DESIGNING AN INFORMATION SYSTEM INTEGRATION ENTERPRISE ARCHITECTURE WITH THE TOGAF FRAMEWORK IN THE OIL AND GAS BUSINESS UNIT CASE STUDY: PT PWS

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ABSTRACT

PT. Pacific Well Services (PWS) was originally a service company for upstream oil and gas activities. As time went on, PWS changed its function to become an oil and gas field management company. The current problem is that the data system in PWS is still not standardized and manual, resulting in difficulty in consolidation and information. Besides, along with the increasing number of business units at PWS, data management is getting higher.Many applications are used in data processing and management at PWS, but the information generated is not integrated with a container, so management requires various teams to summarize these results to assess company performance, portfolios, and other decisions.The purpose is to design an Enterprise Architecture (EA) system that can summarize and integrate data of various sources to meet company management needs. In building an EA design based on The Open Group Architecture Framework (TOGAF) with a system architecture design based on Service Oriented Architecture (SOA). The TOGAF framework is through (1) selection of the reference model, viewpoints, and tools; (2) creating a description of the current architecture (baseline architecture); (3) creating a description of the target architecture; (4) implementation of gap analysis; (5) determining the components of the roadmap proposal; (6) settlement of impacts across the architectural landscape; (7) formal stakeholder review; (8) finalize the architecture; and (9) making architectural definition documents. The research was conducted by interviewing the parties where the case studies were conducted, collecting data in the form of related documents such as technical documents, supply chain, administration, finance, legal, projects, portfolios, and other related documents.From this study can be concluded that (1) the resulting informatian system architecture will be used in PWS; (2) the solution implementation is proposed to be carried out in stages, starting with support activities and then the main activities to minimize risks that may harm the company's business operations; (3) Application of Data Warehouse and Business Intelligence is a solution to facilitate PWS to report and analyze information for internal and external company needs.

Keywords : *Information System Architecture, Upstream Oil, and Gas Industry*.

INTRODUCTION

Oil and gas investment has been going on for years, with many changes in prices and also domestic policies [1]. The use of oil and gas by consumers and industries that are not oil and gas industry accounts for 22% of world emissions [2]. Like in Canada, the oil and gas industry is proliferating as a contributor to greenhouse gas emissions [3]. Although Oil and Gas also have an impact on the environment, such as disturbing animal habitats and dumping oilfield waste [4]. Many are demanding companies to reduce soil damage, clean up contamination, replace and treat the land, and revive areas that have been used for oil and gas development [5]. It does not affect how the oil and gas business has become a competition between many countries in export and import, such as Saudi Arabia or the Persian region with India [6].

The world of Oil and Gas has evolved from the manual era to the computerized era. It is because technology has changed very much for only twenty-five years [7]. Meeting the needs of the energy sector, oil and gas, and electricity and nuclear require the help of computer technology or software today [8]. It relates to a complex economy and business influenced by the environment [9], including the era of computerization. Now the

communication relationship can use computers and machines [10] and what happens in the development of the world of Oil and Gas. Therefore, with the advancement of this era, companies' competitive advantages, including Oil and Gas, began to be affected [11] so that they must also develop according to the times.

Business in the upstream oil and gas sector has unpredictable characteristics [12]. It coupled with the increasingly intense competition between oil and gas businesses and other energy businesses such as coal, geothermal, and the booming new renewable energy. The world of oil and gas business players must adapt to these conditions. Modernizing, taking advantage of technological advances, and developing new technology and making efficiencies to survive [13]. PT PWS was a company that initially engaged in supporting services for upstream oil and gas activities. However, over time, PWS changed its function to become an oil and gas field management company that now manages onshore fields.

Various applications, from subsurface to selling point or final collection station before delivery to Pertamina or the buyer, include the following applications:

a) Various Geological, Geophysic, Reservoir (GGRE) Engineering Applications were developed to understand the natural processes (geology) working to form reservoir rock and the maturity process of fossils until they accumulate in a reservoir. It can simulate when it is produced for a specific time and predict future production. Provide drilling points with the most optimum production potential.
b) Applications to increase well production can simulate the production process of Oil and Gas wells, both natural products and using production assisted technology (Artificial Lift).
c) The application of production facilities, connecting from reservoirs, wells, production pipes, production facilities to production delivery points, is based on Pressure, Volume, and Composition changes.

Apart from engineering applications, applications for Supply Chain, Administration, and HR, Finance was also developed.

These applications stand alone so that management requires a team to summarize all of these results for management needs in assessing company performance and for portfolios and decisions on cooperation with other parties.

