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Construction Model Generation Based on DEMO: Case Study of Telecommunication Industry in Indonesia

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Abstract

Enterprise engineering is a discipline aspect of an enterprise, including designing and modeling a system. To create a new system, we can perform manipulation of existing systems. A construction system can be decomposed into several subsystems, and those subsystems can be merged into another construction system. Construction of an enterprise can be represented by DEMO (Design & Engineering Methodology for Organizations), specifically DEMO Construction Model. This research attempts to demonstrate the process of construction model generation using DEMO, and also develops the criteria for submodels and merged models. This article applies a case study of telecommunication industry in Indonesia. By using this framework, one can gather several enterprise models and model them as construction models, generate submodels and create a pool of submodels, merge them to generate a new construction model.

Keywords

Construction Model, Generation, Manipulation, DEMO, Telecommunication Industry

1. Introduction

The competitive nature of business in this modern society leads to the necessity of business innovation to create a new business. To create a new, successful business, a deep and complete understanding of ontological aspect of enterprise as a system is necessary, aided by Enterprise Engineering. Enterprise Engineering (EE) is a discipline aspect of an enterprise, including designing and modeling a system [1]. Three major disciplines of EE are Enterprise Architecture, Enterprise Governance and Enterprise Ontology (EO). Of these, EO offers a set of notions, concepts, and a methodology on a Way of Thinking (WoT), a Way of Modeling (WoM), and a Way of Working (WoW) for understanding the construction of enterprises.

In order to conduct (re)design of an enterprise, an enterprise model is used to perform the (re)design prior to the implementation. To create a new system, we can perform manipulation of the construction of existing systems. Construction system of an enterprise can be represented by DEMO (Design & Engineering Methodology for Organizations) [2], and, to date, the only methodology available in EO. In particular, DEMO Construction Model as one of the aspect models of DEMO can be decomposed into several subsystems, and those subsystems can be merged into another construction system [3]. The manipulation, merging and decomposing DEMO Construction Model can be explained in algebraic notation [4], therefore it is possible to create a pool of submodels of construction models, and then merging them to create a new construction model. **Figure 1** illustrated the proposition.

To create a new construction model, we can modify the existing one by a process of (de)composition of a model, called manipulation, in line with enterprise engineering concept. A manipulation is performed using a formal set of rules. DEMO Construction Model can be manipulated, merged, or decomposed by using algebraic notation based on prior research ([3], further explained in [4]), making it possible to analyze and synthesize, or simply manipulate, construction models. They defined a model, a submodel as a part of the model, and the three basic operations (merge, complement, and digest). Given a global model, one can construct the family of all the submodels and the three basic operations. They also showed that those operations are closed on the domain, and that some

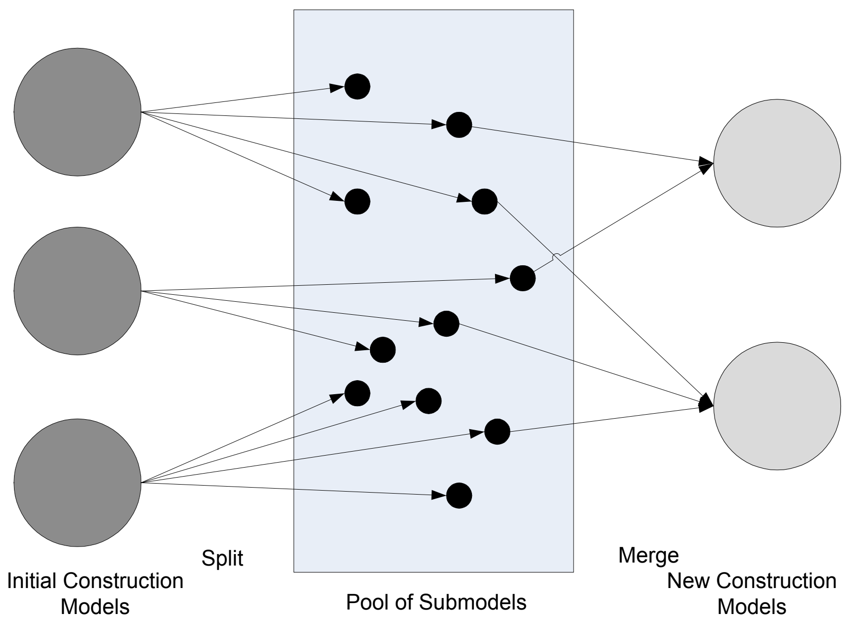


Figure 1. Illustration of model manipulation.

are commutative and associative. The advantage of this method is removing the necessity of model checking. A tool support for DEMO Construction Model was also developed [5], to provide functions to execute DEMO Construction Model manipulation without manual calculation.

Although the framework of DEMO Construction Model manipulation and tool support has been established, the practical application of this approach has not been intensively discussed. The ultimate objective of this research field is to minimize the aspect of craftsmanship in enterprise design, and bring enterprise engineering closer to design and/or engineering work for realizing agile enterprises [4]. However, the prior research lacks explanation of the criteria of submodel, related to the proposition of creating a pool of submodels and then merging them to create a new model. This leads to the following problems:

- The practicality of this approach is not verified.
- There is no clear definition or criteria of the submodel split from the existing model.
- The criteria for the applicable merged models also not yet established.

Hence, to address those problems, this study aims to demonstrate the process of construction model generation using DEMO Construction Model, and also develops the criteria for submodels and merged models. This article applies a case study of telecommunication industry in Indonesia, because there can be many construction models that can be captured in this industry. In Indonesia, business of telecommunication industry has developed rapidly [6]. Telecommunication companies in Indonesia have provided the best services, improving operational systems to improve their business performance [7]. [8] mentioned that the number of Internet users in Indonesia in 2016 reached 132.7 million peoples (about 51.8%), increased from 88.1 million in 2014.

This work will serve as a method of construction model generation and manipulation. By using this framework, one can gather several enterprise models and model them as construction models, generate submodels and create a pool of submodels, merge them to generate a new construction model in a certain industry.

This article aims to answer these following research questions to address the emerged problems:

1) How can we perform Construction Model Generation of Telecommunication industry?

2) What are the criteria of submodels split from the existing model?

3) What are the criteria for merged models to be applicable?

The remainder of this article is composed as follows. Section 2 will explain the literature review related to this work. Section 3 will explain the phase of the framework and proposed phases taken in each phase. The application of this framework in telecommunication industry will be mentioned in Section 4. Section 5 will cover the discussion of the result and the conclusion of this research will be given in Section 6.

2. Literature Review

2.1. DEMO Construction Model

DEMO can be described as *a meta-model for modeling organizations* [2]. DEMO Construction Model (CM), one of the aspect models of DEMO, is the most abstract aspect model and governs the rest of the aspect models [2] [4], therefore this article is focused on DEMO CM. DEMO CM indicates transaction kinds and actor roles associated with them and also information links between them, or in a simplified term, the construction of the organization [9]. A Transaction Kind represents coordination act/fact in a business conversation, and an Actor Role represents the initiator/executor of such coordination. CM is a part of four aspect models expressing the ontological knowledge of the target enterprise. The other aspect models are Process Model (PM), Action Model (AM), and Fact Model (FM), as depicted in **Figure 2**.

In this study, we only focus on the coordination part, or interaction model of CM of an organization, which contains **Actor Transaction Diagram (ATD)** which is part of Organization Construction Diagram (OCD), and **Transaction Product Table (TPT)**. These two composed the interaction structure of an organization [2]. **Figure 3** expresses an example of ATD and TPT of an organization, ATD on the upper left part and TPT on the lower left part of the figure, also legends of ATD on the right part. In this figure, we use an example of a simple retail shop that sells a product. ATD consists of Actor Roles and Transaction Kinds identified [10]. **Actor Role** defined as the unit of authority, responsibility, and competence of the system. **Transaction Kind** defined as a sequence of acts that comprises transaction patterns: *request*, *promise*, *declare*, and *accept*. An Actor Role can be an **initiator** and/or **executor** of a Transaction Kind. Actor Role can be classified as an **Elementary Actor Role**, an Actor Role that is the executor of one Transaction Kind, or a **Composite Actor Role**, composed by multiple Elementary Actor Roles. In ATD, Actor Roles are shown in a rectangle and transaction kinds depicted as a circle with diamond. A line connecting both

