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Conceptual Approach for Research of Organizational Networks

Master's Thesis

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The research settings, where project teams consisting of researchers from different scientific fields, and working together to provide solutions to the issues of networked partner organizations, are challenging in terms of communicating and accumulating research knowledge. Although the focus of the research is shared, difficulties emerge beacuse it is explored from different scientific perspectives, relying on theories and methods that do not match with others. This observation was made during research work conducted at the University of Lapland in projects that concentrated on business networks in the manufacturing and tourism industries. The organizations in these commercial environments typically seek benefits from information technology to intensify the network-wide business relationships and to improve knowledge-intensive operations and management.

The main problem is that new projects cannot easily benefit from the results of past projects because the collected research materials, analyses and models are not easily found and they are difficult to align with the objectives of new projects. In this work, to resolve theses issues, conceptual models and related approaches have been analyzed and elaborated to support crossdisciplinary research on business networks, and at the same time enable the re-use and sharing of research knowledge.

The solution presented in this Master's thesis has been developed by relying on conceptual modeling approaches to analyze business networks. As a result, general concept model of inter-organizational environments has been built that focuses on the integrative relationships in them. Further, accompanying research process that enables the conceptualization and annotating of the project research outcomes has been constructed. This helps in organizing and sharing research information between researchers and stakeholders. Additionally, metadata descriptions and controlled vocabularies based on semantic web technologies are defined to align research constructs originating from different projects and to support research knowledge management.

Keywords:
crossdisciplinarity, project research, concept modeling, organizational networks, knowledge exchange relations, information technology, semantic web

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Tutkimusympäristöt joissa eri tieteenalojen tutkijat toimivat yhdessä ratkaistakseen verkostoissa toimivien kumppaniyritysten ongelmia ovat haastellisia tiedonvaihdon ja tutkimustiedon keräämisen kannalta. Vaikka tutkimuskohde on yhteinen, tutkijat lähestyvät sitä omien tieteidensä näkökulmasta käyttäen siihen teorioita ja menetelmiä jotka eivät ole yhteensopiva muiden kanssa. Lapin yliopistossa tehdyn tutkimustyön aikana nämä ongelmat tulivat esiin, kun useissa monialaisissa projekteissa tarkasteltiin liiketoimintaverkostoja sekä teollisuusliiketoiminnan että matkailun alalta. Projektien kohteina olevissa verkostoissa yritykset pyrkivät tyypillisesti hakemaan verkostotoiminnasta hyötyjä informaatioteknologian avulla tehostaakseen liiketoimintasuhteitaan ja siten edesauttamaan johtamiseen ja operatiiviseen toimintaan liittyvää tiedonkulkua.

Pääasiallinen ongelma näissä ympäristöissä tapahtuvassa tutkimuksessa on, että uudet projektit eivät helposti pysty hyödyntämään edellisten projektien tuotoksia, koska aikaisemmin kerättyä tutkimustietoa, analyysejä tai luotuja ratkaisumalleja ei ole saatavilla siinä muodossa että ne voitaisiin ottaa uuden tutkimuksen pohjaksi. Tässä työssä on tarkasteltu ja kehitetty käsitteellisiä malleja ja niihin liittyviä menetelmiä, jotka tukevat monitieteistä liiketoimintaverkostojen tutkimusta, ja samalla tekevät mahdolliseksi hyödyntää jo olemassa olevaa tutkimustietoa.

Tässä diplomityössä kehitty ratkaisu perustuu liiketoimintaverkostojen analysointiin käsitemallintamisen avulla. Tämän tuloksena on luotu organisatoristen ympäristöjen käsitemalli, joka keskittyy integraatiota edistäviin yhteistoimintasuhteisiin, ja kuvattu siihen liittyvä tutkimuksellinen prosessi joka mahdollistaa projektin aikana syntyvän tutkimusaineiston käsitteellistämisen ja lisätiedon liitämisen niihin. Tämä helpottaa tutkimustiedon jäsentämistä ja sen jakamista tutkijoiden ja kohdealueen toimijoiden välillä. Lisäksi työssä määritellään metatietokuvauksia ja rajattuja sanastoja jotka perustuvat semanttisen webin tekniikoihin, joilla voidaan luokitella eri projektien aikana syntyviä tutkimusartefakteja ja hallinnoida tutkimustietoa.

Asiasanat:
monitieteisyys, projektitutkimus, käsitemallintaminen, organisatoriset verkostot, tiedonvaihtosuhteet, informaatioteknologia, semanttinen web

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Most of all, this work is dedicated to my son, the 'dinosaur researcher' Karri Linus, who came to my life nearly 6 years ago. Since then, the question about the meaning of life for me has had its answer!

Rovaniemi, June 2010

Jukka Aaltonen

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1. Introduction

During the scientific work in several projects that have focused on information technology enabled organizational networks, challenges have appeared that relate to the storage, management and the sharing of the research artefacts that were produced. The project teams consisted of researchers from different scientific fields and used their own set of theories and methods to study the target domain. The research constructs in these kinds of multifaceted settings are the many types of end-results and by-products of the research activities performed by the individual scientists. Typically the research process includes phases like collecting data, analyzing the domain, and constructing the solutions. In these particular case-projects, the common domain of interest has been supply chain networks in production industry, and tourism business distribution channels. The data have been collected, and the basic research understanding about these environments have been formed during research initiatives where the common research goal has been to improve the strategic network-wide competencies and intra-organizational operational efficiency of the stakeholders. The role of the author in these projects has been specifically to explore how could these enhancements be enabled by the utilization of information technology, and in which way are the existing information modeling and knowledge management practices beneficial in this. These networked organizational environments have also been investigated from the perspective of other disciplines, like business models, network theory, information security, contract law and software engineering. Based on the concrete case-research experiences, then, the main issues of these multidisciplinary project settings consist of:

- assuring effective communication of research artefacts between the domain stakeholders and researchers,
- enabling the crossing the borders of scholarly disciplines, and
- the management of the project artefacts that supports the cumulation and sharing of research knowledge.

The specific objectives of this work, thus, is to address these challenge by developing a conceptual model that can be used to represent and align research information and knowledge about organizational networks in these settings. Also a practical methodology grounded on semantic web technologies and ontology engineering is presented that supports this kind of information-based modeling in crossdisciplinary contexts.

Mainly this work is based on the practical and model-theoretical lessons-learned in the project-cases where the research scope has been determined by the needs of partner organizations. In the projects, domain of interest has been defined based on the details of the partner consortium, their area of business, and the characteristics of the network in question. Because of this, the project-scoped view of the organizational networks is relatively narrow to focus the research in each case to the stakeholder-specific essential aspects of the real-world phenomena under investigation. Thus, the results of the research projects too, have typically been relevant to the specific target domain only. But from the perspective of the research community (e.g. the project team, or the university research group), it is desirable to be able to carry out a new project relying on the results of the previous ones. To support the research continuity, a more general representation of the target domain could be helpful to, for example, identify the common features of the new research phenomenon and the focus areas of the past projects. This is also in alignment with natural progression of scientific work that builds on the existing models. In concrete terms, doing this means that the commonality of industrial networks and travel business value chains can be seen by using a higher level model that represents the mapping of the corresponding structural elements of each. Thus, the main part of this work is dedicated to the development of the general representation model of organizational networks.

To advance the project research further to benefit from these kind of re-usable models, the second part of this thesis concentrates on analyzing the suitable research activities that help in this. As the past case-studies have been grounded on constructive research approach, the methodological recommendation here extends it with the techniques of conceptual modeling that rely on semantic technologies. This way, all the project-specific conceptualizations and domain-specific artefacts can be described and these annotations stored in a research repository, for example, to be accessible later. The physical storage of the research constructs is not the main focus here, but the definition and the structure of the logical *research space* by which the data about these research artefacts, i.e. the semantic descriptions of them, can be represented.

In summary, the specification of the generic research domain area representation, and the method to collect research data, analyze and conceptualize it to be usable in future projects focusing on organizational networks, is the main contribution of this work. These parts together form the conceptual model for research of organizational networks (CMON). It is a research framework because it defines and proposes both representation model and applicable methods for research in this context. The developed specification of a *research space* (and the semantization of it), particularly, are useful, for example, in analyzing the requirements of collaborative web-based crossdisciplinary research environment.

1.1. Project research background

The underlying motivation of this work is strongly anchored to practical experiences during the scientific work in four successive research projects. The overall goal in them has been to overcome the information and knowledge sharing issues of the stakeholders, and to intensify the strategic and operational co-operation of varied organizational networks situated in the Lapland region. Because of this, the research during these projects was mainly setup to respond to the needs of the project partners with which the Applied Information Technology Unit of the Department of Research Methodology in the University of Lapland in each case formed the individual research consortium. However, in addition to just reflecting and analyzing the results of the projects that aimed to benefit the target organizations, the presentation here also aims to support the cumulation of research knowledge, as well as, advance the sharing of research artefacts between the researchers (and scientific community) in the context of crossdisciplinary scientific environment.

As the partner organizations in each project consortia were mostly small-and-medium sized private commercial enterprises (SMEs), the local economical market situation of the relevant business area naturally formed the background for the network analysis in each case. The specific details of the business relationships of the project partner organizations and the collaborative phase of the overall intra-organizational structure that they were part of are some of the important features that had been explored. The results of these are here used to further characterize and categorize networked business environments in general. They, at the same time, serve as a starting point to analyze networks also in terms of the functional roles of organizations, and from the perspective of information flow characteristics in the wide range of knowledge exchanges between them.

The common denominator of the aggregated whole of the project research work has been the utilization and facilitation of information technology (IT) in the developed solutions implemented in the networked organizations. In alignment with the fact that the project consortium in each case has been formed and co-ordinated by researchers working in a university department that belongs to the Faculty of Social Sciences, the research had been scoped such that besides exploring the technology enablers in local business environments there has been equally strong emphasis on the knowledge-based organizational management and business modeling issues. Therefore significant attention in each project has been paid to support the organizational decision making that aims to improve the network-wide collaborative structure and the dynamic features of the inter-organizational relationship patterns. In general, the alignment of the effects of the transient economical environments and the novel organizational network-wide management practices with the emerging information technology enablers have constituted the essential substance of these scientific studies. The research projects then have produced many types of research data, materials, analyses and solutions that have addressed the case-specific target domain stakeholder needs. In what follows (Table 1.1), these projects are briefly outlined in chronological order, to identify the typical characteristics of the research content that need to be governed in order to support research knowledge sharing and cumulation.

Table 1.1 Summary of crossdisciplinary research projects

Project	Description	Project partners	Type of network	Time span
Business Network Integration (BNI/YVI)	Industrial enterprise network studied from the perspective of process-based business modeling in alignment with information security and systems integration considerations.	University of Lapland, Finland Lappset, Finland LapIT, Finland	Industrial supply-chain network with a focal company in the manufacturing industry.	2005-2007
Interreg III A Nord: Civil Engineering Structures – Assessment, Repair and Strengthening.	IT based development and optimization of construction industry networks.	University of Lapland, Finland Luleå University of Technology, Sweden University of Oulu, Finland Sito, Finland Ramböll, Finland Ramböll, Sweden	In the project the focus was to establish the requirements for future international collaboration with the regional universities and companies that would concentrate on construction industry networks. (only a preliminary analysis of these types of networks was conducted).	2007-2008
Operative Network Integration (ONI/OVI)	Travel industry distribution channel shortening and strengthening by supporting the development and utilization of customized IT service provision solutions.	University of Lapland, Finland Fintravel, Finland WafSolutions, Finland	Tourism network in which the focus was the Incoming Tour Operator in Lapland travel business and several travel service providers, such as hotels and tourism event organizer.	2007
Service Process Management in Tourism Business Networks (SPMiTN/ Provem)	Analyzing information-intensive tourism service provision network-management approaches in order to support organizational CRM-solutions and travel value chain improvements..	University of Lapland, Finland Hullu Poro Oy, Finland Fintravel, Finland WafSolutions, Finland	Tourism network with the same companies as in the OVI with the addition of larger destination management company that provides most of the travel services by itself.	2008-2010

The key idea to pursue to consolidate the diverging approaches used by distinct researchers in different projects, is to focus closely in this work on how the target domain understanding is formed, and in what ways the collected and analyzed research data should be managed to support the building of re-usable knowledge. This topic was partially addressed between the first case projects where preliminary steps were taken to harmonize the research field-specific domain terminologies by the adoption of a conceptual modeling approach for multidisciplinary research environments (MCE) [1][2] developed by the author in collaboration with the project research colleagues. However, the creation of semi-formal conceptualizations of each research field in project work still did not adequately solve the problems of the research knowledge sharing and cumulation. Therefore a more wide-ranging solution was needed. In this work then, some of these research area specific domain analyses are elaborated and generalized to enable the specification of conceptual schemes to represent the research artefacts emerging in project research contexts. The idea is that this way the constructs could be annotated and these representations furthermore managed in the web-based research environment provided, for example, by the existing lab server platform (SoitLab) that has already been in use in the project work. A more detailed descriptions of the subject matter that the wide range of research constructs are concerned with, is given in the chapter where the related theories are aligned with the topics of the research projects.

1.2. Research problem and motivation

Based on the above overview of the past research projects and their goals, the target domain in each of them can be characterized as being a complex and multidimensional phenomenon that has been simultaneously viewed from diverging stakeholder and scientific perspectives. The focus of this thesis, however, is to seek solutions to the problems that the research teams have confronted in the practical project work focusing on different types of organizational networks. The context in which these past and on-going scientific explorations have been conducted is depicted below in terms of the project research activities, methods, models and tools (Figure 1.1).

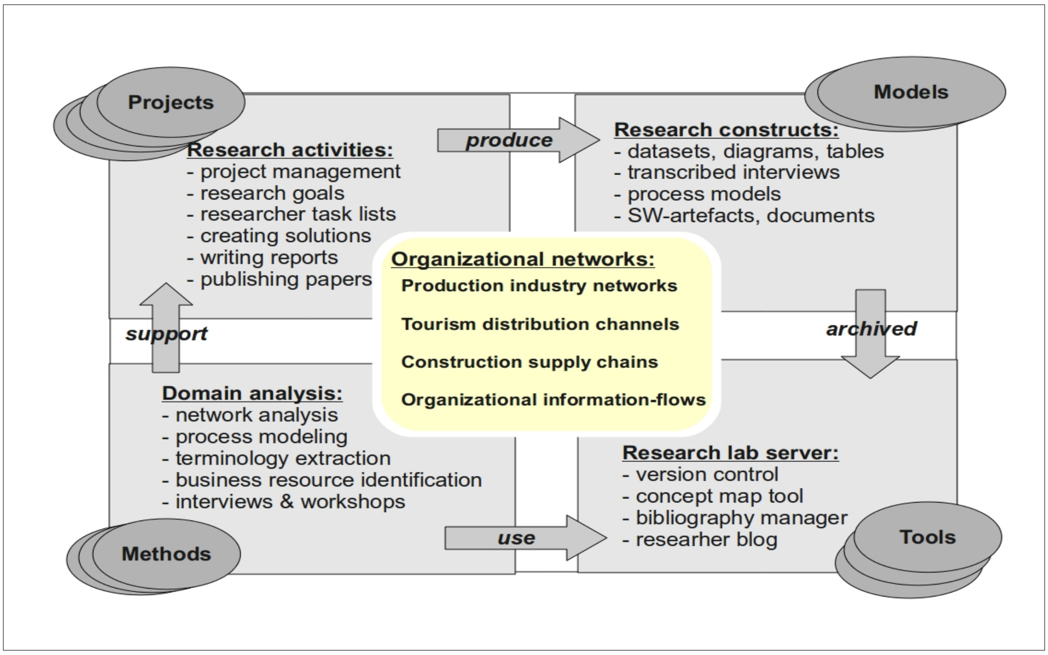

Figure 1.1 Project research activities, models, methods and tools

In each project the activities performed by the researchers from different fields of science have produced many types of research constructs, like datasets consisting of various media files, enterprise documents, transcribed interviews, also models and analysis of the target networks and the member organizations, and process models and software engineering artefacts. The researcher assignments were based typically on task lists construed by the project management mainly to respond to the needs of the partner organizations. The individual researchers then have relied on their own set of scientific theories, models and methods to design solutions of different levels of abstraction to these issues, and to write project reports and publish scientific articles. The crux of these methods are many data gathering and modeling approaches by which the research fields have tried to form an understanding about each target domain (e.g. industrial networks, tourism value chains and intra-organizational social networks). In this kind of *domain analysis*, for example, process modeling techniques, network analysis methods and business resource identification practices have been employed. The tools that the researchers typically used were the office suite programs installed in their personal computers like spreadsheet, word-processing and presentation applications. In the end of the first project a lab server was acquired which hosted a version control system (Subversion), concept map drawing environment (CmapTools), and a weblog software (WordPress). The information modeling research area of the author thus also included the responsibility to administer, configure and manage this server platform mainly in order to provide a shared storage space for the research materials, documents and models produced by the project team members.

