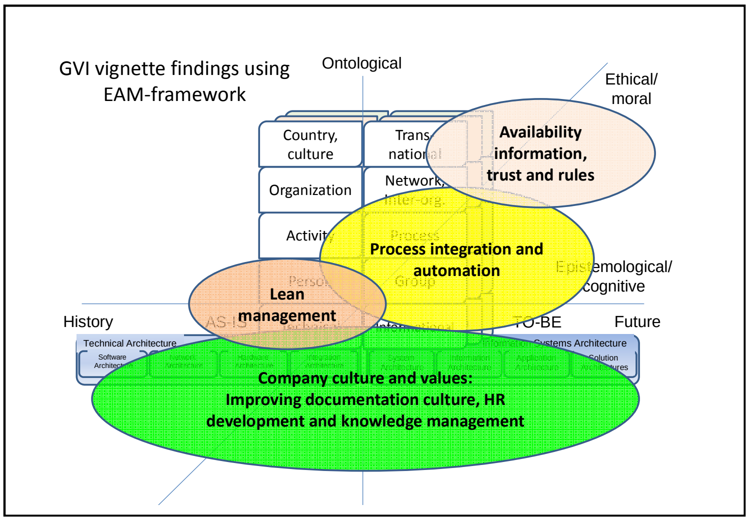

FIGURE 37 GVI vignette findings using EAM–framework.

7.3.5 GVI/external knowledge-sharing perspective elaboration

From an external knowledge sharing perspective (Østerlund & Carlile 2005, 92) this GVI vignette indicates GVI-knowledge structuration between integration developers, ICT development and integration support service organizations. Before the year 2000 there has not been that much structuration between integration development and support organizations, which has been, in most cases, the one and the same person. This approach has caused major work load to integration developers, and created high person dependency without proper knowledge sharing practices.

After development of a GVI –solution and an increase in the B2B –integration level, the ICT –organization has mostly coordinated integration design and development projects between several integration developers, which has increased the division of labor between various actors, but not created any actual procedures for managing the whole of integration architecture nor creating practices for knowledge sharing to customer service organization. This indicates that a practical EA approach for managing business integration and process definitions together with information and integration architecture could improve knowledge sharing about the whole of business integration.

7.3.6 GVI summary

The GVI vignette shows that integration architecture is an important and challenging part of EA management. Integration can be developed at the physical, social, informational and technical levels, which makes it a quite complex domain for documentation. But just as EA management should support EA, business and process architecture integration, integration architecture should document information architecture and technical integrations between organizational and technical system components.

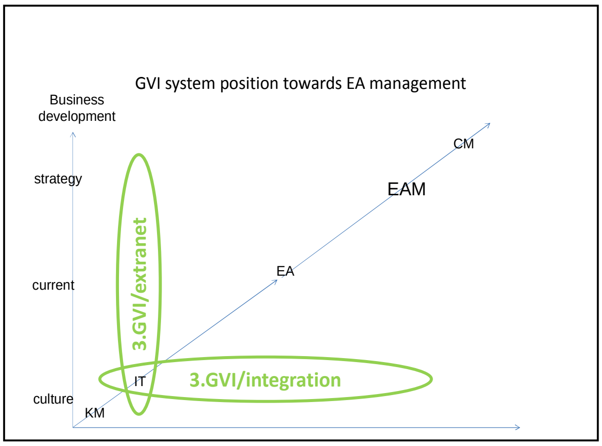

FIGURE 38 GVI system position towards EAM maturity

Figure 38 illustrates the GVI system as an integration and business development platform. The GVI system has been an agile technology for Vianor and value-chain integration. The extranet part of GVI has also been used for business development purposes. But the GVI system might have been too technical, supported with limited documentation, lacking business event monitoring and the proper presentation layer for wider EA management purposes.

7.4 Warehouse Management System/WMS vignette

7.4.1 WMS introduction

During the ERP-project in 1997, ERP support for the warehouse operations at the main tyre inventory system were implemented with the Oracle Inventory –module. At a high-level, this shipping process was quite simple, and goes as follows. When a batch process called “Concurrent Request” was launched from the Order Entry –module with appropriate parameters, those sales order lines within the request parameter range were processed further to Oracle the Inventory –module for picking, packing and shipping. Then another “Concurrent Request” with given parameters processed shipped sales order lines generating needed shipping documents. Successful shipping process updated sales order lines with the quantity of the shipped products and posted sales order lines to Receivables -module and invoicing processes. For those sales order lines that included some unshipped quantity remaining, a back-order was created to wait for the next pick release. This was a quite simple process, but when implementing the totally new, American-speaking technology and replacing the legacy in-house solution, the range of possible data and process combinations needed plenty of iterations, learning and customizations.

During the ERP design phase in 1996, solution development was about to lead into a new TO-BE process for order fulfilment. By design the new ERP system included new procedures and process integrations causing some possible operational changes at the inventory operations. Some potential changes into inventory operations were blocked by saying “This change would immediately cause a strike”. Based on the history of strikes at the Nokia factory and Laurila’s (2011, 64) statement that a departure from Nokia group and practical management style of Lasse Kurkilahti was just changing the company culture from strikes to discussion and practical issue resolution, this sensitivity in 1996 might still have been in place. Therefore some negotiations and customizations were required to modify TO-BE order fulfilment process adopting current inventory operations and procedures. Thus practical issue resolution culture enabled discussions and system changes were agreed without major conflicts. From 1997 until 2002 this Oracle Inventory –based solution with agreed customizations was successfully enabling deliveries from the main tyre inventory.

Then shipping volumes from Nokia factory were growing. To ensure the appropriate level of service during seasonal peaks for Vianor and export, a new logistics center was built in Nokia. This new warehouse was equipped with modern warehousing technology and opened at the end of 2001 with the following remarks in the annual report: a new 32 000 m2 warehouse for storing almost 700 000 tyres, annual flow-through for 4 million pcs and an annual studding capacity for 1 million pcs, replaces the several small inventory locations enabling better cost-efficiency and customer service (Nokian Renkaat 2002, 31). This modern warehousing technology meant that physical warehousing operations were executed by warehousemen driving with forklifts, which were equipped with industrial PC -clients and barcode readers for efficient inventory operations. New customized Oracle Forms screens were developed for forklift terminal screens as extensions to the Oracle Inventory –module. Inventory transactions were committed into the ERP system with barcode scanners and touch screen terminals, which were connected into an ERP system and database using wireless local area network (WLAN) cards and antennas, standard wireless local area network (WLAN) and Oracle SQL*Net –protocol. This solution was developed by the Nokian Tyres ICT –department, system managers and a technical specialist from Oracle Finland. This extended Oracle Inventory –based solution was successful, but did not force First-In-First-Out (FIFO) material flow in the warehouse. Thus it was more upon inventory management routines and physical storage place arrangement as to whether, in the picking phase, a warehousemen collected first the oldest tyres applicable for the picking request. Nokian Tyres was responsible for technical development of warehousing facilities and technologies, but an outsourcing partner was running daily warehousing operations.

Tyre export into Central Europe was increasing, and German customers were especially demanding and sensitive to tyre age; meanwhile customers in Eastern and Southern Europe were also accepting older tyres. Increasing volumes required a new extension to the just-finalized warehouse, and increasing customer awareness for tyre manufacturing dates initiated the improvement of FIFO and tyre flow inside the growing warehouse. Thus enlargement of a logistics center and warehousing operations were started in autumn 2004 (Nokian Renkaat 2005, 35). The corporate annual report 2004 reported the warehouse enlargement investment to double volumes and tyre storing capacity from 600 kpcs to 1200 kpcs, which was expected to enable a 50 % increase in daily shipping capacity at the end of the year 2005 (Nokian Renkaat 2005, 36).

The corporate annual report 2006 from Nokian Tyres announces in the Process –section's high-lights of the year "New warehouse management system introduction at Nokia" (Nokian Renkaat 2007, 37). This new warehouse management system (WMS) was supported with an Oracle WMS –application module, which was the first release of the module included in Oracle eBusiness Suite 11i9. Implementation of this WMS –module was first launched as part of the 11i9 –upgrade project, but it continued much longer and needed much more resources than expected when starting the actual 11i9 -upgrade project. There were several technical and operational reasons for these WMS –challenges, which caused several postponements to the WMS go-live schedule. Finally, the warehouse enlargement was finished in June 2006 and the WMS –solution was moved into operational use on the 20th of August, 2006. There were still many severe issues in the WMS –system, which caused operational problems for warehousing operations and major problems in customer deliveries for starting winter season. The most important key performance indicator (KPI) at the warehouse collapsed from 60 to 40, and errors and delays in customer deliveries caused publicity in the Finnish media. More technical and operational resources and capability was needed to fix these complex issues.

One year later in August 2007, the major WMS –system issues were fixed, and performance of warehousing operations were returning back to the original KPI –level, and actual operational performance development could start. In August 2011, this warehouse was more efficient than ever, which meant that the most important KPI was now at the level of 80. This WMS –system now running on old de-supported servers and aging data center facilities, and a new development project for WMS –system replacement was started with a definition phase.

7.4.2 WMS/IT–framework elaboration

The WMS –system implementation for Nokian Tyres logistic center at Nokia was technology-wise a minor development step: inside Oracle ERP inventory organization was configured to be a WMS –organization, not a normal inventory organization. But in practice, only ERP –servers, database and application services for setups and the warehouse control board were the same as for the rest of the ERP; the rest of the warehouse functionality was using their own data schema, mobile services, FTP-protocol and character-based mobile terminal user interface.

An idea about WMS –application, including configurable rules engine, was accepted without hesitation or pre-study. But in the beginning of the system development phase, Nokian Tyres' WMS –team noticed their limited competency, and the complexity and rigidity of the WMS –application together caused frustration and requests for help. Oracle's R&D –related WMS-specialists, presales and consulting specialists were employed in both a remote and an on-site mode, but incompleteness of the software caused delays and several customizations. The character-based mobile terminal screens were especially limited and difficult to customize, which was explained with the beta-phase of the application and the pilot customer use-cases from the US-Mexican high-tech and medical industry. Later on, Oracle suggested a delay in the WMS -project at Nokian Tyres until the next release of EBS R11i10 with flexible graphical mobile user interface were available. At that phase of the WMS –implementation, Nokian Tyres did not want to delay their WMS –project any more.

The WMS –system testing was limited and far away from reality. The training phase had technical problems and limited resourcing regarding trainer competence and warehouse operator participation. The final technical issues for the go-live readiness were limited warehouse locator setups, data migration errors with full pallets converting to loose quantities, and interface bugs from the factory inventory to the warehouse interface. These were not noticed during limited testing rounds. After go-live, the worst mess was caused by the latency of the WLAN –network, which generated FTP-protocol and session failures for mobile forklift terminals. In addition to all these technical issues in the WMS –system implementation, the training level, attitude and motivation for operational changes and a new WMS –system at the warehouse operations was quite uncertain and unwilling. The result of the transition of the incomplete WMS-system to business critical warehousing operations at the beginning of the winter season was almost complete chaos.

Quick resourcing decisions, top management involvement and hard work at the warehouse shopfloor level saved the winter season, but the customer service reputation and reliability of the deliveries from Nokian Tyres were lost for a while. Additional resources and new capabilities were acquired for Nokian Tyres ICT, logistics and warehouse operations in order to release the original WMS-project team to recover from the project. The WMS –system improvements and reconfigurations were done during the whole spring of 2007. Attempts were made to tackle issues with the WLAN in various ways, but despite changing network adapters, tuning antennas and increasing the amount of base stations to avoid radio coverage for moving forklifts in a full warehouse did not help. Only after noticing that, when moving, forklift terminals and WLAN adapters were finding too many base stations at the same time, the functionality of the standard WLAN caused latency when the mobile terminal was trying to decide to which base station to connect next. This latency combined to FTP –protocol were killing application sessions, which caused reboots for mobile terminals and corrupted warehouse data immediately, causing errors in deliveries. After piloting two advanced, controller-based WLAN –technologies during June 2007, more reliable controller-based WLAN –technology was selected and all base stations were changed with compatible WLAN adapters into forklifts during the low season in July 2007. This additional investment in advanced WLAN –technology enabled robust and reliable transaction processing from mobile terminals, returning trust and performance just in time before the winter season 2007. Nevertheless, the WMS –solution included many strange, unsolved issues, but now a joint task force, including the warehouse operator, logistics and WMS –specialists, managed to tackle and work around these minor defects, enabling recovery and improving the WMS –system even beyond the original expectations. IT–framework-findings for WMS development are illustrated in Figure 39.

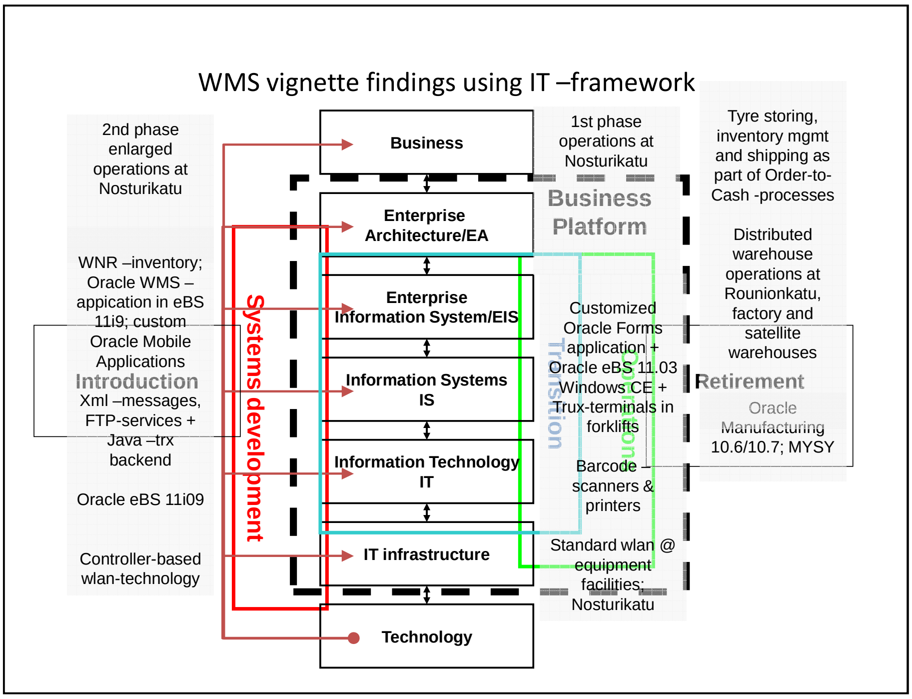

FIGURE 39 WMS vignette findings using IT –framework.

In the WMS vignette where the operational and technical scale of changes is more narrow than in previous vignettes, this IT–framework illustration enables more detailed presentation of changes. More business and user-related changes could be communicated by adding process, user interface and usability related data into the IT–framework –illustration.

7.4.3 WMS/EA–framework elaboration

In this WMS vignette, all dimensions of the substantial EA layer were failing. Technology was not matching the operative environment, data structures were incomplete from both setup and dynamic data perspective, and the involved parties were lacking the competence and culture for changing warehouse operations at Nokian Tyres.

In the WMS vignette, challenges with organizational sub-cultures were more visible because of the outsourced warehouse operations. Also, somewhat technical determinism was prevailing during the WMS-project initiation, which caused some absence for sensitivity to social analysis, re-engineering and operational change management. In particular, these social deficiencies caused other failures as the technical platform and informational content were not detected before it was too late to cancel or re-evaluate the whole change. The tendency to strike at the warehouse had created a company culture which tried to avoid changing operations and preferred changing technology to fit with AS-IS warehousing processes. But now, with a rigid and incomplete WMS-technology, limited system management services the combination of the affordances of Nokian Tyres and the capability of its vendors were not sufficient for fitting the WMS –application and technology stack to the existing warehouse operations. At the same time, the culture of minimal documentation prevented comparison and communication of changes between AS-IS and TO-BE operations. Only after quick reactions and corrections to failing technology, information content and human behavior at the warehouse saved this fragile technology and new WMS –system functionality to achieve and exceed expected system benefits. WMS development findings are presented with the EA–framework in Figure 40.

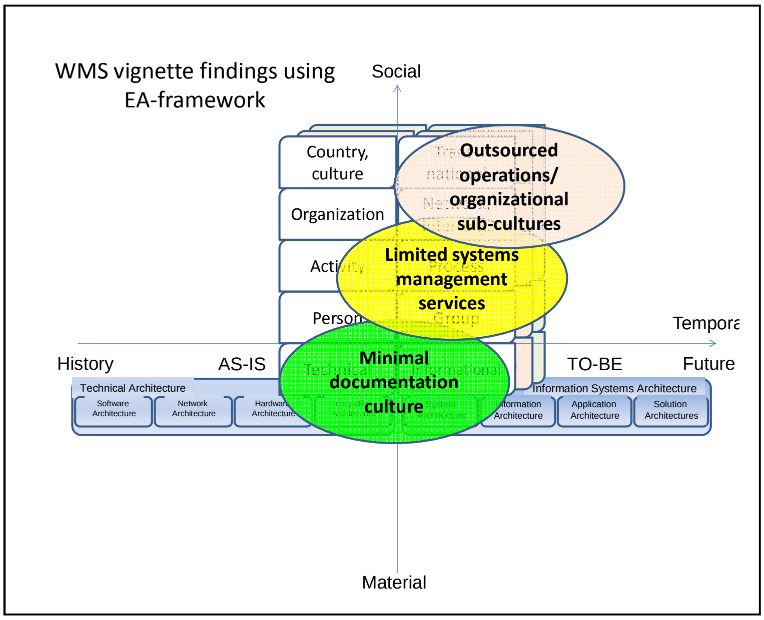

FIGURE 40 WMS vignette findings using EA–framework.

7.4.4 WMS/EAM–framework elaboration

Regarding WMS development in our case enterprise, we face personal difficulties to analyze this case without any bias. Our role in this WMS –episode has been changing from the sales role at Oracle Finland in 2003 to fire-fighting at the warehouse shopfloor level together with Nokian Tyres' ICT, Logistics and warehouse operators in 2006-2007. WMS issues initiated this EA –field study, which continued during the period of 2007-2011 in order to ensure the development of future WMS –system and warehouse operations at Nokian Tyres.

From an ethical perspective, Oracle should have stated early that this first release of the WMS –module was not fully functional, but also Nokian Tyres should have done a proper pre-study before rushing into the WMS -implementation project. Tieto, as the original WMS system implementation service provider, should have been more transparent and honest regarding resources and risks of the WMS –implementation project. Nokian Tyres' WMS –project team requested a visit to some other reference customer, but this was not possible with the given schedule constraints. As a comparison one, Finnish retail enterprise was planning a similar project to their Norwegian sales company, and, as a result of their technology evaluation WMS -pre-study, they decided to keep their local Norwegian WMS-solution because Oracle's WMS –concept was too mechanistic for their company culture. Ethically, a similar kind of analysis regarding warehousing processes, division of labor, roles and responsibilities between humans and technology would have enabled better informed decisions before starting with the WMS –implementation project in business critical operations. Thus the technology evaluation process and TO-BE drafts of the business and IT architecture should have been reflected back to the process architecture, where possible changes and decisions should have been combined to people and change management practices, including both the company's own and outsourced operations. This implies needs for developing more strict investment processes and project management practices, which should include the company's own phase gates for technology evaluation documentation and communication to outsourcing partners and service providers for improving people and change management. In the beginning, DB Schenker, as owner of Rengaslinja, was not involved in the WMS development project. Only after the situation escalated to involve Schenker, did new capable development resources and executives become involved in the resolution of the WMS issue and in development of the warehousing operations.

From an epistemic perspective, the previous inventory solutions and operations at Nokian Tyres have trusted in human calculations and decisions to execute efficient inbound, internal and outbound warehousing operations. But now with this WMS –solution, these calculations and decisions about efficient warehousing operations were moved to a combination of WMS –system setups, a warehouse data model, and a warehousing rules engine logic, which together informed warehousemen to execute put-away and picking requests. This reconfiguration of human-machine actor network inside enlarged the warehouse operations required more the WMS –level system knowledge, informational decoding and changes in operational warehouse culture than any change before. One part of this change management challenge was due to the unclear roles and responsibilities between operations of Nokian Tyres as warehouse and technology owner and Rengaslinja as the warehouse operator. But when both parties started actively to improve capabilities to control, coordinate and communicate development issues with systematic meetings and memos, these deficiencies in epistemic perspective improved.

From the ontological perspective, the WMS –implementation project was over-loaded with technical details, which were consuming almost completely the available human capacity to understand and manage changes. At the same time, social and material structuration, affordances, decision rules and constraints were not properly visible and managed, which caused various issues to emerge and delays before the new WMS –system was back at the normal daily routine level. Only then was this new WMS –imbrication robust enough for enabling payback for this WMS –investment and improvement in warehousing KPI from the initial level towards targeted performance goals. The EAM–framework regarding WMS development is presented in Figure 41.

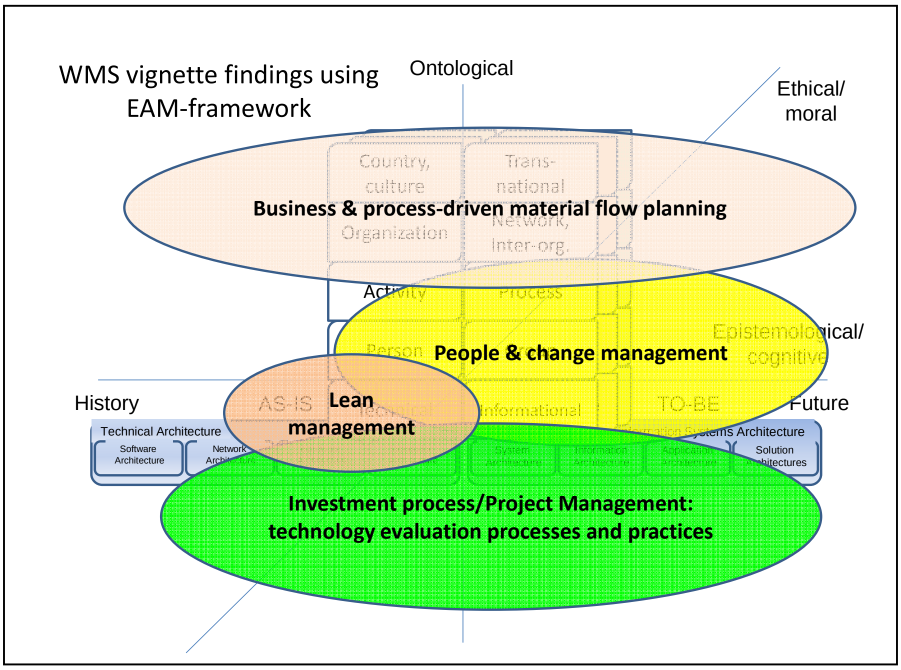

FIGURE 41 WMS vignette findings using EAM–framework.

7.4.5 WMS/external knowledge-sharing perspective elaboration

An external knowledge sharing perspective (Østerlund & Carlile 2005, 92) to WMS-knowledge at Nokian Tyres causes interesting an example of emergent knowledge creation of new technology between several organizations.

The Oracle WMS knowledge-owners worked at Oracle in product design and development teams in the States and India. The second wave of WMS -knowledge-owners worked at Oracle and Oracle partners like Tieto-Enator in pre-sales and consulting organizations: these actors were at the same time implementing and learning this new piece of technology in customer cases. The third wave of WMS –knowledge-owners were working in customer projects and at the Oracle Support organization: these actors were at the same time learning and finding issues and constraints regarding the operational and technical structure of their own WMS –implementation project and original

WMS –application functionality. The fourth emergent wave of WMS –knowledge owners were working in warehouses as warehouse operators: these actors were at the same time learning and trying to survive and find workarounds for managing change between the current operational and technical structuration of their own AS-IS and TO-BE –states of WMS –operations.

The new WMS -module should have included better documentation, training materials and knowledge transfer mechanisms to the first implementation projects. Inventory operations at Nokian Tyres' warehouse were based on the logic of the minimal documentation culture of the company. Therefore, the knowledge gap between outsourced AS-IS operations and technology-driven TO-BE –procedures would have needed more investigation and information about the logic of WMS –technology and warehousing process changes needed to achieve the expected operational benefits.

After this WMS –development episode, the Logistics –department at Nokian Tyres has taken a more proactive attitude and procedures for controlling, coordinating and communicating warehouse operations and WMS -systems development. After ending the relationship with Tieto as the WMS –implementation partner, the WMS –knowledge sharing practices were arranged between Nokian Tyres and Oracle according to the ERP –system related knowledge sharing systems and structures. Oracle's WMS development team from India and WMS –module specialist from Sweden were supporting system changes and successful WMS –module implementation at Nokian Tyres logistics operations.

