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# DEVELOPING AN ONTOLOGICAL VIEW OF OUTSOURCING

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# DEVELOPING AN ONTOLOGICAL VIEW OF OUTSOURCING RISK, RISK CATEGORIES AND THEIR RELATIONSHIPS USING PROTÉGÉ AND OWL

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## Abstract

*An understanding of information technology outsourcing risks, risk categories and their relationships, has been developed over the years from multiple research and theoretical perspectives. These perspectives are not well integrated, however, and do little to develop a common and shared understanding of sourcing risks for organisations. This means that IT sourcing decisions are not well supported by a coherent and well-understood body of knowledge. To start to address the shortcoming, we have conducted three workshops with skilled practitioners and academics to supplement our current understanding of sourcing risk, risk categories and their relationships. From these workshops we have developed an integrated ontological view of sourcing risk which defines the relationships between sixteen risk categories and over hundred and fifty risks, and maps the relationships between them. To facilitate this integrated ontological view we have applied the commonly using OWL and the Protégé-tool to our workshop data..*

*Keywords: outsourcing risk, ontology, agency theory, transaction cost theory, offshoring*

# 1 INTRODUCTION

The management and control of sourcing risks, has been a major challenge within the field of information systems (IS) over a long period of time (Earl 1996; Willcocks et al. 1999; Warkentin and Adams 2007; Herath and Kishore 2009; Yim 2014). Gonzalez et al. (2013) highlight that risk presents a complex series of challenges to IS practitioners and that meeting these challenges is of great importance to organisations. The service range and scope as well as the number of service vendors only adds to the complexity (Jain and Thietart 2013) and presents most organisations with a service integration issues (Deloitte 2013a; ISACA 2014). Current cheap and diffuse technological developments such as cloud, mobile and broadband has meant that a broader range and diversity of organisations are both sourcing and providing IT products and services. Outsourcing practices are changing how modern organisations operate and conduct their business. Customers and vendors are becoming more transparently connected and these developments have highlighted the inter-dependency of both IT sourcing customers and providers especially in relation to their operational security (Rocco Grillo cited in Protiviti 2014).

The transformation of the connections and inter-dependencies between the customers and suppliers of IT products and services has had a direct impact on inter-organizational systems and processes, where multiple vendors and multiple customers must engage in alliances and strategic partnerships. This change has created new and novel benefits and risks for both customers and outsourcing vendors.

While the IT sourcing research to date has been considerable, it is not well integrated. As such, most of the research in the outsourcing domain has not directly addressed a comprehensive definition of outsourcing which included a list of relevant outsourcing risks, their categories and how they relate to each other i.e. a comprehensive ontological view. What do we mean when we discuss IT sourcing risk and how does our definition of risk inform the relationships between risks? This directly impacts the usefulness of the research (to-date) for the practitioner community.

Our paper outlines the first stage of our project that is the creation of a preliminary sourcing risk ontology, which seeks to address the following questions:

1. What do we mean when we discuss outsourcing risk?
2. Can outsourcing risks be comprehensibly categorized?
3. Can outsourcing risks be related to each other through the development of an ontological view?

To address questions 1 & 2 our research project combines what we know from the literature about risks and their relationships, with data collected from outsourcing experts in a series of workshops. From this position of understanding we then answer question 3 through the creation of an ontological view of risks and their relationships by integrating existing available theory. In future research we hope that the ontology can be used as a basis for further research, to identify, clarify and develop a comprehensive model of outsourcing risks and their relationships, that is relevant to practitioners and academics alike.

Firstly the paper discusses the outsourcing literature, existing available theory as well as the method used to build the ontology. Next, the data collection and analysis methods are explained and then our preliminary results illustrate a first version of the ontology. The paper then concludes with a discussion of the potential use of the ontology and the next steps for the project i.e. ontology enhancement and validation as well as the development of a web-based application for risk assessment and risk sourcing.