On grounds of the above, a wide variety of theoretical and practical challenges can be identified in this kind of multidisciplinary project research context. The issues arise despite the different research fields explore a common target domain (i.e. the inter-organizational network). Further, it is the multifaceted perspectives originating from the specific theories, methods and models used in distinct scientific fields that impose several problems to the research community seeking benefits from this kind of disciplinary triangulation:

- the real-world phenomenon do not naturally follow the existing scientific disciplinary distinctions
- domain stakeholders, i.e. the business organizations, most of which were also members of the project consortiums rely mostly on hands-on operational real-world conceptions and use pragmatic terminological conventions in speaking about the domain area of which they are an integral part. In contrast to this is the analytical approach of researchers as representatives of scientific community, who among other things, try to describe, interpret, explain, and eventually optimize the structural and behavioral features of the domain of discourse
- challenges in enabling effective communication and information sharing between the researchers and the partner organizations, because the reports and documents are typically prepared in ad-hoc manner to only respond to specific needs of the business stakeholders.

In terms of improving the overall quality of the project co-operation, the mutual collaboration of research team members plays a key role. Thus, the scientific knowledge use, creation and accumulation in cross-project, cross-disciplinary environments is considerably easier if the researchers are able to commit to some common modeling practices and to rely on background theories that are familiar to others. Also, it is beneficial if the research fields are willing to strive to align their individual research orientations, and seek alongside with their colleagues such tools and practices that have already been proven suitable by the scientific community.

1.3. Research question

This work then, is motived by the need to respond to the above general research setting-rooted issues, and at the same time to address the amalgamate totality of the domain and partner organization specific phenomena outlined in the above project background descriptions. Thus, the subject matter of this research is the multidisciplinary project work which has concentrated on the IT-enabled inter-organizational information-intensive environments. Accordingly, the main goal is to support the cross-project scientific knowledge building and accumulation while improving the information sharing between the researchers and the target domain stakeholders. Therefore, the top-level research question can now be formulated as:

> *What kind of conceptual domain models, methods and semantic technologies can be used to achieve research knowledge sharing and cumulation in cross-project research settings focusing on organizational networks?*

To support the identification and development of an evaluation criteria for the general research constructs resulting in this type of multi-perspective scientific setting it is useful to attempt to categorize the advancements made in each project case (along with the original problem area definitions) in terms of the following general research related dimensions: (1) crossdisciplinarity, (2) cross-project artefact cumulation, (3) and collaboration between stakeholders and researchers. With the help of these generic research-related problem-space characterizations, the overall problem area is complemented with an additional emphasis in this work to review the existing approaches to the following sub-questions:

1. ***crossdisciplinarity*** [cross- and multi-disciplinary research considerations]:

   What kind of research orientations, conceptual modeling approaches and metamodel representations simplify the "crossing-borders" efforts of the researchers and advance the research artefact sharing between distinct research fields and areas, and scientific disciplines?

2. ***cross-project artefact cumulation*** [research metadata and repository requirements]:

   What kind of metadata specifications and repositories could be used to describe and store the various research artefacts (e.g. the problem statements, collected data, knowledge representations and analyses, and implemented methods and solutions) to support the research construct re-use and scientific knowledge cumulation between different research projects?

3. ***stakeholder/researcher collaboration*** [widening the conceptual correspondence]:

   In what ways should the research data be collected, and how should it be represented so that the research understanding of the phenomenon corresponds to and correlates with the intra-organizational and network-wide stakeholder conceptions (i.e. making sure that correct and meaningful terminology is used when speaking about the domain area)?

In addition to seeking solutions to these generic topics in form of novel, concept-oriented research models and practices, the work here also simultaneously aims to document and discuss several approaches that had been used to address some of the more specific, project-related, research problems. The project-specific questions have mostly been phrased in the initial stages of each project work, for example, during the writing of the funding application, the work package formulation or in the project domain area specific research goal and task definition phase. The analysis of these constructs during the presentation will be beneficial in assessing the validity of the practical, conceptual and methodological recommendations proposed in this work.

1.4. Research approach and methodology

The important *issues of concern* identified and outlined above (i.e. the crossdisciplinarity, artefact cumulation, and conceptual correlation) in relation to the formulation of the overall multi-dimensional research question focuses the attention of discussion in this section to the features of the scientific approaches and methodologies available for the practical research. Even though a detailed and extensive research methodological examination and review here is out of the scope, it is possible to situate the overall research work and the individual project case studies with the help of the following *research continuum matrix* (see Table 1.2). In respect to the *range of study,* this dimension reaches from the most specific and instantaneous case-focus to more widely and generally applicable abstractions and eventually to universally recognizable and validated truths or laws. Mapping the identified issues of concern to these ranges by specifying the typical research-related conceptions in each intersection (i.e. the cells of the matrix) makes it possible to represent the essential features that the selected research orientations or modeling practices should be compatible with. In other words, the idea in laying out this simple two-dimensional research continuum is to provide support for the justification of a selection of a particular research approach, methodology and modeling paradigm from a range of available candidates.

Table 1.2 Research continuum: mapping issues of concern with range of study

Issue of concern / Range of study	**Specific (instances)**	**General (abstractions)**	**Universal (recognition)**
	project-scoped	*research domain-related*	*scholarly reach*
crossdisciplinarity	research field	domain specific or intra-disciplinary	multidisciplinary scientific tradition
artefact cumulation	between research tasks, inside work packages	research consortium or level of research program	scientific knowledge
scope of correspondence	individual researcher	overall research area including the target stakeholders	general public, scientific community, communities of practice (CoP)
Researcher motivation and orientation	simplicity, ease of use, exactness, familiarity, efficiency	commitment, comprehensibility, shareability	recognizability, approvability, valid-ability

In the past projects, typically only such methods and tools with which the researchers are already familiar have been used, to produce research field or project work package specific models. The aim of this work, however is to enable the broadening of the reach of the research by supporting the creation and re-use of more general and sharable artefacts. Widening the scope and the unit of the analysis of the study this way has the consequence that it requires changes in the orientation and motivation of the research community, too. In the case of project-scoped research, the individual researcher selects methods and models that are simple, easy to use and are efficient in terms of the work at hand. But when the results of the performed activities are to be more generally applicable, the practical research needs to be based on the heightened commitment to team work, and thus the comprehensibility and shareability of the models should become integral part of the objectives of the research. Logically, then the most demanding setting to ensure the availability of the solutions and theoretical relevance of the scientific work originate in the context of universal reach of the research, where the recognizability, approvability, and validity of the methods and constructs should be attained. At the same time with these challenges, most of the identified issues of concern should also be addressed in order to enable the crossdisciplinary scientific exploration and cross-project artefact cumulation that supports researcher and target community stakeholder communication and collaboration.

To be successful in all this, it seems that a necessary condition in progressing from the instantaneous specificity level of a study to a more general level, the individual members of the research community (for example, the project researchers) should be committed to make genuine efforts to overcome their personal premises, cultural differences and scientific perspectives in crossing the borders of the research fields, domain areas or disciplines. In *design sciences* [3], for example, the collective creation and promotion of shared research artefacts and results enables the cumulation of scientific knowledge. The research methods used in the projects were mostly in alignment with the constructive research approach (CRA) [4] that emphasizes the importance of showing the practical and theoretical relevance of the identified problem and the construed solution. Thus, it is reasonable to try to follow similar principles in this work (that studies the properties of exactly such project research constructs). A more detailed account of CRA is given while discussing the methods and tools applicable to the concept-oriented research process proposed in this work. Finally, in respect to the methodological choice, it is the *classical theory of concepts* that lay ground to a natural modeling approach for this kind of crossdisciplinary settings where specifically the scope of share-ability and comprehensibility of the research constructs should be extended. According to theory, the concepts have definitional structure (i.e. they are composed of simpler concepts) that express necessary and sufficient conditions for an entity of falling under it [5]. In its paradigmatic form, the related philosophical method of *conceptual analysis* is an modeling approach that "offers definitions of concepts that are to be tested against potential counter-examples that are identified via thought experiments" [5]. Now, comparing the conceptual analysis based on this classical theory of concepts that enables an unified treatment of concept acquisition, categorization and reference determination [5], with the general steps of scientific research work of data collection, analysis and model evaluation, the mapping showing the close linkage of these both (see Table 1.3 below) can be construed.

Table 1.3 Comparing the phases in conceptual analysis and research work

Conceptual analysis [5]	Research tasks
acquisition - process in which new complex concepts are created by assembling their definitional constituents	**collection -** gathering of theoretical and/or domain specific research data
categorization - psychological process in which a complex concept is matched to a target item by checking to see if each and every one of its definitional constituents applies to the target	**analysis** - deductive or inductive reasoning and argumentation or interpretative conclusions that aims in conceptualizing, understanding, describing, explaining the research domain, also changing it by means of re-engineering, optimizing, producing proposals for action
reference determination - matter of whether the definitional constituents do apply to the target	**evaluation** - the assessment and measuring the exactness, adequacy and overall quality of the proposed research solution in terms of both target domain stakeholder and research community criterion

Besides showing how the main tasks in scientific inquiry and model and design creation can quite naturally be aligned with he methods of conceptual analysis, the entity-based methodological research orientation can further be justified by the fundamental role of tacit dimension in the human intellect and understanding. In the conception of *tacit knowledge* [6] "we form, intellectually and practically, an interpreted universe populated by entities, the particulars of which we have interiorized for the sake of comprehending their meaning in the shape of coherent entities". The main idea in this context is that, the scientific knowledge, specifically, does not only consist of explicit statements and theories representing the reality as it is, but also consists of elements, the structure of which are based on phenomenon beyond direct human description. Now, because the specification of the definitional constituents of these indirect references (i.e. the entities and their relations), and the representation of the explicitly observable facts, are both in the domain of the conceptual analysis, it is a well-suited approach to tackle the multi-faceted research process related issues that are the focus of this work.

In conclusion, the main criteria to be used in selecting the suitable research approach and by which to make appropriate methodological and modeling related choices have been discussed. This has been done with the help of a simple research continuum where the identified issues of concern and the range of study have been mapped against each other. Based on this, the overall requirement for crossdisciplinary research and development work is that it should be conducted in such a way that the cross-project artefact cumulation and knowledge sharing in and between both scientific and target domains. This is best matched up with assembling multidisciplinary project teams that can commit to scientific methodologies compliant with constructive research approach specifically in the field of design sciences. Additionally, they should be familiar with simple semi-formal conceptual modeling conventions. These principles are also adhered to in this work which (i) analyses and aims to advance the CRA-based *research processes* supported by (ii) conceptual modeling *methods* and (iii) semantic web-based *tools and technologies* that are applicable in cross-disciplinary research projects that wish to manage and re-use the many types of (iv) *models and other artefacts* that are produced in studying information-intensive organizational networks.

1.5. Main contribution and relevance of the work

The main theoretical solution to address the goals of this work is the development of concept-analysis based framework for research knowledge sharing and cumulation (Figure 1.2). The developed static structures of it, i.e. the generic domain model of organizational networks (GDM) and the semantized research space (SRS), are used in managing and representing the research artefacts that originate from the activities performed in the research projects studying networked environments. An extension of the CRA-based research process with methods based on the semantic web technologies form the complementary dynamic part of the contribution in this work. Following these practical recommendations for scientific work enables the building and re-use of research knowledge in multidisciplinary contexts.

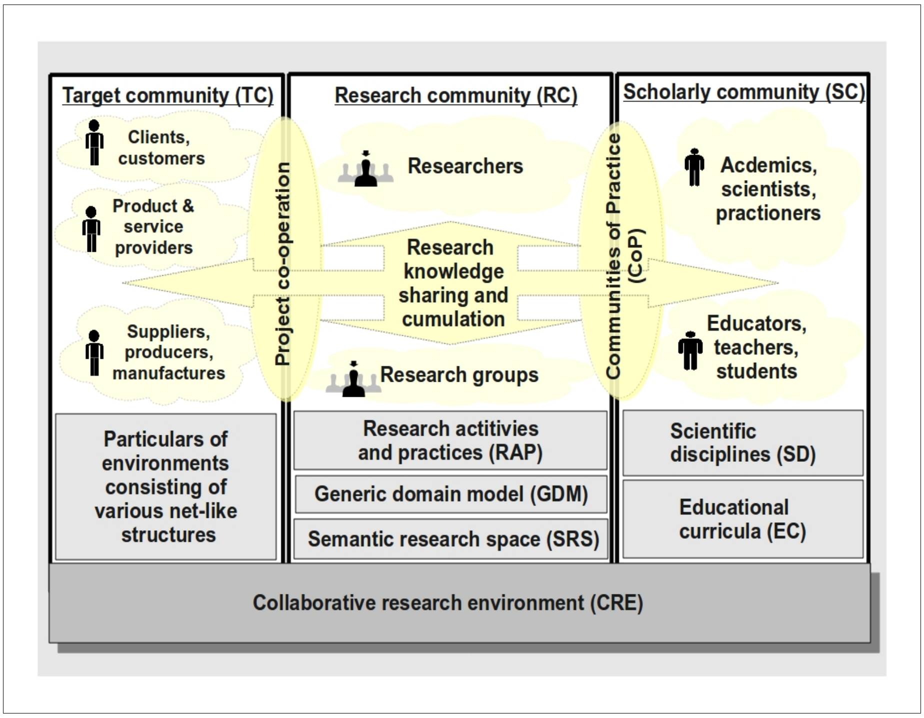

Figure 1.2 Overview of research knowledge sharing and cumulation

The identified parties of interest here are the target community (TC), the research community (RC), and the scholarly community (SC). The individual actors, groups, organizations, or networked constellations emerging from these, take part in the dynamic interactions with the others. The domain of the discourse has been scoped by limiting the number of actor types that are to paid attention to in the research. Thus, the figure depicts only the major *functional roles* in which the individual organizational members take part in these communicative acts. During these interactions tangible and intangible resources flow inside and between the communities.

During the co-operation in project research and in participation to scholarly activities, like *communities of practice* (CoP) [7] [8], mostly information flows and knowledge exchanges take place between the members and organizations of these communities. The domain area and the focus of the project research consists of environments in which the target stakeholders are organized to various types of *net-like structures* (for example, economic markets and different kinds of business networks) [9]. The characteristics of scientific disciplines (SD) and educational curricula (EC) are the main structural elements in the scope of the scholarly communities.

The contribution of this work is mainly relevant in the research community as the formation and utilization of the overall project domain area conceptualization (i.e. the generic domain model, GDM). It is beneficial in the actual project work because it supports the organizing and aligning of the collection of project-specific research artefacts. In respect to model building, it is the key component in the definition of the semantic research space model that can also be used in analyzing the requirements of the web-based semantic collaborative research environments (CREs). The practical benefits and model-theoretical relevance of the main contributions of this work are summarized below (Table 1.4).

Table 1.4 Relevance of the main contributions of this work

Contribution	Description	Practical benefits	Theoretical relevance
Generic domain model (GDM) *Structural model of IT-enabled inter-organizational environments enabling network-wide enhancements using defined integrative enactments.*	Identification and conceptual analysis of the key dimensions (categories) that represent the target domain and their multi-dimensional relations.	Analysis and aligning project-specific research artefacts.	Review and synthesis of relevant theories, approaches and model-artefacts from multiple disciplines.
Research activities and methods	Suggested semantic and conceptual extensions of CRA-based research process and specification of the cycles of semantic engineering (e.g. conceptual domain analysis).	Enabling research knowledge sharing and cumulation	Combining semantic web technologies and conceptual modeling with constructive research approach.
Semantic Research Space	Specification of semantic and conceptual model to organize project research artefacts (problems, data, analyzes, solutions, practices).	Supporting the identification and management of research constructs and enabling their re-use.	

1.6. Organization of the work

In summary, the research here aims at developing and applying a conceptual framework that supports crossdisciplinary project research of technology-enabled information-intensive organizational environments. The organization of the work is outlined below.

First, the project work background and the overall research setting is outlined (chapter 1) depicting the research problem (chapter 1.2), selected research approach and related scientific theories (chapter 1.3). Then a concise overview of the proposed solution to the problem at hand is presented, including a discussions about its relevance to both research and stakeholder communities (chapter 1.4), and the structure of the work (chapter 1.5).

Next, the project research subject matter is aligned with the relevant theories (chapter 2) whereby the projects and main types of networks are described (chapter 2.1), theoretical analysis identifies the key-dimensions (chapter 2.2) to reflect these networked environments from the perspectives of: the complexity of the environments (chapter 2.3), organizational forms (chapter 2.4), the meaning and the content (chapter 2.4), and technological enablers (chapter 2.5).

The models and approaches that have been used in the research of business networks are then presented and elaborated (chapter 3) by introducing the conception of netlike structures to align them (chapter 3,1), discussing the importance of analyzing the relationships (chapter 3.2), and describing the service-oriented integration technologies that can be used to enable the information-intensive resource flows in the networks (chapter 3.3).

After this, a detailed analysis to represent the target domain area is conducted (chapter 4), and it is first presented as hierarchical model (chapter 4.1), that is refined to multidimensional model (chapter 4.2), by which the concepts of the domain area elements are identified (chapter 4.3), interconnectedness of the domain relations analyzed (chapter 4.4), and all these are finally collected to a conceptualized model of inter-organizational environments (chapter 4.5).

Then, the methods and tools applicable for concept-oriented research are presented (chapter 5), starting with conceptualizing the research construct produced in CRA (chapter 5.1), then the semantic and conceptual methods for research are outlined (chapter 5.2), consisting of domain analysis using the relying on the target domain model (chapter 5.3), concept modeling and ontology engineering (chapter 5.4), and outlining the semantic web technologies that can be used to represent these models (chapter 5.5).