Most of the upstream oil and gas sector businesses still use manual reporting systems from various divisions/departments, even though they already have different information system applications. Reports to Management (Holding) are still compiled manually and take longer, have the potential for human error, and are less efficient.

The problems that occur in PWS are that data are stored in each department and sometimes stored individually so that storage often occurs by many people. Individual data storage is prone to duplication, not updating, data loss, and difficulties in the event of a replacement person or responsible employee.

Research cannot recommend a process flow that combines various data to produce the reports required by management from the existing problems.

Recommended Enterprise Architecture that can summarize multiple sources of data to meet management needs. By integrating various data from various applications and using AI technology, it is hoped to provide input, value, sensitivity, and potential hazards to management.

This research aims to build an enterprise architecture that can handle problems that fall within the research boundaries. The enterprise architecture approach also aims to improve organizational coordination and communication [14]. Enterprise architecture is also understood as an essential organization of a company as a socio-technical system and the principles of building design [15]. The problem to be solved is an application architecture that integrates data from various engineering applications and support applications.

The benefits of this research will be obtained from enterprise architecture to

overcome problems that have been defined. Furthermore, for the case study organization, enterprise architecture will be obtained, which is expected to support the business's progress and growth in the increasingly fierce competition.

The world of Oil and Gas has evolved from the manual era to the computerized era. The upstream oil and gas business has unpredictable characteristics. It is coupled with the increasingly intense competition between the oil and gas business and other energy businesses such as coal, geothermal and which are currently booming, namely New and Renewable Energy. So the world of oil and gas business actors must adapt to modernization and take advantage of technological advances in addition to developing new technology and making efficiency to survive.

One of the frameworks that can be used as the solution in this era is TOGAF. It is a short term of The Open Group Architecture Framework**.** This framework is one of the most regularly used frameworks by administrations or organizations around the world. This is because TOGAF has the openness principle which is believed that TOGAF will become the most used framework. Thus, because of that, TOGAF has been chosen as the framework to design the information system integration enterprise architecture in the oil and gas business unit of PT. PWS. Henceforward, TOGAF is explained latter on the next section of this paperwork.

LITERATURE REVIEW

Enterprise Architecture

Enterprise Architecture (EA) is the business processes' organizing logic and IT infrastructure, reflecting the integration and standardization needs of an enterprise operating model [16]. Meanwhile, what is meant by the operating model is the level required for integration and standardization of business processes to produce goods and services to customers [16]. Scholz explained that Enterprise Architecture (EA) builds a roadmap to achieve the company's mission through optimal performance of its main business processes in an efficient Information Technology (IT) environment, and policies that have been made in the best industry standards [17]. More specifically, Enterprise Architecture (EA) is a discipline for designing corporate architecture guided by principles, frameworks, methodologies, requirements, tools, reference models, and standards [18]. EA is also useful for identifying interoperability problems [19].

EA aims to optimize the pieces of prior processes (manual and automation) throughout the company into an integrated environment responsive to change and can support the implementation of the company's business strategy [20]. The steps in building and managing an EA [17] are:

1. Define the Operating Model
   Two main dimensions in the operating model are standardization and integration of business processes [16]. Standardization of business processes and associated systems means defining how exactly a process is executed regardless of who carries out the processor where it is executed [18]. Meanwhile, integration connects activities between organizational units through data that is shared (shared data). This sharing of data can be carried out between processes to enable the processing of the entire transaction, or throughout the process to present the same image to customers [21]. There are four types of operating models, namely: Unification (low level of standardization, low level of integration); Coordination (low standardization level, high integration level); Replication (high standardization level, low integration level); and Diversification (high level of standardization, high level of integration). Determination of an organization's operating model category can be identified through the answers to the following questions [16]: To what extent does the transaction in a business unit depend on the availability, accuracy, and freshness of data from other business units? This question is often referred to as integration needs; to what extent does the company benefit from having business units run its operations in the same way?

2. Implementing the Operating Model through Enterprise Architecture
   IT units generally describe four levels of architecture under EA [22], namely:
   1. Business process architecture (activities or tasks that make up the main business processes identified by business process owners)
   2. Data or information architecture (shared data definitions)
   3. Application architecture (each application used and its interface)
   4. Technology architecture (the infrastructure's services and technical standards).

3. Navigate the stages for the EA maturity level in the organization.
   The stages of the EA maturity level, namely:
   a. *Business Silos*, an organization seeks to maximize a business unit's needs or function within the organization.
   b. *Standardized Technology*, where IT is efficiently available in the organization through standardization of technology and, in most cases, through centralization of technology management.
   c. *Optimized Core*, where data and process standardization has been provided in all areas of the organization, aligns with the operating model.