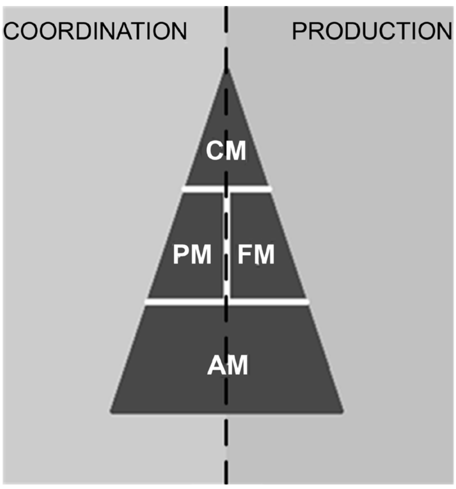
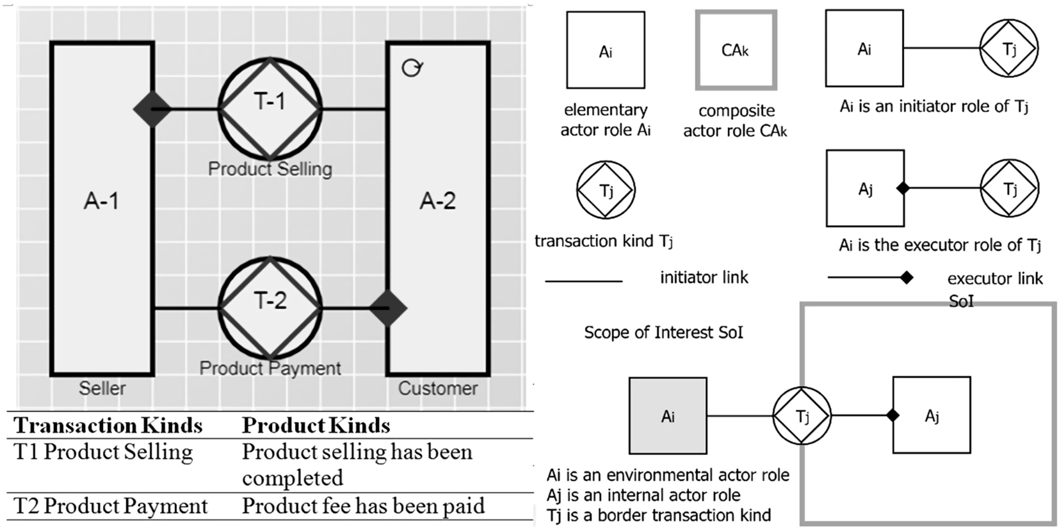


Figure 2. DEMO aspect model [9].



Transaction Kinds	Product Kinds
T1 Product Selling	Product selling has been completed
T2 Product Payment	Product fee has been paid

Figure 3. Example ATD and TPT of an organization. Legends of ATD excerpted from [10].

of them indicates there is a link: line without diamond indicates **initiator link**, and line with diamond indicates **executor link**. There can be a **Scope of Interest (SoI)** to divides the Actor Roles into environmental and internal Actor Role. A Transaction Kind lies within the border of SoI is called Border Transaction Kinds. TPT shows the transaction kinds and the product kind of each transaction kind.

Transaction kinds in DEMO CM may be related to each other. It is possible that a transaction kind, in practice, is inside the flow of another transaction kind, or in other words, belongs to a Transaction Tree [2]. Taking an example of **Figure 3**, in practice, Product Payment is part of Product Selling. To complete Product Selling, Product Payment must be completed. We call such transactions as Parent-Child Transactions.

DEMO Construction Model has been applied mainly in information system research, in particular, organizational ontology [11] [12] and business process [13] [14] [15].

2.2. Manipulation of DEMO Construction Model

DEMO Construction Model, with ATD as its representation, emphasizes clear coordination models so that it is possible to conduct manipulation of CM. In the literature, there exist several researches of DEMO application to solve practical problems, such as project [16], production [17], and even emergency management [18]. Among those researches, a series of research [19] [20] provides general guidelines of enterprise splitting and allying, using real cases with DEMO model, and tests the validity of designing enterprises in the real world via DEMO models.

[4] developed a formal specification of ATD and its submodels and defined algebraic operation as a means of model manipulation. They formalized the definition of a transaction kind $\boldsymbol{T}$, an actor role $\boldsymbol{A}$, a model $\langle \boldsymbol{A}, \boldsymbol{T} \rangle$, and a submodel

$\langle A', T' \rangle$. A tuple $\langle A, T \rangle$ is an ATD of DEMO CM if it satisfies these following conditions:

1) (Unique Actor Role Name Identification) If the names of two actor roles are equal, the two actor roles are the same;

2) (Unique Transaction Kind Name Identification) If the names of two transaction kinds are equal, the two transaction kinds are equal;

3) (Numbering Identification) The executor of a transaction kind gets the same number as the transaction kind;

4) (Closed ATD for Actor Role) All the actor roles responsible for a transaction kind included in the set of actor roles of the ATD;

5) (Actor Role Participation) For every actor role in the ATD, there is at least one transaction kind such that the actor role participates.

They also defined operators of CM manipulation. Given that $\langle A_x, T_x \rangle$ and $\langle A_y, T_y \rangle$ are the submodels of $\langle A, T \rangle$, there are three basic operators:

- Merge: The merger of two submodels $\langle A_x, T_x \rangle \nabla \langle A_y, T_y \rangle$ should produce a pair of every actor role and transaction kind $\langle A_x \cup A_y, T_x \cup T_y \rangle$ that are in at least one of the submodels;
- Complement: The complement of a submodel $\overline{\langle A_x, T_x \rangle}$ is the pair of actor roles and transaction kinds $\langle A_x, T_x \rangle$ that are part of model $\langle A, T \rangle$ which are not parts of that submodel;
- Digest: The digest of two submodels $\langle A_x, T_x \rangle \Delta \langle A_y, T_y \rangle$ is a pair of every actor role and transaction kind $\overline{\overline{\langle A_x, T_x \rangle} \nabla \overline{\langle A_y, T_y \rangle}}$ that is in both submodels.

They also showed that those operations are closed on the domain, and that some are commutative and associative. The advantage of this method is removing the necessity of model checking. A tool support for DEMO Construction Model was also developed [5], to provide functions to execute DEMO Construction Model manipulation without manual calculation. This tool is designed to automate the conversion between ATD of DEMO CM and mathematical objects, and the execution of computation so that users can input the CMs, perform manipulation operators, and then retrieve the results. Using this tool, users can focus on the manipulation itself rather than mathematical computation and translation.

3. Methodology

This section explains the framework of Construction Model Generation using split and merge operation to demonstrate the case study. The framework is illustrated in **Figure 4**.

To better understand this section, we introduced some related statements below. To understand deeply about construction of algebra, see [4]:

1) A model $\langle A, T \rangle$ is an instance of ATD containing a pair of set of actor roles A and transaction kinds T. A transaction kind $T \in T$ is described as $T = (A_{in}, A_{ex})$ with $A_{in}, A_{ex} \in A$ that represents initiator and executor for transaction kind T. For example in **Figure 5**, the model α is a model

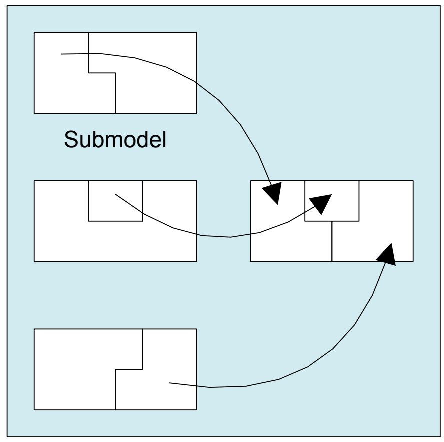


Figure 4. Construction Model Generation using split and merge operation.

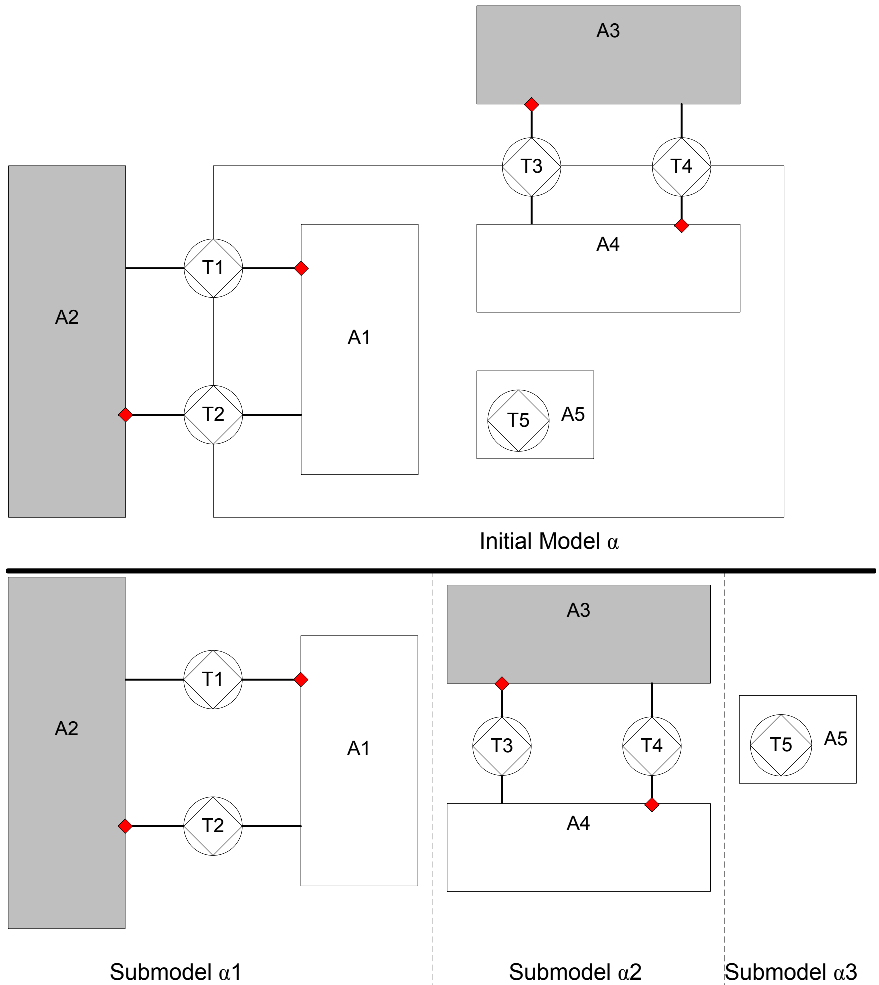


Figure 5. Model and submodel.

