Yoshimasa Masuda
Murlikrishna Viswanathan

# Enterprise Architecture for Global Companies in a Digital IT Era

## Adaptive Integrated Digital Architecture Framework (AIDAF)

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# Foreword

The challenges in the digital information society are quite difficult but exciting. People are working on them with enthusiasm, tenacity, and dedication to develop new analytical methods and provide innovative solutions to keep up with the latest trends of big data, Internet of Things, cloud computing, mobile IT, etc. In this new age of the digital information society, it is necessary to advocate a new Enterprise Architecture Framework. This book provides state-of-the-art knowledge and practices about Enterprise Architecture Framework beneficial for IT practitioners, IT strategists, CIO, IT architects, and even students and serves as an introductory textbook for all who drive the information society in this era.

Tokyo, Japan

Dr. Jun Murai
Keio University

I found this book to be a very nice contribution to the enterprise architecture community of practice. Congratulations on your development of the AIDAF! Also, it would be helpful to get your views on global trends in the EA community—there are lots of jobs posted for enterprise, solution, data, software, and security architects.

I can recommend this book of "Enterprise Architecture for Global Companies in a Digital IT Era: Adaptive Integrated Digital Architecture Framework (AIDAF)" as a textbook for digital IT strategists/practitioners, EA practitioners, students in universities and graduate schools.

You have done good work! Best of luck in the future.

Pittsburgh, USA

Dr. Scott A. Bernard
Carnegie Mellon University

# Preface

First, we clarify the sharing of roles in this book. As a primary author, Dr. Yoshimasa Masuda wrote the whole contents of this book. Dr. Yoshimasa Masuda and Prof. Murli developed the "Questions and Exercises" in the final parts of each chapter. Furthermore, Prof. Murli reviewed this book to enhance this book as the text/reference book suitable for graduate schools and universities worldwide, involving Carnegie Mellon University.

Many global enterprises have encountered various changes, such as the progress of new technologies, globalization, shifts in customer needs, and new business models. Important changes in cutting-edge IT technology with recent developments in Cloud computing and Mobile IT (such as progress in big data technology) have emerged as new trend these days. In global IT industry, CIO's IT investment is shifting to Cloud/digital platforms largely, toward the next generation of Digital IT, mainly in Europe and USA (Nils Olaya, Jeanne W. Ross, MIT CISR research, 2015). Enterprise Architecture can be effective because it contributes to the design of mid-/large integrated systems, which show a major technical challenge toward the era of Cloud/Mobile IT/Digital IT in digital transformation. On the other hand, in the reality, we had difficulties in starting up Enterprise Architecture with existing EA frameworks in global firm toward a Digital IT.

In the beginning, from standpoints of Digital IT, strategic architecture frameworks (Enterprise Architecture) were investigated. Thereby, existing EA approaches and frameworks did not meet with the direction of shifting to advanced Digital IT areas—Cloud/Mobile IT. Therefore, we recognized a new EA framework for a Digital IT era as the important research theme and task, and we systematized the architecture framework/EA that should suit the direction of advanced Digital IT areas (Cloud/Mobile IT/Digital IT) in consideration of the results of the "EA framework analysis" and the "case study in global enterprise" at this time.

This book aims to investigate solutions incorporated by Architecture Board in the global enterprise for solving issues and mitigating related architecture risks while proposing and implementing "Adaptive Integrated Digital Architecture Framework—AIDAF" and related models and approaches/platforms, which can be applied in companies promoting IT strategy using Cloud/Mobile IT/Digital IT.

This book can be divided into three main parts. The first part consists of Chaps. 1 and 2. These chapters address the background and motivation for the Adaptive Integrated Digital Architecture Framework proposed in this book, to meet with IT strategy toward Cloud/Mobile IT/Digital IT. Chapter 1 is the introduction such as the purpose, scope, and structure of this book that covers the introductions of "the history of information systems toward Digital Transformation" and "Enterprise Architecture." Chapter 2 explains the background of this book, such as the trend of Digital IT and the direction of Enterprise Architecture. Furthermore, problems in Enterprise Architecture toward the era of Digital IT are shown and countermeasures/solutions are also suggested in this chapter.

The second part of this book comprises Chap. 3. In this chapter, first, the author shows the overview and positioning of strategic architecture framework and related models in the era of Digital IT. Furthermore, we show the necessary elements in EA frameworks for the era of Cloud/Mobile IT/Digital IT and propose the new Enterprise Architecture Framework named "Adaptive Integrated Digital Architecture Framework—AIDAF" and related models for architecture assessment/Risk Management and knowledge management on digital platform, which can solve the problems toward the era of Digital IT described in the previous chapter, while these models and frameworks are applied in companies promoting IT strategy using Cloud/Mobile IT/Digital IT.

The third part of this book demonstrates the application and usefulness of my proposed Enterprise Architecture Framework and several approaches/models related to this Architecture Framework. Three case studies are presented in Chaps. 4, 5, 6, and 7. In Chap. 4, a case study that built and practically implemented our proposed EA framework in a global pharmaceutical company is presented. This case study evaluates the effectiveness and adaptability of my proposed "Adaptive Integrated Digital Architecture Framework—AIDAF" and shows the benefits and results of this EA framework in the era of Cloud/Mobile IT/Digital IT.

Chapters 5 and 6 present two evaluations of this Architecture Framework-related approaches and models. The case study in Chap. 5 is focused on "Architecture Board reviews and knowledge management." This case study has verified the "Assessment meta-model in Architecture Board," "Global Digital Transformation Communication model," and "Solution Collaboration Model" on digital platforms and shows the effectiveness and results of these approaches/models related to my proposed AIDAF. In Chap. 6, the case study is focused on "Risk Management approach for Digital Transformation" and Big Data. That case study evaluated the "Strategic Risk Management model for Digital Transformation," clarified the strategy elements to mitigate risks in Digital Transformation, and showed results of this approach/model related to my proposed AIDAF. Furthermore, Chap. 7 presents the overall evaluation of AIDAF and the perspectives for AIDAF and related approaches/models.

Chapter 8 presents the conclusion and some important points from this research. This chapter summarizes the results of verifying my proposed Architecture Framework—AIDAF—and related approaches/models and shows important points of this Adaptive Integrated Digital Architecture Framework—AIDAF—and the related approaches/models.

Chapter 9 presents the future direction of the AIDAF and Internet of Things. This chapter introduces and briefs the direction and concept of the research initiative named "Open Healthcare Platform 2030," for the above purpose.

Adelaide, Australia/Tokyo, Japan Yoshimasa Masuda
Adelaide, Australia Murlikrishna Viswanathan

# Acknowledgements

We would like to thank our advisors and colleagues in the field of digital and Enterprise Architecture in writing *Enterprise Architecture for Global Companies in a Digital IT Era*.

Through our research and working experience in starting up Enterprise Architecture in the global company, the problems toward Digital IT have enhanced my motivation and attention, which can lead to our selection of a research topic for this book without hesitation. Besides, our research would have been difficult without the devoted supports of the following people.

Recommendations from Scott Bernard and Jun Murai are precious contributions to this book. Scott Bernard has worked as the US Federal Chief Enterprise Architect with the President's Office of Management and held as CIO positions while teaching EA in Carnegie Mellon University. Jun Murai is Founder of JUNET starting Internet in Japan and known as "the father of Internet in Japan" while teaching Information Technology at Keio University.

Moreover, especially we would like to also express our great appreciation to Prof. Riaz Esmailzadeh in Carnegie Mellon University, Australia, for their willingness to become external advisors for our research and the book. His advice and suggestions are very precious in terms of enterprise architecture, information system architecture, and digital transformation as well as managerial aspects.

We would like to express great appreciation to advisors, Prof. Seiko Shirasaka of Keio University and Shuichiro Yamamoto of Nagoya University, for their efforts in improving and finalizing the quality of Dr. Yoshimasa Masuda's thesis leading to this book. We would like to also present our great appreciation to Prof. Kenichi Takano and Prof. Tetsuya Tohma, for their positive intention to become reviewers for Dr. Yoshimasa Masuda's thesis leading to this book. We would like also to present our great appreciation to Dean Prof. Takashi Maeno, Prof. Taketoshi Hibiya, former Dean Prof. Yoshiaki Ohkami, etc., for their comments for this book and advices.

We also would like to express our appreciation to Prof. Michael Cusumano in MIT Sloan School of Management, for guiding toward the world of the state-of-the-art Yoshi's doctoral research and the fruitful future career. We would like to also show our thankfulness to Dr. Thomas Hardjono who is CTO of Connection Science and Engineering at MIT Media Lab for his contribution as the co-author of some Yoshi's research papers.

Many verification activities of the research in this book were conducted in the global organization of global company where one of us had worked. Therefore, we would like to present our thankfulness to the colleagues of the company's architecture community in Boston, USA, Switzerland, Germany, Europe, Japan, etc.

Finally, we would like to show our gratitude to our family. They have been very supportive and patient to live with the authors who spent most of their time in work and research even in the midnight, weekend, and holidays. We would like to also express our great appreciation to our parents as well.

# Contents

# Abbreviations

| | |
|---|---|
| AA | Application Architecture |
| ADM | Application Development Method |
| AGATE | Atelier de Gestion de l'ArchiTEcture des systèmes d'information et de communication—An Architecture Framework for modeling computer or communication systems architecture for French Defence and military |
| AIDAF | Adaptive Integrated Digital Architecture Framework |
| API | Application Programming Interfaces—key element for digital transformation because of an essential component in Microservices, merging the old and the new IT platforms |
| AUSDAF | Australian Defence Architecture Framework |
| BA | Business Architecture |
| BI | Business Intelligence |
| BPR | Business Process Redesign/Reengineering |
| C4ISR | Command, Control, Communication, Computer and Intelligence, Surveillance, Reconnaissance |
| CAFEA | Common Approach to Federal Enterprise Architecture |
| CIO | Chief Information Officer |
| CISO | Chief Information Security Officer |
| CMC tools | Computer-mediated communication tools |
| CMMI | Capability Maturity Model Integration |
| COBIT | Control Objectives for Information and Related Technology |
| CRM | Customer relationship management |
| DA 2.0 | Disciplined Agile 2.0 |
| DA | Data Architecture |
| DoDAF | Department of Defence Architecture Framework |
| EIS | Enterprise Information Systems |
| ERP | Enterprise Resource Planning |
| FEAF | Federated Enterprise Architecture Framework |
| GDTC | Global Digital Transformation Communication model |

| | |
|---|---|
| GHE | Global Healthcare Enterprise |
| GxP | Good x Practice (validation) |
| IaaS | Infrastructure as a Service |
| IE | Internet Explorer (Microsoft) |
| IIS | Internet Information Services (standard Web services for Microsoft Windows) |
| JDBC | Java Database Connectivity |
| KOL | Key opinion leaders (management) |
| LAN | Local area network |
| LeSS | Large-Scale Scrum |
| LOBs | Lines of business |
| MDM | Master data management (platform) |
| MIT CISR | Massachusetts Institute of Technology—Center for Information Systems Research |
| MIT EA | Massachusetts Institute of Technology—Enterprise Architecture approach |
| MOD | Ministry of Defence (UK) |
| MODAF | British Ministry of Defence Architecture Framework |
| MVS | Multiple Virtual Storage (operating system for IBM mainframe) |
| NIST | National Institute of Standards and Technology (USA) |
| OASIS | The Organization for the Advancement of Structured Information Standards |
| ODBC | Open Database Connectivity |
| ONM | Organizational network model |
| PaaS | Platform as a Service |
| PMO | Project management office |
| POS | Point of Sale |
| SaaS | Software as a Service |
| SAFe | Scaled Agile Framework |
| SCM | Supply Chain Management |
| SCM model | Social Collaboration Model |
| SDLC | System (Software) Development Life Cycle (process) |
| SNS | Social networking service |
| SOA | Service-oriented architecture |
| SoS | Scrum of Scrum |
| STRMM | STrategic Risk Mitigation Model |
| TA | Technology Architecture |
| TOGAF | The Open Group Architecture Framework (EA) |
| TRM | Technology Reference Model |
| VM | Virtual Machine (operating system for IBM mainframe) |
| VSE | Virtual Storage Extended (operating system for IBM mainframe) |
| WAN | Wide area network |
| WWW | World Wide Web |

# Chapter 1
# Introduction

**Abstract** This chapter provides an overview and histories of Digital Transformation and Enterprise Architecture, the purpose, scope, and structure of this book. This chapter covers the primary previous researches regarding Enterprise Architecture, consisting of main four categories as well. During the 1980s, the term Architecture Framework appeared with the publication of the Zachman Framework for Information System Architecture. Since the year 2000, Enterprise Architecture has been focused as a method for promoting an IT architecture that establishes consistency between corporate business and IT strategies, and it has been applied mostly in global corporations. And whereas, with the recent progress in Cloud computing, Mobile IT technology, and big data solutions, in the IT systems of global corporations, the shift from conventional on-premise server-based IT systems to Cloud computing, such as Software as a Service (SaaS), hybrid Cloud, and connected Mobile IT systems, has become more pronounced. This book focuses on Architecture Framework suiting an era of Digital IT. In later chapters, we will show the direction of Digital IT and Enterprise Architecture, strategic architecture framework suiting in a Digital IT era.

**Keywords** Digital transformation · Enterprise architecture · EA · History of information systems

## 1.1 An Overview of Digital Transformation and Enterprise Architecture

Many global corporations have experienced a variety of changes resulting from the emergence of new technologies, globalization, shifts in customer needs, and the implementation of new business models. Figure 1.1 shows the history of information systems toward Digital IT. In the 1970s, mainframe systems had been utilized in companies. In the 1980s, office computers were used with workstation and PCs. In the 1990s, client–server technology had become popular in offices. In the 1995, Internet emerged and came into fashion while groupware also utilized. In the 2000s, Web computing had spread with wireless networks. In the 2010s, significant changes



Y. Masuda and M. Viswanathan, *Enterprise Architecture for Global Companies in a Digital IT Era*, https://doi.org/10.1007/978-981-13-1083-6_1

| Periods | IT Direction | Primary Technology |
|---|---|---|
| 1970 | Main Frame | MVS, VSE, VM, |
| 1980 | Workstation, PC, Office Computer | Unix Workstation, PC x86 Workstation, Razer Printer, POS system, IBM AS/400, NEC System3100, Fujitsu K series. |
| 1990 | Client Server | Unix, Windows NT, NetWare, Oracle DB, DB2, ODBC, Visual Basic, C++, Ethernet LAN, WAN |
| 1995 | Internet | WWW, Netscape Navigator, IE, TPC/IP, Unix, Java, Windows95, Lotus Notes, MS Exchange, Fire Wall. |
| 2000 | Web Computing | Apache, IIS, Netscape Server, WebLogic, WebSphere, JDBC, Java Servlet, Windows2000, Wireless LAN. |
| 2010 | Cloud computing | Private Cloud (VMWare, Citrix, etc.), Public Cloud (SaaS, IaaS), Hybrid Cloud, Mobile IT. |
| → 2020 | **Digital IT Transformation** | **Mobile IT applications, Cloud applications (SaaS), Big Data solutions, Internet of Things, with Cloud platforms (PaaS, IaaS, SaaS)** |

**Fig. 1.1** History of information systems toward digital transformation

in cutting-edge IT technology due to recent developments in cloud computing and mobile IT (such as progress in big data technology), in particular, have arisen as new trends in IT. Cloud-based services and accelerated digitized platforms represent a growing percentage of the total IT budget of most firms in global and are shifted from existing on-premise based application systems toward the next era of Digital IT (Nils Olaya and Ross 2015). Toward 2020, Digital Transformation is undertaken in many corporations, such as Cloud, Mobile IT applications, Big Data solutions, and Internet of Things related systems these days. Furthermore, major advances in the abovementioned technologies and processes have created a “digital IT economy,” introducing both business opportunities and business risks, forcing enterprises to innovate or face the consequences (Boardman and KPN 2015).

Enterprise systems (ES) are complex application software packages that contain mechanisms capable of supporting the management of the entire enterprise and of integrating all areas of its functioning (Davenport 1998, p. 121). This requires Enterprise Architecture (EA) to be effective because contributing to the design of such large integrated systems would, in future, represent a major technical challenge toward the era of cloud/mobile IT/digital IT. Figure 1.2 shows the descriptions of the perspectives (i.e., owner’s perspective, designer’s perspective, product’s perspective, etc.) of architectural representation depicted in the process of complex engineering project. Figure 1.2 identifies information systems analogs along with the building and airplane ones while identifying the information system model analogs along with architect’s plan of buildings and engineering design of airplanes. (Zachman 1987).

Figure 1.3 shows the relationship between city planning (Shirvani 1985) and Enterprise Information Systems—Enterprise Architecture. In the left side of this Fig. 1.3, city planning covers various scales from the object level to the national level. The policy-oriented direction shows at coarser level, while product-oriented direction shows at finer levels (Namba and Iijima 2005).

The right side of Fig. 1.3 provides the corresponding unit for EIS (EA) city planning. In terms of EIS—EA, comprehensive and interoperable characteristics corre-

| Generic | Buildings | Airplanes | Information Systems |
|---|---|---|---|
| Ballpark | Bubble charts | Concepts | Scope/objectives |
| Owner's representation | Architect's drawings | Work breakdown structure | Model of the business (or business description) |
| Designer's representation | Architect's plans | Engineering design/bill-of-materials | Model of the information system (or information system description) |
| Builder's representation | Contractor's plans | Manufacturing engineering design/bill-of-materials | Technology model (or technology-constrained description) |
| Out-of-context representation | Shop plans | Assembly/fabrication drawings | Detailed description |
| Machine language representation | — | Numerical code programs | Machine language description (or object code) |
| Product | Building | Airplane | Information system |

**Fig. 1.2** Architectural representations depicted in the processes of complex engineering project, along with analogs in buildings, airplane, and information systems communities (*Source* Zachman 1987)

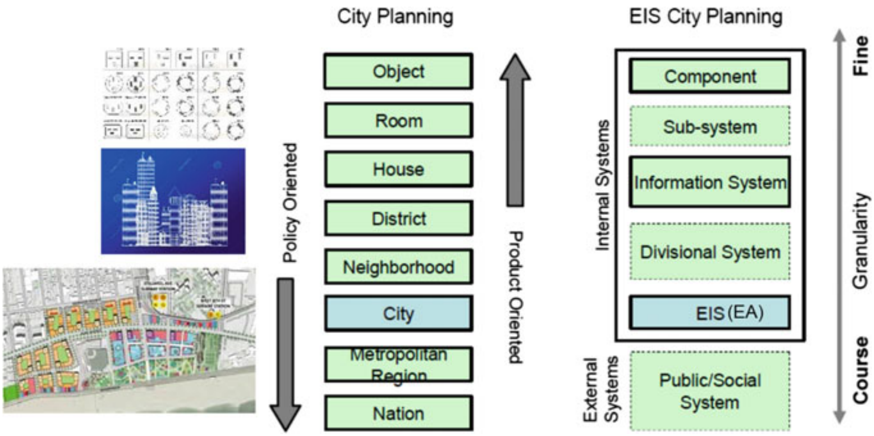


**Fig. 1.3** Granularity of planning levels for city planning and information systems (*Source* City planning part was cited from Shirvani (1985))

spond to coarser granularity; on the other hand, specific/analytical characteristics correspond to finer granularity (Namba and Iijima 2005). Therefore, Enterprise Architecture can correspond with city planning, while information systems can correspond with houses and buildings, and components can correspond with objects as shown in Fig. 1.3.

Moreover, in terms of Enterprise Architecture, the ISO/IEC/IEEE 42010:2011 standard also recommends providing architectural descriptions of systems to manage their escalating complexity and alleviate the risks incurred during the development and evolution of these systems (Alwadain et al. 2014). From a comprehensive perspective, EA encompasses all enterprise artifacts, such as business, the organization, applications, data, and infrastructure, which are necessary to establish current architecture visibility and future architecture to produce a roadmap. EA frameworks need to embrace change in ways that adequately consider new emerging paradigms and requirements that affect EA, such as enterprise mobile IT/cloud computing (Buckl et al. 2010; Alwadain et al. 2014). However, specific EA frameworks, e.g., The Open Group Architecture Framework (TOGAF), are criticized for their size, lack of agility, and complexity (Gill et al. 2014). On the other hand, the necessity of implementing EA in parallel in the midterm/long term (roadmaps and target architectures, etc.) in the era of cloud/mobile IT/digital IT should be emphasized in terms of promoting the alignment of IS/IT projects with management strategy/IT strategy.

In consideration of the above background information, first, this book addresses the aforementioned challenges by comparing the widely used EA frameworks based on the positions in each framework. As the next step, the author proposes a new Architecture Framework to meet the requirements of the digital transformation in relation to the above agility-related aspects. The proposed EA framework will be verified to support an IT strategy promoting cloud/mobile IT/Digital IT, while this book also presents the results of our investigation of an example case in a Global Healthcare Enterprise (GHE), where the abovementioned EA framework is built and practically implemented. This is the only case study of related up-to-date EA toward the era of digital IT and enables us to clarify the effectiveness, adaptability, benefits, and critical success factors of this EA framework in the era of cloud/mobile IT/digital IT.

## 1.2 The Purpose and Scope of This Research

As aforementioned in the previous section, accelerated digitized platforms and Cloud-based services show a growing percentage of the total IT budget of most firms in global and are shifted from existing on-premise based application systems toward the next era of Digital IT. (Nils Olaya and Ross 2015). The purpose of this research is to propose a new Architecture Framework to meet the requirements of the digital transformation and to support an IT strategy promoting cloud/mobile IT/Digital IT in corporations in global and to verify the proposed Architecture framework. Furthermore, the author of this book proposes several models related to this proposed Architecture framework, such as architecture assessment model, communication model for knowledge management on digital platforms and strategic Risk Management model for digital transformation and verify these models, which will lead to the contributions of enhancing business values in global corporations as the final purpose of this research in this book.

On the other hand, the Open Platform 3.0 standard enables an agile digital architecture for the development of enterprise business solutions. These enterprise business solutions take advantages of IT capabilities utilizing digital technology such as Cloud computing, Mobile IT, Big data analytics, social computing, and embedded systems with sensing and/or actuation capabilities (Boardman and KPN 2015). The scope of this research for Digital IT systems and projects should be the IT architecture covering the above elements of Digital IT.

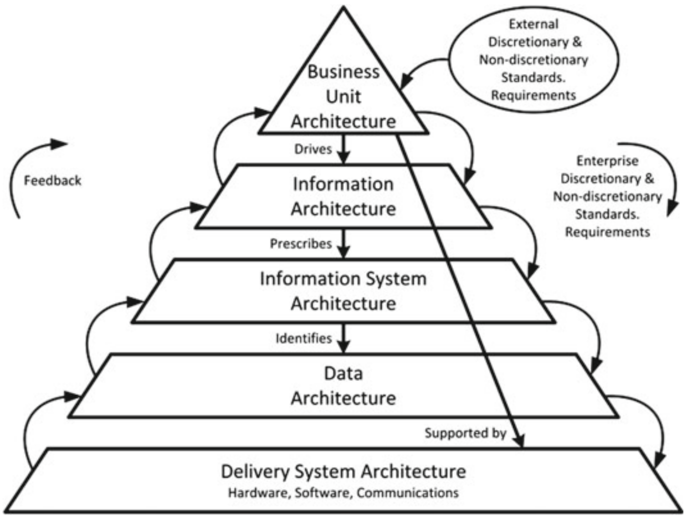


**Fig. 1.4** NIST EA model (*Source* Rigdon 1989, p. 138/Journal of Enterprise Architecture, Association of Enterprise Architects 2016—Volume 12, No. 1, p. 31)

## 1.3 The Primary Related Research

The previous researches for state-of-the-art system architecture and Enterprise Architecture are categorized as the following four types.

1. Histories and state-of-the-art progress in Architecture Frameworks
2. Alternative approaches to Enterprise Architecture—the MIT approach
3. Service-oriented Enterprise Architecture evolution model
4. Adaptive Enterprise Architecture Framework.

### *1.3.1 Histories and State-of-the-Art Progress in Architecture Frameworks*

In the beginning, as the first type of previous research for histories in Architecture Frameworks, the Association of Enterprise Architects published the article of "The History of Enterprise Architecture: An Evidence-Based Review" in Journal of Enterprise Architecture—Volume 12, No. 1 (Kotusev 2016a, b). According to the above previous research, in 1989 the National Institute of Standards and Technology (NIST) issued the first official guidance regarding EA (Rigdon 1989). Figure 1.4 shows the NIST EA model. The NIST EA model organizes an architectural deliverable into five different architecture levels: business unit, information, information system, data, and delivery system (Kotusev 2016a, b).

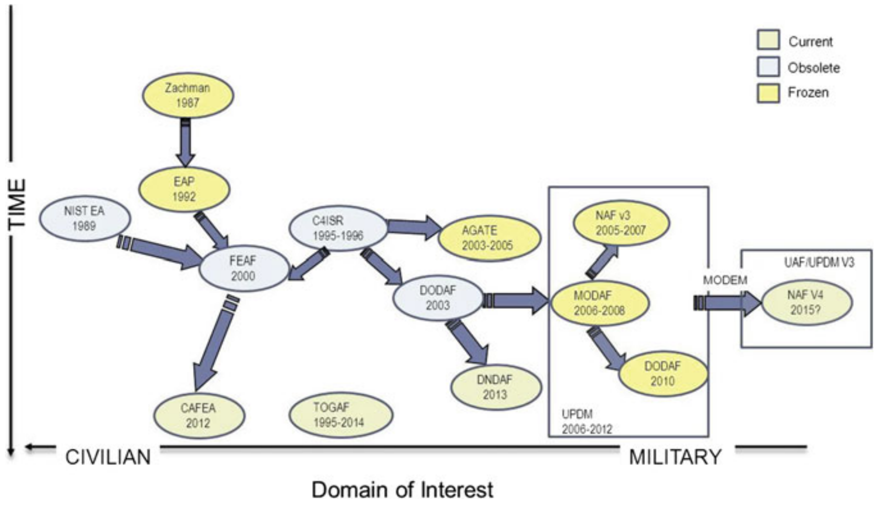


**Fig. 1.5** Architecture frameworks' evolution (*Source* Garnier et al. 2014)

As the first type of previous researches for histories and state-of-the-art system architecture and Enterprise Architecture, the group of ISO/IEC-JTC1-SC7 has shown the "State of the Art in System Architecture and Future Trends" in their study report (Garnier et al. 2014). Figure 1.5 shows the history of Architecture Framework's Evolution.

First, during the 1980s, the term *Architecture Framework* emerged with the publication of the Zachman Framework for Information System Architecture. Figure 1.6 shows the "Zachman Framework for Information System Architecture." This was followed by the introduction of various modeling approaches such as the "4 + 1 view model of software architecture" (Kruchten 1995). At that time, the purpose was to formalize the modeling of an Information System architecture and to rapidly evolve IT system architecture design from a centralized solution.

The first EA methodology called enterprise architecture planning (EAP) was proposed by Spewak and Hill (1992). This EAP defines the following sequence of steps to practice EA:

1. Understand and document the current state of an organization.
2. Develop the desired future state of an organization.
3. Analyze the gaps between current and future states.
4. Prepare the implementation plan.
5. Implement the plan.

Although Spewak and Hill (1992) claim that EAP "creates the top two layers of Zachman Framework," the Zachman Framework is seemingly mentioned just for marketing-related purposes and is not used in any real situation because the actual deliverables in EAP can hardly be mapped to the Zachman Framework as claimed. For instance, the EAP methodology and its deliverables are structured four

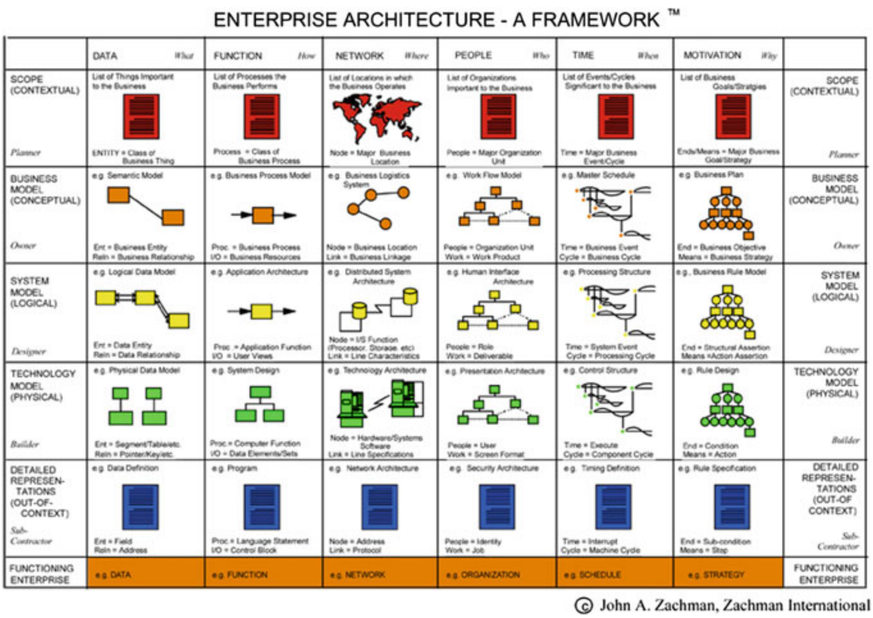


**Fig. 1.6** Zachman framework for information system architecture (*Source* The Open Group 2002)

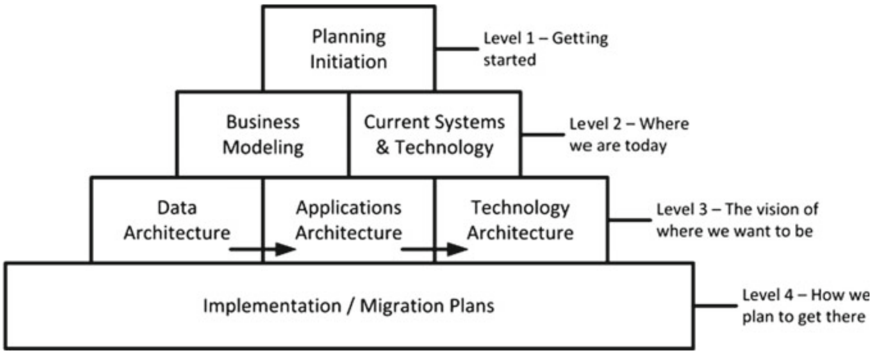


**Fig. 1.7** EAP methodology (*Source* Spewak and Hill 1992, p. 16/Journal of Enterprise Architecture, Association of Enterprise Architects 2016—Volume 12, No. 1, p. 31)

architecture domains (business, data, applications, and technology), which do not map to the three columns of the Zachman Framework (what—data, how—processes, and where—locations) and do not distinguish between its top two rows (ballpark and owner's views) (Spewak and Hill 1992). Subsequently, the EAP methodology served as a basis for many modern EA methodologies such as FEAF (Spewak and Tiemann 2006). Figure 1.7 shows the EAP methodology like "wedding cake."

The US Department of Defense decided to define an architecture framework for architecture descriptions to enable analysis and decision making regarding systems' interoperability in the interface level across various "C4ISR—Command, Control, Communication, Computer, Intelligence, Surveillance, and Reconnaissance" software-intensive systems. This effort led to the publication of the "C4ISR Architecture Framework" in 1996 that was later updated and entitled "DoDAF V1.0," published in 2003, while Atelier de Gestion de l'ArchiTEcture des systèmes d'information et de communication (AGATE) was promoted until 2010 by the French MOD–DGA.

During this period, the French military agency performed the development and evaluation programs for defense, and the major defense acquisition programs of systems and information system were required to document their proposed system architectures with utilizing the set of views defined in AGATE. These days, the US Department of Defense continues to require architecture data as a part of the deliverables for material development and acquisition processes. DoDAF was adapted by many other defense organizations such as the UK's MOD, DND/CF (Department of National Defense/Canadian Armed Forces) and NATO. The above UK's MOD defined an architecture framework named MODAF in the 2006–2008 with adapting DoDAF. In the 2013, the Department of National Defense/Canadian Armed Forces Architecture Framework (DNDAF) was also defined as the standard for use in all DND/CF architecture activities. DNDAF specified an approach and a set of supporting tools to develop and maintain the DND/CF Enterprise Architecture (EA). The DNDAF can provide the foundation for DND EA lifecycle management covering the governance, design, building, analysis, and change management of EA as well.

On the other hand, NATO also builds DoDAF and MODAF to define an architecture framework of "NATO Architecture Framework (NAF V3)." NATO Architecture Framework (NAF V3) (NAF 2007) provides some explanations on architecture kinds as shown in Fig. 1.8.

NATO Architecture Framework (NAF) provided NATO the formalism to start up the enterprise architecture for the alliance, supporting all of NATO's processes and nations working together. This architecture framework is close to DoDAF, MODAF, Australian Defense Architecture Framework (AUSDAF), etc.

At the same time, other industry consortium and standards bodies had been defining complementary architecture frameworks that specified methodologies for developing an architecture description for IT systems in corporations such as TOGAF's Architecture Development Methodology® (ADM) (TOGAF 2011).

These days, utilization of architecture frameworks has evolved into a state-of-the-art practice for both civilian and military domains as depicted in Fig. 1.5. As an example in September 2013, The Open Group announced that it had certified 8500 architects over a 12 month period on TOGAF V9 in worldwide.

In the military domain, architecture frameworks cover most of the architecture descriptions, while they do not adequately cover methods. Since 2000, the US federal government had also defined a similar framework for federal EA description in the FEAF toward the CAFEA—the "Common Approach to Federal Enterprise Architecture" in 2012.

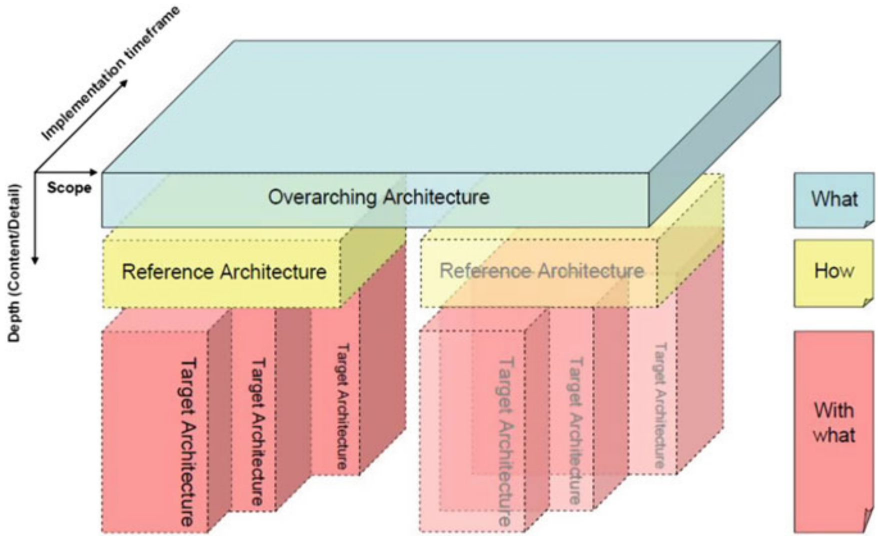


**Fig. 1.8** NATO architecture framework (NAF V3) (*Source* Garnier et al. 2014)

In other civilian domains, architecture frameworks are commonly used for their provided methodologies, such as TOGAF (TOGAF 2011) to model enterprise architecture activities, assets, and deliverables. Architecting tasks are generally limited to business process modeling and making of maps and architectural charts for applications and to perform portfolio analysis and management activities (Garnier et al. 2014).

### *1.3.2 Alternative Approaches to Enterprise Architecture—The MIT Approach*

As the second type of the previous research for state-of-the-art Enterprise Architecture, as an alternative one, more pragmatic EA approach was proposed by Ross et al. (2006) in Massachusetts Institute of Technology (MIT) Center of Information Systems Research. According to this kind of the previous research, many companies tried to improve the business and IT alignment with EA frameworks of popular formal and heavyweight approaches to EA such as the TOGAF ADM (TOGAF 2011). However, many of these companies fail to proceed with EA because of the excessive rigidity and clumsiness of existing selected EA approaches (Holst and Steensen 2011; Lohe and Legner 2014). The MIT approach to EA is more flexible and can help overcome the typical challenges related to the heavyweight existing EA approach (Kotusev 2016a, b).

The MIT approach to EA was considered and developed from research findings at Massachusetts Institute of Technology (MIT) Sloan School of Management by Ross et al. (2006). The MIT approach to EA is shown in Fig. 1.9. In MIT approach, as the first step, business and IT executives need to decide on the operating model in each organization, such as the necessary level of "business process integration and standardization" for delivering goods and services to customers, which can provide more clear foundation for EA development than a business strategy. As the second step, collaboratively, business and IT executives can develop the core diagram—an important EA document describing the main business and IT capabilities, corporate data, major customers and key technologies, as the description of a long-term enterprise-level architectural vision (Kotusev 2016a, b).

Finally, business and IT executives will design and implement the IT engagement model such as the system of governance structure assuring that business and IT projects achieve both local and company-wide enterprise objectives. The IT engagement model includes three essential elements as below.

1. Enterprise-level IT governance—top management decision-making process/framework including the core diagram
2. Project Management—controlled project delivery methodology with necessary checkpoints
3. Linking mechanisms—processes and committees ensuring the communication between enterprise-level decisions and project-level activities.

The aforementioned core diagram is continuously used in concrete project-level decisions through the linking mechanism with business and IT managers on various organizational levels. Hence, through the MIT approach to EA, each IT project can attain both local and global objectives, and they can move to a company toward the desired long-term architectural vision (Kotusev 2016a, b).

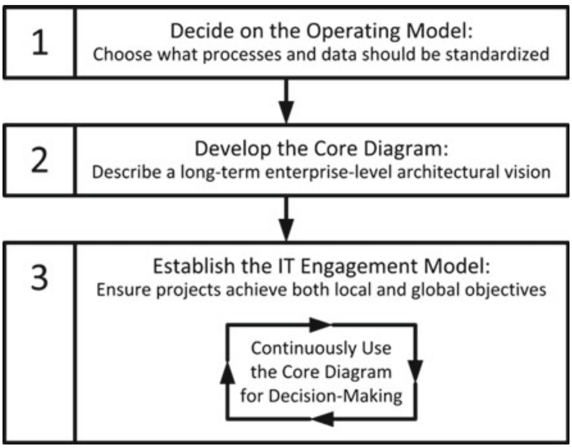


**Fig. 1.9** MIT approach to EA (*Source* Journal of Enterprise Architecture, Association of Enterprise Architects 2016—Volume 12, No. 4, p. 9)

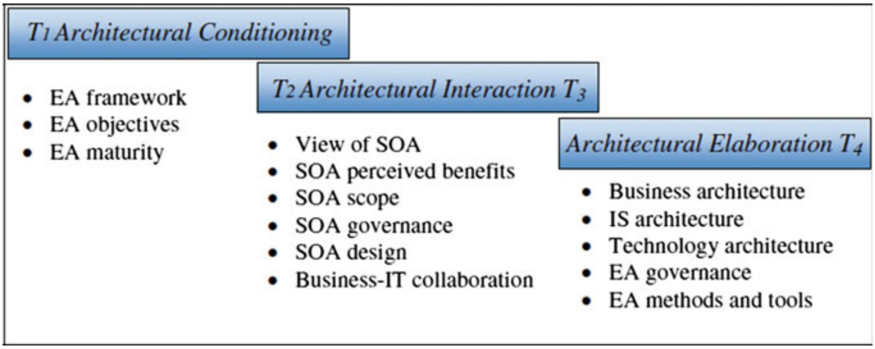


**Fig. 1.10** Service-oriented EA evolution theoretical model for SOA integration (*Source* Alwadain et al. 2016)

### *1.3.3 Service-Oriented Enterprise Architecture Evolution Model*

As the third type of the previous research for state-of-the-art Enterprise Architecture, Alwadain proposed and theorized about Enterprise Architecture Evolution model in service-oriented architecture (SOA). Alwadain investigated EA evolution using the morphogenetic theory (Archer 1995), a critical realism-based theory, to comprehend the evolution process triggered by SOA introduction. This theory provides an useful conceptualization for the investigation of organizational changes, especially involving technological changes (Alwadain et al. 2016). As a result of the above research, they conceptualized the EA evolution process by distinguishing three phases: (1) architectural conditioning (due to an organization's preexisting EA), (2) architectural interaction (e.g., SOA introduction), and (3) architectural elaboration (outcomes of EA evolution). Furthermore, they developed the model into more detail (Fig. 1.10) based on the literature review and explorative interviews as described in the previous work (Alwadain et al. 2014). Figure 1.10 shows this detailed model of service-oriented EA evolution for SOA integration.

For the architectural elaboration (T4), five possible levels of EA evolution outcomes were identified: Business Architecture, Information System Architecture, Technology Architecture, EA governance, and EA methods and tools. Simultaneously, they identified three conditional generative mechanisms regarding architectural conditioning (T1): EA framework, EA objectives and EA maturity, and six generative mechanisms concerning Architecture Interaction (T2–T3): View of SOA, SOA perceived benefits, SOA scope, SOA governance, SOA design and Business-IT collaboration (Alwadain et al. 2014).

The above scope of change under this investigation is limited to SOA introduction as the trigger of EA evolution. Other aspects of causing changes for EA evolution, for instance, new corporate strategy, emerging technologies such as Cloud/Mobile IT/Digital IT were outside the scope of this research (Alwadain et al. 2016).

### *1.3.4 Adaptive Enterprise Architecture Framework*

As the fourth type of the previous research for state-of-the-art Enterprise Architecture, Gill proposed and verified the "Adaptive Enterprise Architecture Framework" in the case study of Australian Government partially as Cloud adoption strategy for IT environment (Gill et al. 2014). The Adaptive Enterprise Architecture Framework (known as the Gill Framework) is a meta-framework that enables support by specifying the situation and tailoring an Adaptive EA function and framework. It is based on adaptive enterprise service system logic expanding on the System of Systems (SoS) and agility, service science approach (Gill 2013). This Adaptive EA framework is defined from the viewpoint of integrating cloud computing elements, and broadly speaking is composed of two main layers: an external layer (context, assessment, rationalization, realization, and un-realization) and an internal layer (defining, etc.) (Gill et al. 2014).

## 1.4 Book Structure

This book comprises eight chapters. This chapter is the introduction such as the purpose, scope, and structure of this book. Furthermore, this book can be divided into three main parts as shown in Fig. 1.10. The first main part consists of Chap. 2. This chapter addresses the background and motivation for the "Adaptive Integrated Digital Architecture Framework—AIDAF" proposed in this book, to meet with IT strategy toward Cloud/Mobile IT/Big Data/Digital IT. Chapter 2 explains the background of this book, such as the trend of Digital IT and the direction of Enterprise Architecture. Furthermore, problems in Enterprise Architecture toward the era of Digital IT are shown and countermeasures/solutions are also suggested in this chapter.

The second main part of the book comprises Chap. 3. In this chapter, the necessary elements in EA frameworks for the era of Cloud/Mobile IT/Big Data/Digital IT are shown, and the author proposes the new Enterprise Architecture Framework named "Adaptive Integrated Digital Architecture Framework—AIDAF" and related models for architecture assessment/Risk Management, and knowledge management on digital platform, which can solve the problems toward the era of Digital IT described in the Chap. 2.