7.4.6 WMS summary

This WMS vignette shows the risk of technology-driven EA development. Changing business needs were triggering change that the shared IT and process development capabilities were not able to manage. Thus, in the beginning, the IT management was not able to deliver a business critical system without causing major problems for IS and process performance. After severe problems with the WMS system knowledge transfer and IT management capability, a new WMS technology was well-supported as a shared object between business, IT and process development organizations.

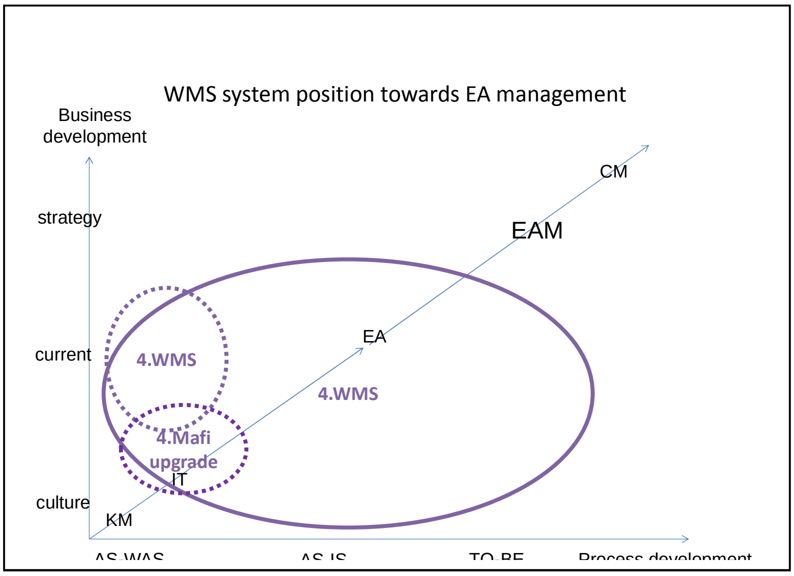

FIGURE 42 WMS system position towards EAM maturity

As Figure 42 illustrates, the WMS system at Nokian Tyres is difficult to capture with one view. The ellipse with dotted line shows how, at first, the high business expectations were not supported with the relevant IT and process management operations. Then, the larger ellipse with solid line illustrates how extra effort from Nokian Tyres, DB Schenker/Rengaslinja and Oracle successfully enhanced the WMS system support and organizational capability for improving warehousing operations above the expected performance level. This observation supports our view that for creating real business benefits, both IT and EA management are dependent on tight integration with business and process development capabilities. Thus the WMS development crisis improved business, IT and EA alignment, communication and coordination of business, IT and cross-functional process development, but required strong CEO and CIO contribution for creating shared EA leadership and commitment to collaborate with technology and service vendors over organizational borders.

7.5 Sales & Operations Planning/S&OP vignette

7.5.1 S&OP introduction

This vignette is about the Sales & Operations Planning (S&OP) –process development. It includes the process and systems development for integrated and balanced demand and supply management practices. The S&OP development can be seen as an attempt to improve business and process-driven material flow planning, which was presented as the EAM–framework –findings for WMS development. Thus the S&OP –process should improve material and resource planning visibility for the whole supply chain and logistics operations.

At the end of 2006, the Oracle ERP upgrade into 11i9 was successfully in the operations phase, but new application modules were still having many issues. One of the new ERP modules was called Advanced Supply Chain Planning (ASCP). ASCP –module implementation was stuck with multiple challenges. The ASCP –solution was planned to replace production scheduling and global MRPII for raw materials and resources for both the Nokia and Vsevolozhsk factories. The ASCP also included inventory replenishment plans for all sales company inventories. But the most important reason for ASCP –implementation was global product availability information, which should improve customer service with lower inventory levels and enable customer-specific tyre inventory allocations. Above the ASCP –module, global product availability information would need Global Available-to-Promise (ATP) module implementation. Both new modules – ASCP and Global ATP - together could enable Global Order Promising (GOP) functionality to various demand channels, including Oracle Order Management –modules or integrated B2B –portals like Nokian Store. The promise of global tyre availability information was worth trying, but the challenge of implementing both ASCP and Global ATP at the same time was huge.

At that moment, the best ATP information was GVI –based availability data, which was updated during EDW –loads during the night time. During seasonal peaks, this GVI –availability information was aging too quickly. Another limitation in GVI –availability was that it included only actual inventory quantities without expected receipts from factory or inventory replenishments. The need for more reliable global tyre availability data needed ASCP-implementation to enable a Global ATP –solution. ASCP –implementation was also needed to support logistics in demand/supply –balancing. But ASCP implementation was not able to replace customizations for production scheduling and procurement.

An Excel-based production planning tool remained as standard for tyre production and studding until 1999. The Excel-based production scheduling tool was replaced by a customized Oracle Forms -application modified from Oracle Manufacturing –modules. This customization enabled production scheduling at Nokia tyre factory for a 3 weeks production plan. A studding plan for winter tyres were maintained with separate work orders, which generated demand for non-studded tyre production. This customized solution enabled an MPS/MRP –solution for the Nokia factory for both car tyres and heavy tyres. This customization was implemented in Finnish and without support for Cyrillic letters, a limitation which now which created a major obstacle for rollout to the Russian factory. Raw material procurement was stuck with the customized Oracle Purchasing –module showing Days of Supply –information for raw materials. Standard

MPS/MRPII –logic suggested when and how much raw material should be purchased to secure production of demanded tyres. Raw material procurement was used to conclude the purchasing moment and the needed amount based on how many days of supply the current raw material inventory would last.

Production planning and raw material procurement were too busy to change daily routines and current planning behaviors. The technically deterministic ASCP –module implementation was not able to solve data issues with standard ASCP –functionality. During 2007, the ASCP –implementation issues were tackled with a more process-oriented Global Planning –project and external project manager introducing Sales & Operations Planning (S&OP) –method and processes. The S&OP –approach was introduced to create a new business planning culture, improving the global operating model and process integration at Nokian Tyres. Thus the S&OP –model should transfer Nokian Tyres from the "factory at Nokia" towards an international, demand-driven tyre enterprise. With executive support, a Global Planning –project was able to establish monthly S&OP –meetings for the Car and Van –tyre business. A monthly S&OP –meeting was in the first phase struggling with technical details and data quality issues of the Global Planning –project. But when the next level of managers were involved and responsible for issue resolution between monthly S&OP –meetings, some of the technical and data issues were fixed and S&OP -practices established as part of the tyre business management culture.

The now emergent S&OP –processes were in place, but Global Planning –project was not able to solve technical issues for factory scheduling or raw material procurement. The external Oracle –specialists using the Oracle Manufacturing Scheduling -module were not able to fix scheduling issues with common resources, causing capacity constraints for tyre assembly and the curing process. The demand forecasting process work was slowly proceeding with the Cognos –based forecasting solution. The inventory replenishment process was slowly proceeding with an Excel-based approach, combining data from demand forecasting, EDW –system and ASCP –data. The Global Planning –project was slowly proceeding to integrate the ASCP –module and planning data into departmental processes and the EDW –system. But because of various data problems and limited resources, the Global Planning –project and ASCP –implementation seemed to fail.

After understanding the root cause for capacity constraints with common production resources, production scheduling issues could be tackled in a more constructive manner. Between years 1995-2005, tyre production technology had developed a flexible method for creating efficient and configurable tools for increasing product mix with shared resources. These innovations have created configurable manufacturing tools for both tyre assembly and the curing process. This required more sophisticated data models and capacity level loading procedures to capture the production constraints from shared resources. This shared resource was beyond the standard ERP data model and discrete manufacturing logic. When expressing this production scheduling issue at this level of detail for production managers and planners, the actual issue resolution and real attempts for improving the demand driven production planning process and system support for production resource modelling could begin. After a pre-study project, a Production Efficiency System (PES) investment was suggested in May 2008. The complexity of AS-IS planning processes and systems is illustrated with Figure 43.

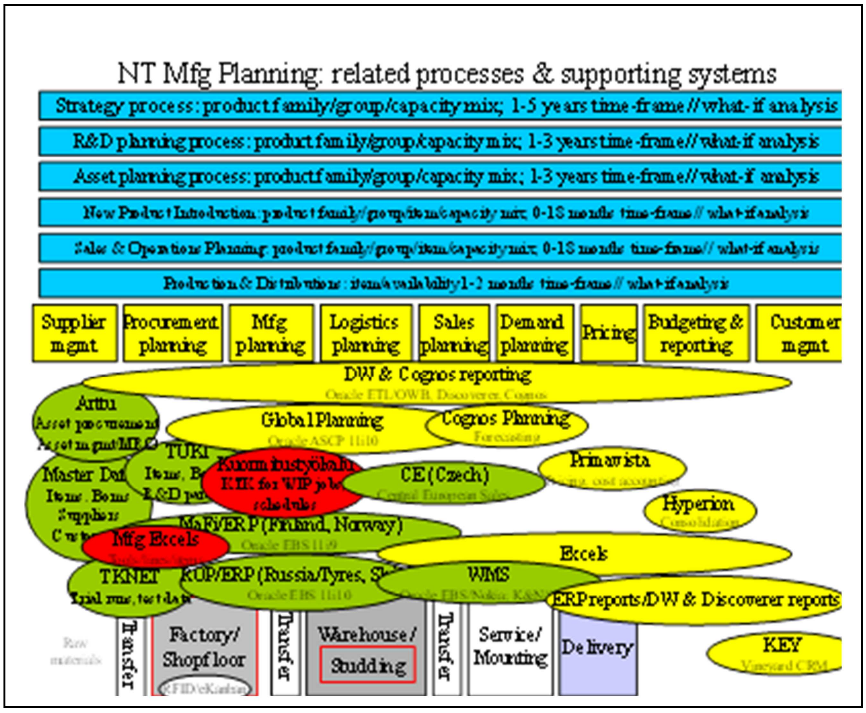

FIGURE 43 Nokian Tyres manufacturing planning (Kimpimäki 23.5.2008).

In Figure 43, the top-most layers present the levels of manufacturing planning. Boxes in the middle of the figure present business functions and departments. Ellipses below the business functions and departments present the current information systems, which support raw material flow and the physical value-chain illustrated with boxes at the bottom of this picture. The project called Mooses was suggested to replace the customized production scheduling tool and various excels used for manufacturing planning and scheduling. PES –investment initiation was approved and the Mooses –project was started. A full-time project manager from Nokian Tyres was selected to guide and enable successful solution development for the PES –system. The application module called Global Resource Register, GRR, for managing the bill of resources for shared production tools and configurations was ready in November 2008. First, this GRR was implemented as common data storage managing production resource data between product development, production and maintenance processes in car tyre production at Nokia, and later at the Vsevolozhsk factory. After having common master data for production tooling with integrated maintenance processes available, actual development of the production scheduling tool PES was able to start. With some delays, PES was taken into use, and ATP –data was published to sales in January 2011. The GRR -system production planning process had a robust data foundation for analyzing production capacity and constraints for the PES –module. With the PES –application, production planning could create production schedules to supply tyres against expected demand from various demand sources and avoid tooling constraints from shared resources.

With the help of improved production planning as well as scheduling tools and processes, supply chain planners and buyers were getting better data with a longer planning time window to improve their own processes. This improved data was returned back to the ERP, ASCP and EDW, thereby improving data for all integrated S&OP –processes and systems. At the same time, more resources were allocated to improve systems and processes for the whole S&OP –development. An external ASCP-specialist was involved in reconfiguring the R12 –version of Oracle ASCP for improving the S&OP –process support for inter-national, multi-factory and multi-ERP operations. Because of the challenges with the ASCP –implementation and production scheduling issues, Global ATP –system development was not started during the year 2011. Despite these delays, the joint resources from the ICT and Logistics –department have defined concepts, documented key business requirements and use cases for development of the global availability system. At the same time, a local ATP –inquiry in Oracle ERP was improved with modification, and GVI –availability data has been improved to reflect inventory changes more frequently than before. Slowly improving S&OP –processes, systems and data quality created better affordance and imbrications for Global ATP –data quality and sharing into different sales channels.

7.5.2 S&OP/IT–framework elaboration

S&OP –system is more about processes, process integration and the enterprise level information system than actual IT technology. Thus S&OP –processes and practices can be introduced into business operations without actual changes in IT. But because S&OP –processes are information intensive by nature, supporting S&OP –processes with IT –based solutions could improve process efficiency. One of the S&OP –process supporting IT-systems, which were introduced as part of the Global Planning –project was Cognos Planning –based forecasting solution. The purpose of this forecasting tool was to collect sales forecasts from sales companies for estimating future sales potential at aggregate level when the order stock in sales systems was presenting demand information at a detailed level. This aggregate total demand data was loaded into an EDW –system for analyzing demand potential and for making supply decisions. Therefore, some EDW-based reports were implemented for reporting a demand picture for the S&OP –process and for following the core KPIs like forecasting accuracy and other

S&OP –supporting measures. Also, the NR PES –solution enabled more detailed supply data from the production schedule for the S&OP –process and also for the ATP –view, which could now be even 6 months into the future when with the Kuormitustyökalu this supply data for the ATP –view was limited to the next 3 weeks. With the continuous ASCP –development, the previously factory-specific MRP –runs were now integrated to one global MRP, which included raw material needs for both factories and enabled disposing of the old customized Riitto-näyttö/Days-of-supply forms for global raw material procurement. The IT –framework findings for S&OP are illustrated in Figure 44.

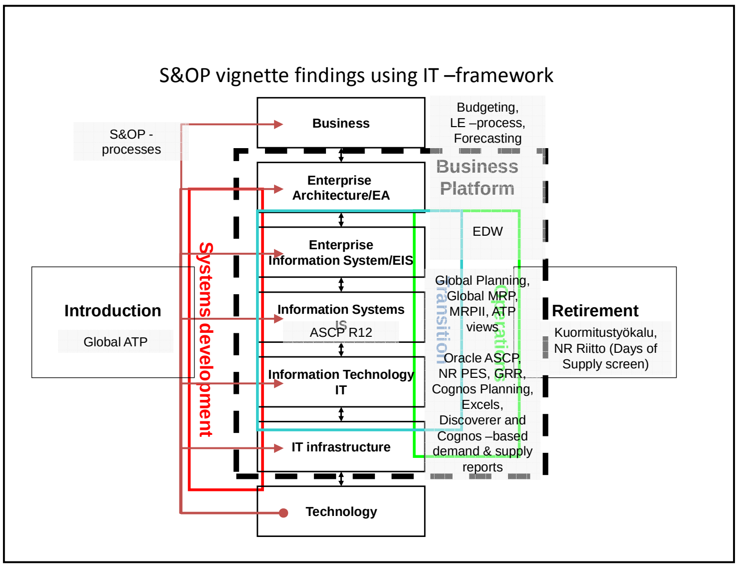

FIGURE 44 S&OP vignette findings using IT –framework.

IT platform-wise, the local Finnish customizations for production scheduling and purchasing for one factory were in the retirement phase. Several budgeting, forecasting, planning and reporting tools were an active part of the current production systems. A major development was done at the business process and data level with existing systems. Business, process and information architecture development is not very visible in this IT-driven analysis with the IT–framework model. The new release R12 from ASCP –module was in a development and configuration phase. Business units fully bought the idea of global tyre availability, but Global ATP technology was slowly coming into the early introduction phase.

7.5.3 S&OP/EA–framework elaboration

Technology-wise, the S&OP –system includes various tools from Excel to EDW –based analytical reporting solutions. Information-wise, S&OP –process introduction requires common information architecture, which should define common hierarchies for integrated demand and supply balancing. But, socially, the S&OP –process introduction creates new rules, roles, responsibilities and routines for sales and supply organizations to process information and data according to common customer and product hierarchies and according to a S&OP –process calendar.

S&OP –process work was started with monthly S&OP –meetings and continues now, causing process improvements and changes in all functions, systems and data processing rules. At the business planning level, S&OP –processes should be aligned with previous business planning processes like budgeting, latest estimate/LE-process and forecasting. The new Product Introduction/NPI and corporate Master Data Management/MDM –processes should be coordinated for smooth planning of ramp-ups and ramp-downs. The same applies to all cross and sub-processes like sales and marketing, pricing, production planning and procurement. Thus S&OP development is mostly related to business and process architecture development, both of which are tightly related to IT architecture for communicating master data for all related transactional and reporting systems. Process coordination and system management capabilities should be developed to eliminate technical issues with fragmented systems and data models. The S&OP development findings are presented with the EA–framework illustration in Figure 45.

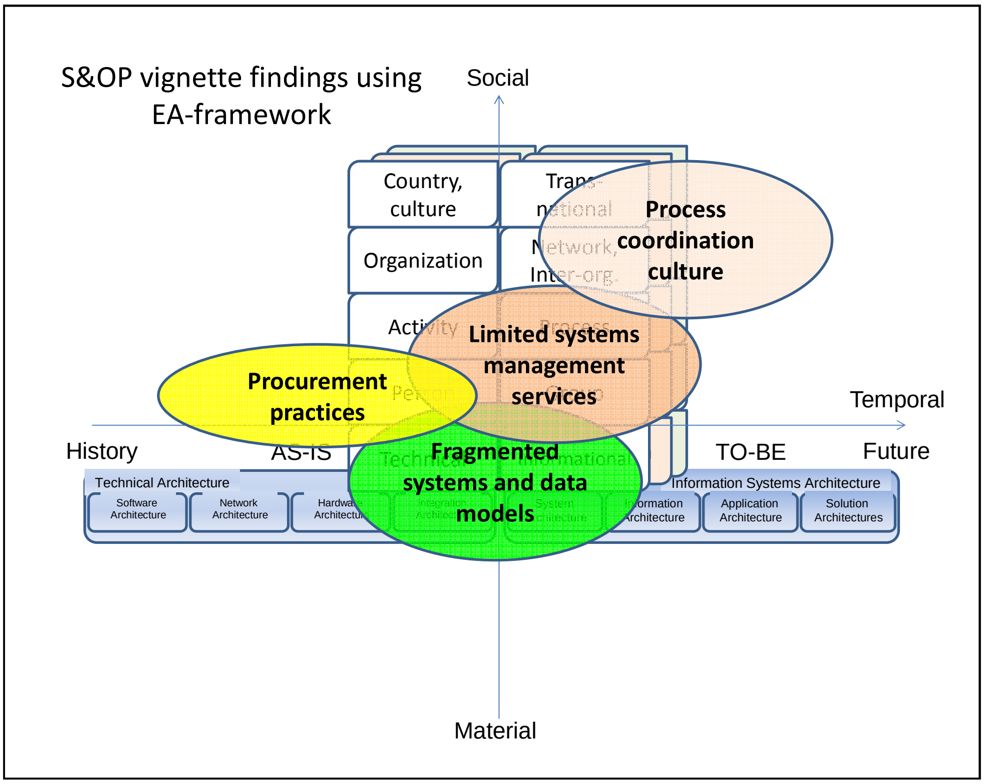

FIGURE 45 S&OP vignette findings using EA–framework.

EA-wise, the S&OP development causes several changes to process architecture, process development and coordination culture. These process-level changes should be integrated into EA and business applications supporting S&OP data processing. But these application and IS related changes were slow because of the limited capability of system management services. Because S&OP processes are ideally fact-based and data driven analytical operations, these decision-making mechanisms are heavily dependent on analytical data models and the quality of data from transactional systems. With fragmented systems and inconsistent data models, this approach to the analytical decision-making process requires additional resources and capabilities for manual data processing.

7.5.4 S&OP/EAM–framework elaboration

Because the S&OP –process is an integrative and information intensive business process by nature, it causes more challenges in master data maintenance, rules and analytical structures than any previous information system at Nokian Tyres. Thus ontological and epistemic dimensions are tightly integrated into S&OP –rules: how new products, customers, factories, raw materials and suppliers are identified, defined, communicated and integrated into existing and new analytical structures and systems.

Ethically, the S&OP –system should be beneficial for the whole enterprise by clarifying information structures and processes for the demand-driven supply chain. When the S&OP –process is further developed and integrated into the financial and procurement processes, these improvements should also create even better visibility into financial forecasting for shareholders and better demand estimates for raw material and service providers. This indicates the need for systematic process development internally and together with business partners, which further implies an additional need for improving documentation management and knowledge management beyond enterprise borders.

EA –wise, this S&OP –system development indicates a more holistic need for managing integrated business, process, information and technology architectures, which together should enable more efficient planning processes and effective decision-making processes. The S&OP development findings are presented with an EAM–framework in Figure 46.

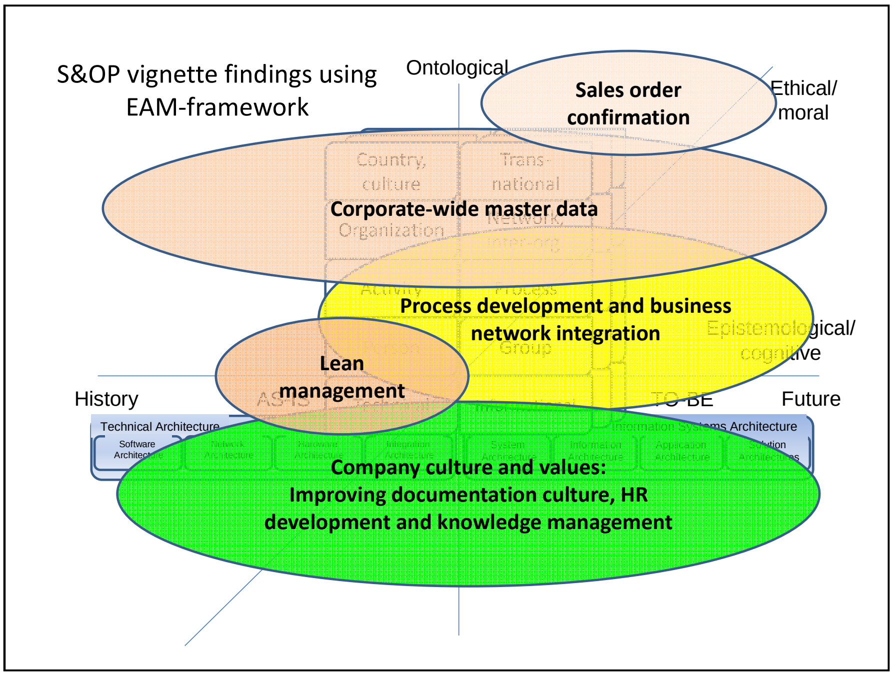

FIGURE 46 S&OP vignette findings using EAM–framework.

From our EA vignettes, the S&OP process and system development seems to be the most potential candidate for improving EA management for information, application and integration architectures. But, at the same time, the S&OP vignette indicates that EA management should be integrated into business, process and HR development practices. Because the S&OP development requires improvements in master data management, data quality and analytical data processing, integrated business, process and EA management practices could enable faster S&OP implementation than an IT driven approach.

7.5.5 S&OP/external knowledge-sharing perspective elaboration

The external knowledge sharing perspective (Østerlund & Carlile 2005, 92) for S&OP-knowledge structuration is a quite challenging task. A clear difference could be made between S&OP –developers and others who may be involved in business, demand, supply and planning data or system maintenance for S&OP –process purposes without knowing anything about the S&OP –process itself. The web of S&OP –developers includes previously mentioned system and service suppliers, and about 20 persons from Nokian Tyres' side involved in Global Planning- and Mooses –projects as well as common S&OP –process development. But due to the quite limited process management culture and change management practices, there has not been any formal training or communication about S&OP –process development for others who have not been participating in these S&OP –related development projects.

S&OP –knowledge sharing relates to system and process principles as well as S&OP –data and meanings. One challenging example of this knowledge sharing and communication comes from the concept of "Sales Plan", which in S&OP –language and theory means decision from a monthly S&OP –meeting about how much supply is allocated to certain sales areas. In practice and in a normal demand situation at Nokian Tyres core business, this could mean that when sales companies are forecasting more sales than what supply-side is able to deliver, the Sales Plan could be used for communicating supply-allocations and related management adjustments back to sales companies and sales representatives as possible changes to their sales targets. But because the sales management and budgeting practices have not yet aligned and integrated to S&OP –processes, this kind of S&OP –process rules, guidelines and training practices have not yet established at the enterprise level.

7.5.6 S&OP summary

The S&OP vignette shows the risk of technology-driven process development. In this case, quite complex and highly integrated ASCP technology failed in production scheduling, and advanced very slowly for supporting supply-chain operations. ASCP integrated Global ATP technology was not possible to operate before the ASCP layer and data quality was improved with more consistent master data and planning operations. All these improvements are tightly inter-woven into organizational restructuring and competence development for the development of the information and demand-driven supply chain and logistics. These new competence requirements caused challenges for organizational restructuring, process integration and capability development. The Nokia-centric company culture was slowly adapting new concepts and requirements for a holistic and systematic S&OP culture.