$\mathcal{M}_\alpha = \langle \{A_1, A_2, A_3, A_4, A_5\}, \{T_1, T_2, T_3, T_4, T_5\} \rangle$ in α contains actor roles and transaction kinds of ATD of model α, where $T_1 = (A_2, A_1)$, etc.

2) There is a set E consists of environmental actor roles, and a set B consists of border transaction kinds. For example in Figure 5, the environmental actor roles

are $E_a = \{A_2, A_3\}$ and the border transaction kinds are $B_a = \{T_1, T_2, T_3, T_4\}$.

3) All models of ATD must satisfy the following conditions:

a) (Unique Actor Role Name Identification) If the names of two actor roles are equal, the two actor roles are the same;

b) (Unique Transaction Kind Name Identification) If the names of two transaction kinds are equal, the two transaction kinds are equal;

c) (Numbering Identification) The executor of a transaction kind gets the same number as the transaction kind;

d) (Closed ATD for Actor Role) All the actor roles responsible for a transaction kind included in the set of actor roles of the ATD;

e) (Actor Role Participation) For every actor role in the ATD, there is at least one transaction kind such that the actor role participates.

4) A submodel of a model $\langle \boldsymbol{A}, \boldsymbol{T} \rangle$ is a pair of $\boldsymbol{A}' \subseteq \boldsymbol{A}$ and $\boldsymbol{T}' \subseteq \boldsymbol{T}$ satisfying the five conditions mentioned in 3). For example, submodel $\mathcal{M}_{\alpha 1} = \langle \{A_1, A_2\}, \{T_1, T_2\} \rangle$ in α is a submodel α_1 corresponds to model α consists of actor roles A_1 and A_2, and transaction kinds T_1 and T_2, as depicted in **Figure 5**.

5) In the split operation, we remove the system boundary line that defines the Scope of Interest (SoI) for the sake of simplicity in the specification of algebraic notation. In merge operation, we draw the system boundary based on the attribute of actor roles and transaction kinds that composed the merged model. In principle, a system boundary line should pass through border transaction kinds, and all environmental actor roles should be placed outside the system boundary.

Given the initial model $\langle \boldsymbol{A}, \boldsymbol{T} \rangle$, there are 3 phases to generate new CMs.

3.1. PHASE 1: Split Operation of the Initial CM to Create Submodels

In this phase, one or several initial models are split into several submodels. To maximize the effectiveness of the overall process, a submodel must also comply with some defined criteria. In addition to conditions stated in 3), a submodel resulting from split operation must also hold the following criteria:

1) Contains at least 1 transaction kind T and corresponding actor roles (initiator and executor) (A, A').

2) If there are Parent-Child Transactions, the submodel must contain all transaction kinds of such parent-child transactions and their respective actor roles.

3) To maximize the number of submodels, a submodel should be as simple as possible, *i.e.* contains the smallest possible number of transaction kinds, with their respective actor roles.

4) The submodels from the same given model should be mutually exclusive with each other, *i.e.* the *digest* of those submodels results in an empty set

$$\langle \boldsymbol{A}_x, \boldsymbol{T}_x \rangle \Delta \langle \boldsymbol{A}_y, \boldsymbol{T}_y \rangle = \varnothing . \quad (1)$$

A submodel can be classified into 3 categories:

a) Payment-Coupled Submodel: Parent-Child Transaction submodel that involves "payment" transaction kinds from a "customer" actor role denoted as **p-type** submodel;

b) Border Submodel: A submodel that has at least one border transaction kinds that do not involve "payment" transaction from a "customer" actor role denoted as **q-type** submodel;

c) No-border Submodel: A submodel that has no border transaction kinds denoted as **r-type** submodel.

If a submodel is able to be classified as Payment-Coupled Submodel, then it cannot be classified as Border Submodel or No-border Submodel, making the classification mutually exclusive with each other. Looking at Figure 4, if we assume that T_2 is Payment Transaction, then submodel α_1 is Payment-Coupled Submodel, submodel α_2 is Border Submodel, and submodel α_3 is a No-border Submodel.

To split a submodel from a model, we can follow these steps:

Step 1: Select pair of actor roles and transaction kinds complies with the Criteria 1, 2, and 3, and determine the *complement* of the submodel.

Step 2: Check the resulting complement whether it complies with the Criteria 1, 2, and 3. If it is, the complement also becomes a submodel. If not, repeat Step 1 using the resulted component.

The repeating process in Step 2 complies with the Criteria 4. Figure 5 also shows the split operation of initial model α. As mentioned, submodel $\mathcal{M}_{\alpha 1} = \langle \{A_1, A_2\}, \{T_1, T_2\} \rangle$ in α is a submodel α_1 corresponds to initial model α. After the submodels of several initial models are generated, a pool of submodels can be created.

3.2. PHASE 2: Merge Operation of Submodels

From pool of submodels, a new model can be formed. A new model $\langle \boldsymbol{A}^*, \boldsymbol{T}^* \rangle$ is the merged submodels of $\langle \boldsymbol{A}_1, \boldsymbol{T}_1 \rangle, \cdots, \langle \boldsymbol{A}_n, \boldsymbol{T}_n \rangle$ so that

$$\langle \boldsymbol{A}^*, \boldsymbol{T}^* \rangle = \langle \boldsymbol{A}_1, \boldsymbol{T}_1 \rangle \nabla \cdots \nabla \langle \boldsymbol{A}_n, \boldsymbol{T}_n \rangle = \langle \boldsymbol{A}_1 \cup \cdots \cup \boldsymbol{A}_n, \boldsymbol{T}_1 \cup \cdots \cup \boldsymbol{T}_n \rangle. \quad (2)$$

To find the possibility of a new model that is meaningful, the following criteria of a new model must be fulfilled:

1) There can be only one **p-type** submodel in a new model. A new model is meant to be a simple business model, therefore only one payment transaction is necessary.

2) New model cannot have **r-type** submodels. The new model focused on transaction between internal and environmental actor roles, therefore we exclude submodel without border transaction kinds.

3) The new model is composed of no more than 3 submodels. More combination of submodels means expanding the possibility of new models; too many combinations can make the new model selection become too complicated.

4) New model cannot be an element of a single initial model ($\boldsymbol{A}^* \subseteq \boldsymbol{A}$ and

$T^* \subseteq T$), as it will not be a new model if it is only a part of one initial model.

Using these criteria, new model consists of one **p-type** submodel and up to two **q-type** submodels. The possibility of new models depends on the number of combination of **p-type** and **q-type** submodels. If necessary, preliminary selection of submodels to be included in merge operation can be conducted to narrow down the possibility of non-meaningful models. Of course, it is possible to manually select those submodels and merge them to create a new, meaningful model. After the models are merged, draw system boundary line based on the attributes of actor roles and transaction kinds.

3.3. PHASE 3: Selection of New Models

After we found the number of possible submodels, selection of new models can be conducted. The previous phases only result in a set of possible new models, without regarding their meaningfulness and newness of the model. This can be done by examining the possible new models and determine the selection criteria; the criteria are different depends on the business context.

Depends on the amount of initial models gathered, and subsequently, the amount of submodels in a pool of submodel, the number of possible new models can be vary. Generally, the number of submodels and the number of possible new models will be higher. Checking the meaningfulness of a big number of possible new models can be exhausting; we need to filter out the non-meaningful model. This can be done by analyzing the submodels. We can filter out generic submodel that does not change the essence of the business and identical submodels. Cluster analysis on submodels can also help to analyze the submodels; a submodelis merged with another submodel from a distinctively different cluster may not form a meaningful model.

4. Case Study: Telecommunication Industry in Indonesia

This section demonstrates the case study of Telecommunication Industry in Indonesia. Telecommunication industry, or sector, consists of companies that makes communication possible through phone or Internet, allowing data in words, voice, audio or video to be sent anywhere in the world [21]. In this section, we present DEMO Construction Model of Indonesian Telecommunication Industry, then we conduct Construction Model Generation of Telecommunication Industry consists of the three phases explained in Section 3, showing one of the representative DEMO Construction Model as a case study.

4.1. DEMO Construction Model of Indonesian Telecommunication Industry

In this study, we captured six DEMO Construction Models as initial models from three Indonesian telecommunication companies. The CMs are captured from the existing business elements of the company, and represents telecommunication sector defined in [21]. The CMs captured are:

1) Mobile Internet Package: Provide mobile internet service;

2) Mobile Cash: Provide alternative payment through mobile;

3) SMS Banking: Provide banking transaction via SMS;

4) IoT Vending Machine Controller: Provide stock control for Vending Machine;

5) Video Package: Provide mobile movie video;

6) Home Internet: Provide home phone, internet, TV service.