The third main part of this book demonstrates the application, use, and value of my proposed Enterprise Architecture Framework and several approaches/models related to this Adaptive Integrated Digital Architecture Framework—AIDAF. Three

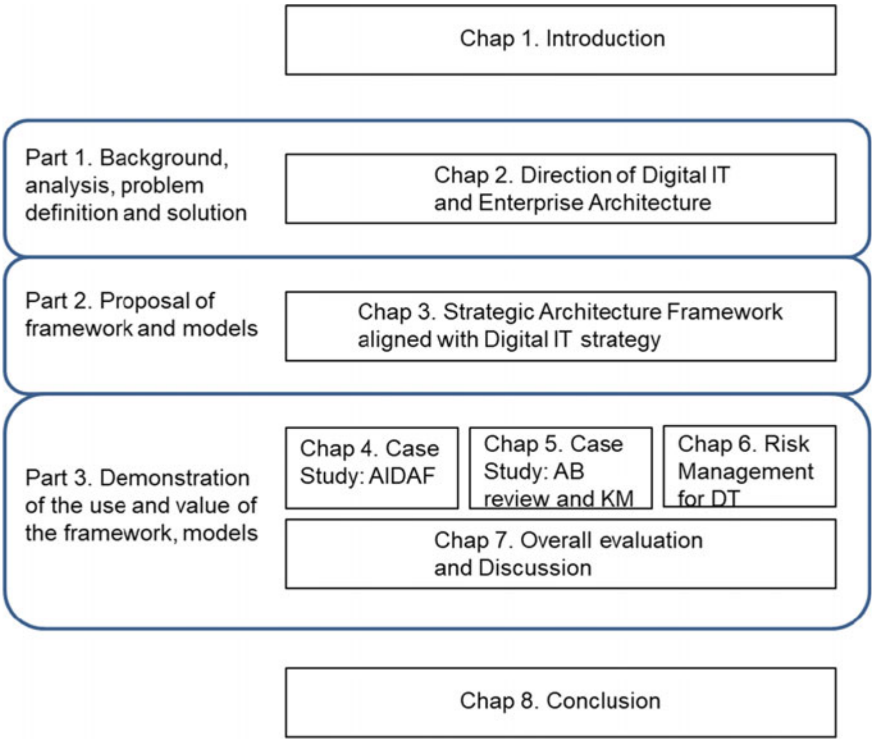


**Fig. 1.11** Structure of the book

case studies are presented in Chaps. 4–6. In Chap. 4, a case study that built and practically implemented our proposed Adaptive Integrated Digital Architecture Framework—AIDAF in a global pharmaceutical company is presented. This case study evaluates the effectiveness and adaptability of my proposed "Adaptive Integrated Digital Architecture Framework—AIDAF" and shows the benefits and results of this Adaptive Integrated Digital Architecture Framework—AIDAF in the era of Cloud/Mobile IT/Digital IT.

Chapters 5 and 6 present two evaluations of this Architecture Framework related approaches and models. The case study in Chap. 5 is focused on "Architecture Board reviews and knowledge management on digital platforms." This case study has verified the "Assessment meta-model in Architecture Board" and "Global Digital Transformation Communication model" on digital platforms and shows the effectiveness and results of these approaches/models related my proposed AIDAF. In Chap. 6, the case study is focused on "Risk Management approach for Digital Transformation" and Big Data. That case study evaluated the "strategic Risk Management model for digital transformation" and clarified the Strategy elements to mitigate Risks in Digital Transformation and shows results of this approach/model related my proposed

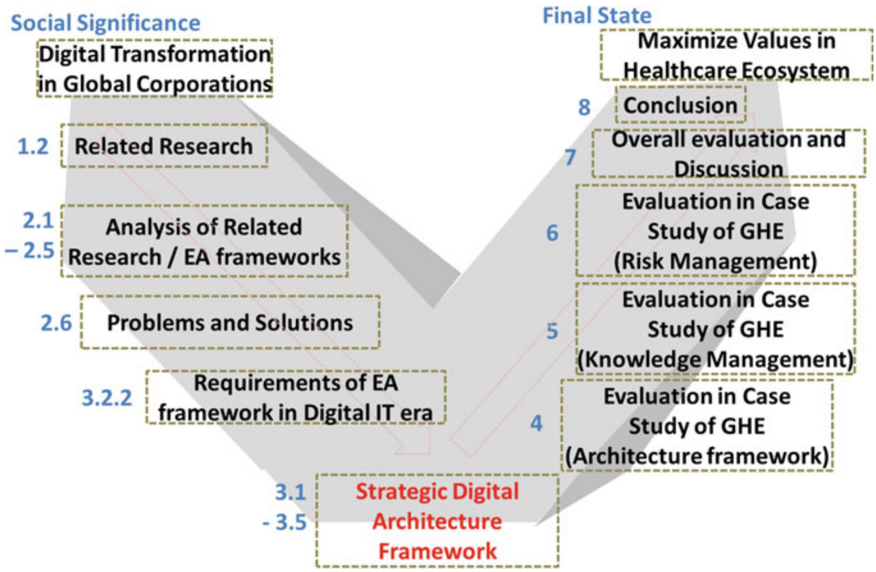


**Fig. 1.12** V-model of this book

AIDAF. Furthermore, Chap. 7 presents the overall evaluation of AIDAF and the perspectives for AIDAF and related approaches/models.

Chapter 8 presents the conclusion and some important points from this research. This chapter summarizes the results of verifying my proposed Adaptive Integrated Digital Architecture Framework—AIDAF and related approaches/models and shows important points of this Adaptive Integrated Digital Architecture Framework—AIDAF and the related approaches/models.

Chapter 9 presents the future direction of the AIDAF and Internet of Things. This chapter introduces and briefs the direction and concept of the research initiative named "Open Healthcare Platform 2030," for the above purpose.

As the above briefing, this book consists of nine chapters and Fig. 1.11 shows the relationship with each chapter in this book. Especially, as the constitution of this book, Chaps. 4–7 evaluate and verify the "AIDAF and related approaches/models" hypothesized in this book. Therefore, the author summarized the constitution of this book as V-model in Fig. 1.12.

## Questions and Exercises

1. Research online sources and identify the top five architecture frameworks used by global organization.
2. What are the five elements of Digital Information Technologies (IT)?
3. What is the definition of Digital IT transformation?
4. Identify trends in the development of enterprise architecture for digital transformation.

5. Using online resources search and find three examples of modern EA frameworks or methodologies in use within Fortune 500 companies.
6. Why is EA important in a Digital IT era?
7. Choose correct EA frameworks:

   a. MODAF
   b. DoDAF
   c. DAF
   d. AUSDAF.

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# Chapter 2
# Direction of Digital IT and Enterprise Architecture

**Abstract** This chapter explains the direction of Digital IT such as Cloud/Mobile IT, Big Data, and Internet of Things. This chapter introduces and briefs EA frameworks such as TOGAF, FEAF, DoDAF, MODAF, Adaptive EA, and $EA^3$ Cube framework and analyzes the selected EA frameworks from standpoints of Cloud/Mobile IT integration, as well. Furthermore, this chapter briefs Agile Enterprise Architecture, introduces the primary scaling agile frameworks, and compares them. In the latter of this chapter, we investigated problems in Digital Transformation and related enterprise architecture, and we show solutions to cope with these problems in Digital Transformation and enterprise architecture. In later chapters, we will show the strategic architecture framework aligned with Digital IT strategies on the basis of the above solutions.

**Keywords** Digital IT · Cloud computing · Mobile IT · Big data · Internet of Things · EA frameworks

## 2.1 Introduction for Directions of Digital IT and Enterprise Architecture

In the past ten years, EA has become an important method for modeling the relationship between the overall image of corporate and individual systems. In ISO/IEC/IEEE42010:2011, architecture framework is defined as "conventions, principles, and practices for the description of architecture established within a specific domain of application and/or community of stakeholders." Furthermore, in the TOGAF (2011) technical literature, it is defined as "a conceptual structure used to develop, implement, and sustain an architecture." In addition, EA visualizes the current corporate IT environment and business landscape to promote a desirable future IT model (Buckl et al. 2010). EA is required as an essential element of corporate IT planning; it is not a simple support activity (Alwadain et al. 2014), and it offers many benefits to companies, such as coordination between business and IT, improvement in organizational communication, information provision, and reduction in the complexity of IT (Tamm et al. 2011). In order to continue to deliver these benefits, EA



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frameworks need to embrace change in ways that adequately consider the emerging new paradigms and requirements that affect EA, such as the paradigm of Cloud computing or enterprise mobility (Alwadain et al. 2014).

Mobile IT computing is an emerging concept in general that uses Cloud services provided over mobile devices (Muhammad and Khan 2015). In addition, Mobile IT applications are composed of Web services. There is not much literature that discusses EA integration with Mobile IT and the relationship between the two; however, integration with SOA has been discussed greatly. Many organizations have invested in SOA as a crucial approach for achieving agility as an organization that can manage rapid change (Chen et al. 2010). In the meantime, there has been a recent focus on Microservices architecture, which allows rapid adoption of new technologies, such as Mobile IT applications and Cloud computing (Newman 2015). This chapter considers both perspectives.

In terms of Cloud computing, mobile devices also widely use Cloud computing capabilities, and many Mobile IT applications also operate with SaaS Cloud-based software (Muhammad and Khan 2015). There is the literature that concerns the integration and relationship between EA and Cloud computing, but it is scarce. Although Cloud computing formats consist of three general services—SaaS, PaaS, and IaaS—under the current EA framework, there is merely a modeling of only this computing format and the business components managed by this company. Considering recent dynamic moves in business and the characteristics of Cloud computing, it is necessary for companies to link the service characteristics (those similar to the above Mobile IT characteristics) of EA and Cloud computing (Khan and Gangavarapu 2009). It is said that the traditional EA approach requires months to develop an EA that allows Cloud technology in order to realize a Cloud adoption strategy, and organizations will demand Adaptive Enterprise Architecture to iteratively develop and manage an EA adaptive to the Cloud technology (Gill et al. 2014).

In addition, the Open Platform 3.0 Standard was developed and approved by The Open Group, and it focuses on emerging technological trends, such as Cloud computing and Mobile IT, that create new business models. In this environment, many basic architecture models are noted, including Mobile IT/Cloud computing. Furthermore, the core elements of mobile devices, applications, device management, and application management, as well as those of Cloud computing, which are SaaS, PaaS, and IaaS, have been proposed (Boardman and KPN 2015). On the other hand, the public standard group OASIS (MacKenzie et al. 2006) has introduced the SOA Reference Model, which presents SOA core elements of service and service interface.

## 2.2 Directions of Cloud/Mobile IT

### *2.2.1 Cloud Architecture*

In NIST Cloud computing definition highlights three Cloud service models: SaaS, PaaS, and IaaS (Gill 2015). Figure 2.1 shows the "high-level architectural components of Cloud computing from an enterprise point of view." The architectural components shown in Fig. 1 are divided into two types: "service-based" enclosed in an oval and "resource-based" enclosed in a rectangle. Although the "service-based" component is used by "Cloud computing consumers," the "resource-based" component supports the "service-based" (Khan and Gangavarapu 2009) component.

*PaaS* is a platform hosted at IaaS. PaaS includes both system software and integrated development environment (IDE), in addition to a programming language, test tools, Web, application, database and file servers, and integrated utilities and infrastructure software (Gill 2015). As shown in Fig. 2.1, the PaaS key architectural component is the "development resource" including development platforms. In addition, "service-based" components include "composition" (software components, utilities to build applications) and "execution" (application on the platform to run) (Khan and Gangavarapu 2009).

*SaaS* is a software application developed and deployed, or run, by the underlying PaaS. The SaaS interface can be accessed through client and API interfaces (Gill 2015). As shown in Fig. 2.1, the main SaaS "resource-based" component is "application resources," which includes virtualization and middleware. Although "service-based" components have "application objects" (modules, process logic, and databases), the "processing" components change "customer's data" into "output" (Khan and Gangavarapu 2009).

*IaaS* provides a pool of computing, network, storage, memory, and other related infrastructure resources located in a particular facility. IaaS accommodates PaaS and

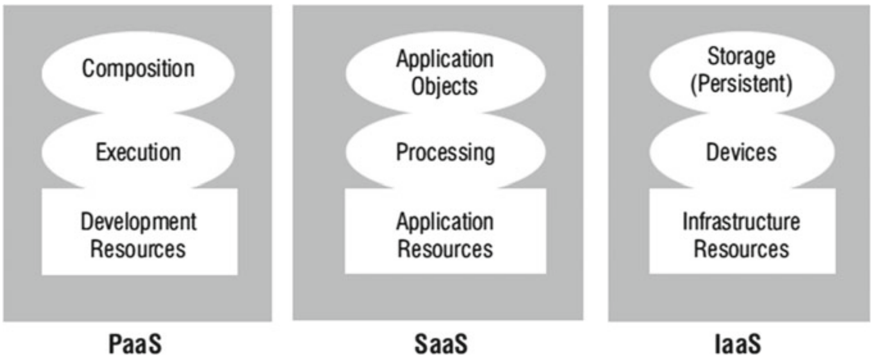


**Fig. 2.1** High-level architectural components of cloud computing from EA perspective (*Source* Cutter IT Journal, November 2009)

SaaS (Gill 2015). As shown in Fig. 2.1, the IaaS key architectural component is "infrastructure resources," which includes servers, disks, devices, and CPUs. With regard to the other two "service-based" components, IaaS includes "storage of consumer's data" (permanent data storage) and "devices" (using the physical computing resources of networks, servers, and CPU power). In network components, there are also low-level architectural components of bandwidth, routers, and switches (Khan and Gangavarapu 2009).

### 2.2.2 SOA and Microservices

*SOA* and *Microservices* vary greatly from the perspective of service characteristics (Richards 2015). In this section, we explain these characteristics.

*SOA* is a collaborative design approach for multiple services to offer various capabilities; its design approach has been used for large monolithic applications (Newman 2015). In terms of service types and roles in SOA, there are extremely clear and formal service classifications. The SOA architectural pattern, shown in Fig. 2.2, defines four basic types (Richards 2015).

Business services are abstract, high-level services that define the core business operations performed at the enterprise level, with XML, Web Services Definition Language (WSDL), etc.

Enterprise services are concrete, enterprise-level services that implement the functionality defined by business services. As shown in Fig. 2.2, middleware components bridge abstract business services and corresponding actual enterprise services. Enterprise services are generally shared across an organization (Richards 2015).

Application services are application-specific services bound to the specific application context. Application services provide specific business functions not seen at the enterprise level, and they can be directly called through dedicated user interfaces or enterprise services.

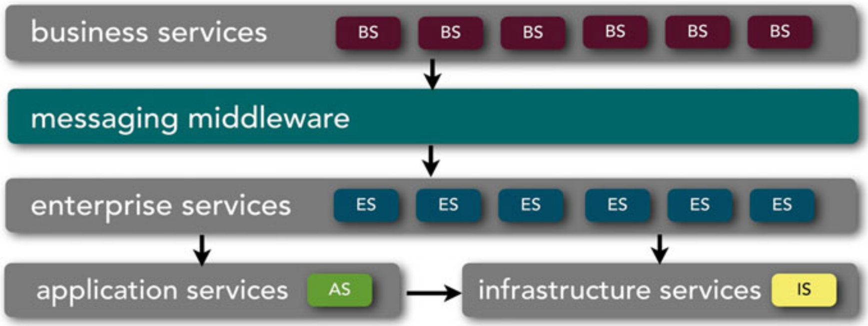


**Fig. 2.2** SOA taxonomy (*Source* Microservices vs. service-oriented architecture, O'Reilly, November 2015)

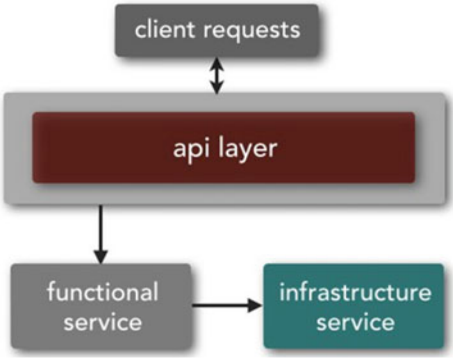


**Fig. 2.3** Microservices service taxonomy

Finally, infrastructure services are those services that implement nonfunctional tasks, such as auditing, security, and logging, almost similar to the Microservices architecture. In SOA, it is possible to call infrastructure services from application or enterprise services (Richards 2015).

*Microservices* are the approach to distributed systems that promote the use of finely grained services with their own life cycles. Such services collaborate together while integrating new emerging technologies to solve the potential problems of many SOA implementations (Newman 2015). Microservices architecture is identified as the optimal architecture for Cloud-hosted solutions. Composed of multiple cooperating Microservices, Microservices architecture is enabled by Mobile IT applications, the Web, and by mounting wearable devices that will become popular in the future (Familiar 2015).

Microservices categories differ decisively from SOA service categories. Microservices architectures have limited service taxonomy in terms of service-type classification. As shown in Fig. 2.3, Microservices are mainly composed of only two service types.

While functional services support specific business operations and functions, infrastructure services support nonfunctional tasks, such as authentication, permissions, auditing, logging, and monitoring, because infrastructure services are not external facing, but are recognized as “private shared services” that can be used internally only for other services. Functional services can be accessed externally and are generally not shared with other services (Richards 2015). Microservices allow early adoption of new technology, such as Mobile IT applications and Cloud computing (Newman 2015). Composed of multiple cooperating Microservices, it can be implemented as a Mobile IT application (Familiar 2015).

## 2.3 Specific Application Layer on Cloud/Mobile IT—Big Data, Internet of Things

### *2.3.1 Big Data*

The new computing trends require data with far greater volume, velocity, and variety than ever before. Big data is utilized in ingenious methods to predict customer buying behaviors, detect fraud and waste, analyze product opinion, and react quickly to changes in business conditions (a driving force behind new business opportunities) (Chappelle 2013). The term "big data" refers to data that is so large, and it is difficult to process using currently available IT systems. There is a growing opportunity for analysis, visualization, and distributed processing software to enable users to extract useful information from such data (Boardman and KPN 2015). Sources of big data include the following.

- Corporate data in SQL databases
- Data in cloud-based SQL or NoSQL databases
- Data provided by social networks
- Data provided by sensors or object identifiers in the Internet of things (IoT).

Big data applications may include visualization functionality for effective user presentation of analytical results. Furthermore, big data applications should leverage Web services that make the results of their analyses available to other applications through APIs; objects in the IoT can be data generators (Boardman and KPN 2015).

Existing Big Data Reference Architectures have been shepherded by NIST, which helped create the big data interoperability framework, including a reference architecture volume. The strengths of a NIST reference architecture include strict vendor neutrality, while providing clear definitions of big data terminology across many domains (US Department of Commerce 2015). Figure 2.4 shows this NIST Big Data Reference Architecture (NBDRA).

The NBDRA represents a big data system comprised of five logical components connected by interoperability interfaces (i.e., services). These include "System Orchestrator," "Data Provider," "Big Data Application Provider," "Big Data Framework Provider," and "Data Consumer." Moreover, two fabrics envelop those five components: "management" and "security and privacy" (US Department of Commerce 2015).

The NBDRA is organized around two axes showing two big data value chains: the information (horizontal axis) and the IT (vertical axis). Along the information axis, value is created by data collection, integration, analysis, and application of these results into the value chain. Along the IT axis, value is created by offering networking, infrastructure, platforms, application tools, and other IT services for hosting and operating Big Data to support required data applications. The intersection of both axes is the Big Data Application Provider component, indicating that, in both value chains, data analytics and its implementation provide value to Big Data (US Department of Commerce 2015). The "DATA" arrows in Fig. 2.4 show the flow of

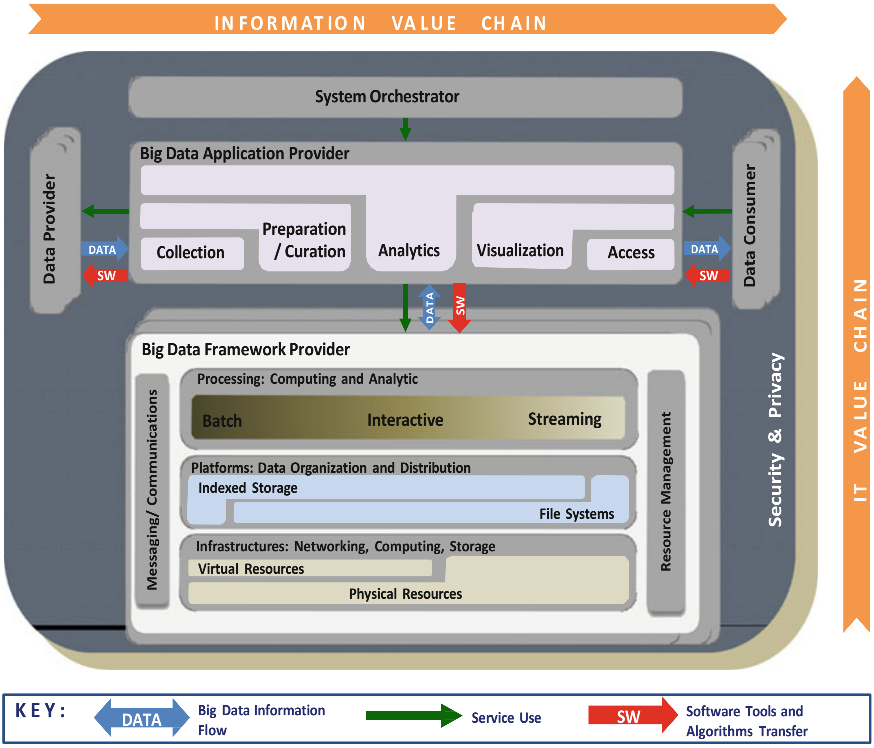


**Fig. 2.4** NIST Big Data Reference Architecture (NBDRA)

data between the main components. The "SW" arrows show transfer of software tools for processing Big Data. The "Service Use" arrows show software programmable interfaces (US Department of Commerce 2015).

LinkedIn, for example, collects data from users and offers services, such as skill endorsements or newsfeed updates to users based on data analysis. Additionally, Twitter uses collected data for real-time query suggestion (Pääkkönen and Pakkala 2015). Therefore, most solutions exist in the Big Data Application Provider component and should be categorized as Specific Application Layers on Cloud and Mobile IT platforms. Technology vendors such as Oracle (2014), IBM (Mysore et al. 2013), and Microsoft (2012) have also developed Big Data Reference Architectures (Kein et al. 2016). These vendors publish practical reference architectures for Big Data toward EA practitioners in corporations and other groups. Most companies already use analytics for forms, reports, and dashboards based on structured data from operational information systems that conform to predetermined relationships. However, Big Data cannot follow this structured model. The streams are all different and have difficulty establishing common relationships. However, this diversity and abundance can provide opportunities to learn and develop new ideas to support business transformation (Chappelle 2013).

The architectural challenge is to bring the above two paradigms together. Therefore, rather than Big Data becoming a new technology silo, organizations should share a unified information architecture to leverage all types of Big Data for promptly satisfying business needs. Oracle provides a practical Big Data Reference Architecture to face the challenges depicted in Fig. 1 of the previous white paper of Chappelle (2013), which provides a conceptual view of the Big Data Analytics Reference Architecture, designed to provide a high-level architecture description of the Big Data and analytics solution (Chappelle 2013).

The above Big Data Analytics Reference Architecture concentrates the following three important aspects.

- "*Unified information management*" corresponds to the need to manage information holistically, as opposed to governed business silos independently, such as with "high-volume data acquisition," which acquires high-volume data with some discards, and "multi-structured data organization and discovery," which organizes data of different structures into a common schema.
- "*Real-time analytics*" can contribute to businesses by leveraging information and analysis with prevailing events using "interactive dashboards" to react to information and to drill down root cause analyses of situations.
- "*Intelligent processes*" can execute business processes more effectively and efficiently, using analysis such as "optimized rules," "recommendations," and "performance/strategy management."

The middle/lower layer of Fig. 1 depicted in the previous white paper of Chappelle (2013) represents "information," in which Big Data and analytics architecture incorporate many different types of data, such as "operational data," "content," and "external/analytical data." In the lower layer of Fig. 1 depicted in the previous white paper of Chappelle (2013), "deployment" options are presented for deployment of architecture components, such as "Public Cloud," "Private Cloud," and "Managed Services" (Chappelle 2013). Hence, Big Data can be categorized as Specific Application Layers on cloud and mobile IT platforms.

### *2.3.2 Internet of Things (IoT)*

The term "Internet of Things (IoT)" is used to mean "the collection of uniquely identifiable objects embedded in or accessible by Internet hosts" (Boardman and KPN 2015). A "uniquely identifiable object" can be described as follows: These objects are connected with real-world interaction devices, smart homes, and cars, and other SmartLife scenarios. The IoT fundamentally revolutionizes digital strategies with innovative business operating models (Ross et al. 2006), and holistic governance models for business and IT (Weill and Ross 2004), under fast-changing markets (Zimmermann et al. 2015).

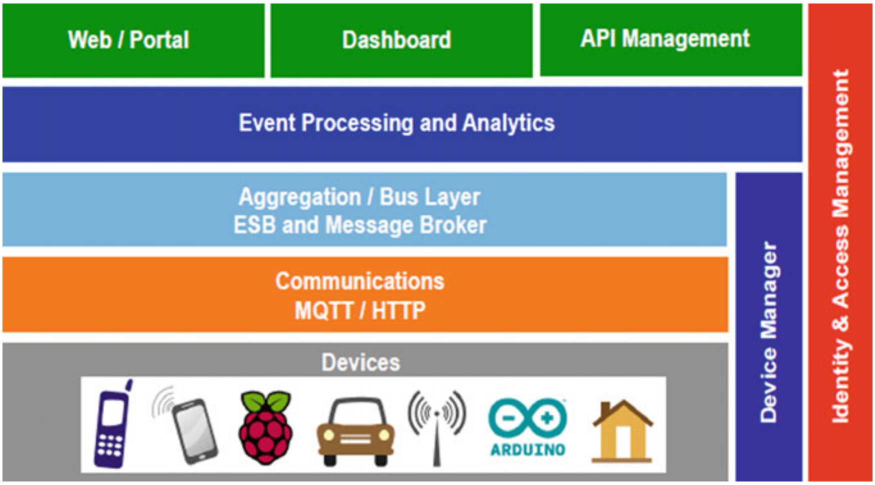


**Fig. 2.5** Internet of Things reference architecture [WS15]

- A sensor, such as a temperature sensor (thermometer)
- A control; for example, to control a valve in a heating system
- A combination of sensor and control (e.g., a thermostat)
- An object identifier, such as an RFID tag or a bar code.

The current state of research for the Internet of Things architecture (Patel and Cassou 2015) lacks an integral understanding of EA and management (Iacob et al. 2015; Johnson et al. 2014; The Open Group 2011a, b, 2012), and shows a number of physical standards, methods, tools, and a large number of heterogeneous IoT devices (Zimmermann et al. 2015). A first reference architecture (RA) for the IoT is proposed by WSO2 (2015) as shown in Fig. 2.5 and can be mapped to a set of open-source products. This RA covers aspects like "cloud server-side architecture," "monitoring/management of IoT devices, services," "specific lightweight RESTful communications," and "agent, code on small low power devices." Layers can be instantiated by suitable technologies for the IoT (Zimmermann et al. 2015; Masuda et al. 2018).

On the other hand, in the field of IoT, platforms are designed to deploy digital IT applications that monitor, manage, and control connected IoT devices. McKinsey also shows the layered model of the "Internet of Things tech stacks" as shown in Fig. 2.6.

From standpoints of IoT middleware, based on Ngu et al. (2017) architecture categories, comparative analysis, and key issues of IoT middleware were clarified. Ngu et al. defined "(1) lightweight and portability," "(2) composition engine," "(3) semantic service discovery," and "(4) the guarantee of security" as issues of IoT middleware (Yamamoto et al. 2017).

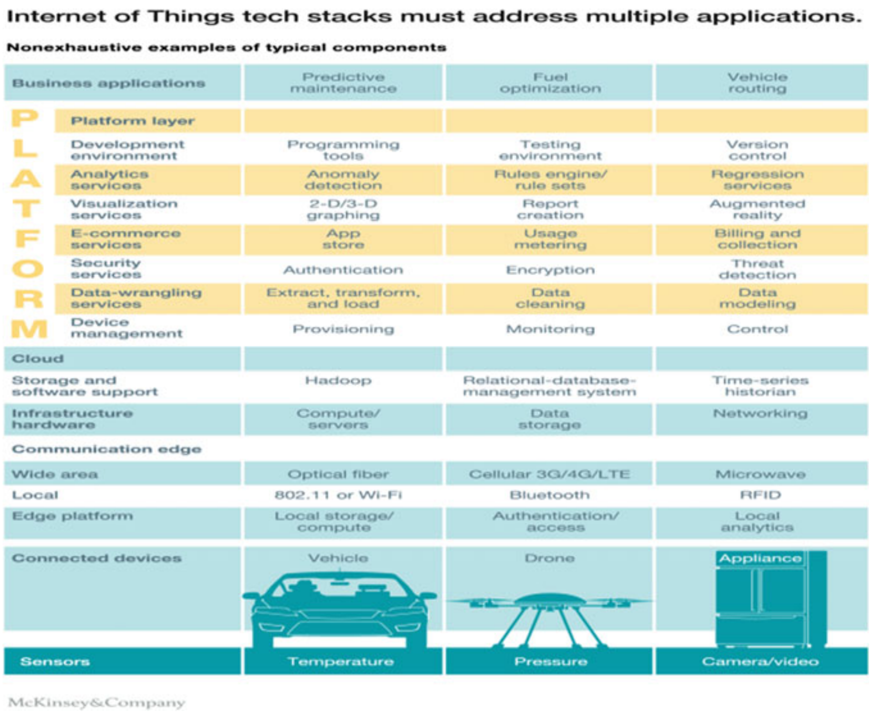


**Fig. 2.6** McKinsey IoT stacks

First, during development, an IoT middleware, such as IoT devices and gateways, must be available in the cloud as well as on the edge to support all kinds of IoT applications. This requires the middleware to be portable and lightweight. Only Calvin (Persson and Angelsmark 2015), Node-RED (Node-RED 2016), and Ptolemy (2017) are designed to be portable and lightweight (Ngu et al. 2017).

Second, to create IoT applications targeted to their context, a composition engine should be provided for consumers. The visual tools provided by Node-RED (Node-RED 2016) and Ptolemy (2017) can be used as composition tools for this purpose (Ngu et al. 2017).

Third, to provide a semantic service discovery for IoT services/devices, it is necessary to be capable of discovering or querying for compatible services at the right time and at the right place both at the time of design and at runtime (Ngu et al. 2017). OpenIoT (OpenIot 2018), GSN (GSN 2018), and Hydra (2017) can provide semantic service discovery as the IoT middleware (Yamamoto et al. 2017).

Finally, to guarantee the security of IoT applications and protect the privacy of users, many digital applications need to utilize a reliable IoT infrastructure. GSN (2018) and Hydra (2017) can provide such security guarantee functions (Yamamoto et al. 2017).

## 2.4 EA Frameworks—TOGAF, FEAF, Adaptive EA, etc.—With the Integration of Cloud/Mobile IT

To start, the first step is to select an EA framework for this research. The criteria for this selection are: (A) widely used and highly evaluated EA frameworks and (B) an EA framework that supports Mobile IT/Cloud computing and Web service elements. According to a survey in the Journal of Enterprise Architecture (Cameron and McMillan 2013), from the perspective of the "widely used" criterion, TOGAF, Zachman, Gartner, Federal Enterprise Architecture Framework (FEAF), and DoDAF are the most widely used EA frameworks, and it was decided that TOGAF, FEAF, and DoDAF are "highly evaluated." Furthermore, according to Sessions (2007), Zachman, TOGAF, FEAF, and Gartner are the most commonly used EA frameworks.

In this chapter, the second criterion for EA framework selection is integration with the elemental framework of Mobile IT/Cloud computing and services (part of SOA). From the perspective of integrating the elements of Mobile IT and strongly directly linked Cloud computing, Gill et al. (2014) argued that FEAF, TOGAF, Zachman, and the Adaptive Enterprise Architecture framework (Gill 2013) are suitable. In addition, TOGAF, FEAF, DoDAF, and the British Ministry of Defence Architecture Framework (MODAF) are discussed from the perspective of integration with SOA elements, which have Web services (Alwadain et al. 2010, 2014; Federal CIO Council 2008; US Department of Defense 2009).

In addition, because the Gartner framework is limited to commercial use, complete access is not possible and it is therefore outside of our scope (Franke et al. 2009). Moreover, because the Zachman Framework does not provide an enterprise architecture process for implementing and operating an enterprise architecture capability (Gill 2015), this is also out of our scope at this time.

What follows is an explanation of the five EA frameworks, selected in the above steps, that were the subject of a comparative survey in this research for the book.

### *2.4.1 TOGAF (The Open Group Architecture Framework)*

As TOGAF is a framework for developing enterprise architecture with a detailed method and supporting tools, developed and maintained by members of The Open Group. Architecture Development Method (ADM) is the core of TOGAF. Figure 2.7 shows this ADM in TOGAF9. It describes a step-by-step approach to developing enterprise architecture (ISO/IEC JTC 1/SC7 Architecture Guidance, Garnier et al. 2014). TOGAF is not attached to government enterprises. It is a generic and comprehensive framework that can be tailored for the development of effective enterprise architecture capability for technology-enabled enterprise adaptation (Gill 2015). With regard to the remaining parts of TOGAF, "the content framework" provides a conceptual meta-model for describing architectural artifacts. "The enterprise continuum" is a virtual repository for storing architectural models and architectural

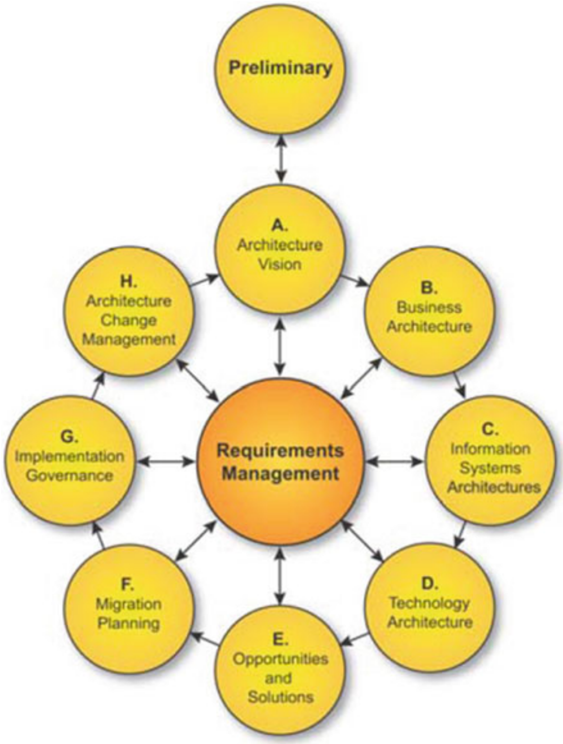


**Fig. 2.7** Architecture Development Method (ADM) in TOGAF9 (*Source* The Open Group (2009))

descriptions. "The TOGAF reference models" are divided into the TOGAF Technical Reference Model and the Integrated Information Infrastructure Reference Model (Buckl et al. 2009; The Open Group 2009).

Web service/SOA elements in TOGAF are found in its meta-model and discussed further in its documentation (The Open Group 2009). TOGAF has three layers. First, in the Business Architecture, a business service is identified in the meta-model. In the Application Architecture, application and information system services are represented in the meta-model. In the Technology Architecture, a platform service is identified in the meta-model (Alwadain et al. 2014). There is a specific notation of the Mobile IT Category, particularly in the mobile device part of "Enterprise Security View" and "Communication Engineering View" under the content framework Technology Architecture portion. In addition, there is mention of the APIs under Application Architecture and Technology Architecture in ADM and TRM. In TOGAF, a service interface is identified as part of all three architectures of business, application, and technology, whereas there is no element of a Cloud category (Masuda et al. 2016).

### 2.4.2 *Federal Enterprise Architecture Framework (FEAF)*

FEAF (Federal Enterprise Architecture Framework 2013) is a comprehensive framework for developing and maintaining the enterprise architecture capability of the federal government. FEAF provides a common and standardized approach and principles for developing and sharing architecture information between agencies (Gill 2015). Figure 2.8 shows the structure of this FEAF. FEAF was developed by the US Federal Chief Information Officers Council (Federal CIO Council 2008). The core of FEAF is a Collaborative Planning Methodology (CPM) and Consolidated Reference Model (CRM). CRM specifies six interrelated reference models: Performance Reference Model (PRM), Business Reference Model (BRM), Data Reference Model (DRM), Application Reference Model (ARM), Infrastructure Reference Model (IRM), and Security Reference Model (SRM) (Gill 2015). The reference models are intended to standardize terms and definitions in EA contexts and improve sharing and collaboration across the entire federal government (Federal CIO Council 2008).

First, with regard to FEAF Mobile IT Category elements, mobile devices appear in SRM and IRM meta-models and in ARM and BRM. APIs are produced in the ARM meta-model and DRM (Federal Enterprise Architecture Framework 2013). With regard to FEAF Cloud Category elements, Cloud computing is produced in IRM meta-models, and SaaS, PaaS, and IaaS are noted in IRM Cloud First Initiatives. Furthermore, Cloud computing is noted in ARM and SRM (Federal Enterprise

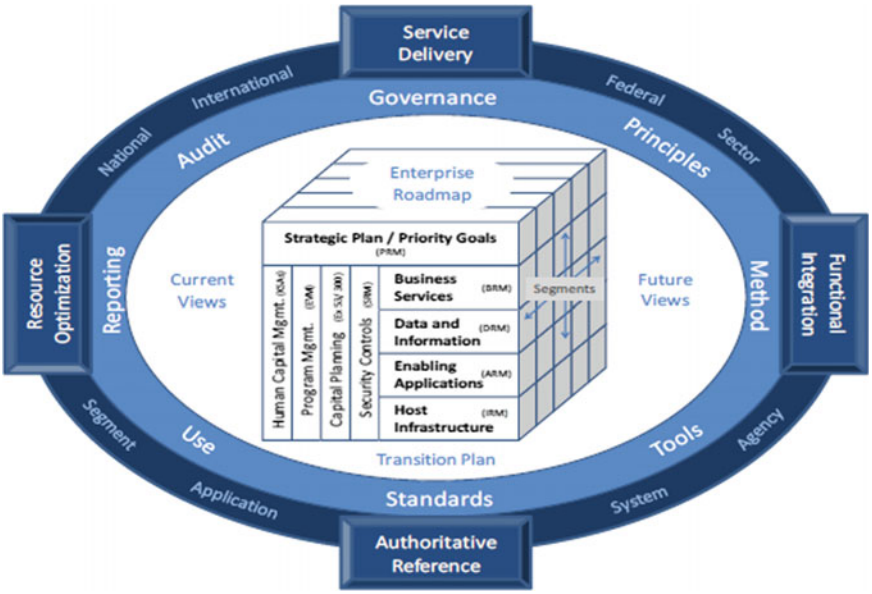


**Fig. 2.8** Structure of the FEAF (*Source* Federal Enterprise Architecture Framework Version 2 (2013))

Architecture Framework 2013). Concerning FEAF Web service/SOA elements, business service appears in the BRM meta-model, DRM, and ARM. Application service is noted in ARM, enterprise service in BRM, and infrastructure service in IRM (Federal Enterprise Architecture Framework 2013). Service consumer and service provider are also identified in BRM (Federal Enterprise Architecture Framework 2013; Federal CIO Council 2008). Moreover, Application interface appears in ARM meta-models (Federal Enterprise Architecture Framework 2013), and service interface is noted in ARM (Federal CIO Council 2008).

### *2.4.3 Department of Defense Architecture Framework (DoDAF)*

DoDAF is an architecture framework for the United States Department of Defense and defines a standard approach for describing, presenting, and integrating DoD architecture. DoDAF provides the guidance and rules for developing architecture descriptions in order to show a common denominator for understanding, comparing, and integrating System of Systems (SoS), and interoperating and interacting architectures (ISO/IEC JTC 1/SC7 Architecture Guidance, Garnier et al. 2014). DoDAF provides a six-step architecture development process: Define Architecture Use, Define Architecture Scope, Define Required Architecture Data, Manage Architectural Data, Analyze Architecture Data, and Document Architecture (according to the intended architecture use or needs). Figure 2.9 shows the "DoDAF six-step architecture process".

The DoDAF meta-model is structured around the interoperability of processes and systems (Gill 2015). DoDAF V2.0 has different layers (viewpoints): Systems Viewpoint (SV), Service Viewpoint (SvcV), Data and Information Viewpoint (DIV), Operational Viewpoint (OV), Standards Viewpoint (StdV), Capability Viewpoint (CV), Project Viewpoint (PV), and All Viewpoints (AV) (US Department of Defense 2009). DoDAF provides a concrete EA process, meta-model, models, viewpoints, etc. (Gill 2015).

First, with regard to Mobile IT Category elements in DoDAF, mobile devices are mentioned under CV. Concerning Cloud categories in DoDAF, SaaS is noted in SvcV and CV. In addition to PaaS and IaaS, Cloud computing is also addressed under CV. With regard to Web service/SOA elements in DoDAF, in the DoDAF generic meta-model, a service (including business and software services), a service port, and performer (both service consumer and provider) are identified. The main viewpoint that has Web service/SOA elements is SvcV. However, these elements appear in other viewpoints, such as AV and CV, when mapping services to capabilities (Alwadain et al. 2014).

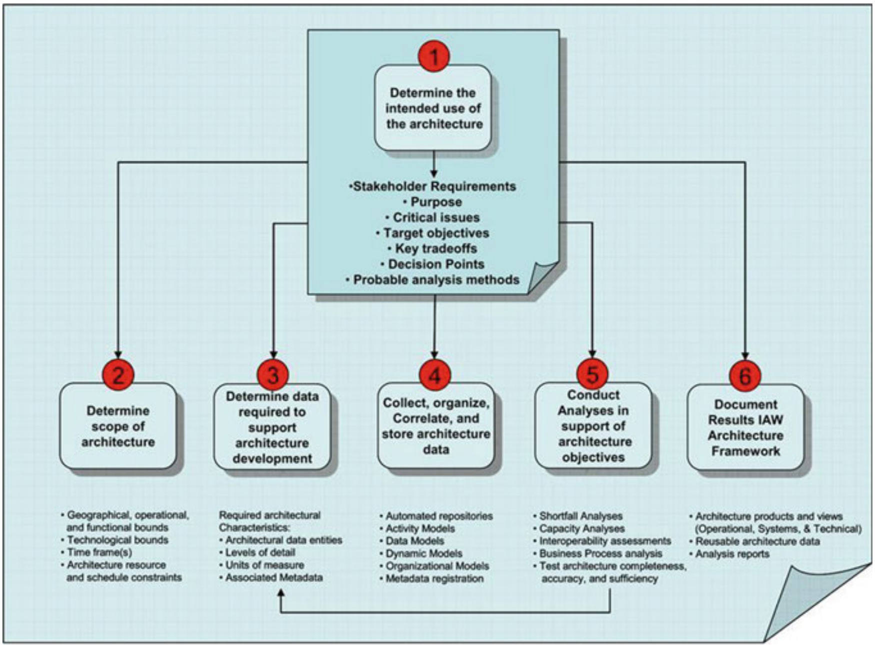


**Fig. 2.9** DoDAF six-step architecture process (*Source* Architecture Guidance Study Report, ISO/IEC JTC1 SC7 Software and systems engineering, April 2014)

### *2.4.4 MODAF (British Ministry of Defence Architecture Framework)*

MODAF defines a normalized way of conducting enterprise architecture, and it was originally developed by the UK Ministry of Defence (MOD). The UK's MOD defined an architecture framework named MODAF in 2006–2008 with adapting DoDAF. Figure 2.10 shows the "MODAF architecture process". MODAF is an internationally normalized EA framework developed by MOD to support defense planning and change management activities (ISO/IEC JTC 1/SC7 Architecture Guidance, Garnier et al. 2014). MODAF provides a consistent set of rules and templates, known as views, that present a textual and graphical visualization of an area of the business. Each view provides a special perspective of the business in order to meet various stakeholder concerns. The views are divided into seven categories: strategic, operational, service-oriented, systems, acquisition, technical, and all views. MODAF includes a meta-model that defines the relationship between all data in all the views (UK Ministry of Defence 2010a).

