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Business Analysis Method for Constructing Business–AI Alignment Model

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Abstract

In this study, we consider the construction of a model for representing an artificial intelligence (AI) service system project. When developing a system using AI technologies to support a business task in a company, all project members from both business and IT divisions must have common understandings on the project before starting it. For this purpose, a business–IT alignment model for AI service systems is proposed as a business–AI alignment model. However, we need to substantiate this business–AI alignment model for each project, because it is a generic model. To address this problem, we propose a method for constructing the business–AI alignment model and apply it to a real project for developing an AI service system in a case study, and confirm that we can construct the project-specific business–AI alignment model–without support of data scientists.

Keywords: Artificial Intelligence; Business–IT Alignment; Enterprise Architecture; Business Process Analysis

1. Introduction

Many machine-learning-based artificial intelligence (AI) programming modules, such as text classification and image recognition, have been developed and made available as application programming interfaces (APIs). As a result, the use of AI technologies for practical business is now possible. When a system using these APIs is developed, the developers need not concern about the details of the machine-learning algorithms, and can use the module functions by simply preparing the training data required for the machine-learning programming module. In this study, we consider system development projects using AI technology APIs.

Business offices have started to incorporate AI technologies to support office-type activities, such as inquiry services that operators answer queries about business operations, products, and services or screen operations using documents. When AI technologies are applied to these activities, training data on the target business domain are collected.

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In such situations, knowledge of, or experience in, the domain is essential; therefore, members from the business division are required to participate in the project.

New features in AI system development projects present many challenges in the requirement, design, implementation, and test phases. Usually, we implement the proof-of-concept (PoC) system to assess these new features to the applied business. In this study, we focus on the project design phase before starting such a PoC project and consider a consensus of the AI system development project between the business and IT divisions. A common understanding of an IT system between the business and IT divisions is important to maximize the return on IT investment and is a challenge of the business-IT alignment.

As mentioned above, projects encounter numerous points of contention and technical challenges when AI service systems are being developed[1]. There are nine reasons why machine-learning projects fail [1]. Among the nine reasons given, the following are project management-related issues.

1. Asking the wrong questions
2. Trying to use AI to solve the wrong problems
3. Not having suitable data

These problems can be solved during the project's planning phase if project members from both business and IT divisions have common understandings of the project.

In this study, we consider the construction of a model representing projects that develop AI service systems, so that all stakeholders from both the business and IT divisions can understand the project from their own perspectives. For such a purpose, the business–IT alignment model can be used and the model for AI service systems is proposed [13]. However, to apply the model, we need to substantiate it and construct a project-specific model. To address this problem, we propose a method for constructing a business–IT alignment model for AI service systems. In this method, we introduce business analysis tables by extending the tables used in the requirement analysis and business modeling, and propose steps for the model construction.

The remainder of this paper is structured as follows. In Section 2, we describe the related work. In Section 3, we introduce the AI service system and the business–AI alignment model, and describe the research hypothesis proposed in this study. In Section 4, we explain our proposed method for constructing the business–AI alignment model. In Section 5, we present a case study of the proposed method. After the discussion in Section 6, we summarize the key points and future work in Section 7.

2. Related Work

In this study, we consider a model representing a project developing an AI service system. It is noted that an architecture for representing a whole system is needed in a practical project applying big data analytics or machine-learning technologies[4], and some architectures for development teams have been proposed[3][6]. Although an architecture containing related business elements has been proposed[5], it does not contain business goals for each stakeholder. Therefore, it is difficult to use these architectures for a discussion between the business and IT organizations. In addition, few studies have been conducted on the assessment of an AI system development project itself. In [8], it was proposed that some system evaluation issues should be solved when realizing prediction algorithms such as machine-learning technologies as a practical social system. In particular, it is important to assess a project by combining the business goal, the business process, and the developed application. However, for AI system development projects, such multiviewpoint evaluation methods have not been introduced yet.