After all the above, the outcomes are collected and inspected in terms of the implications to the project research community performing scientific activities in crossdisciplinary setting (chapter 6). Here, the characteristics of the interacting communities are analyzed (chapter 6.1), the research space conceptualized (chapter 6.2), the research community activities presented (chapter 6.3), and an example of the semantization of the research space is presented (chapter 6.4).

Finally, the conclusion of the work is given (chapter 7).

2. Mapping the project research topics with relevant theories

During the five years of research work in the University of Lapland, various business network research teams have produced scientific and practical contributions that are on the one hand domain-related analyses and solutions (project-specific *research constructs)*, and on the other hand models and tools that can not be directly linked to a particular project (generic *representations* and *methods*). For example, the solution proposed to research knowledge sharing and cumulation that will be developed in this thesis, is mostly based on the generic models advanced parallel to the project research by the author, e.g the conceptual model for representing and harmonizing domain area analyzes (MCE) [2][1], set of practical methods for information model development and utilization (network-wide information acquisition) [10], and the design and deployment of a web-based research environment (SoitLab). In the following, however, the project research and the topics that were studied specifically to address the stakeholder needs are outlined. This is done to show in more detail the scientific and practical project-related backgrounds that prompted the need to develop in this work solutions to support the representation and management of cross-disciplinary project research artefacts.

2.1. Research projects

The flow of research activities during project work, in general, was not very well-structured even though the constructive research approach and methods of the design science were to some extend followed. For example, depending on the individual research project goals and requirements (like "to develop and document a process-based systems integration model for a local production industry supply-chain"), the research fields separately started to build the research understanding about the project domain area. For this the individual researchers used data collection techniques and methods of their research fields like structured interviews, process modeling, information modeling or web based surveys. In analyzing these research materials they relied on theories relevant to their discipline, such as network theory, organization theory, administration theory, information technology, and contract law. Finally, the results of the research were typically delivered to the target domain stakeholders in various forms of project reports, such as diagrams, process models, legal contract templates, or survey analyzes. Also, in line of action research, few participatory events and engagements for bringing forth developments and change within the target communities were organized: focus groups, workshops, and even organizational forum theater happenings.

In the following a short overview of the projects are organized under the two types of networks studied in them: industrial supply chains and tourism distribution channel based service provisions. There were two projects that focused on the industrial business network integration issues. The first was concerned with manufacturing industry supply chain intensification (YVI/BNI-project) that is described here, and the other with construction industry collaboration which is not in the scoped of this discussion, because the main objective in the Interreg-project was just to inspect the possibilities of future research collaborations with interested parties.

2.1.1. Process-based supply-chain integration

During the business network integration project (YVI/BNI), that was conducted in two separate phases between 2005 and 2007, the goal was to construct a generic collaboration framework and deploy process-based models and solutions for business organizations interacting in a network context. The project was financed by the Finnish Funding Agency for Technology and Innovation (TEKES), and the consortium originally consisted of three collaborating partners: (1) University of Lapland, (2) a local IT service provider, and (3) an industrial manufacturing company pursuing business benefits by intensifying and improving the operation of its supply chain network. By collecting the specific needs and goals of all the partner organizations in the consortium, the main objectives of the project were to:

- construct generic collaborative frameworks and implement practical models for business network integration
- develop novel information and communication technology (ICT) provision strategies and practices for the local IT-service provider company, and
- implement and deploy effective business driven process modeling and re-engineering methodologies and ICT-solutions based on the surveys conducted in the CASE-network enterprises

In the project the main partner organization in the project consortium was the headquarters of a relatively large local private enterprise having multinational branches (production plants and retailers) operating in the manufacturing industry concentrating on designing, assembling and selling children playground systems and facilities. Because of this, the research focused on the process-based business modeling, information security aspects and systems-integration analysis of the supply chain of this focal company. In addition to this, a model to upgrade the network-wide business integration level was to be specified and developed in co-operation with a local information technology service provider. The specific tasks of the research relevant to this work was to first conduct a conceptual review of the existing B2B-integration and e-commerce frameworks and standards. Then, based on that, an appropriate set of modeling approaches and tools were to be used to analyze and document the deployment of a selected message-broker based technical systems integration solution.

To tackle these goals, the project domain area was divided into three separated but overlapping research fields: (i) *business models,* focusing on the business processes and corporate governance modeling and survey methodologies, (i) *information security***,** aiming to develop secure information architectures for the integrated enterprise network, and (iii) *systems integration***,** studying the business information systems integration issues, requirements and enabling technologies.

The specific research task of the author of this work was to explore the technical systems integration field in order to define an electronic business process collaboration prototype model. This was to be done by synthesizing the results of theoretical business process modeling, security and integration studies with the description of the selected information technology based enterprise integration solution, that was to be deployed in the supply chain type industrial business network.

2.1.2. Service provision and information sharing in tourism value chains

The need of travel enterprises in the Lapland area to enhance their service provision value chain (i.e. tourism distribution channel) prompted the establishing of two projects in which the main network under study and project partners were essentially the same in both. These projects concentrated in tourism industry networks and companies: the Operative Network Integration (OVI/ONI) on information-flows in inter-organizational travel industry distribution channel, and the Service Process Management in Tourism Business Networks (PROVEM/SPMiTBN) on the organizational knowledge exchanges, and information system infrastructures supporting the customer relationship management.

Operative Network Integration

The two year work was started in 2008 and was also funded by TEKES. The research in the projects concentrated on the following topics:

- analyze the tourism distribution channel in terms of information flows between the main travel service provision companies and network-wide knowledge service requirements using *role-based* modeling
- design a novel franchising-based business model (including the related contract forms and templates) for a *incoming tour operator* (ITO) to have more control on its travel distribution channel, i.e. the regional suppliers of basic tourism services
- contribute to the efforts of a small local software engineering company to develop a web-based communication and travel business information sharing platform to support the integration of the tourism value chain

In the project, the research was conducted from the perspectives of network governance, strategic business management, information security [11], and inter-organizational relationships. The author focused on the topics of the project from the perspective of knowledge management and information modeling, and provided support for the software development company in the service oriented platform design, and in user requirement analysis. The outcome of this was the developed *service-oriented extension of the roles-linkage model* and accompanying method by which the main travel industry service provision roles could be mapped with service-oriented architecture requirements [9].

Intra-organizational knowledge sharing and communication

The PROVEM-project focused on the modeling of the information content in the intra- and inter-organizational operations of the local tourism industry company. The scientific work was conducted by a team of several researchers some of which just worked for the project for several months. To succeed in achieving the multitude of project goals, research competency from multiple fields of science were required: (i) mastery of the contract law in preparing collaborative business partnership agreements, (ii) familiarity with the enterprise and network analyses to model the existing business relationships and the practices of customer information management, and (iii) methodological expertise in knowledge and information modeling of intra-organizational communication linkages and related infrastructures.

During this project, the author focused in research mainly on the modeling of the business *information contents* and *communicative knowledge flows*, along with the description of the information system infrastructure in the medium-sized *destination management company* (DMC). Research data was collected by making a web-based survey, using structured and non-structured interviews that were recorded, and organizing interactive focus groups and work-shops. In collaboration with project team members the interview material was also mostly transcribed. The practical information modeling-based contributions to this target organization included:

- an overview of the internal information system usage linked to the main business information contents types and functions,
- analysis of the knowledge sharing and communication patterns related to its *customer relationship management* (CRM) conventions
- an account of the internal and external communication and knowledge flow characteristics of the personnel using social network analysis and graph visualizing software
- identification and analysis of the essential information-related problem areas in the management and operations extracted from collected data, and presenting them by organizing a participative *organizational theater* event to the company personnel.

2.2. Theoretical analysis of the target domains

As the above discussion shows, in the past projects the *target domain* of the research in Applied Information Technology, University of Lapland has been different types of business networks. An analysis of all these domains is essential in this work that aims to identify the main structural elements and interaction characteristics of the inter-organizational environments to propose a conceptual approach to model and represent them. The commercial enterprises are typically trying to intensify their business relationships, and participate to network-wide knowledge exchanges, by relying on various forms of service-oriented information technologies. This has been mainly the consequence of the lately advancements in the Internet-technologies. Considering the complex multidimensional nature of this phenomenon, and the wide range of theories that address the issues, it is advantageous here to make an effort to identify the main perspectives from which to analyze them in this research. Establishing these *key-dimensions* is grounded mainly on the objectives of this of this work, and is thus based on the concept-oriented approach, and the practical research understanding gathered by the author as a researcher in these projects.

In reflecting the theoretical backgrounds of the research that focus on the inter-organizational environments, the criteria of selecting a set of theories and models to be used is strongly dependent on the ontological (objectivist or subjectivist) and epistemological (positivist or interpretative) [12][13] assumptions of the research field. In terms of these philosophical choices of the scientific inquiry, the researcher may commit to a particular theory in order attempt to *explain* (modernism), to *describe* so as to produce understanding and appreciation (symbolic-interpretativism), or to criticize or to *create* (postmodernism) a segment of reality [12]. The pluralistic nature of the target domain phenomenon and the crossdisciplinary research setting from which they were studied signifies that it is unfeasible to try to establish an unambiguously optimal stand point for the entirety of the following discussion. Thus, the subject matter is here analyzed separately from the selected theory-driven perspectives in order to justify the development of a generalized model derived from the original domain area descriptions. The approach here acknowledges that the research perspectives, approaches, and models can be:

- based on paradigmatically divergent theoretical premises,
- influenced by distinct practical impressions,
- interpreted according to incompatible semantic conceptions, and even
- represented by potentially inconsistent symbolic systems, or incompatible syntactic languages

By allowing this, a potentially novel set of features emerges making it possible here to make new inferences from the initial project-research observations. Most importantly, an analysis of the main perspectives gives valuable insights to the development of models and methods in this work.

Selection of the key-dimensions

The overall subject matter of theory-oriented discussion here is scoped in terms of the project-specific goals and themes illustrated below (Figure 2.1), showing the variety of theories and approaches that were used in project research to address the challenges of the target domains. Positioning organizations this way within their environments is based on the modern *organization theories* [12], and analyzes on the strategic risks in networked businesses [14] studied during the research projects discussed here. However, in contrast to these, here the various types of networks are forming structures in the environment, and thus belong to it. Further, the *content* (e.g. business resources of many types) is explicitly embedded inside the organizations as a substance that is owned and can be controlled by the companies. Also, the conception originating from many forms of *contingency theory* [12], that there are signals or effects "arriving" to organizations or resources passing through them, is here elaborated by typifying these input-output streams to exchanges, transfers and flows of various forms of content.

Thus, analyzing business networks where the organizational stakeholders seek benefits from information technology in their information-intensive interactions and communications, the main focus areas can be identified; (i) environment, (ii) organization, (iii) content, and (iv) technology. These key standpoints enable the determination of the overall *domain of interest* that has been relevant in the projects, but makes it also possible to abstract oneself from the specific topics of the individual projects. Most of the research themes and topics that have been addressed in the projects are positioned to the circular regions drawn within each other in the figure representing these key-dimensions or domain areas. Now, the overall target domain that is mostly discussed in this work is shown as the black, closed line that connects all the main areas of research interest. The business networks (supply chains in manufacturing and distribution channels in tourism industries) belong to the domain of environment, commercial enterprises are the main types of organizations that are concentrated on, the content consists mainly of knowledge and information-intensive resources, and the service-oriented enabling IT technologies (e.g. SOA, B2Bi, etc.) are the most important ones for the networked domain stakeholders.

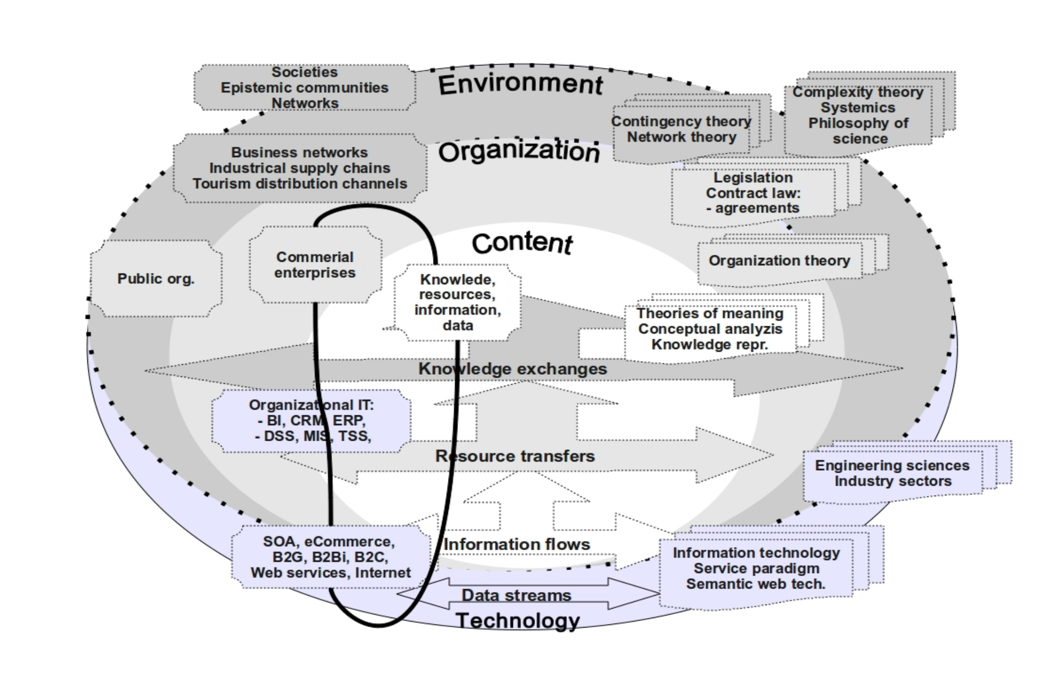

Figure 2.1 Key-dimensions, target domain and related theories

Additional key insight for this research is to inspect the target domain characteristics also in terms of various *integrative enactments* that manifest themselves as specific connectivity patterns between the domain areas. The networked environments promote communicative *knowledge exchanges*, organizations participate in interactive business *resource transfers*, and the semantics of *information flows* are enhanced by the inter-interoperability and compatibility of utilized information technology solutions. The depth of the following review is limited by the scope of this work in that it does not address all the intricate subtlety and overlaps in the key-dimension. Instead, the main objective of the discussion here is in exploring the different characteristics of these domain areas by means of the corresponding fundamental background theories. This way the the intrinsic differences of the conceptual realms to which they belong are exposed. These insights are later used to present the research findings about the (conceptual) interconnectivity and dependency patterns between these top-level domain areas.

2.3. Complex environments

In general terms, environments (and specifically networks) exhibit such characteristics and properties that they belong to, and have been addressed in, wide range of disciplines (like mathematics, technology, biology or sociology) [15]. In alignment with theories that concentrate on the complex and systemic nature of various environments, the external observable reality can be seen as a holistic composition, an aggregate of different types of organized structures that emerge, self-organize, function, interact and disappear in intricate relationships and unpredictable ways. The transient nature of environments is noticeable also in the ways by which the various forms of substance or discrete entities are created, altered, concentrated and destroyed in processes evoked or mediated by technical, mechanical and physical systems. Also, the complex nature of these systemic environments (consisting of structural forms and dynamic patterns) is not always explainable in terms of the constituent parts of the whole.

In terms of the scientific-philosophical commitments of the research, in the traditional modern and positivistic thinking the environment in which human and non-human entities are embedded in, is about ontologically objective communities and epistemologically subjective facts. However, in the symbolic-interpretative and anti-positivistic view, the *epistemic communities* are based on the *construction of social reality* where the sense of collectivity and social intentionality gives rise to ontologically subjective but epistemologically objective social facts [16].

In the recent organization theory, based particularly on the "open systems" -thinking [17], the environment may be viewed as a source for information, resources or ecological variation, and as a driving force for learning [18]. In contrast to this, is the view that has its origins in *contingency theory* [19], that the dynamic characteristics in the environment surrounding organizations, i.e. the circumstances, constrain the managerial decision making insomuch that the strategical planning and the operational choices are fundamentally situation-dependent. Furthermore, this perspective emphasizes the importance of the environment to *organic organizations* that are constantly required to adapt to changes mostly caused by external factors. In business contexts, the structures formed by organizations can be seen as *networks* for which several classification approaches exist. First, it is typical to distinguish horizontal and vertical inter-organizational systems depending on the roles of the organizations between which the business relations exist. In *vertical networks*, buyers and suppliers or member of the same distribution channel are collaboratively related aiming to offer products and services to a common body of customers. In contrast to this are *horizontal network* configurations, where the competitive relationships or connectivities spanning different industry sectors are considered important. In the field of *network theory,* there is a more general typology according to which there are three types of networks [20]:

- **social** - informal organizational relations, social exchanges (e.g. learning networks)
- **entrepreneurial** - based mostly on formal contracts (e.g. commercial franchise)
- **proprietary** - formalized and based on right of property (e.g. investment ventures)

Further division of these can be done based on the mutual power-relations, to (i) *symmetric networks* where all participants share the same capacity to influence, and (ii) n*on-symmetric networks* in which one or several organization(s) is in dominating position compared to others [20].