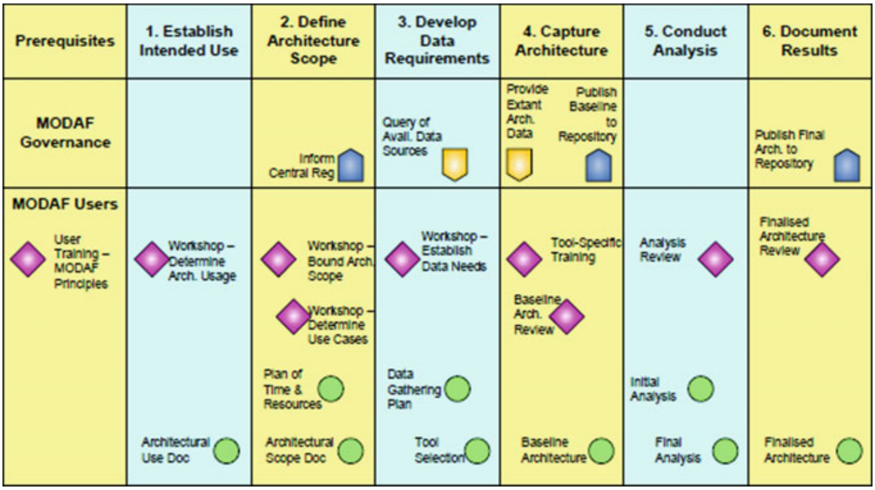


**Fig. 2.10** MODAF architecture process (*Source* MOD Architecture Framework (MODAF), UK Ministry of Defence, October 2010)

With regard to Mobile IT Category elements in MODAF, although mobile devices are noted in strategic and System Viewpoints, the focus is from a mobile network perspective. Moreover, there are no Cloud Category elements in MODAF. Web service/SOA-related elements identified in the MODAF models are service, service interface, and service consumer in the service-oriented viewpoint (UK Ministry of Defence 2010b). In addition, there is note of application services under the service-oriented viewpoint (Masuda et al. 2016).

### 2.4.5 *Adaptive Enterprise Architecture Framework*

The Adaptive Enterprise Architecture framework (also known as the Gill Framework) is a meta-framework that can be used to support the tailoring of a situation-specific Adaptive Enterprise Architecture capability or framework (Gill 2013). Figure 2.11 shows the "Adaptive Enterprise Architecture framework." This framework provides support for developing and managing adaptive or Agile Enterprise Architecture in a modern context, including adaptive Cloud technology-enabled enterprise architecture. This framework has its foundation on the new "adaptive enterprise service system" theory, which extends the SoS, agility, and service science approaches for defining, operating, managing, supporting, and adapting a modern enterprise as an "adaptive enterprise service system" (Gill 2013). This framework has two main layers: outer and inner. The outer layer presents five adapting capabilities (i.e., context awareness, assessment, rationalization, realization, and un-realization) to guide the continuous adaptation of the Adaptive Enterprise Architecture as an adaptive enter-

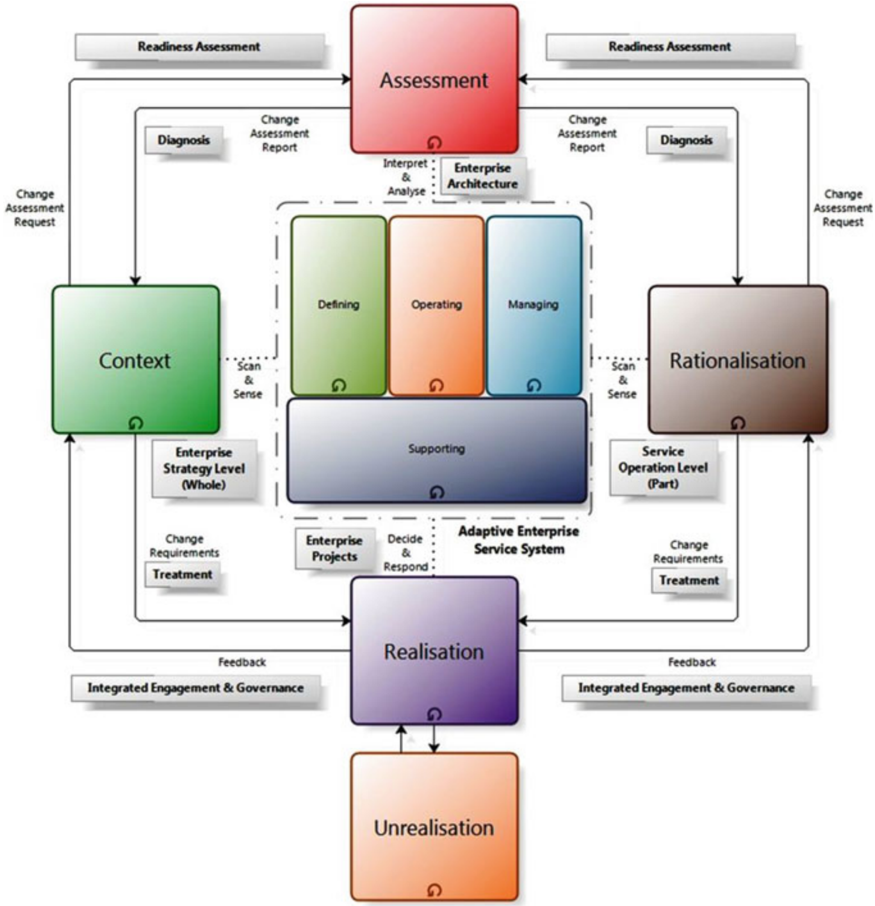


**Fig. 2.11** Adaptive Enterprise Architecture framework (*Source* Gill 2014)

prise service system in response to internal and external changes. The inner layer assists in defining, operating, managing, and supporting the complex enterprise as an adaptive enterprise service system in response to changes or requirements reported by the outer layer (Gill et al. 2014).

First, with regard to Mobile IT Category elements in an Adaptive EA framework, there is note of mobile devices and APIs in Cloud EA Capability. With regard to Cloud Category elements in the Adaptive EA framework, SaaS, PaaS, and IaaS reside in the Adaptive Cloud EA Model, and the Cloud interface is described in the Adaptive Cloud EA—the model for the federated adaptive enterprise Service Information System (SIS). Furthermore, concerning Web service/SOA elements in an Adaptive EA framework, business, application, information, infrastructure, and platform services reside in the enterprise service system meta-model and Cloud EA

Model (service mapping—external view) and the service-based mobile application is described in Cloud EA Capability. Moreover, business interface resides in the Business Architecture Model (internal view) of Cloud EA Capability (Masuda et al. 2016).

### 2.4.6 EA$^3$ Cube Framework

The EA$^3$ Cube Framework is the framework which has a cubic shape with three dimensions relating to different aspects of documenting the abstracted enterprise (Bernard 2012). Figure 2.12 shows the "EA$^3$ Cube™ Framework". The levels of this framework are hierarchical; therefore, the different sub-architectures can be logically related to each other. This is performed with positioning high-level strategic goals/initiatives at the top, and business products/services and data/information flows in the middle, and supporting systems/applications and technology/infrastructure at the bottom (Bernard 2006).

Utilizing the EA$^3$ Cube Framework, the top two levels of this framework (strategy and business) primarily draw their legitimacy and relationships from sociological aspects on how people organize, attain goals, and plan and work (March and Olson 1989, Weick 1995).

The middle level of the Cube Framework (information/data) is the middle ground, where it is influenced by both social and physical sciences, shows why and how people share information to attain goals and tasks, as well as influences from physical sciences such as information theory and database theory (Martin 1986).

The bottom two levels of this framework (systems and networks) are largely influenced by physical sciences such as software engineering and computer science (Bernard 2006).

For the purpose of lowering risk and promoting efficient implementation methods, the EA$^3$ Cube Framework is divided into segments as lines of business (LOBs). For instance, each line of business has a complete sub-architecture that covers all five hierarchical levels of the EA$^3$ framework. An architecture encompassing all five framework levels focused on one or more LOBs can be referred to as a segment of the overall EA (Bernard 2006).

As an example of recent types of organizations and enterprises, the organization/enterprise's structure is based on the teams and remote workers, and their goals and functions may change depending on internal and external influences. As called the organizational network model (ONM), the executive team can set policy and goals, approve resources, and evaluate results, while semiautonomous functional teams and independent workers manage ongoing programs, new IT projects, and team-specific resources (Bernard 2012). The functional teams and independent workers obtain policy and goals, general direction from the executive team, and still execute organizational functions in an independent or cooperative manner, depending on the goals. Figure 2.13 shows the relationship of the EA$^3$ Cube Framework to the organizational network model.

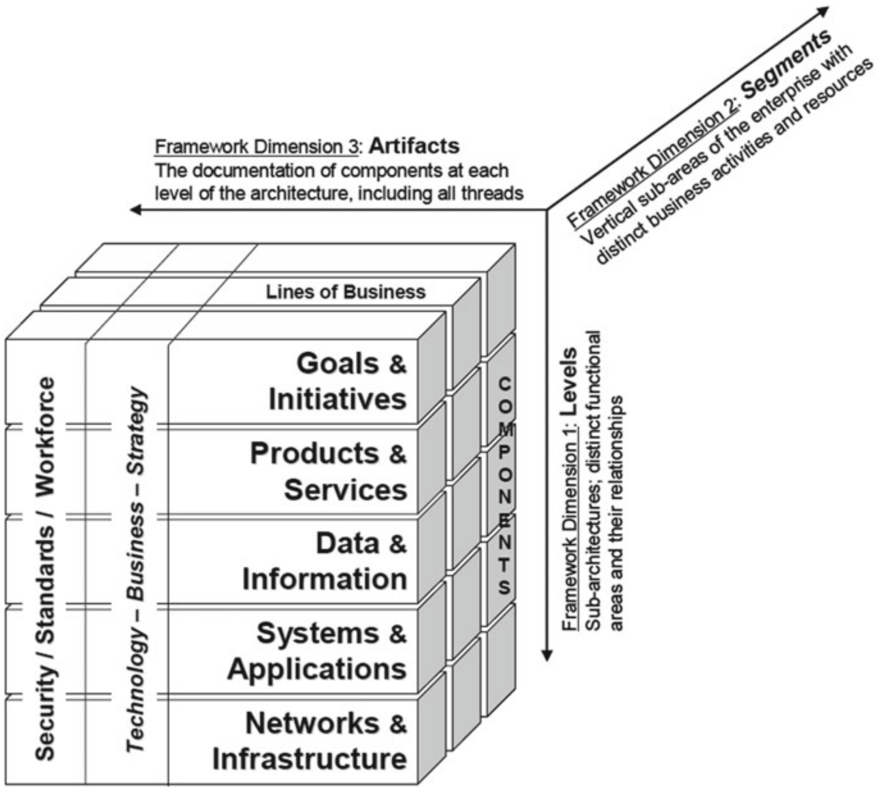


**Fig. 2.12** EA$^3$ cube framework (*Source* Bernard 2012)

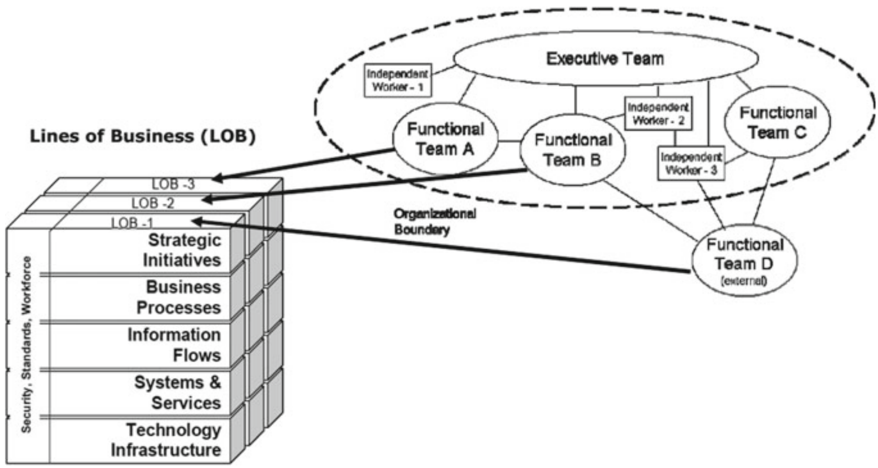


**Fig. 2.13** EA$^3$ cube framework and relationship with the organizational model (*Source* Bernard 2012))

These types of ONM-based organizations can respond to changing requirements more quickly by creating, modifying, or eliminating functional teams or adjusting the number and type of independent workers, which includes trusted business partners and independent consultants that should be allowed to share sensitive information and key resources with the enterprise as a part of the activities of the functional teams and independent workers. Figure 2.13 shows how functional teams in the above organizations can be related to an enterprise's LOBs in the EA$^3$ Cube Framework as well (Bernard 2012).

## 2.5 EA Framework Analysis

### *2.5.1 Comparison of Mobile IT/Cloud Integration in EA Frameworks*

The five selected EA frameworks are compared based on the key elements of Mobile IT/Cloud computing and services in order to present an overview of the status in terms of the Mobile IT/Cloud elements and the position of these elements in the layers (viewpoints) of the five frameworks as shown in Fig. 2.14. Perspectives and conclusions based on this comparison are presented in the following sections (Masuda et al. 2016).

First is the Mobile IT Category. The Mobile IT-related elements are identified in all frameworks. For instance, mobile device is found in the FEAF meta-models in IRM and SRM, and FEAF documents in BRM and ARM. Moreover, mobile device is identified in the TOGAF, DoDAF, MODAF, and Adaptive EA framework documents. An API is found in the FEAF meta-model in ARM, and FEAF documents in DRM. Furthermore, an API is presented in the TOGAF and Adaptive EA framework documents. However, *Mobile Device Manager* and *Mobile Application controller* are not found in all frameworks (Masuda et al. 2016).

Second is the Mobile IT-related Cloud computing category. Many elements of "Mobile IT-related Cloud computing" that involve SaaS, PaaS, and IaaS are found in the meta-models of Adaptive EA framework. Moreover, SaaS is identified in the FEAF document in IRM, and DoDAF documents. PaaS and an IaaS are used in the FEAF document in IRM and DoDAF document. Furthermore, other Cloud-related elements are identified in the FEAF meta-model in IRM and FEAF documents in ARM and SRM, and in the DoDAF document. Moreover, in the Adaptive EA framework documents, a Cloud interface is found (Masuda et al. 2016).

Third is the service category. The service is identified in all frameworks, but it varies remarkably in the details. For instance, a generic service element is found in the meta-models of DoDAF, MODAF, and Adaptive EA framework, whereas a business service is recognized in the meta-models of TOGAF, FEAF, and Adaptive EA framework, and in the DoDAF documents. In addition, an application service is identified in the TOGAF and Adaptive EA framework meta-models, and in the FEAF,

| EA Frameworks | | TOGAF 9 | | | FEAF | | | | | DoDAF v2.0 | | MODAF | | Adaptive EA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Layers (views) Mobile IT/Cloud elements | | Business | Information Systems | Technology | BRM | DRM | ARM | IRM | SRM | Capability View | Services View | Strategic /System Viewpoint | Service Oriented Viewpoint | Enterprise Service System | Cloud EA Capability |
| Mobile IT Category (TA) | Mobile Device | | | * | * | | * | ** | ** | * | | * | | | * |
| | API | | * | * | | * | ** | | | | | | | | * |
| | Mobile Device Manager | | | | | | | | | | | | | | |
| | Mobile Application Controller | | | | | | | | | | | | | | |
| Mobile IT-related Cloud Category (TA) | SaaS | | | | | | | * | | * | * | | | | ** |
| | PaaS | | | | | | | * | | * | | | | | ** |
| | IaaS | | | | | | | * | | * | | | | | ** |
| | Cloud Interface | | | | | | | | | | | | | | * |
| | Other | | | | | | * | ** | * | * | | | | | ** |
| Services Category (AA) | Service | | | | | | | | | * | ** | | ** | ** | ** |
| | Business Service (micro service) | ** | | | ** | * | * | | | | * | | | ** | ** |
| | Application Service (functional service) | | ** | | | | * | | | * | * | | * | ** | ** |
| | IS Service (functional service) | | ** | | | | | | | | | | | ** | ** |
| | Enterprise Service (functional service) | | | | * | | | | | | | | | * | |
| | Infrastructure Service (infrastructure service) | | | * | | | | * | | | | | | ** | ** |
| | Platform Service (functional service) | | | ** | | | | | | | | | | ** | ** |
| | (Service based) Mobile Application | | | | | | | | | | | | | | * |
| Actors Category | Actor | * | | | * | | | | * | | | | | ** | ** |
| | Service Consumer | * | | * | * | | | | | | | | ** | * | |
| | Service Provider | * | * | * | * | | | | | | | | * | | |
| | Performer | | | | | | | | | * | ** | | | | |
| Interfaces Category | Business Interface | | | | | | | | | | | | | | ** |
| | Application Interface | | | | | | ** | | | | | | | | * |
| | Infrastructure Interface | | | | | | | | | | | | | | * |
| | Service Port | | | | | | | | | | ** | | | | |
| | Service Interface | * | * | * | * | | * | | | | | | ** | * | |

**Fig. 2.14** Mobile IT/cloud elements in EA frameworks

DoDAF, and MODAF documents. Furthermore, an information system service is found in the TOGAF and Adaptive EA framework meta-models, and an enterprise service is identified in the FEAF and Adaptive EA framework documents. Moreover, an infrastructure service is presented in the Adaptive EA framework meta-model, and in the TOGAF and FEAF documents, whereas a platform service is used in the TOGAF and Adaptive EA framework meta-models (Masuda et al. 2016; Chief Information Officer Council 2001). From the perspective of Microservices and application, information system, platform services, etc., in SOA, these are equivalent to functional services. Service-based mobile application is not found in all frameworks, with the exception of Adaptive EA framework. In terms of Microservices, infrastructure service in SOA is equivalent to infrastructure service, whereas business service in SOA is close to Microservices (Masuda et al. 2016).

Fourth is the actors' category. In the Adaptive EA framework meta-model, an actor is identified in the business layer and in the TOGAF and FEAF documents in BRM and SRM. A service consumer is presented in the MODAF meta-model and in the TOGAF, FEAF, and Adaptive EA framework documents. Moreover, a service provider is used in the TOGAF and MODAF documents, and FEAF documents in BRM, whereas a performer that could be a service provider or consumer is presented in the DoDAF meta-model and documents (Masuda et al. 2016).

Fifth is the interface category. A business interface is identified in the Adaptive EA framework meta-model. Moreover, application and infrastructure interfaces are found in the Adaptive EA framework documents. However, in the DoDAF meta-model, it is called a service port, whereas in the TOGAF, FEAF, Adaptive EA framework documents, and MODAF meta-models, it is called a service interface (Masuda et al. 2016).

### 2.5.2 Analysis of Cloud/Mobile IT Integration in EA Frameworks

The analysis from previous sections resulted in several beneficial findings. First, the Mobile IT element is recognized in the frameworks. A mobile device and/or API were identified in most layers (viewpoints) of TOGAF, FEAF, and Cloud EA Capability of Adaptive EA framework. Moreover, only the mobile device was found in DoDAF and MODAF. On the other hand, all frameworks did not include the elements of a Mobile Device Manager and Mobile Application controller at the current time, which can lead to difficulties for making proper architecture models/guidelines for Mobile IT to promote EA (Masuda et al. 2016).

Second, most frameworks have elements of Cloud computing related to Mobile IT, with the exception of TOGAF and MODAF. All the elements of Cloud computing related to Mobile IT, such as SaaS, PaaS, and IaaS, are included in FEAF, DoDAF, and Adaptive EA framework meta-models. Because the US government agency promotes the IT strategy called "Cloud First," where shared services become suitable for budget reduction and optimization with common sense approaches, Cloud IRM defined in FEAF has the elements of SaaS, PaaS, and IaaS. In terms of DoDAF, SaaS is found in the description of "DoDAF meta-model for services," whereas PaaS, IaaS, and SaaS are identified in the description of "service-centric IE capability." The Cloud interface is identified only in Adaptive EA framework. Because all frameworks do not have the Cloud interface indispensable for implementation of the hybrid Cloud-based system in companies, with the exception of the Adaptive EA framework, it is obvious that few model-defining hybrid Clouds appropriate for companies exist in EA frameworks. Therefore, it will be considered that the corporation adopting TOGAF, etc., can adopt the integrated framework with the Adaptive EA framework supporting elements of Cloud computing to meet the shift to Cloud computing environments in the future. In addition, concerning the Zachman Framework, Zachman has published an Official Newsletter specific to the Cloud Category that mentions a definition of Cloud computing within physical and detailed views (Zachman 2011). Moreover, Laplante et al. (2008) defined SaaS within an entire view of contextual, conceptual, logical, physical, detailed, and functioning (Masuda et al. 2016).

Third, all frameworks have a service element, but some differences are observed by examining further and comparing systematically. A business service is included in most EA frameworks. An application service is also included in most frameworks. However, the IS, enterprise, and platform services are less frequent. Each of these is covered in one framework and the Adaptive EA framework. Although the platform service is presented in TOGAF and Adaptive EA framework, the infrastructure service is used in these frameworks as well as FEAF—they have similar semantics. Furthermore, it is apparent that TOGAF has a clear categorization and representation of services in all their layers (viewpoints). A service-based mobile application is found only in the document of the Adaptive EA framework. On the other hand, few service elements described as Microservices are found in all frameworks at the current time (Masuda et al. 2016).

Fourth, the actor element is included in the frameworks. An actor as a generic element is discovered in TOGAF to represent both the service provider and the consumer. The separation of the provider from the consumer in two elements is only observed in FEAF (Alwadain et al. 2014). In Adaptive EA framework, only service consumer is found in two elements. The actor element is similar to many of the other elements in terms of terminology discrepancy, regardless of whether a generic actor element is used to represent both the provider and the consumer (Alwadain et al. 2014).

Fifth, all frameworks have an interface element, but some differences are identified by comparing them. In terms of the service interface, all frameworks contain interfaces as part of SOA. However, interface-related elements are represented through different terms in the various frameworks. For example, in DoDAF, the term "service port" was chosen instead of "service interface" (Alwadain et al. 2014). Adaptive EA framework includes business, application, infrastructure, and service interfaces (Masuda et al. 2016).

Furthermore, it appears that the presented frameworks can generally or partially accommodate the elements that constitute the categories of Mobile IT/Cloud computing and services as part of SOA. However, there are few elements of Mobile IT and related Cloud computing, which is beneficial to the definitions of architecture models/guidelines/processes in Mobile IT and related Cloud computing to promote EA in corporations. In specific, in terms of the Mobile IT Category, the existing EA frameworks have not supported the essential mechanisms of this one to date because most elements, such as mobile device management, mobile application, and its controller, are not included in all EA frameworks at the current time. We concluded that there should be a problem where there is no element useful for defining proper architecture models/guidelines/processes in Mobile IT and Mobile IT-related Cloud computing in all frameworks to promote EA (Masuda et al. 2016).

### *2.5.3 Results of EA Framework Analysis*

In this section, five EA frameworks were investigated and compared in terms of Mobile IT/Cloud computing and service elements. They all supported service elements at different levels and almost all included the elements of Mobile IT/Cloud computing, even if they supported Mobile IT/Cloud related ones partially. However, although only Cloud computing elements were found in the Adaptive EA framework and FEAF meta-models, which led to architecture models/guidelines/processes for Cloud computing, there were few elements of Mobile IT and related Cloud computing effective for making appropriate architecture models/guidelines/processes in Mobile IT and related Cloud computing to promote EA in corporations. For instance, there was no element of Cloud interface in the meta-models of all frameworks, which is essential for defining a hybrid Cloud system, whereas there was no element of Mobile Device Manager, Mobile Application controller, or mobile application in the meta-models of all frameworks. The problem to be solved is that there is no effective element for making appropriate architecture models/guidelines/processes in Mobile IT and related Cloud computing in all frameworks to promote EA that can lead to business contributions, cost reductions, and profit increase in corporations. For the purpose of coping with these matters with regard to Mobile IT/Cloud computing integration in EA frameworks, we propose to establish "TOGAF Guidelines for Mobile IT," "TOGAF Guidelines for Cloud computing" and "TOGAF Guidelines for Microservices" as "TOGAF Guidelines for SOA" was published several years ago. Moreover, we are hopeful that the architecture reference models for Mobile IT/Cloud computing will be established in DoDAF in the future. On the other hand, it will be useful for the architecture meta-models of Mobile IT and Microservices to be defined in the Adaptive EA framework in the future (Masuda et al. 2016).

The contribution of the section is that, to the best of our knowledge, this is the first section to compare EA frameworks with a focus on the Mobile IT/Cloud computing elements integrated into those frameworks. Moreover, this study will be the first step in understanding and improving the integration of Mobile IT/Cloud computing with service in EA. This study will be the preparation for defining appropriate architecture models/guidelines/processes in Mobile IT and related Cloud computing to promote EA as a very important factor of IT governance in corporations for the future. On the other hand, for practical reasons, although the study referred to the relationships and interactions among the elements of Mobile IT/Cloud computing and service, it could not analyze their relationships in EA frameworks because of space restrictions. Future research needs to look beyond the existing literatures to better identify the role of Mobile IT/Cloud computing with services for EA in order to define architecture meta-models in Mobile IT and related Cloud computing. It can be proposed as a good option that a company having applied TOGAF, FEAF, etc., can adopt the integrated framework with the Adaptive EA framework supporting elements of Cloud computing to meet the trend shift to Cloud computing/Mobile IT environments from now onward. Future research needs to verify these proposed EA frameworks, such as surveys and case studies, while being able to consider utilizing quantitative analysis/methodologies to clarify the practical values of these proposed EA frameworks in an applicable manner. Furthermore, the Internet of Things (IoT), which is an important category of Digital IT, also has architecture elements similar to Mobile IT/Cloud. The IoT consists of IoT devices such as sensor/control/RFID tags and Web service APIs, according to the definitions of models related to the IoT and also to big data analytics in Open Platform 3.0 Standard. Moreover, the IoT can involve the SaaS Cloud model as software becomes more deeply integrated into the machines around us (Loukides and Bruner 2015).

Further research is required to explain the differences in the integration approaches that could be generalized to new emerging concepts, such as Mobile IT/Cloud computing, that need to be integrated into the EA frameworks (Masuda et al. 2016).

## 2.6 Agile Enterprise Architecture and Scaling Agile Frameworks

### *2.6.1 Agile Enterprise Architecture*

There are a number of industry architecture frameworks developed since the latter of the 1980s, and the author introduces and briefs well-known Enterprise Architecture Frameworks recognized worldwide in Sects. 2.4 and 1.2, such as Zachman, TOGAF, and DoDAF. However, the tailoring and adoption of EA Capability in a Digital IT era are not directly proceeded. According to Buckl and Matthes, Monahov, etc., four general challenges for Agile Enterprise Architecture are summarized as stakeholder's satisfaction and customer's requirements, stakeholders' commitment, and the flexibility to requirement changes (Buckl et al. 2011). They discuss and raise that these challenges cannot be coped with the traditional EA (e.g., Zachman, TOGAF, and DoDAF) in agile software developments in enterprises.

In ISO/IEC/IEEE42010:2011, an architecture framework is defined as "conventions, principles, and practices for the description of architecture established within a specific domain of application and/or community of stakeholders." The EA can be defined as “a blueprint that describes the overall structural, behavioral, technological, social, and facility elements of an enterprise’s operating environment that share common goals and principles.” Agile enterprise is defined as “an entity is described to be an agile enterprise when an enterprise is speedy (accommodates expected or unexpected changes rapidly), responsive (scans, senses, and reacts appropriately to expected and unexpected changes), flexible (adapts to expected or unexpected change at any time), lean (focuses on reducing waste and cost without compromising on quality), and learning (focuses on enterprise fitness, improvement, and innovation)” (Gill 2013; Alzoubi et al. 2015). Therefore, Agile Enterprise Architecture can be defined as “a blueprint that describes the overall structural, behavioral, technological, social, and facility elements of an enterprise’s operating environment that share common goals and principles with the elements of speediness, responsiveness, flexibility, leanness, and learning” (Gill 2013, Alzoubi et al. 2015). Agile architecture frameworks such as the Adaptive Enterprise Architecture framework in Sect. 2.4.5 provide human-centric and align to agile principles, and adaptive capabilities to adapting, defining, operating, managing, and supporting an agile EA, different from traditional heavy architecture frameworks like TOGAF and Zachman (1987), etc. (Gill 2013; Alzoubi et al. 2015)

### *2.6.2 Scaling Agile Frameworks*

The origin of agile thinking ways in business was the commencement with the creation of the Agile Consortium in 1994 (Agile Business Consortium 2014). While these ideas were found in software engineering independently, the initial Agile Manifesto based on the experiences of Microsoft and IBM, others, collected principles and practices mainly and had the same guiding principles as ones in business (Ebert and Paasivaara 2017). In 1992, the development of scaling agile frameworks was undertaken with the Crystal Family (Abrahamsson et al. 2002) and has become popular gradually these days. The primary purpose of scaling agile frameworks is to manage large agile teams distributed across several geographical locations in an agile approach. Traditional agile methods like Scrum cannot manage this scale of developers, but scaling agile methods show new challenges like coordination and distribution of work without properly defined requirements and defined architectures (Leffingwell 2007).

As well-known, popular scaling agile frameworks, Large-Scale Scrum, Scaled Agile Framework, and Disciplined Agile 2.0 are described (Uludağ et al. 2017). We will brief the main concepts of these scaling agile frameworks with enterprise architects there, in the following section.

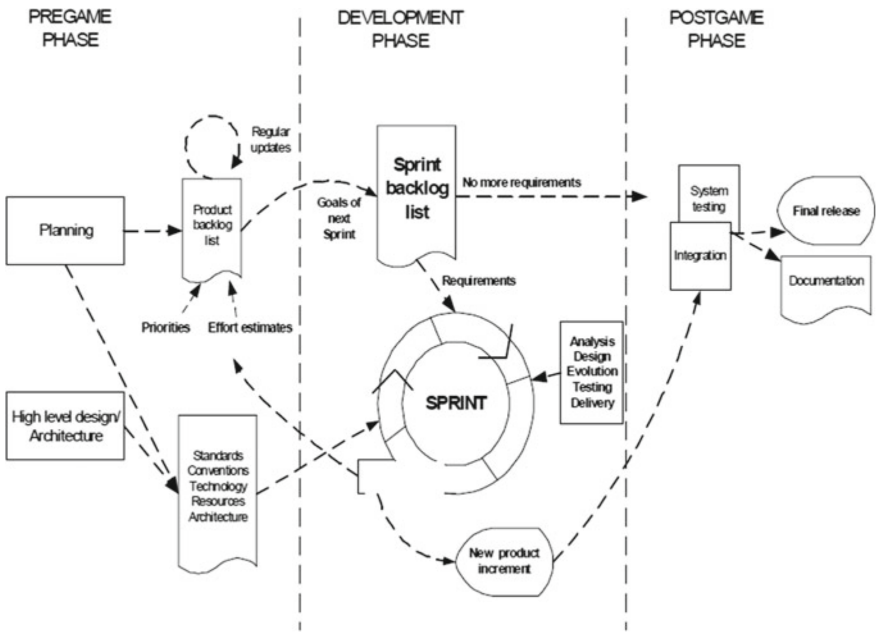


**Fig. 2.15** Scrum process in SoS (Scrum of Scrum)

#### 2.6.2.1 Scrum of Scrum (SoS) and Large-Scale Scrum (LeSS)

Most of scaling agile frameworks appeared from very basic approaches to agile development such as Scrum (Uludağ et al. 2017). The first references in the literature to the term “Scrum” are found in the article of Takeuchi and Nonaka (1986), and the term “Scrum” is originated from the strategy in the game of rugby where an out-of-play ball should be got back into the game with teamwork. The SoS (Scrum of Scrum) approach has been developed to manage the system’s development process (Schwaber and Beedle 2002). The main concept of Scrum is that system development covers several environmental and technical variables such as requirements and time frame, resources, technology that are likely to change during the process (Schwaber 1995). Scrum helps to improve the existing engineering practices like testing practices in organizations. Scrum process covers three phases of pre-game and development, post-game as shown in Fig. 2.15 (Abrahamsson et al. 2017).

Craig Larman and Bas Vodde released Large-Scale Scrum (LeSS) in 2008 that extends Scrum with scaling rules and guidelines by keeping sight of Scrum’s original goals. LeSS requires a deep organizational change to become agile. For example, cross-component, cross-functional, end-to-end feature teams are suggested by LeSS, while removing roles of traditional team lead, project manager, etc. (Craig Larman 2013).

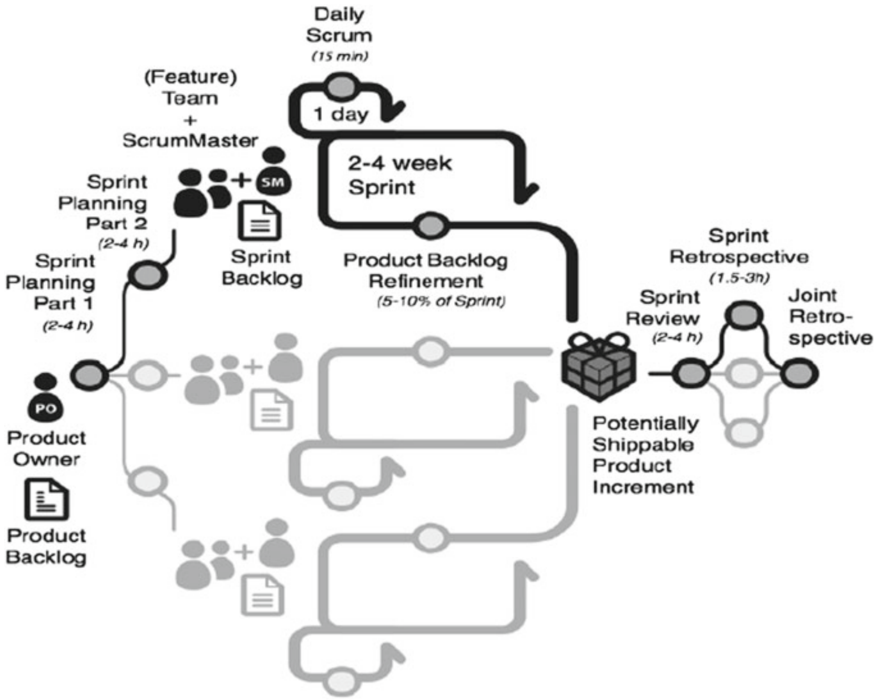


**Fig. 2.16** Basic LeSS framework (*Source* Larman and Vodde 2013)

LeSS provides two different frameworks, which are "the basic LeSS framework" and "LeSS Huge framework."

The basic LeSS framework provides guidelines and techniques for agile development with less than eight teams (of eight teams each). In basic LeSS, a single product owner (PO) is common to all teams, different from SoS (Scrum of Scrum). This LeSS framework changes the structure of sprint planning meetings in comparison with traditional Scrum of Scrum (SoS) approach. The PO and two members represented in each agile team will decide which group of backlog items to work on, different from the way of standard SoS, where the rest of the agile team can participate. Besides, sprint review meeting can be changed to a single one for all agile team. Furthermore, three more changes should also be considered in the interteam coordination meeting, the joint light product backlog refinement meeting, and a joint retrospective in the basic LeSS framework (Vaidya 2014). Figure 2.16 shows the overview of "the basic LeSS framework."

The second LeSS framework, named LeSS Huge, can cope with agile developments with up to a few thousand people on one product in large enterprises. LeSS Huge shows the new concept, what we call requirement areas—RAs. RAs cover major fields of customer concern from a standpoint of product point views. All RAs follow the same sprint conference and pursue continuous integration across the

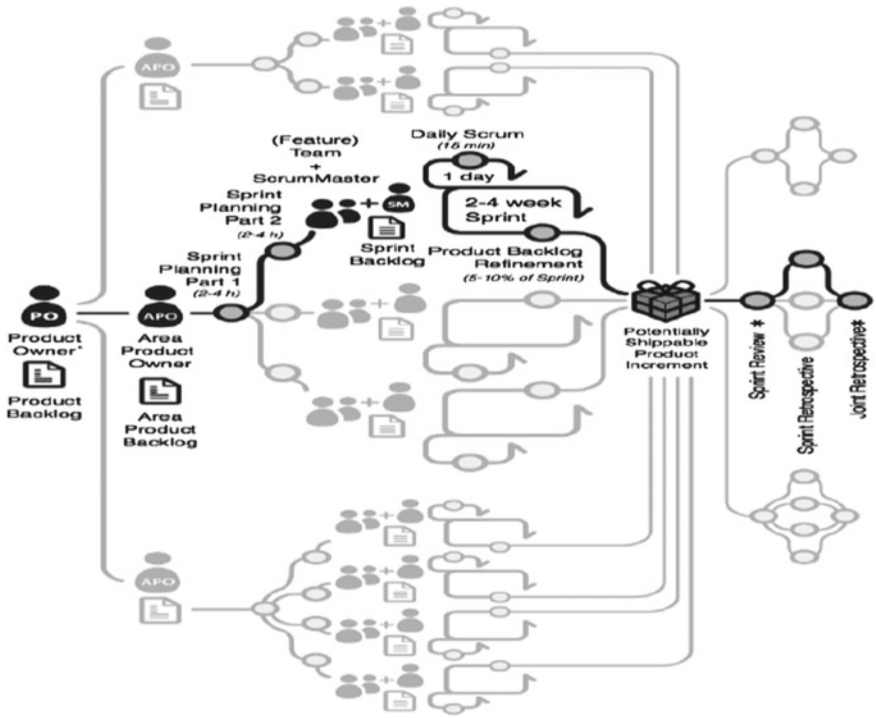


**Fig. 2.17** LeSS Huge framework (Larman and Vodde 2013)

whole product. The area product backlog (APB) view for each RA can be created by adding the RA as an attribute in the product backlog, which represents the new feature in LeSS Huge framework. Each product backlog item belongs to one area product backlog. Area product backlog items are defined and prioritized by the area product owner (APO). The APO focuses on one APB and is basically an expert in that area. The APO performs like the PO in the basic LeSS framework (Uludağ et al. 2017). Figure 2.17 shows the overview of “LeSS Huge framework” (Vaidya 2014).

#### 2.6.2.2 Scaled Agile Framework (SAFe)

Scaled Agile Framework—SAFe—was released in 2011 by Dean Leffingwell, and SAFe 4.0 is at the current version. SAFe covers existing lean-agile principles, which are combined into methods for large-scale agile projects. SAFe can show an introduction to the agile field, while it specifies a number of structured patterns.

SAFe is effective for people transitioning from a more traditional environment, particularly in large projects. The agile adoptions are accompanied with such major cultural changes to organizations. Therefore, SAFe can provide the structure to make the transition more smoothly. SAFe shows four levels of organization: team, program, value stream, and portfolio.

Each level integrates agile and lean practices, manages its own activities, and is aligned with the other levels.

At the team level, the methods are those used in Scrum, and two-week sprint cycles are recommended. Each team consists of less than ten members, who involves a Scrum master and a PO, similar to standard Scrum of Scrum (SoS). Agile teams deliver continuous flows of incremental releases of value. All SAFe teams are part of one agile release train (ART).

Each agile team is responsible for defining, building, and testing stories from its team backlog in a series of iterations and synchronization to align the activities with other teams so that the entire system is iterating in unison. Teams use ScrumXP or Kanban to deliver prototypes every two weeks (Leffingwell et al. 2016).

At the program level, SAFe extends Scrum of Scrum (SoS) but on a higher level. The program level is based on an ART composed of five sprint cycles. Teams, roles, and activities are organized around the ART (Leffingwell et al. 2016). At this level, a product manager (PM) works as the content authority for the ART and is accountable for identifying program backlog priorities. In addition, the PM works with POs to optimize feature deliveries and show directions for the work of POs at the team level.

A release train engineer (RTE) facilitates program-level processes and execution, reports difficulties, manages risk, and supports to drive continuous improvement.

At the optional value stream level, as important roles, business owner, DevOps team member, release manager, and solution manager have been defined.

Furthermore, SAFe specifies processes at one higher level, the portfolio level, using lean principles such as optimizing value streams, which are long-lived kinds of steps to deliver value. These enable executives and leaders to identify and prioritize features broken down at the program level and scheduled for ARTs (Leffingwell et al. 2016).

From standpoints of enterprise architecture, in SAFe, enterprise architects can work with business stakeholders and software/solution architects to drive whole technology implementation across value streams. Enterprise architects are concerned with driving EA strategy, such as choice of technology, software and solution strategy, development and deployment infrastructure strategy, interprogram collaboration, and implementation strategy. This should be communicated, along with other key business drivers of architecture, with system architects and nontechnical stakeholders.

The main contributions to the enterprise architects are to provide strategic technical directions and to drive the collaboration of programs and teams around a common architectural vision. The portfolio level expresses the enterprise architect's area of interest. The strategy for working with enterprise architects is to involve them positively in the portfolio level while ensuring the presence of enterprise-wide architectural systems, platforms, and infrastructures (Leffingwell et al. 2016). Figure 2.18 shows the "SAFe Big Picture" (Vaidya 2014).

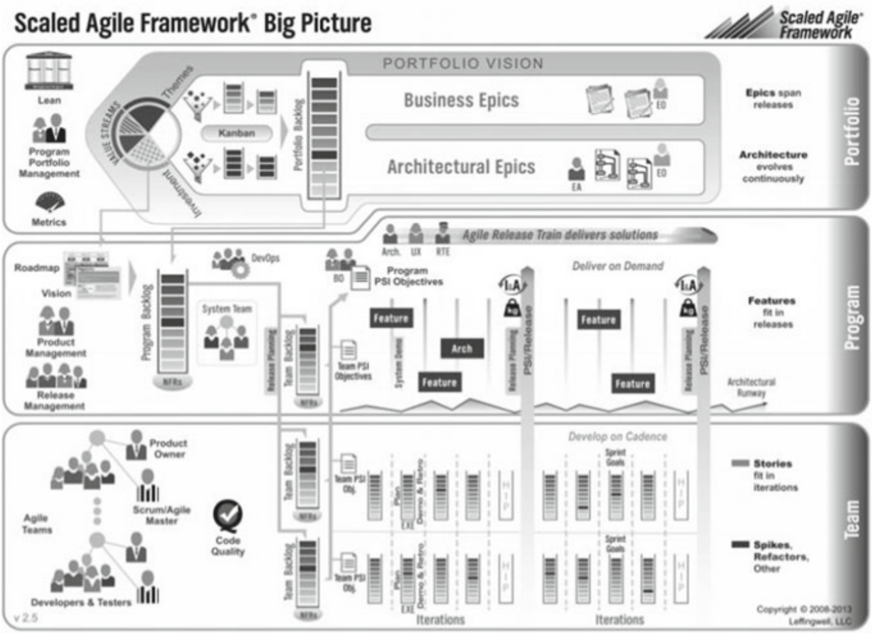


**Fig. 2.18** Scaled agile framework big picture (*Source* Scaled Agile Framework)

#### 2.6.2.3 Disciplined Agile 2.0 (DA 2.0)

This framework was originally developed in IBM Rational Team in 2009–2012. That IBM team worked with business partners involving Scott Ambler and Mark Lines.