The EA development process is achieved logically or in business terms (mission, business functions, information flow, and system environment) and technical terms (software, hardware, and communications). It involves sequential plans for the transition from initial to targeted conditions [17].

Internal factors

It is an approach to execute the company's strategy effectively, including optimization from the operational side. EA is described as managing the Enterprise (Figure 1). The top of the pyramid represents the company's vision and mission. They were then followed by corporate strategy. The company strategy contains steps to achieve the vision and mission. The strategy contains concrete goals that must be implemented. EA has the role of translating goals into operational activities [23]. EA provides an overview of current and planned operations and the steps that must be taken to achieve company goals.

Picture 7 *EA as management instruments*

External Factors

External factors are external influences, such as regulations and others.
In this case, IT architecture is defined as an integrated framework for developing or maintaining existing IT and acquiring new IT to achieve organizational strategic goals [23].

Enterprise Architecture Framework (EAF)

The Open Group Architecture Framework (TOGAF)

TOGAF is an architectural framework that provides supporting methods and tools, assisting in the acceptance, creation, and maintenance of an Enterprise Architecture [24]. Currently, TOGAF is one of the most frequently used frameworks by organizations around the world. Because of its openness principle, it is believed that TOGAF will become the most used framework [25].

Four architectural domains are generally accepted as part of the overall EA, which TOGAF is designed to support [24]:

1. Business Architecture defines the business strategy, governance, organization, and effective business processes.
2. Data Architecture describes the organization's structure's logical and

physical data assets and resources for data management.
3. Application Architecture provides a blueprint for each application to be deployed/deployed, as well as the interaction and relationship between these applications with the organization's primary business processes. Data and Application Architecture in the TOGAF framework is often referred to as Information System Architecture.
4. Technology architecture logically describes the capabilities of software and hardware required to support the installation/deployment of business services, data, and applications. It includes IT infrastructure, middleware, networking, communications, processing, standards, and etcetera.

Often an organization has limited time, funds, and human resources to build a top-down architecture that includes the four architectural domains in its implementation [25]. The methodology used in the TOGAF is the Architecture Development Method (ADM), which has a basic structure, as shown in the TOGAF Architecture Development Cycle (Figure 2).

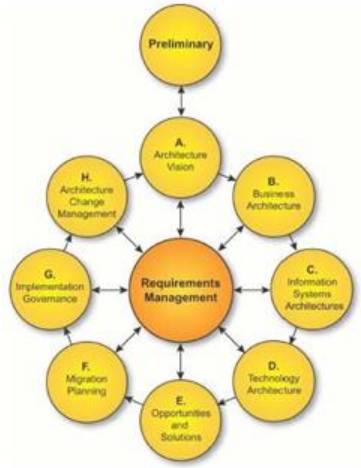

Figure 8 *TOGAF Architecture Development Cycle*

The steps to design a company's EA with the TOGAF framework for each ADM phase [25] are as follows:
1. Selection of the reference model (reference model), viewpoints, and tools
2. Creating a description of the current architecture (baseline architecture)
3. Creating a description of the target architecture (target architecture)
4. Implementation of gap analysis (gap analysis)
5. Determining the components of the roadmap proposal
6. Settlement of impacts across the architectural landscape
7. Formal stakeholder review
8. Finalize the architecture
9. Making Architectural Definition Documents

Zachman Framework

John Zachman wrote that in order to keep the business from disintegrating, the concept of information system architecture is no longer an option but rather a necessity [26]. Zachman's framework describes the classical architectural discipline to define and describe today's complex enterprise systems [27]. Zachman's framework is rated as one of the most prominent conceptualizations [28], which provides a holistic and descriptive representation of a company to provide input and understanding [29].

The Zachman framework's chart, in its simplest form, depicts design artifacts based on the perspective of the listener/audience. Namely Owner (final product recipient). Designer (technician, architect, who formulate data elements and functions needed in business processes). Builder (compilers of EA and determinants of the technology and materials required). Planner (the party that sets the EA preparation plan, determines its boundaries, costs, who is involved, and how EA relates to the environment in which it is implemented). And the Enterprise itself. As well as the abstraction of the product, namely What (material) / what makes it, How (process) / how does it work, Where (geometry) / where the components depend on each other, Who (operational instructions) / who does what work, When (timing diagram) / when something happens, and Why (engineering design objective) / why does something happen [27].

The Zachman Framework does not guide EA sequencing, process, or implementation. However, it focuses on ensuring that all views are appropriately constructed/implemented, and ensuring the system is complete, regardless of the sequence of implementation [30].