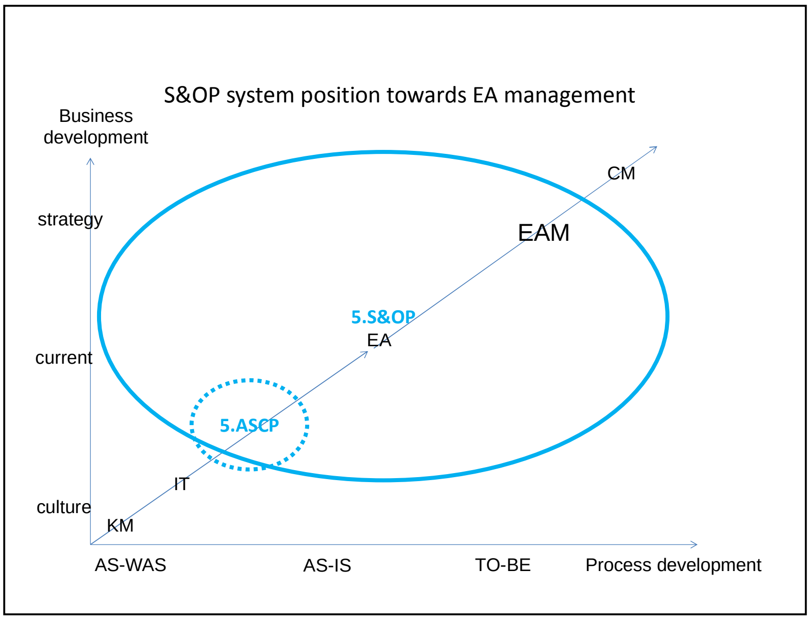

FIGURE 47 S&OP system position towards EAM maturity

S&OP development seems to create new information-driven analytical requirements on the business, process and even on the IS level. These needs are causing new capability requirements for individuals, teams and organizations, which could benefit from EA as knowledge and change management tools. At the same time, EA management practices could support business and process development in information, technology and IS development challenges. This observation implies that S&OP development could benefit also from SCM solution architecture practices. More benefits could come by integrating enterprise-wide EA management, including business, process, HR and financial structures and systems, into a holistic EA structuration for supporting integrated S&OP development.

7.6 Electronic Commerce/eCommerce vignette

7.6.1 eCommerce introduction

This vignette is about eCommerce development at Nokian Tyres. It occurred in 2010 and 2011 while initiating Russian consumer web-shops for Nokian Tyres and Vianor. This eCommerce –development has been an emergent topic for several years, but during the corporate strategy workshops in 2009 clear attempts to move into direct consumer business was decided. After that decision, the Boston Consulting Group was selected to make an eCommerce –market study for Russian consumer behavior preferences and to initiate go-to-market suggestions for Nokian Tyres' eCommerce strategy for Russian web-shops.

A market study indicated the potential for a multi-channel approach to reach four different consumer segments willing to buy tyres from a web-shop. During 2010, in internal discussions, two consumer segments were selected to initiate tyre eCommerce in Russia: a direct Nokian Tyres –branded channel for brand/product -oriented consumers and an indirect Vianor –branded channel for brand/service –oriented consumers. After these decisions, project planning, investment and resourcing negotiations and solution architecture discussions continued until the end of year 2010. Then in January 2011, resourcing and scheduling of the Russian eCommerce program were agreed: both Nokian Tyres and Vianor web-shop implementation projects were started in February, both aiming to launch web-shops in the beginning of August 2011 before the next winter tyre season.

New eCommerce-experts were recruited to the Russian and Finnish sales operations, and additional technical support specialist resources were recruited to the Russian ICT-operations. Call center services were bought from an external call center service provider, and new e-payment methods and cash collection processes were agreed for supporting fluent web-shop payment services. New consumer delivery channels for Nokian Tyres were established using pickup points and home deliveries in the greater Moscow and St. Petersburg areas, which were selected as pilot markets for the web-shop launch. On the Vianor –side, its own tyre service outlets and selected partner outlets agreed to be involved and integrated into the Vianor web-shop operations, offering pickup points, mounting and other tyre services in the greater Moscow and St. Petersburg areas. The process and system design was planned during spring 2011, and a major system and integration implementation was done during May-July 2011. Some delays and late changes in solution design pushed implementation schedules, but during August 2011 all major solution components were successfully in place and functional. Because of some issues with the system integration complexity with the Nokian Tyres web-shop and limitations of the consumer registration functionality, two additional development sprints were agreed to execute mid-September and end-of-September releases of Nokian Tyres' web-shop before the expected higher seasonal demand started in October 2011.

7.6.2 eCommerce/IT–framework elaboration

System-wise, the Russian eCommerce-business solution has been successfully coordinated by the Russian operations of Bearing Point consulting. Bearing Point managed in 2007 to implement a Russian Oracle ERP –system called ROP (from Russian Oracle Project or Russian Operations Platform). The ROP –system was the second attempt at implementing the Oracle ERP for the Vsevolozhsk factory organization of Nokian Tyres and the Russian sales organization Nokian Shina. The first attempt in 2006 was a centrally coordinated RIMP- project, which was aiming to rollout the Finnish MaFi –solution to Russia but for several reasons this was not successful. One of the technical reasons for the failure was that the Finnish Oracle ERP –instance MaFi did not include the UTF8-character set supporting Cyrillic letters. Socially, there were much more embedded, cultural differences in business practices and communication which were not properly understood by the Finnish part of the RIMP –project team. Thus, the second ERP attempt for the Russian operations, called the RIMP2 –project, was managed by Russian operations together with the ex-Oracle –team of Russian Bearing Point, co-operation with whom produced a quite separate ROP –system. This imbrication of the ROP –system through the Oracle ERP back-office and with cooperation between Nokian Tyres Russia and Bearing Point services enabled a quite smooth and aligned process design changes as well as new ROP-customizations to support complex integrations between ERP –system and the web-shop for the Russian tyre business.

Technology-wise, solutions for the Russian web-shops were quite different for Nokian Tyres and Vianor. The common technologies for both web-shops can be found from the end-user layer acting as the EIS-level, which in this case materializes into a web-shop application and data center services delivered by a Finnish service vendor. Web-shop applications were developed by two different teams: one developed web-shop functionality for Nokian Tyres, and another for the Vianor web-shop. The web-shop applications were customized for both Nokian Tyres and Vianor purposes, but the whole technology and service stack for this internet layer were harmonized to the same technology as the embedded part of the web-pages for Nokian Tyres and Vianor.

The web-shop integration to back-office systems needed totally different solutions for Nokian Tyres and Vianor outlets. At the Nokian Tyres side, integration was a new imbrication above GVI –availability and integration solutions, where the Russian Oracle ERP –instance ROP was integrated through a GVI to the web-shop application. At the Vianor side, integration included a totally new technology, which was delivered by Russian Business Intelligence (BI) and an integration solution vendor, Contour Components, enabling data flows between Vianor outlet ERP -systems and the Vianor web-shop application. Contour Components' BI –technology was also used for the Vianor web-shop reporting and analytics solution, before Vianor web-shop related data was included in the Nokian Tyres EDW and reporting solutions. In addition to back-office integrations, Russian web-shops also included integrations to local Russian proxy-services, local Yandex –search engine and Chronopay –payment services for the Nokian web-shop. Thus the whole web-shop integration layer was quite complex, including local web-service integrations and several back-office integrations for services and payments.

At the ERP and CRM system level, Russian web-shops included new integrations and customizations to transactional systems. Corporate-level marketing introduced a consumer registration module, which was used for capturing consumer data in a new CRM system for marketing and after sales purposes. The whole technology stack for Russian web-shops was quite modern and supported by technology vendors. The only concern at that time came from the Oracle ERP –technology: the ROP –instance with R11i10 was no longer supported by Oracle application support. While focusing limited resources to Russian eCommerce and web-shop development, Nokian Tyres did not have any more development capacity for upgrading the ROP –instance to a release level required by Oracle Support services. For ensuring Russian web-shop support operations during evenings and weekends, it was agreed to include an enhanced SLA in all corporate web-sites and Russian web-shops and integrations. The inclusion of Nokian Tyres' GVI –system into the Oracle SSI –support service contract for 24*7 –monitoring ensured that the ERP –system platform for Nokian Tyres Russian web-shop was operable for eCommerce development at Russia. The eCommerce development IT–framework -findings are presented in Figure 48.

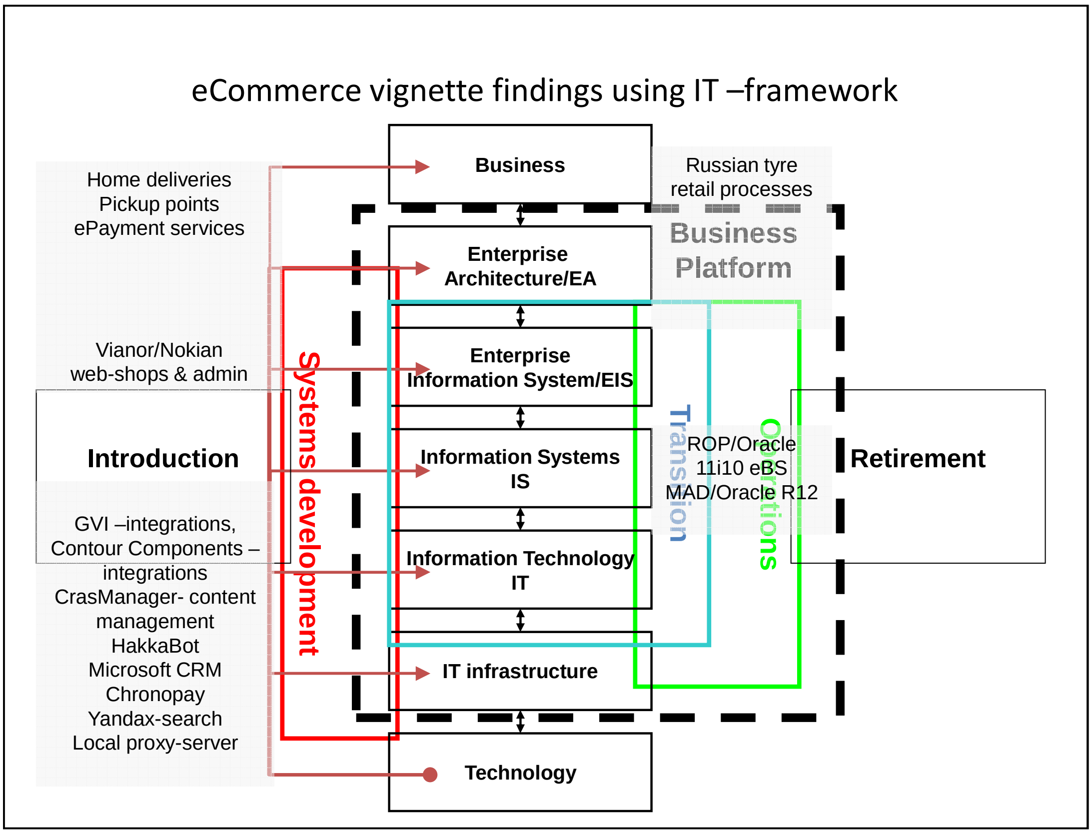

FIGURE 48 eCommerce vignette findings using IT –framework.

IT –wise, the processes and systems for Russian retail business were ready. The eCommerce development introduced various new technologies into system development phase, which was managed by joint resources from Russian and corporate organizations.

7.6.3 eCommerce/EA–framework elaboration

eCommerce -development included consumer-driven business processes, which were totally new for the Nokian Tyres –business, but for the Vianor –side consumer-driven business processes were in their core competence. But because the Vianor –side business model and especially the wide Vianor –partner network in Russia has been operating quite independently from central operations; now this common web-shop development included new coordination processes for product and service master data and pricing, which has previously been executed with separate partner driven business processes and systems. Thus master data management/MDM-related common product and service catalog creation and maintenance processes caused more challenges for the Vianor web-shop than actual new technology introductions.

Process-wise, these new web-shops were causing tensions between the existing inventory management, shipping, payment collections and the period closing procedures. Thus the new process variants were needed to include material and financial accounting flow into the existing process architecture. Consumer registration procedures and data requirements were discussed and changed during the implementation, which seemed to be a quite sensitive topic in terms of eCommerce consumer behavior and thus suspect for further changes. Also, discount and campaign management procedures were implemented with simple initial functionality, which should be further developed after more business experience is collected with initial web-shop versions. Potential channel conflicts were also emerging during the eCommerce development, but these issues seemed to be tackled with pricing related business decisions. Most likely, the business model and architecture will need careful follow-up and fine-tuning with web-shop processes to enable the expected eCommerce business success. Special remarks should be done regarding documentation: the eCommerce development produced plenty of project, process and solution documentation, which was needed because of managing multi-vendor, multi-language and new business model related risks. The eCommerce development findings are presented with the EA–framework illustration in Figure 49.

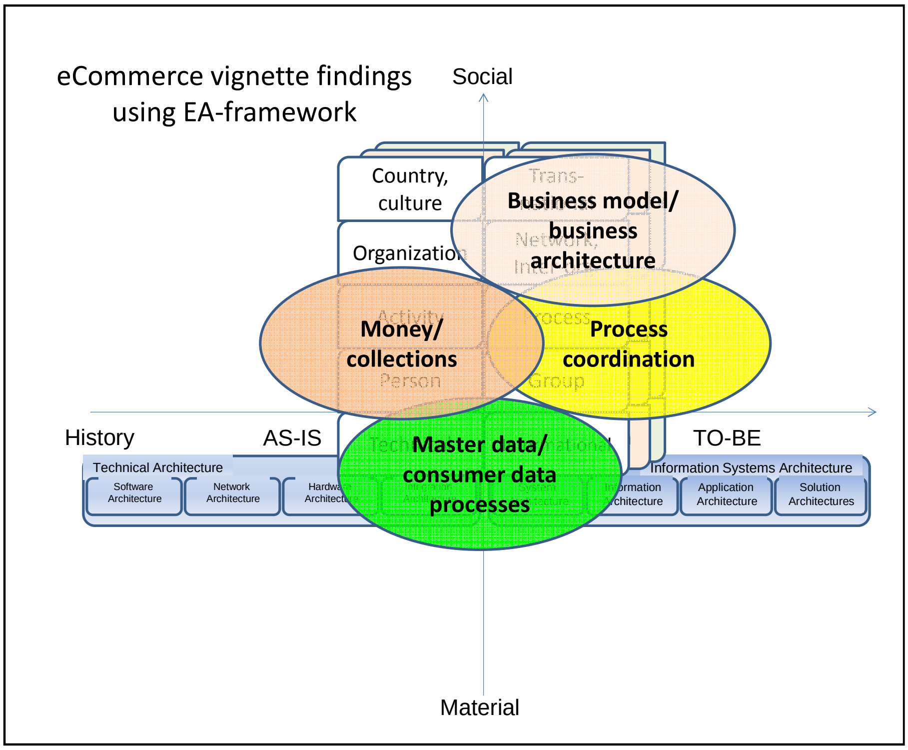

FIGURE 49 eCommerce vignette findings using EA–framework.

7.6.4 eCommerce/EAM–framework elaboration

At the time of writing this EA –vignette, Nokian Tyres eCommerce –business has just started. The first generation of eCommerce –technology is now in place, but the ontological and epistemic understanding of how consumer data, market behavior and business models should and could be captured, managed and develop in the tyre business in Russia are still in the early phases.

On the Vianor –tyre service chain side, the Russian market potential is remarkable. The Vianor –web-shop initiation in the Moscow and St. Petersburg areas were only the first steps towards a country-wide system integration between Vianor web-shops and partner-driven outlet ERP –systems. Technology-wise, Vianor web-shop integration is executed by a local, trusted and capable solution vendor, Component Contour. The major challenge is much more social than technical: new direct sales channels from both Nokian Tyres and Vianor are competing against partner web-shops and sales, which may cause channel conflicts and need some new profit sharing mechanisms and incentives for Vianor partners. The Vianor web-shop must also include other tyres than Nokian –branded ones to be a credible and neutral tyre supplier as well as relevant sales channels for Vianor partners. This development creates possible conflicts when Vianor a web-shop may be used as a major sales channel for non-Nokian –branded tyres. The eCommerce development findings are presented in Figure 50.

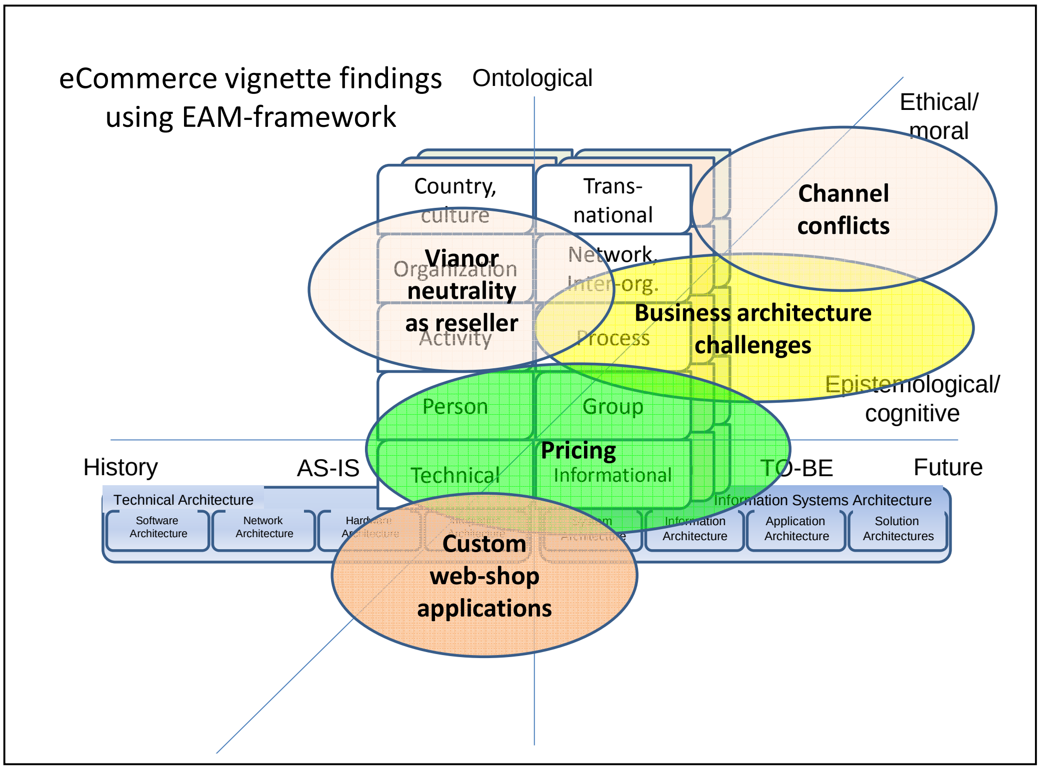

FIGURE 50 eCommerce vignette findings using EAM–framework.

The eCommerce development success is dependent on business decisions regarding pricing, marketing and other sales channel arrangements for changing consumer behavior from traditional channels to web-shop usage. Technical considerations may relate to integration of various new technologies embedded to a web-shop platform, which may cause major maintenance challenges for future development work.

7.6.5 eCommerce/external knowledge-sharing perspective elaboration

Knowledge sharing needs regarding eCommerce –development, process management and system knowledge have been growing while eCommerce –system development has been proceeding. Quite naturally, Russian eCommerce –development teams from both Nokian Tyres and Bearing Point were suspicious regarding the small Finnish company Crasman as a technology vendor for this major business development investment. Especially because Crasman and their CrasManager –technology was a content management platform was offered without a ready web-shop capability in-build in their technology, The Russian eCommerce-development team was somewhat frustrated while teaching basic web-shop functionality in English to the Crasman –team, but in a quite quick and flexible manner the Crasman –development team was able to code and modify their own technology stack according to the customer needs.

The language gap between Finnish service vendors operating in English and the Russian business operations, who preferred to explaining Russian eCommerce-requirements in Russian, caused some communication challenges during these projects. Therefore, the author decided to replace phone-based teleconferences with video meetings as media for weekly project meetings: these language-related communication constraints caused less understanding problems than using only verbal communication over sometimes poor telephone lines. Another knowledge sharing practice which was used for accelerating common knowledge and understanding about business requirements and implementation details were quite frequent site visits at both the Vsevolozhsk and Nokia factory. Informal meetings, workshops, dinners and ad-hoc video meetings enabled relaxed communication and knowledge sharing regarding quite complex integrations and emerging business practices for Russian eCommerce development. Development service providers used their Russian speaking technical specialists in these development projects, which improved knowledge sharing about key business requirements and helped in issue resolution. Nokian Tyres' operations in Russia do not follow the company culture of minimal documentation that much because the top management has a more diverse background from experience with western companies with more intensive documentation cultures. The major obstacle in enterprise-wide knowledge sharing comes from the documentation language, which in typical cases is Russian. The language barrier is now much lower when ICT service providers allocate their Russian speaking specialists to this web-shop development work.

7.6.6 eCommerce summary

The eCommerce vignette seems to combine business, process and technology-driven business platform development. Several quite separate technologies were integrated into a new eCommerce platform, which enabled new business models and sales channel creation. The eCommerce development could be seen as a successful solution architecture introduction to corporate and Russian EA, but at the same time harmonizing EA at the web-page and web-shop levels.

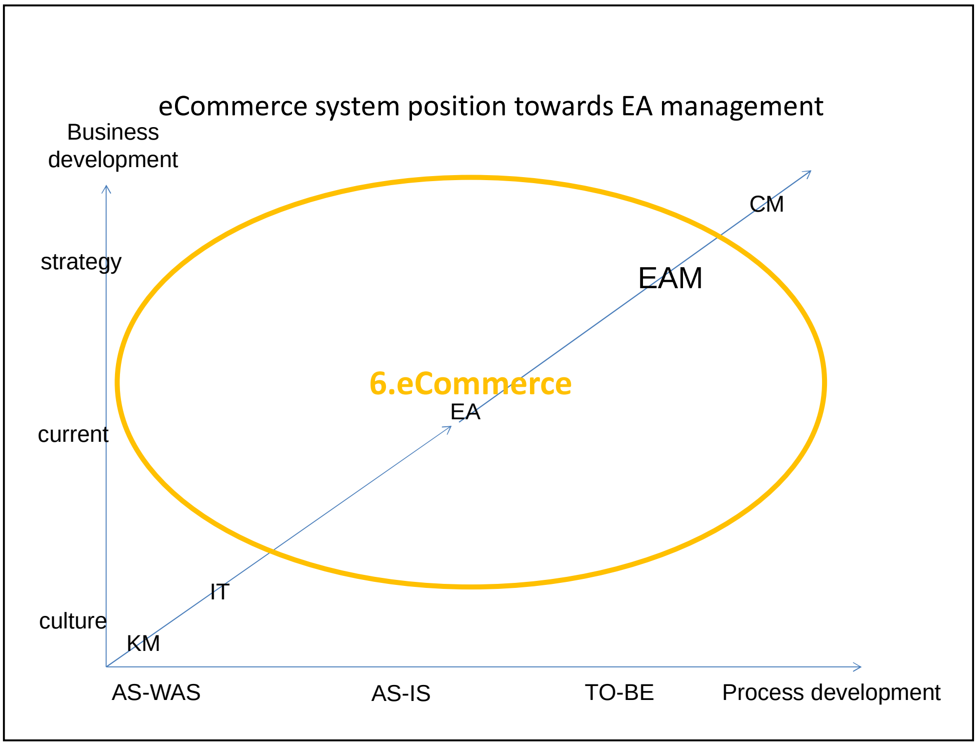

FIGURE 51 eCommerce system position towards EAM maturity

The eCommerce vignette successfully combines process and EA development. The new eCommerce resources, competencies and capability were developed to manage eCommerce and consumer business development. The commercial success of this eCommerce platform will be decided with business decisions regarding pricing, services, product mix and marketing.

7.7 Enterprise Architecture Management/EAM vignette

7.7.1 EAM introduction

This vignette reflects the author’s experiences and attempts to develop more structured EA management at Nokian Tyres Corporate Development and ICT operations. When the author joined the Nokian Tyres Corporate Development and ICT –organization at the end of 2006, Enterprise Architecture as EA or Enterprise Architecture Management as EAM were not known concepts at Nokian Tyres. ITIL was somewhat known because of the major IT service providers like HP and Fujitsu have been promoting their own service models and offerings, which were based on the ITIL –model. There was some IT architecture documentation and solution architecture documentation available from some previous development projects, but most of the documents were not up-to-date with current operations. IT architecture management was the shared and implicit responsibility of several senior technical experts and supervisors.