# 2 OUTSOURCING RISKS AND THEORY

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 (Gonzales et al. 2008, Hirschheim 2009, Goo et al. 2009, Lacity et al. 2010, Gonzalez et al 2013). Research in the area is comprehensive (Herath and Kishore 2009; Nakatsu and Iacovou 2009; de Sà-Soares et al. 2014) and as Bunker et al. 2015 explain "typically include 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". Most of knowledge in the area of strategic sourcing is in the form of literature reviews complemented by a small amount of empirical research conducted in the USA (eg. Kim and Chai 2014), Europe (Lacity et al. 2010) or Asia (Lam 2011; Qin et al 2012). There have been few recent strategic sourcing studies conducted in Australia.

Academic research has also widely discussed theoretical relationships between outsourcing risks. The most discussed theoretical perspectives include Agency Theory (e.g. Sharma 1997) and Transaction Cost Theory (e.g. Dibbern et al. 2008). Some researchers also extend their theory-based discussion to risk mitigation factors, such as Bahli and Rivard (2003), who discuss multiple mitigation strategies related to Transaction Cost Theory. Similarly agency theory's contribution to risk controls via contracts, has been discussed at length by Eisenheardt (1989).

With technical developments gathering pace in the form of cloud, mobile and service offerings and vendors become larger and more multi-national in their offerings, it is critical that we develop a common and shared understanding of what constitutes risk (and the relationships between risks) in strategic sourcing as a matter of priority. IT sourcing decisions are becoming more complex and are being made at all levels within the organization from senior management to local operations managers and from IT specialists to general purchasing managers. IT vendors and service providers are becoming more strategically important to the organisations that use their products and services just as conversely, customers are becoming more strategically important to vendors. With these factors in mind, all parties to an IT sourcing decision must have a common understanding of what constitutes IT sourcing risk, in order to make effective sourcing decisions.

In order to create a first version of the risk ontology based on the literature only 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 reviews by Dibberns et al. (2004), Lacity et al. (2009), and Gonzalez et al. (2013). From these three literature reviews we have selected and reviewed the papers, which specifically discuss *outsourcing* risks and listed examples of the risks. Papers not directly listing risks and discussing theories related to specific risks were excluded from the development of our ontological view. Table 1 provides a summary of research that categorises and relates risk through the use of various theories.

| Authors and theory | Risks |
|---|---|
| Jurison (1995)<br>Transaction cost theory | 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)<br>Agency theory | Opportunistic behaviour. |
| Duncan (1998)<br>Resource-based view | Market and vendor bases hazards: vendor opportunistic behaviour; hidden costs.<br>Uncertainty/complexity: rapid technology change; opportunism; inadequate service over time.<br>Expected cost savings not realized. |
| Gonzales et al. (2010)<br>Agency theory<br>Transaction cost theory | Agency: hidden costs; deficient quality; risks related to language; cultural, political, and legal problems.<br>Transaction cost; poor infrastructure; different time zones; deficient quality; risks related to language; cultural, political, and legal problems. |
| Elango and Chen (2012)<br>Transaction cost theory | Contextual risks (i.e. environmental risk).<br>Relational risks: risk of not achieving co-operation between partners; partner diversity; differences in partner goals and contributions; poor joint venture management capability.<br>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. |

*Table 1. Risk categories and relationships by theory*

Research focusing on risk relationships by theory also includes issues such as risk identification as well as risk assessment (Lyytinen et al. 1996; Willcocks and Margetts 1994). The risk identification and assessment literature highlights outsourcing models appropriate for an individual information technology project or an information technology function outsourced to third party vendor. Recent developments also include service-based outsourcing, such as IT and cloud-based services (Marston et al. 2011, Gill et al. 2015). These new service models can potentially introduce new risk types but research has yet to adequately address the strategic implications of these new ways to outsource.

Little research has been conducted on the application of practitioner frameworks such as COSO or COBIT (with the exception of Paape and Speklè 2012)). The lack of research of the use of the frameworks is surprising, considering practitioners have utilised such frameworks in their organisations for many years.

We now go on to explain how we attempt to overcome these research shortcomings through the development of an ontological view of IT sourcing risks.