2.4. Organizational forms

As the environment is on the one hand ordered and "well-behaved", and on the other hand chaotic or highly contingent setting in which the organizational structures are embedded, the optimal strategies for operation are difficult to determine. In these complex settings the organizations act by responding and adapting to external driving forces, concurrently trying to have a bearing on their surroundings in order to maintain their identity. In the field of *organization theory* itself, the three main views to organizational forms (corresponding to the scientific-theoretical choices mentioned above) can be distinguished [12]:

1. *modernism* - organizations are objectively real entities operating in real world, favoring rational structures, rules, standardized procedures and routine practices,
2. *symbolic interpretativism* - they are socially constructed realities where meanings promote and are promoted by understanding of the self and others that occurs within the organizational context,
3. *postmodernism* - organizations are texts produced by and in language, and seen as sites for enacting power relations or encouraging reflexive and inclusive forms of theorizing.

The exposition of these fundamentally divergent stances here emphasize the importance of being able to committing to multiple and simultaneously coexistent perspectives in focusing on organizational forms, specifically in network research.

Also, organizations can be differentiated depending on what internal resources owned by them they focus on governing in planning their internal operations or external relations. For example, in the strategic business planning, the management of the multitude of contractual, collaborative or dependency relationships that the organizations participate in, is usually identified as one of the *critical success factors* (CSF) [21] In combining the traditional *process based view* (PBV) with the *resource based view* (RBV) of the firm [22], the emphasis is on the different types of intra- and inter-organizational resource flows generated in enacting in various transform-and transfer activities. Increasingly, however, these operational functions depend on the management of the information-intensive business assets by relying and making use of technological (particularly IT-based) services, applications and infrastructures, like *knowledge intensive business services* (KIBS) [23], business intelligence (BI) solutions, or business-to-business integration (B2Bi) architectures [24]. Also, in the field of organization theory, an example of this kind of *knowledge based view* (KBV) of firm, is the conception of the *knowing organization*, according to which signals from the environment are received and reflected upon, new knowledge and capabilities are created inside the organization in order to respond to them and make decisions for purposeful action [25].

2.5. Meaning and content

The focus is here in the referents in the representations of the domain of discourse in the sense of *referential meaning.* In this conception *semantics* is assigned to the expressions of a language, and the view has its origins in the philosophical *theories of meaning.* They can be divided to two classes: (i) semantic theories that can be either propositional or non-propositional, and (ii) foundational theories that are mentalist or non-mentalist [26]. Herein, it is reasonable to assert that the meaning is linked to the human need of comprehending the environment and the essence of it, i.e. pertaining fundamentally to the act of the *self* making sense of the reality in which it and the *other* exists. Furthermore, *meaning* can be interpreted in three different ways as: (1) *significance* (importance), (2) *purpose* (orientation), or (3) *understanding* (content) [27].

In the entity-based view, the real world is at some chosen level of observation, made of discrete singular units or objects that can be represented and to which, for example, the conceptual descriptions should correspond to. A wide range of entities of this kind can be identified, such as: physical objects, facts, theoretical constructs, socially construed reality (social facts), knowledge representations, information content, data items etc. According to a more holistic way of thinking, the content itself is ontologically formless continuous substance, the structure and meaning of which depends on the motivations and comprehension of the (human) subjects belonging to various organizational forms. The given interpretations about the form of the substance then are mostly constrained by the epistemological premises prevailing in the societal systems of the organizational environments.

In the knowledge-based view of reality, maintaining the emphasis on the essential role of subjective interpretations manifesting in the context of social reality, the types of contentual elements to which meaning potentially can be attached typically are:

- *data* - any physical "thing", symbol, sign, number, or any collection of these
- *information* - consists of a number of data which is well-formed and is meaningful
- *knowledge* - information with practical value, rules, competencies; explicit or tacit

It is fairly well established that the relationships of these are such that they form a continuum in which the order and the level of organization increases in human activities of physical, cognitive and social structuring. [25], Also, it is common to extend this continuum from the bottom end so that various types of physical signs or impulses are at the lower level of order than data. These signals are coming in to existence mostly in the physical environment and are perceivable and sensed by human beings. More disputable however, is the idea that some sort of a combinations of many types of knowledge forms wisdom or even understanding [28], that should then be placed at the up-most level in the *information continuum*.

2.6. Technological enablers

The ontological stance of *technology* is not easy to establish as wide range of conceptions about its fundamental characteristics exists. In general, however, it can be positioned in the overlap of social and natural sciences, and thus has effects on the environment (i.e. the social system) but at the same time emerge from interplay of the environmental phenomena and organizational innovation and development. Technologies are usually closely linked to a particular scientific discipline and the foundation theories and models therein. From these the main techniques and methods are then extracted and applied in relevant real-world environments and situations. The multifaceted relation of technology to the other perspectives of this discussion (i.e. the environment, organization and content) is shown in the varied functional roles it can take: enabling enhancements, storing and retrieval of information, automating operations, supporting communication, changing societal structures thru innovations, or simply providing many kinds of tools to help everyday private and working life.

Another set of models relevant to this discussion are various maturity and capability adaption models by which the technology development processes and the effects of these artefacts on the organizational and societal structures can be assessed. For example, in Capability Maturity Model (CMM) [29], a set of phases, stages or levels (like initial, repeatable, defined, managed, optimized) describe a continuum of technological (specifically the software process) utilization and/or design skills of an organization. The adoption and acceptance of technology can also be described and analyzed based on models of "diffusion of innovations" [30], where organizational and societal actors (like customers) are categorized to different groups (enthusiasts, visionaries, pragmatics, skeptics etc.) according to their preparedness to adopt a specific technology.

The role of technology as an enabler in relation to the other key-dimensions of this work is clearly seen in the advancements in *information technology* (IT) during the last 20 years, This has had a major influence on: (i) the organizational management and operations, (ii) social networks and inter-organizational business environments, and (iii) data processing, and information and knowledge representation. Specifically, the web-based infrastructures and service oriented approach (SOA) have extensively been used in information-intensive intra- and inter-organizational environments to support multi-agent interactions (between humans and information systems). To be useful in these varying contexts, the service oriented IT should, at the minimum, adhere to such a design and development principles and requirements that ensures that deployed services are [31]:

- *discoverable* - in commercial scenarios, especially, the services should be discoverable by human and non-human consumers
- *communicable* - services should be accessible by distinct communication and interaction patterns (for example, synchronous, asynchronous or transactional)
- *conversational* - the services are invoked by sending simple requests and receiving responses, that can be combined to multiple steps of complex interactions between several services and service consumers
- *secure and manageable* - security, manageability, reliability, quality of service (QoS) and availability are crucial factors for services that are to be deployed to commercial production environments

Since the service orientation has such a wide range of applications, there are many conflicting notions about what a service actually is. To overcome some of these issues caused by the lack of established vocabulary, there has been attempts to clarify the basic notions of the *service paradigm*. In an initiative by the Organization for Advancement of Structured Information Standards (OASIS), a reference model for service oriented architecture (SOA-RM) has been developed [32]. It consists of descriptions and definitions that depict the main concepts of SOA (and the relations between them). According to it, the *service* is "a mechanism to enable access to one or more capabilities where the access is provided using prescribed interface and is exercised consistent with constraints and policies as specified by the service description" [32]. In the organizational context, mostly IT-service provision is useful in supporting the managerial and operational activities (technology as an instrument). In light of the latest developments in IT (e.g the semantization of the web), it can be argued, that the service paradigm also is beneficial in mitigating the attitudinal difference of technological and organizational orientations. For example, the service orientation can conveniently be used to align the ICT-infrastructure solutions or enterprise application deployments with the business process re-engineering and management.

3. Models and approaches in network research

To build a generic model of organizational environments viewed from the key-dimensions of this work, some of the relevant model-theoretical constructs are here reflected on the particulars of the overall target domain. The idea here is to establish a coherent view of the target domain phenomenon, and to analyze the applicable models and tools to be used in project research. This is done mainly to support the alignment of the many types of research constructs that are to be created during scientific research processes focusing on inter-organizational networks. This allows the main structural elements of the target domain to be identified and represented. In preparation for developing this generalized model the discussion here will focus on:

1. representing the main types of networks by relying on the conception of *net-like structure*, and providing a preliminary assessment of its applicability by using it to align the two types of networks (industrial and tourism) studied in the projects (chapter 3.1)
2. specifying high-level typification of the relations in organizational networks, and suggesting a role-based modeling approach for the analysis of relationship (chapter 3.2)
3. reviewing the existing service-oriented IT solutions in terms of their support to network-wide knowledge exchanges, and organizational information-flows (chapters 3.3 and 3.2.2)
4. introducing applicable approaches to model and categorize organizational information-intensive resources (chapter 3.3.1)

3.1. Net-like structures

In general terms, a *network* is any complex system or collection of interrelated things, having topographical features, like lines of transportation, communities of people, directed graphs of service chains, information system connectivity maps, etc. This very broad definition can be expressed more formally, that a *net* is a 2-tuple consisting of two sets: **N** (nodes) and **C** (connections), where the elements of **C** connect (with directed or undirected links) the point-like elements of **N**. Given the wide range of environments that exhibit net-like features, and scientific fields that refer to these, the nodes and the connections mean different things in different contexts.

The previously presented theory-oriented views correspond to the focus areas of the project research: network analysis (environments), organization theory (organizations), information modeling (content), and service-oriented IT (technology). The preliminary research activities in each project (typically, the *domain analysis*) produced various models based on these diverging approaches. They needed to be aligned to enable the building of sharable research understanding. The notion of *net-like structures* made it possible to identify theoretically relevant common features of the particulars in the target domains, and characterize them in terms of:

- **context** - the logical context or scope, the surroundings from which the networks emerge, or to which they are embedded
- **nodes** - the point-like entities, actors or agents, organizations
- **resources** - the substance or material that can be consumed or transferred between the nodes
- **dynamics** - the various interactions and communications between the nodes being observable as the dynamic behavioral patterns of the net
- **connectivity** - the properties of the links, relationships or resource flows that connect the nodes forming specific topological structures

In analyzing the collection of project research target domain environments, the case-networks are embedded in two types of commercial environments: (i) *industrial business networks* and supply-chains in production and manufacturing industries, and (ii) service provision-based distribution channels in travel industry (i.e. *tourism value chains*). Using the properties of net-like structures these networks can be aligned with the theoretical key-dimensions of this work (Table 3.1). Also, *economic markets* [33] can be seen as logical locations or contexts where the supplier and customer meet. Similarly then, they exhibit netlike characteristics in that they consist of: (i) participants (supplier, buyer, wholesaler, retailer, etc), (ii) the products and services, and (iii) the transactions and processes. Thus, in terms of net-like structures and key-dimensions of this work, in the market context organizational participants enact in transactions (e.g. processes or service provision actions) whereby products are exchanged in economic trust and power relationships.

Table 3.1 Characteristics of net-like structures. Extended from [9].

Key-dimensions	**Net-like structures**	**Economic markets [33]**	**Industrial networks [34]**	**Tourism value chains [35]**
Environment	**context**	market	(supply chain) networks	distribution channel
Organization	**nodes**	participants	actors, (agents)	producers and service sector actors
Content (information)	**recourses**	products and services	tangible and intangible resources	knowledge assets
Behavioral patterns	**dynamics**	transactions, processes, service provision	transformation and transfer activities	information flows, knowledge exchanges
Relations: [36] (social, pragmatic, semantic, syntactic)	**connectivity**	relationships, economic exchange: trust and power relations	actor bonds, resource tiers, activity links,	contractual agreements, tour management liabilities, regional tourism boards and committees
Technology (IT)	**enabler (facilities)**	Market-specific tech, eCommerce and ICT-infrastructure	Industry-specific tech. B2Bi solutions	- information and knowledge services

Considering the comparative mapping here, it shows that the preliminary model of net-like structures need to be extended by adding a new characterizing element to it (i.e. **enabler**) corresponding to the technological perspective. It simply represents in these environments such circumstances that facilitate or improve some features of the net in question, but may possibly exist outside of it. For example, the economic environments are in general enabled by market-specific technologies. Specifically, in respect to information and communication technology (ICT), the most common technical enablers in the organizational network contexts are eCommerce, B2B-integration. and ICT-infrastructure solutions.

Additionally, this alignment of net-like structures reveals that the aspects of *behavioral patterns and relations* are an important augmentation to the set of already recognized theory-based key-dimensions for research. However, the dynamics and connectivity properties of net-like structures is to be elaborated later (chapter 3.2). Here, some of the relevant characteristics and key terminology of business networks in production industry, and the value chain distribution channels in tourism context are first briefly presented.

3.1.1. Industrial networks

Especially in strategic business networks the inter-organizational relationships are considered important in relation to business management and operations. In order to cope with the complexities of modeling industrial networks and re-engineering the enterprise relationships therein, an approach based on the Actor-Resource-Activity (ARA) model has been proposed [34]. It consists of three basic variables that are related to each other by the following circular definitions:

- **actors** perform activities and/or control the resources and they can be individuals, groups of individuals, enterprises or groups of enterprises.
- **resources** are the means used and required by the actors when they perform activities. They have an unlimited number of property dimensions and they can be characterized by the actors controlling them and by their utilization in activities.
- **activities** occur when actors combine, develop, exchange or create resources. *Transformation activities* are controlled by one actor and through them resources are changed in some way, and *transfer activities* link the transformation activities between actors and transfer the direct control over a resource from one actor to another.

The internal structure of the nodes of the business network can be characterized with help of these ARA-model layers by correspondingly representing the *organization structure*, *activity structure* and *resource collections* for each enterprise. In order to capture the variety of business interactions, two dimensions of analysis have been proposed: the *substance* and the *function* of business relationships [37]. The substance becomes manifest when the business relationships and the characteristics of the overall network structure influence the coupling of the enterprises along all the layers of ARA-model thus dynamically strengthening and/or weakening respectively the *actor bonds*, resource *tiers* and *activity links* between companies. The functions of a relationship can be conceived in terms of *effects* the dynamics of interaction between two companies produce for their internal structures, for the pair of companies (dyad), and for the third-parties. In the latter case, the overall network topology, in form of *activity patterns*, *web of actors* and *resource constellations,* impacts the propagation and the net result of the change in the given business relationship. All these ARA-based characteristics and the respective dimensions of business relationships are depicted below (Figure 3.1).

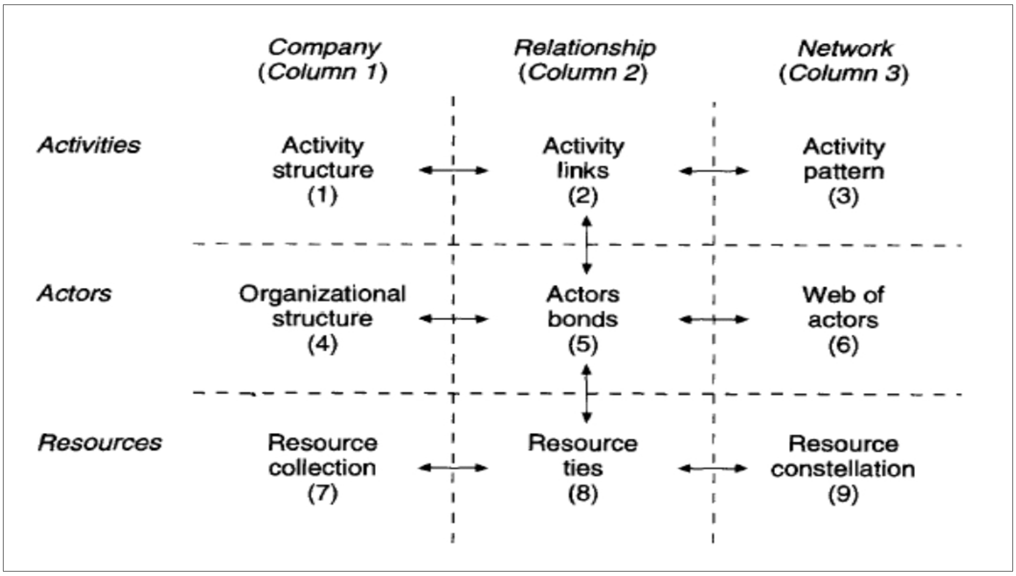

Figure 3.1 ARA substance and function of business relationships [37]

The industrial network approach belongs to field of network analysis and being part of the marketing science, some parallel notions to the above have been developed by the Industrial Marketing and Purchasing Group, IMP [38]. The driving force behind the business networks and inter-organizational networking in these approaches is the focus on the core competencies. A business organization should concentrate on the value production activities, which are part of its core competence and at the same time acquire other competencies from other enterprises by cooperating with them. It is this kind of enactment in outsourcing activities that creates dependencies between enterprises. Then the value creation activities of different enterprises together form a *value creation system*, which eventually exists in order to provide an offering for the end customers [39].

To conclude, in the specific context of this research, the (industrial) business network can be seen as a particular structure of linkages of commercial organizations interacting and collaborating in both dyadic and multilateral relationships. Depending on the level of detail (the *unit of analysis* in the *network theory* terminology), the business network can depict the connectivity of a global markets, or the inter-relations of the stakeholders in a specific industrial segment. Thereby, it represents the patterns of trading in a particular type of business (e.g the supply chain, the value chain or distribution channlel), and the transactions, process interfaces and resource constellations in a specific economic environment. Also, in terms of internal networks, the industrial business networks cover the inter-dependencies of intra-organizational business activities and communications patterns of the individual members or departments of a single enterprise.