Continuous IT services were managed with an application list for support services. In 2007, this application list contained 22 standard office applications, 26 miscellaneous professional applications, and 51 varying operational business applications. For each application, this list included information about the system provider, super-users, escalation channels, technical support information, installation owners and internal costing methods. These approximately 100 applications were used and supported primarily at the Nokia factory and for Finnish operations at Nokian Tyres, but at the enterprise-level there were still more applications used at sales companies and Vianor operations, which were not fully included in this centralized service coordination at Nokia. But of course these approximately 100 applications are used in several business purposes and use cases, which generate a much bigger amount of active, operational IS than this application technology and technical support related number of applications. The number of operational business applications increased from 51 to 68 application services, which were included in a corporate Excel-based ICT service catalogue in 2010. This increase now includes more international business applications, which were supported as part of corporate ICT –services from Nokia. Also, this 33% increase gives some indication about the growth of role of business application services.

The original reason for the application list has been the communication with application related stakeholders and installation packages for external IT infrastructure service vendors. Since introducing the Jira-based service desk approach into the ICT –organization, a more up-to-date business application list with related system roles and responsibilities were found as email lists the communication and tracking of issues. Thus continuous IT services for business applications were delivered and tracked with the Jira-based communication. Except for standard office applications, MS Windows –related issues, workstations, networks and printers were supported by the IT infrastructure team and external service vendors, which were not using Jira in their daily communication and issue tracking. This separation of IT –related tasks seems to follow a cultural separation of business and engineering IT working systems. All the IT, IS and EA related documents were collected into a meta-data driven document management system called M-files. This IT/IS document storage enabled project documentation sharing between distributed service organizations of Nokian Tyres and its’ service vendors. The Excel-based application list was converted into M-files meta-data and each application had a related application card in M-files documentation storage. This approach generated a centralized EA management structure for management of systems related knowledge.

The process management culture and process documentation was also quite limited to tyre production processes and IT –system level processes. Some process documentation was made as part of the quality system development during the 1990s, but these process descriptions were not updated during rapid business growth. Local informal face-to-face discussions between top leaders and the execution level were part of the company culture on a daily and weekly basis. Decisions and execution were very rapid, which seemed to eliminate the need for documentation and the role for middle management and organization structures. Most of this daily communication was held in Finnish, but the need for communication in English and in Russian gained more importance because of the increasing non-Finnish operations.

To discuss system development challenges and the road-map with top management at Nokian Tyres, the following NT EA template was used to illustrate value-chain and structuration for IS development (Fig.52).

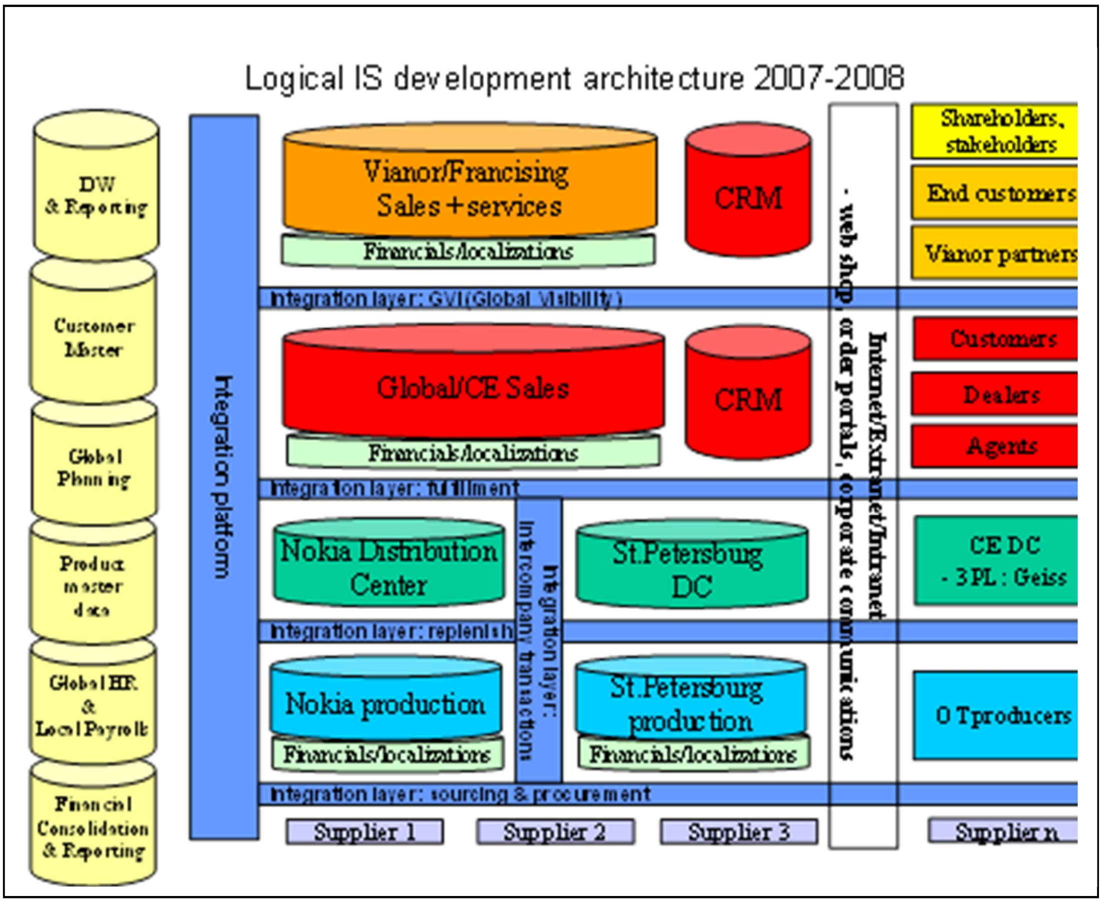

FIGURE 52 NT EA template for ICT-strategy 2011 (Kimpimäki 17.1.2007).

The NT EA –template was used as a boundary object for discussing and communicating enterprise-wide and local IS development and operational issues with various internal and external actors. While working at Nokian Tyres on IS-development, the author produced various illustrations regarding AS-IS, intermediate and TO-BE –states of IS-architecture, where the content and notation of the illustrations have varied based on the expected audience. This behavior of illustrating solution architecture produces some kind of “Big Picture” Figures for communicating business case and key business requirements between technology, processes and systems. This NT EA -template was used as a corporate frame of reference for positioning each solution architecture and development project at the corporate development map. Each solution could be seen as a separate sub-system with its own “Big Picture” and integrations to EA. Next we will try to elaborate on this EA –practice and our attempts to improve EA -management with our EA –study frameworks.

The EA development roadmap was discussed in an annual strategy workshop program, which reviewed and approved capital and operational expenditures (CAPEX and OPEX) for the next 5 years period at a high level. An annual budgeting process reviewed and approved financial plans for the next calendar year, but each investment was separately discussed and approved by a monthly executive Investment Board. Each major ICT investment was presented, discussed and approved in a monthly ICT Development Board, which reviewed investments such as strategic and operational business cases. ICT projects were reviewed and discussed in detail regarding key business requirements, schedules, resources and constraints. These planning and control processes enabled a tight dialog between business executives and ICT management without formal EA management structuration.

7.7.2 EAM/IT–framework elaboration

In our IT–framework –model, the EA-layer is between the business and EIS –layers. This means that EA is seen as an interpretation service between business and enterprise-wide information systems. In other words, the EA –system can be seen as a meta-EIS –system for modeling and managing enterprise as an information system. Thus, in theory, the EA –system itself does not require any particular technology. But, in practice, some technical tools could help improving EA management efforts of communicating, coordinating and controlling development initiatives for change and knowledge management between business and systems development. EA –technologies could also offer process support for service management, issue management and resolution in daily use and maintenance of EIS. In practice, this could mean repository system with status and activity records for tracking the system life-cycle and issue history.

With Nokian Tyres as a Finnish company with a factory in Nokia, the most practical and relevant tool for EA –management has been the “pen, paper and napkin –method”. But now when more inter-related systems, multi-national operations and external business partners are operating closely together in development of the and in daily operations, the more appropriate technical tools are mostly personal, standard office applications like Microsoft Visio, Excel, PowerPoint, Word, and Outlook, which are also used for documenting and communicating business and EIS related changes to related actors. Some process documentation was produced with the ARIS –process modeler as a drawing tool, but several attempts did not produce any consistent process architecture, library or template for harmonizing process development practices. The QPR Process Guide was evaluated for process modeling and Troux for EA modeling. At that time, these technologies were not seen “practical enough” for operations at Nokian Tyres. But, at the same time, M-files –based EA –documentation storage was easily adapted into systems development and continuous services. This document storage enabled enterprise-wide knowledge sharing and management, which was an easy and practical way of collecting and sharing documentation without major changes in the documentation culture.

But as time goes by and the whole of digitalized business structure and business architecture are increasing and expanding over the whole business network and enterprise borders, the whole of EIS is becoming more complex and expensive for managing without more structured operations and processes for EA –management. At the same time, the whole of EIS is growing more critical and information intensive so that more technical and sophisticated EAM –systems could help in establishing efficient and effective EAM –operations. These EAM development findings are presented with the IT–framework illustration Figure 53.

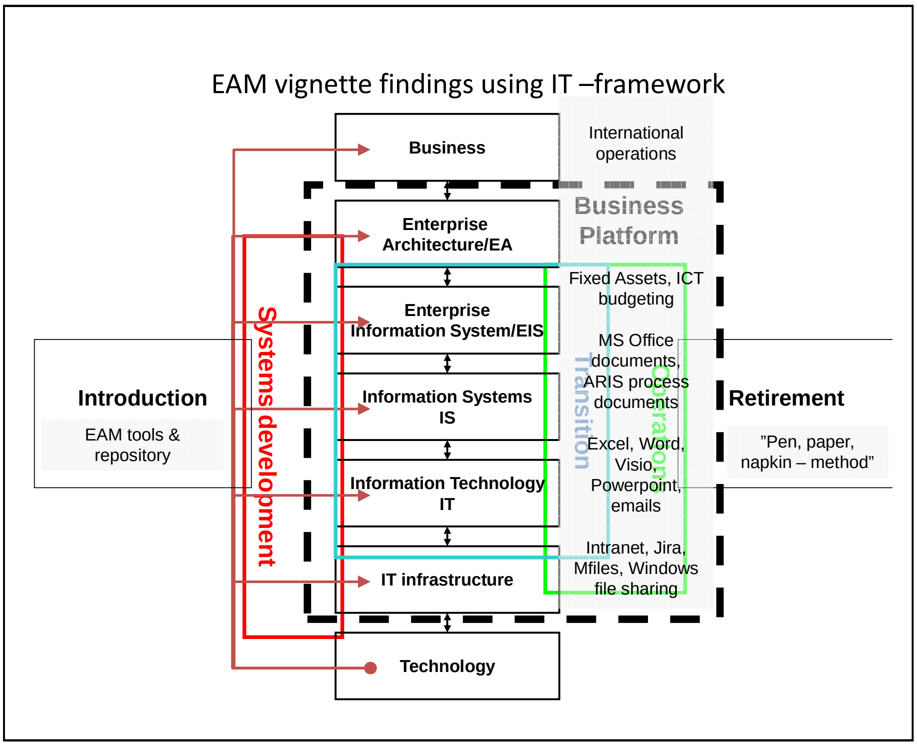

FIGURE 53   EAM vignette findings using IT –framework.

Technology-wise this analysis indicates that locally practical methods for EA management at Nokia factory are replaced by various technical tools for EA related systems documentation. This indicates that EA management requires organizational development and new capabilities for integrated EA management to benefit from integrated EA technologies. But EA technologies seem to require development to enhance integrated business and process capabilities for practical EA management.

7.7.3 EAM /EA–framework elaboration

By design, the EA–framework-model is meant for wider and deeper social analysis of EA –work between various actors, stakeholders and shareholder groups. While the tyre value-chain was continuously growing and expanding from raw material sourcing towards end-user services and consumer communication around the globe, the need for supporting information flows and systems became more critical and embedded in efficient and effective management of seasonal business in a multi-national business environment. Process-wise, operations at Nokian Tyres could be divided into 5 layers: raw material sourcing, manufacturing, warehousing, sales and consumer services. Structuration-wise, Nokian Tyres contains three organizational layers of back-office, operations and external services. If we think of these 5 different process layers as separate business components with their own business and system development, then there are 5 different social EA-networks with different change and EA management networks. At the end of the year 2010, the whole enterprise included 771 Vianor service outlets in 20 countries, 11 sales companies and 2 company-owned production units (Nokian Renkaat 2011, 15). In November 2012, the 1000th Vianor outlet was opened.

The growing scale of business operations, growing number of business applications and extending value-chain for consumer business with eCommerce –solutions, indicates a need for improving EA management governance model, processes, practices and systems. But it seems obvious that an EA management model should have tight integration with both process and business architecture management. Process architecture connections should improve EA relevance and EAM practices for people and change management purposes. Business architecture connections should improve EA value for customers and EAM practices for understanding business-driven priorities, schedules, cost structures and business-driven benefit mechanisms. By design, EAM development should tackle the existing challenges of the minimal documentation culture. The EAM development findings are presented in Figure 54.

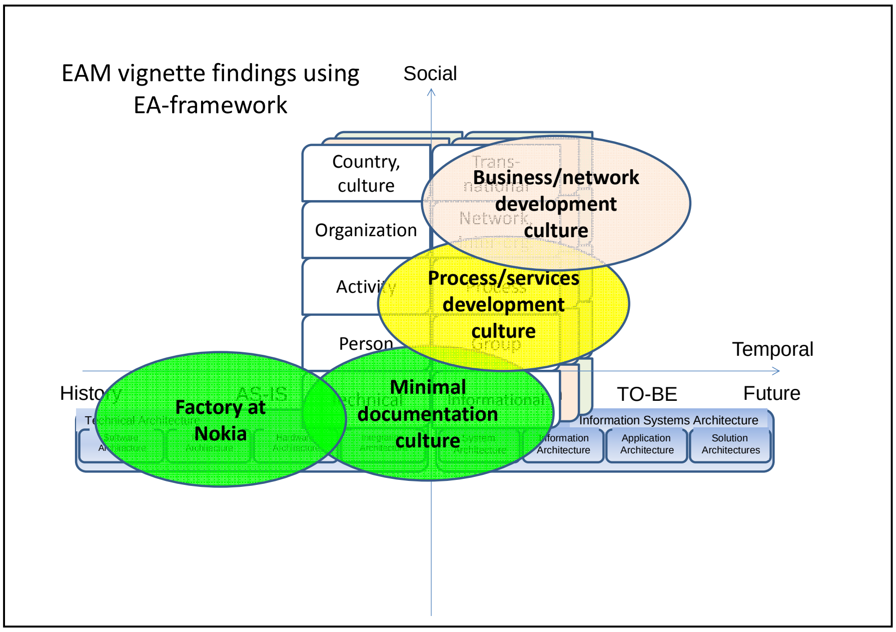

FIGURE 54 EAM vignette findings using EA–framework.

EA-wise, this analysis does not seem to produce new contributions, which have not been discussed in previous EA vignettes. But as a high-level substantial EA-analysis, these findings indicate the potential for integrated business, process and EA management coordination and development. This indication could be explained that without investment into integrated EA-technologies, organizational changes for integrated business, process and systems development could improve EA capabilities and culture.

7.7.4 7.7.4 EAM /EAM–framework elaboration

The EAM –process seems to be similar to the S&OP –process as an integrative and information intensive business process by nature: improving EA management processes causes more challenges in business models, process architecture, master data management, resource allocation rules, analytical structures, knowledge management and change management practices and processes at Nokian Tyres. Thus ontological and epistemic dimensions are tightly integrated into EAM –rules and practices, including the way in which new information needs, business requirements, process changes, new technologies, systems, competencies, service models and suppliers are identified, defined, communicated and integrated into existing and new structures and systems.

Ethically, the EAM –system should be beneficial for the whole enterprise by clarifying business and process development related information structures and processes, thus hiding some technical details and complexities from business decision making and end-user communication. When an EAM –process is further developed and integrated into financial and procurement processes, these improvements should also create even better visibility of financial forecasting for shareholders and better demand estimates for their own ICT -operations and service providers. Organization-wise, EAM –system development indicates needs for additional organization structure, level or roles between business development practices, process architecture management and ICT – demand and supply chain planning. But this additional structuration should lead to more holistic practices for managing and documenting integrated business, process, information and technology architectures, which together should enable more efficient business planning processes and effective decision-making processes and business development benefit realization.

EAM processes and governance models should overcome local and temporal development and management thinking with structuration to improve business network management. At a person and activity level, this business network management should be supported with service-driven resource management, and at a process and group level costs and benefits should be understood and managed with process architecture and development models. At a technical and informational level, EAM should integrate ICT and HR management practices, which should include system documentation, HR development and knowledge management as core components of company culture and values. EAM development findings are presented in Figure 55.

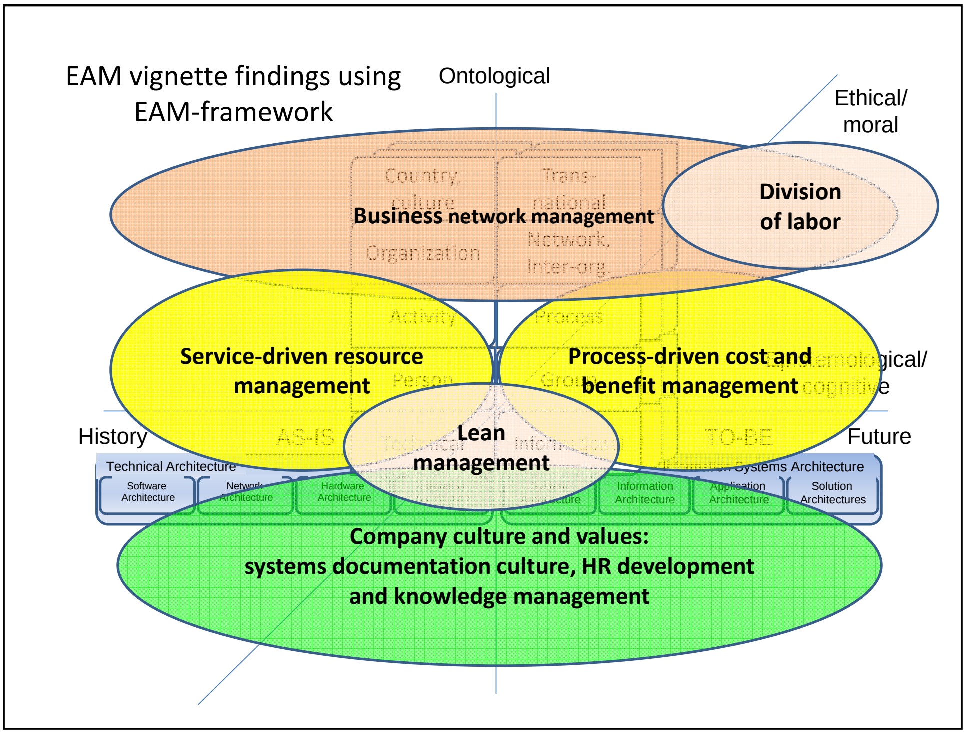

FIGURE 55 EAM vignette findings using EAM–framework.

These EAM findings indicate the potential for improving management culture towards integrated business services for knowledge, change and EA management. Practical

EAM structuration seems to require more global HR and business network coordination for developing HR, capabilities and systems covering enterprise-wide processes and services. The growing scale of global business operations and speculations regarding the third manufacturing site would benefit from improvements in EAM structures.

7.7.5 EAM /external knowledge-sharing perspective elaboration

Additional EA-knowledge structuration should also be quite beneficial for the company culture of Nokian Tyres, if EAM could act as holistic and practical processes for improving the minimal documentation culture towards flexible knowledge sharing structures. But, at the same time, EAM –structuration could generate too complex and detailed EA –documentation, which could add costs and delays without improving business development and change management practices. Therefore, EAM-structuration might be beneficial to start with financial EA –knowledge creation, which were aligned with the company culture and value of improving business profitability. With this approach, the EAM –potential for complexity management would be second priority, which could bring additional benefits for improving business development agility and speed when improvements in AS-IS –system knowledge could speed-up pre-study phases for development projects and, in some cases, perhaps even avoid investment in new technologies and systems. EAM knowledge creation and management should improve communication and knowledge sharing with internal and external business and process developers. For EAM value creation and knowledge management purposes, each business development initiative should include integrated business, process and enterprise architecture evaluation to improve business network level cost structure and benefit mechanisms of EAM.

7.7.6 EAM summary

During fieldwork, the author was trying to understand multiple company cultures, the business development context and the structuration of IT –services for more multinational business operations. As part of the practical work, the author initiated attempts to develop more structured and explicit approaches for EA –management. The EAM vignette summary is illustrated in Figure 56.

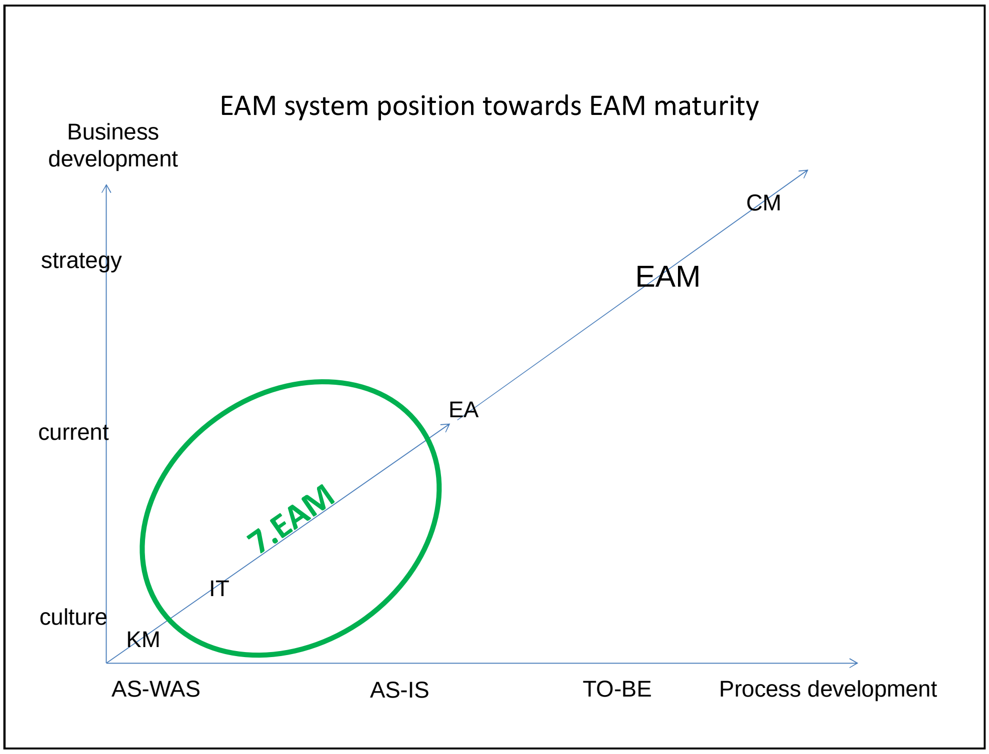

FIGURE 56 EAM system position towards EAM maturity

Because of multiple cultural, situational, structural, mental, technical and resource reasons for constraint, the author does not see being successful in EAM-development as motivational, intentional and practical EA development level. This may be because of a tendency towards too technical of solutions, which may be adequate for capturing technical EA layers from the IT/IS architecture levels. But EA management seems to require more organizational structuration and integration of business, process and EA management capabilities for strategic change management and process development layers. Ulrich and McWhorter (2011, 44) promote the creation of a business architecture knowledge-base for avoiding the technical orientation of hand-drawn Visio and Powerpoint drawings without proper integration to business models. Therefore, some organizational structuration and a systemic approach would be needed to generate capability for integrating business, IT and process development resources into joint EA leadership structures for managing knowledge, change and strategic business transformations at the enterprise level. Both strategy and process development perspectives should be integrated into EA leadership and EAM systems development. To conclude our EAM vignette, improvements in business architecture may be needed both in theory and practice to achieve EAM maturity and capability at the EA leadership level.

7.8 Vignette summary

Now we have analyzed seven different vignettes with four different EA-study frameworks. Next, we will position our vignettes into a Nokian Tyres EA –template to summarize the operational scope of these development areas. Because these seven vignettes have different organizational scope and operative structuration status, this summary evaluates system-specific similarities and differences regarding EA development.