For simplicity, this paper will only explain one of the captured CM: *Mobile Internet Package*, as one of the main business of Telecommunication Industry.

Mobile Internet Package

This is the standard mobile Internet package, to provide guaranteed mobile internet service. The TPT and ATD of Mobile Internet Package can be seen in Table 1 and Figure 6 respectively. The following is the description of Mobile Internet Package:

Table 1. Transaction product table of mobile internet package.

T No.	Transaction Kinds	Product Kinds
T01	Service activation	Service activation has been completed
T02	Service payment	Service fee has been paid
T03	Promotion	Promotion has been done
T04	Product consignment	Product consignment has been done
T05	Network management	Network management has been done
T06	Billing system management	Billing system management has been done
T07	Product development	Product development has been done

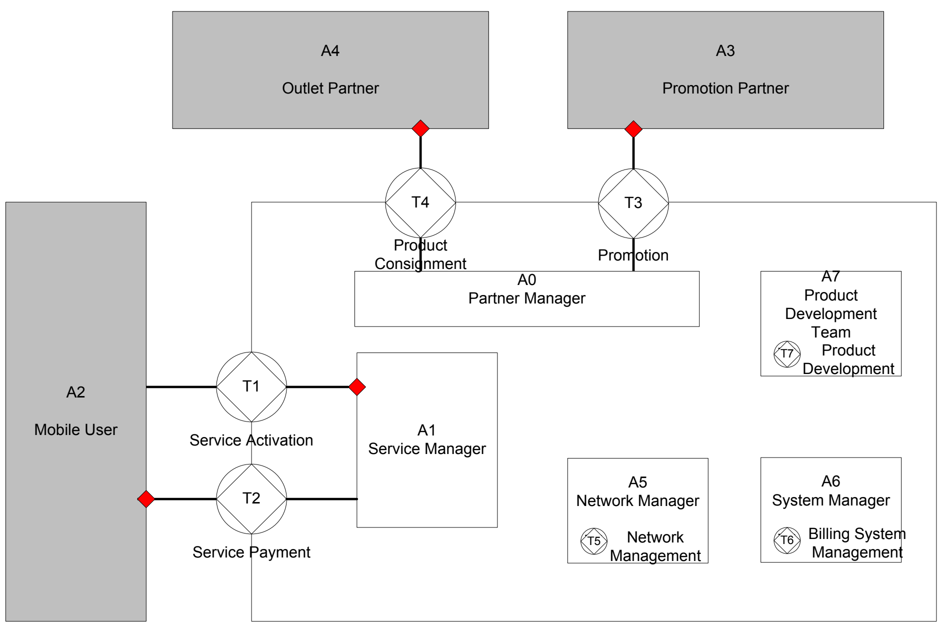


Figure 6. Actor transaction diagram of mobile internet package.

A mobile user who wants to use Internet service can buy or subscribe to the Internet package from designated outlets, or via USSD service with the help of the contact center. The company develops Internet products, conduct promotion, and activate the Internet service via a network system. Billing system deducts the amount of Internet service fee from the mobile balance (prepaid), or via credit card (postpaid).

The ATD represents a CM of Mobile Internet Package. Note that the numbering of Actor Roles complies with Condition 3 in Section 2.2; the executor of a transaction kind gets the same number as the transaction kind, regardless of actor role types.

4.2. Construction Model Generation of Telecommunication Industry

In this section, we applied the phases introduced in Section 3.

4.2.1. PHASE 1: Split Operation of the Initial CM to Create Submodels

The first phase of this phase is to split the initial CM to create submodels. Given the initial CM of Mobile Internet Package $\mathcal{M}_\alpha$, we can create submodels using the steps introduced in Section 3.1. The submodels of Mobile Internet Package is illustrated in Figure 7, complies with the criteria introduced in Section 3.1.

The submodels denoted as follows:

$\mathcal{M}_{\alpha 1} = \langle \{A_1, A_2\}, \{T_1, T_2\} \rangle$ in α (**p-type** submodel);

$\mathcal{M}_{\alpha 2} = \langle \{A_0, A_3\}, \{T_3\} \rangle$ in α (**q-type** submodel);

$\mathcal{M}_{\alpha 3} = \langle \{A_0, A_4\}, \{T_4\} \rangle$ in α (**q-type** submodel);

$\mathcal{M}_{\alpha 4} = \langle \{A_5\}, \{T_5\} \rangle$ in α (**r-type** submodel);

$\mathcal{M}_{\alpha 5} = \langle \{A_6\}, \{T_6\} \rangle$ in α (**r-type** submodel);

$\mathcal{M}_{\alpha 6} = \langle \{A_7\}, \{T_7\} \rangle$ in α (**r-type** submodel).

After we conduct split operation in the entire initial model, we can summarize it in Table 2.

4.2.2. PHASE 2: Merge Operation of Submodels

Based on Criteria 1, 2, and 3 of Section 3.2, we can calculate the number of

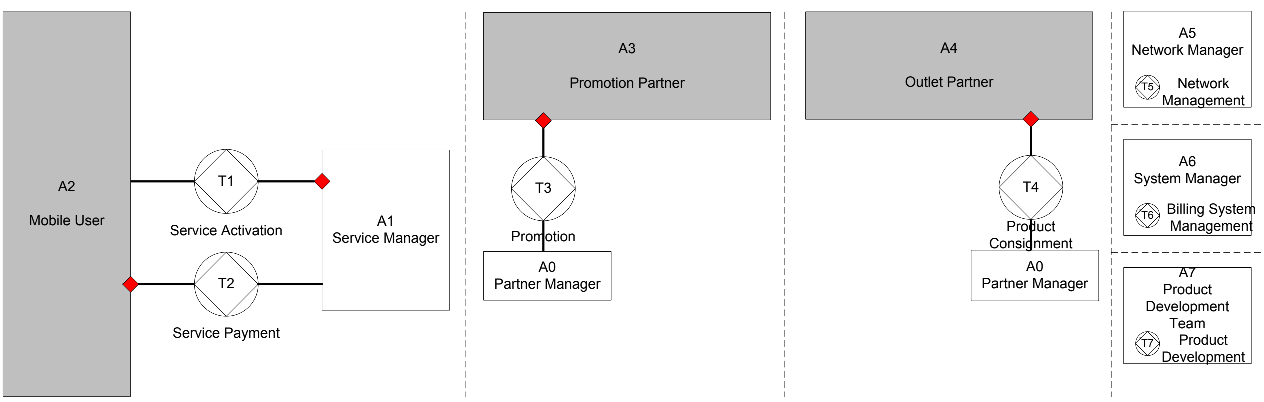


Figure 7. Submodels of mobile internet package.

Table 2. Summary of the submodels.

No	Model Name	No. of Submodel	**p-Type** Submodel	**q-Type** Submodel	**r-Type** Submodel
1	Mobile Internet Package ($\mathcal{M}_\alpha$)	6	1 ($\mathcal{M}_{\alpha1}$)	2 ($\mathcal{M}_{\alpha2}$, $\mathcal{M}_{\alpha3}$)	3 ($\mathcal{M}_{\alpha4}$, $\mathcal{M}_{\alpha5}$, $\mathcal{M}_{\alpha6}$)
2	Mobile Cash ($\mathcal{M}_\beta$)	3	1 ($\mathcal{M}_{\beta1}$)	1 ($\mathcal{M}_{\beta2}$)	1 ($\mathcal{M}_{\beta3}$)
3	SMS Banking ($\mathcal{M}_\gamma$)	4	1 ($\mathcal{M}_{\gamma1}$)	1 ($\mathcal{M}_{\gamma2}$)	2 ($\mathcal{M}_{\gamma3}$, $\mathcal{M}_{\gamma4}$)
4	IoT Vending Machine Controller ($\mathcal{M}_\delta$)	5	1 ($\mathcal{M}_{\delta1}$)	1 ($\mathcal{M}_{\delta2}$)	3 ($\mathcal{M}_{\delta3}$, $\mathcal{M}_{\delta4}$, $\mathcal{M}_{\delta5}$)
5	Video Package ($\mathcal{M}_\varepsilon$)	4	1 ($\mathcal{M}_{\varepsilon1}$)	1 ($\mathcal{M}_{\varepsilon2}$)	2 ($\mathcal{M}_{\varepsilon3}$, $\mathcal{M}_{\varepsilon4}$)
6	Home Internet ($\mathcal{M}_\theta$)	8	3 ($\mathcal{M}_{\theta1}$, $M_{\theta2}$, $M_{\theta3}$)	2 ($\mathcal{M}_{\theta4}$, $\mathcal{M}_{\theta5}$)	3 ($\mathcal{M}_{\theta6}$, $\mathcal{M}_{\theta7}$, $\mathcal{M}_{\theta8}$)
		30	8	8	14

possibility of the new merged models, by calculating the combination of **p-type** and **q-type** submodels satisfying the conditions of a new model, minus the merged models that have the exact same composition with the submodel of initial models. The total number of possible merged model with 1 P and up to 2 Q, where P is the number of **p-type** submodels and Q is the number of **q-type** submodels, is equal to:

$$P \times \left({}_Q C_0 + {}_Q C_1 + {}_Q C_2 \right). \tag{3}$$

with 8 **p-type** submodels and 8 **q-type** submodels, the number is $8 \times \left({}_8 C_0 + {}_8 C_1 + {}_8 C_2 \right) = 296$ models.

