Abstract—Risks and opportunities are important elements in designing enterprise architecture. This is because risks and opportunities are closely related to the success of the company's business goals and strategies. Nowadays, not many people discuss the importance of these two instances to be added in describing the design notation of enterprise architecture especially in developing enterprise architecture modeling languages. In this research, conducted ontology analysis to explain the concept of risk and opportunity on enterprise architecture. The ontology analysis of these two concepts is done using the concept of Unified Foundational Ontology (UFO). This analysis will result in the development of risk and opportunity notation in enterprise architecture modeling language Archimate. Where Archimate is a very open modeling language to be developed and able to adopt new metamodel relevant to the development of the times. Here will use a real cases using new metamodel of risk elements and opportunities that will show the addition of metamodel in certain cases

Keywords—archimate, risk, opportunity, modeling language, metamodel, ontology

I. INTRODUCTION

Today, the development of technology is moving faster. Almost all organizations and enterprises are competing to make use of technology as an effort to increase the company's selling power. But in its application required considerable attention because the application of IT is not cheap. Failure of IT Management is the biggest reason that IT systems often fail. Everything related to the organization can be more complex, especially in regulatory issues, partnership relationships, mergers and acquisitions. In addition, in terms of technology, new distribution models and interoperability and automation targets make the complexity higher [1].

The rapid development of information systems required a method to decompose the complexity of the organization. Enterprise Architecture (EA) is an enabler that provide model business supported by information technology. Enterprise Architecture is not only a theory for aligning business and IT, but also useful in defining operational methodologies and for organizational survival

One of the modeling languages that can be adopted in Enterprise Architecture is Archimate. Archimate is a high-level architecture modeling with new standards [2]. But sometimes organizations are not sure how to effectively implement Archimate to integrate with low-level modeling that has been widely adopted in corporate environments such as UML, BPMN etc.

However, as the complexity of an enterprise increases, the risks faces are also higher. Moreover the risks that occur in the developed enterprise architecture. The traditional method of risk management can not cover the complexity of an enterprise architecture.

In line with the risk assessment on an Enterprise Architecture, in accordance with [3], The Business Motivation Model (BMM) refers SWOT (Strengthen, Weakness, Opportunity, Threat) to portray the conditions of Enterprise Architecture. Not only are risks to be managed, opportunities must also be managed to increase profits for the company. In [4] has added element motivation to archimate using resource and capability to develop company requirement.

The biggest challenge in combining the concepts of risks and opportunities in enterprise architecture is to carry out conceptual identification that appropriate in the enterprise architecture, by carrying out conceptual modeling of risk concepts and opportunities can produce a clear semantic concept in accordance with real conditions. But without a precise conceptualization, the modeling proposed elements is problematic. The use of the same conceptual modeling can also produce different semantics. Therefore, this modeling is subjective, with the existence of subjective properties that produce ambiguity, the resulting interpretation cannot be mapped into the semantic concept.

The main objective of this research is to analyze company projects. Where we develop two new extensions, namely risks and opportunities. We carry out conceptual modeling with semantic results from these two concepts. The novelty of our study is the addition of extensions to the Archimate modeling language. This paper shows the new motivation metamodel of Archimate. It’s called risk and opportunity notion.
The structure of this paper as follows: Section 2 describes the methodology used to conduct this research. This research was conducted by DSRM (Design, Science, Research Methodology) [5]. Where the research steps are done with 1. Identification of Problems and Motivation with the Archimate development, 2. Objective Definition of the Solution, 3. Design and Development, 4. Demonstration, 5. Evaluation.

A. Archimate

Archimate is a high-level modeling language that uses new modeling standards [2]. This framework provides a modeling language that is able to provide comprehensive enterprise architecture modeling languages that are able to describe and analyze at a high level. In addition, this framework is also easily developed according to the needs of the company. Besides that, archimate also has extensions that can be dynamically developed to enrich the concept of archimate.

Archimate opens opportunities for companies to develop motivation element in accordance with the needs of the company, so that the addition of motivation elements is allowed in archimate development.

Motivation elements are used to give the company the ability to design its own needs based on the stated goals. It's a reason that can be used as a guide for making changes and rules in the company. There are some motivation elements in Archimate, stakeholder, driver, assessment, goal, outcome, principle, requirement, constraint, meaning, value.

One of the elements of motivational development in archimate is the risks and opportunities that according to [3]. At each step in creating the design of the company, architects face.