In enterprise system management, business–IT alignment is introduced, where relations among the business goal, business process, and IT system are defined. Business–IT alignment is used to discuss an IT system between business and IT organizations, to decrease organization uncertainty and improve enterprise agility [18]. Some methods for constructing a business–IT alignment model by an enterprise architecture (EA) modeling approach were introduced in [7][11].

[1] https://www.kdnuggets.com/2018/07/why-machine-learning-project-fail.html

To promote the business–IT alignment approach in practice, it is important to prepare generic models for each application domain or each industry. For example, generic models for business–IT alignment by EA were proposed in the IT system operation management domain[15] and IT system risk management domain[10]. In the health insurance industry, a business IT alignment model for an insurance system was proposed and used to discuss the digital transformation of the insurance system[2]. However, in these models, information on the business goal or the stakeholders is not represented, and thus, it is difficult to discuss an IT system from a higher business management viewpoint.

A model representing relations among goals for each stakeholder, services, and business objects in the healthcare industry was proposed in[17]. In the study, the model is developed using ArchiMate, which is a common EA modeling language. It is expected that this model can be used for business IT alignment effectively. A business–AI alignment model represented by ArchiMate, for AI service systems, was proposed in [13]. However, in these studies, methods for constructing the models were not considered. Consequently, we consider that it is important to develop a method for constructing a project-specific business–AI alignment model from a generic model.

3. Subject of Research and Research Hypothesis

3.1. EA and AI Service System

In this study, we use ArchiMate[14] as an EA modeling language. To represent a project developing a system using AI technologies, we use three business concepts and three application concepts defined in ArchiMate, as follows.

- Business service: an explicitly defined exposed business behavior.
- Business process: a sequence of business behaviors achieving a specific outcome.
- Business object: a concept used within a particular business domain.
- Application service: an explicitly defined exposed application behavior.
- Application component: an encapsulation of application functionality aligned to the implementation structure.
- Data object: data structured for automated processing.

Through this EA modeling approach, we represent a practical AI service system project in which we develop a system containing AI technologies for an enterprise function. In an office, employees conduct various intelligent activities. There are three types of human intelligence: analytical intelligence, creative intelligence, and practical intelligence[12]. In our study, we consider developing a system with analytical intelligence for offices that supports human activities or is their substitute.

Analytical intelligence selects an optimal option from predefined ones as output for the given input data[12]. In an office, this intelligence is used in daily activities, such as inquiry services for service queries or business assessment based on documents. We can use machine-learning technologies when we realize this intelligence as a software system. To use machine-learning technology for system development, we need to define options in the target business domain and collect example inputs assumed for each option. A machine-learning model is generated (Training) from training data containing such pairs of options and examples. This model is deployed into a runtime machine-learning engine, which obtains input data and provides output data using the model (Prediction). This system, called the AI service system, is illustrated using the EA modeling approach in Figure 1.

3.2. Business–AI Alignment Model

By using the elements and relations defined in previous sections, we can introduce an EA-based modeling method for representing business AI alignment. Figure 2 shows the proposed generic EA for the AI system development project described by ArchiMate[13]. In real projects, data scientists should have a deep domain knowledge. IT venders sometimes play the same role as that of IT division and develop an AI system. In such a project, data scientists with target domain knowledge will be participated from the IT vender. Therefore, in this generic model, a data scientist is assigned to the IT division.