According to Criteria 4 of Section 3.2, we need to exclude the merged models that only composed of submodels from the same initial model. The number of such merged models composed of submodels from the same initial model i, where Pi is the number of **p-type** submodel in initial model i and Qi is the number of **q-type** submodel in initial model i, is equal to:

$$\begin{gathered} Pi \times \left({}_{Qi} C_0 + {}_{Qi} C_1 + {}_{Qi} C_2 \right) \text{ if } Qi \geq 2 \\ Pi \times \left({}_{Qi} C_0 + {}_{Qi} C_1 \right) \text{ if } Qi = 1, \text{ thus equal to } 2Pi \\ Pi \times \left({}_{Qi} C_0 \right) \text{ if } Qi = 0, \text{ thus equal to } Pi \end{gathered} \tag{4}$$

with their respective number of **p-type** and **q-type** submodels according to Table 2, the number of merged models composed of submodels from the same initial model is:

$$\text{Model } \alpha\text{: } 1 \times \left({}_2 C_0 + {}_2 C_1 + {}_2 C_2 \right) = 4 \text{ models}$$

$$\text{Model } \beta\text{: } 2 \times 1 = 2 \text{ models}$$

$$\text{Model } \gamma\text{: } 2 \times 1 = 2 \text{ models}$$

$$\text{Model } \delta\text{: } 2 \times 1 = 2 \text{ models}$$

$$\text{Model } \varepsilon\text{: } 2 \times 1 = 2 \text{ models}$$

$$\text{Model } \theta\text{: } 3 \times \left({}_2 C_0 + {}_2 C_1 + {}_2 C_2 \right) = 12 \text{ models}$$

In total 24 models, subtracting 296 by 24 we found the possibility of new models is 272 models.

4.2.3. PHASE 3: Selection of New Models

In previous phases, we found the possibility of new models is 272 models. This number is too large to check one by one, so we examine the submodels to narrow down the possibility of new models. We determined that 4 of the submodels ($\mathcal{M}_{\alpha 2}$, $\mathcal{M}_{\alpha 3}$, $\mathcal{M}_{\theta 2}$, and $\mathcal{M}_{\theta 4}$) are a generic submodel that does not change the essence of the business, and $\mathcal{M}_{\theta 4}$ is identical to $\mathcal{M}_{\delta 2}$, therefore $\mathcal{M}_{\alpha 2}$, $\mathcal{M}_{\alpha 3}$, $\mathcal{M}_{\theta 2}$, $\mathcal{M}_{\theta 4}$, and $\mathcal{M}_{\theta 4}$ are excluded. Table 3 summarizes the submodels that are used in the next merge operation.

To further narrow down the possibility of new models that are meaningful, we can conduct cluster analysis to determine the group of the submodels so that submodels that belong to different groups cannot be merged (a submodel belongs to more than one group is possible). Submodels of the same initial model will belong to the same group, at least in one of the groups. By examining the relative closeness[1] between each submodel, we determined that there are two groups, with the summary illustrated in Table 4. Group 1 is a cluster of submodels related to financial transactions, and Group 2 is a cluster of submodels related to entertainment.

Using Table 4, we can calculate the number of combination of merged submodels for each group.

$$\text{Group 1: } 6\times\left({}_3C_0 + {}_3C_1 + {}_3C_2\right) = 42 \quad \text{models}$$

$$\text{Group 2: } 5\times\left({}_3C_0 + {}_3C_1 + {}_3C_2\right) = 35 \quad \text{models}$$

$$\text{Both Groups: } 4\times\left({}_2C_0 + {}_2C_1 + {}_2C_2\right) = 16 \quad \text{models}$$

The possibility of new models can be calculated by adding the total number of combination for each group, minus the number of combination of Both Groups to remove duplicates.

$$42 + 35 - 16 = 61 \text{ models}$$

And using Table 3, we calculate the number of merged models composed of submodels from the same initial model:

Model α: 1 model

Model β: 2 × 1 = 2 models

Model γ: 2 × 1 = 2 models

Model δ: 2 × 1 = 2 models

Model ε: 2 × 1 = 2 models

Model θ: 2 models

In total 11 models. Subtracting 61 by 11, we found the possibility of the new models is 50 models instead of 272 models. This number is still relatively large;

[1]If the two submodels merged will potentially results a meaningful model, those models are relatively close.

Table 3. Summary of the submodels that are used in the next merge operation.

Model No.	**p-Type** Submodel	**q-Type** Submodel
1	1 ($\mathcal{M}_{\alpha1}$)	0
2	1 ($\mathcal{M}_{\beta1}$)	1 ($\mathcal{M}_{\beta2}$)
3	1 ($\mathcal{M}_{\gamma1}$)	1 ($\mathcal{M}_{\gamma2}$)
4	1 ($\mathcal{M}_{\delta1}$)	1 ($\mathcal{M}_{\delta2}$)
5	1 ($\mathcal{M}_{\varepsilon1}$)	1 ($\mathcal{M}_{\varepsilon2}$)
6	2 ($\mathcal{M}_{\theta1}$, $\mathcal{M}_{\theta3}$)	0
Total	7	4

Table 4. Groups of Submodels.

	p-Type Submodel	**q-Type** Submodel
Group 1	6 ($\mathcal{M}_{\alpha1}$, $\mathcal{M}_{\beta1}$, $\mathcal{M}_{\gamma1}$, $\mathcal{M}_{\delta1}$, $\mathcal{M}_{\theta1}$, $\mathcal{M}_{\theta3}$)	3 ($\mathcal{M}_{\beta2}$, $\mathcal{M}_{\gamma2}$, $\mathcal{M}_{\delta2}$)
Group 2	5 ($\mathcal{M}_{\alpha1}$, $\mathcal{M}_{\beta1}$, $\mathcal{M}_{\varepsilon1}$, $\mathcal{M}_{\theta1}$, $\mathcal{M}_{\theta3}$)	3 ($\mathcal{M}_{\beta2}$, $\mathcal{M}_{\delta2}$, $\mathcal{M}_{\varepsilon2}$)
Both Groups	4 ($\mathcal{M}_{\alpha1}$, $\mathcal{M}_{\beta1}$, $\mathcal{M}_{\theta1}$, $\mathcal{M}_{\theta3}$)	2 ($\mathcal{M}_{\beta2}$, $\mathcal{M}_{\delta2}$)

however, it is a reasonable number to check each model briefly. We determine the meaningfulness of the model and determine 3 models that are the most meaningful and new relative to existing models.

The following section describes the construction models of the selected models:

1) Portable Internet Device (Figure 8)

This model is the merger of submodel $\mathcal{M}_{\alpha1}$ and $\mathcal{M}_{\delta2}$. A customer can purchase a portable device (similar to mobile wifi) with the same SIM card number to those of customer's so that another device can connect to the Internet using the mobile connection without subscribing to a new SIM card.

2) Bank-integrated Mobile Cash (Figure 9)

This model is the merger of submodel $\mathcal{M}_{\beta1}$ and $\mathcal{M}_{\gamma2}$. This is a Mobile Cash that is connected to a bank account. A customer can link mobile cash to their bank account or debit card, making it easier to top up mobile cash.

3) Home Theatre (Figure 10)

This model is the merger of submodel $\mathcal{M}_{\theta1}$, $\mathcal{M}_{\varepsilon2}$, and $\mathcal{M}_{\delta2}$. This is an add-on to home internet subscriber. A customer can watch a movie provided by an internet service provider. A device to enhance the movie experience can be added.

5. Discussion

This research demonstrated the Construction Model Generation as a method to generate a new construction model. DEMO Construction Model is used to show the enterprise model. We applied this framework in a case study of Telecommunication Industry in Indonesia. We also developed the criteria of submodel split from existing model, and the criteria of applicable merged model.