3.1.2. Tourism service provision

The service provision in travel distribution channels differs from industrial networks in that the relationships are mostly characterized by loosely coupled business-to-business (B2B) relations. Structurally, however, the travel product creation networks resemble the supply chains of manufacturing sector, for example. The similarity stems from the fact that the producers of the tourism products (e.g. accommodation and program services) are not always directly linked to the tourists. Instead, they act as suppliers to middleman companies that merge the offerings of these providers to packaged travel products and then sell them to end-customers.

Table 3.2 The main organizational roles in travel service provision [9]

<table>
<tr><th>Role</th><th>Description</th><th>Examples</th></tr>
<tr><td>OS - Organizing Services</td><td>Design, selling and marketing, and organizing travel services (in co-operation with the partners)</td><td>Travel organizers, Travel agencies
Travel intermediaries,,
Incoming Tour Operators (ITO),
Outgoing Tour Operators (OTO)</td></tr>
<tr><td>AS - Accommodation Services</td><td>Accommodation in the target travel site</td><td>Hotels, hostels, bed & breakfast, etc</td></tr>
<tr><td>PS - Program Services</td><td>Activities, programs and guided tours and attractions to the end-customers.</td><td>Safaris, experience travel, fun parks, other regional events and activities</td></tr>
<tr><td>LS - Logistics Services</td><td>End-customer & group transportation from source location (abroad) to target location.</td><td>Air travel, transportation by buses, taxis, or ferries.</td></tr>
<tr><td>MS - Marketing Services</td><td>Target country, site and program event marketing to OTOs and end-customers.</td><td rowspan="2">Note: while each individual company has marketing and sales activities these roles represent here services directed to the end-customer</td></tr>
<tr><td>SS - Sales Services</td><td>Travel target site and program sales to OTOs and end-.customers.</td></tr>
<tr><td>KMS - Knowledge Management Services</td><td>Expert, knowledge and information services to mainly business partners and travelers.</td><td>Essential expert services supporting the core business operations: B2B /B2C, Organizational Information Services: like KMO, MIS and BI</td></tr>
</table>

An interesting net-wide phenomena, related to the above, is the problem of *information asymmetry* between the market participants in travel industry [40]. It is a specific connectivity characteristic of these kind of nets and it can be described as a situation where the other party of a economic transaction has relatively more information than the other. Because of its negative implications on trust and power balances, this is usually considered problematic in business relationships [41]. This is another reason why the different intermediaries, e.g. travel agents (TA) or *incoming tour operators* (ITO), try to place themselves in travel industry distribution channels to a key position between the suppliers and buyers. This way they usually (but not always explicitly) make the information asymmetry reduction part of their business model.

Based on related tourism industry studies [42][35], and previous project-case research by the author [9], the main roles of travel service provision networks have been identified (Table 3.2). In contrast to typical travel industry research where the *unit of analysis* is mostly the focal company, here all the (organizational) tourism stakeholders are seen as representatives of their functional roles that produce various types of services to the their partners in the network. In line of this, the intermediaries have a central role because they provide services to manage and organize the overall tourism value chain (i.e. organization services, OS). Destination management companies (DMC) are organizations producing mostly accommodation and program services in the regional tourism site or destination. Also, the marketing and sales activities (MSS), and the information and *knowledge management services* (KMS) are in this view clearly separated from the other business operations. The KMS-provision role is essential here in that it usually is the main driver that affect the network wide business trust relationships, capability and resource distributions, and intra- and inter-organizational activity patterns [9].

3.2. Relations and interactions

As stated in the discussion about the general properties of net-like structures, there is also the need to address the dynamic qualities and connectivity properties of these environments, not merely the static characteristics of them. Especially, when the nodes are seen as *knowledge-level agents* (KLA) [43], which can be humans, organizations or information systems capable to communicate, then the possible interpretations of the connections has some interesting implications in the context of this research. In these kind of multiagent-based complex environments many types of relationships between them exist, and these can represented by many (but not very rigorously definable) connectivity categories, such as: integrative behaviors, collaborations, interactions, conversations, communications, request/response-based messaging, transactions, transformations, or interoperability and compatibility dependencies.

A more structured typification is thus needed to support the analysis of the significance and nature of the linkages between the main representation elements of net-like structures (i.e. between the context, nodes, resources and enablers). It has been proposed that the heterogeneity issues in information systems correspond to a more generalized *interoperability concerns* in the model of Open Systems Framework for Social Interaction [36]:

- **social** world - beliefs, expectations, commitments, contracts, law and culture
- **pragmatics** - intentions, communication, conversations, negotiations
- **semantics** - meanings, propositions, validity, truth, signification, denotations
- **syntactics** - formal structure, language, logic, data, records, deduction, software, file

These concerns are thus in this research translated to a preliminary set of relation categories by which the essential connectivity and interaction characteristics of net-like structures can be represented. In the business organizations, the main levels of intra-organizational activities, i.e. strategic and operational, correspond to two types of relationships between the enterprises: (i) the management and control interactions, and (ii) the operational service and production systems linkages (see Figure 3.2). At the level of management and control systems, the transactions are further typed to three different groups: strategic, planning and scheduling, and operational control. In terms of what is transferred between organizations in these activities, there mostly are knowledge exchanges and information flows in the managerial level, and material and information-intensive resource flows on the operational level [44].

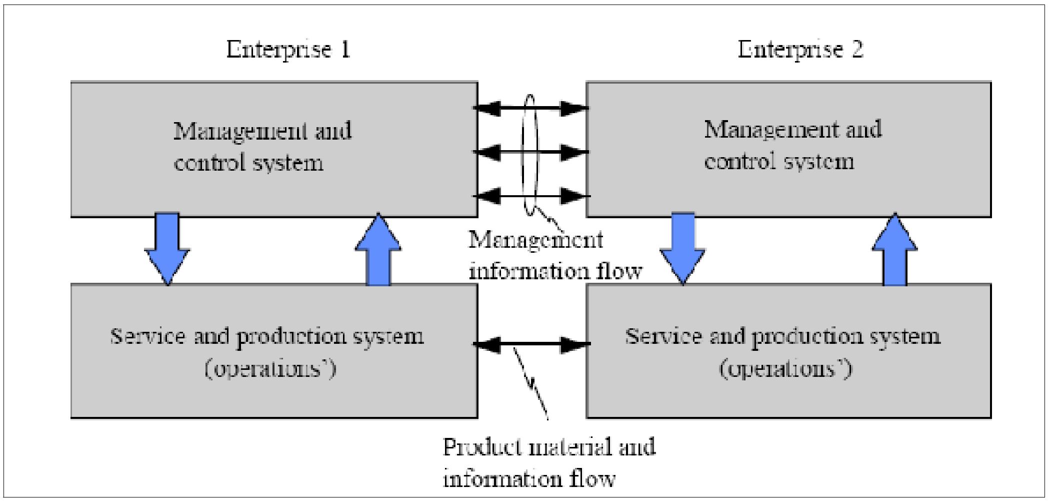

Figure 3.2 Management and operations in inter-organizational relations [44]

This preliminary discussion about relations in organizational networks is later elaborated (chapter 4.4.) in terms of *integrative enactments* that are possible in inter-organizational contexts. These correspond to the selected theoretical key-dimensions of this work (and the above introduced main relation types), and consist of communicative exchanges in network-level, interactive transactions in organization-level, interoperability or compatibility enhancements in content and technology-levels. By using these, the idea is to be able to model the effects of, say, supply-chain agreements (which is a result of communicative acts of the members of the network) to the relations in other levels, for example, organizational IT-adoption or semantization requirements of the deployed message broker system.

Role-based approach

To reduce the complexity of the relation-oriented analysis of the organizational networks, one should abstract oneself from the details by identifying the main categories of the particulars in each element class in the early stages of research. For example, in respect to the organizational key-dimension, functional role-based generalizations of the nodes in net-like structures (i.e. participants, actors, agents, etc.) should first be determined, and just then establish the relation type(s) that most accurately represent(s) their connectivity characteristics. In the *roles-linkage model* [45] the *business role* is seen as, "a grouping of the value-added distinct, technologically separable activities of the individual enterprises". Based on these, the model brings additional benefits to network analysis by reducing complexities and providing more systematic representations of the domain where the basic organizational unit of analysis has typically been one of *focal company*, *dyad*, or *business network*. It also focuses attention to specifically on how the technology adoption affects the configuration of network roles and influences the exchange relations between the firms by defining a set of economic *linkages* that reflect the different modes of network coordination [45].

The organizational connectivity can also be analyzed using Dependency Network Modeling [46] and represented as respective diagrams (see Figure 3.3). Accordingly, the *role* is defined as, "the combination of a specific set of behaviors and the goals to which the behaviors are oriented", and the *exchange relations* then, "can be viewed through a characterization of the roles played and the systems of control that govern the roles within a dependency network" [47].

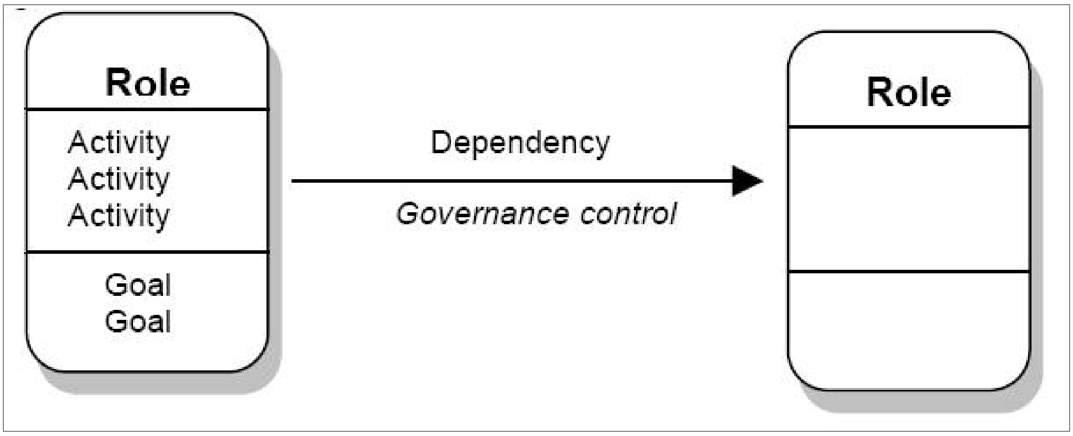

Figure 3.3 Roles in Dependency Network Diagrams [47]

In summary then, applying the relation-oriented approach in organizational networks research reduces the complexity of the analysis somewhat by offering additional connectivity-based criteria to classify the domain particulars to functional role-based categories. To go about in categorizing and analyzing the multitude of distinct entity relations existing in the target domain environments, the following is here suggested:

1. elaborate the understanding about the domain by focusing on entities and the relations
2. utilize role-based modeling relying on dependency networks or exchange linkages
3. analyze the relations in terms of the key-dimensions of the generic domain model (i.e. environment, organization, content and technology)

4. identify main net-like structure element type, the particulars of which the relation links
5. identify the nature of the relation in terms of the typification formulated using the interoperability concerns on the assumption that in most cases:
   - social relations manifest in environmental context,
   - organizations concerns are pragmatic,
   - semantics relates the content elements, and
   - syntactic (symbolic or physical) correspondence connects technological entities

3.3. Technology-enabled information flows

The discussion above concentrated on the relevant models and approaches applicable in analyzing various organizational forms (mostly business enterprises) operating in different networked environments (economic markets). In parallel with that, it briefly outlined a possible top-level typology for classifying the relations between the elements of net-like structures. Subsequently, the subject of the discussion in this section is on the remaining two key-dimensions of this research i.e. the *content* and *technology* (the *information-intensive resources* and the *enablers* in net-like structure terminology, respectively). Specifically, the focus is on enabling the communicative, information-centered knowledge exchanges (i.e. transfer activities) occurring in intra- and inter-organizational contexts. Furthermore, it is the Internet and the service-oriented B2B-integration technologies that provide the application and communication infrastructure that facilitates novel knowledge management practices and the various types of information flows between the networked organizations.

From the organizational point-of-view, there are many types of resources flowing between it and the others with which it has relationships or enacts in mutual interactions. As it has been pointed out (see Table 3.1), two main types of exchange relations can be distinguished in terms of what is transferred between the actors: the tangible and intangible resources. This can be contrasted to *information-intensive* resources, or *knowledge assets,* that have:

- *tangible* component - explicit knowledge, that has a physical manifestation, like manuals and documents accessible by others, and
- *intangible* part - tacit knowledge, like competencies or know-how not made available to others, because it is difficult, and sometimes even impossible to articulate or externalize (i.e. transform to explicit)

This differentiation relates to the creation of knowledge in the context of organizational learning which is seen as a continuous and dynamic interaction between the tacit and explicit dimension [48].

In relation to information flows or knowledge exchanges, the model of *resource-mediated knowledge flows* [49], presents the essential distinction of tangible and intangible resource in specifying a set of resource linkages (question/answering, citations, hyper-links, and semantic links) by which the related information flows take place (Figure 3.4).

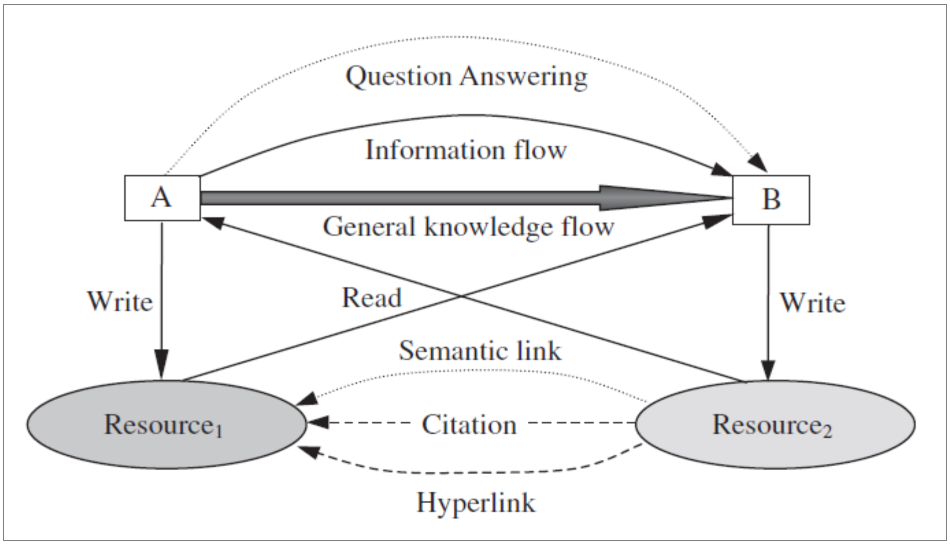

Figure 3.4 Resource-linkages mediating knowledge flows [49]

The specifics of the typology of linkages relates to the environment of this model where the nature of the knowledge flows are presented using knowledge intensive agents or nodes that are, for example, scientists who cite and read each others publications. Here, there is no physical resource transfers, but still the knowledge and information is flowing, and even exchanged between the actors, when the cited author reads the resource (e.g. article or report) of the other.

This kind of differentiation of the resources based on their fundamental characteristics is crucial in terms of analyzing the implications of changes in information flow patterns between interacting networked partners. Also, the control of, and access to information-intensive resources, especially, has a major impact on the structure of the network. The challenge, of course, here is that being able to govern network-wide activities whereby tangible resources are transfered does not by itself ensure the exchange of knowledge assets. In the following first, the main resource categorization schemes used in organizational context is reviewed. This also includes a short account on novel semantic and automatic resource classification approaches. After this, some of the existing service-oriented B2B-integration technologies are briefly outlined.

3.3.1. Categorizing resources

As noted above, the resources and related information flows are one of the key factors in the current economic environments and inter-organizational activities therein. The business organizations, specifically, try to find optimal ways to classify their resources in order to: (i) gain sustainable competitive advantage, (ii) elicit knowledge relating to intra-organizational resources and their criticality, and (iii) improve the strategic management of the information-intensive resources (or knowledge assets). The main focus here is on the resources that are useful and meaningful to the organizations (i.e. information-intensive resources). Below (Figure

3.5), some of the typical organizational resource categorization schemes have been reviewed in the work by the author in preparing the scene to automatic classification approaches for knowledge assets supported by selected semantic technologies[50] .