B. Unified Foundational Ontology (UFO)

The Unified Foundational Ontology (UFO) is a framework to validate enterprise architecture modelling language [6]. UFO are developed consistently and separately to produce theoretical formations that come from formal ontology, cognitive science, logic and cognitive science. UFOs are composed of a collection of micro-theories that discuss things conceptually. In its development, UFOs are divided into 3 types, namely:

a. UFO-A: An Ontology of Endurants on aspects of structured conceptual modeling. It is categorized into 4 categories of ontologies consisting of the types of theory and including matters relating to formal semantic concepts that can be adjusted and modeled logically, in real conditions.

b. UFO-B: An Ontology of processes and events, relating to aspects such as events / processes of mereology, events / process penguruta temoral. Object Participation in events / processes, causing changes and relationships between events / processes through Disposition.

c. UFO-C: An Ontology built on social entities above UFO-A and UFO-B, which discuss ideas such as
Beliefs, Desires, intentions, goals, actions, commitments and practices

Unified Foundational Ontology (UFO) is developed based on the formal form of ontology.

The purpose of UFO developed is to provide a basis for conceptual modeling.

a. Construct excess: occurs when the modeling construct has no correspondence with any ontology concepts. Based on this paper, modeling language user’s make clear relations between constructs of models and concepts of ontology. Easy enough in mapping both.

b. Construct overload: occurs when single modeling constructs can be represented in many ontological concepts. This results in ambiguous meanings of the construct.

c. Construct Redundancy: occurs when many modeling constructs can be used to represent a single ontological concept.

d. Construct deficit: occurs when there is no construct in the modeling language corresponding to a particular ontological concept.

II. METHODOLOGY

This research is produced by following the steps as follow:

A. Identification of problem and motivation

Based on Sergio, dkk, 2013[7] At every step in creating an enterprise design, architects encounter risks and opportunities. In most cases, risk assessment and treatment is done using the company’s internal methodology or based on some best-practices known by the architect. Traditional methods are based only on checklist, heuristic and experience. Most of the risk management methods focus only on Information Technology (IT).

Therefore, archimate which is an enterprise architecture modeling language opens opportunities for organizations in developing their needs. Based on the above problems, this research tries to add extensions that can complement the motivation element in archimate.

B. Objective Definition of the Solution

The objective definition of the addition risk and opportunity extension to the archimate modeling language is expected to produce a quantitative solution by generating the notation and basic relations of the Archimate extension. Quantitative solutions are also generated when defining risk vulnerabilities and increase the opportunities.

C. Design and Development

These stages include design and development of risk and opportunity extensions. The initial design is done by designing the archimate metamodel with the development elements of risk and opportunity motivation. In addition, the relation in the metamodel should be designed according to the concept defined by the archimate. Then, in modeling requires the development of notation that can represent the two new elements.

From that stage an ontology concept analysis is needed to ensure that the concept of risk and opportunity can be used to complement the concept of the motivational element.

D. Demonstration

This stage is design to implement the use of risk extension on the archimate resulting from the design and development stage of the enterprise as a case study. The result of this demonstration is an enterprise architecture model of the case study object which is a risk and opportunity extension to Archimate that has been applied. The modeling aims to demonstrate how risk and opportunity extensions are used in the resulting archimate.

E. Evaluation

This stage is to evaluation conducted by testing the suitability of the application of the resulting extension. Evaluation of this stage is done by comparing the results of the previous stage implementation. Then compare the implementation between the use of risk and opportunity extension on archimate and the use of archimate without using risk and opportunity escalation. To find out the best results using UFO method to get a comprehensive comparison between the both of them.

III. RESULT

A. Output Step one:

Company needs in the development of enterprise architecture based Risk Based Thinking has not been fulfilled. There is no model that can describe the risks and opportunities as a whole in defining the enterprise architecture.

The development opportunity is in the addition of the notation to the archimate motivation element which is open to be developed.

B. Output Step two:

The solution from the problem above is to add risk elements and opportunities as part of motivation element. It starts from adding metamodel to archimate to formation of risk and opportunity notation model.

C. Output Step three:

The main point of this phase is to do an ontology mapping of the Unified Foundational Ontology (UFO) framework which is a framework for evaluating the modeling language. Before being mapped to the archimate metamodel, the construct model of risk and opportunity will be mapped through ontological theory. Where according to

Fig. 4. Existing metamodel of archimate
this framework a construct model should not have 4 main problems i.e. construct excess, construct overload, construct redundancy and construct deficit.

The definition of risk according to Oxford is a noun defined as "A situation involving exposure to danger".

Risk also uncertainty about future events. Risk is defined as an unpleasant (harmful) consequence of an action or action. If we solve the risk problem with the Unified Foundational Ontology, risk classified as universal term, when risk such as characteristic in temporary condition in object.

Risk affects assets where assets are valuable to the company. Based on research published Jose, et al 2012, the risk is always there even if it is detected or not by the organization. Areas that are vulnerable to risk exposure must be addressed in order to achieve company profits such as business risk, market risk, credit risk, operational risk, IT risk and so on.

The risk of influence on assets affected by individuals or organizations. Risks are added to complement the pre-existing extension specialization of assessment extensions. Assessment is a trigger for risk analysis. However, these elements have not been explicitly represented. Risk represents a valuable asset value for a company. The risk of representing each valuable asset object can be either business actor or business object (agentive object and non-agentive object). So the problem found in this interpretation is clear that there is a problem of construct redundancy.