# 3 RELEVANCE OF AN ONTOLOGICAL VIEW OF OUTSOURCING RISKS

Ontologies are, in a philosophical sense, the study of the nature and origins of entities that fundamentally exist for a particular discourse. In the IS/IT context they are defined as "shared understanding of some domain of interest which may be used as a unifying framework to solve the above problems in the above-described manner" (Uschold & Gruninger 1996, pp. 96). The goal of ontology, according, to Uschold and Gruninger (1996), is to provide shared understanding for human communication as well as establish inter-operability between systems.

Ontologies vary from formal to informal representations and from wider scope to a specific domain. Ontologies consist of *concepts* and their *relations* in a specific *context* (Staab & Studer 2010). As our research looks into ways to categorize risks e.g. the concepts, and find relations between these concepts, an ontological representation was best suited for the task.

### 3.1 Language Selection for Ontology Development

In development of applicable and relevant outsourcing risk ontology, we examined a few different approaches taken by other researchers. One approach was to create a new ontological language. For example, Chao-Peng and Batista-Nunes (2009) mapped risks into domain ontology without using any of the existing ontological languages, resulting in the ERP risk ontology REPO. Other, more common approach was to rely on the existing, more widely known languages such as Web Ontology Language (OWL). For example Lykourentzou et al. (2011) and Cuske et al. (2005) had utilized OWL when discussing Operational Risk Management as well as (ORM) for business function ontology (Lykourentzou et al. 2011) and technology risk measurement (Cuske et al. 200).

We decided on the use of OWL as a well-tried and tested approach. Web Ontology Language (OWL) (Bechhofer 2009) is often associated with semantic web applications (McGuinness & Van Harmelen 2004). OWL can be represented as graph-based data model. These graphs consist of nodes and edges where the nodes correspond to objects and the edges represent the properties or relations of the objects (Noy et al. 2001).

The advantage of using OWL over other languages to develop our ontological view of sourcing risks lies in its powerful graphical representation as well as its prominence in semantic web development. Semantic databases are an area that may have beneficial application within risk research in the future. Previously encouraging ontological developments along with the availability of the graphical ontology management tool, Protégé (for example: Noy et al. 2001), made OWL a clear choice for our modeling purposes. Visual graph representation capabilities that the tool provides ensure that the ontology is easily understood and explained for stakeholders who might be less familiar with the ontology concept. The ontology tools, such as Protégé also provide means for definition and modification of different relationships. For example, a spreadsheet file would become very complex when relationships between entities are for example form one to many or from many to many.

## 4 RESEARCH METHODS

The objective of our ontological view was 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 chose to hold a number of workshops across 2014 with a diverse range of participants representing a variety of perspectives (see Table 2). It must be noted that all academic workshop participants were also experienced practitioners in outsourcing domain.

| Titles/Roles | Practitioners |
|---|---|
| Director | 4 |
| Information security manager | 1 |
| Legal council | 1 |
| Project manager/technical lead/practice lead | 4 |
| Professor/Senior lecturer/lecturer | 6 |
| Total | 16 |

*Table 2. Workshop participants*

As a preparation activity for our workshops, an “expert walk-though” session was also conducted with a skilled outsourcing practitioner where a preliminary list of risks was created. The session provided

the research team with "base-line" ontological view i.e. list of categories and their relationships, which was a solid basis for the subsequent workshop activities.

Two workshops were then held with a mix of practitioners and academics that had expertise in IT risk management and control. In order to ensure optimal data gathering from participants within the workshops over a short time period the Quality Function Deployment (QFD) method for workshop facilitation was applied (e.g. Crow 1994; Akao 2004).