The DA 2.0 framework, previously known as Disciplined Agile Delivery, was released in 2012 by Scott Ambler and Mark, and ownership of the DA framework intellectual property was transferred effectively to the Disciplined Agile Consortium in October 2012 (Ambler and Lines 2012). DA 2.0 aims to address fields, which are not covered in smaller scaling agile frameworks at all, in comparison with SAFe, and recommends three phases: inception, construction, and transition, in full system/product life cycle going from the initial concept for the product, through delivery, to operations and support of production. Also, DA 2.0 supports an above full delivery life cycle. Disciplined Agile Delivery is an attempt to fill in the process gaps that Scrum ignored and a hybrid approach which extends Scrum (Vaidya 2014). DA 2.0 also provides flexibility while suggesting different process guidelines for four categories of life cycles: agile/basic, lean/advanced, continuous delivery, and exploratory, which has three phases called the inception, construction, and transition.

The construction phase of agile/basic is Scrum, whereas the lean/advanced life cycle uses processes similar to Kanban.

The inception phase is used to stock a work item pool that is organized to get going in right direction to achieve business values, fixed delivery dates, expedited deliv-

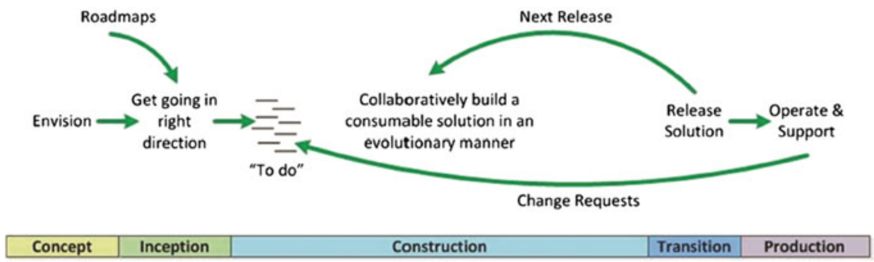


**Fig. 2.19** A high-level view of the system life cycle supported in DA 2.0

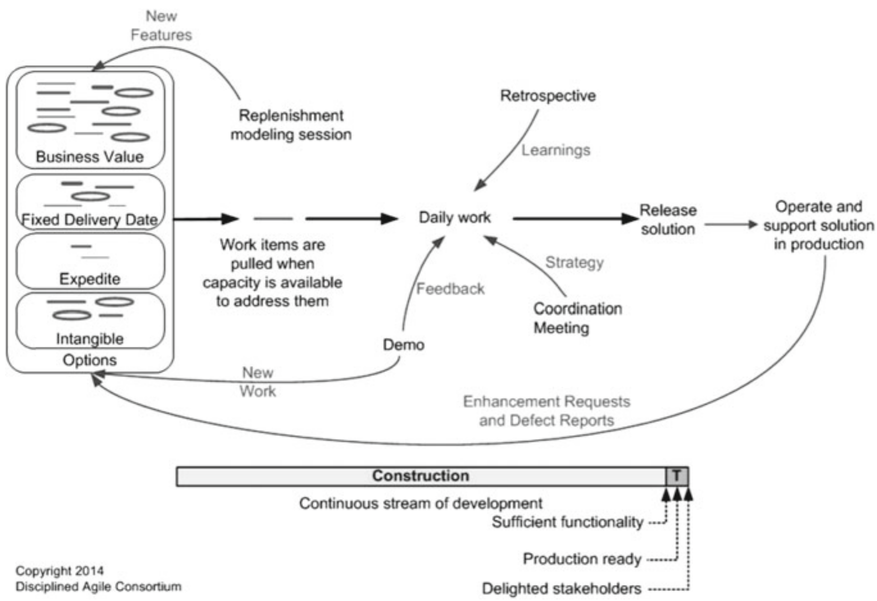


**Fig. 2.20** Disciplined agile's continuous delivery life cycle (Disciplined Agile Consortium)

ery, etc. During the transition phase, planning, retrospection, prototyping, holding meetings, and other activities are undertaken. Figure 2.19 shows the above system life cycle that DA 2.0 supports (Ambler and Lines 2012).

The continuous delivery life cycle focuses on mature DevOps, continuous integration, and deployment processes for digital IT projects that should require frequent delivery to stakeholders. In this third continuous delivery life cycle, the inception phase is obvious and the transition period is very short (Ambler and Lines 2012). In this life cycle, products are produced on a very regular basis: daily, weekly, or monthly. Figure 2.20 illustrates continuous delivery life cycle in DA 2.0 (Vaidya 2014).

The exploratory life cycle minimizes early planning in favor of fast delivery, obtaining feedback, and incorporating that feedback into the next delivery. Moreover,

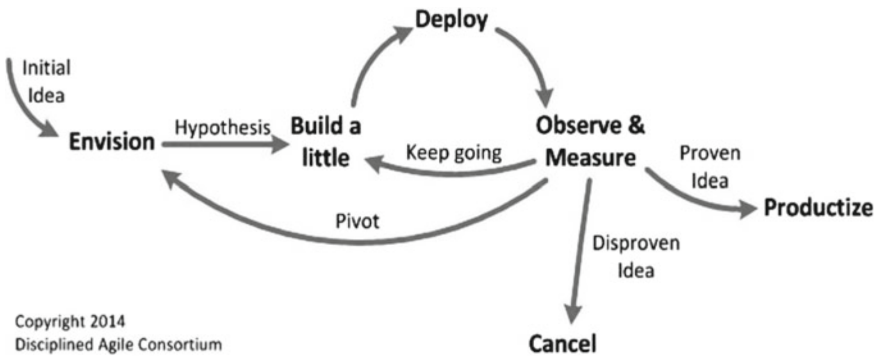


**Fig. 2.21** Disciplined agile's exploratory life cycle (Disciplined Agile Consortium)

this exploratory life cycle aims to encourage agile teams to find themselves in start-up or research situations where the stakeholders have clear ideas for a new product but they do not yet understand the needs of their user base (Ambler and Lines 2012). This life cycle consists of six activities like envisioning, prototyping, deploying, observing, measuring and based on the feedback canceling or productizing the idea. Figure 2.21 shows exploratory life cycle in DA 2.0 (Vaidya 2014).

From standpoints of enterprise architecture, enterprise awareness is one of the key aspects of the DA 2.0 framework, which can motivate agile teams to consider the overall needs of the organization and to leverage existing information assets in alignment with an enterprise-level IT strategy. DA 2.0 recommends that agile teams work closely with enterprise architects, while the enterprise architect has a primary role as a stakeholder and a secondary role as a specialist for assisting agile teams in DA 2.0.

In the inception phase, the enterprise architect works closely with agile teams to align them with enterprise IT strategies and to show nonfunctional requirements (NFRs). Furthermore, the enterprise architect cooperates with agile teams during the initial architectural envisioning and modeling phases and the technology strategy definition phase by ensuring the enhancement of capabilities of the existing digital platforms and infrastructure as possible. In the construction phase, the enterprise architect collaborates with agile teams to ensure that their solution can reflect the overall IT strategy of the organization. In the following phases, the enterprise architect holds regular coordination meetings with project management office teams to ensure consistency and dependencies across teams.

The enterprise architect can contribute to software development by showing the direction and guidance to agile teams while developing high-level architectural roadmaps, which should be aligned with the organization's vision and can help agile teams to understand the overall vision. It is important to involve enterprise architects passively in development projects in DA 2.0 (Ambler and Lines 2012, 2013, 2014, 2016a, b).

#### 2.6.2.4 Comparison of Scaling Agile Frameworks

In this section, the four well-known scaling agile frameworks such as SoS, LeSS, SAFe, and DA 2.0 are compared based on the key elements of descriptive information and maturity/criteria in order to show an overview of their comparison. The comparison and analysis of these four scaling agile frameworks are shown in Fig. 2.22.

In terms of descriptive information like organization, publication date, and category, we quoted from the briefings in the previous Sect. 2.5.2. After Scrum of Scrum (SoS) was released in 2001, LeSS, SAFe, and DA 2.0 were extended from the Scrum.

From standpoints of maturity such as contributions, cases, and documentation in Fig. 2.22, Uludağ et al. calculated maturity of these scaling agile frameworks based on the "number of paper contributions that they found in the literature search" and the "number of case studies described on the home page of the regarded framework," the "available documentation that could be found either on its home page or in other sources" in 2017. While there are more than 25 paper contributions and available documentations in these four well-known scaling agile frameworks, there were more than 20 case studies only for LeSS and SAFe by 2017.

In terms of criteria like scaling, complexity, and cost in Fig. 2.22, many architects and organizations used the Scaled Agile Framework (SAFe) to cover scaled agility. Managers find it comfortable because this framework has a number of role definitions. On the other hand, many users perceive such a highly prescriptive role-and-process scheme as overhead, and many architects and practitioners regard SAFe too heavy and complex. SAFe tries to include all best practices but does not show guidance on how to scale down. Meanwhile, other agile frameworks, such as Large-Scale Scrum (LeSS) and Disciplined Agile Delivery (DAD)*, have addressed this high

| | Descriptive Information | | | Maturity / Criteria | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Organization | Publication Date | Category | Contri-butions | Cases | Docu-mentation | Scaling | Complexity | Cost | EA Role |
| **Scrum-of-Scrums** | Scrum Inc. | 2001 | Mechanism | 27 | 2 | Yes | Is flexible and good to adapt in different settings | Low | Low | --- |
| **Large Scale Scrum** | LeSS Company B.V. | 2008 | Framework | 29 | 22 | Yes | Can be adapted to different settings | Medium | Medium | -- |
| **Scaled Agile Framework** | Scaled Agile Inc. | 2011 | Framework | 35 | 35 | Yes | Targets large companies but is perceived as heavy | High | High | X |
| **Disciplined Agile 2.0** | Disciplined Agile Consortium | 2012 | Framework | 27 | 4 | Yes | Can be adapted to different settings (*) | Medium (*) | Medium (*) | X |

**Fig. 2.22** Primary comparison and analysis of well-known scaling agile frameworks ((*). This analysis was performed on the basis of Disciplined Agile Delivery 1.0 (DAD), which was migrated to the current version of this framework named "Disciplined Agile 2.0.")

complexity. These frameworks define much less and give more freedom for tailoring (Ebert and Paasivaara 2017).

Finally, regarding the role of enterprise architect in Fig. 2.22, SAFe and DA 2.0 have the descriptions and definitions for enterprise architect (Ambler and Lines 2012, 2014, 2016a, b), as briefed in the previous sections of 2.6.2.2 and 2.6.2.3.

## 2.7 Problems and Solutions

### *2.7.1 Problems' Structure and Their Factors in Digital Transformation and Enterprise Architecture*

As results of investigations regarding problems in Digital Transformation and related enterprise architecture in global corporations and previous research in Australia and worldwide, we consider the following seven kinds of factor's categories in their problems' structure.

[1] Factor of Architecture Strategy and Governance
[2] Factor of Business Architecture
[3] Factor of spanning Business Architecture and Application Architecture, their dependencies
[4] Factor of spanning Application Architecture and Technology Architecture, their dependencies
[5] Factor of Data Architecture
[6] Factor of spanning Data Architecture and Technology Architecture, their dependencies
[7] Factor of Technology Architecture.

Therefore, there are a lot of cross-functional problems in Digital Transformation and EA that will lead to the loss of profits because of less Strategic Alignments and nonstandardization in application, technology, and data. Figure 2.23 shows the results of our investigation regarding problems' factors and grouping them.

#### 2.7.1.1 The Factor of Architecture Strategy and Governance

One of the critical factors to problems in Digital Transformation and EA should be the factor of "Architecture Strategy and Governance," especially in global corporations. In the case study of global pharmaceutical company, the author faced with difficulties in holding global Architecture Board and performing architecture reviews in the global level, with applying TOGAF (Masuda et al. 2017). The factor of architecture governance had an affect on this problem. Furthermore, the author faced with difficulties in defining each principle and standard as a global organization in the case study of global pharmaceutical company (Masuda et al. 2017). The factor of

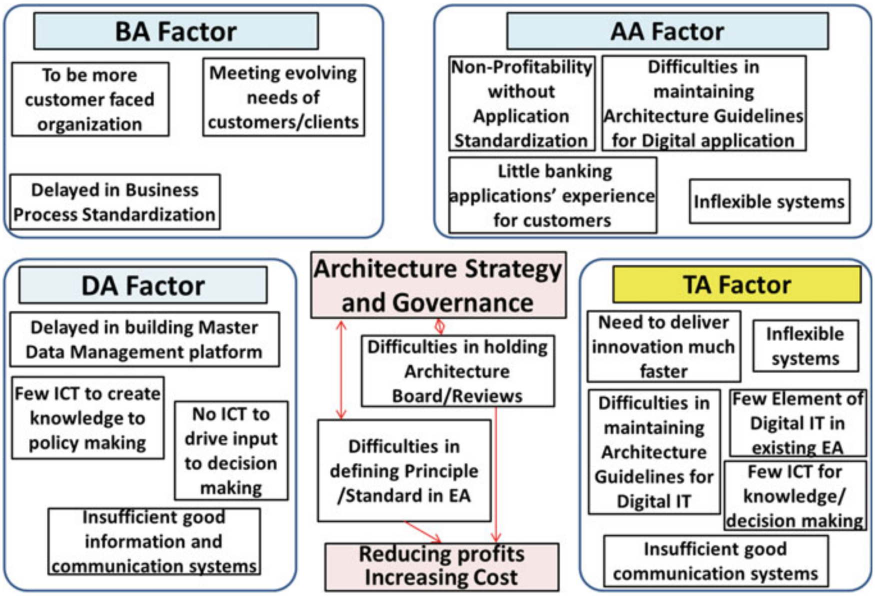


**Fig. 2.23** Problems' structure in Digital Transformation and EA

architecture strategy had an affect on these kinds of problems. Finally, these problems in Architecture Strategy and Governance will lead to the reduction of profits in global corporations.

#### 2.7.1.2 The Factor of Business Architecture

The factor of Business Architecture is also important among critical factors to problems in Digital Transformation and EA. In the case study of global pharmaceutical company, the author faced with the delayed situation in business process standardization in global perspectives (Masuda et al. 2017). On the other hand, Telstra CIO mentioned that they need to help make the large organization a more customer-faced one (Walsh 2012). Demand management in the factor of Business Architecture (BA) had a bearing on this kind of problem. The factor of Business Architecture had an affect on these kinds of problems in Digital Transformation and EA.

#### 2.7.1.3 The Factor of Spanning Business Architecture and Application Architecture, their Dependencies

The factor of spanning Business Architecture (BA) and Application Architecture (AA) with their dependencies should be also most important one among critical

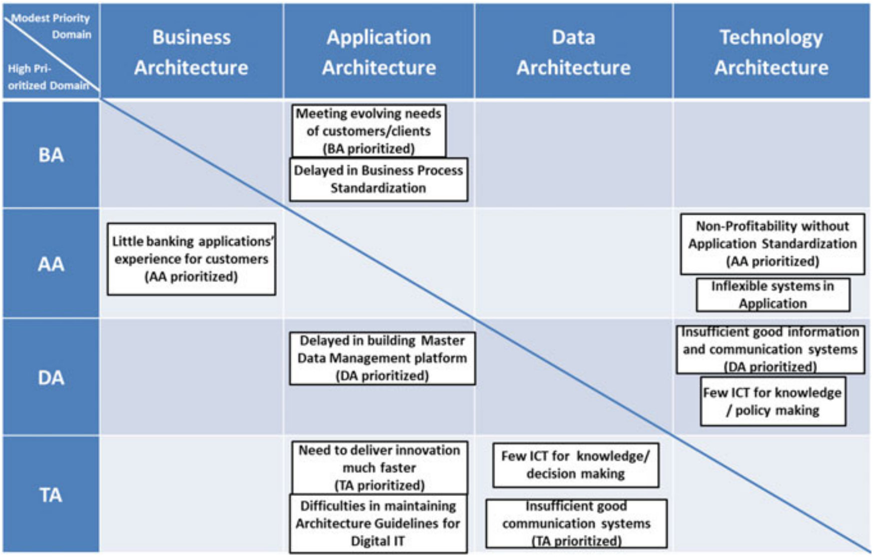


**Fig. 2.24** Interdependency of problems' structure between architecture domains in Digital Transformation and EA

factors to problems in Digital Transformation and EA. Coca-Cola Amatil CIO commented that they need to stay profitable and to keep meeting the evolving needs of its customers and clients. Furthermore, Commonwealth Bank CIO mentioned that little had been done since 1960 to improve the banking applications' experience for customers (Walsh 2012). The factor of spanning Business Architecture (BA) and Application Architecture (AA) had affects on these kinds of problems in Digital Transformation and EA. Figure 2.24 shows the interdependency of problems' structure between architecture domains in Digital Transformation and EA, covering the above interdependency between BA and AA.

#### 2.7.1.4 The Factor of Spanning Application Architecture and Technology Architecture, their Dependencies

The factor of spanning Application Architecture (AA) and Technology Architecture (TA) is the most critical one to problems in Digital Transformation and EA. ING Direct CIO mentioned that it should be important to enable them to deliver innovation much faster than they could before, with more cost efficiency with application standardization. In the case study of global pharmaceutical company, the author had difficulties in developing/maintaining architecture guidelines for Cloud/Mobile IT application systems in global level (Masuda et al. 2017). Moreover, Commonwealth Bank CIO commented that the systems were inflexible in application and technology (Walsh 2012). The factor of spanning Application Architecture (AA) and Technology

Architecture (TA) with their dependencies had affects on these kinds of problems in Digital Transformation and EA. Also, Fig. 2.13 shows the interdependency of problems' structure between AA and TA in Digital Transformation and EA.

#### 2.7.1.5 The Factor of Data Architecture

The factor of Data Architecture will become more important as a critical factor to problems in Digital Transformation and EA, while Big Data solutions are prevailing more. In the case study of global pharmaceutical company, the author met the situation that the project of building the master data management platform had not proceeded in global perspectives (Masuda et al. 2017). The factor of Data Architecture had a bearing on this kind of problem in Digital Transformation and EA.

#### 2.7.1.6 The Factor of Spanning Data Architecture and Technology Architecture, their Dependencies

The factor of spanning Data Architecture and Technology Architecture will also become more important as critical factors to problems in Digital Transformation and EA. Australian Government CIO commented that good information and communication systems should be vital to efficient, effective government. Furthermore, Australian Government CIO mentioned that ICT should be critical to creating knowledge to inform policy making, to drive input to decision making (Walsh 2012). The factor of spanning Data Architecture and Technology Architecture with their dependencies has affects on these kinds of problems in Digital Transformation and EA. Figure 2.13 shows the interdependency of problems' structure between Data Architecture and TA in Digital Transformation and EA.

#### 2.7.1.7 The Factor of Technology Architecture

The factor of Technology Architecture is also critical factor to problems in Digital Transformation and EA. In the case study of global pharmaceutical company, the author found out that there were few elements of Cloud/Mobile IT/Digital IT in existing EA framework such as TOGAF, FEAF, and DoDAF (Masuda et al. 2016). The factor of Technology Architecture has affects on the problems in Digital Transformation and EA.

### 2.7.2 Solutions to Cope with Problems in Digital Transformation and Enterprise Architecture

If the author of this book mentions prior notice basis, the solutions proposed and verified in this book, which should consist of AIDAF with related five kinds of agility elements and four kinds of models, can correspond to the above problems in Digital Transformation and EA. Figure 2.25 shows the relationship between the above solutions and problems in Digital Transformation and EA, while the left side of problem items shows architecture domains related to each problem and the right side of problem items shows problem categories applicable to each one.

The solutions in Fig. 2.25 will be explained and proposed in the next chapter in this book. Furthermore, each solution in Fig. 2.15 will be evaluated and verified in Chaps. 4–7 in this book.

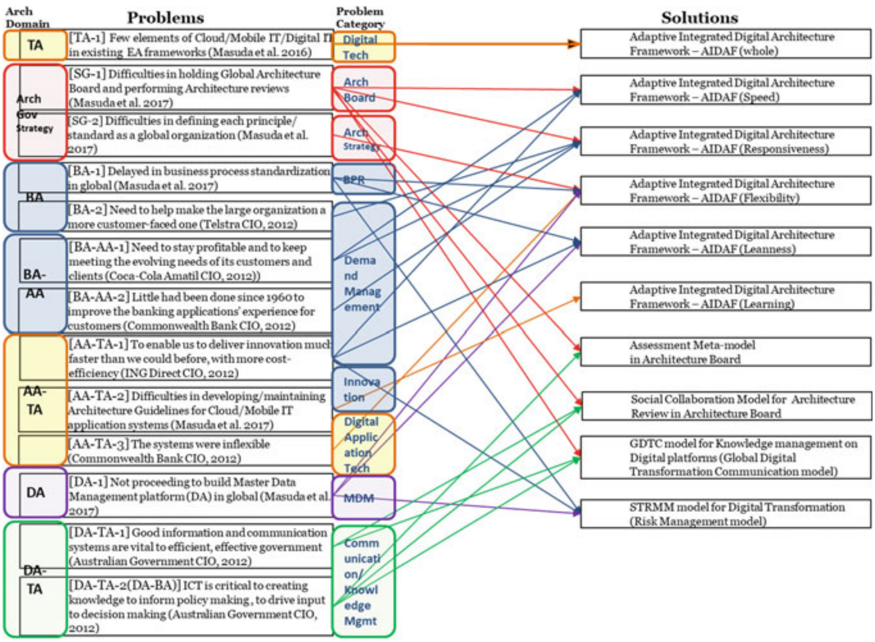


**Fig. 2.25** Relationship between problems and solutions for Digital Transformation and enterprise architecture (*Source* The Australian Business Review, July 2012/Masuda et al. 2017)

**Questions and Exercises**

1. Describe Cloud service models defined by NIST.
2. How does the cloud era impact the enterprise architecture field? To answer this, you will need to research online sources.
3. What is the difference between SOA and Microservices?
4. Based on the frameworks described in this chapter under Sect. 2.2.3, compare any four of the EA frameworks.
5. Compare FEAF and the Adaptive EA framework.
6. Select appropriate sources of Big Data:
    a. Confidential data on backup devices
    b. Data provided on Twitter
    c. Verbal opinions in onsite meetings
    d. Corporate data in SQL databases.
7. ABC Industries is a large private sector business enterprise and global corporation. Its businesses span telecommunication, digital services, organized retail, and energy and petrochemical products. Explain how ABC can use EA frameworks to manage and coordinate its architecture and IT management. ABC currently has a massive IT infrastructure and systems which helps to manage its 3000+ business processes and 1500+ applications spread over 10,000+ servers.

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# Chapter 3
# Strategic Architecture Framework Aligned with IT Strategy Promoting Cloud/Mobile IT/Digital IT

**Abstract** The purpose of this chapter is to propose an "Adaptive Integrated Digital Architecture Framework—AIDAF" to meet the requirements of the digital transformation in relation to the above agility-related aspects. The proposed EA framework should support an IT strategy promoting cloud/mobile IT/Digital IT, based on what our prior research suggested. Also, we show the recommended EA artifacts in AIDAF, compared with Zachman Framework and DODAF, for use with the $EA^3$ Cube Framework. Moreover, we propose an architecture assessment model, global communication/knowledge management model, and Risk Management model related to the above AIDAF in this chapter. In later chapters, we will show a case of EA framework building by the global company.

**Keywords** Architecture assessment · Digital Agility · Global communication · Knowledge management · Risk Management

## 3.1 Overview of Strategic Architecture Framework in the Era of Digital IT (AIDAF-Covering-Related Models)

### *3.1.1 Overview and Positioning of AIDAF and Related Models*

For the purpose of proceeding with IT strategy promoting Cloud/Mobile IT/Digital IT/Big Data, the first author introduces strategic architecture approach and framework in the era of Digital IT in this research. This approach and framework suit the requirements of Digital IT-related application systems that need the agility elements, while coping with each life cycle defined in System Development Life Cycle (SDLC). According to the definitions of agility elements published by Gill (2014), agility elements consist of "speed," "responsiveness," "feasibility," "leanness," and "learning." Figure 3.1 illustrates the overview of strategic architecture framework in



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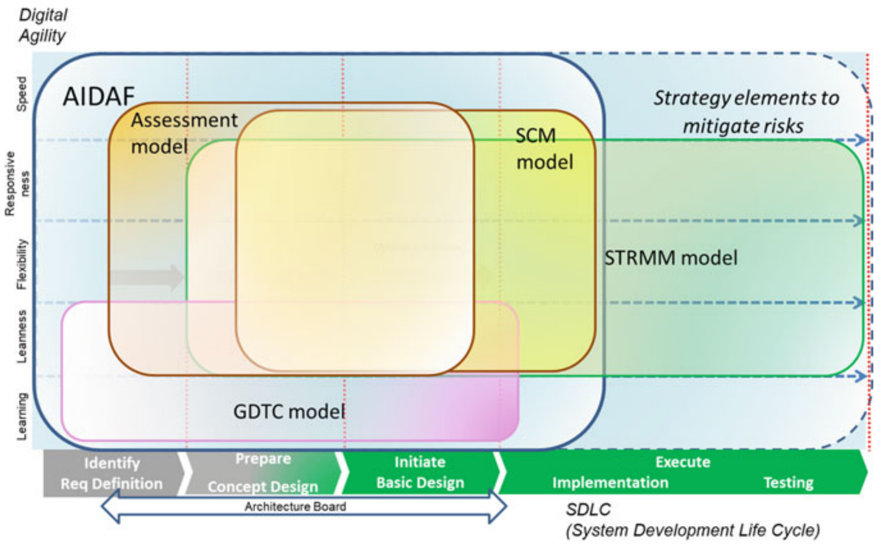


**Fig. 3.1** Overview of strategic architecture framework in the era of digital IT (AIDAF and related models)

the era of Digital IT (AIDAF-covering-related models) while the vertical axis shows "Digital Agility" and the horizontal axis shows SDLC in Fig. 3.1.

The author proposed an "Adaptive Integrated Digital Architecture Framework—AIDAF" supporting all elements of Digital Agility, and the author proposed and divided the related models, involved in AIDAF, into several ones: (1) Adaptive Integrated Digital Architecture Framework—AIDAF, (2) Assessment meta-model in Architecture Board, (3) GDTC model for global communication on enterprise portal, (4) Social Collaboration Model for Architecture Review in Architecture Board, (5) STrategic Risk Mitigation Model for Digital Transformation, with strategic elements to mitigate risks.

First, the "Adaptive Integrated Digital Architecture Framework—AIDAF" is the overall Architecture Framework that will support and promote an IT strategy toward the Digital IT. This Architecture framework can be applied in most of the phases from "Requirement Definition" to the mid of "Implementation" in SDLC. In this Architecture framework, Architecture Board can be held on a short-term basis to respond to business user's requirements flexibly with lean structure of architectural processes and deliverables, while developing and utilizing architecture guidelines for Digital IT architectures with learning basis.

The scope of the dotted line in Fig. 3.1 shows the AIDAF in the phases from the latter of "Implementation" to "Testing," where mechanisms of Architecture Change Management need to be fully defined and processed in AIDAF. At the current time, projects related to architecture changes can be submitted and reviewed in Architecture Board partially; however, appropriate mechanisms of Architecture Change

Management should be defined and developed in AIDAF to cover the above scope formally.

Second, the “Assessment meta-model in Architecture Board” is covered in AIDAF and the one that can perform Architecture Review regarding solution architectures of new IS/IT projects on the basis of defined evaluation criteria. This Assessment model will support the Architecture Board reviews in the early phases from the mid of “Requirement Definition” to “Basic Design” in SDLC that can be held on a short-term basis to respond to business user’s requirements flexibly with lean structure of architectural deliverables such as target architectures, current architectures, and roadmaps.

Third, “GDTC model for global communication on enterprise portal” is the effective knowledge management process and model on digital platforms for Architecture Board reviews and involved in AIDAF. This model can be applied in the early phases from the “Requirement Definition” to “Basic Design” in SDLC with the lean structured processes on digital platforms involving architecture guidelines for Digital IT architectures on learning basis.

Fourth, “Social Collaboration Model for Architecture Review in Architecture Board” is the Architecture model on digital platforms for Architecture Board reviews, covering Business Architecture, Application Architecture, and Technology Architecture, and this model is covered in AIDAF as well. This model can be applied in the phase from the mid of “Conceptual Design” to the early “Implementation” in SDLC with the lean structured processes on digital platforms to respond to business user’s requirements flexibly on a short-term basis.

Fifth, “STRMM for Digital Transformation” is the risk mitigation model with Architecture Board toward the digital transformation while involved in AIDAF. This model can be applied in the full life cycle and phases from the mid of “Requirement Definition” to the “Testing” in SDLC with the lean structured processes for Architecture reviews, while responding to the questions and requests from the risk’s stakeholders flexibly. Furthermore, in Digital Transformation, strategy elements to mitigate risks, as well as scaling agile frameworks briefed in Sect. 2.5.2, can be effective mainly in the execution phase (implementation and testing) of SDLC and will sometimes support all elements of Digital Agility, while covered in AIDAF.

Finally, the AIDAF will support the all elements of Digital Agility, and STRMM will be applied in all phases from “Requirement Definition” to “Implementation” and “Testing” as shown in Fig. 3.1. Therefore, in terms of the overall assessment in Chap. 7, the AIDAF will be evaluated from standpoints of all elements of Digital Agility, and the STRMM covered in AIDAF will be evaluated in terms of the full life cycle in SDLC.

Additionally, “Internet of Things with AIDAF” will be possible and verified in the research initiative named “Open Healthcare Platform 2030” described in Chap. 9. It is also shown that the AIDAF as well as $EA^3$ Cube Framework can be scalable while addressing all aspects of an organization, and the AIDAF will have the scalability even for a community, an ecosystem, as depicted in Fig. 9.1.

### *3.1.2 Research Strategy*

In the previous section, as the "Architecture Framework and Risk Management approach" fitting to the strategy of promoting cloud/mobile IT, we proposed an "Adaptive Integrated Digital Architecture Framework—AIDAF" covering related models such as "STrategic Risk Mitigation Model for Digital Transformation" on the basis of the previous research in this field. The above framework needs to cover the necessary EA elements for the era of cloud/mobile IT/digital IT, while the above model should be applied in full life cycles of SDLC.

Moreover, as a research strategy of this book, the author shows strategic research questions to verify this "Adaptive Integrated Digital Architecture Framework—AIDAF" toward the requirements and overall elements of Digital Agility in the era of cloud/mobile IT/digital IT and to ensure the effectiveness of the proposed models involved in the Architecture framework, such as "STrategic Risk Mitigation Model for Digital Transformation" in overall full life cycles of SDLC. Next, we evaluate these strategic research questions corresponded to the case study of a Global Healthcare Enterprise (GHE), which is a research-based global company with primary focus on pharmaceuticals. Being the largest pharmaceutical company in Asia and an industry leader, this GHE prioritizes the future direction of digital healthcare as an important element of corporate strategy; therefore, this case study of the GHE is among the only advanced cases of EA implementation toward the era of Digital IT, especially in the field of digital healthcare.

RQ1: How can our proposing EA framework covering related models solve problems in the era of cloud/mobile IT/digital IT?
RQ2: How can an "Adaptive Integrated Digital Architecture Framework—AIDAF" meet the requirements and elements of Digital Agility in the era of cloud/mobile IT/digital IT?
RQ3: How can the "STRMM" be effective for mitigating risks for Digital Transformation in terms of full life cycle in SDLC?

Then, one of the authors who actually led the project to build and implement this EA carried out the case study within a global pharmaceutical company, where we built and implemented the "Adaptive Integrated Digital Architecture Framework—AIDAF," by focusing on real developments and progress histories. Moreover, we evaluate the aforementioned research questions using this case study of the global pharmaceutical company, as a research strategy of this book (Masuda et al. 2017a, b, c).

On the basis of the above research, we clarify the challenges, benefits, and critical success factors of this Architecture framework covering related models for EA practitioners in Chap. 7.

## 3.2 Necessary Elements and Requirements in EA Frameworks for the Era of Cloud/Mobile IT/Digital IT

### *3.2.1 Necessary Elements in Enterprise Architecture Framework for the Era of Cloud/Mobile IT/Digital IT*

When considering the necessary elements of the EA framework for the era of cloud/mobile IT/digital IT, the EA should have the ability to accommodate agility-related elements. However, the TOGAF is criticized for its size, lack of agility and complexity (Gill et al. 2014). Figure 3.2 contains the results of efforts to identify the elements defined in each of the architecture domain categories and agility-related elements in all-subject EA frameworks below. In Fig. 3.2, TOGAF9, FEAF, MIT EA, and our proposed “Adaptive Integrated Digital Architecture Framework” are included as all-subject EA frameworks (Masuda et al. 2017a, b, c). Moreover, the author of this book has named this EA framework suitable for the era of Digital IT as “Adaptive Integrated Digital Architecture Framework—AIDAF” (Masuda et al. 2017a, b, c). DODAF and MODAF were excluded from this Fig. 3.2 because these frameworks do not contain a specific description of agility-related elements (US Department of Defense 2009; UK Ministry of Defence 2010a, b). In addition, because the Gartner framework is limited to commercial use, complete access is not possible and it is therefore outside of our scope (Franke et al. 2009). Moreover, because the Zachman Framework does not provide an enterprise architecture process for implementing and operating an enterprise architecture capability (Gill 2015), this is also out of our scope at this time. Moreover, when describing the review criteria of “elements in each Architecture Domain Category” in Fig. 3.2, we referred to the definitions of each element in the EA framework development project (in this case the global pharmaceutical company) because there were no specific definitions for these elements in existing EA frameworks. On the other hand, regarding the review criteria of “agility-related elements,” we referred to the definitions of agility elements published by Gill (2014).

First, all the elements of each architecture domain such as Business Architecture (BA), Application Architecture (AA), Data Architecture (DA), and Technology Architecture (TA) are identified in TOGAF9 (The Open Group 2009). On the other hand, agile-related elements can be realized by extension by IT4IT, although there is no specific description regarding agile-related elements such as “leanness” and “learning” in TOGAF9 itself.

IT4IT can be used to cover the agile-related elements that would extend the capabilities of TOGAF, whereas the logical service model defined in IT4IT should be equivalent to parts of the Adaptive EA framework (The Open Group 2017).

Second, all the elements of each architecture domain (BA, AA, DA, and TA) are also identified in FEAF (Federal Enterprise Architecture Framework 2013). However, in terms of agile-related elements, there is no specific description regarding “speed,” “leanness,” and “learning” defined in Fig. 3.2. “Flexibility,” which may be realized

| EA Frameworks | | | TOGAF 9 | FEAF | MIT EA | AIDAF (Adaptive Integrated Digital Architecture Framework) |
|---|---|---|---|---|---|---|
| | Necessary elements of EA for Cloud/Mobile IT/Digital IT | Review Criteria | | | | |
| Elements of each Architecture Domain Category | BA – High level | Business process policy | ○ (definable) | ○ (definable) | ○ (definable) | ○ (definable) |
| | BA - Detailed level | Business function chart Business Process flow | ○ (definable) | ○ (definable) | × (none) | ○ (definable) |
| | AA – High level | Application optimization policy | ○ (definable) | ○ (definable) | ○ (definable) | ○ (definable) |
| | AA – Detailed level | Application function chart, Application user location & Communication diagram | ○ (definable) | ○ (definable) | × (none) | ○ (definable) |
| | DA – High level | Data Integration Policy | ○ (definable) | ○ (definable) | ○ (definable) | ○ (definable) |
| | DA – Detailed level | Standard Logical Data model, Standard Interfaces, BI/DWH Specifications | ○ (definable) | ○ (definable) | × (none) | ○ (definable) |
| | TA – High level | Technology Platform Integration Policy | ○ (definable) | ○ (definable) | ○ (definable) | ○ (definable) |
| | TA -Detailed level | Technology Standard, Technology Reference Model, Logical diagram | ○ (definable) | ○ (definable) | × (none) | ○ (definable) |
| Agility related Elements | Speed | Rapid flexible response of enterprise in timely manner | Extensible with IT4IT RA (Requirement to Deploy) | × (none) No specific description | -Faster develop in stage 4 (Business Modularity) | ○ (definable) -Accommodates expected or unexpected changes rapidly by short-term cycle |
| | Responsiveness | Appropriate responses to deal with changes while sensing situations | Extensible with IT4IT RA (Detect to Correct) | - Service Responsiveness in Performance Reference Model | -IT responsiveness improve in stage 2(Standardize) & 4 | ○ (definable) - scans, senses and reacts properly to expected and unexpected changes by short-term cycle |
| | Flexibility | Adapt to changing complex business demands in defining Principles in EA. | Extensible with IT4IT RA (Requirement to Deploy) | Extensible with SOA (Service Oriented Architecture | -"Foundation for execution" is this base. | ○ (definable) -Able to define Principles flexibly |
| | Leanness | EA operation with optimal /minimal resources without compromising quality | × (none) No description | × (none) No description | -Optimal core business process and data in stage 3 | ○ (definable) -With optimal EA deliverables, focus on reducing waste and cost without compromising on quality |
| | Learning | EA using up-to-date knowledge/experience with continuous growth/adaptation | × (none) No description | × (none) No specific description except for education systems | -Management Practice in stage 4 accelerate learning | ○ (definable) -With knowledge sharing, focuses on enterprise fitness, improvement, transformation and innovation. |

**Fig. 3.2** Elements of each architecture domain and agility in EA frameworks

by extending SOA and "responsiveness," is identified in the Performance Reference Model (PRM) in FEAF itself (Federal Enterprise Architecture Framework 2013).

Third, all high-level elements of each architecture domain, such as the "business process policy" in BA, "application optimization policy" in AA, "data integration policy" in DA, and "technology platform integration policy" in TA, are identified in the MIT EA (Ross et al. 2006). However, almost none of the detailed elements in each architecture domain (BA, AA, DA, and TA) are found in the MIT EA (Yamamoto 2017). On the other hand, descriptions regarding the agility-related elements of "speed," "learning," and "responsiveness" are found in stage 4 of the "business modularity" section in the MIT EA, and a description of "responsiveness" is also found in stage 2 of "technology standardization." A description concerning the agility-related element of "leanness" is found in stage 3 of "optimized core" and the description of the agility-related element of "flexibility" is found in the "foundation for execution" in the MIT EA (Ross et al. 2006)

Fourth, all the elements of each architecture domain (BA, AA, DA, and TA) should be identified in the Adaptive Integrated Digital Architecture Framework proposed in this study, because this EA framework is designed to include long-term principles and target architectures in addition to an Adaptive EA framework. Moreover, descriptions regarding all the agility-related elements of "speed," "responsiveness," "flexibility," "leanness," and "learning" are identified in both the Adaptive EA framework (Gill 2015) and the proposed Adaptive Integrated Digital Architecture Framework.

Based on the above comparison, the "Adaptive Integrated Digital Architecture Framework—AIDAF" we propose in this study should have capabilities for all the elements of each of the architecture domain categories and all of the agility-related elements defined in Fig. 3.3, to address the limitations of TOGAF9, FEAF, and MIT EA (Masuda et al. 2017a, b, c).

### *3.2.2 Documentation Artifacts in EA Frameworks*

EA artifacts are kinds of documentation describing components, including reports, diagrams, and other kinds of recorded information. High-level EA artifacts are often text/diagrams describing strategies, programs, and desired outcomes. Mid-level EA artifacts are documents, diagrams, and briefings of organizational processes, projects, large systems, information flows, etc. Low-level EA artifacts describe specific applications, technology standards, interfaces, network components, etc. When the above EA artifacts are harmonized with the organizational EA framework, more useful views of EA components are generated (Bernard 2006).

Figure 3.3 shows the list of recommended artifacts for use with the EA$^3$ Cube Framework in comparison among Zachman Framework, DODAF, and our proposed AIDAF, to document the current and future views of the architecture. This list of EA artifacts consists of both composite and primitive artifacts. Composite artifacts should be those made up of one or more primitive artifacts. A primitive artifact is a kind of EA documentation describing/modeling a specific aspect of the architecture (such as an entity relationship diagram, a network diagram, or a security controls list) (Bernard 2006). John Zachman emphasizes the importance of doing primitive artifacts (Zachman 1987; Sowa and Zachman 1992); therefore, Zachman EA framework is mapped with the majority of EA artifacts to use with EA Cube$^3$ Framework as recommended ones in Fig. 3.3. DODAF is also mapped with many EA artifacts except for the fields of networks and infrastructure, security, while reference architectures for them are provided.