Federal Enterprise Architecture (FEA)

The Federal CIO Council publishes the Federal Enterprise Architecture Framework for building an EA within the Federal Agency or a system that transcends many federal agency boundaries [31]. The FEAF provides a reliable standard for constructing and documenting architectural descriptions for high priority areas. The FEAF mainly focuses on EAs for government agencies [32]. FEAF divides the given architecture into business, data, application, and technology architectures. The FEAF serves as a reference to facilitate efficient and effective coordination of business processes, technology implementation, information flow, systems, and investment among the Federal Agency. The FEAF provides a structure for building, managing, and implementing high-level operational environments, and supporting IT systems [31]. It is constructed through a collection of interrelated reference models to facilitate cross-agency analysis and identify duplicative investments and opportunities to collaborate with federal agencies [34]. Besides, the FEAF has rules on a holistic perspective that is respectfully better at guiding their survival [35].

Comparison between TOGAF, Zachman Framework, and FEA

For its application, the Zachman and TOGAF frameworks can be applied to various organizations, whereas the application of FEAF is more appropriate for government organizations [36]. Based on the standardization of terms used in the three frameworks' processes/activities, TOGAF is the only framework that establishes a clear standardization of terms for the phases/processes/activities. TOGAF, in its development, is considered the standard way of working to develop modern IT systems in companies [37] and the most trusted [38]. TOGAF also provides a broad framework that includes repositories, policies, and a recognized practice [39]. Based on the completeness and clarity of the phases/processes/activities in the three frameworks, TOGAF is a complete framework and clearly describes the phases/processes/activities. TOGAF is the framework chosen for the development of Information System Architecture at PT Pacific Well Services.

Service-Oriented Architecture (SOA)

SOA is an approach to build an IT system in the form of parts of software modules called services. The goal of SOA-based system development is for organizations to develop systems from simpler modules [26]. It is a fundamental architectural model that supports the paradigm of services computing from an architectural perspective [40]. SOA is also considered a new generation of software architecture and utilizes web services, XML, and other related technologies that provide working solutions for e-business implementations [41]. In other words, the real purpose of SOA is to help align IT capabilities with business goals [42] and improve corporate performance [43], although the process is not easy because SOA requires existing technology to be used to accomplish these tasks [44].

Internal Value Chain Analysis

Value chain analysis is a useful management tool [45] and one of the most popular today [46]. The value chain over the years has undergone development and innovation [47]. The value chain approach distinguishes two types of business activities: 1) Core activities, and 2) Supporting activities. Core activities are activities that play a role in the industrial value chain to meet customer needs. Supporting activities are needed to control and develop a business over time so that it will add value indirectly. The activities are inbound logistics, operations; outbound logistics; sales and marketing, and services [48].

RESEARCH METHODS

The research data is qualitative [49] obtained by carrying out two data collection

methods, namely: primary data by interviewing managers, supervisors, and staff in all fields that fall within the boundaries of the research. Also to the IT Manager. Secondary data with related documents in the form of documents related to research boundaries such as Technical documents, Supply Chain, Administration, Finance, Legal, Project Status and portfolios, and other related documents.

After the data collection phase is carried out, the next processes are Requirements for architecture work, which identifies the Oil and Gas needs according to the direction of the organization's vision, mission, and operations to develop EA by the organization's corporate culture. Furthermore, determining the architectural principles as needed to mapping the stakeholders involved and their roles and responsibilities [50].

Furthermore, an organizational, operational model representing the organization's business is created, taking the example of architectural modeling for large international oil and gas companies. Includes exploration, production, and support activities that fall within the research boundaries—followed by an information system architecture that includes data architecture and application architecture. Then technology architecture.

The next stage is problem identification [51], problem solution, and architectural vision in the form of a solution concept diagram to overview the target architecture. Continued by determining the information system architecture [52], technology architecture, and drawing conclusions and suggestions. This research was conducted following a research framework as follows:

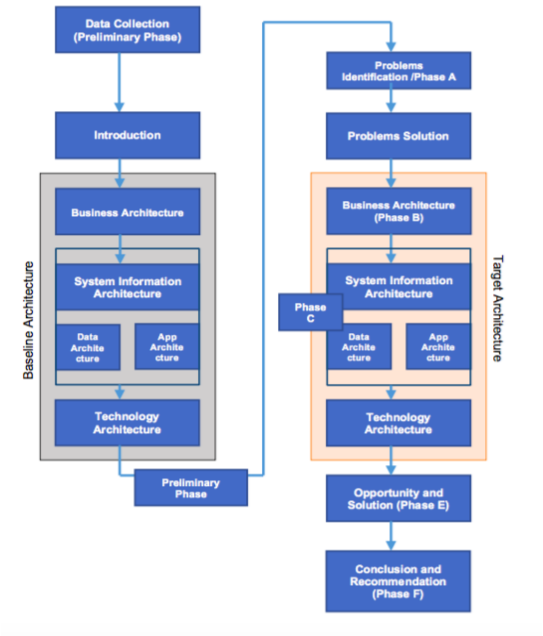

Figure 9 *Research Methodology*

FINDINGS AND DISCUSSION

From the results of data collection, procession, and analysis compiled the Information System, PWS Management Application Architecture, using the TOGAF framework.