A third workshop was also held with a sub-set of practitioners and academics, to apply the risk lists generated from the first two workshops to an IT sourcing case study, in order to test their relevance. The lists were applied to the sourcing case with participants playing a variety of roles in order to see how a given perspective on risk might have a moderating influence on what we know about IT outsourcing risk. Table 4. Provides a summary of workshops and workshop activities.

| Workshop | Workshop activities |
|---|---|
| First workshop: introduction and risks | Gathering requirements for the risk ontology ("If you had a risk ontology, what would you use it for?")<br>Mapping the requirements under different requirement categories<br>Risks written on PostIT notes |
| Second workshop: risks analysis | Additional risks written, one risk per one PostIT note<br>Risks categorised under risk categories<br>Connections (weak-medium-strong) between the categories identified |
| Third workshop: research team internal analysis | The Protégé-mapping reviewed |

*Table 3. Workshop activities*

The workshop data from the first two workshops included transcriptions of discussions as well as the risks and requirements PostIt notes. The risks were transferred from the PostIt notes into a spreadsheet format and from the spreadsheet to Protégé. A Protégé file was then shared with the research team for comments and feedback. The mapping of risks and categories is discussed in detail the following section.

# 5 RESULTS

The first version of our ontological view of sourcing risks was based on our review of the sourcing risk research, existing available theory as well as data gathered from our workshops. We identified risks, risk categories and risk category relationships. A visual representation then was created with the help of the open source ontology tools Protégé 5.0 and WebProtégé.

In following section we will detail what risks, risk categories and relationships were defined by workshop participants as well as from the existing literature and theory. We will then explain how the risk data was transformed into OWL format. Lastly we will present the preliminary version of the risk and theory ontology.

## 5.1 Workshop Data

The workshop data provided the research team with 157 individual risk instances of the entity Risk, divided into sixteen subcategories. For additional clarity, each individual risk was assigned an identification number that defines to which subclass it belongs.

A listing of all subcategories and the number of different risks from each subclass is presented in Table 5. In the first version of 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. Some risks were given longer descriptions as an annotation in Protégé to add clarity, if the label was very concise.

| 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** |

*Table 4. Risk categories and number of risks identified in workshops*

### 5.2 Risks outlined in the existing research

As part of our approach to our analysis we selected the risks that previous researchers had linked together with various theories, explaining why these risks occur in sourcing projects. The list of risks and their relationships (via theory) are presented in Table 1 in section 2.

By comparing risks identified in the workshops with the risks identified from existing research, we matched appropriate theories to the risks highlighted in our workshop data. Some risks were defined by more than one theory and many risks were not defined by any theoretical construct. In next section we discuss how Protégé can be used to develop and ontological view of risk, risk categories and their relationships.

### 5.3 Ontological structure

We quickly realised that the relationships that were identified in the workshops between risks and risk categories were hard to illustrate in a two-dimensional taxonomy. When presenting one-to-many or many-to-many relationships, ontology models are more flexible than matrices or lists. The Protégé-tool provided us with an easy way to map out the relationships between risks and different risk categories by mapping to existing available theories as well as workshop data.

Ontologies constructed in Protégé consist of entities, object properties, data properties, annotation properties and individuals.

The two main *concepts* or *entities* within the outsourcing risk ontology (as defined using OWL) are *risks* and *controls*. Additional concepts that are related to these two main concepts are *theories*, *organisations*, and *industry* but in order to best illustrate the idea of ontological view of risks and not the whole ontology itself, we decided that only *theories* and *risks* would be discussed.

The concepts presented in the first version of the ontology are derived from the first two workshops.

The ***first workshop*** output consisted of a long list of individual risks and their risk categories. One risk can exist in multiple categories. The risk categories have *instances*, (in Protégé termed *individuals)*, which represent the risks that were written on the PostIt notes by the workshop participants. Individual risks consist of a short *label* and a *longer* description of that risk.

The risk categories were defined as *subclasses* of an entity *Risk* in the ontology. Risk subclasses are based on the risk categories sources that were generated from the workshops. The subcategories were assigned identification numbers to make the connections of the individual risk clearer to human minds. In additions to manual numbering, each ontology object has its own unique **uniform resource identifier** (URI, "short strings that identify resources in the web (Connolly 2006)) assigned by Protégé.