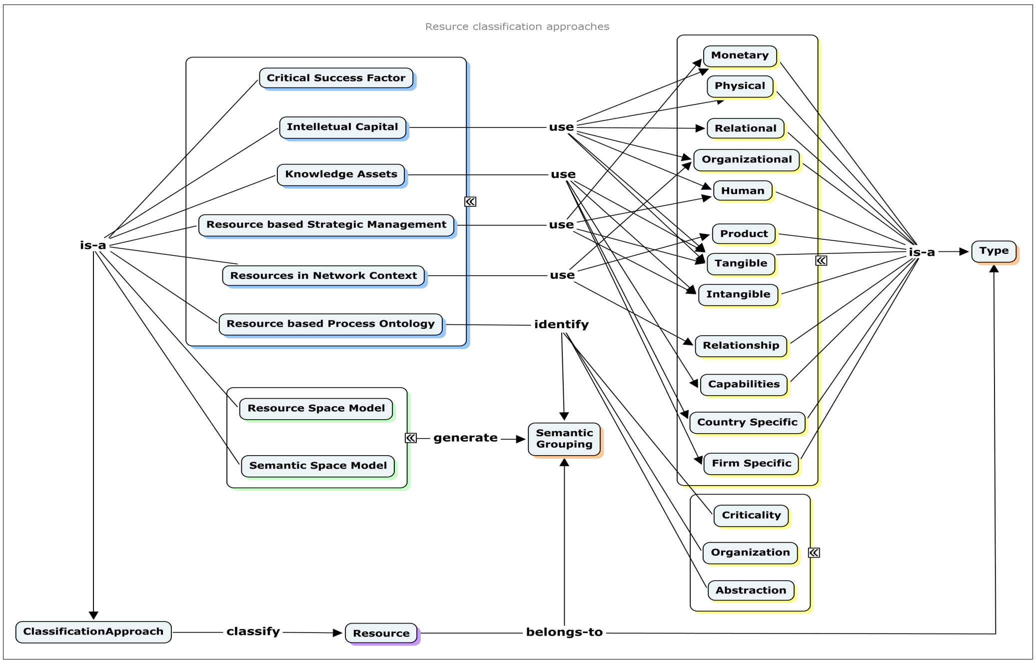

Figure 3.5 Organizational resource classification approaches [50]

In the concept map, the depicted categorization schemes (**ClassificationApproach**) identify their own set of types that characterize the various intra- or inter-organizational resources (**Resource *belong-to* Type**). The basic properties (e.g. products, facilities, organizations or relationships in the scheme of "resources in network context") are combined in different ways to group the resources (**ReseourcesInNetworkContext *use* {Products, Facilities, Organizations, Relationships}**). These divisions are done based on the following views maintained in each about the role of the resources in organizations:

- **critical success factor** - linked to the limited number of areas in which results will ensure successful competitive performance of the organization [51]
- **intellectual capital** - division to categories of traditional economic, intellectual capital, and recognizability based on economic behavior, information asymmetry, or rivalry [52]
- **knowledge assets** - focuses on the information and knowledge characteristics in recognizing tangibles, intangibles, capabilities, and country or firm specific resources [53]
- **resource based strategic management** - utilization and accumulation are the factors of financial, tangible, intangible and human resources [54]
- **resources in network context** - recognizes also the relationships as essential resources [55]

The key point here is that all the above listed categorization schemes are founded on the *static classification* that uses pre-determined contextualized set of resource types which are mostly business driven. In contrast to these, are the *dynamic classification* approaches (relying for example to semantic technologies, like the Resource Space Model and the Semantic Space Model) that are interpretive and can be automated. The *hybrid categorization* schemes (e.g the **ResourceDrivenProcessOntology**) can utilize appropriate methods from both of these.

3.3.2. Service-oriented integration technologies

From the information technological perspective, the overall target domain area of this research manifests itself as an environment of knowledge-level agents (humans or information systems) bounded by the organizational forms and networked structures. Above, in respect to developed model of net-like structures, the service-based technological orientation applicable in these contexts was introduced. Here the interoperability concerns of business organizations are linked to the existing technological solutions in terms different *levels of integration* (extended from [56]):

- *network-wide interactions* - multiagent (human or information-system) collaborations
- *semantics and knowledge exchanges* - focus is on the meaning, shared understanding
- *management and control* - support strategic planning and operation control functions
- *business operations* - business process interfaces between trading partners
- *services* - functional business services, service oriented approaches, web technologies
- *application* - leveraging of interfaces exposed by custom or packaged applications
- *messaging* - communication protocols, message brokers (Internet protocol stack)
- *information and data* - representing, extracting, processing and updating information stored in various repositories (databases), and transferring data between them

The organizations participating in network-wide interactions and knowledge exchanges are in need of various knowledge management services in order to govern their inter-organizational environments, customer information and relationships, and their market information acquisition practices. These services are useful in assisting the strategic decision making, and also improving the control mechanisms of the business operations. Additionally, they will benefit from many types of information-intensive services to support their operations (e.g. process-based transactions). The execution of the business strategies and processes materialize in operative *business transactions* by which the enterprise implements its value-proposition by producing value in form of products, services or information to its customers and trading partners. Approaches to tackle and resolve both the business management and the operation level issues arising in changing network environments, involve using existing enterprise engineering methodologies. Constructing new inter-organizational business models or novel management processes for *enterprise application integration (EAI)* have been beneficial in this.

The past efforts to overcome these challenges have typically been based on classical s*ystems integration* (SI) solutions that only cover the domain of existing intra-organizational information systems that can then be linked by developing interface architectures, message brokers, or shared business logic solutions. The deficiencies of these approaches can be seen in the model that identifies the following dimensions of systems integration (depicted in the Figure 3.6) in terms of the information system characteristics: [57]

1. **distribution**: tackling the problems related to the spatial (geographical) distance of information systems
2. **heterogeneity:** finding solutions emerging from the differences in IT-infrastructures and architectures, including hardware, operating systems, database engines, applications, programming paradigms and languages, information models and representations.
3. **autonomy:** considering the self-sufficiency, atomicity or privacy and security requirements of the deployed information systems (relevant especially in enterprise network integration environments).

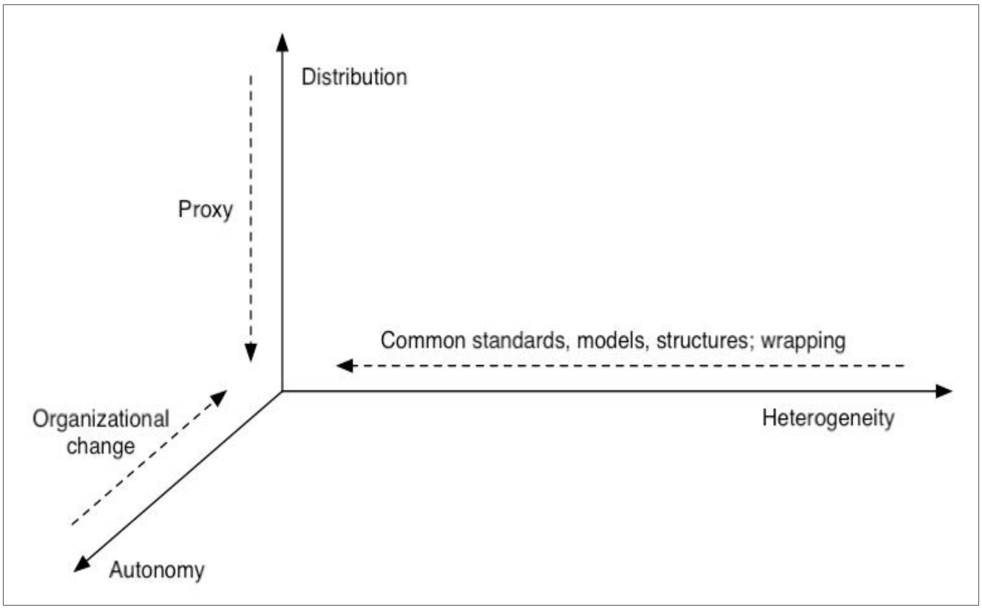

Figure 3.6 Dimensions of systems integration [57]

The model offers proxies and common standards, and discusses about the need of organizational changes in order to succeed in integrating the information systems or enabling their interoperability (i.e bring them logically closer to each other towards the orig in the three dimensional SI-space). In the networked context, however, the distribution of systems (in different organizations) causes the traditional systems integration solutions usually to fail. This is because the integration in the dimension of autonomy, particularly, requires appropriate organizational commitments and agreements besides and beyond the scope of technical solutions. Other issues in the organizational interactions (that depend on usage scenarios, parties involved and business requirements) that complicate the situation are: the coupling among partners, external manageability, scalability and information security considerations [24]. In the inter-organizational EAI, or the *business-to-business integration* (B2Bi), all the levels and dimensions of integration above are to be addressed. The argument for this is that, currently the enterprises are increasingly challenged by the inter-organizational, multi-cultural and net-like business environments. This means, that all the complex and dynamic interactions between business partners, customers and competitors also require and demand additional capabilities and competencies for making successful strategic and organizational decisions and to run business operations effectively.

Related to these, is the business organizations demand to IT solutions that support their interactions with customers (B2C), consisting of business functions, such as placing orders, making reservations, buying and making payments, distributing products, and marketing, In what follows, few types of *integration service* architectures and approaches are outlined that are based on service-oriented information technologies. These are typically used to solve some of the organizational EAI problems, and they also enable many of the B2B- and B2C-functionalities.

Business Process Management

The alignment of the service orientation (SOA) with the business operations is best demonstrated here by linking it to the models defined in approaches like Business Process Management (BPM). These practices empower the business analyst to align the IT-systems with the strategic goals by generating well defined formal enterprise business processes [58]. According to BPM, business process models are created using conventions like Business Process Modeling Notations (BPMN) [59], which is UML Activity Diagram like work-flow notation. The BPMN specification provides a graphical representation of business activities and tasks, with constructs to binding them to various process execution languages. The process automation engines then can implement these based on the architecture of the Internet and service technologies (e.g. the web services, WS) relying on it. Also, by using the monitoring and management capabilities of these systems the automated business operations can be controlled.

Enterprise Service Bus

Enterprise Service Bus (ESB) is an architectural solution to integrate mostly intra-organizational information systems by providing them a common messaging backbone, using which the various systems can communicate in form of data streams and information transfers. It requires interfaces in the applications themselves to be available when the applications connecting to the bus are not compatible with it (which is the usual case). However, this solution scales reasonable well when the number of systems grows because the integrative data format transformations are done in each of the the adapters. From the business perspective this architecture optimally provides an infrastructure that makes it possible to use all the managerial and operational information systems as services interconnected by the bus. The challenge in the enterprise modeling here is the identification of the essential functionalities needed in the organizations. This should be carried out to establish the business-driven service requirements for the ESB, thus avoiding a situation where a tangled set of applications are slightly more integrated without the business benefits.

Hub/Spoke

In the star-shaped architectural topology there is the centralized broker (the hub), and the information systems are connected to it through the adapters (the spoke). Here the integration of the application data and incompatible message formats, for example, is achieved by the combination of the processing in central message broker and in the adapters. From the applications point of view the integration service is just an interface by which it communicates with the broker. The bottle-neck of these architectures is the hub which must handle all the data translation and routing between each of the adapters.

SOA and Web Services

The SOA and the related web based services and architectures can be seen as the concrete platform on which the solutions presented here can be build. The service paradigm was previously introduced in the theory-oriented discussion about the role of information technology as an enabler to organizational activities (see chapter 2.6). In continuation of that, the *service oriented model* [60] to which it is based is presented here (Figure 3.7), and the related Internet based technologies that are used to implement the SOA-solutions are outlined.

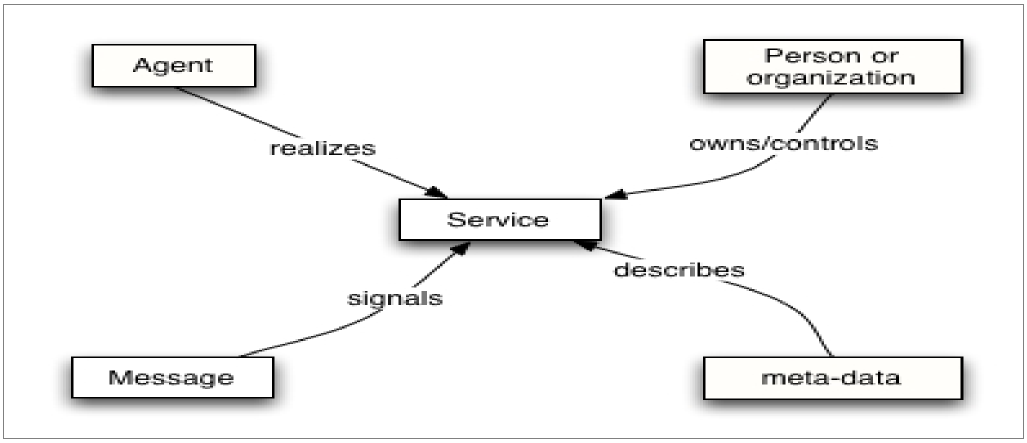

Figure 3.7 Simplified service oriented model [60]

The service oriented architecture (SOA), seen from the organizational perspective, enables the independent construction of services which can be combined to realize business processes in enterprise context, and provide support to inter-organizational interactions. In general, however, the service oriented model specifies a service in relation to: (i) an *agent* that realizes it, (ii) an *organization* that owns or controls it, (iii) *message exchanges* by which they are mediated, and (iv) *metadata* that describes it.

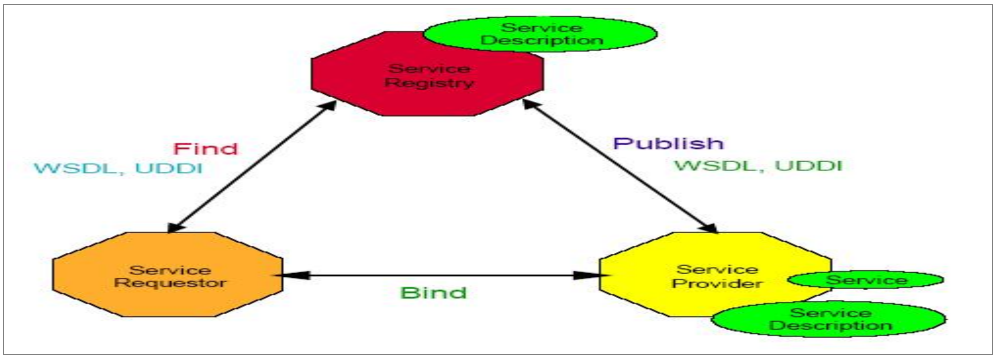

Figure 3.8 Web Service architecture and technologies

As the service itself is an abstraction, it means that it does not strictly depend on any particular set of technologies, although the SOA-related specification(s) include several such recommendations. The service paradigm actually exists exactly in order to hide the details of the Web Service (WS) architecture and the related technologies, that are one concrete implementation of the SOA-model. It is realized by the exchange of messages between the *service consumers* and *service providers* (see Figure 3.8). The providers first describe the available services (using Web Service Description Language, WSDL) and publish them service registries (Universal Description Discovery and Integration, UDDI) from where the consumers can find them. The *service request* from the service consumer and the corresponding *service response* from the provider forms a *service binding* between them whereby the *messages* can be exchanged using a specific protocol (Service Object Access Protocol, SOAP). All of this relies on the underlining architecture of the world wide web (WWW) that builds on the Hypertext Transfer Protocol (HTTP) and the Internet Protocol Suite (TCP/IP).

XML

The core technology for representing wide variety of data that can be exchanged in the Internet is the eXtended Markup Language (XML) [61]. It is a structured text format, derived from SGML, that is used, among other things, in the specifications of the Web Service technologies and protocols. However, because it was not designed to define semantics, descriptions of message exchange sequences, or to be used to specify correct interpretations of exchanged messages [62], several higher-level XML-based frameworks and standards have been developed [24]. In the context of this research, the most notably of these efforts is the Semantic Web [63], in which meaning (i.e. semantics) is attached to the content (i.e. the web resources) in such a way that it is processable also by information systems. However, the details of the semantization of the Internet and the benefits of it to the tackle the challenges of this work, are addressed later when the research methods and tools are discussed that enable target domain models to be represented using semantic technologies.

4. Representing organizational networks

The identified requirements of the representation model of the CMON-framework (i.e. conceptualization of the generic domain model) is to support both crossdisciplinary research and to enable the governance of research artefacts in cross-project settings. After the theoretical insights and models related to the target domain have in previous chapters been analyzed and further developed, the aim here is to combine them to the *generic domain model* (GDM) of organizational networks. This is mostly based on the introduction and analysis of net-like structures and the preliminary identification of the main types of relations between the model elements therein. In its conceptual form it is the domain-related structural part of the representation model (i.e the *research space)*, that enables the alignment of research artefacts (specifically conceptualized domain analyses). In this respect, the discussion here also serves as a definition of the logical interface layer between descriptions of the target domain, and the semantic topology of the research space.

First, the generic domain model is here presented as hierarchical structure (chapter 4.1) with short discussion about the intrinsic limitation in layered models (e.g expressive insufficiency). This is thus transformed, to three dimensional model that more accurately corresponds to the multifaceted nature of the domain of interest (chapter 4.2), and in which all the relevant interconnections between the domain elements are shown. Then based on this, conceptual analysis is conducted that furthermore defines in detail the main elements of each domain (chapter 4.3.), and their relationships to support the interpretation of the cross-domain relation couplings (chapter 4.4). Finally, a concept map is produced that visualizes the overall representational structure of the target domain (chapter 4.5).

4.1. Layered model

Layered models are based on hierarchies that represent the dependencies or abstraction levels of the particulars under study. They are generally build by first making observations of the most numerous and specific instances of the domain that is focused on and then moving to higher (e.g. more abstract) level of analysis. This is done under the assumption that, the instances that belong to the same level are in similarity relation to each other (in reality or conceptually), and that there are distinguishing characteristics between the different layers (and the particulars in them) of the model..

In the analysis of the structure of *tacit knowing*, two terms have been identified: *proximal* which includes the particulars that are directly observable, and *distal* which is their comprehensive meaning, and these can be seen as two parts of reality that are controlled by distinctive principles or laws [6]. Applying this idea in relation to structured models where each layer depicts a different perspective of reality provides the research in this work a useful instrument for formulating hierarchical representations. Building models accordingly further means that the analysis of the members of the layers and the determination of their order adheres these two basic rules:

i. a specific layer is on higher level than another if the particulars on the lower level form structures that can only be governed by the laws of the upper level (*emergence*), and if the higher level has only marginal control on the lower level particulars (*control*).

ii. it is impossible to represent the organizing principles of the higher level by the laws governing its isolated particulars [6].