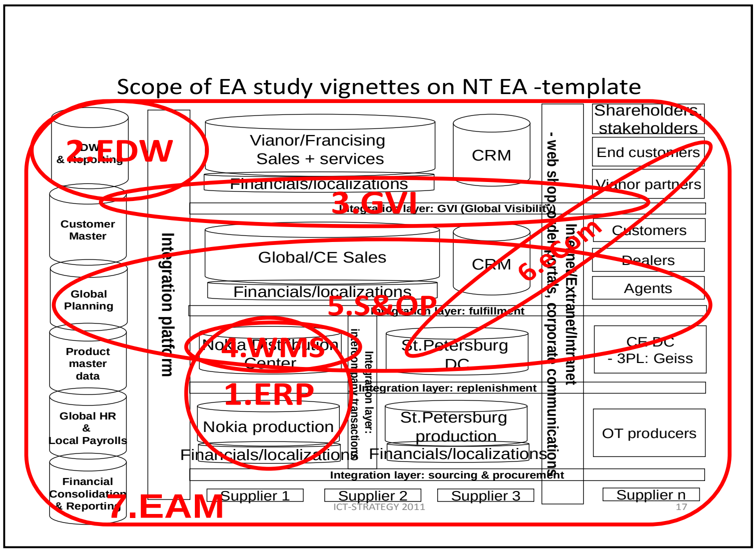

FIGURE 57 The scope of EA –study vignettes on NT EA template.

From Figure 57 above, we can explain that the **ERP and WMS** vignette present transactional system development projects at Nokia factory. Therefore, these vignettes may reflect and include change management challenges from the company culture of the old rubber factory. But, at the same time, these two vignettes reflect those challenges, which come from operational conflicts when fitting a mid-sized Finnish company into a large-scale American application package. From a process and transaction perspective, eCommerce could be seen as a member of this vignette group, but because of the customized and integrative nature of the eCommerce solution, we see it as a separate group of solutions. Business-wise, ERP and WMS vignettes should have created new capabilities. Process-wise, both development initiatives were forcing unforeseen changes, which were difficult to manage with existing capabilities.

Then the next set of inter-related vignettes are **EDW and GVI**, both of which are results from the tailor-made integration solutions between Nokian Tyres product business and Vianor –tyre service business models. During the years, both systems have been upgraded and extended for a growing business scale and volumes, the process of which has been quite fluent because the vendor of the same solution, Solita, has been able to deliver both development, support and knowledge management services in close cooperation with Nokian Tyres ICT-operations. These development areas can be seen as integrated to the business and process development culture, which has resulted to wide system usage and a good strategic fit with growing business operations. An **eCommerce** vignette is clearly different in many ways, but at the same time, technology-wise, a clear extension and combination of both Oracle ERP and GVI –capability at Nokian Tyres. Culturally, this vignette includes national and company culture related differences between the Russian and Finnish operations. In practice, this vignette also presents a show case of how enterprise-level strategic decisions are put into operations in a planned and structured way. Business and process-wise, this eCommerce development presents a new, multi-national company culture, which requires more documented communication and service management resources and processes. Strategic alignment of eCommerce development is good, but much more business and process architecture work is needed to realize the full business potential of the first web-shop implementations for the development of the Russian tyre business.

S&OP and EAM vignettes have many similarities and common challenges, which may be explained with a limited process management culture, limited system management services and limited development resources for operational changes without major financial investments or new technology. These development cases seem to be quite slow, which may again be explained in various ways. One explanation may be that the company culture prefers, or understands better, explicit technical investments, which are expected to bring immediate business benefits without the need for behavioral changes or change management. This may be because of the Finnish, informal and flat hierarchy and the flexible company culture promoting individualism without a heavy admin culture, which may still involve some kind of subconscious battle to avoid the old Nokia group tensions between HQ/Admin in its ivory tower controlling but not listening to the rubber factory. Perhaps both changes seem to introduce new organizational levels and structures, which may bring in additional costs without immediate payback. Also, both cases may be seen to introduce additional structures and processes, which may cause delays, constraints and inflexibility into the company culture, which normally expects rapid and flexible development with the slogan “Nothing is impossible”. But perhaps also these process development cases are part of those growing pains, which are related or beneficial only at a certain scale of operations. Thus it may be worth patience to slowly but in a persistent manner to work further towards holistic and integrated processes, structures and systems for enterprise-wide demand and supply management in the logistic and ICT services. This section concludes the elaboration of our empirical field study at Nokian Tyres. Vignettes in this chapter were presented in chronological order. In the next chapter, we will analyze findings for each research framework, which should create more of an aggregated view regarding the IT, EA, EAM and knowledge management findings of these seven vignettes.

8 Findings

In this chapter, we will present our EA study findings for each EA research framework. While doing so, we will try to analyze each framework separately to find out the strengths and weaknesses of each EA framework in this case enterprise setting for these seven vignettes presented in the previous chapter. We will summarize these findings for each EA framework by grouping commonalities according to closely related vignette groups of ERP & WMS, EDW & GVI, eCommerce, and finally S&OP & EAM.

8.1 IT–framework findings

After analyzing seven EA-vignettes with our IT–framework-framework, we are able to collect all the IT–framework findings into a collected illustration presented in Figure 58.

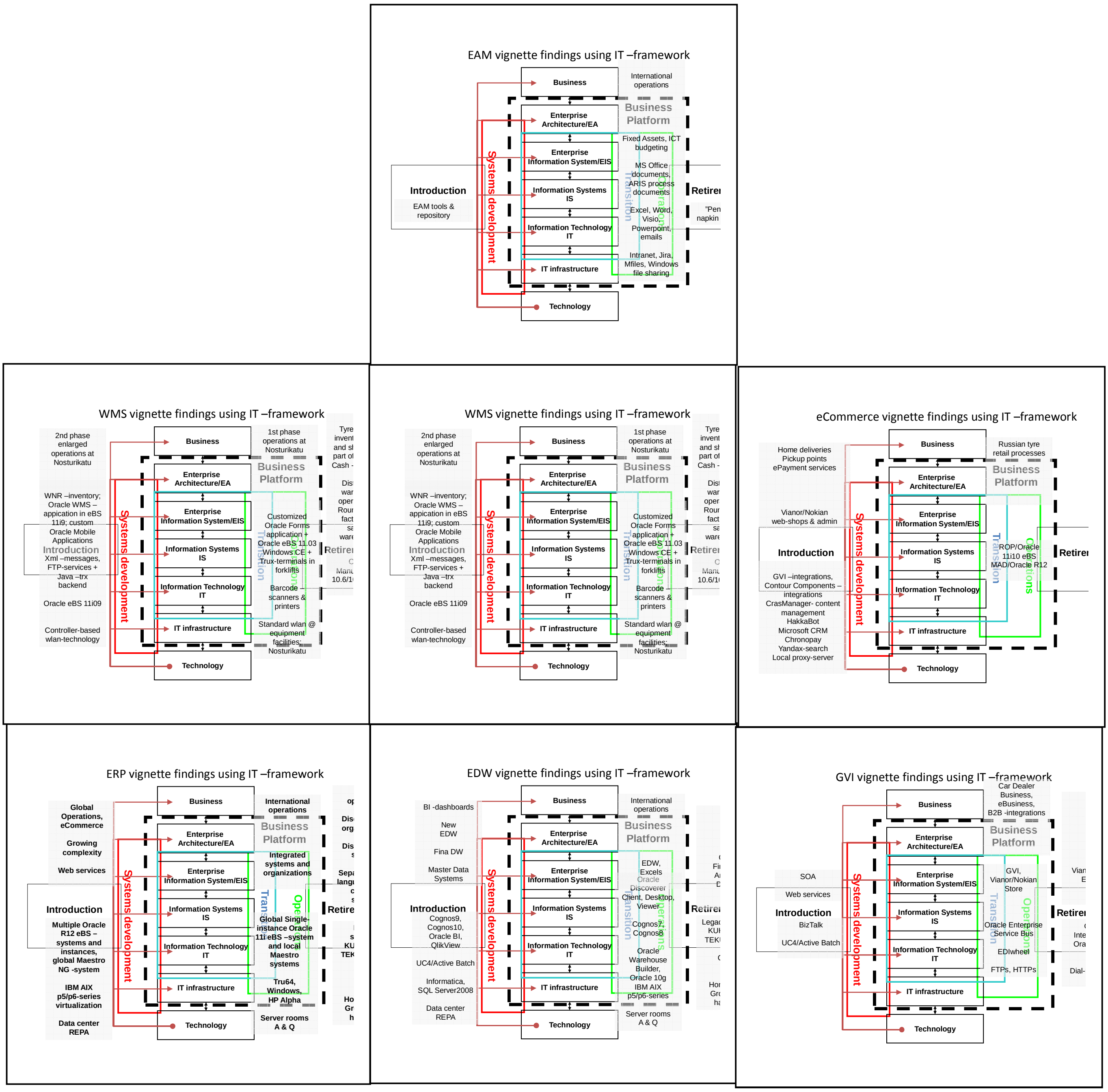

FIGURE 58 Collected IT–framework findings from EA –vignettes.

An aggregate-level IT–framework illustration would generate chaos because so many different technical components have changed at Nokian Tyres during 1996-2011. Therefore, the collected findings of IT–framework are presented in three layers. The lowest layer covers EA foundation development in vignettes for ERP, EDW and GVI. The layer above EA foundation presents extensions to the lower part, where WMS development is enhancing ERP, S&OP development is enhancing EDW and eCommerce is enhancing GVI. Thus WMS, S&OP and eCommerce are a creating 2nd layer, which is highly dependent on the lower level EA foundations. The EAM vignette is positioned on the 3rd layer above the analytical stack of EDW and S&OP. By nature and IT-wise, the EAM could be seen as being different to other systems, yet similar to analytical reporting and decision-making solutions.

The IT –framework based analysis into our EA-study vignettes at Nokian Tyres shows that ERP, WMS, S&OP and EAM –development cases are much more demanding technology driven initiatives than more business driven EDW, GVI and eCommerce –development cases. There may be several inter-related and intertwining reasons for this difference, which we will shortly reflect on in this section.

Because of the seasonal business culture at Nokian Tyres, tyre sales, production and deliveries must occur in certain time-frames for keeping profitability at an ambitiously high level. Therefore, all major business and system development must occur in between the seasons without risking short-term profitability of the enterprise. Thus all those systemic and highly structural changes, which requires changing organizational structures, processes, human behavior, IS and IT –layers are much more challenging to schedule and execute between seasons so that “quick wins” are realized as immediate economic benefits in the next season in order to legitimate resource allocations and continuing development for long-term operational benefits. From this perspective, complex software application technologies like ERP and WMS, and complex process-technologies like S&OP and EAM have been much more demanding technology introductions into the company culture of Nokian Tyres, than more strategy and sales driven IT-technology introductions of EDW, GVI and eCommerce. But all these vignettes have simultaneously included new technology introductions at all IT-layers between business and IT infrastructure, but with EDW, GVI and eCommerce –development cases being more business and sales driven that ERP, WMS, S&OP and EAM. Implicitly this means that these more business and sales driven development cases have to be phased according to the annual business calendar, bringing short-term business benefits without risking seasonal sales performance or the short-term profitability of the enterprise.

For EA and business development at Nokian Tyres, this means that for complex application or process technology introductions, intermediate development states and the development roadmap between AS-IS and TO-BE must be carefully planned in coordination with the annual business calendar. For EAM –system development at Nokian Tyres, this observation indicates that our previous idea of connecting EAM –processes first to financial planning processes could bring short-term business benefits during a budgeting process. Long-term structural benefits from EAM-development could then come with improvements in investment planning, capability of managing complexity, changes and knowledge of the whole EA and business development. But this EAM development should be implemented in tight coordination with process development to ensure business performance for seasonal peaks.

The IT –framework seems to be a quite flexible tool for presenting major technical changes and communicating changing IT competence requirements. Thus this IT–framework could be a practical tool for change management purposes in the ICT –department and in super-user competence management. Because of being a technology life-cycle and systems oriented layer model, this framework does not seem to fit for analysis of social and organizational process and business-oriented changes.

8.2 EA-framework findings

Following IT-findings, next our EA-findings from seven vignettes are gathered into a collected illustration presented in Figure 59.

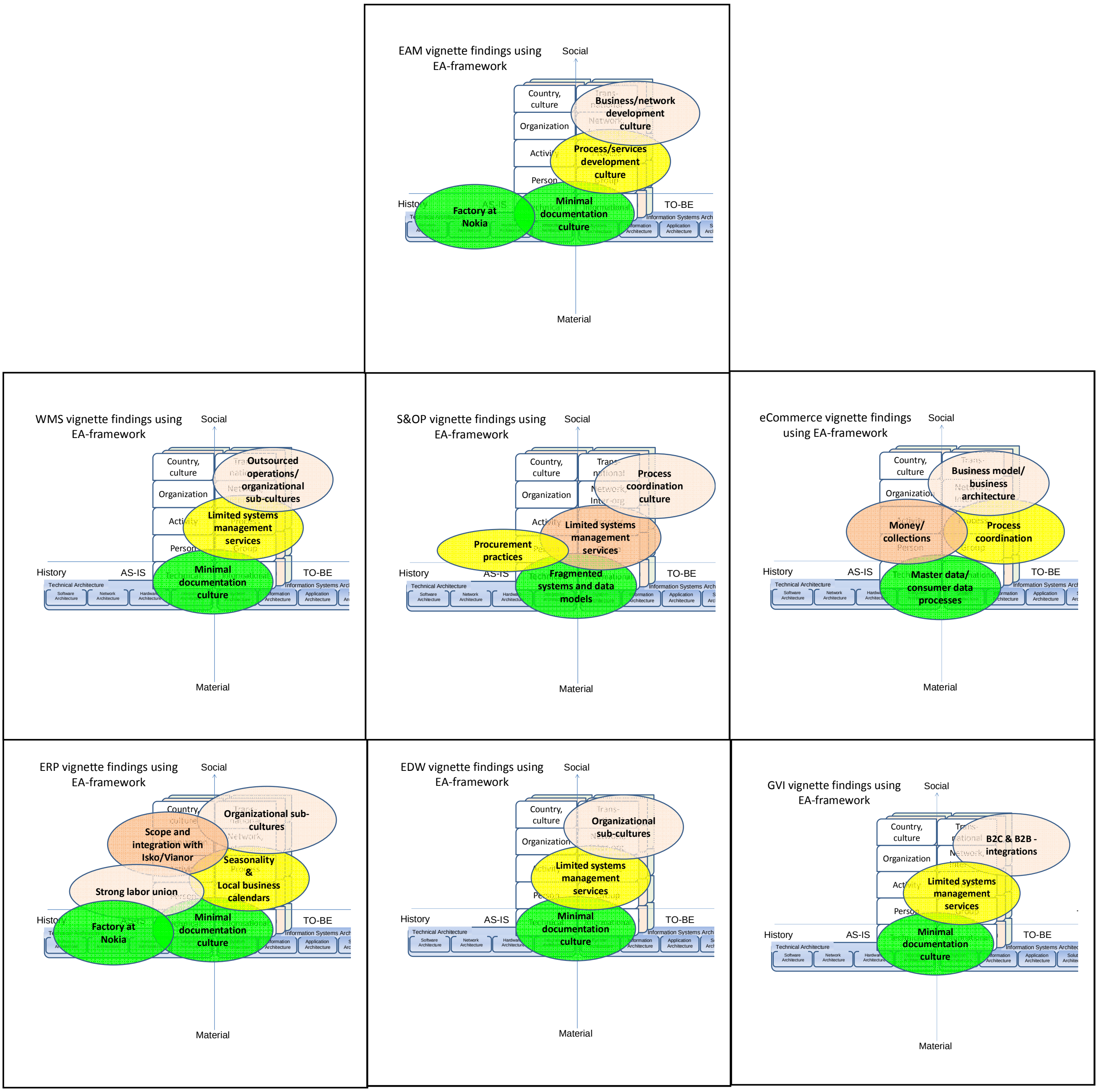

FIGURE 59 Collected EA–framework findings from EA –vignettes.

Collected EA-findings are also presented in three layers: the EA foundation created in ERP, EDW and GVI vignettes; WMS, S&OP and eCommerce create a 2nd layer; and EAM as meta-IS covers all the other systems.

The growing scale of business operations, growing number of business applications and extending value-chain aimed at consumer business with eCommerce -solutions indicates a need for improving EA management processes, practices and systems. The organizational capability for improving the information processing capacity may be somewhat increased by training and increasing head-count in EA management operations. Because the growing geographical scale adds social complexity and new time-zones are increasing scheduling challenges for sharing EA management knowledge and resources, in some point of growth it may be relevant to introduce more structured and technically supported EA –systems for enterprise-wide usage.

Technically, the current EA at Nokian Tyres is getting quite complex and somewhat fragmented, which indicates the growing costs for managing and maintaining the current EIS as a whole. The more or less prevailing minimal documentation culture has implications in support and maintenance costs, delays in knowledge transfer in case of changing responsible super-users or support service providers. Findings regarding challenges in service level monitoring and information logistics indicates needs for improving process management and process level KPI definitions and monitoring. On the other hand, renewal of the management system, which includes process and product quality related instructions, could also create improvements in process documentation.

Information architecture is also quite fragmented because various separate systems have their own data models, which cause more maintenance and development work in integration and reporting solutions. Consumer business and eCommerce also create new opportunities and challenges for information architecture development, which should at the same time respect local laws regarding person register, enable secure business transactions, and provide fluent service experiences to end-customers through the distributed service organization.

The social dimensions for business development are also becoming more complex because of the above-mentioned reasons. The eCommerce vignette included some findings regarding cultural differences between Russian and Finnish company cultures, but more cultural variety and new sub-cultures will come if and when enterprise-wide retail and consumer operations grow further to China and North America. Increasing social complexities indicate needs for more systematic management of HR –data, roles and responsibilities, improvements in CRM –system management and development to combine consumer and business driven requirements and views for information architecture regarding various actors and stakeholder groups.

Based on the EA-framework –analysis, there seem to be three major sources for EA challenges at Nokian Tyres: the business architecture is somewhat fragmented because of various organizational sub-cultures, the limited system management services are causing challenges for both system and business services, and finally the minimal documentation culture is causing business, process and system management challenges in various ways. This implies that the increasing investment in harmonizing the company culture and processes, in combination with ICT and HR operations integrations, could be beneficial for EA –level development. Growing international operations would also benefit from breaking the mindset of the management, which seems to continue running the whole company as “factory at Nokia”.

The EA–framework seems to work well when analyzing substantial EA –content. Without having a systematic EA –framework, such as the TOGAF or Zachman Framework, in use at Nokian Tyres, our EA–analysis shows major similarities, seemingly relating relate business, process and IT architecture. The lack of system services or limited business services, which seems to repeat in various EA domains, could be interpreted as an organizational design principle or as a lack of process development culture, which could be tackled by implementing some EA framework with a systematic EA process model. A major simplification relates again to the temporal aspect because all our EA-framework findings are positioned as AS-IS issues without future TO-BE status concerns.

8.3 EAM–framework findings

Next our EAM -findings are gathered into a collected illustration in Figure 60. The layering of collected EAM-findings is according to IT- and EA–findings sequence.

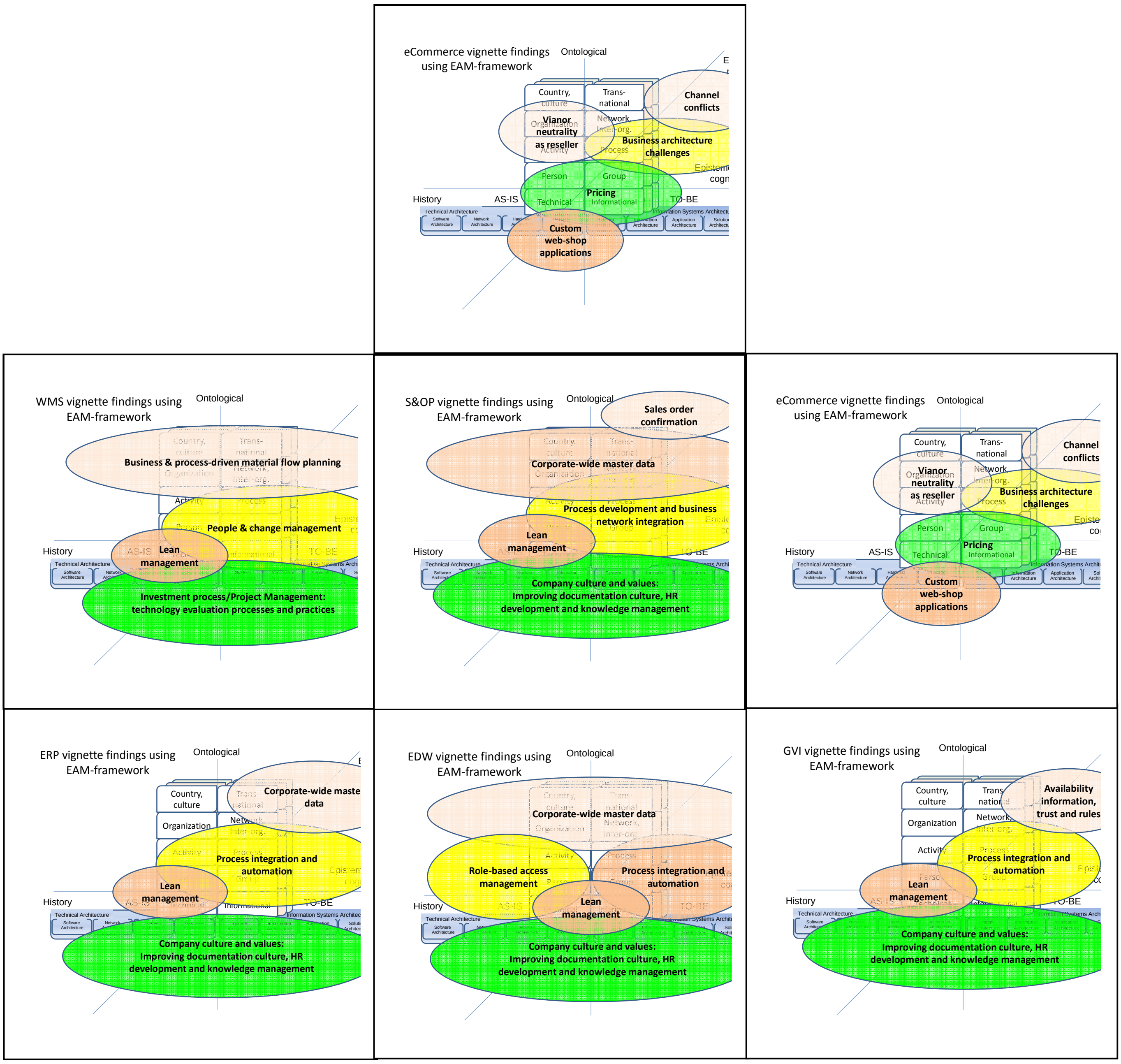

FIGURE 60 Collected EAM–framework findings from EA –vignettes.

A major challenge for EA management seems to be the requirement for finding an enterprise-level ontological balance between social, material and technical details. So far, EA –models seem to be more like IT architecture models biased towards technology and thus going into too much detail about the technology domain and getting too complex for business communication. When increasing business-related social and informational structures, like business and process architecture in parallel with EA –modeling, IT domain and technologies should be simultaneously be modeled at a more aggregate level concentrating on information flow and content of business communication between different actors in current and future business networks. Therefore, IT-related “Big Pictures” are a major risk of getting too complex, when containing too much information in one illustration. Thus this ontological balance between social, material and technical issues is a challenging task, but critical for EA being beneficial for enterprise-level communication, at least in Nokian Tyres. More aggregate, higher-level “Business Big Picture” could be useful for leading the systemic whole of an enterprise.

The Epistemic EA –challenge at Nokian Tyres comes from the minimal documentation culture, which leads to a longer pre-study phase for business and system development. The current management system includes some operational instructions, but with limited contribution to process and system documentation. Knowledge about the current AS-IS –situation must be investigated through the business layer towards technical details of system implementation. In practice, this sometimes leads to instant TO-BE –visioning, and instant implementation without time for planning operational changes through the organizational unit and process variants. One good example from this kind of delayed transition comes from the NR PES –project, where data migration to various legacy systems and excels took several attempts because new excels were popping-up while the go-live date was agreed and training proceeded. This could be explained as departmental lean management, which has been practical for local scale of operations. More holistic and improved master data management was needed to improve documentation and communication for multi-site operations.

