Ontology for Risk Management in Software Project

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Abstract— *Engineering design processes are highly creative and knowledge-intensive tasks that involve extensive information exchange and communication among diverse developers. Software Project Management is a knowledge intensive process that can benefit substantially from ontology development and ontology engineering. Ontology development could facilitate or improve substantially the software development process through the improvement of knowledge management, the increase of software reusability, and the establishment of internal consistency within project management processes of various phases of software life cycle. Risk management is the identification of the hazards and possible problems, the evaluation of their importance and the drawing up of plans to monitor and deal with those Problems. Failure of some sort has been a common occurrence in the software development milieu. Survey indicates that more than 25% of all software development projects are cancelled outright before completion and about 80% overrun their budgets. This paper describes an integrated ontological view of sourcing risk which defines the relationships between risks framework that can be used to document the relationship between risks in a software development project and repeatable identification of risks associated with a software-dependent development project. The result from this work shows that, the ontological view will provide the groundwork for the development of a strategic sourcing risk tool for risk assessment. It will also help with communication between practitioners through the development of a shared and common understanding of IT sourcing risk, risk categories and their relationships to one another.*

Keywords— ***Software Project Management, Ontologies, Risk Management***

I. INTODUCTION

The absence of project management skills could deteriorate many different activities at many different stages of project management, for instance the risk "lack of user communication can lead to list of potential risk". Good project management risk management is essential if software project is to be developed on schedule and within budget. Risk management is now recognized as one of the most important project management task. The management and control of sourcing risks, has been a major challenge in the field of Information technology (IT) for a long period of time [19]; [20]; [12] and [21]. [7] Highlighted that risk presents a complex series of challenges to IT practitioners and that meeting these challenges is of great importance to organizations. The service range and scope as well as the number of service vendors only adds to the complexity [14] and presents most organizations with service integration issues [3].

When outsourcing issues are not effectively managed unacceptable risks may result. Identification and management of appropriate providers, outsourcing objectives, relevant stakeholder input, client problems, budget arrangements, and suitable contracts, are all critical to outsourcing success [11], [10], [15], [7]. Research in this area is comprehensive [12], [16]; [3] and as [2] explained "typically includes categories such as client/vendor capabilities, supply risk, strategic, legal/regulatory risks, financial, geopolitical, technology, strategic, environmental and sustainability, reputation, employee morale and process and control risks.

In computer science and information science, Ontology is a formal naming and definition of data types, properties, and interrelationships of the entities that really or fundamentally exists for a particular domain of discourse.

It is thus the practical application of philosophical ontology, with taxonomy [1].

The ontology provides a framework for organizing and studying the breadth of software development issues. Hence, it serves as the basis for eliciting and organizing the full breadth of software development risks—both technical and non-technical. The ontology also provides a consistent framework for the development of other risk management methods and activities. In the IT context, ontologies are shared understanding of some domain of interest which may be used as a unifying framework to solve the outsourcing risks problems [18]. The goal of ontology, according to [18], is to provide shared understanding for human communication as well as establish inter-operability between systems.

II. Related Work

In order to create a version of the risk ontology based on the literature and to develop an understanding of the extent to which the research base has related risks to specific theories, we have relied on three extensive and influential literature review by [4], [15], and [8]. From these three literatures, we have selected, which specifically discuss *outsourcing* risks and listed examples of the risks in Table 1. A summary of research that categorizes and relates risk through the use of various theories is shown in Table 1.

Table 1: Risk categories and relationships by theory

Authors and theory	Risks
Jurison (1995) Transaction cost theory [13]	Irreversibility of the outsourcing decision; breach of contract by the vendor; loss of autonomy and control over IT decisions; vendor's inability to deliver; loss of control over vendor; uncontrollable contract growth; loss of critical skills; biased portrayal by vendors; vendor lock-in; loss of control over data; lack of trust; and hidden costs.
Sharma (1997) Agency theory [17]	Opportunity behaviour
Duncan (1998) Resource-based view [5]	Market and vendor bases hazards: vendor opportunistic behaviour; hidden costs. Uncertainty/complexity: rapid technology change; opportunism; inadequate service overtime. Expected cost savings not realized.
Gonzales et al. (2010) Agency theory Transaction cost theory	Agency: hidden costs; deficient quality; risks related to language; cultural, political, and legal problems. Transaction cost; poor infrastructure; different time zones; deficient quality, risks related to language; cultural, political and legal problems.
Elango and Chen (2012) Transaction cost theory [6]	Contextual risks (i.e. environmental risk). Relational risks: risk of not achieving co-operation between partners; partner diversity; Differences in partner goals and contributions; poor joint venture management capability. Performance risks; commercial risk (business risk): risk that the joint venture will fail to achieve its performance objectives; differences in the institutional environments of the partner countries and the joint venture country; lack of protection of patents in some countries.

III. Research Method

The objective of our ontological view is to examine if outsourcing risks could be comprehensibly categorized and if the risks could be related to each other. To reconcile the variety of positions on risk, we used the results of a number of workshops in [22]. Our ontological view of sourcing risks was based on the review of the sourcing risk research, existing available theory as well as data gathered from the workshops where risk categories and risk category relationships were identified. A visual representation was

then created with the help of the open source ontology tools Protégé 5.0.