Preliminary Phase

It contains architectural design preparation activities. The preliminary phase's input is a reference to the TOGAF framework [24], the organizational structure and main tasks of PWS Management, and the PWS ICT Strategic Program according to the direction and expectations of the PWS board of directors. This phase's process is through document/artifact review [53] to get an overview of the actual conditions and expectations of the company, determine the architectural design framework, and identify the principles of PWS Management architecture. It is mapping the strength/interest matrix of each stakeholder based on the Stakeholder Power Grid. The preliminary phase's result is a description of the company's condition, the EA framework, and architectural principles consisting of business principles, data principles, application principles, and technology principles.

Phase A - Architectural Vision

It contains activities to identify the architectural vision with input from the vision, mission, and strategic objectives of PWS, the company's main KPIs, the organizational structure and main tasks of each PWS function, and the principles of output architecture from the preliminary phase.

The process begins with the identification of stakeholders involved in the preparation of the EA [54]. Then it is mapped into a strength/interest matrix. This phase also results in value chain analysis at PWS. PWS's business functions are divided into main activities, such as exploration and exploitation, well drilling, field development, operation, and production. Supporting activities include management of internal audit, finance, performance, supply chain, human resources and relations, legal and health, safety, security, and environment (HSSE).

Phase B - Business Architecture

It contains activities to identify Business Architecture through architectural principles from the preliminary phase and the company value chain resulting from phase A. Identify the business processes at PWS, along with a description of whether the process has been automated or is still being run manually. Process identification and process modeling use a flow chart in the BPMN format. Identification of the Operations and Production business processes and their mapping against supporting applications that have been used in PWS, the Operation and Production process, the PWS Oil and Gas Delivery and Sales Process, Supply Chain Management and the mapping of supporting applications, the Procurement Process, the Logistics Management Process & Marine.

Phase B produces outputs such as Functional Decomposition Diagram, describing the decomposition of the primary and supporting activity processes in PWS, based on BIS1 Business Principles - Maximizing Benefits for the Company and Parent Company, and BIS2 - Common Use of Applications.

Phase C - Information Systems Architecture

In Phase C - Information System Architecture, identification of the current information system architecture (baseline architecture), making the targeted information system architecture (target architecture), implementing gap analysis, and modeling the solution based on Architectural Principles, which is the output of Preliminary phase. Face C also uses business architecture input from phase B and a list of applications in PWS.

The output of phase C is an application architecture with 1) As-Is Application Landscape, which describes the current application architecture (baseline architecture) in PWS based on mapping each application to the main activities and supporting activities. 2) To-Be Application Landscape describes the target application architecture (target architecture) in PWS based on the mapping of each application to the main activities and supporting activities. Twenty-eight applications to support the main activity, 34 applications to support supporting activities, and five applications to support all activities. Each application will be used on the PWS collectively, without duplication, per BIS2's Business Principles, namely Common Use of Applications.

In addition to the application architecture, the output of phase C is also a data architecture where 1) As-Is Data Landscape, which describes the current data architecture (baseline architecture) in PWS based on mapping to the main activities and supporting activities of the company. 2) To-Be Data Landscape describes the target data architecture in PWS based on the data structure and mapping it to its primary and supporting activities. The target data architecture is built according to the DAT1 Data Principle - Data to be Shared and DAT2 - Data Accessible.

Data consolidation is using the Data Warehouse concept. Data from ERP, business applications, petrotechnical applications, and data in the form of flat files in PWS are data sources that will be consolidated into the Data Warehouse by Extract, Transform, Loading (ETL) tools. Furthermore, the data is presented in the form of Dashboards, Analytical Reports,

and Static Reports for internal and external analysis and reporting purposes.