Also, we show the recommended artifacts in our proposed AIDAF, as the artifacts recommended to implement EA in a Digital IT era, for use with the EA Cube$^3$ Framework in Fig. 3.3, while the artifact of "Knowledge Management Plan" can be recommended in AIDAF in consideration with GDTC model explained in Sect. 3.5,

| EA$^3$ Cube Level/Thread | Artifact ID # | Artifact Name (* Composite Artifact) | Zachman Mapping | DODAF Mapping | AIDAF Mapping |
|---|---|---|---|---|---|
| **Strategic Goals & Initiatives** (I) | S-1 | Strategic Plan* | C6/R1 | AV-1 | Recommended |
| | S-2 | SWOT Analysis | C5/R1 | | Optional |
| | S-3 | Concept of Operations Scenario | | AV-1 | Recommended |
| | S-4 | Concept of Operations Diagram | C2/R1 | OV-1 | Recommended |
| | S-5 | Balanced Scorecard™ * | C6/R4, C6/R5 | | Optional |
| **Business Products & Services** (B) | B-1 | Business Plan* | C2/R2, C5R1 | | Recommended |
| | B-2 | Node Connectivity Diagram | C3/R1 | OV-2 | Optional |
| | B-3 | Swim Lane Process Diagram * | C4/R2 | OV-5 | Recommended |
| | B-4 | Business Process/Service Model | C2/R2 | OV-5 | Optional |
| | B-5 | Business Process/ Product Matrix * | C4/R2 | | Recommended |
| | B-6 | Use Case Narrative & Diagram | C6/R3, C6/R4 | OV-6a, SV-10a | Recommended |
| | B-7 | Investment Business Case* | | | Optional |
| **Data & Information** (D) | D-1 | Knowledge Management Plan | C1/R1, C1/R2 | | Recommended (GDTC model) |
| | D-2 | Information Exchange Matrix* | C3/R2, C4/R2 | OV-3 | Optional |
| | D-3 | Object State-Transition Diagram | C1/R3 | OV-6b, SV-10b | |
| | D-4 | Object Event Sequence Diagram | C2/R2, C5/R3 | OV-6c, SV-10c | |
| | D-5 | Logical Data Model | C1/R3 | OV-7, SV-11 | Recommended |
| | D-6 | Physical Data Model | C1/R4 | | Optional |
| | D-7 | Activity/Entity (CRUD) Matrix * | C1/R3, C4/R2 | SV-9 | Optional |
| | D-8 | Data Dictionary / Object Library | C1/R5 | AV-2 | Optional |
| **Systems & Applications** (SA) | SA-1 | System Interface Diagram | C3/R4, C3R2 | SV-1 | Recommended (Defining) |
| | SA-2 | System Communication Description | C2/R4, C3/R2 | SV-2 | Recommended |
| | SA-3 | System Interface Matrix * | C2/R4 | SV-3 | Recommended (Defining) |
| | SA-4 | System Data Flow Diagram | C2/R3 | SV-4 | Optional |
| | SA-5 | System/Operations Matrix * | C2/R4 | SV-5 | Optional |
| | SA-6 | Systems Data Exchange Matrix * | C2/R3 | SV-6 | Optional |
| | SA-7 | System Performance Matrix * | C2/R3 | SV-7 | |
| | SA-8 | System Evolution Diagram | C2/R4 | SV-8 | Recommended |
| | SA-9 | Web Application Diagram | C2/R3 | | Recommended |
| **Networks & Infrastructure** (NI) | NI-1 | Network Connectivity Diagram | C3/R5 | | Optional |
| | NI-2 | Network Inventory | C3/R5 | | Optional |
| | NI-3 | Capital Equipment Inventory | C3/R5 | | |
| | NI-4 | Building Blueprints * | C3/R5 | | Optional |
| | NI-5 | Network Center Diagram | C3/R5 | | Recommended |
| | NI-6 | Cable Plant Diagram | C3/R5 | | |
| | NI-7 | Rack Elevation Diagram | C3/R5 | | |
| **Security** (SP) | SP-1 | Security and Privacy Plan* | C4/R5 | | Recommended |
| | SP-2 | Security Solutions Description | C4/R5 | | Recommended |
| | SP-3 | System Accreditation Document* | C4/R5 | | Recommended |
| | SP-4 | Continuity Of Operations Plan* | C4/R5 | | Optional |
| | SP-5 | Disaster Recovery Procedures * | C4/R5 | | Recommended |
| **Standards** (ST) | ST-1 | Technical Standards Profile | C3/R4 | TV-1 | Recommended (Defining) |
| | ST-2 | Technology Forecast | C3/R4 | TV-2, SV-9 | Recommended (Defining) |
| **Workforce** (W) | W-1 | Workforce Plan* | C4/R1 | | Optional |
| | W-2 | Organization Chart | C4/R2 | OV-4 | Recommended |
| | W-3 | Knowledge and Skills Profile | C4/R3 | OV-4 | Recommended |

**Fig. 3.3** Recommended artifacts' comparison for use with the EA$^3$ cube framework

and several artifacts are recommended for defining phase of Adaptive EA cycle in AIDAF, briefed in Sect. 3.3. Furthermore, we show the optional artifacts in our proposed AIDAF for use with the EA Cube[3] Framework in Fig. 3.3, as the artifacts useful to proceed with EA in a Digital IT era.

### *3.2.3 Requirements in Enterprise Architecture Framework for the Era of Cloud/Mobile IT/Digital IT*

According to Fig. 2.12 of problems and solutions in Chap. 2, several kinds of requirements in Enterprise Architecture Framework in the era of Digital IT are identified.

First, in terms of Architecture Strategy and Governance, there should be the requirement of holding Architecture Board and reviews in global organization, etc., while defining each principle/standard in global ones for EA framework and models in the era of Digital IT. For the purpose of coping with the above requirements, the first author can propose "Adaptive Integrated Digital Architecture Framework—AIDAF" from standpoints of speed, responsiveness, and flexibility of agility-related elements described in the previous section, and "Assessment model," "Social Collaboration Model," and "Global Digital Transformation Communication model" in the following sections.

Second, according to Fig. 2.12, from standpoints of Business Architecture (BA) and Data Architecture (DA), there should be the requirement of coping with delays in standardization projects of business processes and master data management platforms flexibly. In the following sections, the author can propose "Adaptive Integrated Digital Architecture Framework—AIDAF" from standpoints of flexibility, leanness of agility-related elements described in the previous section, and "STrategic Risk Mitigation Model" to minimize the related risks.

Third, according to Fig. 2.12, in terms of Business Architecture (BA) and Application Architecture (AA), there should be the requirement of coping with the difficulties of demand managements for Digital IT systems and projects. In the following sections, the author can propose "Adaptive Integrated Digital Architecture Framework—AIDAF" from standpoints of speed, responsiveness and leanness of agility-related elements described in the previous section, and "STrategic Risk Mitigation Model" to minimize the related risks.

Fourth, as described in Sect. 2.5, from standpoints of Application Architecture (AA) and Technology Architecture (TA), there should be the requirement of keeping up with the rapid progress of digital application technologies for Cloud/Mobile IT/Big Data/Digital IT. In the following sections, the author can propose "Adaptive Integrated Digital Architecture Framework—AIDAF" from standpoints of learning, speed, and flexibility of agility-related elements described in the previous section.

Finally, according to Fig. 2.12, from standpoints of Data Architecture (DA) and Technology Architecture (TA), there should be the requirement of good communication systems with knowledge management for the decision making. The author can propose "Assessment model," "Social Collaboration Model," and "Global Digital Transformation Communication model" for this requirement in the following sections.

## 3.3 Adaptive Integrated Digital Architecture Framework—AIDAF

### *3.3.1 Proposal of Adaptive Integrated Digital Architecture Framework—AIDAF*

The preliminary research of this study promoted the strategic use of cloud/mobile IT. This suggests that corporate entities that implement EA by having applied frameworks such as TOGAF and FEAF could adopt a framework that enables the integration of an Adaptive EA framework to provide further support for cloud elements as one possible solution. Accordingly, this study proposes an "Adaptive Integrated Digital Architecture Framework—AIDAF" based on this suggestion for an EA framework that can even be used by corporate entities to promote a cloud/mobile IT strategy. Figure 3.4 illustrates the proposed model of the AIDAF. The proposed model is an EA framework integrating an Adaptive EA cycle in the lower part of the diagram with TOGAF or a simple EA (framework)[1] for different business division units in the upper part of the diagram.

The Adaptive EA cycle in the proposed model makes provision for initiation documents (including conceptual architecture designs) for new cloud/ mobile IT-related projects that are continuously drawn up on a short-term basis (monthly, etc.). This begins with the Context Phase, which is prepared for referencing the defining phase

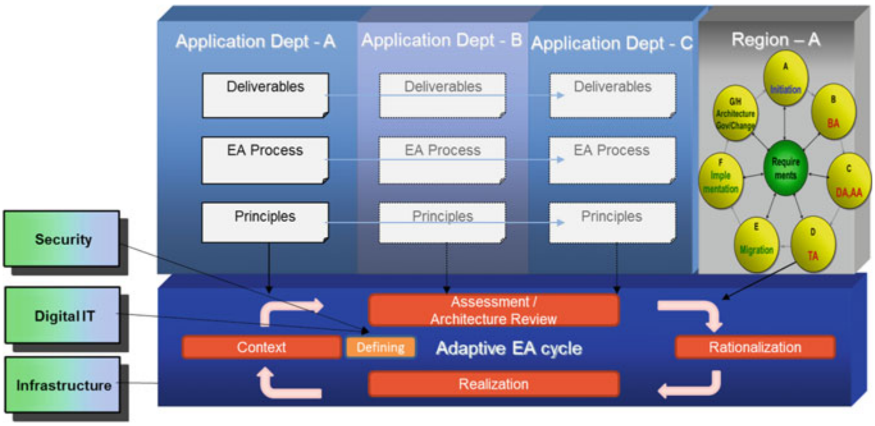


Fig. 3.4 AIDAF proposed model (e.g., TOGAF and adaptive EA framework)

(architecture design guidelines related to all types of security/ cloud/mobile IT consistent with the IT strategy) in line with the needs of business divisions. In the next phase of the assessment/architecture review, the architecture committee/organization reviews the architecture by focusing on the conceptual design portion of the initiation documents for this IT project. In the rationalization phase, the stakeholders and Architecture Board differentiate/decide upon information systems that will be replaced by the proposed new information system structure or that are no longer necessary and can be abandoned. In the realization phase, this project team begins to implement the new IT project agreed upon as a result of deliberating these issues/action items. This enables the corporate entity to adopt an EA framework capable of flexibly adapting to new cloud/mobile IT projects that continuously occur, and which are composed of these four phases.

Moreover, the "TOGAF" and "simple EA (framework)" based on an operational division unit in the top part of Fig. 3.4 are able to respond to differing policies and strategies in business divisions from a mid-long-term perspective. This part of the framework has a structure that can select the above EA framework in line with the characteristics of business division unit operational processes and future architecture. This part also enables application.

Further, the framework should align EA guiding principles with the definitions of these principles for business divisions to ensure consistency between the Adaptive EA cycles in the lower portion of this Fig. 3.4 and the "TOGAF" and "simple EA (framework)" in the upper portion. Furthermore, in the defining phase, the architecture committee/organization promotes the appropriate architectural design of each of the new cloud/mobile IT-related systems by developing/publishing the architectural guidelines for security/cloud/mobile IT, etc., to achieve alignment with the IT strategy (Masuda et al. 2017a, b, c).

### *3.3.2 Research Methodology*

In the previous section, as an "EA Framework fitting to the strategy of promoting cloud/mobile IT," we proposed an "Adaptive Integrated Digital Architecture Framework—AIDAF" on the basis of previous research in this field. The proposed framework needs to include the necessary EA elements for the era of cloud/mobile IT/digital IT.

Moreover, we present research questions to verify this "Adaptive Integrated Digital Architecture Framework—AIDAF" toward the requirements in the era of cloud/mobile IT/digital IT and to ensure the effectiveness of this proposed EA framework. Next, we evaluate two research questions corresponded to the case study of a Global Healthcare Enterprise (GHE), which is a research-based global company with primary focus on pharmaceuticals. Being the largest pharmaceutical company in Asia and an industry leader, this GHE prioritizes the future direction of digital healthcare as an important element of corporate strategy; therefore, this case study of the GHE is among the only advanced cases of EA implementation toward the era of Digital IT, especially in the field of digital healthcare.

RQ1-1: How is an "Adaptive Integrated Digital Architecture Framework—AIDAF" developed to meet the requirements in the era of cloud/mobile IT/digital IT?
RQ1-2: How can our proposing EA framework solve problems in the era of cloud/mobile IT/digital IT?

Then, one of the authors who actually led the project to build and implement this EA carried out the case study within a global pharmaceutical company, where we built and implemented the "Adaptive Integrated Digital Architecture Framework—AIDAF," by focusing on real developments and progress histories. Moreover, we evaluate the aforementioned research questions using this case study of the global pharmaceutical company (Masuda et al. 2017a, b, c).

On the basis of the above research, we clarify the challenges, benefits, and critical success factors of this EA framework for EA practitioners in Chap. 7.

## 3.4 Assessment Meta-Model in Architecture Board

### *3.4.1 Background*

There is the description regarding Architecture Board in the TOGAF9 documentation (TOGAF® Version 9.1, The Open Group 2011), but processes and criteria for Architecture Board have not existed in previous researches. On the other hand, COBIT5 also guided the way of implementing architecture governance, involving Architecture Board, aligned with IT governance (ISACA 2012), but this guide did not refer to processes for Architecture Board, either. Furthermore, from standpoints of ISO standards on architecture, the draft of overview for architecture process—ISO/IEC42020 (Martin 2016) and Architecture Evaluation—ISO/IEC42030 (Martin 2017) was shown, but the above ISO standards on architecture have not been published at the current time.

In this book, the author hypothesized the process for Architecture Review and Evaluation and verified this in the case study in the Global Healthcare Enterprise (GHE).

### *3.4.2 Architecture Board and Global Healthcare Company Case*

Our preliminary research for this section proposes an Adaptive Integrated Digital Architecture Framework to align with IT strategy, promoting Cloud/Mobile IT/Big Data/Digital IT, and is verified by our case study (Masuda et al. 2017a, b, c). The

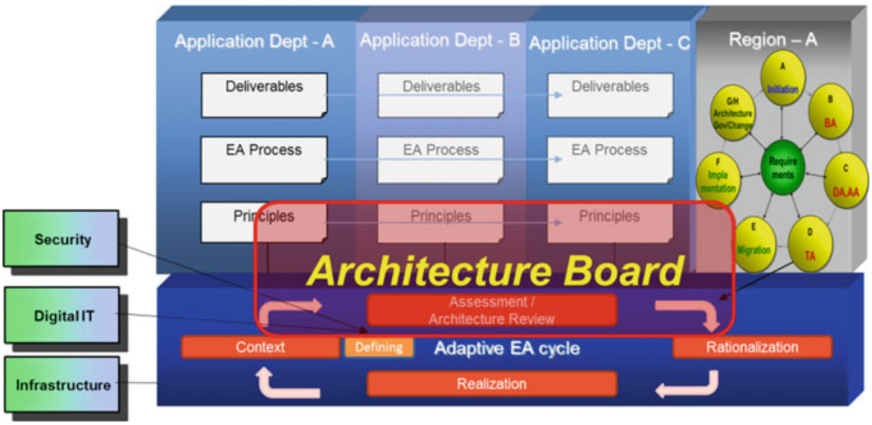


**Fig. 3.5** AIDAF proposed model with Architecture Board (e.g., TOGAF and Adaptive EA framework)

author of this book has named the EA framework suitable for the era of Digital IT as "Adaptive Integrated Digital Architecture Framework—AIDAF" (Masuda et al. 2017a, b, c). Figure 3.5 illustrates the AIDAF proposed model with Architecture Board.

This AIDAF begins with the context phase, while referencing the defining phase (i.e., architecture design guidelines related to Digital IT aligned with IT strategy). During the assessment and architecture review, the Architecture Board reviews the initiation documents and related architectures for the IT project.

In particular the Architecture Board, the example of the EA framework structure in a certain global pharmaceutical company examined in this book is explained. This global pharmaceutical company is the largest Japan-headquartered global company in the industry in Asia based on a sales basis. In a global EA rollout, they are handling Cloud/Mobile IT/Big Data strategic projects and systems that took priority in Europe and US Group companies well by structuring and implementing EA with the above Adaptive Integrated Digital Architecture Framework—AIDAF—to be consistent with global IT strategy focusing on Cloud/Mobile IT/Big Data/Digital IT (Masuda et al. 2017a, b, c).

Actually, one of the authors works in this global pharmaceutical company and conducted all phases of structuring and implementing in this EA framework and was the facilitator and managed the coordination of the global Architecture Board. In this global pharmaceutical company, one of the authors had the above responsibilities in the Assessment/Architecture Review phase on the global Architecture Board as shown in Fig. 3.6, which we were focusing on, and performed the above tasks (Masuda et al. 2017a, b, c).

| Responsibilities of Architecture Board | Tasks of Architecture Board |
|---|---|
| -Operational/Functional Aspect and Viability of solution architectures with Enterprise level Standard conformance are assessed properly, and the projects related architecture risks should be coped with.<br>-Architecture integration issues across<br>IS/IT organization are assessed, reviebd and resolved.<br>-Enterprise architecture risks are assessed and mitigated timely and consistently. | -Review solution architecture/standard/common platform of new IS/IT projects, involving new technologies.<br>-Endorse signed architecture of new IS/IT projects for the month<br>-Share Architecture strategy in each departments, initiatives and their status. |

**Fig. 3.6** Responsibilities and tasks of the Architecture Board

### *3.4.3 Proposal of Assessment Meta-Model in Architecture Board*

As a result of investigating tasks of architecture reviews in Architecture Board, in this case, we confirmed that project planning documents of almost all-new IS/IT projects have been submitted into the Architecture Board. This Architecture Board performs Architecture Review regarding their solution architectures on the basis of the following evaluation criteria of four elements—[1], [2], [3], [4]—and issued the action items there. One of the authors found out the risks connected to each action item and defined equivalent solution for each risk in or after this Architecture Board (Masuda et al. 2017a, b, c).

[1] Enterprise-level conformance—align with architecture roadmap, standard, each architecture principle.
[2] Functional aspect—clarify solutions/architecture specs, integration points, with standard master data.
[3] Operational aspect—alignment with the service level, security design and privacy, system availability.
[4] Viability—application rationalization, risks/countermeasures, data migration/testing strategy.

We propose the "Assessment meta-model in Architecture Board" in Fig. 3.7, based on the above steps and descriptions in this case study (Masuda et al. 2017a, b, c).

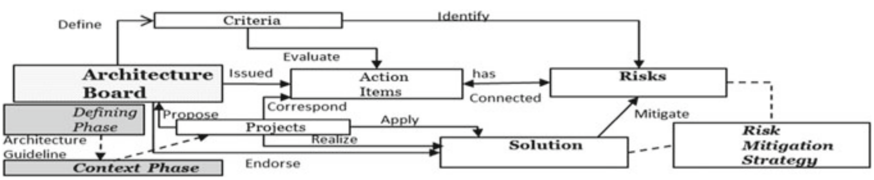


**Fig. 3.7** Assessment meta-model in Architecture Board

### 3.4.4 Research Methodology

In this book, we first state research questions to understand the practices and effectiveness of the Architecture Board in Enterprise Architecture. Then, we evaluate these research questions using a case study in the Global Healthcare Enterprise (GHE).

The following research questions are evaluated in the case study.

RQ2-1: How can Architecture Board be processed with the state transition defined in Assessment model in Architecture Review?
RQ2-2: What are the relationships that can be clarified between solutions and risks raised in Architecture Board for projects and solutions across the enterprise systems covering ERP, CRM, and Digital IT?

To investigate architecture risks and solutions in enterprise systems and EA, we look into the case study within a large-scale GHE, where we built and implemented the "Adaptive Integrated Digital Architecture Framework" and started the Architecture Board. In the global Architecture Board, all-new IS/IT project's architecture designs were reviewed and action items for next steps were raised by architects and top management and PMO members. After the Architecture Board was held, we defined risks connected to each action item and considered solutions to mitigate those risks.

Then, we propose an Assessment meta-model in Architecture Board as hypothesis. Furthermore, the data of activities in Architecture Board in this GHE is analyzed and the proposed model is evaluated. In our analysis, we mapped the solution categories into the previously defined risk categories in Architecture Board. We analyzed the interrelationships between these risks and solutions that were defined in the architecture risk analysis with this Architecture Board.

Based on the above research, we formulated the effective elements of Risk Mitigation Strategy with Architecture Board for EA practitioners. Moreover, we conducted further research regarding these solutions spreading across the enterprise systems of Digital IT in this case of Global Healthcare Enterprise (Masuda et al. 2017a, b, c).

## 3.5 GDTC Model for Knowledge Management on Digital Platforms

### 3.5.1 Background

#### 3.5.1.1 Organizational Evolution

Evolutionary organization theory (Howard Aldrich 2007) states that organizations evolve through four processes, namely variation, selection, retention, and competition. During the variation process, the organization's activities and abilities change, intentionally or unintentionally, through the creation of new organizations or exploration of problems. During the selection process, specific variations are selected while others are eliminated, based on conditions related to the market, competitive pressures, stability, and administration. During the retention process, selected actions arising from the selected variations are replicated, preserved, and reproduced through standardization, systematization, and specialization. Furthermore, competition for capital and legitimacy arises as a result of various actions seeking to obtain resources.

In the following sections, we discuss the processes of variation, selection, retention, and competition, as well as the organizational change and evolution that occur due to these processes in terms of their relationship with global communication regarding digital IT transformation.

The global communication that accompanies digital IT transformation affects organizations in two ways. The first is the advent of variation in digital-related organizational activities due to the introduction of a global communication medium accompanying digital IT transformation, and the corresponding evolution of digital-related organizations. The second is that global communication becomes an important factor in organizational evolution, because global communication media accompanying digital IT transformation promotes variation in digital-related organizations (Masuda et al. 2017a, b, c).

### Organizational Transformation and Global Communication in Digital Transformation

Organizational transformation includes three dimensions: goals, boundaries, and activities (Howard Aldrich 2007). In goal transformation, the organization's activity, products, and services areas change. In boundary transformation, the organization and its members expand or contract, for example, during enterprise integration. In activity transformation, the activity system changes due to business activity transformations caused by factors such as digital IT deployment.

As a result of the implementation of enterprise portals as a global communication method accompanying digital transformation, the following variations may occur in the dimensions of goals, boundaries, and activities (Masuda et al. 2017a, b, c).

1. Transformation of goals

Enterprise portals accompanying digital transformation can be used to expand the scope of information which employees can take advantage of for distributing and publishing information related to digital IT platforms and business applications (e.g., FinTech and digital healthcare), as well as digital IT services (such as cloud and big data analysis), in addition to traditional business systems information. Furthermore, global communication allows information related to the above services that are managed by overseas corporations (USA, Europe, and so on) to be distributed and published. It also allows information to be distributed and shared with employees of overseas corporations, resulting in new ways of thinking and the potential generation of a synergetic effect (using digital information on a global scale and the accompanying increases in productivity, among others).

2. Transformation of boundaries

Using an enterprise portal to form a global communication network for distributing and sharing information with employees in foreign corporations and departments (USA, Europe, and so on) can aid in overcoming the barriers between global logical organizations and regional organizations.

3. Transformation of activities

The introduction of enterprise portals accompanying digital IT transformation can enhance global communication with employees of overseas corporations. Moreover, enterprise portals will make it possible to incorporate a diverse range of viewpoints when implementing solutions to problems that arise in daily business activities and global business activities, as well as problems faced by customers and society, by using digital IT-related business applications (e.g., FinTech and digital healthcare), which distribute and share information.

As explained, the introduction of global communication methods accompanying digital IT transformation has the potential to transform organizations from these three perspectives (Masuda et al. 2017a, b, c).

#### 3.5.1.2 Organizational Transformation Process and Global Communication in Digital Transformation

In the variation process, transformational periods increase as more variations are generated. In the selection process, new actions are introduced through changes on the basis of selection, such as environmental compatibility, technological innovation, and regulations. In the retention process, transformation is completed by externalizing knowledge necessary for reproducing the new configuration within the practicing community, such as a social network of individuals.

Introducing an enterprise portal as a method of global communication accompanying digital IT transformation can generate the following organizational transformations, through the variation, selection, and retention processes (Masuda et al. 2017a, b, c).

1. Variation process

The introduction of an enterprise portal accompanying digital IT transformation requires diverse variations, including the activities of the internal digital IT promotion public offering team and the new digital IT service/delivery team, support of the top management level's digital IT strategy and activities, and operation during the experimental phase of digital IT projects, so that opportunities for transformation may increase.

2. Selection process

Information and solutions to problems related to the diverse and rapidly proposed new digital IT-related projects and systems may be distributed and shared on the enterprise portal.

3. Retention process

It is anticipated that the formation of employee networks, including employees in overseas corporations, will aid in obtaining and retaining practical knowledge for improving business activities and customer value using digital IT.

As discussed, it is expected that the introduction of a new method of global communication accompanying digital IT transformation will transform the organization throughout all stages of the evolutionary process of global logical organizations and regional organizations.

#### 3.5.1.3 Intermediary Knowledge Model

In organizational computer-mediated communication (CMC), such as portals and social networks, it has been established that experiential knowledge is visualized and shared through text that is generalized as explicit knowledge (Yamamoto and Kanbe 2008a, b; Kanbe et al. 2010).

Fragmented knowledge that is disseminated horizontally across the organization by its employees, through corporate digital media, is referred to as intermediary knowledge (Yamamoto and Kanbe 2008a, b; Kanbe et al. 2010). The knowledge-sharing process based on intermediary knowledge is visualized through publication, resonant formation, collaboration, sophistication, and fragmentation. The intermediary knowledge model is shown in Fig. 3.8.

In this study, we show that knowledge sharing through intermediary knowledge can effectively and efficiently promote global communication as a result of digital IT transformation, by means of corporate bodies conducting global communication accompanying digital IT transformation through enterprise portals (Masuda et al. 2017a, b, c).

#### 3.5.1.4 Communication Model

There are two types of communication models: the linear information model, which transfers activities from the speaker to the receiver, and the convergence model, in which an iterative process occurs until a mutual understanding of the information has been reached (Rogers 1992). In addition, Yamamoto et al. proposed the cooperative model, focusing on the process of organizational activities for the purpose of achieving goals (Yamamoto 2010).

In this book, we assume that enterprise portals introduced as a method of global communication accompanying digital IT transformation follow the convergence model of global organizations and communities. Furthermore, we anticipate that they will follow the cooperative model, with the combined use of a corporate social network, as a result of global communication (Masuda et al. 2017a, b, c).

### 3.5.2 Research Methodology for Global Communication Process on Digital Platforms

In this section, we first state research hypotheses to understand the effectiveness of the global communication process on an enterprise portal. Then, we evaluate these hypotheses using a case study on the enterprise portal application of the Global Healthcare Enterprise (GHE) (Masuda et al. 2017a, b, c).

The following research hypotheses are evaluated in the case study.

RH1: Barriers between global logical organizations and those among regions and locations may be overcome through global communication within the enterprise portal community. (Reason) A number of cross-functional problems should occur during digital transformation among global logical organizations, as well as within each region and country.
RH2: Global community members can supply and share informal knowledge among one another with global communication activation on the enterprise portal.
RH3: The global communication process on the enterprise portal exhibits common patterns for solving the cross-functional problems, via the intermediary knowledge model in a global organization, community, and corporation.

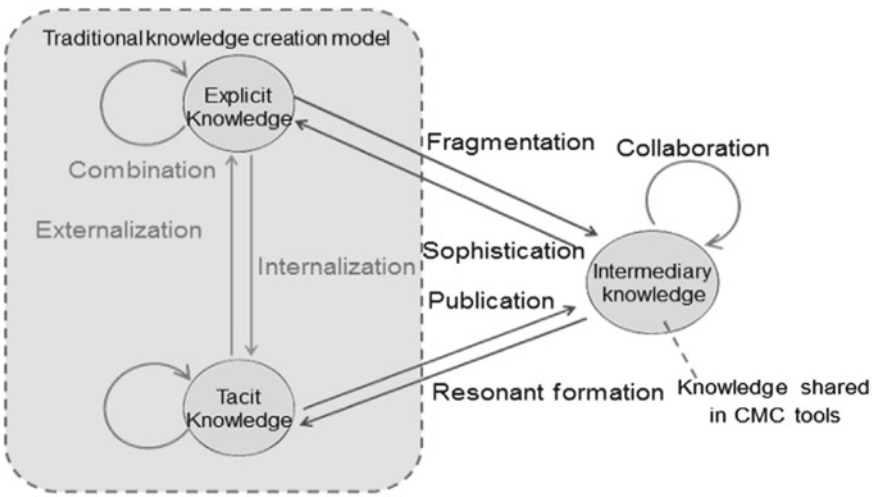


**Fig. 3.8** Intermediary knowledge model

The following section describes the new CMC model for global communication on an enterprise portal, named as the Global Digital Transformation Communication (GDTC) model. This model is used to evaluate the three research hypotheses (Masuda et al. 2017a, b, c).

### 3.5.3 GDTC Model Overview

The author proposes the GDTC model for global communication on an enterprise portal, which will be able to promote the digital transformation in the global community. The GDTC model consists of three layers: the tacit knowledge group (TKG), intermediary knowledge group (IKG), and explicit knowledge group (EKG), as shown in Fig. 3.9 (Masuda et al. 2017a, b, c).

TKG contains roles for exchanging tacit knowledge, and its group node is human. TKG is related to organizational structures, member roles, and decision-making process, among others, and is generated in telephone or Web conference communications. It appears that TKG does not generate any documentation for global communication, and we assume that it does not create any formal documents. The deliverables of TKG are discussions and meetings; however, it does not always produce tangible deliverables that can be observed.

IKG performs the role of exchanging intermediary knowledge, and its group node is portal contents, which is related to the portal, SNS and e-mail within the global community. IKG provides just-in-time documentation to global community members, and CMC tools can be used if one member needs to coordinate with others. Just-in-time documentation refers to necessary knowledge becoming documents when global community members communicate with each other using CMC tools.

| Knowledge Group | Group node | Media | Documentation | Examples of deliverables |
|---|---|---|---|---|
| Tacit Knowledge Group | Human | Telephone, Web conference | No documentation | Discussions, Web Meetings |
| Intermediary Knowledge Group | Portal contents | Portal, SNS, e-mail | Just in time documentation | Architecture Board logs, SNS logs, e-mail logs |
| Explicit Knowledge Group | Document | Document management services | Full documentation | Architecture Board Results, Architecture guidelines |

**Fig. 3.9** Elements of layers in GDTC model

The deliverables of IKG are Web conference, SNS, and e-mail logs (Masuda et al. 2017a, b, c).

The role of EKG is the exchange of explicit knowledge. The group node of EKG is documented, and the document group results from document management services, whose functions are historical management, enterprise document searching, and document file sharing. EKG provides full documentation to global community members, and its deliverables are documents such as conference results and guidelines (Masuda et al. 2017a, b, c).

As a whole, the TKG group undergoes human communication during discussions and meetings. Communication between TKG and IKG involves the processes of intermediary knowledge provisions and acquisitions in the portal, SNS, and e-mail, while communication between IKG and EKG consists of the processes of quotations and documentation of explicit knowledge in the portal, SNS, and e-mail (Masuda et al. 2017a, b, c).

### *3.5.4 Proposal of GDTC Model for Global Communication on Enterprise Portal*

The traditional global communications employ TKG and EKG in the knowledge process; however, a great deal of communication in meetings is necessary among the stakeholders in the case of covering many regions, such as Europe, Asia, the USA, South America, the Middle East, and Africa.

Figure 3.10 shows our proposed GDTC model, which adds IKG to the traditional knowledge process in global communications. CMC tools, such as the portal and SNS, are used to support IKG. The square balloons illustrate the representative knowledge process of the GDTC model, while the dotted square balloons represent the knowledge processes of traditional global communication styles (Masuda et al. 2017a, b, c).

The knowledge processes in IKG consist of open and agile communication in the portal, SNS, and e-mail, and these CMC tools facilitate communication within global communities and organizations. IKG records meeting, SNS, and e-mail logs, which are not formal documents, but still very effective knowledge for global communication. Global community members can read each other's knowledge processes in these logs. The knowledge processes in the GDTC model correspond to the knowledge transfer modes in the intermediary knowledge model in Fig. 3.8. Tacit, intermediary, and explicit knowledge correspond to the TKG, IKG, and EKG, respectively (Masuda et al. 2017a, b, c).

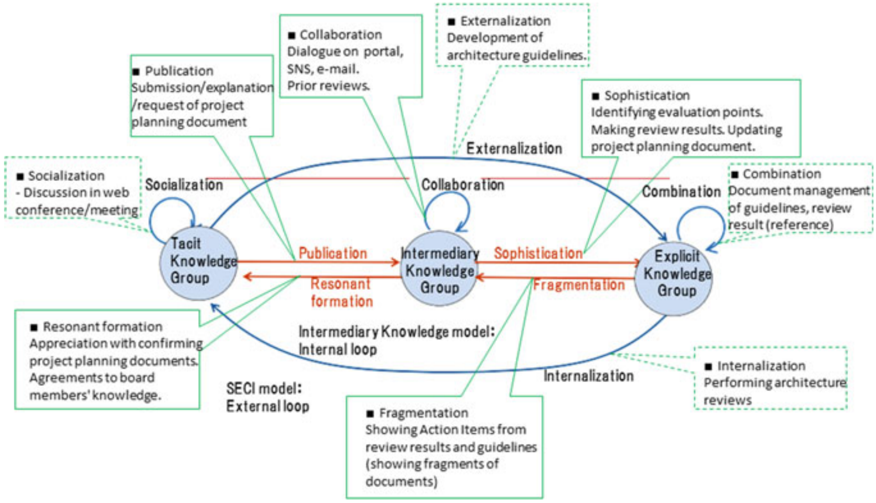


**Fig. 3.10** GDTC model with knowledge sharing

## 3.6 Social Collaboration Model for Architecture Review in Architecture Board

### *3.6.1 Proposal and Overview of Social Collaboration Model for Architecture Review in Architecture Board*

Our latest research of global communication case study suggested that the global communication steps on the enterprise portal should be divided into the types such as request, reference, consolidation, confirmation, evaluation, and understanding and that each new project planning document was made/submitted and reviewed/evaluated in the Architecture Board, and in another, the review results were published and the project was endorsed after dealing with the necessary action items (Masuda et al. 2017a, b, c, 2018). The above global communication process of Architecture Board review on the enterprise portal between the leader/Architecture Board members and new project manager, for the purpose of review in the Architecture Board, can be equivalent to Business Architecture (BA) for Architecture Review in Architecture Board. The author proposes the "Social Collaboration Model for Architecture Review in Architecture Board" in Fig. 3.11 in this book, while the above global communication process is shown as BA of this SCM model in the upper part of Fig. 3.11 (Masuda et al. 2018).

The back-colored scope in Fig. 3.11 suggests that this scope of BA should conform to assessment meta-model shown in Fig. 3.7 for architecture reviews in Architecture Board.

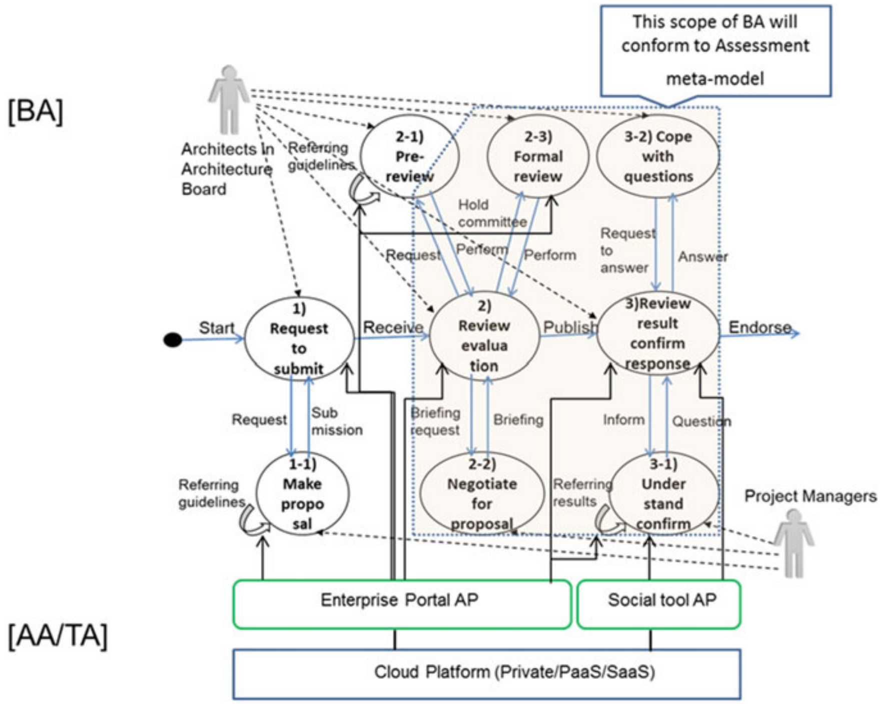


**Fig. 3.11** SCM model for Architecture Review in Architecture Board

Furthermore, the above global communication process as BA of Architecture Review in Architecture Board should be activated on the enterprise portal application and social tool application, as Application Architecture (AA), built on Cloud-based technology platforms like Private Cloud, PaaS, and SaaS as Technology Architecture (TA) as depicted in Fig. 3.11 (Masuda et al. 2018).

### *3.6.2 Research Methodology for Social Collaboration Model for Architecture Review in Architecture Board*

In this book, the author states the research question to understand the practices and effectiveness of the Architecture Board in Enterprise Architecture and Architecture reviews with utilizing digital/social platforms there. Then, the authors evaluate the research question using a case study in the Global Healthcare Enterprise (GHE) (Masuda et al. 2018).

The following research question is evaluated in the case study additionally.

RQ2-3: How can Architecture reviews be performed with the review process of a state transition based on Social Collaboration Model on digital platforms in Architecture Board?

The author proposes the new Social Collaboration Model for Architecture reviews in Architecture Board, named as the "Social Collaboration Model for Architecture Board Review" in Fig. 3.11. Moreover, this proposed Social Collaboration Model for Architecture Board Review should be verified in the global communication case study on digital platforms in this GHE (Masuda et al. 2018).

Based on the above research, the author will clarify the challenges and critical success factors of Architecture reviews on social/digital platforms in Architecture Board for EA practitioners.

## 3.7 STRMM for Digital Transformation

### *3.7.1 Proposal of STRMM for Digital Transformation*

As a result of investigating tasks of architecture reviews in the Architecture Board, in this case, we confirmed that project planning documents of almost all-new IS/IT projects have been submitted to the Architecture Board. This board performs an Architecture Review on the basis of the following evaluation criteria of four elements, namely [1], [2], [3], and [4], and issued the action items there. One of the authors found out the risks connected to each action item and defined an equivalent solution for each risk, and started the Risk Management process with the Architecture Board based on proper Mitigation Strategy (Masuda et al. 2017a, b, c).

[1] Enterprise-level conformance—align with architecture roadmap, standard, each architecture principle.
[2] Functional aspect—clarify solutions/architecture specifications, integration points with standard master data.
[3] Operational aspect—alignment with the service level, security design and privacy, system availability.
[4] Viability—application rationalization, risks/countermeasures, data migration/testing strategy.

We propose the "STrategic Risk Mitigation Model for Digital Transformation" in Fig. 3.12 in this case study (Masuda et al. 2017a, b, c).

### *3.7.2 Research Methodology*

To investigate architecture risks and solutions in ES and EA, we investigate the case study within a large-scale GHE, where we built and implemented the "Adaptive Inte-

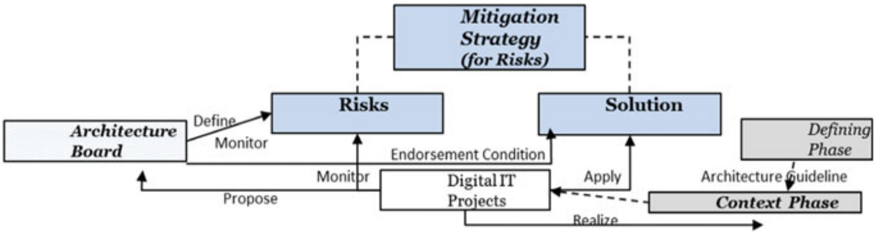


**Fig. 3.12** STRMM for digital transformation

grated Digital Architecture Framework—AIDAF" and started up the Architecture Board. In the global Architecture Board, all-new IS/IT project architecture designs were reviewed and action items for the next steps were raised by architects, top management, and PMO members. After the Architecture Board was held, we defined the risks connected to each action item raised and considered solutions to mitigate them.

As the next step, we propose the STrategic Risk Mitigation Model for Digital Transformation in the Architecture Board as a hypothesis. Furthermore, we analyze the data of activities for digital IT projects in the Architecture Board in this GHE, and we evaluate our proposed model in this empirical research. In our analysis, we mapped solution categories into the previously defined risk categories in the Architecture Board. We analyzed the interrelationships between these risks and solutions that were defined in the architecture risk analysis for digital IT projects involving Big Data-related digital IT ones in the Architecture Board.

Based on the above research, we defined the effective strategy elements to mitigate risks with the Architecture Board for EA practitioners as a hypothesis. Moreover, we conducted further research regarding these solutions spreading across the Digital IT systems, such as Cloud (SaaS, PaaS, and IaaS), Mobile IT applications, and specific application layer on Cloud/Mobile IT(Big Data and Analytics) in this case of GHE. We evaluated our defining elements in the empirical research (Masuda et al. 2017a, b, c). Specifically, the research questions employed in this study are:

RQ3-1: How can the Architecture Board control the solutions with Risk Mitigation model in Digital Transformation involving Big Data?
RQ3-2: What strategy elements can be clarified to mitigate risks for Digital Transformation?

**Questions and Exercises**

1. What are some of the models related to Architecture Board in the AIDAF?
2. Describe five elements of Digital Agility in the era of cloud/mobile IT/digital IT.
3. How is EA changing in the cloud era? How can EA be adapted to support the new digital IT architectures?
4. Describe in detail the components of the AIDAF.
5. What kind of documents will be published in the defining phase of Adaptive EA cycle in AIDAF?
6. Which one of the following is not a phase of Adaptive EA cycle in AIDAF?
   a. Rationalization
   b. Context
   c. Alignment
   d. Realization
7. A large healthcare provider organization that operates outpatient clinics across the USA seeks to improve coordination of care, improve health outcomes, and manage costs more effectively. To achieve these objectives, the client needs to update existing clinical systems and develop new communication channels, including Web portals and mobile devices to engage patients, physicians, and partners. The existing clinical systems are built on 20-year-old technology that cannot accommodate the mobile channels expected by patients and physicians. A new Technology Architecture will help meet these needs and provide a foundation for emerging data-driven healthcare capabilities. Describe how AIDAF can be applied in this content.

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# Chapter 4
# Evaluation for EA Framework Implementation Method

**Abstract** This chapter describes a case of EA framework building in a global company. In this global company, first, we built an EA framework through TOGAF; however, there were some problems with EA implementation in cloud/mobile IT/digital IT strategy. Therefore, we built and apply the AIDAF in a global deployment of EA. This chapter refers to an integration approach between Adaptive EA cycle and TOGAF in AIDAF. In the latter of this chapter, we evaluated how each problem was addressed in a global deployment of the AIDAF. In later chapters, we will show the case study for the Assessment model with Architecture Board, the Global Digital Transformation Communication model and Solution Collaboration Model.

**Keywords** Digital IT strategy · Enterprise architecture · EA · Case study · TOGAF · AIDAF

## 4.1 Case of EA Framework Building in a Global Pharmaceutical Company

Here we present a case of EA framework building by the global pharmaceutical company featured in this chapter. This global pharmaceutical company, which is headquartered in Japan, has the largest Asian pharmaceutical market share in terms of sales volume and is smoothly advancing its global deployment of EA by implementing strategic cloud/mobile IT projects and systems at its divisions especially in the USA and Europe. One of the authors is actually responsible for all phases of building and implementation of this EA framework and provides background and details of how the EA framework was built (Masuda et al. 2017).



Y. Masuda and M. Viswanathan, *Enterprise Architecture for Global Companies in a Digital IT Era*, https://doi.org/10.1007/978-981-13-1083-6_4

### *4.1.1 Building an EA Framework Through TOGAF at Japan Headquarters*

As the global pharmaceutical company featured in this chapter engaged in several mergers and acquisitions with US research institutes and European pharmaceutical companies since 2008. Consequently, the information system environment at each of its bases in Japan/Asia, the USA, and Europe was separated. Therefore, in order to promote the deployment and coordination of IT architecture aligned with its global IT strategy, from the end of 2013, the company first commenced an EA framework building project at its Japan headquarters and proceeded to adopt TOGAF, an internationally recognized EA framework for corporations. The company proceeded with the actual building of its EA framework at Japan headquarters according to the TOGAF9 ADM phase. First, the company verified existing IT architecture documentation at its Japan headquarters and set EA project objectives as the Preliminary Phase. Thereafter, the company formulated an IT vision according to its 2020 management vision strategy under Phase A: Architecture Vision, and defined about 12 EA guiding principles necessary to realize this vision. Next, in parallel phases B: Business Architecture, C: Information system architecture, and D: Technology Architecture, the company visualized its current architecture, prepared a current business function map/chart for its Business Architecture (BA). At this time, the company also produced current application maps of the application architecture (AA) within that information system architecture, current high-level data flowcharts of its Data Architecture (DA), and a current TA map (execution environment/operating environment/development environment/infrastructure) of the technology architecture (TA). Thereafter, the company formulated a future image of each of the BA/AA/DA/TA architectures, envisioning the next five years of the parallel implemented Phase B, Phase C, and Phase D. In addition, the company formulated technology standards for some TA target architecture prepared in Phase D, referencing and utilizing the TOGAF9 TRM (Technology Reference Model) (Masuda et al. 2017).