Protégé

Protégé is a free, open-source platform that provides a growing user community with a suite of tools to construct domain models and knowledge-based applications with ontologies (Stanford Centre for biomedical informatics design). At its core, Protégé implements a rich set of knowledge-modelling structures and actions that support the creation, visualization, and manipulation of ontologies in various representation formats. The Protégé-Frames editor enables users to build and populate ontologies that are frame-based, in accordance with the Open Knowledge Base Connectivity protocol (OKBC)

IV. Experimental Data

The workshop data provided 157 individual risk instances of the entity Risk, divided into sixteen subcategories.
A listing of all subcategories and the number of different risks from each subclass is presented in the table below. In the ontological view, each risk only belongs to one risk subclass but it is expected that as development of the ontology progresses, risks will be associated with multiple subclasses. Thus, each risk consists of an identification number of the subclass, sequence number, and a short label name.

Table 3 lists the Entities and Object Properties of the ontology. For the purpose of brevity, all sixteen subclasses are not included in the table. The risk subclasses are shortened with <risk subclasses> and there can be three different types of properties that link risk subclasses with other subclasses.

Table 2: Risk categories and number of risks identified in workshops

Risk subclass	No. risks
R1. Strategy Risk	34
R2. Reputational Damage Risk	5
R3. Design Risk	0
R4. Vendor Risk	9
R5. IP Risk	2
R6. SLA Risk	26
R7. Staff Risk	6
R8. Practices Risk	15
R9. Disaster Recovery Risk	4
R10. ROI Risk	4
R11. Requirements Risk	5
R12. Selection Risk	12
R13. Cost Risk	4
R14. Contract Risk	27
R15. Transition Risk	3
R16. Psychological Risk	1
Total	**157**

Table3: Object properties

Entities	Object Properties
Risk	Has Subclass <risk subclasses> Is Define by Theory
Theory	Define Risk
<risk subclass>	has Weak Relationship <risk subclass> has Medium Relationship <risk subclasses> has Strong Relationship <risk subclasses>

V. Implementation and Results

Protégé can be used to better represent the connections between entities. Protégé uses yellow round marks to indicate entities and purple diamonds to mark individual risks. Unfortunately, it's not feasible to present all relationships between all sixteen risk subclasses, one hundred and fifty-seven risks individual and their

corresponding theory entities. We decided to use few examples to illustrate the mapping that would clarify the structure of the ontology.

A. Creation of class and subclass

Classes represent concepts in the domain and not the words that denote these concepts. Here top down development process is handled which starts with the definition of the most general concepts in the domain and subsequent specialization of the concepts. The classes of ontology may be extensional or intentional in nature. A class can subsume or be subsumed by other classes.

B. Creation of instances

All subclasses of a class inherit the slot of that class. One or more slots can be created for each class. The slots can have either a single value or multiple values.

C. Parent class

This is used to view the parent for the selected class when the user has selected the class completeness. It is used to determine whether the given requirements are complete or not (Fig. 1).

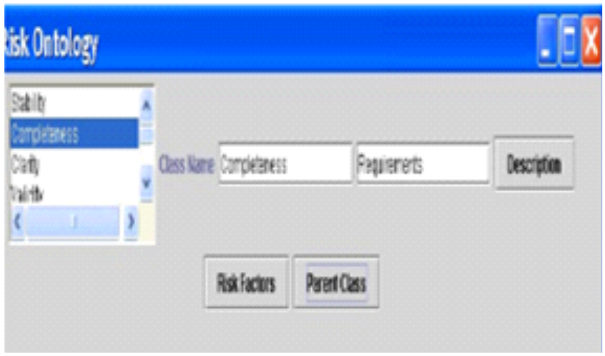

Fig. 1: Parent Class Window

Fig. 2: Description Window

D. Description window

The user can select the class and if he wishes to know more about the selected class then he can click the description button. The above screen shot (Fig. 2) shows the description about the class validity. The class validity is highlighted in the list box.

E. Risk Factors

The risk factor window is used to view the associated risk factors of the selected class. The risk factors of the selected class are indicated below. The risk factors listed below are by no means complete in any aspect. It is only a small indication about the possible risks associated with that particular class.

F. Parent Class Interface

The parent classes are listed in the list box. The user has to select a parent class from the given list. Then he can get a list of all the child classes for the selected parent class. This will facilitate to know what the subclasses are and also to observe the pattern of super-sub class hierarchy.