The ***second workshop*** identified more individual risks and added these to the list but participants also attempted to define the connections between the risks and any additional risk attributes. Risk relationships were also discussed and agreement as to risk relationships emerged i.e. strong, medium, weak or none.

Outputs from the first two workshops were used to generate the ontological view with Protégé using Object Properties. The object properties in the ontology can be either symmetric or asymmetric. OWL does enable other types of object properties but they were not included in first version of the ontology. Table 7 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.

| Entities | Object properties |
|---|---|
| Risk | **hasSubclass** <risk subclasses><br>**isDefinedBy** Theory |
| Theory | **defines** Risk |
| <risk subclasses> | **hasWeakRelationship** <risk subclasses><br>**hasMediumRelationship** <risk subclasses><br>**hasStrongRelationship** <risk subclasses> |

*Table 5. Object properties*

The visualisation tools in 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 is not feasible to present all relationships between all sixteen risk subclasses, one hunderd and fifty seven risk individual and their corresponding theory entities. The graph that presents all the relationships at once is too complex and a table representation would require a very large and complex spreadsheet. Instead, we decided to use few examples to illustrate the mapping that would clarify the stucture of the ontology. The full model can be obtained from the authors.

Figure 1. illustrates how properties are presented in Protégé. In our example, **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 Figure 1 show the direction of the relationship. The **R10 ROI risks** is a subclass of entity *Risk*. The edges leaving the **ROI 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 versions: *defines*. ***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.