Ethical EA –challenges are related to the minimal documentation culture. But if and when the business culture does not value, require or want to pay for systems documentation, it may be more due diligence or more like the service supplier’s own knowledge management practice for the service supplier to produce proper solution documentation about system development. But, again, another ethical definition problem arises of the nature and the amount required of proper system documentation versus minimal system documentation. In this respect, EA –development could and should undertake normative development to define how and at what level all business systems should be documented before being approved for operative use. Some more emphasis could be put on business and process architecture documentation supported with relevant systems and IT architecture documentation. This may be required for knowledge transfer, especially if business operations will grow to new sites or time zones.

The EAM–framework seems to work well for analysis, but challenges are visible in the illustrations. The EAM–framework contains and operates in a 3-dimensional analysis between ontological, epistemological and ethical dimensions, which is very difficult to illustrate and visualize in a 2-dimensional presentation. Also, the recursive nature of social life at three planes of temporality (Jones 1999b, 111) should be somehow illustrated to visualize

- durée (the temporality of daily experience),
- Heideggerian dasein (the temporality of the life cycle, being-unto-death), and
- Braudel's longue durée (the temporality of institutions).

This implies that perhaps we should reconsider how to include temporal aspects to our EA research frameworks and especially ethical considerations related to the aspect of time.

8.4 External knowledge-sharing perspective findings

External knowledge-sharing perspective elaborations on our seven vignettes at Nokian Tyres seems to reflect the old rubber industry culture, which values learning by doing in communities of practice. In the current EA –practice at Nokian Tyres, this seems to lead into system-specific limited structuration between a web of developers, super-users as teachers and organizational memory, and a web of users. The only major difference comes from EDW –knowledge structuration, where EDW-knowledge seems to be structured between business developers, end-user developers, super-users, users, ICT coordinators, system developers and support service specialists. On the other hand, inside Nokian Tyres group Vianor –tyre chain presents a quite pragmatic documentation culture and the Russian operations a quite bureaucratic documentation culture, which could be combined for achieving more balanced, common and pragmatic structures and processes for knowledge sharing and language usage.

This flat knowledge structuration seems to have similar structure as rubber industry and knowledge. But at a systemic EA-level, this kind of super-user model is missing, which causes knowledge fragmentation into IS- and IT-specific domains. Yet another complexity in knowledge sharing comes from local languages. Most of the systems and business practices seem to be documented in the local language, which causes additional challenges into knowledge sharing between operational business units.

These findings indicate that the practical EA-driven knowledge management approach for managing business information and process definitions, together with information and integration architecture could improve knowledge sharing about the whole of business information and data structures. Daily ICT –support operations, maintenance and user access rights management could also benefit from practical EA-driven knowledge sharing, which should maintain process definitions and official mappings between user roles and responsibilities for different IS/IT- access rights.

The external knowledge-sharing perspective was challenging to analyze and report because this perspective was lacking a visualized framework. But when analyzing knowledge management processes and knowledge transfer for new technologies, needs and possibilities for social (re)structuration were found. These findings were quite initial, but opened potential avenues for further research in areas such as the sociomaterial nature of knowledge.

8.5 Wrapping-up the findings

When summing up EA findings from seven EA vignettes, we have collected the summary findings in Figure 61 for system positions towards EAM.

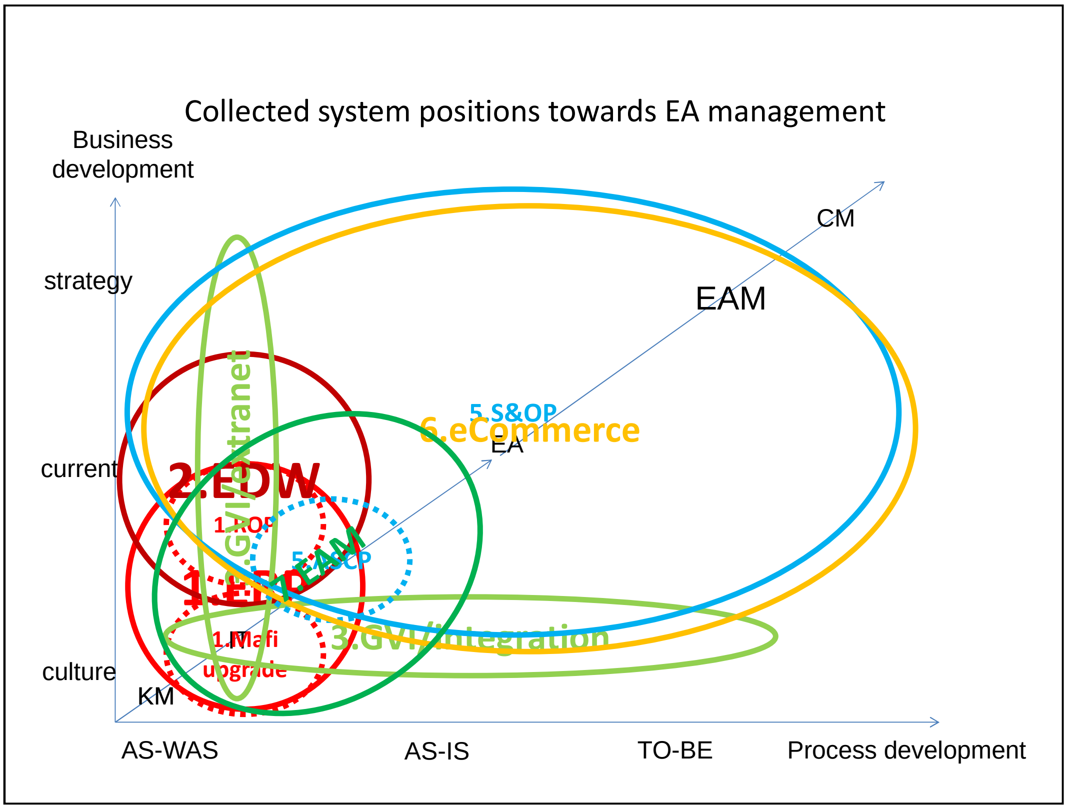

FIGURE 61 Collected system positions towards EA management.

This illustration in Figure 62 shows that S&OP and eCommerce vignettes include the EA management approach, which integrates business and process development into EA. One could argue that this is more like solution architecture management for S&OP and eCommerce domains because a holistic EA management approach is missing at the enterprise level. But with S&OP and eCommerce also being the latest and major development areas since 2007, one could argue that organizational systems development culture has been developing towards an EA management approach.

The WMS vignette shows a major transformation from IT management towards EA management and EA leadership. The first WMS development approach illustrated with a dotted line was too technically oriented to be successful, but since October 2006 the revised WMS development approach gained business resourcing from the executive level and process development resourcing from corporate logistics, warehousing operators and ICT. This indicates that the WMS development challenges could be seen as a major organizational transformation project from technical IT management towards an integrative EA management project. Resources, capabilities, procedures and integrative behavior, which were successful during the revised WMS development seems to continue development towards organizational capability for integrative EA management in S&OP and eCommerce development projects. Thus WMS development failures can be seen as a major transformative organizational learning experience, which transformed Nokian Tyres from business-IT dualism towards more integrated EA management practices and a holistic EA leadership approach.

ERP, EDW and GVI vignettes, creating an EA foundation, seem to be executed at the IT management level. Despite having some business and process development components, these vignettes indicate IT separation from business and process development. This could be explained in various ways. First, these development domains have been bought from external IT vendors and managed as technical IT systems without direct business development motivation. Second, the company's own organizational and technical capability for ERP, EDW and GVI development has been limited, which has caused dependency on external IT service vendors and their capability to understand the tyre business, processes and holistic EA development. Third, these vignettes have mainly occurred between years 1996-2005, when Nokian Tyres was, both operations-wise and psychologically, managed as "Factory at Nokia". One major location has enabled tight integration between HQ operations, R&D, manufacturing, sales and customer service. But decisions of Vianor integration as a service and pricing instrument for increasing tyre sales, using franchising operations for the growing Vianor tyre service chain without capital investments, and investing in Russian factory and tyre market penetration together caused systemic growth beyond the traditional IT management approach. Rapid growth and scaling from local operations to an international scale triggered simultaneous changes in business operations, processes, resources and systems. This increasing need for improving IT management practices from separate, local knowledge management and service operations for an international and integrated EA management approach was emergent in 2005. But since the complex WMS development project crises and growth of Russian operations in 2006, a more holistic approach for change management was needed.

Findings from our empirical EA study indicate that a practical EA management approach integrates business, process and IT development at Nokian Tyres without using any specific EA framework. EA leadership can be found, but more organizational structuration, capability and systematic EA framework and processes could improve EA management practices towards a learning organization. EA management faces some cultural challenges in knowledge management, which relate to the minimal documentation culture and documentation language practices. At the same time, EA technologies seem to need further development for managing various practical and social shareholder expectations for business and process development. Business calendar and strategy driven communication could especially improve setting priorities for EA management from business benefit and cost management perspectives. More formal EAM processes could improve socio-economic analysis and strategic decision making. These business and process development driven realities could improve EA management from an IT-related knowledge and documentation management theory into an integrated business, process and systems development practice for enterprise-wide change management at Nokian Tyres. Both EA leadership and EAM seems to be required as organizational structuration towards EA governance and benefits from continuous business and IT alignment operations in practice. This implies that combining IT capabilities into tactical business operations and organizational structuration between strategic business development and process-driven business execution could be the EA leadership recipe for balancing both long and short-term business and social goals. Now in 2014 country-level social challenges seem threaten strategy of Nokian Tyres and dependency on Russian markets (Yaffa 2014; Talouselämä 2014).

9 Discussion

IT management seems to engineer and split IT into several, manageable technical pieces. This “divide and conquer” approach generates an alignment challenge with every separately managed IT domain. Thus the alignment problem seems to be an increasing issue, especially in large organizations. If EA is adapted as an engineering practice, the issue of business IT alignment may even seem to be growing worse because business, organization and EA products seem first to generate even more separate topics for alignment. When taking strategy into the scope of EA, the misalignment between future intentions, current business practices and human behavior even seem to present an increasing challenge for business IT alignment. Thus an engineering and technical approach to EA even seems to generate more complex systems, when adding one system layer above all existing ones. Forrester (2013, 5) divides technology-driven EA –archetypes into technology-project and technology-strategy categories, which have foci in IT-infrastructure, application and technology roadmap management.

We have adapted social, integrative systems thinking approach to EA for transforming EA into management and leadership practices for managing growing organizational complexity and ever-increasing business IT alignment issues. First, this transcriptive approach to EA may seem to be a trick to capture the same business/technology dualism in a new package. But when accepting technology as an integrative means for combining strategic development and business transformations into effective operational processes beyond organizational borders, EA seems to start capturing instrumental features for managing modern enterprise. Forrester (2013, 5) divides business-oriented EA –archetypes into business-project and business-strategy categories, which have a focus on business solution architecture, business IT strategy, planning and alignment. When business operations, goals and strategy are accepted as drivers for EA management, EA may be seen as a strategy for integrating business process development into improvements in data, applications and technology management (Ross et al. 2006). This approach seems to combine organizational impacts and business process benefits into EA driven benefits of data management, application development and IT infrastructure (Espinosa, Boh & DeLone 2011). Cao (2010, 279) argues that when IT and organizational factors (process, structure, culture, power and politics) reinforce each other, superior IT business value can be expected. We think that EA leadership could be an organizational practice for reinforcing IT and organizational factors towards superior IT business value. But EA leadership requires systemic thinking and systematic HR management practices and HR architecture (Colbert 2004) to enable strategy-driven EA resource development between business, IT and process management domains. Thus EA management and development seems to require organizational learning and behavioral changes at various organizational levels (Stettiner & Messerschmidt 2012, 57).

EA products, EAM processes and holistic EAM thinking seems to involve social innovations which can easily fall into a technology pitfall and, thus, fail in producing business benefits and organizational impacts. There is still no empirical evidence showing whether the organizational benefits of EA outweigh the coordination and management costs associated with the architecting process (Espinosa et al. 2011). We maintain that social theories could improve EA theory and practices in reinforcing IT and organizational factors towards superior IT business value. Therefore, we will next shortly reflect our empirical EA findings from Nokian Tyres back to social theories.

9.1 Actor-network theory (ANT)

Actor-network theory (ANT) seems to offer neutral practice for including technical components and systems into a requirements negotiation process (e.g. Sidorova & Kappelman 2010, Walsham 1997). But when starting to adapt systems thinking (like Brynteson 2006; Gharajedaghi 1999) and ANT for creating a wider understanding about social and technical systems included in practical EA negotiation and creation process, ANT emerges as an extremely problematic theory. Following Sidorova and Kappelman (2010, 83), we will see EA as political and strategic practice causing challenges with regard to actor identification, integration, transparency, and alignment.

9.1.1 Actor identification challenge

Actor identification challenges seem to relate to ontological questions of EA, which highly parallels with integration challenges of inter-related domains within EA. The logic of ANT is about modelling dialogue and negotiations of social and technical, human and non-human actors, and it fit well to an architectural negotiation process (Sidorova & Kappelman 2010, 74). Thus ANT seems to fit well as an EAM philosophy for modelling an EAM negotiation process between AS-IS and TO-BE transitions of business, process and IT/IS entities of value chain and business network. But, for our study about

EA in practice, ANT seems to be too flexible and theoretical for contributing actual EA structuration findings at Nokian Tyres. More specifically, we have faced these actor identification issues with our IT–framework, including dualistic business-technology actor-view and ISO/OSI-oriented actor identification of different EA-layers. We assume that a service-oriented IS delivery model will increase this actor identification challenge.

Socio-technical design and traditional IT management cultures have created the illusion of designing technical layers and IT as separate organizational practice without major business involvement. In an EA context, this attitude seems still to prevail if Zachman's EA framework is applied without creating internal integration between business and technology actors. This dualistic ontology may be seen to be replicated by accepting business architecture and technology architectures as separate actors inside the EA universe (Ballengee 2010b, 149; Ulrich & McWhorter 2011, 55) without any major integration mechanisms, merely praying for alignment. Highly technical IT engineering may create technically complex platforms and perfect systems including a high number of technical actors, which may not be agile and flexible for reflecting social changes and behavioral transitions required by changes in business strategy and competition. With this approach, business and IT seems to define their own development agendas and identify their own actor-networks, causing alignment challenges and issues with benefit realization. Our EA vignettes seems to follow this business-IT dualistic actor identification approach until the first WMS development failure, which triggered a rapid organizational learning curve towards integrated business operations and shared business IT benefits. This IT-driven WMS and EA development failure may be seen as strong evidence of EA-in-practice as a social phenomenon to ensure realistic strategic decision-making, setting a clear and focused project scope and monitoring of a firm's development (Alhleman & El Arbi 2012, 39). However, because of the lack in organizational structures for systematic EA management and leadership practices, this organizational learning from initial WMS failure required the high price of executive focus and various costs of losing sales and fixing claims of delivery errors and delays.

Empirical actor definition challenges are highly related to organizational culture and practices for business development. At Nokian Tyres, the organizational tendency towards technology-driven business development may also be seen in vignettes following WMS crises. Both S&OP and eCommerce vignettes include implications of actor definition challenges: in both cases, technology may be seen as setting phases and delays for business development. But business processes seem simultaneously to evolve without explicit key business requirements for technology development. This kind of co-development may be argued to be slow and confusing AS-IS operations, but enable organizational learning and change management as shared EA management and leadership practice. Nolan (2012, 91) has found similar implications regarding ubiquitous IT being everywhere, but IT strategic leadership remained fragmented and nowhere. We argue that EA leadership findings from EA-in-practice indicate that EA leadership could generate organizational practices for managing EA and ubiquitous IT as strategic assets between business and process development.

While ANT is for creating a wider understanding about social and technical systems included in practical EA negotiation and creation process, ANT emerges as an extremely problematic theory. A major actor identification challenge relates systems thinking (Brynteson 2006), a holistic understanding of interaction between IT and organizational factors (Cao 2010, 279) and complexity of an organization as a system of resource-based living (Colbert 2004, 341). When each technology can be seen as a primitive materialization of a development system, the immaterial components and effects of a technology system are sociomaterial composites and continuously changing instantiations (Simons et al. 2010, 131). But when trying to define a living enterprise as a holistic system, which is then divided into subsystems including humans and their continuously changing understanding and intensions (ibid., 137), the version management challenge of interrelated social subsystems is growing beyond our resources. At the same time, when social systems are creating actor identification challenges of composite EA subsystems, technology layers and social subsystems are creating another actor identification challenge. Each discrete technology has its own development system, which is transferred and translated into the organizational context by some delivery system. During the technology transfer and diffusion in an organizational context, the delivery system creates several sociomaterial transcriptions and, using these negotiation processes, the organizational knowledge and capability is created into an implementation instance. Thus complex composite systems create an instantiation, which is continuously affected by changing social and service subsystems. This may increase or decrease organizational effects of a composite sociomaterial system. In ANT thinking, one socio-technical system may be transcripted into one actor, which may be seen as the EA management benefit for improving the organizational management capability of complex sociomaterial systems. But the challenge of actor identification in ANT modelling gives us some intellectual tools to understand a complex EA negotiation process and an organizational instantiation process from primitive models into complex systemic instantiations.

To conclude, ANT offers strong theoretical authorization for including technical actors into EA negotiations, which supports IT-related knowledge and change management. Therefore, ANT should be included in professional education of EA and EAM studies. In EA-in-practice, ANT offers theoretical and intellectual tools for defining EA scope and systemic inscriptions and translations for complex systems modeling and abstractions.

9.1.2 Integration challenge

The ANT related integration challenge is highly interwoven with actor identification challenges and the systemic nature of EA. Ahlemann and El Arbi (2012, 39) argue that EAM requires executives to rethink the (architectural) consequences and decisions to create shared visions towards integrated enterprise and EAM culture of joint decision-making. Sidorova and Kappelman (2010, 83) argue that EA integration requires comprehensive typology of all inscriptions, which should present stakeholder interests related to complete enterprise ontology. This kind of hierarchical EA ontology could integrate business strategy and policy structures into organizational data and knowledge management domains, the requirement of which triggers management and execution challenge for EA communication and business terminology differences between various business and technology actors.

Thus ANT seems to include the difficult task for integrating highly fragmented entities from various social, organizational and technical domains. In simplified theory, this kind of requirement *to create complete and comprehensive enterprise ontology* (Sidorova & Kappelman 2010, 84) may be realistic. But from our empirical EA study context, the issues with organizational documentation culture and the lack of EA maturity create major challenges for modelling integrations and networks between actors within the EA domain. ANT as loose theory itself includes an integration challenge between actors, which in the EA context consists mainly of immaterial composites and complex instantiations of sociomaterial actors and subsystems. Therefore, integrations between sociomaterial and technical primitives into complex enterprise-wide living systems and holistic composite instantiations are difficult to model and manage with ANT concepts. But ANT terminology gives us a strong mental tool called transcription, which enables our thinking and intellectual processes to integrate business, IT and process development related domains into an organizational EA context. In this sense, ANT offers us mental ladders to abstract complex sociomaterial systems formed into holistic systemic wholes, which we have documented in this EA study as EA related frameworks as instruments to analyze our seven EA vignettes as instantiations of an EA development process at Nokian Tyres. The strength of ANT thinking seems to be in the EA context related to a high-level of generality and abstraction, which helped us to generate EA–framework as mental ladders to transcript IT–framework primitives into a sociomaterial framework for EA management and analysis purposes.

9.1.3 Transparency challenge

Ahlemann et al. (2012a, 21) define EAM as a culture of an open approach to reach consensus among managers on the basis of their shared vision of establishing a global optimum for the firm, free of local and personal egoism and opportunism. Certain parts of Hakkapeliitta Spirit as a company culture (Nokian Tyres 2004, 5) may be seen as conflicting at a micro level, but at a macro level these cultures could be seen to be combining and balancing each other towards business growth and profitability.

The generic integration challenges of ANT and empirical challenges with organizational documentation culture together seems to emphasize an ANT related transparency challenge. In theory, *complete and comprehensive enterprise ontology* (Sidorova & Kappelman 2010, 84) could improve transparency of power and politics for various shareholder requirements and organizational EA structures. But, at least in our EA-in-practice, organizational culture and immature EA management structures do not support ANT as theory or EA as management practice towards higher organizational transparency.

In our EA study, the empirical and ethical challenges relate mainly to transparency challenges with the ANT model. We agree with Cao (2010, 279) that superior IT business value can be expected when investigating and understanding the relationship between IT and organizational factors as process, structure, culture, power and politics in the same transparent systemic model. We have tried to implement this transparency and integration of organizational values into our EAM–framework. But due to our long period of fieldwork and the insider access to socially fragile values, we are facing moral and ethical conflicts in reporting our EAM-findings fully in this thesis. These moral conflicts are generic to ethnography as a method for studying cultural behavior and observing sensitive social values (Emerson et al. 2011, 1). Thus when applying ethnography as a method to study EA-in-practice (like Shoib et al. 2006) and practice-based knowledge creation practices (like Carlile 2002), ethnography showed its strength to observe social and situated practices and simultaneously to participate in them (Corradi et al. 2008, 23). While acting as an ethnographer to seek deeper immersion in others' world in order to grasp what they experience as meaningful and important (Emerson et al. 2011, 3), we were getting insightful information (Fetterman 2010, 9) about organizational process, structure, culture, power and politics beyond this report. Therefore, we think that our EAM–framework offers the potential for creating transparency for ANT modelling in an EA context. Our EAM–framework offers an ethical visibility dimension above sociomaterial ontology between EA technologies, documentation and shareholders. But as a result of our own moral and ethical dilemma as organizational insiders in our case enterprise, we have broken the academic rigor of reporting the ethnographic fieldwork (Emerson et al. 2011, Fetterman 2010) with rich quotes from our insightful EA discussions during our fieldwork period. Some attempts to use voice recording produces too much organizationally sensitive insider material, which could have enabled ANT transparency beyond our research goals. Therefore, field notes were captured with pen and paper using the ethnographer as sensitive filter to process EA-related observations, which were transcripted to abstract results by using our IT and EA frameworks as lenses to keep privacy and rich insider data beyond this EA study report.

These observations indicate possibilities of EA to improve transparency of power and politics for various shareholder requirements and organizational EA structures (Sidorova & Kappelman 2010, 84). Our EAM–framework could have practical relevance while creating transparency in organizational settings. Our attempt at ethnographic research and theoretical ANT applications may lack some rigor from an academic perspective, but in our practice-driven EA fieldwork, both ethnography and ANT as loose social theory, have offered us mental tools for modelling and understanding EA related organizational complexity.

9.1.4 Alignment challenge

The alignment challenge seems to be embedded and evident for ANT modelling. This issue seems to be included in human behavior and changes in mental moods and feelings. The idealistic nature of alignment is expressed by Kappelman (2010a, 3) while discussing about true alignment. When Kappelman (ibid.) states that *a true alignment begins with the alignment of concepts and ideas of people: from thought to action and physical resources, activities and technologies*, they implicitly express that true alignment does not exist. The material world, social behavior and human intentions seem to be infrequently but continuously out-of-sync and therefore somewhat misaligned even at the individual level. Therefore, it is not surprising that within bigger social groups and large enterprises, social behavior and strategic changes generate continuous events and sources for business IT misalignment. With the concept and idea of EA, we are making this *true alignment from concepts to technologies* even more impossible because it seems that there is no common understanding about EA as resources, activities and technologies.

Our empirical EA vignettes include alignment challenges for applying ANT as social theory for EA theory development. The WMS vignette can be seen as major evidence for the EA alignment creation effort: the first WMS development attempt included business, IT and process level sources for misalignments, which were tackled during the second attempt with a major executive task-force. Thus the WMS crisis improved business, IT and EA alignment, communication and coordination of business, IT and process development, but required strong CEO and CIO contributions for creating shared EA leadership and commitment to collaborate with technology and service vendors over organizational borders. After the WMS project, the following EA development projects were contributing and performing at higher EAM and EA leadership levels supporting business strategy and improving cross-functional business processes.

Integration and transparency challenges of ANT as social theory for EA management and leadership structuration do not eliminate organizational EA challenges. But if EA leadership can be created as an organizational capability in change management practice for integrating business, IT and process development, this management structure should decrease challenges of separate development organizations. But this approach does not eliminate ANT related alignment challenges.

9.2 Activity Theory

Activity theory seems to value organizational culture and social history regarding community rules and division of labor (e.g. Engeström 1987). In EA management and leadership, the actors use EAM processes and products as tools for changing human behavior, business, organization and processes from AS-IS status towards TO-BE status. Mental models and behavior from AS-WAS status resist this change. Ahlemann et al. (2012b, 233) states that an EAM introduction changes the organization's power structures, which cause passive or open change resistance against EAM rules and guidelines. This potential conflict and cultural change resistance requires high moral and professional discipline, which indicates that activity theory could be a potential source for social negotiation and a neutral boundary object for managing organizational EAM changes.