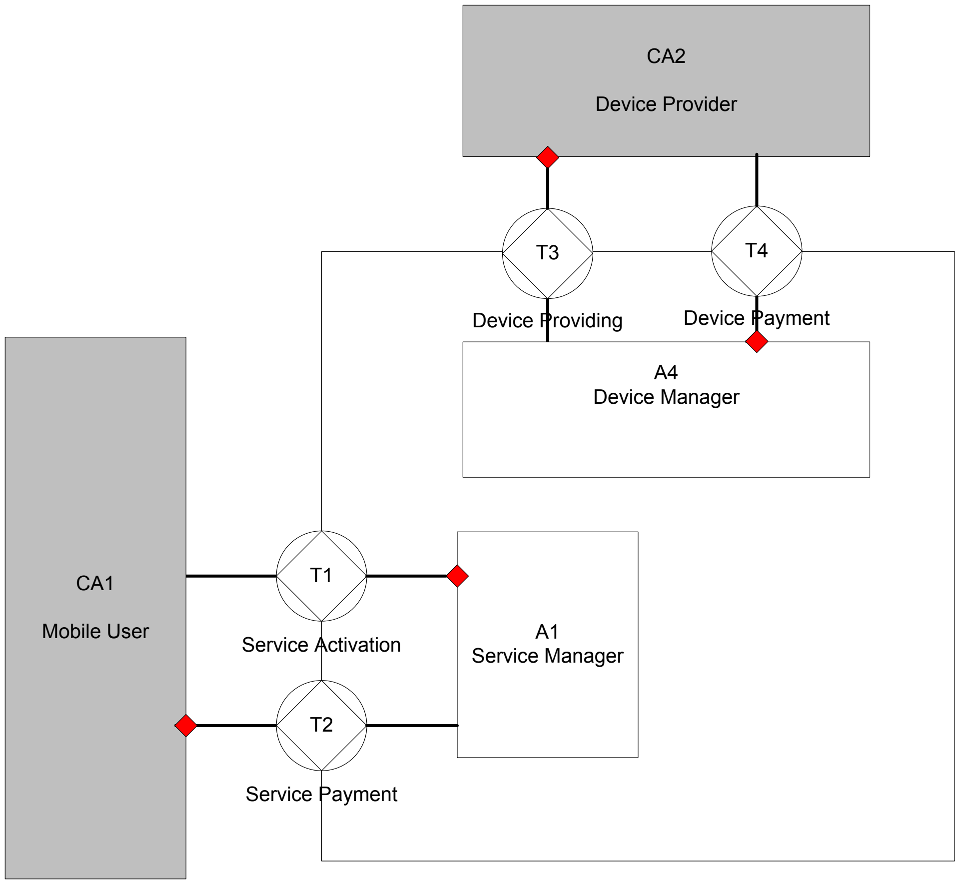


Figure 8. Construction model of portable internet device.

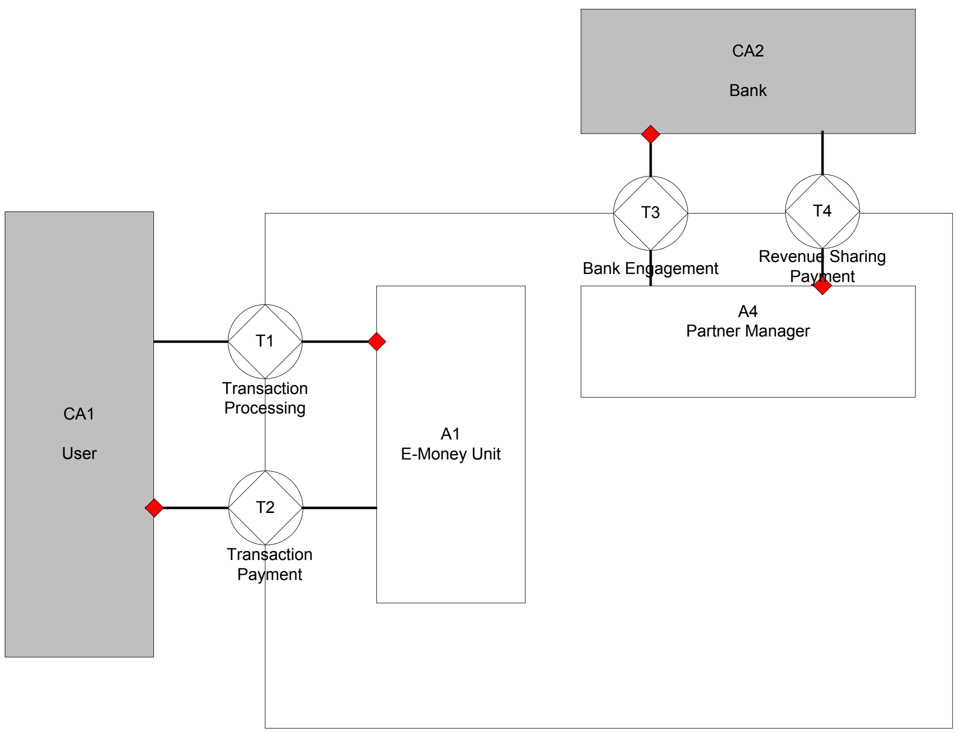


Figure 9. Construction model of bank-integrated mobile cash.

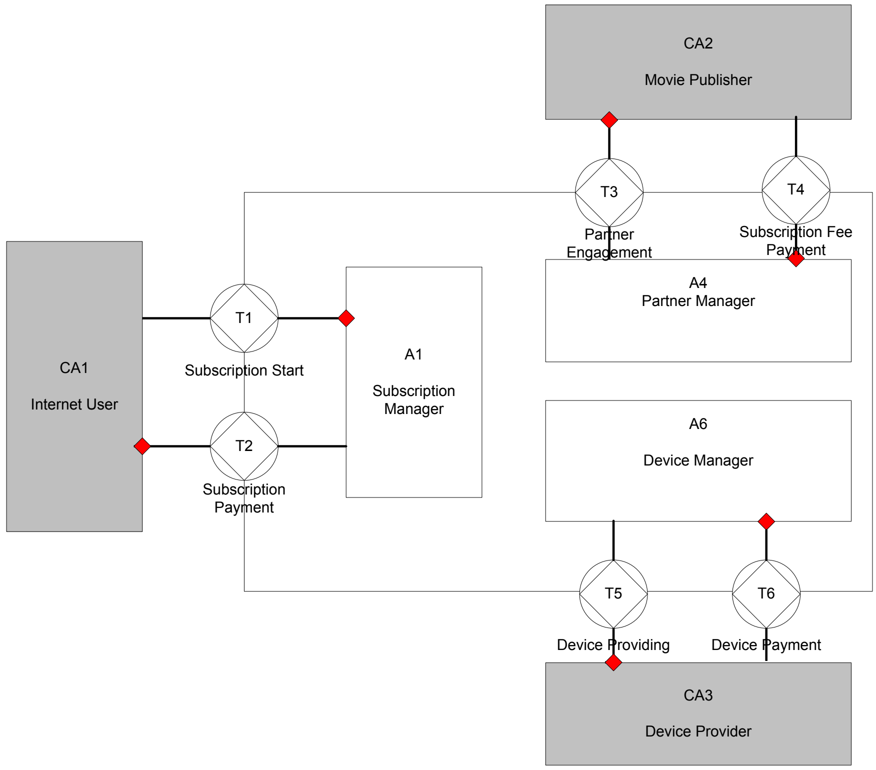


Figure 10. Construction model of home theatre.

The results of this study answered our research questions. First, we perform Construction Model Generation of Telecommunication Industry to demonstrate the model manipulation using DEMO CM. Second, we defined the criteria of submodels split from the existing model. Third, we defined the criteria of merged models to be applicable, so that these models can potentially be implemented as a new construction model.

The contribution of this study is related to information systems development, in particular synthesis and analysis of enterprise model. The resulting new model proved to be meaningful, and new to some extent. We discussed the result of new models with practitioners in Telecommunication Industry, and getting feedback from them.

1) Portable Internet Device: This model is getting more relevant, seeing that the current multi-device needs of the customer. They actually had 1 number multi-SIM product. However, it is not getting buy-in by the market, because in Indonesia it was very easy to get a starter pack.

2) Bank-integrated Mobile Cash: This model is actually already formulated, but not yet implemented. From mobile cash Apps, user can top up mobile cash balance with top up menu from user's bank account. Transfer to a bank account is also possible.

3) Home Theatre: This model was included in their ideation. It is very good to customer in their opinion.

From the feedback, we can see that the resulting new models are relevant to the industry and can be applied to the business in Telecommunication Industry. Therefore it can be said that the framework is successful to synthesize a new enterprise model from the existing models. However, there are limitations regarding the newness of the models. Using the criteria of applicable merged models we avoid any possible recurrence of the initial models, however, there is still no way to avoid recurrence of business models outside of the captured models. Therefore to minimize this "fake" newness, existing enterprise models in an industry have to be captured as many as possible. This way we can also expand the pool of submodels, therefore the possibility of new, meaningful models can be improved.

Another limitation can be observed in terms of new model selection. Currently, there is no syntactical way to determine which models are meaningful, as the criteria of meaningful model highly depend on the business context. It is difficult to determine that a model (resulted from merge operation) is meaningful and can be implemented. A cluster analysis conducted in this study is useful to reduce the number of non-meaningful merged models, however the clusters depend on the business context; the clusters for other kinds of industries could be different. Future studies can cover another type of industry to check the consistency of the framework. A case study of telecommunication industry in a developed country can also be conducted as a comparative study, and possibly to expand the pool of submodels.

We can see that using DEMO in model manipulation has its merit and demerit. The advantage of DEMO is to provide the construction model that can be easily manipulated using algebraic notation. Manipulation of DEMO CM is proved to be closed on the domain, and that some are commutative and associative. The set of rules of models and submodels, and the manipulation operations, are all defined, so that all models and submodels are consistent with the definition of DEMO CM, removing the necessity of model checking. The disadvantage is the meaningfulness of the merged model needs to be discussed because there is no value-related context in DEMO. To address this, another modelling artefact containing value aspect can be introduced; one of the most popular is Business Model Canvas [22], commonly abbreviated as BMC, given that we can transform BMC into DEMO CM [23] or vice-versa [24].