A typical example of hierarchically layered model in the information and communication technology (ICT) field is Open System Interconnection (OSI) Reference Model (Zimmermann1980) by the International Standardization Organization (OSI), in which a (computer) network architecture is represented as a stack of seven interconnected layers (Physical, Data Link, Network, Transport, Session, Presentation, and Application) where the lower layer provides the services required for the functionalities of the upper level. In the field of inter-organizational information system (IOIS) research [64] and also in many technology-oriented standardization efforts, it is the legacy of hierarchical model view expressing itself in the structure of the frameworks and in the linkage patterns of the model elements. This kind of interdependency character in the layered models is usually warranted especially when it corresponds well with the structural relations of the real-world entities. Here, it serves as establishing the generalized layers of the target domain model by contrasting project-case domain particulars to relevant existing theoretical insights and models.

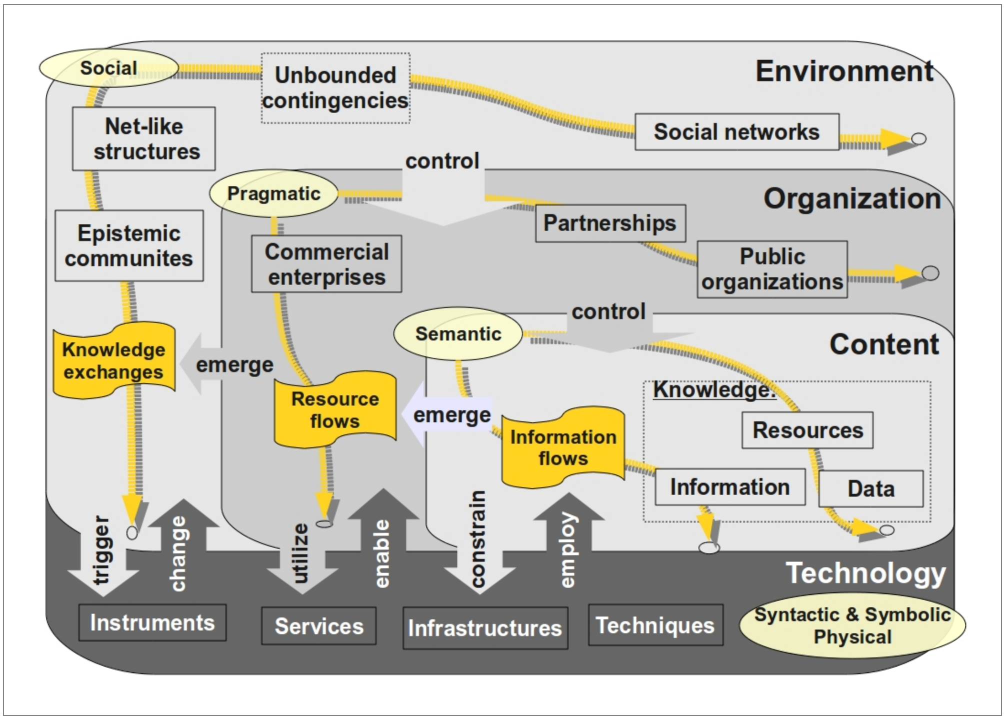

Figure 4.1 Layered representation of the target domain

Based on the above, the overall target domain area can now be represented as a hierarchical model. It is done by following the fundamental principles in separating the the real-world entities (or categorized particulars) to a structure consisting of distinct abstraction layers. Dependencies between these levels are in general characterized by the interplay of various types of control functions and feature emergence relations. Accordingly, in the analysis of the aggregated domain area of IT-enabled information-intensive organizational networks, the generalized layers correspond to mapping of the theoretical perspectives to the elements of net-like structures, and technology enabled information flows discussed previously. The order of the hierarchy in the model has been determined in accordance with the described principles of layered models, and by relying on the analysis of the main relation types linking the role-based abstractions of the particulars belonging to them (see Figure 4.1).

In the technological layer instruments, infrastructures, instruments or services are mostly in syntactic, symbolic and physical relationships to each other. Technologies are constrained by the substances that the techniques or methods are employed to. This can result in data-driven streams or information flows. Organizations then can utilize, for example, service oriented technologies or infrastructures that enable the information-intensive resource flows between various organizations, like commercial enterprises or governmental agencies. Environmental contingencies trigger technological innovations which then can change the circumstances.

In the content layer, semantics is attached to the elements of substance like various types of resources (physical or tacit), capabilities, facts, rules, or data. Their dynamic interconnectedness and the changes in their tempo-spatial relations brings about features that manifest themselves in organizational layer as (information-intensive) resource flows, for example. Organizations, then control the many resources and assets they own by limiting access to, or by sharing them . They may also seek to constrain the dynamics of the commons (i.e. substance not in their direct control) by trying to have influence their distribution or using them for their own advantage. Information technology relates to the elements of (information) content by enabling the processing the syntactic and symbolic representations of them.

The dynamics of different organizational forms is based on their practical and pragmatic needs and goals. Two main types of organizations depicted here are the commercial enterprises and the governmental agencies or public (communal) actors. The relations of the particulars in this layer are mostly interactions whereby information and materials flow between the organizations. From these, higher level knowledge exchanges can come to existence. Also, the emergence of networked structures is typically caused by the variations in power and dependency relationships between the organizations. Again, enabling technologies are utilized in these circumstances because of the practical value they have (speeding up he operations or minimizing the costs) for the identity, growth or survival of the organization.

The environment can be divided to many types of different organizational constellations (like social networks, epistemic communities and business networks) depending on the selection of premises by which the borders are to be drawn. These structures are embedded into a setting where also a wide range of unbounded contingencies constantly affect them. In this layer the typical relations between these netlike structures are communicative social knowledge-exchanges. The networks have control on the organizations that are part of them, and also the adoption of available technological artefacts can change the dynamic patterns of the environmental structures.

Limitations in layered models

In terms of the *completeness of the model*, any reality-representation should cover the scoped phenomenon as broadly as required and at the same time not to make unreasonable simplifications. This concern can clearly be shown in analyzing in more detail the model depicted below (Figure 4.2) where information, process, portal and service oriented enterprise application integration (EAI) approaches [65] have been aligned along the axis of maturity. In respect to the above discussion, the shown two-dimensional bottom-up -structure seems to have a conceptual drawback in that while it implies that the enterprises integration maturity level builds on the "orientations" in the layers stacked upon each other, at the same time the possible multiform of the relations between the model elements in each layer is hidden.

Additionally, because the direct conceptual relation between the top and bottom layer elements in this presentation is missing, it can be misread. For example, based only on the hierarchy-constrained indirect dependency relations between the layers, maybe it means that the indicated maturity level separation of the furthermost entities (like SOAI and IOAI) also corresponds with the *semantic distance* between them. However, while this conclusion might be fair in this situation, it is because of the structural limitation of the model, and the explicated linkage information is absent, that confidence of this conceptual inference can not be assessed.

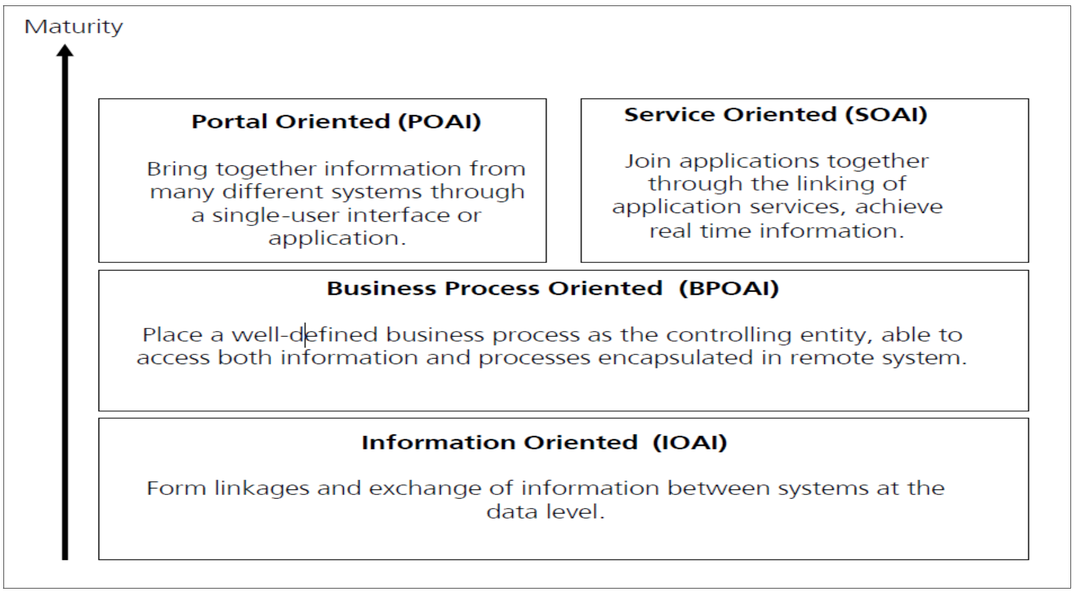

Figure 4.2 Enterprise application integration [65] as a hierarchical model

In summary then, this appears to be an indicative example of similar existing layered framework representations, that they also exhibit same kind of characteristics, where relevant conceptual and semantic information could be missing or would be difficult to represent because of the structural constraints of the model. In general it can be claimed that some of the essential characteristics of the complex, inherently multi-perspective and multidimensional nature of the phenomenon under investigation in this research could be missed when relying solely on these kind of hierarchical models.

Thus, to avoid this, the three-dimensional form of the proposed metamodel makes sure that the four abstracted main elements and all the corresponding relations between them can be explicitly and naturally specified. Also this way the models *expressive power* is not bounded by the direct dependency-relation as in the hierarchical arrangements of domain entity categories. Additionally, in the non-hierarchical models, the conceptual link between any two of the main elements can be omitted, if an open ended continuum of entities positioned on-top of each other, like in hierarchical models, need to be represented.

4.2. Multidimensional model

In the above, the target domain was reflected both from the practical project research and theoretical perspectives. Based on that a hierarchical model of organizational networks was build. Here, that construction is further elaborated in order to represent the multidimensional nature of the inter-organizational network domain. The vertices of the tetrahedron (environment, organization, content, technology) represent the multi-faceted approach to analyze the target domain phenomenon. The previously identified relationship types (i.e. social, pragmatic, semantic and syntactic) are here attached to these categories as relations that connect the particulars of the domain areas as conceptual classes and the particulars falling under them. The parts of the model form a "conceptual space" that will later be incorporated to the eventual specification of the research methodology proposed in this work. As shown in the schematic of synthesizing the generic domain area model (Figure 4.3), it has been build by:

- applying the relevant theoretical approaches (chapter 2) and relying on the analyses of existing models that have further been combined to a construct of net-like structures (chapter 3),
- making appropriate abstractions and generalizations of the research case specific domain area conceptualizations scoped by the individual project goals and constraints.

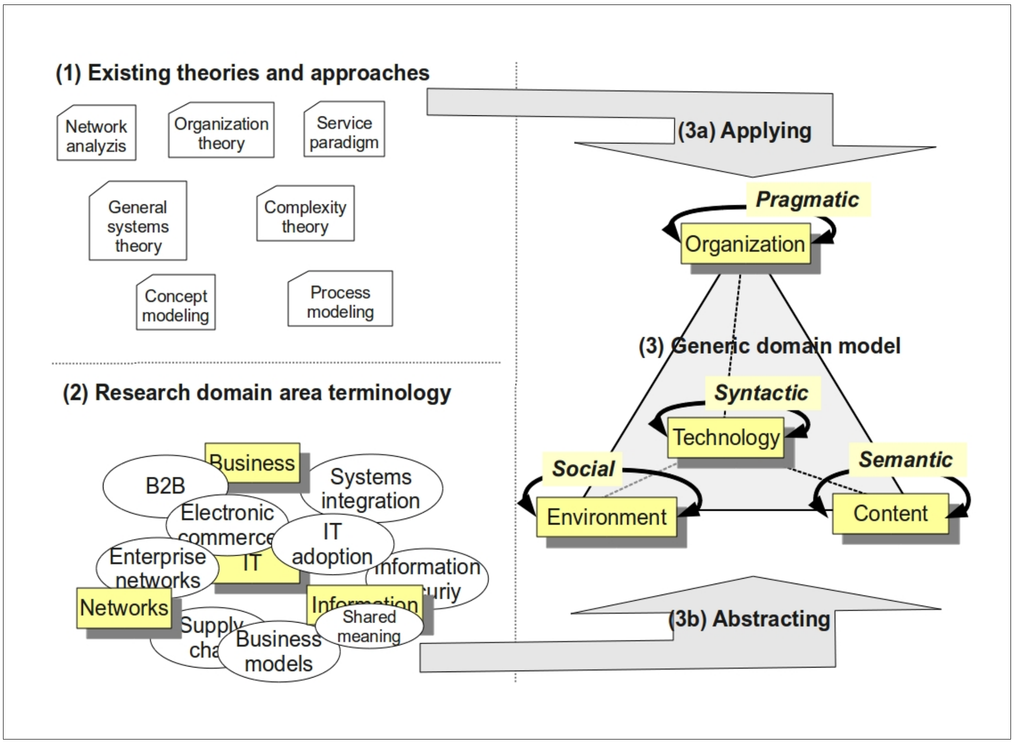

Figure 4.3 Synthesizing he generic domain area model

In the three-dimensional topology of this model all the main domain areas are pair-wise linked to each other and not anymore hierarchically aligned. Main argument for this kind of model structure is that it solves a class of model-theoretical layer-dependency issues in the purely hierarchical representations. Thus it increases the expressive power and improves the referential correspondence of the model. This way, also, all the main domain elements in model can be seen as conceptual classes that share a characteristic that each class and every concept therein can be in *direct relation* with any other concept in the model.

Each of the domain elements is below represented as categories and concept hierarchies, and the analysis supplemented with a detailed specification of the concept relations and their inter-dependencies. The entity-relationship models applicable to the cross-project research phenomenon are depicted in the following as *concept maps* created with a CmapTools software [66] which is well suited for semi-formal object-oriented representations. These kind of conceptualizations can be developed and specified entirely with graphical tools by drawing boxed entities (i.e. concepts) and connecting them with lines (i.e. relations) and thus providing a visualization of the domain area. They also have an equivalent textual representation where the entity-relations are specified as a list of propositions, i.e. triplets of a form {**Subject *relation* Object**}.

4.3. Domain elements as conceptual classes

In this work it is required, that the multidimensional generic model can be used to represent the particulars of the target domain areas that are specific to each individual research project. Using the construct of netlike structures and the hierarchical model above the preliminary topological model was derived and it is further elaborated here. To reach this level of detail, the analysis of the organizational networks conducted so far is complemented here relying on the concept analysis approach. In concept models the *concept* is a representation of a set of real-world entities to which it refers to, having a definitional structure expressing the necessary and sufficient conditions for a particular or an instance to belonging to it. As these kind of conceptualizations are based on entity-oriented view of the reality they can be depicted with concept maps that are an informal, graphical way to illustrate the entities (i.e. concepts) and their inter-connectedness (i.e. relationships). Equivalent representations can also be construed in relation to the object-oriented modeling paradigm which typically rely on the modeling conventions and notations of Unified Modeling Language (e.g class or use-case diagrams).

4.3.1. Environments and social interactions

Instead of detailing the wide variety of different kinds of *environments,* only their essential features and main types of them are depicted and listed below (see Figure 4.4). Based on the above theoretical review the representation of any environment should contain a description of the nature of the complexity, and an analysis of the contingencies and its systemic characteristics. For example, building a model of a business network under study in a particular project research these properties could be identified from the perspectives of each member organization and thus an understanding of their overall operational context can be formed. The *knowledge exchanges* are inflicted by, and are the consequence of, the *social interactions* in the *bounded structures* of the environment. *Unbounded contingencies* consist of ecological, biological or physical factors. As it has been pointed out previously (in chapter 2.3.) the external contingencies have major influence on the formation and internal properties of several types of structured constellations that can be identified. These can also be bounded by the characteristics of their constituents, like organizational forms, or adherence relations and behavioral patterns.