If and when following Cao's (2010, 279) argument that superior IT business value requires understanding of the relationship between IT and organizational factors, such as process, structure, culture, power and politics, existing organizational cultures, rules and division of labor require transformations when shifting from IT management towards EA management and EAM leadership. When understanding EA leadership as a mental model towards *development for all individuals, groups, organizations and societies, and that many different global* futures (Walsham 2005b), activity theory could be used as a tool for modelling and understanding the wider organizational EA frame of reference. Thus, we will next reflect on our EA study, empirical findings and frameworks back to activity theory and how EA related organizational transformations could benefit from activity theory applications at the individual, group, organization and even society levels (Korpela et al. 2001; Walsham 2000, 2005b).

9.2.1 Individual level reflection with IT–framework

Professional development from an IT architect towards an Enterprise Architect requires the personal motivation to shift thinking from a technology specialist to systems thinking. In IT practice, this could be seen as a shift from changing technology according to human needs and opinions, which may sometimes be spoken as business requirements. In practice, technology is setting constraints for human intentions and ideas. But in practice money and human resources are setting more powerful constraints than technology.

In small and medium-size organizations, individual employees may present key business requirements. An entrepreneur using her own time and investing money is, without knowing it, acting as a superior Enterprise Architect, shaping her firm, its' strategy, structures, IS and technical infrastructure to support her personal goals, motivations and capabilities. But when hiring new employees and buying business services, an entrepreneur is using money to acquire and modify organizational processes and structures, culture, power and politics to aim towards her motivational, mental goals and objects. Thus human resources, time and money could be seen the major integration instruments and mediating tools which directly or indirectly are shaping and reflected to both the internal and external activity system of an enterprise. Thus micro- and macro-level EA operations can be seen as complex living systems of actors as subjects, activity, action and operations, shaping the objective world and immaterial sociomateriality as objects. In EA, context activity theory could be used for conceptualizing and understanding human behavior, unconscious actions and cultural action structures, triggered by organizational conditions in a dynamic relationship with human motives and needs (Bertelsen & Bødker 2003, 301). Ries (2011, 226) argues that growth from a lean startup towards a larger adaptive organization should invest in a training program for new employees to automatically adjust its process and performance to changing conditions. This approach invests in social structures and processes for validated learning as an embedded part of social architecture of adaptive enterprise.

In a larger organization, the EA work system is becoming more complex by default. In our case enterprise, our IT- framework could be a practical instrument for an individual EA actor to conceptualize changes and simultaneous activity structures at various IT layers between business and technology actors. Thus our applications of the IT-framework could improve understanding and management of complexity of systemic changes within the activity systems. Systemic EA conceptualization of system lifecycles and technology introductions may enable more conscious actions for balancing social and technical actions towards human goals and organizational benefits. But when changing organizational division of labor and rules towards EA management, group level agreements are needed for achieving improvement in business IT performance.

9.2.2 Group level reflection with EA–framework

Engeström's (1987) integrated activity system model as intertwining subject, object, instrument, rules, community and division of labor is useful for understanding the fragile nature of EA management. When existing AS-IS structures of current enterprises are created with traditional division of labor between business, financials, HR and IT subjects, then the integrative EA management approach is changing the whole activity system, which becomes unstable and must develop to obtain renewed stability (Bertelsen & Bødker 2003, 302). The cultural historical activity model CHAT (Cole 1996; Daniels & Edwards 2010) theory may be used to support knowledge and change management for producing and sharing EA products and processes as boundary objects and instruments between business, IT and process development. Thus activity theory should have potential for improving communication and coordination of knowledge and change management between IS/IT groups operating at various system layers and domains.

Ideally, EA management aims to use EA products as tools for steering social activity towards organizational states and behavior, which is expected to produce immediate business benefits and to be more efficient and effective for future business possibilities. But, in practice, EAM requires many stakeholders to change their behavior, which may threaten individual interests, generate fear of transparency to past management mistakes and jeopardize individual habits (Ahlemann & El Arbi 2012, 49). Thus EAM is trying to change individual behavior, organizational culture and whole social activity systems. Hobbs (2012, 86) is sensitive to organizational differences, cultures, decision styles, objectives and EA maturity, which should be carefully considered while implementing 'just enough' EA governance and balancing (ibid., 87)

- The level of controlling development activities.
- Centralizing vs. decentralizing EAM structures.
- Common good vs. project needs.
- Reactive vs. proactive decisions.
- Strategic vs. tactical views.

Based on our empirical EA fieldwork at Nokian Tyres, activity theory is very useful for explaining organizational dynamics of EA work in practices at the group level. Particularly in our WMS vignette, which included several systemic changes in activity systems of warehousing the subject, object, instrument, rules, community and division of labor, CHAT theory indicates the potential for understanding the challenge of collaborative EA management challenge. The ubiquity of IT is increasing system complexity and the need for understanding social and organizational perspectives of EA. Collaborative EA development requires group level concepts for informed decision-making regarding risks, benefits and resource sharing. The same mindset is applied to conceptualize the EA management potential at the business network level. At a group level, both business developers and technology management can share the EA potential for improving tools for communication and systems development (Kappelman 2010b, 120).

9.2.3 Organization level reflection with EAM–framework

The activity system at Nokian Tyres is legitimated with the corporate culture and values of Hakkapeliitta Spirit: entrepreneurship, inventiveness and team spirit (Nokian Tyres 2004, 5). Because business has been profitable and growing well with optimized management structures, EAM has been more like a 'just enough' common sense, combined with strategy-driven product and business development operations. The "Trust the Natives" culture (Nokian Renkaat 2007, 16) with a strong R&D and sales approach has produced continuous growth and profit. Thus, both in terms of human resources and money, the whole EA activity system has been producing good business IT performance.

At this scale of operations, the ICT-development steering and EA governance have been an embedded part of the practices of project steering groups, the ICT development board, the investment board and the corporate strategy process. But while business and operations are growing more profitable, EAM could be embedded into a strategy process for supporting planning (Radeke & Legner 2012, 113) and managment costs and complexity of the growing EA (Makiya 2012, 140) and IT infrastructure. For increasing integration of business networks and improving business IT benefits, activity theory and especially CHAT seems to offer a culturally sensitive theory for understanding social balance and social systems for managing knowledge and changes in wide and multi-cultural business networks. This implies the EAM potential for increasing visibility and change management for organizational changes regarding division of labor between systems, corporate operations, country organizations, subsidiaries and sub-contractors at the enterprise level.

9.2.4 Society level reflection with EAM–framework

Our EA fieldwork and observations included some remarks about national differences and strategic decisions about various society-level activity systems. Global and national differences within the automotive and tyre industry caused some implications and differences in society-level composites of the subject, object, instrument, rules, community and division of labor. These findings have similarities with Chattopadhyay (2011) regarding national and cultural differences in manufacturing organizations. Thus when understanding primitive EA products and components in the IT, business and process level, the EA management work for various society level variances may limit the risks and improve the control for system level knowledge and change management. But in this kind of multi-cultural EA work between several nationalities and social systems, the EA work may become explicit as a language problem (Simons et al. 2010, 132). A common language may be the most important instrument for managing change and the challenge of knowledge management in EA work. For practical EA work in a private sector organization, the activity theory is a mostly invisible model to understand labor organization’s role and rules for (re)negotiating division of labor. But in the public sector and national organizations, CHAT might be a more important social theory for understanding EA challenges and socially responsible development work. Ethical differences and conflicting values and roles at the level of society goals, rules and division of labor may especially offer academic and practical potential for an ethical dimension within our EAM- framework.

9.3 Structuration theory reflections for organizing EAM work

Giddens’ Structuration Theory (ST) is a general theory of social organization concerning the relationship between individuals and society. Rejecting the traditional dualistic views that see social phenomena as determined either by objective social structures, which are properties of society as a whole, or by autonomous human agents, Giddens proposes that structure and agency are a mutually constitutive duality. Thus social phenomena are not the product of either structure or agency, but of both. Social structure is not independent of agency, nor is agency independent of structure. Rather, human agents draw on social structures in their actions, and at the same time these actions serve to reproduce social structure (Giddens 1984; Jones 1999a, 1999b; Jones & Nandhakumar 1993; Jones et al. 2004; Jones & Karsten 2008; Barad 2007).

9.3.1 EAM as control mechanism

Structuration Theory seems to offer versatile structures and layers for explaining EAM as a holistic management philosophy for managing change. If we understand EAM as a management philosophy for managing change (Stettiner & Messerschmidt 2012, 73), integration and alignment (p. 60), EAM can be used as a strategic initiative for improving business control of IT (p. 67). EA ideology and EA management practices seem to include the idea of getting control of enterprise as a complex living system. Thus EA may be seen as an ideological continuum of Taylor’s “scientific management” and Juran’s “statistical quality control (Kappelman 2010c, 35; Salmans 2010, 89; Simons et al. 2010, 143). Stettiner and Messerschmidt (2012, 65) recognize EA as a philosophy, as a framework or as a process to enhance organization’s ability to sense, analyze and respond effectively to change. They state that EAM comprises a management philosophy that approaches enterprise-related changes in a holistic, unambiguous and consistent way, with the goal of aligning all of an organization’s assets and capabilities with its strategy (Stettiner & Messerschmidt 2012, 60). Their thinking seems to be well-aligned with EA maturity models (CMMI Software Engineering Institute 2010a; Ross 2003; EAMMF GAO 2003; Salmans 2010). EAMMF (GAO 2003) defines EA as *a corporate tool for managing both business and technological change and transformation*. When transferring this philosophical EAM maturity thinking into the agile business development setting of Nokian Tyres, flat organizational structures and lean operations require embedded and integrative EAM structuration. This means that EA leadership is an embedded part of the business executives' CxO roles, and EA management is an embedded part of organizational, business and ICT management structures. But instead of making a clear distinction between machine-age thinking of organizations as machines and organizations as living systems (Senge 2006, 267), our EA management makes systematic processes and management platform for successful EA leadership as social structuration and hierarchy for managing actor-network, knowledge and change. WMS and S&OP vignettes especially imply the EAM potential as a control mechanism for internal and business network-level process development. But this potential may be conflict culturally with the lean thinking of the automotive industry and the process automation trend in the rubber industry.

9.3.2 EAM as Giddens' modality layer and facility mechanism

Using Giddens' matrix (1984, 29) from structuration theory, we may find similarities between our EA study structure of seeing EAM development between business and process development. Our horizontal process development axis may be seen as a structure line (signification, domination, and legitimation) in Giddens' model, and our vertical business axis may be seen as an organizational interaction line (communication, power, sanction). Our EAM maturity axis may be seen as a modality layer (interpretive schemes, facility, and norm) between structure and interaction. This comparison generates analogies between EA as "interpretive schemes", EAM as "facility" and EA leadership as "norm". Accordingly TO-BE –processes, process development inherits the structural role of "legitimation", and strategy and business development inherits the interactional role of "sanction". This mapping matches quite well onto the organizational structuration at Nokian Tyres where business interaction operated at the highest level of power and sanction, the modality layer of IT/EA was a quite lean and well-optimized layer for facilitating business, and the structural layer were quite flat but embedded in labor union structuration. EDW, GVI and EAM vignettes indicate the EAM potential as a modality layer and facility mechanism for enterprise-level visibility and communication.

9.3.3 EAM as integration mechanism

Using Giddens' matrix (1984, 29) from structuration theory, we may find similarities as Giddens' structuration theory seems to offer conceptualization that could increase social structuration for EA towards EA management as an integration mechanism between business, process, IT and EA development. Applying Leonardi's (2011) approach for combining structuration theory and human agency to understand how flexible routines and technologies as material agency are intertwining into layered imbrications, we found, both in theories and our fieldwork, the implications and needs for EA leadership as a key for EA success and improving business IT performance. For this study, the Giddens structuration theory offered conceptual lenses to capture a holistic view of driving and steering business-driven changes and transformation to execution through business networks and collaborative enterprise structures. ERP and eCommerce vignettes especially indicate the EAM potential as enterprise-wide integration mechanism. In practice, ERP may be to an applicable integration mechanism inside an enterprise, but GVI and eCommerce systems include more flexibility towards external business integration and collaborative structuration mechanisms.

9.3.4 EAM as ethical mechanism

Giddens' Structuration theory almost completely neglects technology (Jones & Karsten 2008, 134). But in his later work about the consequences of modernity, Giddens (1990, 170) discusses accelerating processes of technological innovation and industrial development. While reviewing the ecological risks of technological innovations, Giddens (ibid.) names biotechnology and the humanizing of technology as potential sources of increasing moral issues, which may emerge when an instrumental relation between human beings and the created environment is changing.

This observation can be reflected back to Wajcman's (2008, 813) quote from Haraway's image of the cyborg and biotechnologies potential to transform the relations between the self, the body, and machines. Transition from instrumental technology use towards humanizing of technology seems to be continuing and causing moral challenges at various levels. IT as a part of so-called NBIC (nano, bio, information and cogno-technologies) convergence (Roco & Bainbridge 2003) is enabling human enhancements and new moral issues (Khushf 2004, 125). The globalizing tendencies simultaneously connect individuals to large-scale systems as part of complex dialectics of change at both the local and global poles (Giddens 1990, 177).

These new technologies are increasing the amount of information and new business opportunities for information and IT service enterprises. New analytical systems and solutions are needed for managing data, risks, decisions and opportunities, which are related innovations for NBIC convergence and humanizing of technologies. The ethical dimension of our EAM-framework could increase visibility, communication and change management support for moral issues related to human enhancing technologies. S&OP and EAM vignettes especially indicate the EAM potential as an enterprise-wide ethical mechanism.

9.4 Sociomateriality

Our approach to EA as a sociomaterial structure implies the organizational need for holistic EA management structuration. Sociomateriality seems to fit well into EA analysis and discussion because the material part always exists to create, enable and manage EA development and management processes. EA leadership elements seem to be located at the immaterial part of EA, which is quite fluid and complex to capture. We will shortly elaborate the sociomaterial nature of the EAM domain from material, immaterial and entanglement perspectives.

9.4.1 Materiality of being

Making an agential cut into the material and immaterial part of EAM is difficult and never an innocent operation (Barad 2007, 178). Because the EA roots have been growing from an IT platform, the most typical EAM constellations like TOGAF are concepts producing IT oriented EA products. IT based layering of materiality is visible from our IT framework, which is one possible apparatus to execute technology-driven agential cuts through a contemporary enterprise. This techno-centric perspective to organizational materiality (Orlikowski 2007, 1436) is a quite strange logic of mattering. IT is now everywhere, and it is critically essential for current operations, communication and future strategies of modern enterprises (Nolan 2012). If this is the fact, instead of IT, we could as well be studying white pigment, energy or carbon atoms as part of enterprise structures and social organizations. One may argue that different business models or legal entities and organization structures could be a more practical way to segregate, organize and manage organization specific EA than technologies and systems. But because we are interested in improving IT productivity and EAM practices towards EA leadership, we have studied materiality as an embedded part of our IT framework to understand contemporary forms of organizing that are increasingly constituted by multiple, emergent, shifting, and interdependent technologies (Orlikowski 2007, 1435).

Reflecting our IT framework and its seven layers with a critical ontological lens can question the existence of material substance, materiality and borders of the layers between matters. All layers from technology through IT infrastructure, IT, IS, EIS and EA to business are inter-twining and interacting in various ways. Dynamics of technology-driven changes are iterative inter- and intra-actions between matters, where matter plays the role of agent in its iterative materialization (Barad 2007, 177). Thus each layer itself and various combinations between layers from technology to business includes matter and materiality, which are dynamically potential for reconfiguring in space, time and matter in a recursive and iteratively manner.

ERP, WMS and S&OP vignettes especially indicate how material components of EA can be reconfigured and shifted from material technology layers to social practices and routines for managing enterprise-wide changes. But, in our case enterprise context, the cultural challenges of minimal documentation causes issues for knowledge management, which might be eliminated by improving material documentation and EAM processes.

Our IT -systems driven vignettes may be a reason for quite the limited contribution regarding sociomaterial understanding. In the future, IS and business development research could benefit from deeper sociomaterial analyzes of functionality-, tool-, role-, procedure-, and social process-orientation of the change in practices, the sources of control (hierarchical versus emergent), and innovation activity (De Vaujany et al. 2013) at various social levels of an enterprise.

9.4.2 Immateriality of knowing and entanglement of reconfigurations

Digitalization has been and will be transforming materiality in various ways, causing continuous systemic changes in social interaction, organizing and enterprises as open systems. Materiality and the knowledge about an enterprise are in continuous change. Iterative intra-actions are the dynamics through which temporality and spatiality are produced and iteratively reconfigured in the materialization of phenomena and the (re)making of material-discursive boundaries and their constitutive exclusions (Barad 2007, 179). The immateriality of knowing about enterprise still increases when digitalization proceeds and so-called big data enables storing, processing and sharing huge amounts of data from digital business networks. Analytical data processing and knowledge management requirements are becoming more important for EA to model and to capture *“all the knowledge about the enterprise”* (Burgess et al. 2010, 252). All these immaterial structures are enabled by material and technical platforms which will enable and help to execute and materialize strategies and business development, creating new immaterial entanglements and EA reconfigurations.

Sociomaterial inter- and intra-actions in a substantial EA domain has somewhat similar but nevertheless different dynamics than IT and technology layers. In our EA framework technologies, IT and information related materiality creates platforms and enables social structuration and interactions at various levels of human societies. At social, organizational, cultural and national levels, materiality are more traditionally enabled and constrained by physical and geographical differences liken national infrastructures and resources. These sociomaterial elements are an integrated part of cultural and social environment for enterprises, thus having effects on industrial and cultural position and organizing models for contemporary organizations. Globalization processes seem to decrease national differences (Friedman 2005), but getting things done together and reaching the goals of various forms of social communities in digital worlds is highly dependent on social structuration (Giddens 1984).

These sociomaterial dynamics of materiality between business and technology is impossible to capture in all its details and space-time reconfigurations. But, at the same time, sociomateriality offers a versatile conceptualization and our IT and EA framework offers simplified instruments to discuss and understand on-going changes in the EA domain and in organizing EAM work. In particular, EDW, GVI and eCommerce vignettes include major immaterial challenges for knowledge management, which relates to the wide business network coverage from consumer behavior to rubber sourcing. Therefore, these vignettes combine informational, communicational and analytical challenges at all different sociomaterial layers as presented in Table 6 (Boell & Cecez-Kecmanovic 2010, 4). Our IT –framework might be useful to tackle these immateriality and reconfiguration related issues if each layer between business and technology can be integrated and systematically managed from knowledge and change management perspectives.

9.4.3 Ethics of mattering in EA leadership

But when we look at EA from EAM and EA leadership perspectives, the social nature and component of EA as products, function, service and culture (Lange et al. 2012, 4231) are much more important and critical for EA benefits than material and technical components. On the other hand, EA as architectural, managerial and strategic process (Sidorova & Kappelman 2012) is all about power and politics of negotiating architectural cuts between social and material structures. Both EA leadership and EA management are about executing agential cuts, (Haraway 1997, 27; Suchman 2007, 285) power and politics of including and excluding social requirements, actors, materials and technologies while reconfiguring sociomaterial structures for an enterprise. Thus requirement decisions for development projects and technology selections are agential cuts with power and money giving funding to some actors and for some values, which should generate organizational, material and financial benefits to investing organization.

While contemporary forms of organizing are increasingly constituted by multiple, emergent, shifting, and interdependent technologies (Orlikowski 2007, 1435), business values, strategy and social responsibilities should be guiding principles for business and EA development. In this development, EA leadership could increase visibility, communication and coordination improving IT productivity with integrated business, process and EAM development. The WMS vignette in particular forced our case enterprise to invent and improvise EA leadership behavior for survival. The EAM vignette includes a potential for making this EA leadership behavior as part of EAM processes and systemic organizational capability toward well-informed and wise EA development decisions (Tichy & Bennis 2007). The WMS vignette included reactive EAM capability, while the

EAM vignette included a potential for proactive EAM elements (Abraham, Aier & Winter 2012) towards organizational capability combining alignment and adaptability (Birkinshaw & Gibson 2004). For a reflective practitioner and a democratic leadership style, the ethical dimension of the EAM-framework seems to offer neutral ground to increase visibility and discussion about possible scenarios and decisions, which have long-term strategic effects to the sociomaterial systemic whole called an enterprise. Lean systems thinking, supply-chain agility and increasing process automation are transforming automotive and tyre industries into supply networks, which require continuous operational changes and efficiency. These systemic changes might benefit from EA capabilities for change management, coordination and EA leadership at an enterprise-level. EAM processes and negotiation processes might improve visibility of organizational planning processes and ethical considerations of possible scenarios of division of labor.

10 Contributions, limitations and possible EA futures

In this chapter, we will also discuss our study contributions, limitations, and possible avenues for future EA –research topics. To succinctly recapture our aims, our EA study started with two research questions:

- "How could EA-in-theory be reframed towards socially structured EAM practices?"
- "What sociomaterial elements should be included into EAM practices when shifting from IT management towards EA leadership?"

First, we will start with our theoretical and practical contributions. Then we will present some limitations to this work. At the end of this chapter, we sketch out possible EA-scenarios and a timeline for estimating future vision for EAM development.

10.1 Contributions to EA theory

We have explored EA development history as complex social-technical phenomena starting from the IT roots through architectures and business IT alignment towards EAM. From EAM, we continued using social theories as ladders towards EA leadership.

While studying these four social theories, ANT, Activity Theory, Structuration Theory and sociomateriality, we created three EA related study frameworks. Our EA frameworks were tested while analyzing field notes from our case enterprise setting and EA development vignettes with the following remarks:

- ANT seems to vanish into the philosophical thinking of EAM, but offers an important cultural shift for balancing and transcripting social and technical actors as equal components for modern EA and business network modeling.
- Activity Theory generates activity system triangles for modeling and developing EA understanding as an modern multi-faceted instrument for improving busi-

ness IT performance and activity systems towards various business benefits at the individual, group, organizational and society levels.

- Structuration Theory creates organizational structures and hierarchy for organizing EAM development and EAM culture for EA products, process for EAM and strategic role for EA leadership.
- Sociomateriality improves our vocabulary for understanding and developing immaterial enterprise-level capability towards goal-oriented management of human/machine reconfigurations. But the generic language-related challenges of sociomaterialism (Kautz & Jensen 2013) remain intellectual obstacles to producing any structured contribution to this domain.

This way of thinking about EAM structuration using Giddens' (1984) concepts from the Structuration Model and applying the activity system triangle from Activity Theory (e.g. Engeström 1987) enables us to compile the following illustration presenting the EA activity system shift towards reconfiguring activity system for EA leadership.

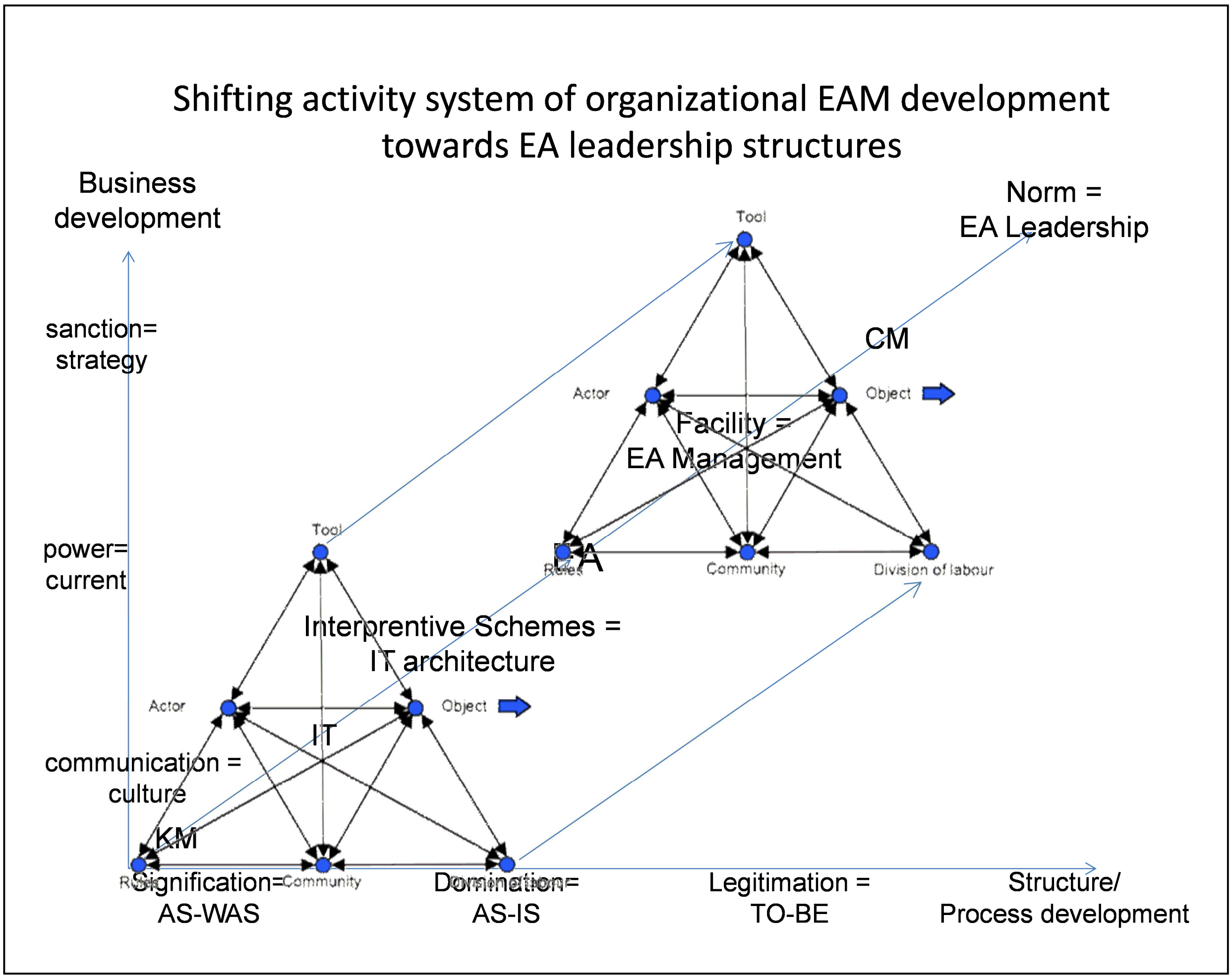

FIGURE 62 Shifting activity system towards EA leadership.