The composite situation of risk is an opportunity, where opportunity also have same characterization with risk. It’s occure in temporary condition in some certain object. The definition of Opportunity according to Oxford dictionary is a time or set of circumstances that makes it possible to do something.

Risk and opportunity classified into anti-rigid universal. Risk is purely and speculative. Example of pure risk is natural disaster and example of speculative risk is debt payable. Pure and speculative is the nature of risk, then a natural disaster is defined as w any property defined to be x impossible to be an instance of both pure and speculative nature or a natural disaster entering in the nature of speculative risk and it is unlikely that debt payable enters the nature of risk pure.

Beside that, Opportunity defines as improving business value, influenced by external influences, for example: external influences are the nature of the opportunity where the defined opportunity is w, the external and internal influences are unlikely to be an instance of an opportunity so that it will allow external influences to belong only to the opportunity.

Risks and Opportunities are classified as a Universal Moment. We can the formula about moment universal.

\[
\text{MomentUniversal}(U) = \text{def} \text{Universal}(U) \land \forall x (x::U \rightarrow \text{Moment}(x)) \quad (1)
\]

x is an instance of U or x has a character that is part of U. Budget risk is a category of risk. Object budget risk is an instance of universal risk. When it is said that risk identification in budget risk or monitoring and reporting on budget risk. We can say that budget risk is an example of universal risk. Risk identification and monitoring and reporting are done specifically on risk.

Opportunity is based on external conditions. External conditions will change based on certain-for example: new technological developments the development of new technology x is an instance of universal Opportunity Technology U.

Risks and Opportunities are Non-Agentable Objects. In line with the nature of risk as a noun, which is the object of risk is Non-Agentive Object. Risk does not affect their individuals. The risk is attached to a particular object or element.

Risks can be attached to physical objects and social objects. Social objects: describe objects that affect certain communities such as corporate regulation and public law.
Social objects are performed by social entities such as presidents or managers. Opportunity is a noun which is also an object. Where this object is passive (Non-Agentive) that will change with other influences. Opportunity is a social object.

Figure 4 shows the risk and opportunity concept in UFO represents a object which may be trigger by action of assessment. The metamodel proposed here defines one relation from assessment, namely one that already existed in the extention.

The metamodel also introduce a controls relation between assessment and structure element, where assessment assosiated with the meaning and value who control by stakeholder. The realized relation between risk, opportunity and assessment is understood as being available for organization (e.g., by an risk assessment).

Enterprise architecture modeling is done with the development of risk notation and opportunity based on criteria on [2]. The development of risk and opportunity notation includes:

<table>
<thead>
<tr>
<th>Table 1. Concrete syntax and definition for risk and opportunity</th>
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<tbody>
<tr>
<td><strong>Modeling Element</strong></td>
</tr>
<tr>
<td><strong>Risk</strong></td>
</tr>
<tr>
<td><strong>Opportunity</strong></td>
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</tbody>
</table>
D. Output Step four:

In order to see the reliability of the proposed extension model, a case study is provided by comparing the modeling of enterprise architecture without the use of extensions proposed and using the proposed extension.

The result of the comparison extension usage is shown in Fig. 6 and Fig. 7. Where the addition of extensions in the proposed model detailed the process that can be done by the architect.

E. Output Step five:

The evaluation process is done by doing ontology mapping and checking the concept of construct risk and opportunity model. Unified Foundational Ontology (UFO) is directing and evaluating results and processes during the creation of risk elements and opportunities.

IV. DISCUSSION

In this paper, we perform ontological analysis of the archimate extensions of risk and opportunity and associated notions of both the elements. We have employed a comprehensive foundational ontology that incorporates concepts to eal with objects, relation, moment, etc.

Modeling construct risks and opportunities can be used to complement the company's needs. Companies are required to always think risk-based thinking so that the process of handling.

We have been able to clarify that the risk and opportunity element represent a universal form, where the characteristic of both elements will change based on moment. Our well-founded recommendations should lead to a language that allows improved enterprise capacities.

the result of ontological mapping is used to ensure that the construct model is free of the 4 major problems avoided from Unified Foundational Ontology. For starters the metamodel mapping is done on the basic concept of Archimate. Risk and opportunity are used as a form of assessment where the main objective of the assessment is the company's objectives. Both of these elements will realize the form of assessment by bringing special symbols. Where only the scope of the assessment done then the limitations of the definition of the process. Risks and opportunities used by the company as a mindset of process considerations that can be done company.

V. CONCLUSIONS

From our research we have shown that it is able to represent the key aspect of real-world case, the first case describes an enterprise architecture model without the use of risk elements and opportunities. we show that without the risk and opportunity construct the EA mode is not able to capture the key aspect of information system's development. The EA model without the risk and opportunity is focused mostly on the operational aspect of loosing the focus company for mitigate the risk and improve the opportunity.

REFERENCES