Furthermore, in the parallel implemented Phase E: Opportunities and Solutions, a gap analysis was performed between each of the current architectures (BA/AA/DA/TA) visualized in phases B/C/D, and global pharmaceutical industry benchmarking information/best practices. Opportunities for transformation to promote EA in each BA/AA/DA/TA were identified and incorporated into the respective target architectures of each of the aforementioned BA/AA/DA/TA (Masuda et al. 2017).

Next, in Phase F: Migration Planning, the company selected and organized various IT projects for each of the BA/AA/DA/TA target architectures and each in-progress global IT initiative, and then prepared an architecture roadmap for business application areas and each technology area. In addition, in the parallel implemented Phase G: Implementation Governance, each EA governance process (target architecture formulation and updating process, standard architecture management process, etc.,) and the structure of each EA deliverable were defined for BA/AA/DA/TA, and related tasks were incorporated into the architecture roadmap prepared in Phase F. Finally, in Phase H: Architecture Change Management, and Requirements Management, it was determined whether the tasks needed to be defined globally depending on their nature, and then they were defined and the timing of their implementation earmarked for global deployment of EA at a later phase (Masuda et al. 2017).

### *4.1.2 Problems with EA Implementation in Cloud/Mobile IT/Digital IT Strategy*

After EA framework building according to TOGAF9 ADM at the Japan headquarters as described above, the company initiated coordination among overseas information system departments (USA/Europe) and started global EA training and meetings in July 2014. These meetings with USA and European information system departments clarified that, at that time, there were not many information systems at Japan headquarters that were based on SaaS and IaaS-based cloud services and mobile IT. It was established that these information systems actually exceeded half of the new information systems and projects planned for the USA and Europe and thus already constituted the mainstream. Therefore, this global pharmaceutical company faced the following problems in terms of the further global deployment of EA (Masuda et al. 2017).

(1) The inclusion of information system departments in the USA and Europe complicated the definition of each principle/standard for the global organization.
(2) New European and US IS/IT system projects in the cloud (SaaS and IaaS-based)/mobile IT/digital IT fields constitute more than half of the total, and it was no longer possible for conventional SOA-based reference architecture to be used for architecture guidelines.
(3) There exist areas in which BPR projects intended to define standard global business processes (BA) and MDM projects to design and build global master data management platforms (DA) have stalled, and no progress is being made in the formulation of target architecture (BA/DA).
(4) Even under the above circumstances, global architecture committees hold meetings for the Architecture reviews on a flexible basis, and there has been demand for reducing architecture risks in each new IT project, and the promotion of a solution based on sound architecture design (Masuda et al. 2017).

### *4.1.3 Building and Application of an "Adaptive Integrated Digital Architecture Framework—AIDAF" in Global Deployment of EA*

In the latter half of 2014, after 10 or more global EA training sessions and meetings had been held with the overseas USA and European information system departments of this global pharmaceutical company, it was decided to pursue global deployment of the EA from 2015. On the other hand, at that time the company was not in a position to globally pursue the formulation of target architecture in BA/DA. There were many new AA-related projects in the cloud (SaaS and IaaS-based)/mobile IT/digital IT fields in Europe and the USA, and conventional SOA-based architecture guidelines were often inapplicable; thus, the company started each task in the area of TA (technology architecture) for global EA. These TA tasks for global EA included determining and drafting global technology standards organized along the lines of a global IT infrastructure integrated system building project, and the formulation of the target architecture and guidelines in each IT infrastructure area (Masuda et al. 2017).

Thereafter, this global company initiated a global Architecture Board in July 2015 (facilitated and coordinated by one of the authors from 2016), started architecture reviews for each new IT/information system project, and realistically pursued the global deployment of EA. Specifically, the company first proceeded to build an EA framework as part of the global deployment of EA according to the steps (Fig. 4.1) of the Adaptive EA cycle (framework) presented in the lower part of the Adaptive Integrated Digital Architecture Framework in Fig. 3.1. This would allow them to flexibly introduce new cloud (SaaS and IaaS-based)/mobile IT/digital IT projects successively in each overseas region. First, in the context phase, the company embarked upon each project team's short-term (monthly) drafting of new successive cloud/mobile IT/digital IT-based IT system projects (including conceptual architecture design) based upon business department needs, by referencing the security/cloud/mobile IT-related architecture guidelines. When architecture guidelines were drafted in the defining phase, the company's architecture teams defined principles conforming to IT strategy elements and established consistency with global IT strategy by linking the guidelines to various architecture patterns (Masuda et al. 2017).

From standpoints of the integration with architecture deliverables based on TOGAF in Japan headquarter in AIDAF proposed and shown in Fig. 4.2, first, the above architecture guidelines and each principle there in defining phase were developed with referring to principles and deliverables defined in Phase A: Architecture Vision in TOGAF in Japan headquarter. Second, the above application architecture-related guidelines such as customer relationship management (CRM), manufacturing and supply chain management (SCM) were developed with referring to target architectures and roadmaps defined in Phase B: Business Architecture and Phase C: Information Systems Architecture (application architecture (AA) and Data Architecture (DA)) in TOGAF in Japan headquarter. The above Technology Architecture-related

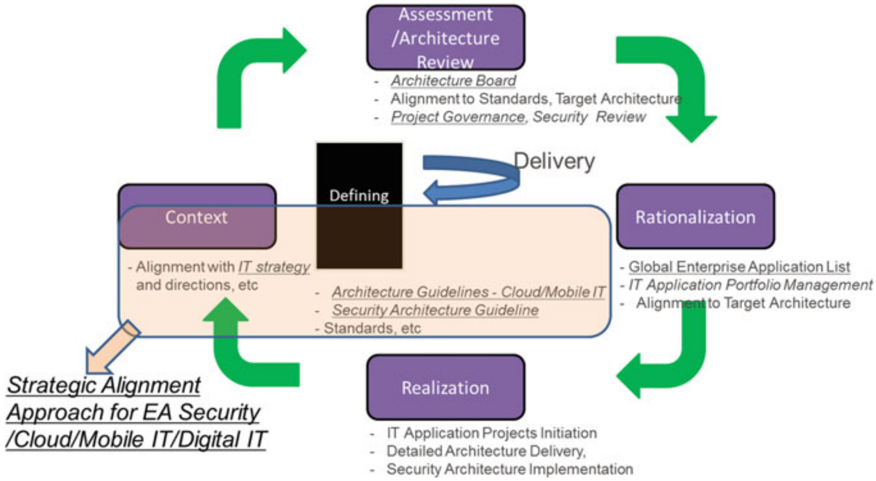


**Fig. 4.1** Adaptive EA cycle built and implemented during global deployment of EA (created by Masuda et al. 2017 and partially acknowledging Gill (2013), "Proceedings of the 19th Americas Conference on Information Systems (AMCIS 2013), Fig. 1")

guidelines such as cloud architecture guideline and security architecture guideline were also developed while referring to target architectures and roadmaps defined and depicted in Phase D: Technology Architecture in TOGAF in Japan headquarter. Third, architecture roadmaps in Migration Plan of TOGAF Phase-E were reflected into architecture guidelines in defining phase of Adaptive EA cycle. Fourth, above architecture deliverables in TOGAF were adopted and used in Architecture Review and rationalization phase of Adaptive EA cycle in AIDAF. Finally, above architecture deliverables can be considered in Risk Management based on STRMM of AIDAF (Strategic Alignment, Architecture Conformance, etc.). Furthermore, during operations of global Architecture Board meetings, architecture deliverables defined in Phase G: Implementation Governance in TOGAF in Japan headquarters were referred to, when necessary.

In the subsequent Assessment/Architecture Review Phase, each of these new system planning drafts was submitted to the monthly global architecture committee and thus received architecture reviews, mainly of the conceptual design sections of IT project planning drafts. Altogether, the company's Architecture Board distinguished "replaced systems" and "unnecessary, eliminable information systems" according to the implementation of these proposed new information systems, and determined the positioning of new information systems at the rationalization Phase. Here, application portfolio management was started mainly by sales finance departments. Thereafter, as a result of these phases, endorsed/approved new IT system projects were initiated in the Realization Phase and implemented. Moreover, in the latter half of 2016, one of the authors (EA team) worked toward the development of a digital platform to enhance the efficiency of Architecture Review and to improve communications

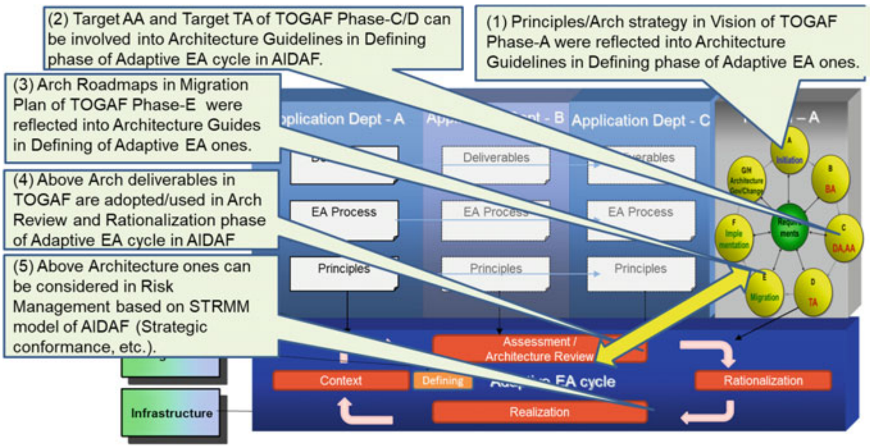


**Fig. 4.2** Integration between Adaptive EA cycle and TOGAF in AIDAF (created by Masuda 2018)

among Architecture Board members using tools such as the enterprise portals and social tools. Thus, the global pharmaceutical company globally adopted Adaptive EA cycles and built flexibly applicable EA mechanisms for successive new cloud (SaaS and IaaS-based)/mobile IT projects (Masuda et al. 2017).

On the other hand, from the latter half of 2015, in an attempt to facilitate global deployment of EA in terms of mid- to long-term cycles (global principle and target architecture formulation, etc.), the company promoted the EA framework built around business division units. More specifically, Application Dept-A in Fig. 3.4 was defined as a manufacturing supply chain department, Application Dept-B as a sales marketing finance department, and Application Dept-C as a research and development/quality/personnel department in the proposed Adaptive Integrated Digital Architecture framework in the upper part of Fig. 3.4, in a form integrated with the Adaptive EA cycle (framework). Specifically, as proposed in this book, mechanisms were arranged for selecting and applying an EA framework matching the characteristics of business processes and future architecture in business divisions (TOGAF and simple EA (framework)). Thus, it would be possible to respond to different policies/strategies in each business department from the mid- to long-term perspective (Masuda et al. 2017).

For example, in global manufacturing supply chain departments, referencing the EA deliverables based on TOGAF9 deployed at Japan headquarters (principle and target architecture, etc.), a simple EA framework was built matching the characteristics of the business applications of manufacturing supply chain departments (MES, supply chain systems). In addition, target architectures were formulated by defining principles conforming to global manufacturing supply chain department strategies and policies, by considering coordination of the annual processes for the scheduled acquisition of IT project budgets. Altogether, the company coordinated against the Adaptive EA cycle in the lower part of Fig. 3.4, and for each EA guiding principle that was defined according to IT strategy, they defined conforming global manufacturing supply chain department principles. Furthermore, by referencing the security/application/cloud/mobile IT/integration-related architecture guidelines drafted and proposed in the defining phase, they instructed each IT project team to design new IT/information systems for the manufacturing supply chain departments. In addition, other global sales marketing finance departments, and each of the research and development/quality/personnel departments, also selected and formulated EA frameworks matching the characteristics of business processes and future architecture in terms of business division units from TOGAF and the simple EA (framework). These departments are considering the application of the above EA framework in forms coordinated against the Adaptive EA cycle in the lower part of Fig. 3.4 (Masuda et al. 2017).

## 4.2 Evaluation and Analysis of Case Study

Currently in the case study described in this chapter, we evaluated when and how the various issues (1) to (4) presented prior to the start of global deployment of EA were addressed. The responses to each of these problems are structured in Fig. 4.3 Masuda et al. (2017).

In terms of issue (1), as the status at the time of EA framework building at Japan headquarters through TOGAF, about 12 EA guiding principles were defined based on the direction of global IT at Japan headquarters. Thereafter, from 2014 to 2015, a request was made to mainly sales finance business application departments in Europe and mainly IT infrastructure departments and research and development departments in the USA in order to promote definition of architecture and principles conforming to EA guiding principles, but the obligation to define each principle was temporarily stopped without being determined globally. Moreover, global definition of each standard based on global organizational agreement was difficult. As of 2015, the global

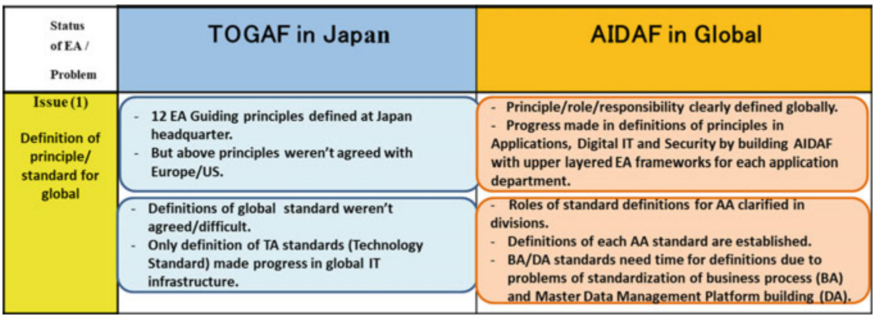


**Fig. 4.3** Status of responses to each problem in the global deployment of EA (1/2) (created by Masuda 2018)

| Status of EA / Problem | TOGAF in Japan | AIDAF in Global |
|---|---|---|
| Issue (2) Architecture Guidelines to handle Cloud/Mobile IT projects | - Drafting began for AA Guidelines<br>- But, external RAs were based on only SOA.<br>- There was no external RAs for microservice based Mobile IT applications and SaaS/PaaS. | - In Defining phase, each department of security, cloud and mobile IT developed security/cloud/mobile IT Architecture Guidelines.<br>- Above Architecture Guidelines can handle microservice based cloud/mobile IT systems raised by project teams. |
| Issue (3) Delays in standardization of global business process(BA), MDM system building(DA) | - No global standard business process (BA)<br>- Master Data Management platform building started at the time (DA). | - Less progress in definition of global standard business process(BA)/global Master Data management platform(DA).<br>- But, new IT/information system project drafts were reviewed by Architecture committee in considerations with the above direction of BA/DA. |
| Issue (4) Holding global Architecture committee/ architecture reviews | - Architecture committee reviewed mainly TA in Europe and US regional units.<br>- But, there were demands to conform to Digital IT strategy in a global level. | - Global Architecture Board was set up to define objectives, EA implementation processes Architecture reviews aligned to IT strategy for each new IT projects.<br>- New projects of Cloud/Mobile IT/Digital IT were spread globally.<br>- Global deployment of EA was fully promoted. |

**Fig. 4.4** Status of responses to each problem in the global deployment of EA (2/2) (created by Masuda 2018)

IT infrastructure related building project had already made progress, and the definition and formulation of TA related standards (technology standards) conforming to this direction were occurring with the agreement of the global IT infrastructure team.

As results of the resolution after global deployment of EA through AIDAF, each principle role and responsibility are being clearly defined globally, and progress is being made in defining each principle involving the areas of applications, Digital IT and Security, by building an EA framework matching the system characteristics of each area within each business application department. Furthermore, the role of standard definitions for AA in each area is clarified within each business application department, and presently definitions for each AA standard are being established. BA/DA standards require time for definition due to Issue (3) "Global business process standardization (BA) and delayed progress in MDM platform building (DA)" (Fig. 4.4).

From a standpoint of issue (2), as the status at the time of EA framework building at Japan headquarters through TOGAF, drafting began for guidelines related to application architecture, but the external reference architecture available at the time (hereinafter, RA) was mainly based on SOA, and there was no external RA based on cloud interface and microservice needed in mobile IT application development and SaaS/PaaS implementation. As results of the resolution after global deployment of EA through AIDAF, at the defining phase, the departments responsible for the areas of security, cloud, and mobile IT are developing a security/cloud/mobile IT-related architecture guide to handle each area, including microservice, in the form of a service catalog, and are promoting it as a reference when new cloud/mobile IT-related systems are drafted by each project team.

In terms of issue (3), as the status at time of EA framework building at Japan headquarters through TOGAF, no global standard business process (BA) formulation or master data management platform building started at the time. As results of the resolution after global deployment of EA through AIDAF, no progress in the definition of global standard business processes (BA) or master global data management system building (DA), and target architecture (BA/DA) not formulated. On the other hand, new IT/information system project drafts were reviewed by the architecture committee at the Assessment/Architecture Review Phase of the Adaptive EA cycle. In actual reviews, the direction of BA/DA at the time was the same, while architecture review was performed based on the most realistic solution at the time. Efforts were made to promote design quality improvements for each new system and conformance with global IT strategy to address Issue (3).

From a standpoint of issue (4), as the status at time of EA framework building at Japan headquarters through TOGAF, Architecture committee/architecture reviews consisted mainly of reviews related to TA in Europe and US regional units, but there was a demand for activity to conform to IT strategy covering the promotion of Digital IT on a global level. As results of the resolution after global deployment of EA through AIDAF, the global Architecture Board was set up according to definite objectives and the EA implementation process, and architecture review conforming to IT strategy of each new IT/information system project involving Cloud/Mobile IT/Digital IT was gradually spread globally, therefore, global deployment of EA was fully promoted.

As described in Fig. 4.3, the initial three problems (1), (2), and (4) have either been solved or are being solved by promoting the use of the AIDAF—Adaptive Integrated Digital Architecture Framework during the global deployment of EA. Regarding problem (3), BA/DA had the same direction at the commencement of each architecture committee, while it is possible to consider problem (3) as resolved based on architecture reviews based on the most realistic solutions (Masuda et al. 2017).

## 4.3 Summary

This chapter described the history and result regarding the case of EA framework building in a global company. In this case study, in the beginning, we built the EA framework through TOGAF at Japan headquarters, however, there were several problems regarding the global EA deploy toward a digital IT era. Thereafter, we implemented and applied our proposed AIDAF in global deployment of EA while integrating between Adaptive EA cycle and TOGAF in AIDAF. The above study verifies that our proposed “Adaptive Integrated Digital Architecture Framework—AIDAF” can solve problems occurring in the era of Cloud/Mobile IT/Digital IT to address RQ1–2 (Masuda et al. 2017). Chapter 5 will brief our proposed architecture assessment model with knowledge management and verify them in the case study.

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**Questions and Exercises**

1. Discuss in your own words the process of framework building by using the Global pharmaceutical company mentioned in this chapter.
2. Describe problems with Digital IT strategy execution and EA implementation in your organization.
3. What are some of the differences between TOGAF and AIDAF?
4. What are some challenges with EA implementation in modern enterprises?
5. How can the integration between existing EA framework and Adaptive EA cycle in AIDAF be planned in your organization?
6. How can AIDAF help your organization to cope with problems raised in Q2?
7. Explain how AIDAF can support this following case. Consider the case of a financial management company with multiple services including retail banking, financial planning, and insurance. This client was rapidly expanding across all lines of business and acquisitions. The current state infrastructure was unable to support periods of rapid growth. As a result, the client faced the following challenges:
   - Increased marketing time for new capabilities
   - Current IT expenses were higher than industry benchmark target.
   - Lack of infrastructure needed to be available on demand to accommodate growth and scaling.

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# Chapter 5
# Evaluation of Architecture Board Review Process with Knowledge Management

**Abstract** This chapter describes a case of Architecture Board reviews in global company. We evaluated and analyzed this case study, and we verified Assessment model in Architecture Board. Also, this chapter briefs solutions to mitigate risks in the field of Digital IT systems, CRM and ERP. In the latter of this chapter, a global communication case study is described, and we analyzed this global communication case study and verified the Global Digital Transformation Communication (GDTC) model and Solution Collaboration Model. In later chapters, we will show the case study for the Risk Management with Architecture Board and evaluate STrategic Risk Mitigation Model for Digital Transformation.

**Keywords** Architecture review · Architecture Board · Case study · CRM · ERP · Digital IT · Knowledge management · Digital platform

## 5.1 Case of "Architecture Board Review" in Global Healthcare Company

When strategically promoting the Cloud/Mobile IT, the preliminary research of this book suggests that a method of corporate entities that implement EA by having applied TOGAF, FEAF, etc., adopting a framework, integrating an Adaptive EA framework, providing further support to Cloud elements is one solution for realization. Accordingly, this book proposes the "Adaptive Integrated Digital Architecture Framework—AIDAF" based on this suggestion as an EA framework that can even be applied to corporate entities, promoting a Cloud/Mobile IT strategy. Figure 5.1 shows a model image of this proposal. The AIDAF proposed model with Architecture Board in Fig. 5.1 is an EA framework model integrating an Adaptive EA cycle in the bottom portion with a TOGAF or simple EA (framework) by business division units in the upper portion.

In the Adaptive EA cycle in the proposed model, initiation documents (including conceptual architecture designs) for new Cloud/Mobile IT-related IT projects continuously occurring are drawn on a short-term basis (monthly, etc.) beginning with the context phase, referencing defining (architecture design guidelines related to all

 
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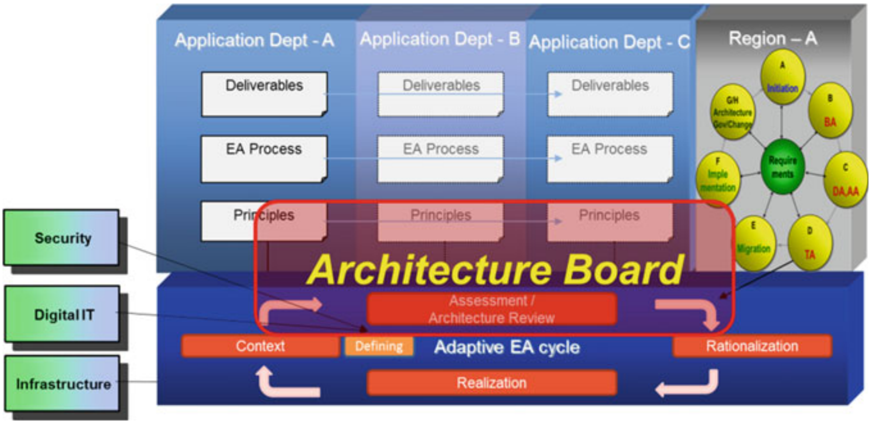


**Fig. 5.1** AIDAF proposed model with Architecture Board (e.g., TOGAF, Adaptive EA)

types of security/Cloud/Mobile IT consistent with IT strategy) in line with the needs of business divisions. In the next phase of the Assessment/Architecture Review, the architecture committee/organization will review the architecture focused on the conceptual design portion of the initiation documents for endorsing the project's the budget and beginning the IT project. In the rationalization phase, stakeholders and Architecture Board will differentiate/decide information systems that will be replaced by the proposed new information system structure or that are no longer necessary and can be decommissioned.

In the realization, this project team will begin and implement the new IT project agreed upon as a result of coping with these issues/action items. This enables the corporate entity to adopt an EA framework able to flexibly adapt to new Cloud/Mobile IT projects that continuously occur, which is composed of these four phases.

Moreover, to respond to differing policies and strategies in business divisions from a mid-long-term perspective, the operational division unit-based "TOGAF" and "simple EA (framework)" in the top portion is a structure that can select the above EA framework in line with the characteristics of business division unit operational processes and future architecture and enable applications. Further, there should be the alignment of EA guiding principles with the principle's definitions for business divisions to assure consistency between the Adaptive EA cycle in the bottom portion of Fig. 5.1 and the business division unit-based "TOGAF" and "simple EA (framework)" in the upper portion.

Here, a particular Architecture Board is explained in the example of the EA framework structure in a certain global pharmaceutical company. This global pharmaceutical company is the largest Japan-headquartered global company in the industry in Asia in terms of sales. In a global EA rollout, they are handling Cloud/Mobile IT strategic projects and systems that are prioritized in Europe and US Group companies by structuring and implementing EA with the above Adaptive Integrated Digital Architecture Framework—AIDAF; this will enable them to be consistent with the

| Responsibilities of Architecture Board | Tasks of Architecture Board |
|---|---|
| -Operational/Functional Aspect and Viability of solution architectures with Enterprise level Standard conformance are assessed properly, and the projects related architecture risks should be coped with.<br><br>-Architecture integration issues across IS/IT organization are assessed, reviewed and resolved.<br><br>-Enterprise architecture risks are assessed and mitigated timely and consistently. | -Review solution architecture/standard/common platform of new IS/IT projects, involving new technologies.<br><br>-Endorse signed architecture of new IS/IT projects for the month<br><br>-Share Architecture strategy in each departments, initiatives and thier status. |

**Fig. 5.2** Responsibilities and tasks of Architecture Board

global IT strategy focusing on Cloud/Mobile IT/Digital IT. Actually, one of the authors, working in this global pharmaceutical company, conducted all phases of structuring and implementing this EA framework and was the facilitator and managed coordination of the global Architecture Board. In this GHE, the Architecture Board has the responsibilities listed in Fig. 5.2.

Moreover, as a result of investigating tasks of architecture reviews in Architecture Board, in this case, we confirmed that project planning documents of almost all new IS/IT projects have been submitted to the Architecture Board. This Architecture Board performs Architecture Review regarding their solution architectures on the basis of the following evaluation criteria of four elements—[1] [2] [3] [4]—and issued the action items there. One of the authors found out the risks connected to each action item and defined equivalent solution for each risk in or after this Architecture Board.

[1] Enterprise-level conformance—align with architecture roadmap, standard, each architecture principle
[2] Functional aspect—clarify solutions/architecture specs, integration points, with standard master data
[3] Operational aspect—alignment with the service level, security design and privacy, system availability
[4] Viability—application rationalization, risks/countermeasures, data migration/testing strategy.

We propose the "Assessment meta-model in Architecture Board" in Fig. 5.3, based on the above steps and descriptions in this case study (Masuda et al. 2018).

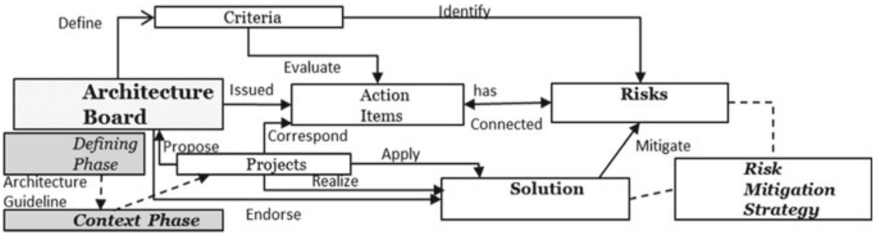


**Fig. 5.3** Assessment meta-model in Architecture Board

## 5.2 Evaluation and Analysis of Case Study for Architecture Board Review

### *5.2.1 Data Analysis*

#### 5.2.1.1 Risk Categories Raised in Architecture Board

As a result of data analysis regarding the results of Architecture Board in this GHE for 1 year and 6 months, greater than 170 items/risks were raised and categorized into 11 risk categories. The revealed risk categories are presented in the following, with percentages of each category indicated in parentheses (Masuda et al. 2018).

[R1] Architecture Conformance (20%)—risks mainly connected with solution architecture conformance in terms of business, process, technical, and sourcing strategy. About 14% was risks related to Architecture Standard conformance

[R2] Security (18%)—risks mainly related to the information security and privacy, cyber security, Security Architecture, security solutions such as user authentication, and access control

[R3] Technology Architecture (15%)—risks mainly connected with Technology Architecture and target architecture in digital-related platforms and mobile applications, infrastructure, etc.

[R4] Project Management (10%)—risks mainly related to the Project Management, project scope and cost structure, project scheme and project planning, project definition

[R5] Data Architecture (6%)—risks mainly connected with Data Architecture and target architecture, roadmap with master data management platforms and data migration strategy, etc.

[R6] Application rationalization (6%)—risks mainly related to application system's rationalization to prevent from increasing the number of applications in vain

[R7] Compliance and Validation (6%)—risks mainly connected with Compliance and Validation such as regulatory compliance and SDLC-related ones, GxP validation, and testing ones

[R8] Application Architecture (6%)—risks mainly related to application systems architecture and target architecture, roadmap in terms of functional aspects and viability

[R9] Strategic Alignment (5.8%)—risks mainly connected with the alignment with IT strategy and architecture strategy, high level of target architecture and roadmap

[R10] Business Architecture (5%)—risks mainly related to business target architecture and roadmap covering standardized business process and business functions

[R11] System development (1%)—risks mainly connected with system development, enterprise system implementations, and smooth transitioning to the new ES.

#### 5.2.1.2 Solution Categories Applied in Architecture Board

In the Architecture Board in this GHE, more than 170 action items with architecture risks have been raised as the results of architecture reviews. Moreover, each solution to mitigate these 173 risks has been defined in the risk assessment process in this global enterprise. During the analysis, we distinguished 12 solution categories. They are shown in the following description that contains short definitions of categories and percentages of adopted solutions as each category. The solution categories have been ordered in decreasing order of percentages of adopted ones. The largest number of category encompasses solutions connected with various approaches for assigning appropriate employees. It is followed by a category that includes solutions related to the involvement of Top Management such as Global IT Executives, CISO, and regional CIO. Then, with the similar frequency of appearance, Application Architecture and system categories occur. They are followed by Project Scope Definition, Technology Architecture, Security Architecture, and Implementation Process categories. Architecture Board adopted the least frequent solutions that belong to System Vendor and Vendor Contract Definition, Data Architecture, and Compliance and Validation categories (Masuda et al. 2018).

[S1] Employees (41%)—solutions that assign proper employees

[S2] Top Management (20%)—solutions connected with top management involvement

[S3] Application Architecture (8%)—verification of appropriate Application Architecture and integration, standard

[S4] System (7%)—system customization, modification, and optimization, decommission

[S5] Project Scope Definition (6%)—solutions connected with the definition of project scope

[S6] Technology Architecture (5%)—verification of appropriate Technology Architecture and interface, standard

[S7] Security Architecture (5%)—verification of appropriate Security Architecture and security solution adoption

[S8] Implementation Process (4.7%)—solutions connected with the management of Implementation Process

[S9] System Vendor (1.2%)—solutions connected with vendor support and consultants

[S10] Vendor Contract Definition (1.2%)—solutions connected with Vendor Contract Definition

[S11] Data Architecture (0.6%)—verification of appropriate Data Architecture with master data management platform

[S12] Compliance and Validation (0.6%)—solutions connected with Compliance and Validation.

## 5.2.2 *Evaluation and Analysis, Results*

### 5.2.2.1 Architecture Board Process with Assessment Model

We proposed "Meta-model of Assessment and Architecture Review in Architecture Board" in Fig. 5.3 for RQ2-1. As a result of processing assessments in Architecture Board for 1 year and 6 months, several types of action items for the new IS/IT projects' document developed with referring to architecture guidelines were issued in the reviews based on the criteria defined in Architecture Board. Moreover, these action items are connected to risks that were summarized in the aforementioned "risk categories." To obtain endorsements for each new IS/IT project from Architecture Board, the solutions summarized as "solution categories" shown in the previous chapter in this book were discussed and defined to mitigate these risks, and each new IS/IT project has been endorsed/realized with applying these abovementioned solutions there(Masuda et al. 2017). In this manner, it is verified that Architecture Board could be processed with Assessment model in Fig. 5.3 to cope with RQ2-1.

### 5.2.2.2 Interrelationship Among Solutions, Risk Mitigation Strategy, and Risks Raised in Architecture Board

Figure 5.4 presents the mapping of risk categories onto solution categories via risk mitigation strategies.

Some solution categories are coped with several risk categories, while five types of "Risk Mitigation Strategy" are clarified in Fig. 5.4. These "risk mitigation strategies" clarify the relationships between solutions and risks that can answer for RQ2-2 in this book (Masuda et al. 2018).

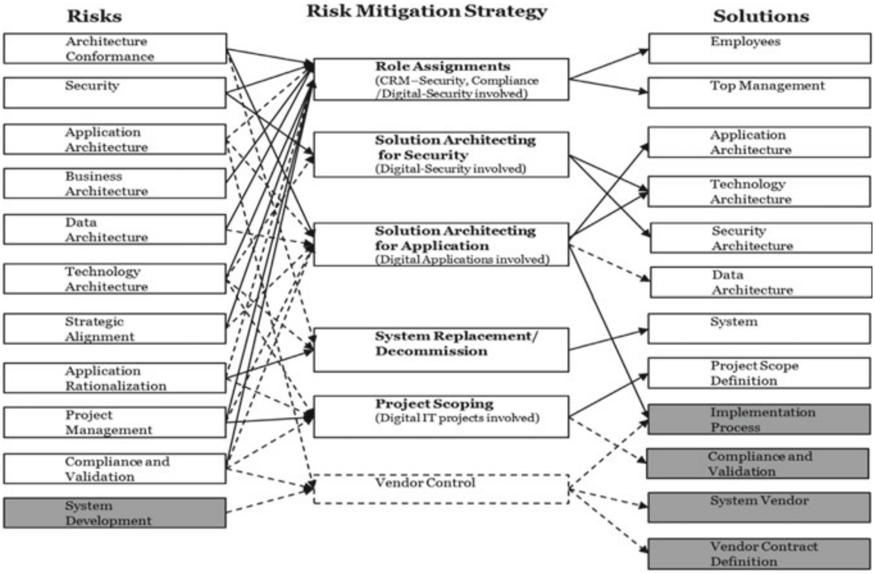


**Fig. 5.4** Three-tiered Risk Mitigation Strategy model in Architecture Board. *Note* Solid lines denote direct correspondence between risk categories and risk mitigation strategies or between risk mitigation strategies and solution categories greater than five times. Dotted lines denote direct correspondence between risk categories and risk mitigation strategies or between risk mitigation strategies and solution ones greater than twice (less than four times). Gray boxes denote risk/solution categories exhibiting that few items were raised for CRM and Digital IT-related systems (less than four times), and there is no tendency of direct correspondence between risks and solutions via strategies.

For example, Employees Solution Category was coped with risks that belong to Architecture Conformance, security, Data Architecture, Technology Architecture and Project Management, Compliance and Validation risk categories, etc. Similarly, solutions from Top Management Solution Category had been coped with the risks from Architecture Conformance and Business Architecture, Strategic Alignment risk categories, etc. The above policy between these risk categories and solution categories of employees and Top Management should be integrated as the Risk Mitigation Strategy of "*Role Assignments*." Furthermore, risks from security risk category had their solutions from Technology Architecture and Security Architecture solution categories. This policy between security risk category and solution categories of Technology Architecture and Security Architecture should be clarified as the Risk Mitigation Strategy of "*Solution Architecting for Security*." On the other hand, risks from Architecture Conformance and Application Architecture, Data Architecture, Strategic Alignment risk categories had their solution from Application/Data Architecture and Technology Architecture, Implementation Process solution categories. This policy between these risk categories and solution categories of "Application Architecture" and "Technology Architecture," "Implementation Process" can be clarified as the Risk Mitigation Strategy of "*Solution Architecting for Application,*" while digital application-related projects are covered here. Furthermore, solutions from System Solution Category addressed risks from application rationalization risk category. This policy between application rationalization risk and system solution should be defined as the Risk Mitigation Strategy of "*System Replacement/Decommission*." Moreover, the solutions of Project Scope Definition addressed the risks of Project Management category. This policy between Project Management risk and the solution of "Project Scope Definition" can be clarified as the Risk Mitigation Strategy of "*Project Scoping*." Additionally, the solutions of "System Vendor" and "Vendor Contract Definition" coped with the risks of "system development" and "Compliance and Validation" that can be clarified as the policy of "Vendor Control," but the number of equivalent projects is restricted to less than three times (Masuda et al. 2018).

#### 5.2.2.3 Solutions to Mitigate Risks in the Field of CRM and Digital IT

The CRM systems provide solutions for three major areas such as "sales force automation," "marketing automation," and "customer service" (Cruz and Vasconcelos 2015). In the Architecture Board in this GHE, 31 action items with architecture risks have been raised for CRM projects as the results of architecture reviews. As a result of aggregation and analysis specialized to this CRM system domain, we could find out 22 cases of applying the Risk Mitigation Strategy of "Role Assignments" to mitigate the risks raised for CRM-related ones in the Architecture Board.

Also, Digital IT systems mainly indicate systems composed of Cloud (application systems structured on SaaS and IaaS) and Mobile IT applications, and this includes some analytical systems. As a result of aggregation and analysis specialized to this digital IT-related system domain, we could find out 56 cases of applying the Risk Mitigation Strategy of "Role Assignments" to mitigate the risks raised for Digital IT-related ones, especially the 19 cases of security-related risks there, in the Architecture Board. Moreover, we could confirm 10 cases of applying the Risk Mitigation Strategy of "Solution Architecting for Security" and 14 cases of applying the Risk Mitigation Strategy of "Solution Architecting for Application" to mitigate the risks raised for Digital IT-related ones in the Architecture Board. Furthermore, we could find out five cases of applying the Risk Mitigation Strategy of "Project Scoping" to mitigate the risks raised for Digital IT-related ones in the Architecture Board (Masuda et al. 2018). The above study in the field of CRM and Digital IT can answer for RQ2-2 in this book.

#### 5.2.2.4 Solutions to Mitigate Risks in the Field of ERP

Figure 5.5 presents the mapping of solution categories onto risk categories in ERP projects. In the Architecture Board in this GHE, 36 action items with architecture risks were raised in ERP projects as the results of architecture reviews. Moreover, each solution to mitigate these 36 risks was defined in the risk assessment process in this GHE. Furthermore, within the above action items for ERP projects, 12 action items raised for ERP projects were related to business process reengineering (BPR), while 4 action items raised for ERP projects were related to supply chain management (SCM) in this GHE, and 5 action items raised for ERP projects were connected to master data management platform (MDM) there. According to Fig. 5.5, the tendency of risks raised many times for ERP projects is different from the one for whole projects, CRM and Digital IT projects because the risks of AA, BA, and Data Architecture were raised for ERP projects with larger number, while the risk of security was raised with smaller number in Architecture Board. In Fig. 5.5, several solution categories are coped with many risk categories. Specifically, the employee solution category was coped with for risks of Data Architecture, Compliance and Validation, BA, AA, and Architecture Conformance risk categories. Similarly, the Top Management Solution Category was coped with for risks from BA and AA, Strategic Alignment, and Project Management risk categories. Therefore, even in ERP projects, the element of "Role Assignments" should be very suitable for mitigating risks.

Furthermore, risks from AA risk category obtained their solutions from the Implementation Process and AA in ERP projects, while AA solution category was coped with risks of Architecture Conformance and AA in ERP projects. Therefore, the element of "Solution Architecting for Application" can contribute to these situations especially in ERP projects to mitigate risks.

On the other hand, only two risks of security were raised to ERP projects while the solution of security was not raised in Architecture Board in this case study. Therefore, the element of "Solution Architecting for Security" was less effective as the element to mitigate risks for ERP projects in the case study of GHE. The above study in the field of ERP can answer for RQ2-2 in this book.

## 5.3 Global Communication Case Study

### *5.3.1 Enterprise Portal*

In this chapter, we analyze a global communication process example by examining the activities of the Architecture Board, using the Global Architecture Board Collaboration Portal (GABCP), which is the enterprise portal of the Global Takeda Group (GHE), the Takeda Pharmaceutical Company Ltd.'s global organization. Takeda is a research-based global company with its main focus on pharmaceuticals. As the largest pharmaceutical company in Japan and one of the global leaders of the industry, Takeda is committed to strive toward better health for patients worldwide through leading innovation in medicine. Takeda's ethical drugs are marketed in around 100 countries worldwide. This global pharmaceutical company prioritizes the direction of digital healthcare as one of the top elements of corporate strategy, and this enterprise portal has the feature of promoting the direction of Digital IT and digital healthcare

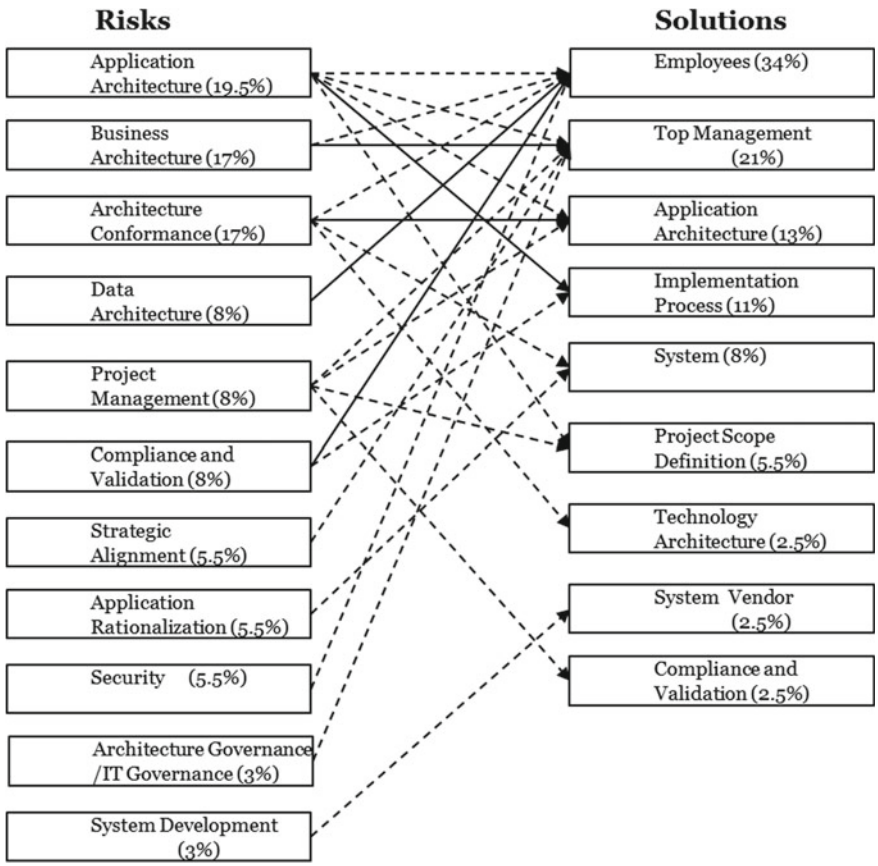


**Fig. 5.5** Solution categories mapped onto architecture risk categories in ERP projects. *Note* Solid line denotes direct correspondence between solutions and risk categories more than three times. Dotted line shows a direct correspondence between solutions and risk categories more than once. The figure in each parenthesis shows the percentage of each accepted risk/solution category in the Architecture Board

as a good example in the GHE. Therefore, this global pharmaceutical company needs to proceed with digital IT transformation as the high priority and was adopted for the GDTC model in this book. The companies indicating the digital IT transformations for the direction toward Digital IT will be able to adopt the GDTC model (Masuda et al. 2017).