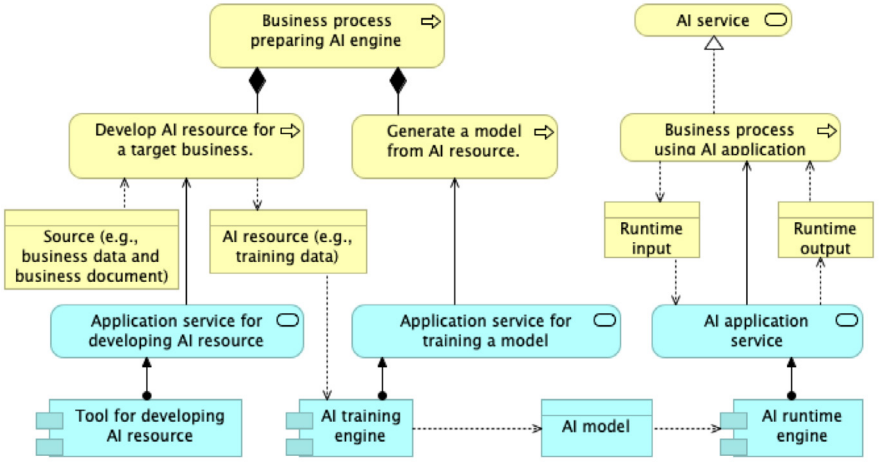

Fig. 1. AI service system represented by ArchiMate

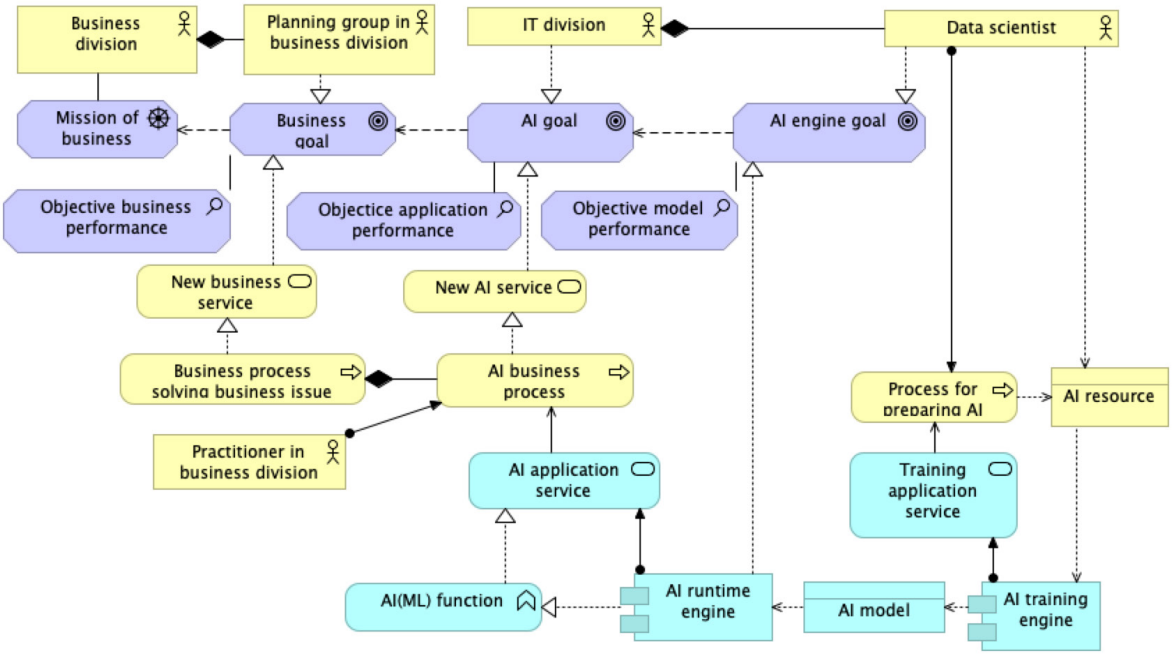

Fig. 2. Generic business–AI alignment model

3.3. Research Hypothesis

The business–AI alignment model described in Figure 2 is a generic model. Therefore, we need to substantiate this model when starting a project developing an AI service system in the business domain. To construct a project-specific model from the generic model, the data scientists are required to discuss with the practitioners in the business division. However, we cannot expect sufficient support from data scientists at an early project-planning stage, because of the issue of human resources[9]. In this situation, members in the project management team in the IT division construct a

project- specific model by collaborating with members from the business division. However, this activity depends on the skills and experience of the project management team.