Phase E - Opportunities and Solutions

Activities to consolidate gap analysis from Phase B - Business Architecture and Phase C - Information Systems Architecture. Evaluation is carried out to formulate a suitable solution proposal to change the current architecture (baseline architecture) into a target architecture (target architecture). The phase E analysis process uses a business architecture gap matrix, an application architecture gap matrix, and a data architecture gap matrix. This phase's output is 1) Business Architecture Solution, where business process standardization at PWS by evaluating each existing business process. Automation of processes that are still done manually through priority setting, and preparation of Work System (Guidelines and Procedures) for development applications to regulate application development mechanisms to be well-coordinated under the ICT function. 2) Application Architecture solutions are determining technology specifications that will be used as standards in application development at PWS. Determining quality objectives for PWS applications includes functionality, reliability, ease of use, efficiency, ease of maintenance, portable, and application standardization at PWS to support activities the same. The standardization process goes through the stages of application upgrades. Deactivating applications after the replacement applications are ready for use. As well as implementing new applications that can be off-the-shelf/commercial applications. 3) Data Architecture Solutions in the form of mapping and standardization of attributes and formats of each existing data entity, Integrated Data Warehouse Development, and Business Intelligence applications at PWS, Policy development and application of data and application access rights settings for internal users and from the parent company, per the authority of each user, and Formulating policies and implementing data/information security by data security, infrastructure technology tools and systems, and all processes related to information management.

Phase F - Migration Planning

Long-term planning activities for the implementation and migration of solutions produced in Phase E. A process of prioritizing and estimating the implementation and migration implementation time of each architectural solution is carried out with input data in the form of Business Architecture Targets and Solutions, Application Architecture Targets, and Solutions, and Target and Data Architecture Solutions. Phase E produces an output in the form of an Architectural Solution Migration Plan at PWS to ensure the implementation of Business Architecture, Data, and Application Targets. The PWS Architectural Solutions migration is planned to start in mid-2017 and finish by the end of 2021.

CONCLUSION

This study concludes as follows:

1. The resulting information system architecture will be used in PWS so that the proposed solutions' primary key is related to the standardization of business processes, applications, and data.
2. Considering the quite complex business processes at PWS, the solution's implementation is proposed to be carried out in stages, starting with support activities and then the main activities. It aims to minimize risks that may harm the company's business operations.
3. Application of Data Warehouse and Business Intelligence is a solution to facilitate PWS to report and analyze information for internal and external company needs.

Suggestions from researchers for companies and other parties involved in further research are as follows:

1. Continue phases D, G, and H to obtain a comprehensive Enterprise Architecture. Besides, iteration can be carried out to a more detailed process level to identify other proposed solutions that need to be added.
2. Validate the Information System Architecture produced in this study with

experts from internal and external companies.
3. Continue this research with other research to roll out the Information System Architecture design for other Business Units.
4. Conduct periodic reviews and updates of the Information System Architecture to ensure the architecture conforms to the latest business goals and needs.

REFERENCES

[1] P. VÃsquez, "Tracing Oil- and Gas-Related Conflicts," in *Oil Sparks in the Amazon: Local Conflicts, Indigenous Populations, and Natural Resources*, Athens; London, University of Georgia Press, 2014, pp. 11-35.

[2] S. Naimoli and S. Ladislaw, "Oil and Gas Industry Engagement on Climate Change: Drivers, Actions, and Path Forward," Center for Strategic and International Studies (CSIS). doi:10.2307/resrep23551.5, 2019.

[3] A. Taylor, M. Bramley, and M. Winfield, Government Spending on Canada's Oil and Gas Industry: Undermining Canada's Kyoto Commitment, Pembina Institute, 2005.

[4] A. Taylor, C. Severson-Baker, M. Winfield, D. Woynillowicz and M. Griffiths, When the Government is the Landlord: Economic Rent, Non-renewable Permanent Funds, and Environmental Impacts Related to Oil and Gas Developments in Canada, Pembina Institute, 2004.

[5] D. Bennet, G. Gilchrist, L. DePauw, P. Dobbie, P. Eggers, R. Anderson, and J. . . . McNeill, "Landowners Primer: What You Need to Know About Unreclaimed Oil and Gas Wells," Pembina Institute. doi:10.2307/resrep22102.5, 2019.

[6] J. Seznec and R. Pallakonda, "India's Energy Needs and the Arab/Persian Gulf," Atlantic Council, 2017.

[7] J. Kelly, "Technology: The Era of Answers," in *In Morson G. & Schapiro M. (Eds.), The Fabulous Future?: America and the World in 2040*, Evanston, Illinois, Northwestern University Press, 2015, pp. 113-128.

[8] B. Woods and A. Bochman, "Supply Chain in the Software Era," Atlantic Council, 2018.

[9] S. M. Rinaldi, "Beyond the Industrial Web: Economic Synergies and Targeting Methodologies," Air University Press, 1995.