An example of the GABCP is shown in Fig. 5.6.

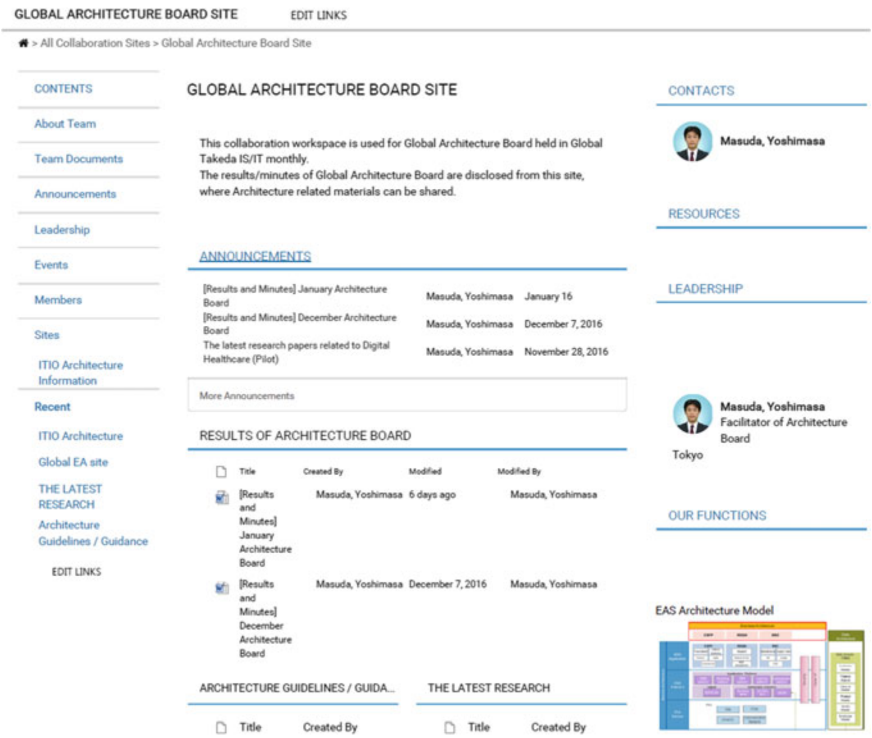


Fig. 5.6 Example of Global Architecture Board Collaboration Portal (GABCP)

#### 5.3.1.1 GABCP Overview

The GABCP can be used to show and distribute announcements, view and download Architecture Board results, architecture guidelines, and recent research information, and link to architecture department Web pages, as well as a menu format. Furthermore, messages can be sent between Architecture Board members through the enterprise social network. In this chapter, we analyze a case study regarding global Architecture Board review activities, using the ability to show and distribute announcements, and view and download Architecture Board results, among others (Masuda et al. 2017).

#### 5.3.1.2 GABCP Functions

With the ability to show and distribute announcements, and view and download Architecture Board results and architecture guidelines provided on GABCP, users can collaborate while conducting architecture review activities and creating and distributing review result documents. Global Architecture Board members are registered on the collaboration portal site. They can then exchange messages via the enterprise SNS or e-mail, while storing and sharing various architecture guideline documents in a portal folder. In this way, the architecture guidelines can be used by the architecture review manager as a review criteria guide and by the architect of the new project proposal as a procedure for the solution architecture. After a meeting of the Architecture Board, a document summarizing the architecture review results is stored in the review results shared folder, and these are published on the GABCP as an announcement letter and also sent to each member of the global Architecture Board via e-mail (Masuda et al. 2017).

### *5.3.2 Global Communication Case Study*

#### 5.3.2.1 Overview of the Case Regarding the Execution of Architecture Reviews

The case study shown in Fig. 5.7 is the record of a process in which a member of the global Architecture Board serving as the facilitator and coordinator (the first author) creates the review results document and publishes the results. In this review, conducted by the member in charge of coordination, opinions are exchanged among the global architecture community members using the global enterprise portal.

The global Architecture Board community contains 16 actions, consisting of 10 actions by the facilitator/coordinator L, 5 by the Architecture Board members M, and 6 by new project managers P. The Architecture Board was held for 17 days in the applicable month, with 11 of the actions (68%) occurring within 7 days of its beginning or end (Masuda et al. 2017).

Figure 5.7 shows the person in charge, types of intermediary knowledge and global communication, and summary of the action details in their order of appearance.

## 5.4 Verifications and Summary

### *5.4.1 Verifying the Research Hypotheses in Global Communication Case Study*

In terms of verifying RH1, the person in charge of each action on the enterprise portal in Fig. 5.7 is the global Architecture Board moderator/coordinator (Japan, EA department), the members (consisting of global logical organization cross-sectional members in Europe, the USA, Japan, Asia, and so on), or the new project manager (same as above). Therefore, global communications take place to overcome the barriers between global logical organizations and location barriers between countries and regions in the GDTC model.

| Action | Person in charge | Intermediary knowledge | Global communication process | Action details |
|---|---|---|---|---|
| 1 | L | Publication | Submission request | (Distributed below) We will hold a meeting of the Global Architecture Board on the date (month) (day). Please submit the new project proposal by date (month) (day). |
| 2 | P | Collaboration (combination) | Reference | Architecture Guidelines on GABCP are referred to, and new project proposals are created. |
| 3 | P->L | Publication | Submission→ consolidation | New project proposals are uploaded on GABCP. |
| 4 | L | Resonant formation | Confirmation (thanks) | New project proposals are checked and appreciation is expressed (e-mail, SNS). |
| 5 | M | Collaboration | Evaluation | Members of the Architecture Board confirm proposals for each project, and evaluate them beforehand. |
| 6 | M, L | Combination | Reference | Members and the leader of the Architecture Board refer to (download) the Architecture Guidelines from GABCP while evaluating projects beforehand. |
| 7 | L | Sophistication | Evaluation (judgement of important point) | The leader reviews proposals for new projects beforehand, judges important evaluation points, and extracts them. |
| 8 | P | Publication (sophistication) | Explanation->evaluation request | Architecture manager/new project manager explains the new project proposal on GABCP, and receives questions. |
| 9 | M, L | Collaboration/internalization (sophistication) | Understanding->question->evaluation | The members and the leader of the Architecture Board ask questions about the new project proposals, and create action items when the documents need to be refined or additional responses are needed. |
| 10 | L | Sophistication (combination) | Summary, official evaluation | After summarizing the review results of the Architecture Board and action items, the leader conducts an official evaluation. |
| 11 | L | Combination | Consolidation (evaluation result) | An official evaluation results document of the review is created and uploaded on GABCP. |
| 12 | L | Sophistication (collaboration) | Confirmation request | The leader creates and publishes an announcement letter on GABCP. E-mails are also sent to members of the Architecture Board. |
| 13 | M, P | Combination (fragmentation) | Understanding | Members of the Architecture Board and the project leader read and understand the review results document on GABCP. The Architecture Board members show action items for the project team to cope with as conditions. |
| 14 | M, P | Collaboration (fragmentation) | Question/confirmation | Members of the Architecture Board and the managers of each project ask questions about the review results document on GABCP, and send messages through the corporate SNS or e-mail. |
| 15 | L | Collaboration | Confirmation, reply | The leader checks the corporate SNS and e-mail and replies. |
| 16 | P | Sophistication | Confirmation, response | The manager for each project checks the corporate SNS and e-mails, refines and edits the proposals for each project, and responds to each action item (if approved, the project begins). |

**Fig. 5.7** Case study of global architecture review activities on enterprise portal. *Notes* L: Leader, M: Architecture Board member, P: New project manager

For verifying RH2, the enterprise portal was used to supply and share informal knowledge among the Architecture Board members in global communications. The "Collaboration for Architecture Review" in the 9th action of the Appendix serves as one of the evidence instances for verifying RH2. This tentative project planning document was supplied by the new project manager, P. The members of the new project politely wrote down the knowledge covering the specific solution architecture, based on the member's own experiences/expertise and not yet formalized. In traditional global communications, such tentative project planning documents may be transferred by means of oral communication in TKG, without architecture guidelines. In this case, knowledge sharing in the enterprise portal may prevent the rediscovery of this knowledge of specific solution architecture in the tentative project planning document, and similar ones in the architecture guidelines. The supplying and sharing of informal knowledge demonstrate the process among TKG (human), IKG (portal contents), and EKG (formal documents) in the GDTC model. Moreover, for each communication process in the enterprise portal in Fig. 5.7, there were ten actions by the moderator/coordinator L (Japan, EA department), five by the Architecture Board members M (consisting of global logical organization cross-sectional members in Europe, the USA, Japan, Asia, the Middle East, and Africa), and six by the new project manager P (same as above). In particular, during the 17-day period in which the Architecture Board was held in the applicable month, 11 actions (68%) occurred within 7 days of its beginning or end. Communication involving the above 9th action of the Appendix within the global organization was particularly active within the 7 days of the beginning and end of this period in the GDTC model (Masuda et al. 2017).

In terms of verifying RH3, it was confirmed from Fig. 5.7 that the global communication actions in the enterprise portal were classified as specific types, such as "request," "reference," "consolidation," "confirmation," "evaluation," and "understanding." These series of actions could solve cross-functional problems such as those of digital transformation in global organizations via the intermediary knowledge model in the GDTC (Masuda et al. 2017). Refer to the details of this global communication structure in the following section.

This chapter describes our proposed GDTC model as well as architecture assessment model and verified them in the above case study in the global company. Furthermore, solutions to mitigate risks in the field of CRM, ERP, and Digital IT are shown with the result of this case study as well.

### *5.4.2 Verifying SCM Model for Architecture Review in Architecture Board with the Global Communication Case Study*

The case study shown in Fig. 5.8 is the record of a process in which a member of the global Architecture Board engaged in as the facilitator and coordinator (the first author) creates the review results document and publishes the results. The global Architecture Board consisted of more than 30 members covering top managements, architects, project management office members from Europe, Asia, and USA. In this review, conducted by the member in charge of coordination, opinions are exchanged among the global architecture community members using the global enterprise portal and social networking service, etc.

The global Architecture Board community contains 16 actions, consisting of 10 actions by the facilitator/coordinator L, 5 by the Architecture Board members M, and 6 by new project managers P. The Architecture Board was held for 15 days in the applicable month, with 9 of the actions (56%) occurring within 5 business days of its beginning or end.

| Action | Person in charge | Global communication process (BA -No. of step) | Application Platform (AA) | Cloud Platform (TA) | Action details (The status of conforming to Assessment meta-model in bold.) |
|---|---|---|---|---|---|
| 1 | L | Submission request (1) | e-mail/ Portal | Private Cloud, Private Cloud -> SaaS | (Distributed below) We will hold a meeting of the Global Architecture Board on the date (month) (day). Please submit the new project proposal by date (month) (day). |
| 2 | P | Reference (1-1) | Portal | Private Cloud -> SaaS | Architecture Guidelines on enterprise portal - GABCP are referred to, and new project proposals are created. |
| 3 | P->L | Submission→ consolidation(1-1)→(1) | e-mail/ Portal | Private Cloud, Private Cloud -> SaaS | New project proposals are uploaded on enterprise portal - GABCP. |
| 4 | L | Confirmation (thanks) (1) | e-Mail/ SNS | Private Cloud, SaaS | New project proposals are checked and appreciation is expressed via e-mail, SNS. |
| 5 | M | Evaluation(2) → (2-1) | Portal | Private Cloud -> SaaS | Members of the Architecture Board confirm proposals for each project, and **evaluate them on the basis of criteria defined in Assessment Meta-model beforehand.** |
| 6 | M, L | Reference (2-1) | Portal | Private Cloud -> SaaS | Members and the leader of the Architecture Board refer to (download) the **Architecture Guidelines defined in Defining phase in Assessment Meta-model** from GABCP while evaluating projects beforehand. |
| 7 | L | Evaluation(judgement of important point) (2-1)→ (2) | Portal | Private Cloud -> SaaS | The leader reviews proposals for new projects **on the basis of criteria defined in Assessment Meta-model** beforehand, judges important evaluation points, and extracts them on enterprise portal – GABCP. |
| 8 | P | Explanation-> evaluation request (2-2) | Portal (Web conference) | Private Cloud -> SaaS, SaaS | Architecture manager/new project manager explains the new project proposal on GABCP, and receives questions. |
| 9 | M, L | Understanding ->question(2)->evaluation (2-3) | Portal (Web conference) | Private Cloud -> SaaS, SaaS | The members and the leader of the Architecture Board ask questions about the new project proposals on enterprise portal, and **create action items on the basis of criteria defined in Assessment Meta-model** when the documents need to be refined or additional responses are needed. |
| 10 | L | Summary, official evaluation (2) | Portal | Private Cloud -> SaaS | After summarizing the review results of the Architecture Board and action items while accessing enterprise portal, the leader conducts an official **evaluation on the basis of criteria defined in Assessment Meta-model**. |
| 11 | L | Consolidation (evaluation result) (3) | Portal | Private Cloud -> SaaS | An official evaluation results document of the review is created and uploaded on enterprise portal - GABCP. |
| 12 | L | Confirmation request (3)→ (3-1) | Portal/ SNS/ (e-mail) | Private Cloud -> SaaS, SaaS, Private Cloud | The leader creates and publishes an announcement letter on enterprise portal - GABCP. Messages are also sent to members of the Architecture Board and Project Managers via SNS as well as email. |
| 13 | M, P | Understanding (3-1) | Portal/ SNS (e-mail) | Private Cloud -> SaaS, SaaS, Private Cloud | Members of the Architecture Board and the project leader read and understand the review results document on enterprise portal - GABCP. The Architecture Board members show **action items for the project team to cope with as conditions, on enterprise portal via SNS, as shown in Assessment Meta-model**. |
| 14 | M, P | Question/confirmation (3),(3-2) | Portal/ SNS (e-mail) | Private Cloud ->SaaS, SaaS, Private Cloud | Members of the Architecture Board and the managers of each project ask questions about the review results document on enterprise portal - GABCP, and send messages through the corporate SNS or e-mail. |
| 15 | L | Confirmation, reply (3) | SNS (e-mail) | SaaS, Private Cloud | The leader checks the corporate SNS and e-mail and replies. |
| 16 | P | Confirmation, response (3-1) | SNS (e-mail) | SaaS, Private Cloud | The manager for each project checks the corporate SNS and e-mails, refines and edits the proposals for each project, and responds to each action item **as shown in Assessment Meta-model** (if approved, the project begins). |

**Fig. 5.8** Case study of global architecture review activities on enterprise portal. *Notes* L: Leader, M: Architecture Board member, P: New project manager

Figure 5.8 shows the person in charge, global communication process (BA), application platform (AA) and Cloud-based technology platform (TA), and the summary of the action details, covering the status of conforming to Assessment meta-model in bold, in their order of appearance.

In terms of verifying RQ2-3, the global communication process of Architecture reviews in Architecture Board was performed on the enterprise portal and social networking service with "Social Collaboration Model for Architecture Review in Architecture Board," while the back-colored scope of BA in Fig. 3.8 is conforming to Assessment meta-model among the Architecture Board member in global communications. The number of each step in BA defined in Fig. 3.8 is described in the third column of Fig. 5.8 that covers all steps and state transitions in BA of SCM model depicted in Fig. 3.8 and can verify RQ2-3. The "(2-1) Preview in Fig. 3.8" in the 5th and 6th actions of Fig. 5.8 serves as one of the evidence instances for verifying RQ2-3. In the 5th action, the planning document of each new project on enterprise portal (AA) was confirmed by architect members of the Architecture Board, which had been built on the technology platform under the migration from Private Cloud to SaaS (TA). Members of Architecture Board evaluated this planning document of each new project on the basis of criteria defined in Assessment meta-model beforehand, as described in Fig. 5.8. In the 6th action, architecture members and the leader of the Architecture Board refer to (download) the architecture guidelines defined in defining phase in Assessment Meta-model from the enterprise portal (AA—GABCP), which had been built on the technology platform under the migration from Private Cloud to SaaS (TA), while evaluating projects beforehand. Therefore, the "(2-1) Preview" in the 5th and 6th actions of Fig. 5.8 was performed with Social Collaboration Model on digital platform (enterprise portal (AA)) in Architecture Board, and this is one of the evidence instances for verifying RQ2-3.

Furthermore, the "(3-1) Understand, confirm in Fig. 3.8" in the 12th and 13th actions of Fig. 5.8, also serves as one of the evidence instances for verifying RQ2-3. In the 12th action, the leader of Architecture Board created and published an announcement letter on enterprise portal (AA), which had been built on the technology platform under the migration from Private Cloud to SaaS (TA). Messages with the link to the enterprise portal (AA) were also sent to members of the Architecture Board and project managers via SNS (AA), which had been built on the technology platform under the migration from Private Cloud to SaaS (TA). In the 13th action, members of the Architecture Board and the project managers read and understood the review results document on enterprise portal (AA), which had been built on the technology platform under the migration from Private Cloud to SaaS (TA). The Architecture Board members showed action items for the project team on enterprise portal via social networking service (AA), which had been built on the technology platform under the migration from Private Cloud to SaaS (TA), to cope with as conditions, as shown in Assessment meta-model. Therefore, the "(3-1) Understand, confirm in Fig. 3.8" in the 12th and 13th actions of Fig. 5.8, was performed with the Social Collaboration Model on digital platform (enterprise portal and SNS (AA)) in Architecture Board, and this is also one of the evidence instances for verifying RQ2-3. Moreover, for each communication process (BA) for Architecture reviews in the enterprise portal in Fig. 5.8, there were ten actions by the actor of moderator/coordinator L (Japan, EA department), five by the actor of Architecture Board members M (consisting of global logical organization cross-sectional members in Europe, the USA, Japan, Asia), and six by the actor of new project managers P (same as above). In particular, during the 15-day period in which the Architecture Board was held in the applicable month, 9 actions (56%) occurred within 5 days of its beginning or end. Communication involving the above 5th and 6th actions of Fig. 5.8 within the global organization was particularly active within the 5 days of the beginning of this period in the SCM model for Architecture reviews in Architecture Board. At the same time, the communication covering the above 12th and 13th actions of Fig. 5.8 within the global organization was particularly active within the 5 days of the end of this period in this SCM model.

This empirical case study of global communications described in Fig. 5.8 provides evidence how Architecture reviews were performed with "SCM model for Architecture Review in Architecture Board" in Fig. 3.8 on digital platforms to cope with RQ2-3.

This chapter also described our proposed SCM model and verified this model in the above case study in the global company. Chapter 6 will brief our proposed Risk Management approach and model for Digital Transformation and verify them in the case study[1].



**Questions and Exercises**

1. Describe the relationship between an Architecture Board and project managers for new digital IT projects?
2. What is the role of the "Architecture Board Review"?
3. What are the four evaluation criteria used in the review process?
4. Explain the top five risks that were raised in the architecture board?
5. Compare solutions to cope with action items raised in the Architecture Board in the field of Digital IT and ERP.
6. Discuss risk mitigation strategies in digital IT.

[1] A simple EA (framework) is a simple mid- to long-term perspective EA structure composed of EA principles, EA processes, and EA deliverables (target architecture, roadmaps, etc.)

7. What is the relationship between GDTC model and SCM model in AIDAF?
8. Which one of the following is not an element related to SCM model?
    a. Social tool
    b. Business Continuity Plan (BCP)
    c. Digital IT strategy
    d. Web portal.

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# Chapter 6
# Evaluation for Risk Management Approach for Digital Transformation

**Abstract** This chapter describes a case of Risk Management with Architecture Board in global company. We evaluated and analyzed the above case study, and we verified the STrategic Risk Mitigation Model for Digital Transformation. Also, this chapter briefs solution categories to mitigate risks in the field of Digital IT systems such as Cloud, mobile IT, and Big Data. In the latter of this chapter, we refer to strategy elements to mitigate risks in Digital Transformation. In later chapters, we will show the overall evaluation of AIDAF and perspectives on AIDAF, such as benefits, challenges and critical success factors, and global Architecture Board activities for digital transformation.

**Keywords** Risk management · Digital transformation · Architecture board · Case study · Cloud computing · Big data

## 6.1 Case of "Risk Management with Architecture Board" in GHE

This book proposes the "Adaptive Integrated Digital Architecture Framework—AIDAF" to align with IT strategy, promoting Cloud/Mobile IT/Big Data/Digital IT, and is verified by our case study (Masuda et al. 2017a, b). The first author has named the EA framework suitable for the era of Digital IT as "Adaptive Integrated Digital Architecture Framework—AIDAF" at this time. Figure 6.1 illustrates this AIDAF proposed model. This AIDAF begins with the context phase, while referencing the defining phase (i.e., architecture design guidelines related to Digital IT aligned with IT strategy). During the assessment and architecture review, the Architecture Board reviews the initiation documents and related architectures for the IT project.

In a particular, Architecture Board, the example of the EA framework structure in a certain global pharmaceutical company examined in this book, is explained. This global pharmaceutical company is the largest Japan-headquartered global company in the industry in Asia based on a sales basis. In a global EA rollout, they are handling Cloud/Mobile IT/Big Data strategic projects and systems that took priority



Y. Masuda and M. Viswanathan, *Enterprise Architecture for Global Companies in a Digital IT Era*, https://doi.org/10.1007/978-981-13-1083-6_6

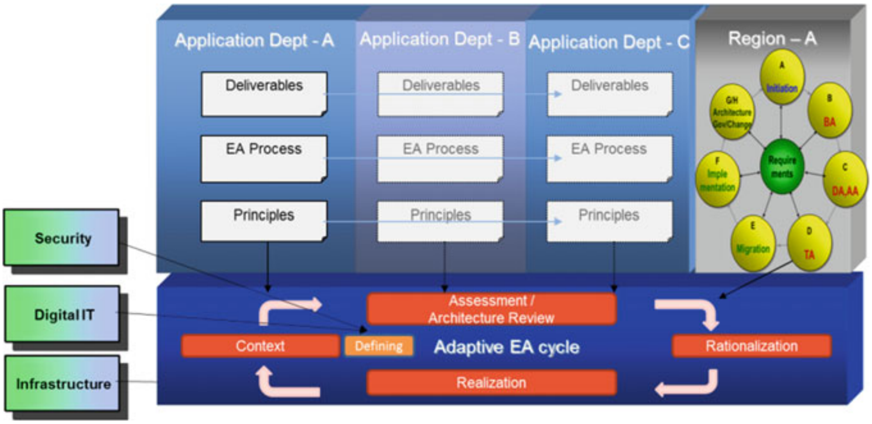


**Fig. 6.1** AIDAF proposed model (e.g., TOGAF and Adaptive EA framework)

| Responsibilities of Architecture Board | Tasks of Architecture Board |
|---|---|
| - Operational/Functional Aspect and Viability of solution architectures with Enterprise level Standard conformance are assessed properly, and the projects related architecture risks should be coped with.<br><br>- Architecture integration issues across IS/IT organization are assessed, reviewed & resolved<br><br>- Enterprise architecture risks are assessed and mitigated timely and consistently | - Review solution architecture/standard/common platform of new IS/IT projects. involving new technologies<br><br>- Endorse signed architecture of new IS/IT projects for the month.<br><br>- Share Architecture strategy in each departments, initiatives and their status. |

**Fig. 6.2** Responsibilities and tasks of the Architecture Board

in Europe and US Group companies well by structuring and implementing EA with the above Adaptive Integrated Digital Architecture Framework—AIDAF—to be consistent with global IT strategy focusing on Cloud/Mobile IT/Big Data/Digital IT (Masuda et al. 2017a, b, 2018).

Actually, one of the authors works in this global pharmaceutical company and conducted all phases of structuring and implementing in this EA framework and was the facilitator and managed the coordination of the global Architecture Board. In this global pharmaceutical company, one of the authors had the above responsibilities in the Assessment/Architecture Review phase on the global Architecture Board as shown in Fig. 6.2, which we were focusing on, and perform the above tasks (Masuda et al. 2017a, b).

As a result of investigating tasks of architecture reviews in the Architecture Board, in this case, we confirmed that project planning documents of almost all new IS/IT projects have been submitted to the Architecture Board. This board performs an Architecture Review on the basis of the following evaluation criteria of four elements, namely [1], [2], [3], and [4], and issued the action items there. One of the authors found out the risks connected to each action item and defined an equivalent solution

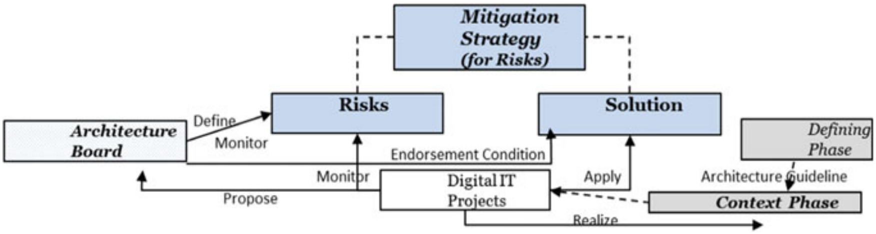


**Fig. 6.3** STRMM for digital transformation

for each risk and started the Risk Management process with the Architecture Board based on proper mitigation strategy.

[1] Enterprise-level conformance—align with architecture roadmap, standard, each architecture principle
[2] Functional aspect—clarify solutions/architecture specifications, integration points with standard master data
[3] Operational aspect—alignment with the service level, security design and privacy, system availability
[4] Viability—application rationalization, risks/countermeasures, data migration/testing strategy.

We propose the "STrategic Risk Mitigation Model for Digital Transformation" in Fig. 6.3 in this case study (Masuda et al. 2017a, b).

## 6.2 Evaluation and Analysis of Case Study

### *6.2.1 Data Analysis—Risk Categories for Digital IT Areas*

As a result of data analysis on the results of reviews for Digital IT projects in the Architecture Board in this GHE for 1 year and 8 months, 118 items/risks were raised and categorized into 10 risk categories. The revealed risk categories for Digital IT are presented, with percentages of each category indicated in parentheses (Masuda et al. 2017a, b).

[1] Security (23%)—risks mainly related to the information security and privacy, cyber security, Security Architecture, security solutions, such as user authentication, and access control in digital IT systems
[2] Architecture Conformance (17%)—risks mainly connected with solution Architecture Conformance for digital IT systems in terms of business, process, technical, and sourcing strategy. 11% of risks are related to Architecture Standard conformance in digital IT area

[3] Technology Architecture (12%)—risks mainly connected with technology architecture and target architecture in digital-related platforms and mobile applications, digital IT systems, and others
[4] Project Management (11%)—risks mainly related to the Project Management, project scope and cost structure, project scheme and project planning, and project definition
[5] Compliance and Validation (8.5%)—risks mainly connected with compliance and validation, such as regulatory compliance and SDLC related compliance, Cloud data centers, Cloud vendors, digital IT-related vendors, GxP validation, and testing ones
[6] Application Architecture (7.5%)—risks mainly related to application systems architecture and target architecture, roadmap of digital IT systems, in terms of functional aspects and viability
[7] Data Architecture (7.5%)—risks mainly connected with data architecture and target architecture, a roadmap of digital IT systems with master data management platforms and data migration strategy
[8] Application rationalization (7.5%)—risks mainly related to application system's rationalization in digital IT areas to prevent from increasing the number of applications in vain
[9] Strategic Alignment (5%)—risks mainly connected with the alignment with IT strategy and architecture strategy in digital IT areas and high level of target architecture and roadmap
[10] System development (1%)—risks mainly connected with system development and enterprise system implementations in digital IT areas and smooth transitioning to the new ES.

### *6.2.2 Data Analysis—Solution Categories for Digital IT Areas*

In the Architecture Board in this global enterprise, 118 action items with architecture risks have been raised as a result of the architecture reviews for Digital IT projects. Moreover, each solution to mitigate these 118 risks has been defined in the risk assessment process in this global enterprise. During the analysis, we distinguished ten solution categories for Digital IT areas. These solutions are presented in the following description, which contains short definitions of categories and percentages of adopted solutions as each category. The solution categories for Digital IT areas have been ordered in decreasing order of percentages of the adopted categories. The largest number of category encompasses solutions connected with various approaches for assigning appropriate employees. It is followed by a category that includes solutions related to the involvement of Top Management, such as Global IT Executives, CISO, and regional CIO. Then, with similar frequency of appearance, the Application Architecture and Project Scope Definition categories occur. They are followed by system, Implementation Process, Technology Architecture, and Security Architecture categories. The Architecture Board adopted the least frequent solutions that belong to Vendor Contract Definition and System Vendor categories (Masuda et al. 2017a, b).

[1] Employees (42%)—solutions that assign proper employees
[2] Top Management (18%)—solutions connected with top management involvement
[3] Application Architecture (9.5%)—verification of appropriate application architecture and integration standard
[4] Project Scope Definition (8%)—solutions connected with the definition of project scope
[5] System (7%)—system customization, modification, and optimization, decommission
[6] Implementation Process (6%)—solutions connected with the management of the implementation process
[7] Technology Architecture (4.5%)—verification of appropriate technology architecture and interface standard
[8] Security Architecture (4.5%)—verification of appropriate Security Architecture and security solution adoption
[9] Vendor Contract Definition (0.2%)—solutions connected with vendor contract definition
[10] System Vendor (0.1%)—solutions connected with vendor support and consultants.

### *6.2.3 Interrelation Between Solutions and Risks for Digital IT*

Figure 6.4 presents the mapping of solution categories onto risk categories. In this figure, some solution categories are coped with many risk categories. Specifically, the employees solution category, which was coped with for risks that belonged to security, Architecture Conformance, Technology Architecture, Data Architecture and Project Management, Compliance and Validation risk categories. Similarly, solutions from Top Management solution category have been coped with for risks from Architecture Conformance and Data Architecture, Project Management, and Strategic Alignment risk categories. Therefore, the element of “Role Assignments of experts” will be suitable for mitigating risks (Masuda et al. 2017a, b).

On the other hand, the security risk category had been addressed by solutions that belonged to Technology Architecture and Security Architecture categories. For this reason, the element of “Solution Architecting for Security” will contribute to these situations to mitigate risks. Similarly, risks from Application Architecture risk category obtained their solutions from the Application Architecture and Technology Architecture solution categories. Therefore, the element of “Solution Architecting

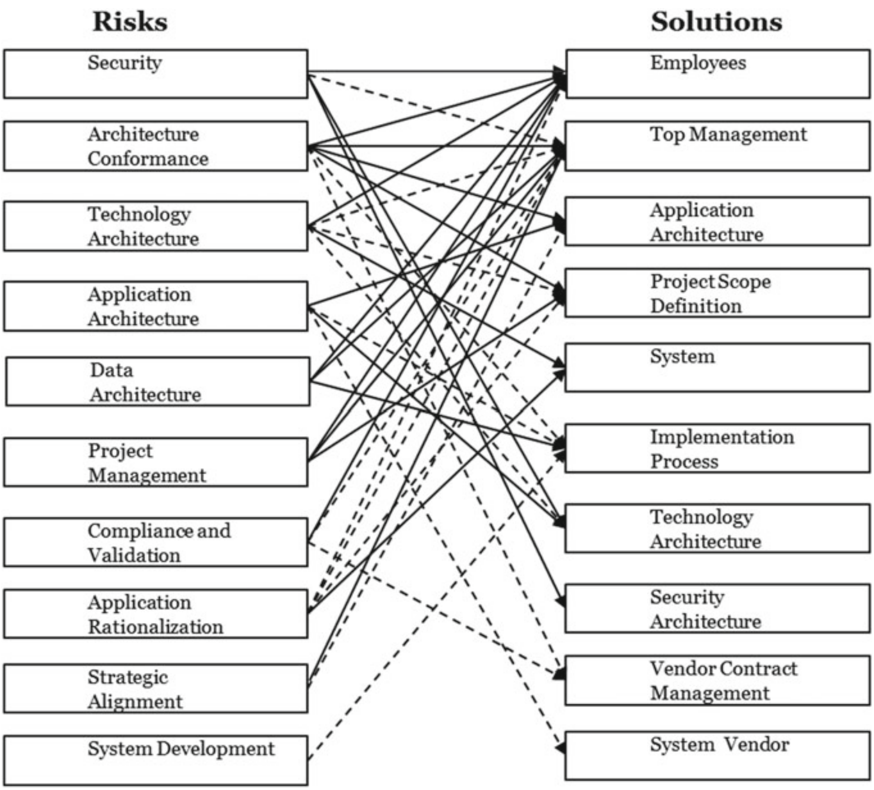


**Fig. 6.4** Solution categories mapped onto architecture risk categories in digital IT projects. *Note* Solid line denotes direct correspondence between solutions and risk categories more than 3 times. Dotted line shows a direct correspondence between solutions and risk categories more than once

for Application" will contribute to these situations to mitigate risks. Moreover, the Data Architecture risk category had been addressed by solutions that belonged to the Implementation Process solution categories. The element of "Data Architecting" may be suitable for mitigating risks. Furthermore, solutions from the System Solution Category addressed risks from the application rationalization risk category. The element of "System Decommission" should be suitable for mitigating risks. Finally, solutions from Project Scope Definition solution category addressed risks from Project Management risk category. The element of "Project Scoping" should contribute to these situations to mitigate risks (Masuda et al. 2017a, b).

## 6.3 Verifications and Summary

### *6.3.1 Cloud/Mobile IT with STRMM Model*

We proposed the "STrategic Risk Mitigation Model for Digital Transformation" in Fig. 6.3 for RQ3-1. As a result of reviews for Digital IT projects in the Architecture Board in this GHE for 1 year and 8 months, more than 110 kinds of action items for new IS/IT projects involving implementations on Cloud, such as SaaS, PaaS, and IaaS, were issued, while 50 kinds of action items for new projects involving Mobile IT applications were issued in the Architecture Board.

These new IS/IT projects' documents are developed with reference to architecture guidelines and abovementioned action items connected to risks summarized in the aforementioned "risk categories." To obtain endorsements for each new IS/IT project involving implementations on Cloud from the Architecture Board, the solutions summarized as "solution categories" described in section VI B were discussed and defined to mitigate the risks, and each new IS/IT project has been endorsed/realized by applying the abovementioned solutions.

The status of solutions for each area of Cloud is presented on the left side of Fig. 6.5.

First, almost all solution categories are defined and controlled for "*SaaS Cloud*"-related projects in the Architecture Board. Extremely high level of solution occurrence is found in the "Security of Employees Solution Category," and high level of solution occurrences is found in the "EA/Data and Compliance/Validation of Employees Solution Category," "Strategy of Top Management Solution Category," "EA/Conformance of Application Architecture Solution Category," and "Project Management of Project Scope Definition Category." Moreover, the medium levels of solution occurrence are found in the "Project Management of Employees Solution Category," "EA/Data and Project Manager of Top Management Solution Category," "Application Solution of Application Architecture Solution Category," "System Solution Category," "Implementation Solution Category," "Technology Architecture Solution Category," and "Security Architecture Solution Category."

Second, approximately half of the solution categories are defined and controlled for "*PaaS Cloud*"-related projects in the Architecture Board. High level of solution occurrence is found in the "Security of Employees Solution Category." On the other hand, low level of solution occurrences is found in the solution categories of "Employees," "Top Managements," "Application Architecture," "Project Scope Definition," and "Security Architecture."

Third, most of the solution categories are defined and controlled for "*IaaS Cloud*" related projects in the Architecture Board, except for the "System Solution Category." High level of solution occurrences is found in the "Security of Employees Solution Category" and "EA/Data of Top Management Solution Category." Medium level of solution occurrence is found in the "Project Management of Project Scope Definition Solution Category."


**Fig. 6.5** Solutions for digital IT areas with mitigation strategy elements. *Note* Bullets represent the level of solution occurrence adopted by the Architecture Board: ●●—extremely high, ●—high, ◑—medium, ○—low (more than 10 times) (5–9 times) (3–5 times) (less than twice)

The status of solutions for the area of Mobile IT application is also presented on the left side of Fig. 6.5.

Almost all solution categories are defined and controlled for "*Mobile IT application*"-related projects in the Architecture Board. High level of solution occurrences is found in the "security" and "Compliance/Validation" of "Employees Solution Category." Moreover, medium levels of solution occurrence are found in the "Project Management of Project Scope Definition Solution Category," "Technology Architecture of System Solution Category," and "Integration Architecture of Technology Architecture Solution Category." (Masuda et al. 2017a, b)

This empirical case study provides evidence of how it is possible to manage risks with solutions and strategy elements using the "STRMM for Digital Transformation" in Fig. 6.3 in the "Cloud/Mobile IT" areas to cope with RQ3-1.

### *6.3.2 Specific Application Layer on Cloud/Mobile IT—Big Data with STRMM Model*

In the current study, we investigate the specific application layer on Cloud and Mobile IT, such as Big Data, social network services, business analytics, analytics for R&D, and IoT.

The status of solutions for each area of "specific application layer" under "Cloud and Mobile IT" is also presented in the middle (light gray) of Fig. 6.5. First, most of the solution categories are defined and controlled for the Big Data solution-related projects, except for "vendor-related solution." In this global enterprise, eight kinds of Big Data projects, such as key opinion leaders (KOLs), occur. Four kinds of KOL management-related Big Data projects involving mobile IT applications for BI/CRM are raised, all implemented on SaaS cloud, except for one developed on PaaS. Two other kinds of Big Data mobile IT projects were also managed, both implemented on SaaS cloud; one project was implemented on IaaS cloud as well. Another Big Data project was partially implemented on SaaS and IaaS. The new Big Data Digital IT project documents were proposed and reviewed; twenty-nine action items were raised. High levels of solution occurrence are found in the "security" under "Employees." Moreover, medium levels of solution occurrences are found in "Compliance/Validation" under "Employees" and "Project Management" under "Project Scope Definition." Moreover, low levels of solution occurrences are found in solution categories under "Employees," "Top Managements," "Application Architecture," "Project Scope Definition," "Implementation Process," and "Security Architecture."

Most of the solution categories are defined and controlled for business analytics-related projects, except for "Security Architecture" and "vendor-related solution." Medium levels of solution occurrences are found in "security and EA/Data" under "Employees" and "EA/Data" under "Top Management." Less than three solution categories involving "Employees" and "Project Scope Definition" are defined and controlled for "social/SNS," "analytics for R&D," and "IoT" projects. The number of the projects in these areas is less than three and limited in this global enterprise.

Our current research verifies that the Architecture Board can control solutions with the STRMM for digital transformation. Fig. 6.5 shows the "specific application layer on Cloud and Mobile IT," including "Big Data solution" and "business analytics," to cope with RQ3-1 (Masuda et al. 2017a, b, 2018).

### *6.3.3 Strategy Elements to Mitigate Risks in Digital Transformation*

Based on the research described in Sect. 3.7.2, six kinds of main strategy risk mitigating elements can be formulated to answer RQ3-2 that are "Role Assignments," "Security Architecting," "Application Architecting," "Data Architecting," "System Decommission," and "Project Scoping." The status of each mitigation strategy element is presented on the right side of Fig. 6.5 (Masuda et al. 2017a, b, 2018). Furthermore, the details of the above risk mitigation elements will be explained in the following discussion chapter.

This chapter described our proposed STRMM for Digital Transformation and verified this model in the above case study in the global company. Furthermore, as a result of this case study, strategy elements to mitigate risks in Digital Transformation were also formulated appropriately. Chapter 7 will brief the overall evaluation and perspectives on our proposed AIDAF and related models, and Chap. 8 will describe the conclusion on AIDAF and related models.

**Questions and Exercises**

1. What are some of the risks when architecting and implementing digital IT systems?
2. Describe a relationship between Risk Management and Digital IT transformation.
3. Compare solutions to mitigate risks in the category of Cloud and Big Data.
4. Which one of the following is the most influential risk to Application Architecture-related solutions?

   a. Data Architecture
   b. Strategic Alignment
   c. Security
   d. Architecture Conformance.

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# Chapter 7
# Overall Evaluation and Perspectives

**Abstract** This chapter describes the overall evaluation of AIDAF for agility-related elements and shows that the AIDAF can have capabilities for the five agility-related attributes necessary for the execution of Digital IT strategies. Moreover, we evaluated and briefed strategy elements to mitigate risks in Digital Transformation. Also, this chapter briefs perspectives on AIDAF, such as benefits, challenges, and critical success factors. In the latter of this chapter, we refer to global Architecture Board activities for digital transformation and the main limitation of this study. In later chapters, we will describe the conclusion in terms of the AIDAF, Architecture reviews, knowledge management and Risk Management for digital transformation and refer to the future researches.

**Keywords** Digital transformation · AIDAF · Architecture Board · Risk mitigation · Digital IT strategy

## 7.1 Overall Evaluation

### *7.1.1 Valuation of AIDAF for Agility-Related Elements*

In this case study, first, the EA team involving the first author built an EA framework on the basis of TOGAF9 in Japan headquarters of this GHE. Moreover, the first author and each architecture team promoted/proceeded with global EA based on the proposed "Adaptive Integrated Digital Architecture Framework—AIDAF," to address the rapid shifts to cloud/mobile IT in US and Europe. We compare both TOGAF and the "Adaptive Integrated Digital Architecture Framework" in terms of agility-related elements. Fig. 7.1 presents a comparison of valuations for agile-related elements between TOGAF and the "Adaptive Integrated Digital Architecture Framework—AIDAF," from the standpoints of qualitative/quantitative analysis, as a result of the case study. The review criteria are the same as in Fig. 3.2; additionally, quantitative criteria have been added as defined by the authors. The authors have referred to the definitions of agility elements published by Gill (2014).