In this study, we propose a method for constructing a project-specific business–AI alignment model. We define three new tables based on the existing tables used in the requirements analysis and business modeling, and propose a business analysis method using these tables. In a case study, we apply the proposed method to a real project and confirm the following:

- Project-specific business–AI alignment model can be constructed through the business analysis.
- Project members can construct a project-specific model without deep knowledge on AI technologies.

4. Proposed Method

4.1. Business Analysis Tables

In requirement modeling, a table containing concerns, problematic situations, cause analysis, target system to be developed, and solution is proposed to analyze the business under consideration[16]. Based on this table, we define a table, called the initial problem analysis table, as shown in Table 1. Here, we analyze a business in which we apply AI technologies from two viewpoints: business level and service design level. Through the business analysis, we fill the blank cells (A-①, ⋯, A-⑤) in this table.

Table 1. Initial problem analysis table for AI service systems

	Business level	Service design level
Actor	Business division	Planning group in business division
Problematic situation	A-①	
To-be situation		A-②
Cause analysis		A-③
Implemented solution		A-④
Implemented method		A-⑤

In [17], the actor, service, objects, means, and goal (ASOMG) are identified as key elements for representing a business service. Therefore, the ASOMG table is introduced to design business models. We extend the ASOMG table and define a new table, called ASOGA table, as shown in Table 2, where the actor, service, objects, goal (key success factor; KSF), and assessment (ASOGA) are defined as key elements for AI service systems. Using the information presented in the initial problem analysis table, we analyze the implemented solution from three viewpoints, user level, service design level, and AI service design level, and fill the blank cells (B-①, ⋯, B-⑪). By using the initial problem

Table 2. ASOGA table for AI service systems

Elements	User level	Service design level	AI service design level
Actor (A)	Planning group in business division	IT division (PM)	Data scientist
Service(S)	B-①	B-④	B-⑧
Object (O)		B-⑤	B-⑨
KSF(G)	B-②	B-⑥	B-⑩
Assessment (A)	B-③	B-⑦	B-⑪

analysis table and the ASOGA table, we additionally analyze the business in which AI technologies are applied from two other viewpoints: application design level and AI engine design level. We add two columns to the initial problem

analysis table and define an extended problem analysis table, as shown in Table 3. In this table, we fill the blank cell (C-①, ⋯, C-⑧) with the cell values in the ASOGA table.

Table 3. Extended problem analysis table for AI service systems

	Business level	Service design level	Application design level	AI engine design level
Actor	Business division	Planning group in business division	IT division (PM)	Data scientist
Problematic situation	A-①			
To-be situation		A-②	C-①	C-⑤
Cause analysis		A-③	C-②	C-⑥
Implemented solution		A-④	C-③	C-⑦
Implemented method		A-⑤	C-④	C-⑧

4.2. Model Construction Method

The business analysis for constructing a project-specific business–AI alignment model comprises the following three parts.

Part A Fill the cells in the initial problem analysis table by analyzing the business in which we will apply AI technologies.
Part B Fill the cells in the ASOGA table with features of the possible solution based on the initial problem analysis table.
Part C Fill the cells in the extended problem analysis table based on the ASOGA table.
Part D Map the cell elements in the extended problem analysis table and the ASOG table to the corresponding elements in the generic business–AI alignment model.

Figure 3 represents an overview of this analysis flow.