[10] S. Even and D. Siman-Tov, "Cyber Warfare: Concepts and Strategic Trends," Institute for National Security Studies, 2012.

[11] J. Strakova, I. Rajiani, P. Partlova, J. Vachal, and J. Dobrovic, "Use of the Value Chain in the Process of Generating a *Sustainability,"* vol. 12, no. 1520 doi:10.3390/su12041520, pp. 1-15, 2020.

[12] SKK MIGAS, "Exploration, beginning of natural oil and gas entrepreneur activity," [Online]. Available: http://www.skkmigas.go.id/: http://www.skkmigas.go.id/eksplorasi-awal-kegiatan-usaha-hulu-minyak-dan-gas-bumi. [Accessed 8 September, 2015].

[13] R. Yuliana and B. Rahardjo, "Designing an agile enterprise architecture for mining company," in *International Conference on Cyber and IT Service Management*, 2016.

[14] R. Abraham, "Enterprise Architecture Artifacts as Boundary Objects - A Framework of Properties," in *21st European Conference on Information Systems (ECIS)*, Utrecht, Netherlands, 2013.

[15] F. Ahlemann, E. Stettiner, M. Messerschmidt, and C. Legner, 12. Strategic Enterprise Architecture Management: Challenges, Best Practices, and Future Developments, Berlin, Germany: Springer Science & Business Media, 2012.

[16] J. Ross, P. Weill, and D. Robertson, Enterprise architecture as strategy, Boston: Harvard Business School Publishing, 2006.

[17] J. Scholz, Enterprise architecture and information assurance., Boca Raton, Florida: Taylor & Francis Group, LLC., 2013.

[18] P. Saha, Handbook of enterprise systems architecture in practice, IGI Global, 2007.

[19] V. Anaya and A. Ortiz, "How enterprise architectures can support integration," in *IHIS '05: Proceedings of the first international workshop on Interoperability of heterogeneous information systems*, https://doi.org/10.1145/1096967.1096973, 2005.

[20] The Open Group, "Part II - ADM," 2011. [Online]. Available: http://pubs.opengroup.org/architecture/togaf9- doc/arch/toc-pt2.html.

[21] K. Surendro, "Utilization of enterprise architecture planning for information system strategic planning," *Journal of Information*, 2007.

[22] M. Van Den Berg and M. Van Steenbergen, Building an enterprise architecture practice, Dordrecht: Springer, 2006.

[23] Institute of Electrical and Electronics Engineers, Inc., ISO/IEC/IEEE 42010 - Systems and software engineering - Architecture description, Geneva, Switzerland, 2011.

[24] The Open Group, "TOGAF Version 9.1.," in *Open Group Standard*, The Open Group, 2011.

[25] The Open Group, "Stakeholder Management," 2011. [Online]. Available: http://pubs.opengroup.org/architecture/togaf9- doc/arch/chap24.html.

[26] D. Minoli, Enterprise architecture a to z: frameworks, business process modeling, service-oriented architecture, and infrastructure technology, Boca Raton, Florida: Taylor & Francis Group, LLC., 2008.

[27] J. Zachman, "The framework for enterprise architecture: Background, description, and utility," 2016. [Online]. Available: https://www.zachman.com/resources/ea-articles-reference/327-the-framework-for-enterprise-architecture-background- description-and-utility-by-john-a-Zachman . [Accessed 14 October 2016].

[28] S. Ostadzadeh, F. Aliee, and S. Ostadzadeh, "A Method for Consistent Modeling of Zachman Framework Cells," in *Advances and Innovations in Systems, Computing Sciences and Software Engineering*, Springer, Dordrecht, 2007.

[29] A. Gerber, P. le Roux, C. Kearney, and A. van der Merwe, "The Zachman Framework for Enterprise Architecture: An Explanatory IS a Theory," in *attaining M., Matthee M., Smuts H., Pappas I., Dwivedi Y., Mäntymäki M. (eds) Responsible Design, Implementation and Use of Information and Communication Technology. I3E 2020. Lecture Notes in Computer Science, vol 12066.*, Springer, Cham. //doi.org/10.1007/978-3-030-44999-5_32, 2020.

[30] L. Urbaczewski and S. Mrdalj, "A comparison of enterprise architecture framework," *Issues in Information System*, 2006.

[31] Chief Information Officer Council, "A practical guide to federal enterprise architecture.," 2001.

[32] B. Rouhani, P. Nikfard, M. Mahrin, and F. Nikpay, "A comparison of enterprise architecture implementation methodologies," *2013 International Conference on Informatics and Creative Multimedia*, 2013.