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| EA Frameworks | | | TOGAF 9 (At time of EA framework building at Japan headquarters) | AIDAF - Adaptive Integrated Digital Architecture Framework (After global deployment of EA, Our proposing) |
|---|---|---|---|---|
| | Necessary elements of EA for Cloud/Mobile IT/Digital IT | Review Criteria | | |
| Agility related Elements | Speed | [Qualitative] Rapid flexible response of enterprise in timely manner | Basically, performed EA tasks corresponding to the mid- or long-term of IT strategy/Business Unit policies | Correspond to new systems of cloud/mobile IT/digital IT occurring short-term cycle based, while addressing the mid- or long-term IT strategy/Business Unit policies as well |
| | | [Quantitative] Timeline of one-EA cycle | 1 year (TOGAF ADM cycle) | 1 month or 2 weeks (Adaptive EA cycle) |
| | Responsiveness | [Qualitative] Appropriate responses to deal with changes while sensing situations | Technology Scan can overcome changes while sensing situations in updating Technology Standard | Monthly Global Architecture Board can correspond to new systems of cloud/mobile IT/digital IT occurring frequently with changes |
| | | [Quantitative] Frequency of corresponding to new IS/IT systems and projects | Once per year in Japan Once per several months in some locals | Once or twice a month in global |
| | Flexibility | [Qualitative] Adapt to changing complex business demands in defining Principles in EA. | Especially no such kinds of adaptation | Each Architecture team can define Architecture Principles in each domain flexibly while adapting to changing complex business demands |
| | | [Quantitative] The number of accepted new IS/IT project planning documents (Architecture Requirements) | Five acceptable new IS/IT planning documents per year (10 Architecture Requirements per document) | Twenty-four acceptable new IS/IT planning documents per month (5-10 Architecture Requirements per document); 288 acceptable new documents per year |
| | Leanness | [Qualitative] EA operation with optimal /minimal resources without compromising quality | Visualize the current Architecture at the global level, each domain, after that, developing Target Architecture at the global level and each domain (the fields of Business Applications /Technology/Data, etc.) | Establish Project Governance and hold Global Architecture Board monthly, where can perform architecture reviews for new IS/IT projects. Develop Target Architecture in the fields of each Application, Digital IT, Security, while visualizing only necessary current Architecture. |
| | | [Quantitative] The number of Governance issues and time required to resolve Governance issues | Four kinds of Governance issues exist; 1)No short-term demand-based correspondence; 2) No global architecture board; 3) No global architecture review;, 4) No project portfolio management. | In particular, no governance issue and four Governance issues were resolved. 1) issue was solved in 1 month; 2) issue was solved in 1.5 month; 3) issue was solved in 3 months; 4) issue was solved in 2 months. |
| | Learning | [Qualitative] EA using up-to-date knowledge/experience with continuous growth/adaptation | Mainly publish SOA-based guidelines of reference architecture, and focus on defining/compliance to standards | Publish service-catalog-based guidelines covering security to accommodate cloud/mobile IT with microservices as well as SOA, while defining the necessary standards. |
| | | [Quantitative] The number of Architecture Deliverables generated on the learning base / The cycle speed of Learning | No Architecture Deliverables generated on the learning base. | 3 Architecture Guidelines generated on the learning base with 3-month update cycles for Learning – cloud with microservices, mobile IT, cloud security involving microservices. |

**Fig. 7.1** Comparison of valuations for agile-related elements between TOGAF and the AIDAF

First, in terms of speed, EA members (the first author) performed EA tasks corresponding to mid- or long-term IT strategy/business unit policies on the basis of TOGAF9 at the Japan headquarter of the GHE in those days. On the other hand, to ensure improvement under the global EA deployment based on the "Adaptive Integrated Digital Architecture Framework—AIDAF," EA members (the first author) corresponded to new short-term cycle cloud/mobile IT/digital IT systems. At the same time, mid- or long-term IT strategy/business unit policies were also considered. Quantitatively, in the case study analysis, the timeline of one EA cycle based on TOGAF ADM was 1 year at the Japan headquarter of the GHE. During global EA deployment, the timeline of one EA cycle based on Adaptive EA was 1 month (or 2 weeks), a notable improvement (Masuda et al. 2017a , b, c).

Second, from the standpoint of responsiveness, the technology scan could accommodate changes while sensing situations when updating the technology standard on the basis of TOGAF9 at the Japan headquarter of the GHE in those days. However, the scope of responsiveness was limited to Technology Architecture. On the other hand, a considerable improvement under global EA deployment based on the "Adaptive Integrated Digital Architecture Framework—AIDAF" would enable the monthly global Architecture Board to correspond to new systems of cloud/mobile IT/digital IT that occur frequently with changes. Quantitatively, the case study analysis, the frequency corresponding to the introduction of new IS/IT systems, and new projects on the basis of the TOGAF technology scan were once a year at the Japan headquarter of the GHE and once in several months in some local regions. However, during global EA deployment, the frequency at which the global Architecture Board introduced new IS/IT systems and new projects on the basis of the "Adaptive Integrated Digital Architecture Framework—AIDAF" was once or twice per month (Masuda et al. 2017a, b, c).

Third, in terms of flexibility, there was no such kind of adaptation to changing complex business demands on the basis of TOGAF9 at the Japan headquarter of the GHE in those days. On the other hand, global EA deployment based on the "Adaptive Integrated Digital Architecture Framework" was improved by defining the architecture principles in each domain flexibly by each architecture team, while adapting to changing complex business demands. Quantitatively, in the case study analysis, five new IS/IT project planning documents (Architecture Requirements) in the TOGAF ADM were accepted (ten Architecture Requirements per document) at the Japan headquarter of the GHE per year. However, the flexibility improved during global EA deployment in that the number of accepted new IS/IT project planning documents (Architecture Requirements) in the "Adaptive Integrated Digital Architecture Framework" was 24 per month (5–10 Architecture Requirements per document), which was equivalent to 288 acceptable new ones per year (Masuda et al. 2017a, b, c).

Fourth, from the standpoint of Leanness, the EA team visualized the current architecture at the level of global and each of the four domains, after which the target architecture was developed at these levels (the fields of business applications/technology/data, etc.) on the basis of the TOGAF9 ADM at the Japan headquarter of the GHE in those days. On the other hand, a significant improvement in the Leanness was achieved during global EA deployment based on the "Adaptive Integrated Digital Architecture Framework—AIDAF." This was accomplished by the EA team established by project governance. The global Architecture Board convened monthly to perform architecture reviews for new IS/IT projects and developed target architecture in each of the fields of application, digital IT, and security, while visualizing only the necessary current architecture. Quantitatively, in the case study analysis, four governance issues were found in the TOGAF ADM (no short-term demand-based correspondence, no global Architecture Board, no global architecture review, no project portfolio management) at the Japan headquarters of the GHE, which were not solved in those days. However, in terms of leanness, a considerable improvement for time taken to resolve governance issues was achieved; during global EA deployment, there were no governance issues, especially in the “Adaptive Integrated Digital Architecture Framework,” because the first issue of “no short-term demand-based correspondence” was solved in 1 month, the second issue of “no global Architecture Board” was solved in 1.5 months, the third issue of “no global architecture review” was solved in 3 months, and the fourth issue of “no project portfolio management” was solved in 2 months, as described in issue(3) of Fig. 4.4 (Masuda et al. 2017a, b, c).

Finally, in terms of Learning, the EA team published the guidelines of SOA-based reference architecture and focused on defining/compliance to the standards on the basis of TOGAF9 ADM at the Japan headquarter of the GHE in those days. On the other hand, learning during global EA deployment based on the “Adaptive Integrated Digital Architecture Framework” was improved as a result of the EA team publishing service catalog-based guidelines covering security to accommodate cloud/mobile IT with Microservices as well as SOA, while defining the necessary standards. Quantitatively, in the case study analysis, no architecture deliverables were generated on the learning base in the TOGAF ADM at the Japan headquarters of the GHE. However, a considerable improvement was achieved in terms of learning during global EA deployment based on the “Adaptive Integrated Digital Architecture Framework—AIDAF”; three architecture guidelines were generated on the learning base by updating the 3-month learning cycle—cloud with Microservices, mobile IT, and cloud security involving Microservices (Masuda et al. 2017a, b, c).

TOGAF is criticized for its size, lack of agility, and complexity (Gill et al. 2014). As seen in Figs. 4.4 and 7.1, the “Adaptive Integrated Digital Architecture Framework—AIDAF” has capabilities for the above five agility-related attributes that are lacking in TOGAF. The proposed “Adaptive Integrated Digital Architecture Framework” also contains all the elements of the architecture domains (BA/AA/DA/TA), thereby ensuring that the global EA deployment based on this framework in the GHE was performed in alignment with the cloud/mobile IT/digital IT approach.

The current research verifies that the “Adaptive Integrated Digital Architecture Framework—AIDAF” is developed to meet the requirements in the era of cloud/mobile IT/digital IT, which involves the five agility-related attributes of “speed/responsiveness/flexibility/leanness/learning,” provided in Fig. 4.4 and Fig. 7.1 to address RQ2 in the research strategy defined in Sect. 3.1.2 and RQ1-1 defined in Sect. 3.3.2 (Masuda et al. 2017a, b, c).

### *7.1.2 Valuation of Strategy Elements to Mitigate Risks in Digital Transformation*

Based on the research described in Sect. 6.3.3, the following strategy risk mitigating elements can be formulated to answer RQ3-2 defined in Chap. 6. The status of each mitigation strategy element is presented on the right side of Fig. 6.5 (Masuda et al. 2017a, b, c). The detail of valuation results for these strategy risk mitigating elements in Digital Transformation is as follows.

#### 7.1.2.1 Role Assignments

Two types of solution categories, "Employees" and "Top Management," are adopted to mitigate risks with this strategy element. High levels of solution occurrences are found in "security," "EA/Data," and "Compliance/Validation" of the "Employees Solution Category." Moreover, medium levels of solution occurrences are found in "strategy" and "EA/Data" under "Top Management Solution Category" and "Project Management" under "Employees Solution Category." In terms of Big Data projects, high levels of solution occurrence are found in "security" under "Employees Solution Category," and medium levels of solution occurrence are found in "Compliance/Validation" under "Employees Solution Category." (Masuda et al. 2017a, b, c).

#### 7.1.2.2 Security Architecting

Several kinds of solution categories, including "Employees," "Security Architecture" and "Top Management," are adopted to mitigate risks with this strategy element. High levels of solution occurrence are found in "security" under "Employees." Medium levels of solution occurrence are found in "user authentication" under "Security Architecture." In terms of Big Data projects, high levels of solution occurrence are found in "security" under "Employees." (Masuda et al. 2017a, b, c).

#### 7.1.2.3 Application Architecting

Seven kinds of solution categories, including "Employees," "Top Management," "Application Architecture," and "Technology Architecture," are adopted to mitigate risks with this strategy element. High levels of solution occurrence are found in "EA/Data" under "Top Management" and "EA/Conformance" under "Application Architecture solution." Medium levels of solution occurrence are found in "security" under "Employees," "Application Solution" under "Application Architecture," and "Application Technology" and "Integration Architecture" under "Technology Architecture." (Masuda et al. 2017a, b, c).

#### 7.1.2.4 Data Architecting

Three kinds of solution categories, including "Employees," "Top Management," and "Implementation Process," were adopted to mitigate risks with this strategy element. Medium levels of solution occurrence are found in "EA/Data" under "Employees Solution Category," "EA/Data" under "Top Management solution," and "Data" under "Implementation Process solution." (Masuda et al. 2017a, b, c).

#### 7.1.2.5 System Decommission

Three kinds of solution categories, including "Employees," "Top Management," and "System," were adopted to mitigate risks with this strategy element. Medium levels of solution occurrence are found in "application rationalization" under "system solution." (Masuda et al. 2017a, b, c).

#### 7.1.2.6 Project Scoping

Four kinds of solution categories, including "Top Management," "Employees," "Application Architecture" and "Project Scope Definition" are adopted to mitigate risks with this strategy element. High levels of solution occurrence are found in the "Project Management" under "Project Scope Definition," and medium levels of solution occurrence are found in the "project manager" under "Top Management solution." For Big Data projects, medium levels of solution occurrences are found in the "Project Management" under "Project Scope Definition." (Masuda et al. 2017a, b, c).

#### 7.1.2.7 Vendor Relationship

The vendor-related solution category was adopted to mitigate risks with this strategy element. However, only low-level solutions are found in the "vendor contract." (Masuda et al. 2017a, b, c).

## 7.2 Perspectives on AIDAF

### *7.2.1 Benefits of EA Implementation Using the "Adaptive Integrated Digital Architecture Framework—AIDAF"*

This book proposed the "Adaptive Integrated Digital Architecture Framework—AIDAF" to promote an IT strategy towards cloud/mobile IT/digital IT. The case study in the GHE confirmed that our proposed EA framework could be expected to introduce the following benefits:

1. Reducing risks for Digital Transformation

In the Assessment/Architecture Review phase of the Adaptive EA cycle in Fig. 3.4 and Fig. 4.1, the Architecture Committee/Board can review the solution architecture by focusing on the conceptual design portion of the initiation documents for all the new Digital IS/IT projects. The action items should be issued there. One of the authors determined the risks connected to each action item raised by the Architecture Board and defined an equivalent solution for each risk. In addition, in the following phases, they monitored the status of each risk capable of reducing the risks for Digital Transformation in the GHE as great benefits of our proposed EA framework (Masuda et al. 2017a, b, c).

2. Improvement of architecture quality

In the context phase of the Adaptive EA cycle in Fig. 3.4 and Fig. 4.1, each project team drafted the project initiation documents of new cloud/mobile IT/digital IT-based IT system projects (including conceptual architecture design) based on business department needs. This was achieved by referencing the security/cloud/mobile IT-related architecture guidelines, which the EA team developed in the defining phase in Fig. 3.4 and Fig. 4.1. The company's architecture teams defined principles conforming to IT strategy elements and established consistency with appropriate architecture patterns. Moreover, in the Assessment/Architecture Review phase of the Adaptive EA cycle in Fig. 3.4 and Fig. 4.1, the Architecture Committee/Board can review the solution architecture in the initiation documents for all the new IS/IT projects involving Digital IT to improve the architecture quality. These activities are expected to improve the quality of the architecture in each new information system in the GHE as great benefits of our proposed EA framework (Masuda et al. 2017a, b, c).

3. More effective cost control

In the rationalization phase of the Adaptive EA cycle in Fig. 3.4 and Fig. 4.1, the company's Architecture Board distinguished "replaced systems" and "unnecessary, eliminable information systems" according to the implementation of these proposed new information systems involving Digital IT and determined the positioning of the new information systems. These activities of application rationalization should lead to optimal cost control in consideration of the appropriate "replaced systems" and "decommissioned information systems" in the GHE as benefits of our proposed EA framework (Masuda et al. 2017a, b, c).

### *7.2.2 Challenges Encountered in EA Implementation of AIDAF*

Although this book proposed the "Adaptive Integrated Digital Architecture Framework—AIDAF" to promote an IT strategy towards cloud/mobile IT/digital IT, the EA implementation in the GHE could face some challenges. Based on the case study of this EA implementation in terms of cloud/digital IT, the following challenges were encountered in the EA implementation of the "Adaptive Integrated Digital Architecture Framework—AIDAF" in the GHE (Masuda et al. 2017a, b, c).

1. Countermeasure for the supplements in BA and DA

The development of target Business Architecture and target Data Architectures is very important in EA implementation. However, the essential projects for the development of these target architectures, such as "business process standardization" and "master data management platform building," were delayed in the GHE in those days. Hence, the challenging tasks are the architecture review for DA and BA in the solution architectures of new IS/IT systems in alignment with an IT strategy promoting cloud/mobile IT/digital IT, without sufficient flexibility in these target architectures (Masuda et al. 2017a, b, c).

2. Communication with resistant employees

This case study identified communication with resistant employees as one of the challenges of EA implementation for Digital Transformation. Some employees failed to understand the reason why it should be important to recognize a "replaced system" or "decommissioned system" as parts of existing IT infrastructure platforms in the IT strategy and EA, especially for Digital Transformation in the GHE. Hence, the challenging task was to overcome these communication problems by utilizing effective methods or platforms such as a communication process or communication platforms in the GHE in those days (Masuda et al. 2017a, b, c).

### *7.2.3 Critical Success Factors for Implementing AIDAF in the Era of Cloud/Mobile IT/Digital IT*

On the basis of the EA implementation experience in this GHE case study in the era of Digital IT, we identify the following three critical success factors for EA implementation with the "Adaptive Integrated Digital Architecture Framework—AIDAF." These factors support an IT strategy promoting cloud/mobile IT/digital IT, especially in a global enterprise (Masuda et al. 2017a, b, c).

1. Commitment from CIO and top management

The implementation of EA as well as Architecture Board formulation in a global enterprise is often resisted. One of the reasons is the inability of almost all existing EA frameworks to meet the requirements in the era of cloud/mobile IT/digital IT as suggested in this book. Even if EA is implemented on the basis of the "Adaptive Integrated Digital Architecture Framework" in the enterprise, commitment from the CIO/top management and their participation in EA are extremely important to achieve EA implementation and Architecture Board formulation, especially in a global enterprise. In this case study in the GHE, early risk identifications and countermeasures for new IS/IT projects as a result of participation of the Architecture Board Top Management (Global IT Executives, Regional CIOs, CISO, etc.) were also very effective. Particularly, for digital IT-related new project Strategic Alignment risk, countermeasures through participation of the Architecture Board Top Management are effective and strategically important (Masuda et al. 2017a, b, c).

2. Collaboration between the architecture and PMO communities

Collaborative EA implementation among the architecture community, PMO community, and top management is another critical success factor for achieving EA implementation on the basis of the “Adaptive Integrated Digital Architecture Framework” and Architecture Board formulation, especially in a global enterprise. In this case study in the GHE, it was a key element to establish project governance and hold monthly meetings of the global Architecture Board to ensure collaboration between the architecture and PMO communities, to perform architecture reviews for new IS/IT projects. Moreover, this collaboration is very important to enable the Architecture Board to discover risks related to Project Management at an early stage and to devise corresponding “Project Scope Definition” countermeasures (project scope redefinition and reconfirmation) particularly for digital IT-related projects (Masuda et al. 2017a, b, c).

3. Effective utilization of digital platforms

Digital platforms such as the enterprise portal and social tools are very effective to overcome the aforementioned challenges of communicating with resistant employees as well as in political organizational situations. In this case study in the GHE, global communications on digital platforms such as the enterprise portal and social tools were conducted to overcome the barriers posed by resistant employees, those between global logical organizations, and the location barriers between countries and regions, especially in the Architecture Board. Effective digital platforms are thus a critical success factor to achieve EA implementation on the basis of the “Adaptive Integrated Digital Architecture Framework” and Architecture Board communications, especially in a global enterprise. These platforms promote communications within the architecture and PMO communities, global/local organizations, and with resistant employees effectively (Masuda et al. 2017a, b, c).

### 7.2.4 *Intermediary Knowledge with GDTC Model in Architecture Board*

The transformation modes in the intermediary knowledge model are also shown in Fig. 5.7. The Architecture Board’s review is carried out through the exchange of explanations and opinions between the leader/Architecture Board members and each new project leader on the enterprise portal. In this process, we observed that the review results, problems, and solutions are formed into explicit knowledge and published as the final project proposals are created through collaboration and sophistication. In Fig. 5.7, the approximate breakdown of the intermediary knowledge types is 14% publication, 5% resonant formation, 27% collaboration, 14% combination, 27% sophistication, and 9% fragmentation (as well as 4% internalization).

In this case study, sophistication and collaboration play the largest roles. In terms of sophistication, the process includes steps in which the tentative project proposals are shared prior to the Architecture Board, the review results are finally published, while the contents and results of the architecture review are sophisticated, and the project proposals are sophisticated based on these results. In terms of collaboration,

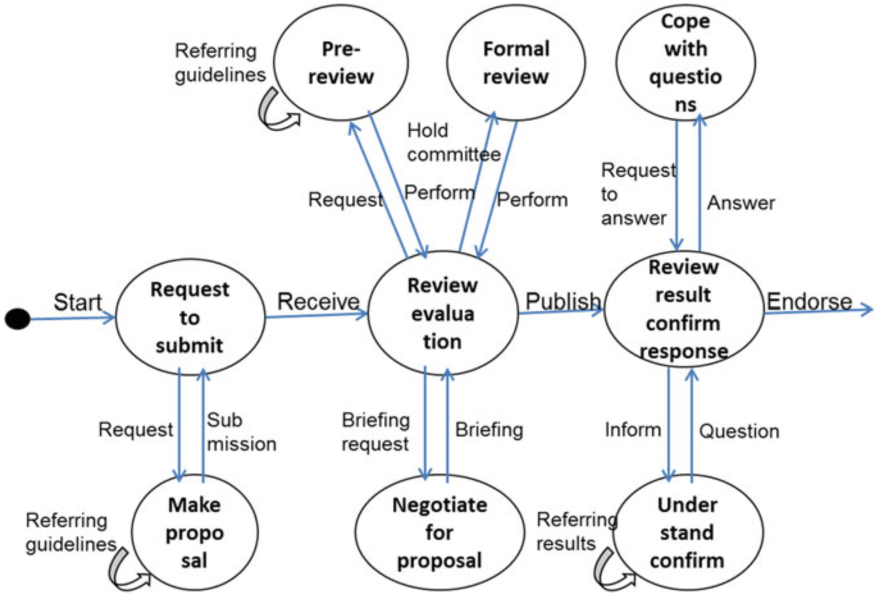


**Fig. 7.2** Global communication structure on enterprise portal

many instances occur through the GABCP on the enterprise portal when the preliminary and actual reviews take place at the Architecture Board, and when the project proposals are responded to, based on the review results (Masuda et al. 2017a, b, c).

### 7.2.5 *Global Communication Structure in Architecture Board*

In RH3, the global communication actions on the enterprise portal can be divided into the types listed in Fig. 5.7, such as request, reference, consolidation, confirmation, evaluation, and understanding. A diagram of the communication structure on the enterprise portal between the leader/Architecture Board members and new project manager, for the purpose of review in the Architecture Board, is shown in Fig. 7.2, based on Fig. 5.7.

According to Fig. 7.2, once the solution architecture of the project planning document is endorsed, the new project can move to the next step of being initiated. It can be seen from Fig. 7.2 that in the communication processes that exist, each new project planning document is made/submitted and reviewed/evaluated in the Architecture Board, and in another the review results are published and the project is endorsed after dealing with the necessary action items. Furthermore, we can verify that, with these global communications via the GABCP enterprise portal, there is a global communication process for solving the cross-functional problems of global organizations via the GDTC model, to cope with RH3 (Masuda et al. 2017a, b, c).

### 7.2.6 Challenges in Architecture Board Formulation Toward the Era of Digital IT

Through the case study of this Architecture Board formulation with AIDAF in terms of cloud/digital IT, the following challenges were encountered in the Architecture Board formulation in Adaptive EA in the GHE.

1. Starting up the specialized Architecture Board such as Digital Board, CRM Board

While Architecture reviews were performed in Architecture Board through AIDAF in this case study for 1 year and 6 months, the number of project initiation documents had increased in global so much. Therefore, the monthly Architecture Board meeting should be focused on managerial matters from standpoints of architecture to enhance the efficiency, on the other hand, the specialized Architecture Board such as Digital Board and CRM Board, etc., need to be started up to enhance the architecture quality and disperse the workload of Architecture reviews. Hence, the challenging tasks are to start up the Digital Board and CRM Board, etc., as specialized ones in alignment with an IT strategy promoting cloud/mobile IT/digital IT with target architectures in these areas (Masuda et al. 2018).

2. Communication with resistant groups on social/digital platforms

This case study identified communication with resistant employees as one of the challenges of Architecture Board formulation for Digital Transformation. Some employees failed to understand the reason why it should be discussed and reviewed to decide a “replaced system” or “decommissioned system” as parts of existing IT infrastructure platforms in Architecture Board for Digital Transformation in the GHE. Hence, the challenging task was to overcome these communication problems by utilizing effective social/digital platforms like enterprise portals, SNS in the GHE in those days (Masuda et al. 2018).

### 7.2.7 Critical Success Factors for Formulating Architecture Board in the Era of Digital IT

On the basis of the Architecture Board formulation experience in this GHE case study in the era of Digital IT, the authors identify the following two critical success factors for Architecture Board formulation with the AIDAF. These factors can support an IT strategy promoting cloud/mobile IT/digital IT in enterprise.

1. Commitment from CIO and top management

The Architecture Board formulation in a global enterprise is often confused. Even if EA is started with applying the AIDAF in the enterprise, commitment from the CIO/top management and their agreement are extremely important to achieve Architecture Board formulation, especially in a global enterprise. In this case study in the GHE, early risk identifications and countermeasures for new IS/IT projects with the participation of the Architecture Board Top Management (Global IT Executives, CISO, etc.) were also very effective. Particularly, for digital IT-related new project, “Role Assignments” by Top Management as Risk Mitigation Strategy were very effective (Masuda et al. 2018).

2. Collaboration between the architecture and PMO communities on social/digital platforms

Collaborative Architecture Board communication/progress among the architecture community, PMO community, and top management involving the utilization of social/digital platforms is another critical success factor for achieving Architecture Board formulation/enhancement based on the AIDAF, especially in a global enterprise. In this case study in the GHE, it was a key element to establish project governance and hold monthly meetings of the global Architecture Board with SCM model for Architecture Review in Fig. 3.11, leveraged by the collaboration between the architecture and PMO communities on social/digital platforms such as the enterprise portal and SNS. Social/digital platforms are very effective to overcome the challenges of communicating in political organizational situations. Moreover, this collaboration is very important to enable the Architecture Board to cope with risks related to Project Management at an early stage with “Project Scoping” of Risk Mitigation Strategy particularly for digital IT-related projects (Masuda et al. 2018).

### *7.2.8 Global Architecture Board Activities for Digital Transformation*

While promoting digital transformation, there should be prerequisite items, such as prototyping in the experimental phase and requirements management using business-specific values, before implementing the project planning document to begin the projects of the digital IT application systems. Yamamoto et al. position “requirement management across the corporation” as the core element of business strategy and operation, as well as enterprise architecture, propose the “Requirement Management Board,” and define the maturity model of requirement management (Yamamoto 2017).

In further accelerating digital transformation, the Architecture Board activities were required to review the solution architecture in the new digital IT project’s planning documents more appropriately, on the basis of requirements discussed/grasped in “Requirement Management Board for Digital IT application systems.” In terms of the abovementioned maturity model of requirement management, the Global Architecture Board activities in this GHE should be estimated as "the fourth level of maturity." This is because the reviews cover considerations from the standpoint of application rationalization to promote cost efficiency by rationalizing the number of application systems in the GHE, as defined in the global IT strategy aligned with the corporate strategy. For the purpose of aiming for "the fifth level of maturity for requirement management," it should be necessary for this GHE to proportion the requirements depending on technology and business changes. For example, while performing application portfolio analysis from a standpoint of the portion adopting digital IT technologies such as cloud computing, and visualizing this status on the enterprise portal, new project members create the solution architecture for each new project planning document considering the analysis results. Moreover, while considering the priority of promoting digital transformation for business categories that should be focused on, to align with the corporate strategy based on the results of the application portfolio analysis, it should be effective to take the analysis results into account when performing architecture reviews in the future (Masuda et al. 2017a, b, c, 2018).

### *7.2.9 Limitations*

The main limitation of this study concerns the scope of the research, which was based on data collected from a single case study in one GHE. The number of projects related to the areas "analytics for R&D" and the "Internet of Things" was limited in this GHE. Moreover, the scope of this research in terms of Data Architecture and Business Architecture was also limited because the project related to the master data management platform and the business process redesign project were delayed in this GHE. The scope of the project for "Big Data" was also limited in terms of Data Architecture, whose data was collected mainly from external social tools and external healthcare IT information sources, while the master data management platform-related project is delayed in this GHE.

On the other hand, in terms of a GDTC model, the research was based on data collected from a case study on the enterprise portal in one GHE. Other case studies need to be evaluated to generalize our proposed model. Furthermore, we have not investigated from the standpoint of each of the regional characteristics in global organizations.

**Questions and Exercises**

1. Investigate online research resources and describe assumed benefits of implementing the AIDAF in companies and societies other than three benefits briefed in this chapter.
2. How can communication problems with people resistant to Digital Transformation?

3. Describe more than three effective ways of utilizing digital platforms in the deployment of AIDAF.

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# Chapter 8
# Conclusion

**Abstract** This chapter discusses from standpoints of the AIDAF, Architecture reviews and global communication process on digital platforms, Risk Management for digital transformation. Also, we describe the conclusion regarding the above categories on the AIDAF, Digital Transformation. In the latter of this chapter, we refer to the future researches in terms of "Internet of Things" and various kinds of "Big Data," with the AIDAF. In the next chapter, we will describe the future research direction and brief the concept of "Internet of Things" related research initiative, named "Open Healthcare Platform 2030" and show the example of an AIDAF application for cross-functional healthcare community.

**Keywords** Digital transformation · AIDAF · Architecture review · Risk management · Digital platform

## 8.1 Adaptive Integrated Digital Architecture Framework—AIDAF

In this book, we proposed the "Adaptive Integrated Digital Architecture Framework—AIDAF," which comprises the necessary EA elements for the era of cloud/mobile IT/digital IT. The framework is based on preliminary research, which suggested an EA framework that can be applied to corporations to promote a cloud/mobile IT/digital IT strategy toward the digital transformation. In addition, we briefed and investigated an example case of a GHE, where the abovementioned EA framework is built and implemented in practice as the only case study of related up-to-date EA toward the era of digital IT. We evaluated the effectiveness of the "Adaptive Integrated Digital Architecture Framework—AIDAF" in the digital IT era by using a case study of a GHE. Furthermore, we clarify the challenges, benefits, and critical success factors of this EA framework for EA practitioners.

We verified that the "Adaptive Integrated Digital Architecture Framework—AIDAF" is developed to meet the requirements of the era of cloud/mobile IT/digital IT, which involves the five agility-related elements of "Speed/Responsiveness/Flexibility/Leanness/Learning," that can answer for RQ2 in



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the research strategy defined in Sect. 3.1.2. Furthermore, we verified that our proposed “Adaptive Integrated Digital Architecture Framework—AIDAF” can solve problems occurring in the era of cloud/mobile IT/digital IT, that can lead to answer for RQ1 in the research strategy defined in Sect. 3.1.2. We are currently investigating further details of the case study of the GHE, with the aim of determining the extent to which our proposed EA can solve the problems associated with the era of digital IT. The main limitation of this study is the scope of the research, which was based on the data collected from a single case study in one GHE. Its application to other industries might be limited; however, to the best of our knowledge, this is the first and foremost useful research result for global companies that operate in a similar industry, i.e., chemical and manufacturing companies positively promoting a digital IT strategy on a global scale.

## 8.2 Architecture Review and Global Communication Process on Digital Platforms

This book proposed the “Assessment meta-model in Architecture Board” in Fig. 3.7 based on this research with GHE case study, where we investigated the procedure of holding Architecture Board and solving risks that were raised in the Architecture Board reviews. On the basis of empirical data gathered from the results of Architecture Board reviews in GHE, the authors clarified the relationships between solutions and risks defined in the global Architecture Board and formulated five elements of “Risk Mitigation Strategy” in Architecture Board, that cover CRM and Digital IT-related systems and can lead to a number of insights and contributions for EA practitioners, researchers, and architects toward Digital Transformation. In general, solutions connected with the Risk Mitigation Strategy of “Role Assignments” can be applied in almost all risk categories raised in Architecture Board and they could include activities connected with employees (appropriate architects for standard platforms, application, security, business process, data, technology, system implementation, and project manager) and Top Management (support and engagement). Special attention should be paid to the risks in the categories of Security and Architecture Conformance (appropriateness of integration architecture and interfaces) and project scope management in Digital IT-related systems.

We verified that Architecture Board can be processed with Assessment model in Fig. 3.7 by processing each task of Architecture Board using our proposed Assessment meta-model in the GHE case study, which can lead to the answer for RQ2-1. Furthermore, we clarified the relationships between solutions and risks using the five elements of “Risk Mitigation Strategy” in global Architecture Board, covering new IS/IT projects of CRM, Digital IT, and ERP, which can lead to the answer for RQ2-2. The main limitation of this research is the scope of research. The research was based on the data obtained from the reviews in Architecture Board in one GHE. Its applications in other industries might be limited; however, to the best of our knowledge, this is the first and foremost useful research for global companies that operate in a similar industry, i.e., chemical industries and manufacturing industries positively promoting Digital IT strategy in global.

Moreover, we have proposed a GDTC model for global communication on an enterprise portal, which can promote digital transformation in the global community. Moreover, in the global communication case study, with the purpose of reviewing activities in the global Architecture Board on the enterprise portal, based on the empirical data, we verified RH3, namely "the global communication process on the enterprise portal has common patterns to solve the cross-functional problem via the intermediary knowledge model in a global organization", as well as RH1 and RH2 proposed as research hypotheses, while utilizing and confirming the GDTC model.

Furthermore, we referred to the desired direction of the enterprise portal in digital transformation from the standpoint of enhancing the maturity of requirement management.

In this book, the first author proposed the "SCM model for Architecture Review in Architecture Board" in Fig. 3.11, based on this research with GHE case study, where the first author investigated the procedure of holding Architecture Board and solving risks that were raised in the Architecture Board reviews in Adaptive EA. The first author verified that Architecture reviews were performed with Social Collaboration Model on digital platforms in Fig. 3.11, which can lead to the answer for RQ2-3.

Finally, the above verifications of AIDAF-related models such as "Assessment model," "GDTC model" and "SCM model" can lead to answer for RQ1 in the research strategy defined in Sect. 3.1.2.

## 8.3 Risk Management for Digital Transformation

This book proposed the "STRMM for Digital Transformation" as the Risk Mitigation model in the Architecture Board based on the current research with the global enterprise case study, where we built and implemented the "Adaptive Integrated Digital Architecture Framework—AIDAF". Based on the empirical data gathered from the result of the Architecture Board reviews in the global enterprise, this research verified that the Architecture Board can control the solutions with "STRMM for Digital Transformation" in areas of "Cloud/Mobile IT" and "Specific Application Layer on Cloud/Mobile IT", such as "Big Data Solution" to cope with RQ3-1 and RQ1 in the research strategy defined in Sect. 3.1.2. Furthermore, we clarified the strategy elements to mitigate the Risk for Digital Transformation, such as "Role Assignments", "Security Architecting", "Application Architecting", "Data Architecting", "System Decommission", and "Project Scoping", which can lead to the answer for RQ3-2. Besides, in the case study of GHE, one of the authors monitored the status of each risk defined in the risk assessment process with Architecture Board in the full-lifecycle of SDLC on the basis of "STRMM for digital transformation" with "Strategy elements to mitigate risks," while the above risks were mitigated then, that can answer for RQ3 in the research strategy defined in Sect. 3.1.2.

## 8.4 Future Research

My future research aims to further analyze the effectiveness of the "Adaptive Integrated Digital Architecture Framework—AIDAF" for systems related to digital healthcare applications, such as the "Internet of Things" and variety kinds of "Big data," both of which were raised during Architecture Board meetings in the global organization. Besides, appropriate mechanisms of Architecture Change Management in AIDAF should be developed and verified in AIDAF to cover the remaining phases from the latter of "Implementation" to "Testing" in SDLC formally, in consideration with CMMI. We aim to propose a new approach to achieve benefits for corporations in these areas.

Moreover, in further researches, it will be valuable to analyze how each regional stakeholder can process the further global communications to correspond to and solve the problems in each category on these digital platforms such as enterprise portals, and SNS.

Furthermore, in the future research, we would like to the further analyze the solutions for Architecture Risks covering Security, Application Architecture, Technology Architecture, and Data Architecture that should focus on digital healthcare applications-related systems, such as the "Internet of Things" raised in the Architecture Board.

We aim to propose a new approach to achieve benefits for corporations in these areas.

**Questions and Exercises**

1. What kinds of industries will be considered as the scope of the AIDAF applications? Describe the above more than five industries rather than the healthcare industry.
2. What differences should be there in terms of tendencies between risks for ERPs and ones for digital IT systems?
3. Research other online sources for Enterprise Architecture and IT strategy in a Digital IT era and describe future researches for EA in a Digital IT era, that you can consider.

# Chapter 9
# Future Direction—Open Healthcare Platform 2030 and IoT Healthcare Platform

**Abstract** This chapter provides our thoughts on future direction and research methodology of "Internet of Things with AIDAF" related research initiative, named "Open Healthcare Platform 2030." This chapter also shows the assumed case of an AIDAF application for cross-functional healthcare community. Of course, Digital IT systems related to "Internet of Things" should become more significant gradually, therefore, standardized digital platforms for IoT in the level of application and middleware will be desired. In the latter of this chapter, we refer to the challenges in the "Internet of Things" related research initiative, named "Open Healthcare Platform 2030." Readers' comments are also intended to help promote discussion in the topic of "Enterprise Architecture in a Digital IT Era" and to encourage the adoption of this Architecture Framework suiting a Digital IT Era from now on.

**Keywords** Internet of things · AIDAF · Digital platform · Digital healthcare · Value-based healthcare system

## 9.1 Research Direction and Research Methodology in OHP2030

In this book, we first state research questions to understand and formulate the layers and specifications for IoT digital platforms at the middleware and application layer in the healthcare industry. Then, we will evaluate these research questions using a case study in the cross-functional healthcare community in Asia and globally. The following research questions are evaluated in the case study.

RQ1-X: How can a layered architecture for the IoT be defined considering existing IoT architecture models?

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RQ2-X: How can layers and specifications for digital IoT platforms in the middleware and application layer be clarified and formulated for healthcare industries?

We will investigate a case study within the cross-functional healthcare community globally and in Asia and Global, where we should build and implement the "Adaptive Integrated Digital Architecture Framework—AIDAF" and start the Architecture Board. In the Architecture Board, all new IS/IT project architecture designs will be reviewed and action items for next steps will be raised by architects and top management and PMO members. After the Architecture Board should be held, we need to compare two kinds of IoT architecture models and define layers and specifications for digital IoT platforms in the middleware and application layers for healthcare industries (Masuda and Yamamoto 2018).

## 9.2 AIDAF Application for Cross-Functional Healthcare Community

The first author of this chapter proposed an adaptive integrated EA framework to align with IT strategy, promoting Cloud/Mobile IT/Big Data/Digital IT, and verified by our case study (Masuda et al. 2017). Furthermore, the first author of this chapter has named the EA framework suitable for the era of Digital IT as an "Adaptive Integrated Digital Architecture Framework—AIDAF" (Masuda et al. 2018). Figure 9.1 illustrates this AIDAF proposed model in the Open Healthcare Platform 2030 (OHP2030) community (Masuda and Yamamoto 2018). The OHP2030 community is comprised of healthcare companies such as pharmaceutical, medical development, and aged healthcare companies, hospitals as well as the OHP2030 initiative and government as depicted in Fig. 9.1. AIDAF will be applied to the abovementioned cross-functional healthcare community in the OHP2030 (Masuda and Yamamoto 2018). AIDAF begins with the context phase, while referencing the defining phase (i.e., architecture design guidelines related to digital IT aligned with IT strategy in the above healthcare community in the OHP2030). During the assessment and architecture review, the Architecture Board reviews the initiation documents and related architectures for the IT project in the above healthcare community in the OHP2030 (Masuda and Yamamoto 2018).

## 9.3 Healthcare Community Case in OHP2030

In OHP2030, a particular Architecture Board will be formulated in the aforementioned cross-functional healthcare community. In the case study of EA rollout in the healthcare community, they will handle IoT/Big Data/Cloud strategic projects and systems well by structuring and implementing EA with the abovementioned AIDAF

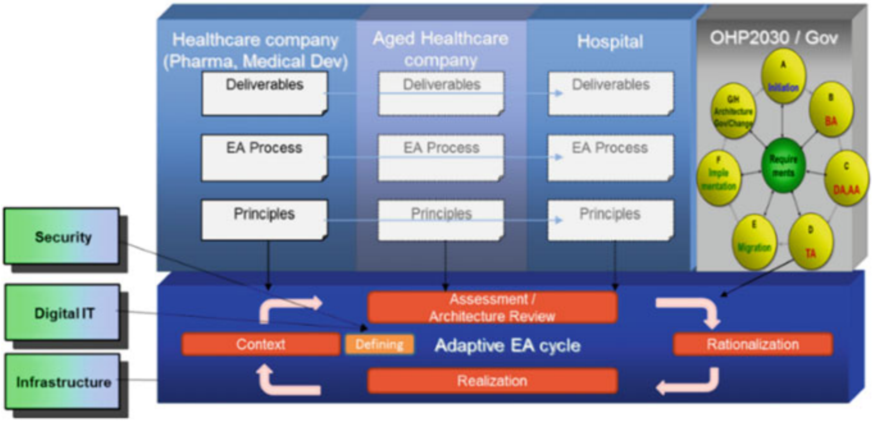


**Fig. 9.1** AIDAF proposed model in the healthcare community in the OHP2030 (ex: TOGAF and Adaptive EA framework)

to be consistent with the IT strategy focusing on IoT/Big Data/Digital IT in the above cross-functional healthcare community (Masuda and Yamamoto 2018).

Furthermore, in the case study of the cross-functional healthcare community, the first author of this chapter assumes that use cases of "IDC's Worldwide Digital Transformation Use Case Taxonomy, 2017: Healthcare," which were defined by IDC, should be applied in the context phase and assessment/architecture review phase as well as the defining phase of the AIDAF for new IoT projects in the healthcare community (Dunbrack et al. 2017; Ellis et al. 2017). According to (Dunbrack 2005et al. 2017; Ellis et al. 2017), the above use cases and digital missions in healthcare are based on the creation of value-based healthcare systems from sick care to healthcare management as shown in Fig. 9.2 above (Porter ).

## 9.4 Challenges in OHP2030

To address technological issues, we need to embody quality assurance methods such as reliability and security for a digital healthcare IoT platform, while implementing IoT demonstration systems in the field of digital healthcare.

From the standpoint of social issues, first, the commercialization of the above platform needs to be simplified by establishing collaborative platforms for IoT services. Second, for the purpose of grasping issues in terms of realizing IoT services/systems on the abovementioned platform, the IoT reference model capability index needs to be designed. Third, we will proceed with the international standardization of a digital healthcare IoT platform, while having discussions in conferences related to OHP2030 geared toward domestic and/or international organizations of research and development. In so doing, we will extensively understand these issues in terms of the

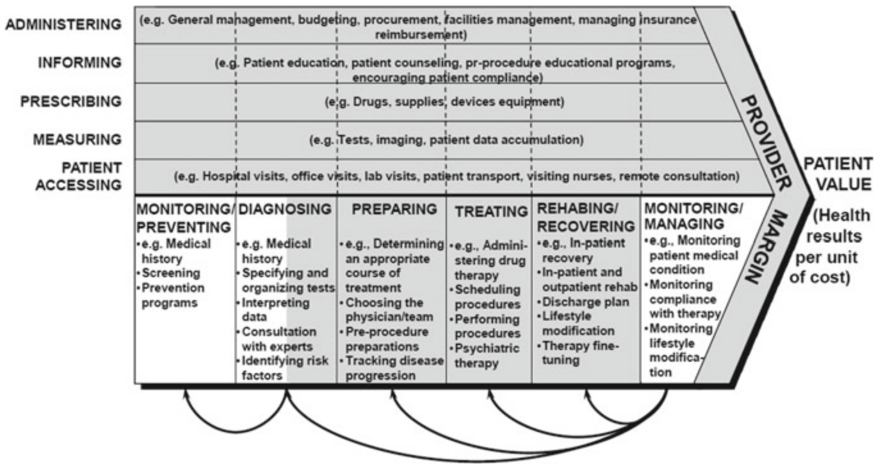


**Fig. 9.2** Healthcare delivery value chain for practice areas (*Source* Porter 2005)

social implementations for digital healthcare applications on the proposed platform (Masuda and Yamamoto 2018).

## 9.5 Final Thoughts for OHP2030

In this chapter, we have described our vision for the collaborative research initiative of OHP2030. This research initiative aims at an exploration and definition of a digital healthcare IoT platform in the middleware layer and above. Can we define and implement a digital platform, in healthcare communities, that can promote and support digital healthcare-related IoT applications, while ensuring information security? (Masuda and Yamamoto 2018).

### Notes

(1) A simple EA (framework) is a simple mid- to long-term perspective EA structure composed of EA principles, EA processes, and EA deliverables (target architecture, roadmaps, etc.).

### Questions and Exercises

1. Describe how IoT-related systems can be reviewed in Adaptive EA cycle in the AIDAF. Brief the necessary guidelines and deliverables for the above reviews and problems in this case.
2. Describe how policies of security and privacy can be applied for IoT-related systems with the AIDAF.

3. A large chemical company develops and promotes the Digital IT strategy focusing on IoT field. This company aims at business growth as well as operational efficiencies by architecting and deploying IoT services. This chemical enterprise consists of departments such as sales and marketing, finance, manufacturing, supply chain, research and development, and external affiliate organizations. Describe how AIDAF can be applied in this case.

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