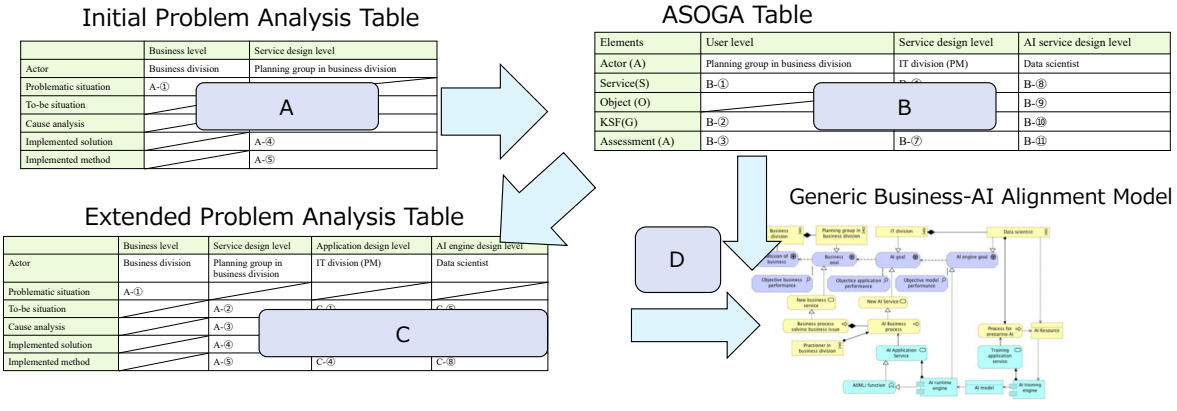

Fig. 3. Overview of the business analysis flow

In part A, we fill the cells in the initial problem analysis table through the flowing steps.

1. Describe the mission of the business division. (A-①)
2. Describe the business goal required in the business division. (A-②)
3. Describe how practitioners in the business division can assess the achievement of the business goal. (A-③)

4. Define a new business service name for realizing the business goal. (A-④)
5. Define a new business process name for realizing the business goal. (A-⑤)

In part B, we fill the cells in the ASOGA table through the following steps.

1. Set the business service name in the initial problem analysis table. (B-①)
2. Set the business goal in the initial problem analysis table as KSF. (B-②)
3. Set the assessment metric for the business goal derived in the initial problem analysis table. (B-③)
4. Through a discussion with members in the planning group in the business division, identify a new business service and new business process that contribute to the business goal, by using AI technologies. If there are some candidate services, select one of them. (B-④)
5. Define input and output for the identified new business service. (B-⑤)
6. Describe the goal of the new AI-embedded business service (e.g., AI goal). (B-⑥)
7. Describe how the planning group in the business division can assess the achievement of the AI goal. (B-⑦)
8. Assess whether AI technologies can be applied to the new business process.
   - yes: Define a new application service name as well as the applied AI engine. (B-⑧)
   - no: Go back to step 4.
9. Describe the resource (e.g., training data) required for the AI engine. (B-⑨)
10. Describe the goal of the AI engine (e.g., AI engine goal). (B-⑩)
11. Describe how the members in the IT division can assess the achievement of the AI engine goal. (B-⑪)

In part C, we fill the cells in the new columns in the extended problem analysis table with the cell values in the ASOGA table. Then, we map the cell values in the ASOGA table and the problem analysis table extended to the generic business–AI alignment model.

5. Case Study

5.1. Subject Project

In this section, we describe the application of our proposed method to a real AI service system development project and the creation of a business–AI alignment model for the project. We consider the overseas transmittance business in a bank as a project where an AI technology is applied.

In a major Japanese bank, there are more than 10,000 transactions in the overseas remittance (OR) business each month. For each transaction, practitioners need to understand the recipient from the natural-language text in the application document and determine the destination information on the basis of the bank's own business rules. In the OR business division, one of the business goals is to reduce the cost. Thus, we consider a solution using an AI service system.

5.2. Result

The OR business is conducted in the foreign exchange business division. From this, the actors considered in the business and service design level views are determined. By following the steps in part A, we can obtain the initial problem analysis table as shown in Table 4

Next, we consider the cells in the ASOGA table by following the steps in part B. Here, there are some candidate solutions for reducing the average time for an OR business transaction. From these candidates, we select a destination decision service and derive that we can use a machine-learning-based named entity extraction (NE Ext) technology. Through these analysis, we can obtain the ASOGA table shown in Table 5.