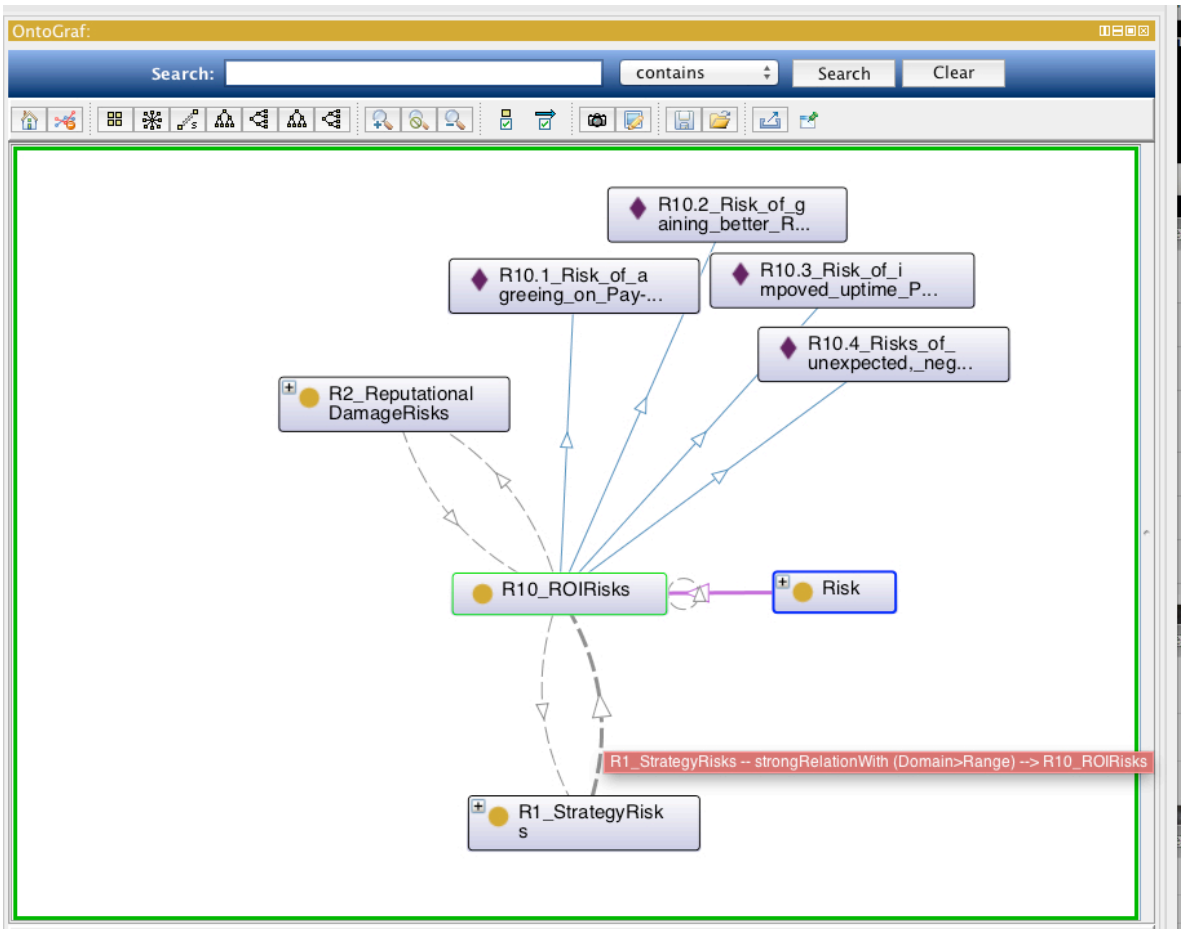


*Figure 1. Strong relationship between risk categories*

In Figure 2 we show the mapping of **Transaction cost theory**, **Agency theory** and the **Resource based view** to example individual risk entities. Here the expression powers of the ontological language used is illustrated by showing that **R4.4 Risk of vendor opportunistic behavior** as defined by both **Agency theory** and **Resource based wiew,** mapping theory relationship entities to one individual risk entity.

In addition the Figure 2 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 modeling language and tool choice allows us to model many to many relationship for entities and allows

relationship between different entity levels such as classes, subclasses or individual instances of an entity.