By using the proposed methodology in this paper and future studies, we expect that we can gather several enterprise models as construction models and split them into several submodels and create a pool of submodels, merge them to generate a new construction model as a new enterprise model in a certain industry.

6. Conclusions

In this research, we identified some research problems related to construction model manipulation in Section 1 and explained the literature review related to this work in Section 2. We explained the framework of Construction Model

Generation using split and merge operation in Section 3. The framework consists of three phases; Split operation of the initial CM to create submodels, Merge operation of submodels, and Selection of new models. We demonstrated the application of this framework in telecommunication industry in Section 4, completed with the new model description, and covered discussion of the result in Section 5.

This article demonstrated the Construction Model Generation as a method to synthesize a new enterprise model using Telecommunication Industry in Indonesia as a case study. We perform Construction Model Generation using case study of Telecommunication Industry to demonstrate the model manipulation using DEMO Construction Model. We defined the criteria of submodels split from the existing model in. We also defined the criteria of merged models to be applicable, so that these models can potentially be implemented as a new enterprise model. Therefore, we answered all three research questions. The first question is described in Section 3, enhanced with the case study of Telecommunication Industry in Indonesia described in Section 4, completed with the results. The second question is described in Section 3.1, we developed 4 criteria and 3 classifications of submodel to help the manipulation process. The third question is described in Section 3.2, we developed 4 criteria of merged model to narrow down the possibility of new models, and eliminate merged models that are not applicable or recurrence of an initial model.

In Telecommunication Industry in Indonesia, we captured 6 existing enterprise models as DEMO Construction Model. We conduct split and merge operation of those models, and we found 3 new, meaningful models of DEMO Construction Model as a new enterprise model that is meaningful and applicable in Telecommunication Industry. The advantage of DEMO is to provide the construction model that can be easily manipulated using algebraic notation. The set of rules of models and submodels, and the manipulation operations, are all defined, so that all models and submodels are consistent with the definition of DEMO, removing the necessity of model checking. The disadvantage is the meaningfulness of the merged model needs to be discussed, because there is no value-related context in DEMO; the authors propose using Business Model Canvas to extend the framework and add the value aspect to the framework. By using this methodology, we expect that we can gather several enterprise models as construction models and split them into several submodels and create a pool of submodels, merge them to generate a new construction model.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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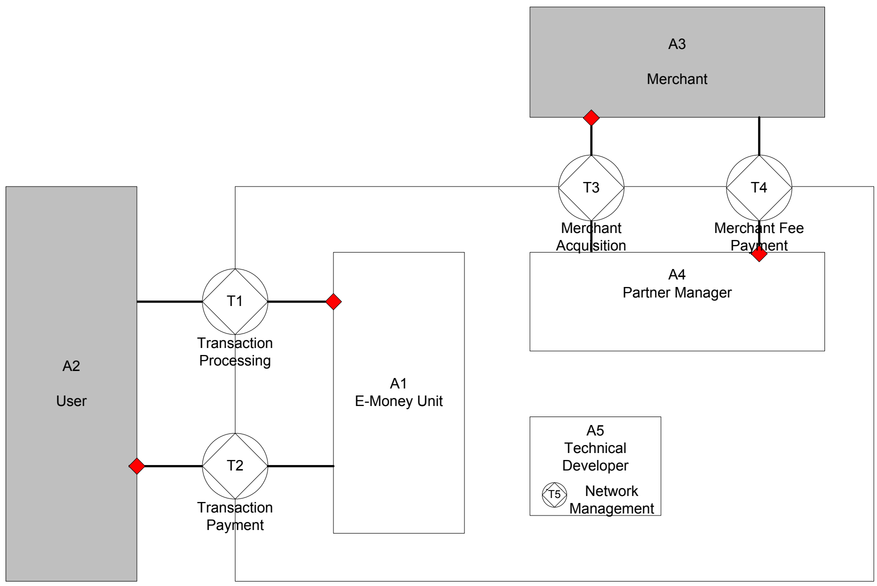
Appendices

This appendix shows the business description, ATD, and submodel of DEMO Construction Model of Telecommunication Industry in Indonesia, aside from Mobile Internet Package.

Mobile Cash ($\mathcal{M}_\beta$)

A mobile user can activate e-money features via Mobile Cash apps, or via USSD service with the help of the contact center. A customer can pay for a goods or services of designated merchant using mobile e-money via Mobile Cash apps. The company develops networing and acquisition of merchants, and maintains e-money system. E-money balance can be filled from the mobile balance (pre-paid), or via credit card (postpaid).



Submodels of Mobile Cash

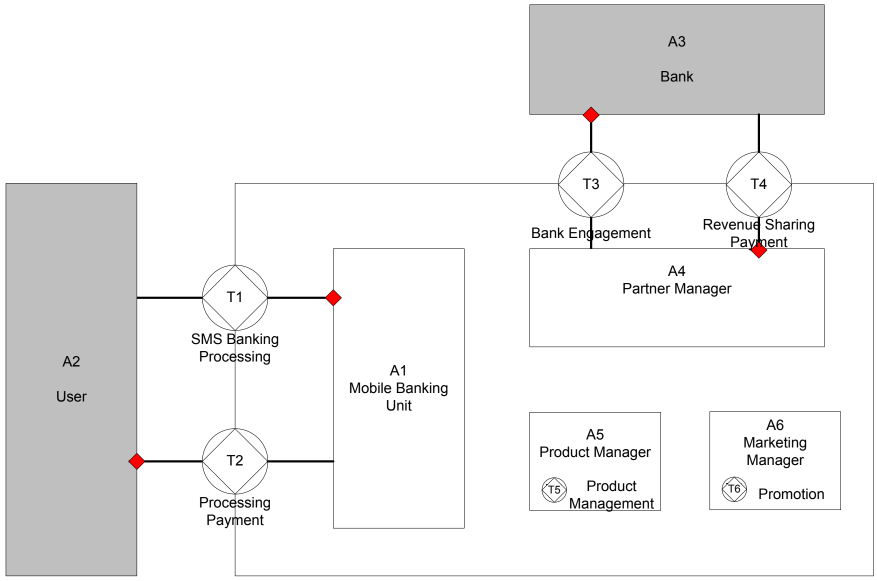
$\mathcal{M}_{\beta 1} = \langle \{A_1, A_2\}, \{T_1, T_2\} \rangle$ in β (**p-type** submodel)

$\mathcal{M}_{\beta 2} = \langle \{A_3, A_4\}, \{T_3, T_4\} \rangle$ in β (**q-type** submodel)

$\mathcal{M}_{\beta 3} = \langle \{A_5\}, \{T_5\} \rangle$ in β (**r-type** submodel)

SMS Banking ($\mathcal{M}_\gamma$)

A bank account owner can conduct banking transaction (checking balance, money transfer, etc.) via Mobile SMS. The company engage with bank and conduct promotion via a mobile banking unit. Billing system deducts the mobile banking fee from the mobile balance (prepaid), or via credit card (postpaid).



Submodels of SMS Banking

$\mathcal{M}_{\gamma 1} = \langle \{A_1, A_2\}, \{T_1, T_2\} \rangle$ in γ (**p-type** submodel)

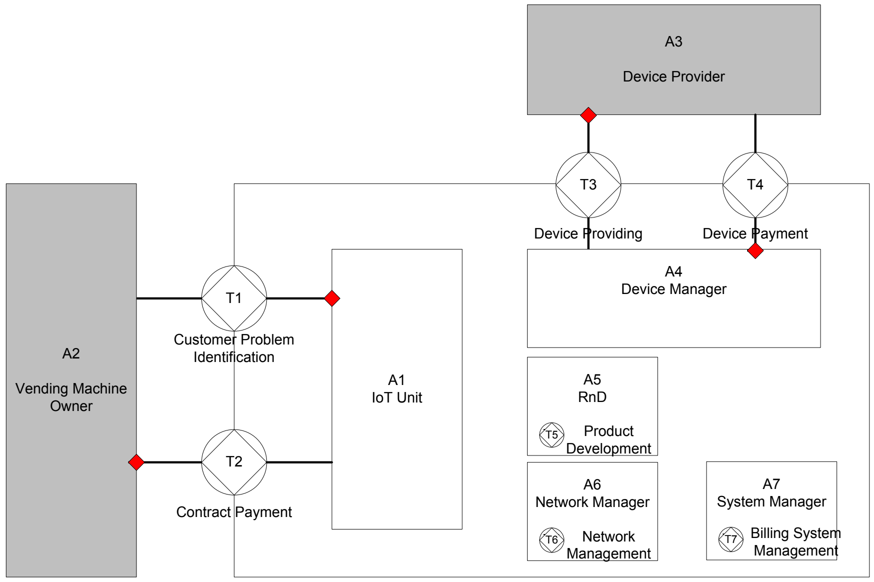
$\mathcal{M}_{\gamma 2} = \langle \{A_3, A_4\}, \{T_3, T_4\} \rangle$ in γ (**q-type** submodel)

$\mathcal{M}_{\gamma 3} = \langle \{A_5\}, \{T_5\} \rangle$ in γ (**r-type** submodel)

$\mathcal{M}_{\gamma 4} = \langle \{A_6\}, \{T_6\} \rangle$ in γ (**r-type** submodel)

IoT Vending Machine Controller ($\mathcal{M}_\delta$)

An IoT Device can be installed to a vending machine to provide customer needs (i.e. stock control). The company develops IoT device, including design, networking, and billing system. The company and vending machine owner form a contract, renewed every 6 months to 2 years.