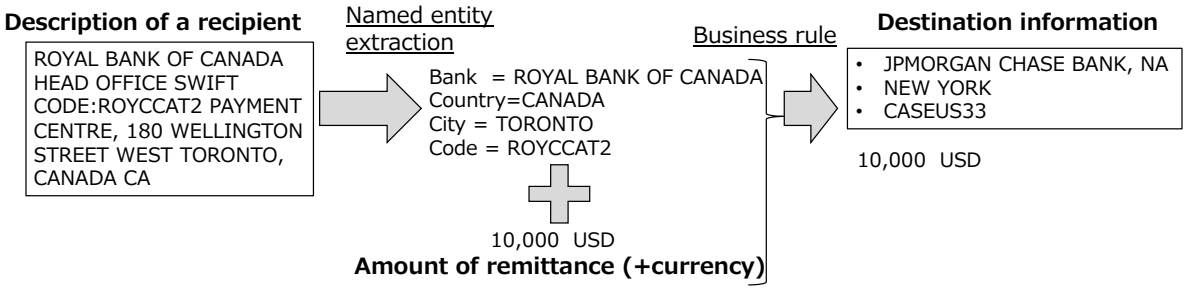

Fig. 4. Determining the destination in the OR business

Table 4. Constructed initial problem analysis table

	Business level	Service design level
Actor	Foreign exchange (FE) business division	Planning group in FE business division
Problematic situation	Overseas remittance (OR) business	
To-be situation		Business cost reduction
Cause analysis		Average time for an OR business transaction
Implemented solution		New OR business service
Implemented method		New OR business process

Table 5. Constructed ASOGA table

Elements	User level	Service design level	AI service design level
Actor (A)	Planning group in FE business division	IT division (PM)	Data scientist
Service(S)	New OR business service (and new OR business process)	Destination decision service (and destination decision process)	Destination information extraction service (and NE extraction engine)
Object (O)		Input: destination of a recipient Output destination information	Training data for NE extraction
KSF(G)	Business cost reduction	Reducing time for destination determination	Automation of destination destination
Assessment (A)	Average time for an OR business transaction	Accuracy of estimated destination when using the service	Precision and recall on NE extraction

From the ASOGA table, we can fill the cells in the extended problem analysis table, as shown in Table 6. Finally, by mapping the cell values in the ASOGA table and the extended problem analysis table, we can construct the project-specific business–AI alignment model. Figure 5 shows the constructed business-AI alignment model.

6. Discussion

In the case study, we confirm that we can construct a project-specific business–AI alignment model from the generic model by using the proposed business analysis method, without requiring any support of data scientists in the business analysis. From this, we confirm the following two research hypotheses. In the case study, we briefly describe a destination information extraction service using the NE Ext technology for realizing the destination decision service from its input and output data, with some industry examples. When identifying such AI technologies for realizing new

Table 6. Constructed extended problem analysis table

	Business level	Service design level	Application design level	AI engine design level
Actor	Foreign exchange (FE) business division	Planning group in FE business division	IT division (PM)	Data scientist
Problematic situation	Oversea remittance (OR) business			
To-be situation		Business cost reduction	**Reducing time for destination determination**	**Automation of destination determination**
Cause analysis		Average time for an OR business transaction	**Accuracy of estimated destination when using the service**	**Precision and recall on NE extraction**
Implemented solution		New OR business service	**Destination decision service**	**Destination information extraction service**
Implemented method		New OR business process	**Destination decision process**	**NE extraction and NE extraction engine**