We have simplified this Figure 62 by eliminating ANT –driven actor-networks between actors of different EA structuration levels and activity systems from this illustration. This illustration is quite complex, but seems to have several analogies with maturity models which seem to require cultural transition through all the stages from IT architectures through EA development towards EA leadership. The major purpose of this Figure is to visualize potential development path for EA as sociomaterial reconfiguration from IT management towards an organizational capability and structure for integrating strategy, process and IT development practices for managing changes and knowledge of modern enterprises. This kind of shift to activity system could be seen as strategic pivot from a product-focus to a market-driven operations mode, which causes systemic and transformational changes to business processes, organizational structures, roles and responsibilities (Moore 2002, 199). Even smaller strategic changes to market or customer segments may cause systemic organizational and business network related changes to products, pricing, marketing and communication (Rope 2013, 81). These kinds of strategic changes have effects to the holistic enterprise system. Change management could benefit from a shifted activity system where EA leadership combines strategy and process changes into EAM and IT changes for cost-effective strategy execution.

In this study, we have produced socially practical generalizations, which may be seen as explanations of EA-as-phenomena derived from empirical interpretive research in a IS setting (Walsham 1995b, 79). Walsham (ibid.) classifies generalizations into four categories called “Development of concepts”, “Generation of theory”, “Drawing on specific implications” and “Contribution of rich insight”. This EA study contributes at several levels of EA, but major contributions may be summarized as development of conceptual frameworks to create rich insights into EA-as-phenomena. Walsham (ibid., 80) advocates Suchman (1987, 2007) and Zuboff (1988) from their contributions of rich insight, but both researchers have also been contributing with EA-related concepts like “human/machine reconfigurations” (Suchman 1987, 2007) and “informate” (Zuboff 1988). Other central concepts for this EA study are “structuration” (Giddens 1984), “changing frames” and “reframing” (Orlikowski & Gash 1992), “sociomaterial” (Orlikowski & Scott 2008), “drift” (Ciborra & Hanseth 2000), “entanglement” (Barad 2003) and “imbrication” (Ciborra 2006; Leonardi 2011). This social and organizational stream of systems development seems to evolved towards emergent architectures (Sims & Johnson 2011, 167), which include continuous re-negotiations of the concept of work, division of labor (e.g. Rifkin 1995) and regulating sociomaterial plurality in organizations (De Vaujany et al. 2013).

Borrowing these concepts, we argue that EA as enterprise-level capability enables goal-oriented management of *human/machine reconfigurations* and *drift* by *informing* various actors about possibilities and possible changes in *sociomaterial imbrications* and *entanglements*, and by *reframing* possible ethical implications, affordances and constrains before decisions and investments in changing *sociomaterial structurations*. But from another, one may argue that, if not managed with social and organizational structures inside a non-EA-enterprise, EA is an invisible or non-existing subjective idea without any resemblance to the “real world”. For public organizations and politically sensitive development domains, EA development might benefit from a distributed EA leadership approach recognizing the inclusive and collaborative nature of the leadership process (Oborn et al. 2013). Distributed EA leadership structures could be studied using a sociomaterial approach to reveal how EA leadership could be distributed across sociomaterial practices which together (re)configure policy coalitions and context for EA and systems development.

10.2 Other future avenues for EAM practices

Technology and IT –architecture biased EA and the technical determinism of EA –approach seems to be too limited of perspectives for producing business benefits from EA management. Our social view of EA development in the case enterprise implicates that social structuration of EA management towards EA leadership should be implemented and integrated into organizational structures of business and process development. An EAM governance model, resources and processes should include and balance business, process and IT architecture management domains, which should be legitimated as part of business practices for integrating business and process development. This EA structuration and operating model could then be supported with an applicable EA -framework and possible EA-technology solutions.

We argue that even if investment in an EA-project for generating EA-documentation and EA-data into some EA-technology would succeed in creating a knowledgebase about current business processes and systems, then within a few years the lack of EA management structures and processes would cause limited benefits from the initial EA-project and investments. Business and process management related social structuration seem to be vital integrations to IT management for EA management benefits. Based on these implications, social structuration and integration into business, process and IT management practices could combine with EA management as knowledge and change management tools for enterprise-wide business and systems development.

Seven vignettes as bottom-up EA-cases and narratives from one case enterprise without any prior EA-system structures contain too little evidence for any proper generalization (Lee & Baskerville 2003, 221). But we could argue that EA-system benefits depend highly on enterprise values, culture, size, business development situation and contingencies related to industrial tradition towards documentation, change management and knowledge management requirements. At Nokian Tyres, inventiveness is one of the core corporate values, which is promoted and motivated in various ways and systems. Thus R&D and business focuses on new technical innovations in core tyre product, where product information and technical innovations like an abrasion indicator scale are embedded into the product surface. In other industries like health care, where information is the primary material product, or information intensive industries like banking and insurance, EA-system investments, benefits and values are part of the information-products. Therefore, EA-practices and knowledge creation in the rubber and tyre industry may not reflect into other business environments, were documentation and knowledge sharing structures are an embedded part of key business processes. Business requirements and company culture seem to play a major role in EA creation and development. An increase in the role of IT technology for business strategy execution and value-chain integration as well as an increase in analytical information processing requirements from international business operations seem to indicate a transition from technology-oriented IT management towards holistic and integrated EA management approach.

During our historical and theoretical journey, we have explored EA development history as complex social-technical phenomena starting from the IT roots through architectures and business IT alignment towards EAM. From a technical-biased EA layer, we continued to study how social structures such as human agency and technologies as material agency are intertwining into layered EA imbrications (Leonardi 2011). While studying four social theories including ANT, Activity Theory, Structuration Theory and socio-materiality, we introduced three EA related study frameworks and one external perspective to model layers between IT, EA, EAM and knowledge management:

- an IT–framework for analyzing IT and technology perspective for EA-development,
- an EA–framework for analyzing EA-content,
- an EAM–framework for analyzing EA-management context, and finally
- an External knowledge-sharing perspective for analyzing knowledge sharing structures and knowledge management practices for each development domain.

Implications from elaborating and reflecting on these EA frameworks with seven vignettes have produced more practical findings, which could also be seen as insights to our case enterprise. But even more important than utilizing these EA frameworks into a historical retrospective analysis of EA development would be applying these EA frameworks into EA development planning:

- An IT–framework for analyzing ontological technology, IT/IS and the EA system development question of what material and immaterial components are needed, changed or getting obsolete by EA development initiatives; and for analysis of what costs and resources are needed for implementing and maintaining those changes (WHAT?).
- An EA–framework for analyzing EA development from an epistemic and methodology perspective of how changes can be implemented to each actor and social groups, and how those changes are reflected to roles, knowledge and division of labor (HOW?).

- An EAM–framework for analyzing moral and ethical questions of why these changes are needed and why new technologies and systems are more valuable for the enterprise than the costs of changing the existing system (WHY?)
- An external knowledge-sharing perspective for analyzing knowledge sharing structures, knowledge-transfer mechanisms for change management and immaterial rights, costs and assets needed and/or created during the change.

Thus these EA frameworks could be part of analyzing organizational values, reasoning changes for business transformation and enabling EA leadership initialization. From our EA vignette findings we could argue that EA management should be aligned with primary business values and business development of the enterprise, which in the case of Nokian Tyres means profitability and EA-related cost management. This EA-related cost management should contain cost structures like CAPEX (capital expenditure into investments) and OPEX (operative expenditure) for financial planning for rolling 18 months. From a strategy perspective, EA-related cost management should include some investment element into future business potential and benefits, which could be handled in EA-costs as real options. This has some similarities with the case study of Boehm and Guo Huang (2003) which suggests a Value-Based Software Engineering-framework for including *principles and practices for extending traditional cost, schedule, and product planning techniques that also manage the value delivered to stakeholders* (p. 33). Boehm has continued studying the value-based approach to software engineering (Boehm 2006; Boehm & Jain 2006), which also seems quite promising for measuring value for application integration of *incompatible, best-of-breed applications, an approach which increases costs and reduces benefits incurred by trying to glue these together* (Yang et al. 2005, 54). This stakeholder value-based "4+1" approach could open a future research topic for value-based enterprise architecting, which again could improve models and methods for value-bases EA –cost management. These EA –cost management improvements should be connected to requirements management to improve cost control and avoid requirements, which are not economically feasible. Yang et al. (2005, 56) argues this by saying that *"Fundamentally, something isn't a requirement if you can't afford it"*.

Another possible and generic value-based source for EA –management benefits could come from change management as managing complexity and improving internal control for EA –related risks. In the case of Nokian Tyres, EA-management could be seen as a similar safety investment like studded tyres are for a driver in challenging Nordic winter conditions. In complexity management, the EA roadmap or blueprint could be seen as a decision (Smolander et al. 2008) regarding the route that the enterprise has selected for its business and EA –development. Seeing the generic EA –benefits in road-mapping and release planning is similar to practices of software development (Jantunen & Smolander 2006). This EA -road-mapping and release planning should in the case of Nokian Tyres be tightly connected to EA –releases and milestones before seasonal peaks for maximal sales and profitability performance, as well as, then, development sprint planning for change management activities between business seasons. But EA management as a change management tool seems to require social structuration for business, process and systems development. This social structuration should be legitimated with an EAM governance model and organizational integration for improving communication and control for change management. The change management value of EAM could be seen as socio-technical problem solving, product, process/action, intention, planning (modeling, representation, etc.), communication, user experience, value, professional practice and service (MacKay et al. 2012).

Possible business benefits from EA could come from knowledge management and knowledge sharing practices regarding process management, system support and maintenance. In this operational context, EA-management should provide consistent and up-to-date EA-documentation, which could be seen as the literature and language (Smolander et al. 2008) regarding current business processes, information structures and systems. At Nokian Tyres and in prevailing company cultures of minimal documentation and national sub-cultures, these EA-products could improve documentation levels for business processes, information flows and systems integration. Also, in the growing multi-national environment of Nokian Tyres, EA-documentation as language could offer a common business language and improve enterprise-wide business communication.

One possible generic implication from the ethical dimension of the EAM–framework comes from competence management as social sharing and caring of individuals and human development while planning for business development. At Nokian Tyres, this could mean that EA –decisions, roadmaps and blueprints could be communicated and shared for personnel, trade unions, training organizations and service suppliers for improving the understanding of future goals, states and changes which will affect processes, information, systems, division of labor, capabilities and technologies for business in the. In this sense, EA-documentation could be used as a discursive collaboration tool (Pulkkinen 2008) between various shareholders, stakeholders and actor-networks, which together are responsible for the future success of the enterprise as socially sustainable work orgnization (Kira & van Eijnatten 2008; Kira, van Eijnatten & Balkin 2010). But when considering using EA-roadmaps and blueprints as collaboration, communication and change management tools for human and business network development, security issues must planned, and confidential business and technical details must be abstracted to avoid any leakage or misuse of business critical information.

10.3 Limitations

A major limitation of this EA –study is an empirical limitation of only one case enterprise, which does not have formal processes, structures or systems for EA –management. Thus our own EA-observations and sensory data about EA-development are strongly limited to our understanding of EA as means for structuration between business, process and IT management. These observations are made from a historical bottom-up exploration of EA development within one case company, thus requiring further research and validation in other enterprises and organizational contexts for broader relevance (Lee & Baskerville 2003, p221).

Another limitation comes from author's role at Nokian Tyres while collecting EA-observations and data for this EA-study. Morally and practically, we have oral approval for the author's combined role of practitioner and Ph.D. student from our supervisors at Nokian Tyres, but academically this kind of field work combining ethnography and action research may be somewhat questionable. Because of this study approach, diaries and working documents present our EA –data, which the author can memorize, interpret and fill with other observations outside our vignette cases. But we think that our EA-study approach is in line with Myers' (1999, 1) description regarding ethnographic research. Especially problematic is our EAM vignette, where the author has worked as action researcher initializing changes and introducing new technologies in the case enterprise.

A major theoretical limitation of our EA -study comes from inter-disciplinary attempts to combine IS, sociology and Social Studies of Science and Technology (STS) research. Our own theoretical education and practical experience comes from the IS domain, and thus our understanding about sociology and STS is limited. In inter-disciplinary work, there is a danger that concepts, theories and principles may not fully integrate between different disciplines. Because our EA –study tries to integrate academic knowledge from these various disciplines, this thesis lies at an intersection of broad avenues making connections and integrations, which may not fully match in other EA-realities than ours. We have covered several wide business, technology, EA, IS and IT concepts and theories at a generic and high-level, leaving many important details untouched. But because EA-as-discipline is emergent, we hope that the value of this dissertation comes from practical insights and from our approach to increase the social aspects in EA –concepts in theory and practice. Our fieldwork and reporting is compromised for not breaking trust and for filtering insider sources and business critical information within our case enterprise.

We will shortly discuss these research limitations using concepts and possible issues of the reflective practitioner as a researcher (Heiskanen & Newman 1997; Schön 1983).

While our fieldwork combined features of ethnography and action research executed and reported by the author acting as a reflective practitioner, we will use an issue list from Heiskanen and Newman (1997, 128) comparing ethnography and reflection-in-action research methods. From generic research issues, our EA research avoided quite well the traps of holistic fallacy, elite bias, going native and neutrality of the researcher because the author as reflective practitioner was required to develop and understand each system as a unique case at a very detailed level without trying to promote his own career or practical interests within our case enterprise. A more problematic issue is the author's limited experience of researcher, which in this case is limited to a single enterprise setting. On the other hand, the author's long working history and active participation in our case enterprise setting as a practitioner for information system development enabled us to easily enter and move around the research site. Also, our access to data and mastering of the language within enterprise were very well established, with the exception of the limitations to understand Russian discussions and documentation in detail. Minor issues for our fieldwork occurred regarding the researcher as a perceived threat and penetrating the fronts of the informants because the author as reflective practitioner represented the parent company and the corporate IS development, the roles of which were partly seen as a threat to the independence of Vianor and country organizations. Because of this potential conflict domain, the author tried to balance between neutrality as a researcher and an active development role within the parent company interests and independent operations and cultures inside subsidiaries. While reporting evidence and verifications from our fieldwork, the author has kept a clear distance and has shared working papers for comments to validate findings within our case enterprise. To conclude, our EA research has quite strong validity within our case enterprise in combining EA development theory and practices, but limitations may occur when applying these findings to wider organizational or theoretical contexts.

10.4 Possible futures for EAM research and practices

EA seems to be a practically evolving concept and, academically, quite a young discipline, which offers numerous topics for future research. In this EA-study, with the IT – chapter and the IT–framework we have tried to cover substantial IS and IT layers between business and technology at quite a generic level, from the introduction of technology to retirement. This IT–framework is our own layered generalization about possible structuration for managing IT-related system development and use. Our IT–, EA– and EAM–frameworks require further research, testing and validation with qualitative and quantitative methods. But this EA-study already showed that technology life-cycle within this IT–framework could have some other, more iterative or technology-specific phases. Another issue comes from the concept of technology itself because knowledge and information intensive process theories like in S&OP and EAM could be introduced to personal and organization behavior without any major development project or technology investments. This indicates that technology life-cycle and phasing may vary at different levels between business and technology, which offers a quite challenging, inter-disciplinary research topic between the social and technical sciences.

The EA-concept seems to have technical origins in the 1980’s technical IT architecture development of PC and unix-workstations and servers, which were used in the 1990’s for creating distributed, technical IT architectures for multi-national enterprises and global corporations. In the beginning of the 1990’s, technical development produced the origins of the Internet, which was everywhere in the 2000’s in creating technical architectures for eBusiness, eCommerce and business networks. The EA –concept was emergent and embedded in IT architectures of the 1980’s, but visible in the 1990’s in Zachman’s work and in various forms of other IT-related architectures. While thinking about evolving EA –standards at a substantial level, we have produced in Table 8 a rough-level EA-timeline in Table 8, where lines are adapted from IT–framework –layers.

TABLE 8 EA-timeline 1980-2020

Layers	EA1980	EA1990	EA2000	EA2010	EA2020
Business	Internationalization	Globalization	Digitalization	Consumerization	Virtualization
EA	Emergent	Zachman, architectures	EA frameworks	EA management	EA leadership
EIS	Departmental	ERP1.0	Extended ERP, BI	SOA	Utility
IS	Tailored	Business applications	eServices	SaaS	Utility
IT	Expensive	Competitive advantage	Integrations	Service	Utility
IT infra	Networks	Internet	Wlan, cloud	Virtualization	Ubiq
Technology	PC, unix	Mobility	Social media	Sensors	Ubiq & NBIC

With this EA-timeline, we argue that while IT and IS –systems are becoming ubiquitous utility services offered by countries and enterprises, the focus of the future of EA –research and practices are moving towards EA management, EA leadership roles and knowledge management. More holistic EA –technologies including social media features are increasing social structures, visibility, dialog and knowledge sharing structures towards EA2.0, which will be part of the enterprise structures in the 2020's. When substantial amount of the content of EA is standardized, the increasing importance of EA management and knowledge management offer various research topics, where continuous and rapidly increasing virtualization is creating challenges for ontological, epistemic and ethical dimensions of EA knowledge management. But more important than technology-driven EA2.0 development is the integration of EA tightly together with business and process development. When EA and EAM are tightly integrated into organizational structures and processes of business and process development, social structuration and knowledge management of EAM may improve the strategic alignment between business and IT. This thinking opens new avenues for studying emergent EA leadership roles and responsibilities between business, process and IT/IS development. EAM seems to have a wide potential for improving knowledge and risk management practices for ubiquitous IT, NBIC technology and robotics management by increasing visibility to moral questions of surveillance, personal rights and humanization of technology. At Nokian Tyres this opens new business and service possibilities, if R&D and EAM integration continues towards tyre safety and service innovations. In addition to technical innovations and information integrations to EAM processes, social and economic innovations could enable crowdsourcing and new pricing models as sources of agile business development. These kinds of IT-enabled business architecture enhancements could challenge existing enterprise borders and would even require ecosystem-level EA leadership. Agile business models and flexible organizational forms could even challenge EA in re-thinking it as Ecosystem Architecture. This thinking could be seen to align with the Agile Manifesto's software architecture principles: "The best architectures, requirements, and designs emerge from self-organizing teams" (Agile Manifesto 2001). When adding social complexity and life-cycle thinking to unknown futures of complex systems, social dynamics and sociomaterial plurality (De Vaujany et al. 2013), emergent architectures seem to support evolving business requirements and social changes (Sims & Johnson 2011, 167).This implies changes to leadership practices towards pragmatic agile leadership (Appelo 2010; Medinilla 2012) combining vertical, self- and shared leaderships (Pearce 2004; Pearce & Manz 2005; Kappelman 2010a, xlv) for knowledge work. Winter et al. (2014, 4) suggests possibility to apply EAM in a 'lightweight'' mode to enable support for urgent business questions.

EA management practices and leadership structuration could also be studied applying Makiya's (2012) perspective to EA as social innovation. The public sector in the United States is a quite homogenous research domain, but the same EA assimilation research approach could also be applied to Finnish or European industrial sectors. As Makiya (2012, 32) argues, there is very little longitudinal EA life-cycle research available, which opens various possibilities for further EAM and EA leadership research at enterprise, industry, regional and global levels. Stettiner and Fienhold (2012, 267) have a more European perspective on the future of EAM when architecting, with the following predictions for EAM development:

- EAM will be presented at the board level.
- Federated and combine teams from business and technology will shape the enterprise.
- The process of strategy development, tactical planning and operations will be more intertwined.
- EA tools will be an integrated part of the enterprise application portfolio.
- EAM monitoring will be established.
- Best practice EAM operations will be defined.
- EAM will have a new name.

Perhaps EA is something that all organizations will notice when they are trying to develop or change their sociomaterial system. Perhaps, to date, EA has been more important for information intensive enterprises. But now, when the Information Society is proceeding in all areas of human activities, not only in industrialized counties but also in developing countries, the EA approach will perhaps become vital to all enterprises that want to stay competitive and survive in the information economy. EA leadership seems to offer organizational structuration for integrating business, process and IT development into a holistic business-driven EA management culture. Maybe EAM will be called business technology management, holistic management, common sense or business-as-usual.

We think that these above presented future scenarios for EA development and EAM practices are examples of technology biased possible futures. From an organizational perspective, Stettiner and Fienhold (2012, 280) predict that in 2020 the Chief Change Officer (CCO) will represent EAM at the board level. From a strategy perspective, they also expect EAM to have a new name that suggests process driven EAM: *strategy to execution* (S2E; Stettiner & Fienhold 2012, 285). Another organizational EAM development perspective could be related to our EA–framework modelling; human relationship (Colbert 2004) and capability driven business development could transfer EAM from the IT campus to the strategic human resource management (SHRM) domain. Causal logic seems to follow (Kim et al. 2011, 487): IT personnel expertise -> IT management capabilities -> IT infrastructure flexibility -> process-oriented dynamic capabilities -> financial performance. Thus SHRM development could integrate EAM as part of the HR operations, at least for some organizations. Ulrich and McWhorter (2011, 44) promote business architecture driven enterprise management, which could embed EA into modern financial operations. Hobbs (2012) has evaluated various EA governance models. We agree that EAM development requires new EA leadership and structures, which must be embedded and integrated into organizational structures and have the capability to ensure competitiveness and survival of an enterprise in the Information Age (Kappelman 2010a, xlv)

Our socially biased approach towards EA could be used in future research and practice for defining, modelling, analyzing and planning EA stakeholders and actors. One possible future substantial EA –research topic could be an EA –governance model, the research of which could utilize an EA–framework, for example, in combination with the RACI –method (Responsible, Accountable, Consulted, Informed) while studying social structuration of EA –management. Feltus, Petit and Dubois (2009) have studied COBIT –governance with a similar approach using the RACI –chart matrix. The other possible substantial future EA –research topic could be EA benefit creation processes and Value-Based EA, which was already discussed in possible implications of this EA –

research. This avenue of EA studies could discuss socio-economic scenarios of benefit, values and ethical considerations regarding the future of the work (e.g. Rifkin 1995).

Our EAM–framework offers various possibilities for future work both in academia and practice. While trying to integrate the ontological, epistemic and ethical dimensions of the EA management domain, it could be used for analyzing current EA –frameworks, EA –models and change management practices between AS-IS and TO-BE states of various EA-roadmaps. An external knowledge-sharing perspective –model offers research possibilities for studying and improving EA –knowledge sharing structures, processes and practices. EAM related knowledge and management of that flux of socio-material will be the major challenge for both academia and practice when aiming towards EA leadership. EAM has potential benefits and risks that we still do not fully understand. Systematic EAM practices seem to have potential to improve cost efficiency, IT productivity and resource allocations. EA leadership seems to have the potential to increase benefits from EAM investments while managing changes and business transformations. Combining agile methods into an EA process could improve EAM flexibility and capability to produce enough documentation to ensure knowledge transfer and operational scaling of EA systems development.

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