Submodels of IoT Vending Machine Controller

$\mathcal{M}_{\delta 1} = \langle \{A_1, A_2\}, \{T_1, T_2\} \rangle$ in δ (**p-type** submodel)

$\mathcal{M}_{\delta 2} = \langle \{A_3, A_4\}, \{T_3, T_4\} \rangle$ in δ (**q-type** submodel)

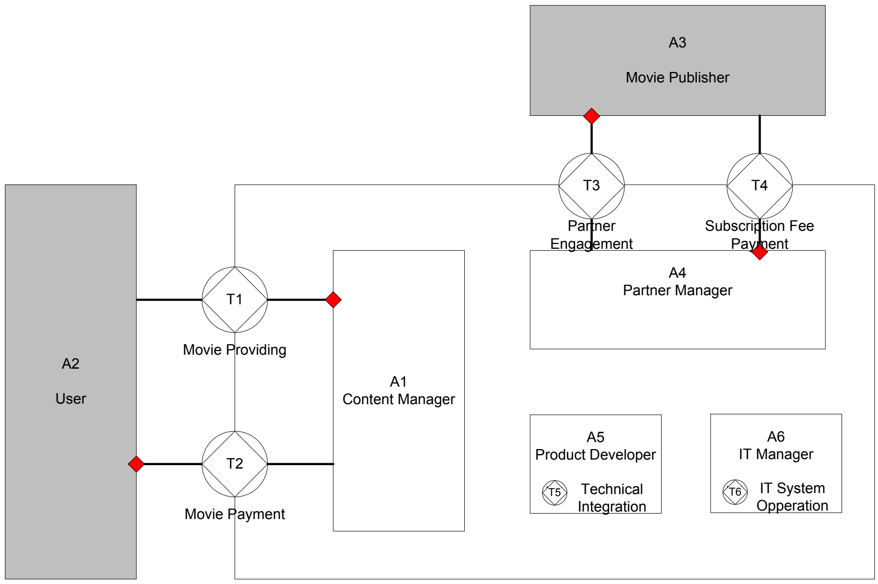
$\mathcal{M}_{\delta 3} = \langle \{A_5\}, \{T_5\} \rangle$ in δ (**r-type** submodel)

$\mathcal{M}_{\delta 4} = \langle \{A_6\}, \{T_6\} \rangle$ in δ (**r-type** submodel)

$\mathcal{M}_{\delta 5} = \langle \{A_7\}, \{T_7\} \rangle$ in δ (**r-type** submodel)

Video Package ($\mathcal{M}_\varepsilon$)

A mobile user can watch a movie video provided by designated partner via mobile apps. The company engages with movie publisher and develops technical integration of movie and app. A certain movie can be subscribed using one-time purchase, and deducts the fee from the mobile balance (prepaid), or via credit card (postpaid).



Submodels of Video Package

$\mathcal{M}_{\varepsilon 1} = \langle \{A_1, A_2\}, \{T_1, T_2\} \rangle$ in ε (**p-type** submodel)

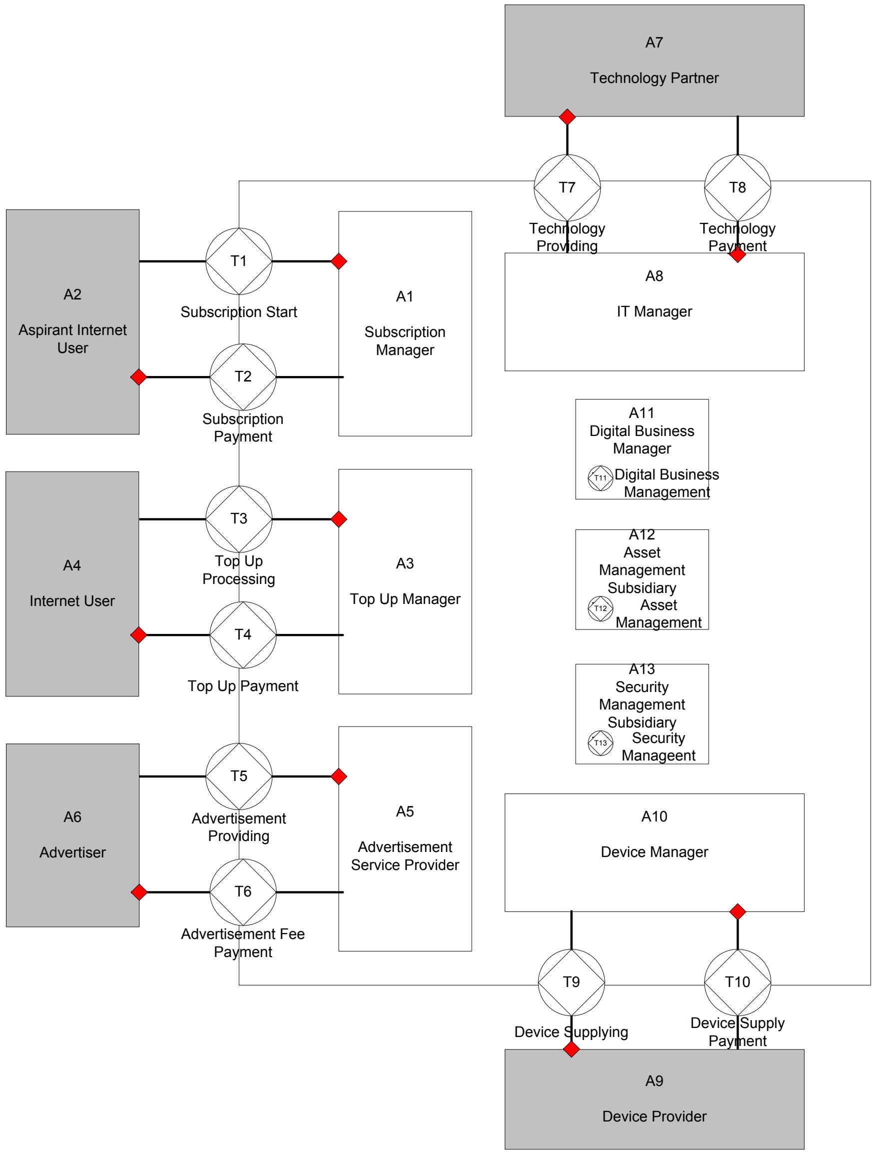
$\mathcal{M}_{\varepsilon 2} = \langle \{A_3, A_4\}, \{T_3, T_4\} \rangle$ in ε (**q-type** submodel)

$\mathcal{M}_{\varepsilon 3} = \langle \{A_5\}, \{T_5\} \rangle$ in ε (**r-type** submodel)

$\mathcal{M}_{\varepsilon 4} = \langle \{A_6\}, \{T_6\} \rangle$ in ε (**r-type** submodel)

Home Internet ($\mathcal{M}_{\theta}$)

A customer who wants to use phone, internet, and TV service at home can subscribe to the Home Internet package from designated outlets, or via phone. The company install the device on site and develops the infrastructure and network. A customer who wants to advertise their products or services can also put the advertisement in the network. The company and the customer form a contract, renewed every 2 *years. A top up for additional service is also possible.*



Submodels of Home Internet

$\mathcal{M}_{\theta 1} = \langle \{A_1, A_2\}, \{T_1, T_2\} \rangle$ in θ (**p-type** submodel)

$\mathcal{M}_{\theta 2} = \langle \{A_3, A_4\}, \{T_3, T_4\} \rangle$ in θ (**p-type** submodel)

$\mathcal{M}_{\theta 3} = \langle \{A_5, A_6\}, \{T_5, T_6\} \rangle$ in θ (**p-type** submodel)

$\mathcal{M}_{\theta 4} = \langle \{A_7, A_8\}, \{T_7, T_8\} \rangle$ in θ (**q-type** submodel)

$\mathcal{M}_{\theta 5} = \langle \{A_9, A_{10}\}, \{T_9, T_{10}\} \rangle$ in θ (**q-type** submodel)

$$\mathcal{M}_{\theta 6} = \langle \{A_{11}\}, \{T_{11}\} \rangle \text{ in } \theta (\textbf{r-type} \text{ submodel})$$
$$\mathcal{M}_{\theta 7} = \langle \{A_{12}\}, \{T_{12}\} \rangle \text{ in } \theta (\textbf{r-type} \text{ submodel})$$
$$\mathcal{M}_{\theta 8} = \langle \{A_{13}\}, \{T_{13}\} \rangle \text{ in } \theta (\textbf{r-type} \text{ submodel})$$