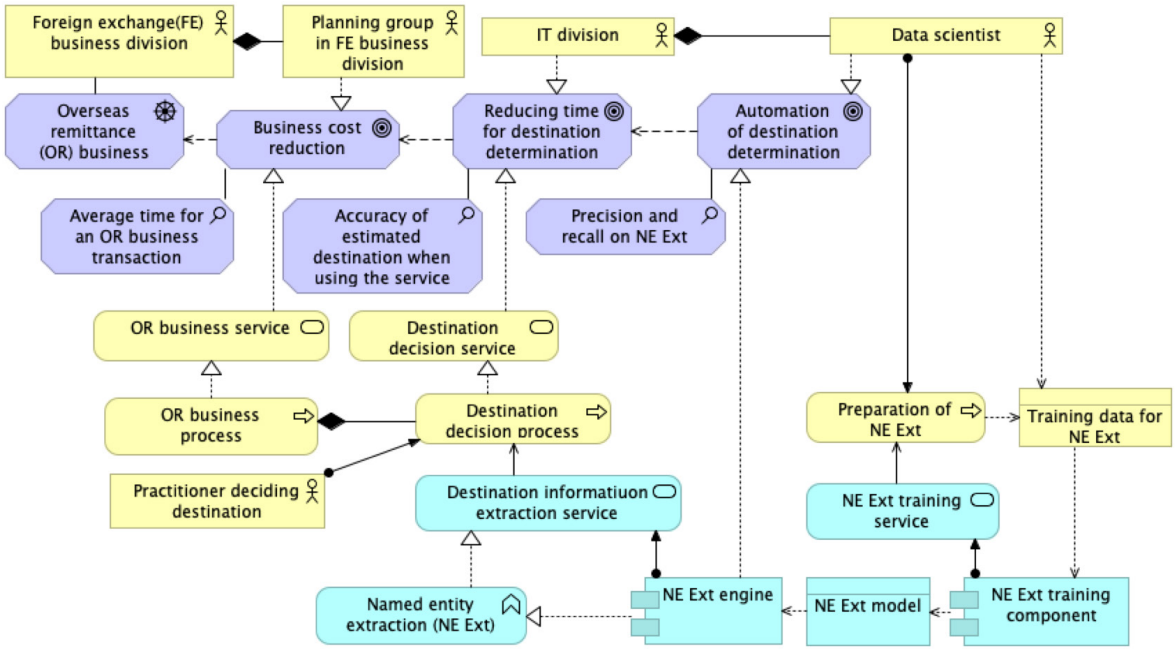

Fig. 5. Business–AI alignment model for the AI service system development project in the OR business

business services, we need to know their possible candidates and the capabilities in advance, for which we might need support of data scientists. This can be solved by preparing an AI technology catalog (e.g., API documents) with the input, output, and capability of each AI technology.

In the analysis using the ASOGA table, we need to identify the application service related to the KSF at the user level. In many cases, there are some candidate application services that are applicable to KSF. Such candidates contain both AI and non-AI application services and we need to select an appropriate one. To identify an application service for KSF at the use level, we need some selection rules based on the development cost or the degree of contribution to the business goal. To define such rules, we need to investigate the proposed method through application to real projects in various business domains. This is our future work.

7. Conclusion

In this study, we constructed a model for representing an AI service system project. For developing a system using AI technologies, to support a business task in a company, it is important that all project members from both business and IT divisions have common understanding of the project before starting it. For this purpose, a business–IT alignment model for AI service systems was proposed as a business–AI alignment model. However, we needed to substantiate this business–AI alignment model for each project because it is a generic model, and constructing a project-specific model from the generic model requires that data scientists discuss with the practitioners in the business division. To solve this problem, we proposed a method for constructing the business–AI alignment model. In this method, we introduced two types of problem analysis tables and ASOGA table by extending the existing business analysis table used in the requirement analysis and business modeling, and proposed steps for filling cells in these tables. In our case study, we applied the proposed method to a real project for developing an AI service system and confirmed that we can construct the project-specific business–AI alignment model without any support of data scientists. We need to investigate the effectiveness of the proposed method quantitively through some other project cases.