[33] Y. Gong and M. Jansen, "The value of and myths about," *International Journal of Information Management*, vol. 46, no. https://doi.org/10.1016/j.ijinfomgt.2018.11.006, pp. 1-9, 2019.

[34] T. Bass and R. Mabry, "Enterprise Architecture Reference Models: A Shared Vision for Service-Oriented Architecture," in *IEEE MILCOM 2004*, 2004.

[35] B. Bellman and F. Rausch, "Enterprise Architecture for e-Government," in *Traunmüller R. (eds) Electronic Government. EGOV 2004. Lecture Notes in Computer Science, vol 3183*, Springer, Berlin, Heidelberg https://doi.org/10.1007/978-3-540-30078-6_9, 2004.

[36] F. Vernadat, "Interoperable enterprise systems: Architecture and methods," in *Plenary Lecture at 12th IFAC Symposium in Information Control Problems in Manufacturing*, 2006.

[37] J. Dietz and J. Hoogervorst, "A critical investigation of TOGAF - based on the enterprise engineering theory and practice," in *Albani A., Dietz J.L.G., Verelst J. (eds) Advance in Enterprise Engineering V. EEWC 2011. Lecture Notes in Business Information Processing, vol 79*, Springer, Berlin, Heidelberg, 2011.

[38] R. Alm and M. Wissotzki, "TOGAF Adaption for Small and Medium Enterprises," in *4th Workshop on Business and IT Alignment (BITA 2013)*, Poznań, Poland, 2013.

[39] P. Desfray and G. Raymond, Modeling Enterprise Architecture with TOGAF: A Practical Guide Using UML and BPMN, San Fransisco, CA, United States: Morgan Kaufmann Publishers Inc., 2014.

[40] "Service-Oriented Architecture," in *Services Computing*, Springer, Berlin, Heidelberg https://doi.org/10.1007/978-3-540-38284-3_5, 2007.

[41] J. Bih, "Service-oriented architecture (SOA), a new paradigm to implement dynamic e-business solutions," *Ubiquity*, p. https://doi.org/10.1145/1162511.1159403, Agustus 2006.

[42] A. Seth, A. Singla, and H. Aggarwal, "Service-Oriented Architecture Adoption Trends: A Critical Survey. In: Parashar M., Kaushik D., Rana O.F., Samtaney R., Yang Y., Zomaya A. (eds) Contemporary Computing.," in *Communications in Computer and Information Science, vol 306*, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-32129-0_21, 2012.

[43] Sutarmin and D. P. Jatmiko, "Value chain analysis to improve corporate performance: a case study of," *Investment Management and Financial Innovations*, vol. 13, no. 3-1 doi:10.21511/imfi.13(3-1).2016.04, pp. 183-190, 2016.

[44] A. Maurizio, L. Girolami, and P. Jones, "EAI and SOA: factors and methods influence the integration of multiple ERP systems (in an SAP environment) to comply with the Sarbanes-Oxley Act," *Journal of Enterprise Information Management*, vol. 20, no. 1, pp. 14-31, 2007.

[45] K. Vattikoti and A. Razak, "CRITICAL EVALUATION OF VALUE CHAIN," *Academy of Strategic Management Journal*, vol. 17, no. 6, pp. 1-14, 2018.

[46] D. Kumar and R. PV, "Value Chain: A Conceptual Framework," *International Journal of Engineering and Management Sciences*, vol. 7, no. 1, pp. 74-77, 2016.

[47] F. Ricciotti, "From value chain to value network: a systematic literature review," *Management Review Quarterly*, vol. 70, no. https://doi.org/10.1007/s11301-019-00164-7, pp. 191-212, 2020.

[48] A. Vasconcelos, P. Sousa, and J. Tribolet, "Information system architectures: Representation, planning, and evaluation," *Systemics, Cybernetics and Informatics*, vol. 1, 2003.

[49] R. Yin, Qualitative research from start to finish, New York: The Guilford Press, 2011.

[50] M. Myers and D. Avison, Qualitative research in information systems: a reader, London: Sage Publications, 2002.

[51] W. Neuman, Social research methods, Boston: Allyn and Bacon, 2003.

[52] K. Laudon and J. Laudon, On Management information systems - managing the digital firm, Twelfth ed., Upper Saddle River, New Jersey: Prentice-Hall, 2012, p. 15.

[53] M. Hammersley, What is qualitative research? London: Bloomsbury, 2013.

[54] R. Boyatzis, Transforming qualitative information: Thematic analysis and code development., Thousand Oaks: Sage Publications. , 1998.