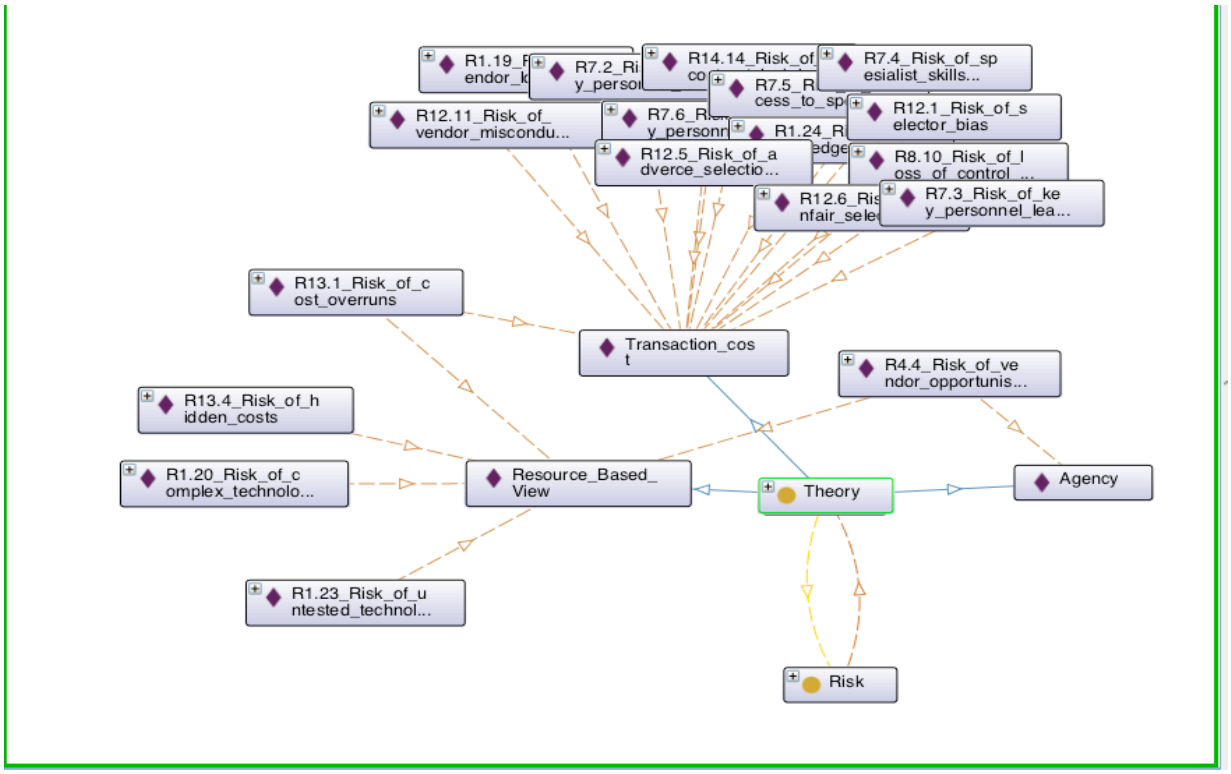


*Figure 2. Theory mapping to individual risks*

# 6 DISCUSSION AND FUTURE WORK

The first version of our ontological view of outsourcing risks, risk categories and their relationships provides a base of understanding for academics and practitioners as well as a potential tool to expand our knowledge. Our next step will be to expand the ontology to include a set of controls, which will be derived from a new series of workshops with practitioners in 2016 as well as existing literature on the subject. We are anticipating that the ontology will map relationships between controls and risks and that various available theories will be used to explain and examine these relationships. OWL permits connections from one to multiple instances and multiple to one. The language is suitable for describing the same objects semantically with multiple names, as long as they are connected with the right Object Properties. For example, if an individual risk is identified but it already exists in our ontological view (but is referred to in different ways) both entries will be valid as long as the connection describing them as duplicates is in place. The mapping practice ensures that the ontological view will encompass all variations of description but will still remain clear and useful as a tool that encompasses differing perspectives and terminology.

The use of OWL provides a basis for the development of future semantic web applications such as websites that can be used to source more risks directly from practitioners via the web. A website version of the ontology would allow us to make further connections between risk and control constructs *interactively* by involving the wider academic and practitioner communities. Another application of the ontology is the development of a risk taxonomy tool that could be used for assessment of project risks.

### 6.1 Limitations and future expansion of the ontology

There are multiple aspects of outsourcing risks that our current ontology is yet to include. In project management risks are commonly classified by their likelihood and their impact but this was not discussed during the workshops, as these factors are context driven. We hope to pursue these factors in latter workshops. The future workshops should also explore the different outsourcing domains and the risk controls that are related to each domain.

In this paper we also decided to exclude the risk perspectives even though this area was discussed in the workshops and modelled in the ontology. Risks can be related to strategic decisions or to operational aspects of the outsourcing endeavour. An individual risk can be a risk from a vendor or a client perspective or both.

Currently the modelled relationships between the risks are based on the workshop data where as the link between theory and risk is sourced from the literature. This provides interesting insights into how theoretical explanations of the risks overlap and complement each other. More research in this area should be done once the model is more complete.

# 7 CONCLUSIONS

Our paper describes the first exploratory steps towards the development of a comprehensive IT sourcing risk and control ontological view. The early version of the ontological approach links together the entities of the outsourcing risk domain; risks, risk categories and theories discusses in literature. The strength of the ontology format lies in the flexible linkage between these entities, expanding the understanding of the relations between the concepts.

In addition to the limitations of the ontology, discussed in previous section, there are research method related limitations that should be considered. The data obtained in the workshops is based on the experiences of those participants and while every attempt has been made to include a variety of representatives from different roles and different industries, we feel that more could be done to broaden our data collection. Most of the of data collected from the workshops focused mostly on risks and more work needs to be done in subsequent workshops to focus on controls which are to eventually become an important extension of our ontological view.

We have described the first version of an ontological view of IT sourcing risks based on data sourced from skilled and experienced practitioners and academics as well that existing within current research and existing available theory. The project will continue to expand the ontological view based on empirical, qualitative research and practitioner input. 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 and academics through the development of a shared and common understanding of IT sourcing risk, risk categories and their relationships to one another.

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