G. Graphical view

In Figure (3), **R10 Return on Investment**, risk subclass of **Risk,** was defined to have a strong relationship between risk **R2 Reputational Damage Risks** and **R1 Strategy Risks**. In Protégé these relationships are defined by the object properties, in the example, the entities have an object property **hasStrongRelationship.**

The arrows in the Fig. 3 show the direction of the relationship. The **R10 risks** is a subclass of entity *Risk*. The edges leaving the **R10 risks**-entity connect the risk individuals, **R10.1, R10.2, R10.3 and R10.4** to the risk

subclass. The dashed line from risk category to risk category defines the relationship property. In our example the line indicates that the entities have a property ***hasStrongRelationship***. The property ***hasStrongRelationship*** as well as the other property defining relationship strength are *symmetric*. Asymmetrical properties such as ***isDefinedBy*** are defined to have an inverse version. ***HasSubclass***-property is asymmetric but it is system defined and the research team created no inversion property for it. For clarity, the illustration only shows the individual risks assigned to **R10 ROI risks.**

Existing theories were then utilized as a method to develop and map the empirical data (risks and risk categories) from the workshops. Protégé allowed us to map entity-to-entity relationships as illustrated with the relationships between the subclasses. It also allowed us to map individual-to-individual relationships or individual-to-subclass relationships. For example, the individual risks and theoretical relationships are linked to their subclasses by the property **hasIndividual**. An example of an individual-to-individual relationship is the connection between theories and risks.

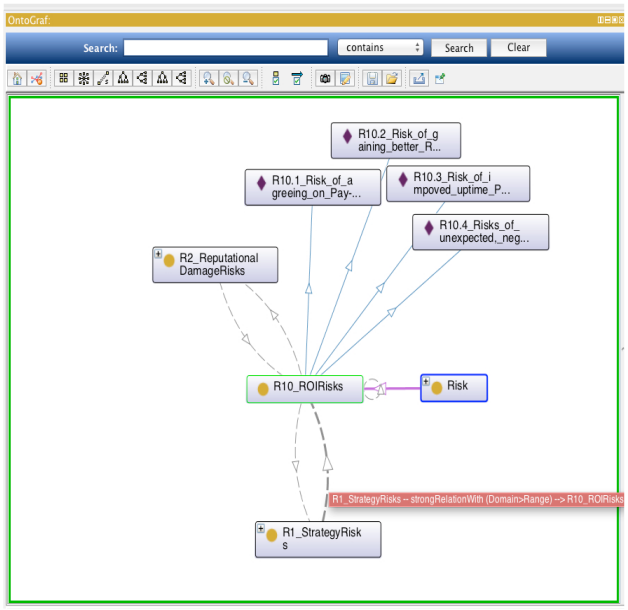

Fig.: 3 Relationship between risk categories

Figure (4) shows the mapping of **Transaction cost theory**, **Agency theory** and the **Resource based view** to individual risk entities. Here the expression powers of the ontological language used is illustrated by showing that **R4.4 Risk of vendor opportunistic behaviour** as defined by both **Agency theory** and **Resource based view,** mapping theory relationship entities to one individual risk entity.

In addition, figure 4 also shows that **Transaction cost** defines, amongst other risks, **R13.1 Risk of cost overruns**, connecting the theory relationship entity to more than one individual risk entity. The same risk is also defined also by **Resource based view** as the model allows us to connect the individual risk entity with multiple other entities, forming one to many relationship connections.

Similarly, one to many connection is demonstrated when the entity **Transaction cost** is mapped to define multiple other risks, for example **R13.4 Risk of hidden costs**, **R1.20 Risk of complex technological environment** and **R1.20 Risk of untested technological environment**. The modelling language and tool choice allows us to model many to many relationships for entities and allows relationship between different entity levels such as classes, subclasses or individual instances of an entity.

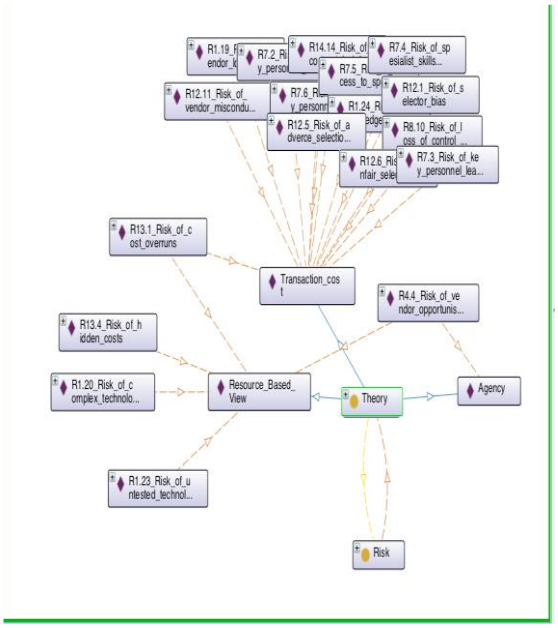

Fig. 4: Theory mapping to individual risks

CONCLUSION

We have described an ontological view of IT sourcing risks based on data sourced from skilled and experienced practitioners as well as the existing available theory and current research. The ontological view will provide the groundwork for the development of a strategic sourcing risk tool for risk assessment. It will help with communication between practitioners through the development of a shared and common understanding of IT sourcing risk, risk categories and their relationships to one another. The relationship between risk categories and the theory mapping to individual risks described in the paper has shown the expression power of the ontology language. The use of ontology during this processes to improve the way of solving the problem in order to achieve a "win-win" in a more effective and friendly ways.

FUTURE WORK

For future work, this research can be enhanced by developing additional methods for risk control, analysis and risk planning.

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