Acknowledgments

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References

[1] Amershi, S., Begel, A., Bird, C., Deliner, R., Gall, H., Kamar, E., Nushi, N.N.B., Zimmermann, T., 2019. Software engineering for machine learning: A case study, in: Proceedings of the 41st International Conference on Software Engineering, pp. 291 – 300.

[2] Degele, J., Hain, J., Kinitzki, V., Krauß, S., Kühfß, P., Sigle, N., 2017. Data architecture for digital health insurances, in: Proceedings of Digital Enterprise Computing (DEC), pp. 107–116.

[3] Demchenko, Y., de Last, C., Membrey, P., 2014. Defining architecture components of the big data ecosystem, in: Proceedings of the International Conference on Collaboration Technologies and Systems (CTS), pp. 104–112.

[4] Earley, S., 2015. Analytics, machine learning, and the internet of things. IEEE ITPro 17, 10–13.

[5] Geerdink, B., 2013. A reference architecture for big data solutions: Introducing a model to perform predictive analytics using big data technology, in: Proceedings of IEEE 8th International Conference for Internet Technology and Secured Transactions (ICITST), pp. 71–76.

[6] Heit, J., Liu, J., Shah, M., 2016. An architecture for the deployment of statistical models for the big data era, in: Proceedings of IEEE International Conference on Big Data, pp. 1377–1384.

[7] Hinkelmann, K., Gerber, A., Karagiannis, D., Thoenssen, B., van der Merwe, A., Woitsch, R., 2016. A new paradigm for the continuous alignment of business and it: Combining enterprise architecture modelling and enterprise ontology. Computers in Industry 79, 77–86.

[8] Hofman, J.M., Sharma, A., Watts, D.J., 2017. Prediction and explanation in social science. Science 355, 486–488.

[9] Kim, M., Zimmermann, T., DeLine, R., Begel, A., 2016. The emerging role of data scientists on software development teams, in: Proceedings of the 38th International Conference on Software Engineering, pp. 96–107.

[10] Mayer, N., Aubert, J., Grandry, E., Feltus, C., Goettelmann, E., Wieringa, R., 2018. An integrated conceptual model for information system security risk management supported by enterprise architecture management. Software & Systems Modeling , 1–28.

[11] Saat, J., Franke, U., Lagerström, R., Ekstedt, M., 2010. Enterprise architecture meta models for it/business alignment situations, in: Proceedings of the 14th IEEE International Enterprise Distributed Object Computing Conference, pp. 14–23.

[12] Sternberg, R.J., 1996. Successful Intelligence: How Practical and Creative Intelligence Determines Success in Life. Simon & Schuster.

[13] Takeuchi, H., Yamamoto, S., 2019. Business AI alignment modeling based on enterprise architecture, in: Proceedings of the 11th KES International Conference on Intelligent Decision Technologies (Springer Smart Innovation, Systems and Technologies vol. 143), pp. 155 – 165.

[14] The Open Group, 2013. ArchiMate 3.0.1 – A Pocket Guide. Van Haren Publishing.

[15] Vicente, M., Game, N., da Silva, M.M., 2013. A design theory nexus for situational enterprise architecture management, in: Proceedings of the 4th International Conference on Exploring Service Science, pp. 86–99.

[16] Yamamoto, S., Olayan, N.I., Fujieda, J., 2018a. e-healthcare service design using model based jobs theory, in: Proceedings of International Conference on Intelligent Interactive Multimedia Systems and Services(KES-IIMSS), pp. 198–207.

[17] Yamamoto, S., Olayan, N.I., Morisaki, S., 2018b. Using archimate to design e-health business models. ACTA Scientific Medical Sciences 2, 18–26.

[18] Zhang, M., Chen, H., Luo, A., 2018. A systematic review of business-it alignment research with enterprise architecture. IEEE Access 6, 18934–18944.