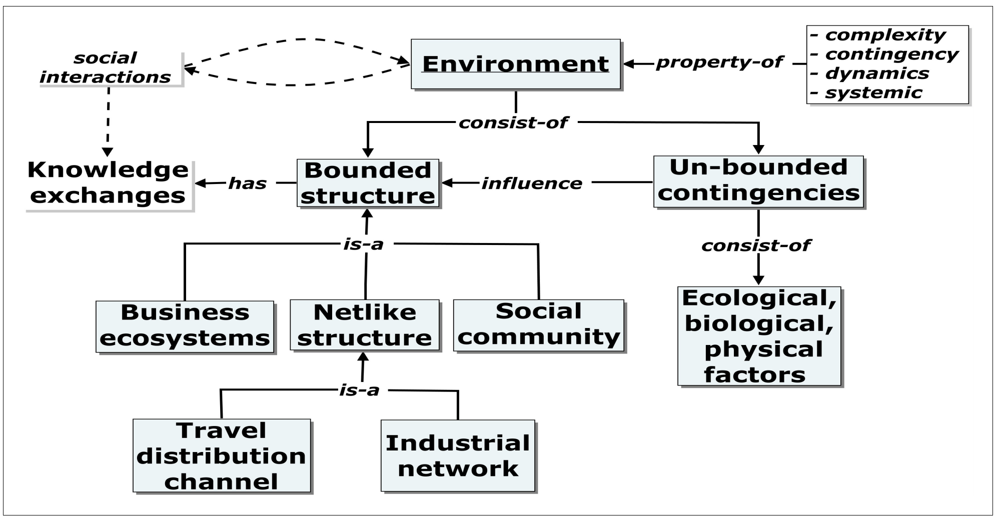

Figure 4.4 Social interactions and knowledge exchanges

In the context of this work, the focus is on the *netlike structures* and specifically on the industrial networks and travel distribution channels. These are clearly *business networks* based on the Open-Edi [67] reference model that defines business as, " a series of processes, each having a clearly understood purpose, involving more than one organization, realized through the exchange of information and directed towards some mutually agreed upon goal, extending over a period of time". These types of inter-organizational forms have often been represented as *supply chains*, where the consecutive buyer-seller transactions configure the topology of the network. In reality, many other types of networked structures exist like, business ecosystems, social networks, smart business networks, collaborative virtual organizations, or epistemic communities. Some of these are similar enough to the conception of netlike structure that mapping to its core elements is possible. However, whether these kind of model constructs and related modeling techniques are useful is to be determined in practical research work case-by-case. This should be done after a sufficient level of understanding of the environment in question has been reached.

4.3.2. Organizations in pragmatic relationships

Various types of organizations are mostly in *pragmatic relationships* with each other that give rise to many (information-intensive) *resource flows* between them. To analyze the nature of these interactions in more detail the participating organizations need to be profiled and categorized. For this, it is beneficial to try to describe some of the internal properties of the organizations, like its value proposition, operation mode, organization structure, and the core competencies. The *value proposition* can simply seen as a description of the circumstances in which the organization is to fulfill its value creation mission, i.e. to which external demands and constraints it is to respond. to respond to the external demands and constraints. Based on this, two main types of organizations can distinguished: commercial *enterprises* and *public organizations*. Instances of the later are many non-profit organizations like associations *of public utility* and *governmental agencies*. The *core competencies,* i.e. the human or physical resources (resource based view of the firm, RBV), processes (process based view of the firm, PBV) or knowledge-intensive capabilities (knowledge based view of the firm, KBV) of the enterprise should determine the internal set up of its *organizational structure* that can be hierarchical, team based, cross-functional, or a combination of project driven and executive governance (i.e. matrix form).

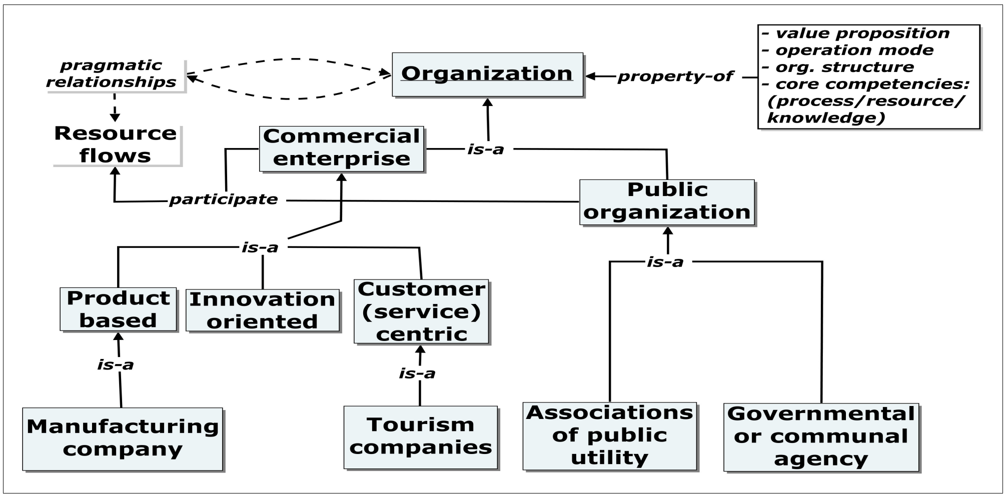

Figure 4.5 Pragmatic relationships and resource flows

The strategic decision making in the organizations, is dependent on the competitive and/or collaborative environment in which the company is embedded. The *operation mode* of commercial business organizations determines by which means its internal operations and structure is to be managed. The circumstances may require the business organization to focus mainly on serving its clients (*customer-centric*), pursue for generating and developing new forms of offerings (*innovation-oriented*), or concentrate on the product and service provision functionalities (*product or service based*). In the past research projects, the focus has been on two types of organizations in their own industrial environments: manufacturing enterprises and tourism companies. While the operation mode does not perfectly separate these types, the industrial network and tourism studies however revealed that the role-based position of the companies in the network are affected by it. For example, the production-oriented steel forges (studied in the business network integration project) were the end-producers in the respective supply chains, and the service-centric companies (e.g the travel agencies and the tour operators in the PROVEM-project) operated in close proximity to the end-customer in tourism networks.

4.3.3. Content and information flows

Because of the complexity of the nature of the general notion of content (and information particularly), it is beneficial here to focus the attention more to the relations between various forms of it. The *content* (see Figure 4.6), in the context of this work, stands for either entity-based representations of the objects (i.e. things) of real-world, or is the manifestation of *formless substance* (like abstractions, meaning or knowledge). Accordingly, it is here maintained that these linkages are mainly *semantic,* in the sense that *meaning* can be attached to the contentual elements, and at this level they are associated in many ways with one another. When these meaningful referrals are made concepts are formed, and the referents can be physical objects and data or non-physical entities (e.g information). As it was pointed out in theory-oriented discussion about the content and meaning (see chapter 2.5.) a hierarchical continuum of *data, information and knowledge* exists in such a way that "knowledge is applicable or usable collection of information that consists of processed or interpreted facts, symbols or marks (i.e. data)" [10].

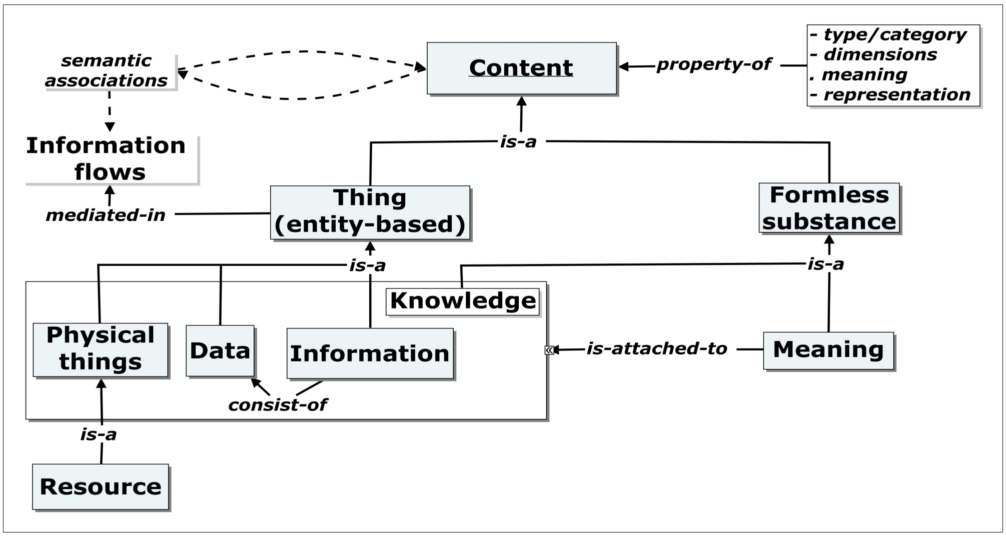

Figure 4.6 Semantic associations and information flows

In a more functional way of thinking, the constituents of the content are distinguished by identifying the operations that are applicable to each of them. In short signals, symbols, marks and physical things can be send, detected and observed, data is processed, transformed or transfered, information emerges from these as meaningful (human) interpretations, and knowledge is exchanged in the communicative acts that can be mediated by the other forms of content. From the organizational perspective, these activities manifest themselves as *information flows* (or information intensive resource flows), the specifics of which depend on which kind of contentual elements are thus mediated.

4.3.4. Technological artefacts

The technologies produce *artefacts* that are in syntactic, symbolic or physical adherence relations to each other (see Figure 4.7). In practical terms, this means that technology can be conceived as a *process* by which inputs are transformed to outputs by using appropriate *tools and techniques* the choice of which is related to the field of science or discipline that is applicable in the each case. In terms of the level of standardization of the transformations and the inputs/outputs (e.g. resources) technologies (and related organizational forms that utilize them) have been in contingency theory typified to three categories [19]: *long-linked,* where fixed sequence of steps transform standardized resources (e.g mass production), *mediating,* where the resource flows to be transformed are unique (e.g brokerages or perhaps intermediaries in travel industry), and *intensive* where the processes are informal and situation-dependent and the resource flows have are unstandardized without fixed patterns (e.g pooling of expertise in R/D-laboratories).

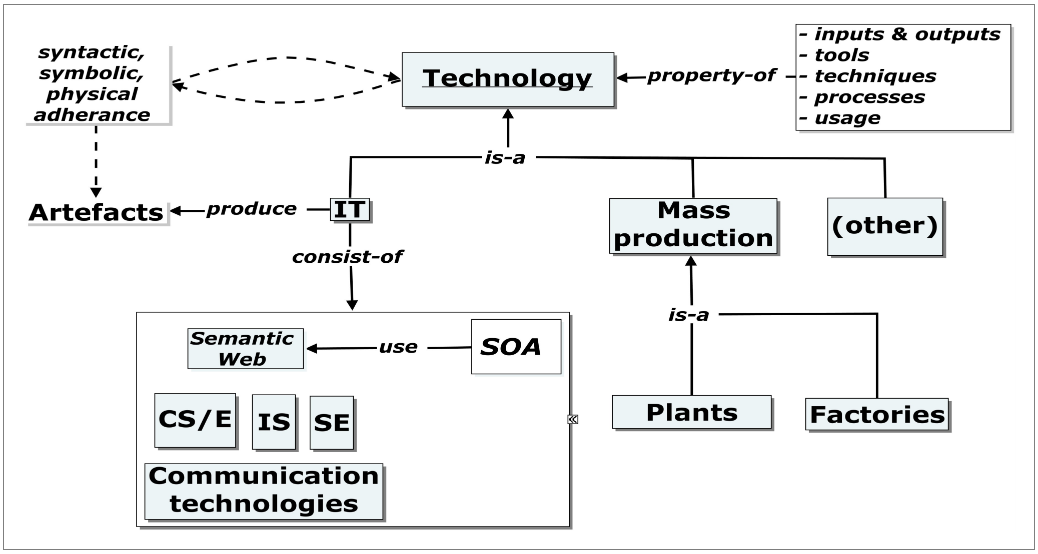

Figure 4.7 Syntactic and symbolic adherence and IT-artefacts

Here, the focus is on Information Technology (IT) that consists of Computer Science/Engineering, Information Systems sciences and Software Engineering together with communication technologies. This typification where the IT is not listed alongside the other fields of the ACM-computing curricula [68] is based on the emerging conception of the *Discipline of Information Technology* (DIT) that is being developed in the University of Lapland [69], which is aiming to get information technology to be recognized as a discipline with its own scientific-philosophical orientation, theoretical and meta-theoretical foundation, and research methodology that has applicability, among others, specifically in the fields of network, organization and information studies [70]. As it was previously outlined, the solutions that employ *service oriented approach (SOA)* in business network contexts are typically implemented using the tool-set provided by the web services (WS) and semantic web technologies.

4.4. Interconnectedness of the domain relations

In respect to the research motivation of this work, incorporating domain relation typology to the core of the conceptual domain model is justified because it makes it possible to utilize modeling techniques that extend the traditional entity-centered conceptualization approaches. The starting point for enabling this is the characterization of the project research focus area in terms of the main types of relations between the domain elements. This complements the analysis conducted above, that concentrated on defining the properties of the top level domain entities. Based on a review of the relevant existing theoretical connectivity paradigms, and by relying the Open Systems Framework for Social Interactions [36], the preliminary analysis had already identified the four main categories of the domain relations:

i. social communicative acts and knowledge exchanges
ii. pragmatic interactions and resource flows
iii. semantic links and information flows, and

iv. syntactic-symbolic adherences (e.g. information system-level compatibility).

This typology is here elaborated by inspecting the dependencies of the real-world particulars that are referred to in the conceptual representations of these relation categories. This way the nature of the *interconnectedness of the relationships* [71] in organizational networks context can be revealed. This is done here to support the building of models in project research that can represent features of the networks, that go beyond the approaches that do not consider the effects the relationships have on each other. In these models, typically, the relations are meant to refer to and depict only the linkages between the entities they connect, thus ignoring the more complex dynamics of the relationships.

The topological inspection of the developed multidimensional model suggests that there are: (i) six dyadic relations that connect domain entities pair-wise (see Figure 4.8), and (ii) four triadic cross-domain relationships that define the planes of the tetrahedron, with the addition of (iii) one quarter-nary relation that encompasses the entire domain area under study. In the illustration all the types of the relations that have been previously identified in this work first in developing the hierarchical model, and then in a more detailed analysis of the characteristics of the multidimensional model. For example, in comparison with the hierarchical model the relation between the environment and content has been added to represent the service oriented architectures that partially belong to the domain of the network-wide phenomena and they thus *mediate* various types of information-intensive flows. These correspondingly contribute to the social and communicate patterns in the network.

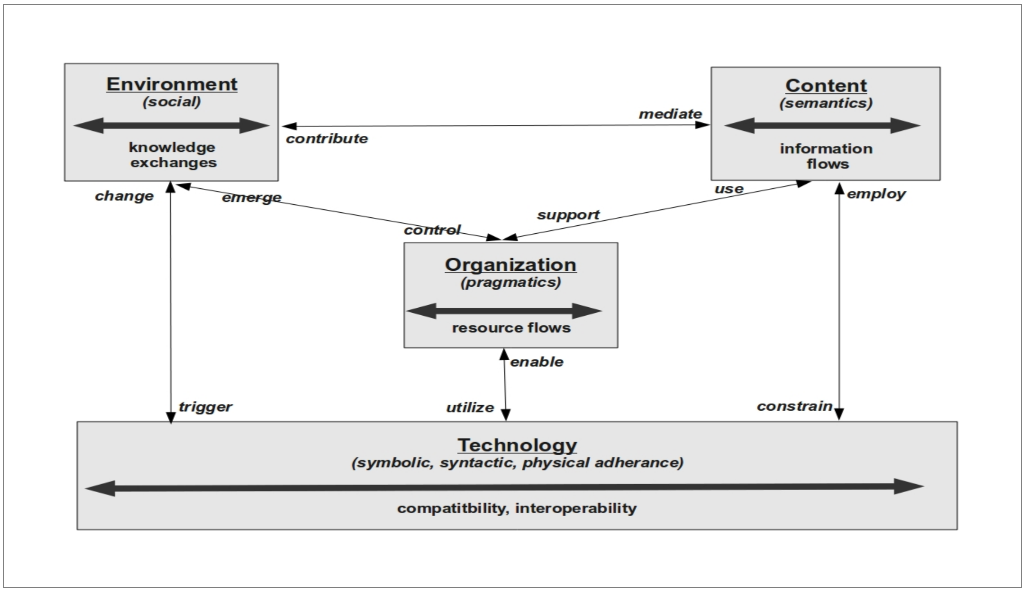

Figure 4.8 Dyadic relations between domain entities

The analysis of these cross-domain relations primarily rests on the basic idea that they represent such functional and behavioral qualities where the level of network-wide organizational cohesion and changes in it is *not only* mediated by the abstract and concrete types of content (i.e. the knowledge exchanges, information and resource flows, data streams or service protocol based messaging interactions) that flow between the entities at the same hierarchical level (the *horizontal connectedness* in the layered models). Instead, they depict the logical dependencies of the particulars (and the relationships of them) between different domain categories in inter-organizational technology-enabled environments (*vertical connectedness* in the hierarchical models). Thus, increasing pragmatic organizational interactions that enable the resource flows between them (e.g linking business process of two enterprises) has a positive effect on the network-wide phenomenon also by enabling knowledge exchanges (e.g better understanding about partners operations). Also the dependency can seen as a requirement, so that the implementation of better process-level co-operation, for example, needs network-wide information services to be deployed.

Here, it is important to distinguish from the above another possible interpretation of the relation-oriented domain analysis. In the context of this thesis they can namely also be considered from the research perspective as logical pathways that can interlink the conceptions, theories, models and methodologies of distinct disciplinary fields. This kind of analysis is beneficial in order to support the objectives to elaborate the research activities of the framework that is proposed in this work. However, the treatment of these and related topics is deferred until the multidisciplinary research process itself is later discussed. This is because the nature of the cross-domain relations in terms of the cross-disciplinary research views is not in the scope in this section where the focus has been to present and develop relevant model-constructs of the relations in the target domain (i.e. the organizational networks).

Mapping the dyadic relations with integrative enactments

The preliminary identification of the main relation types in the context of organizational networks is here developed further. This enables the research to expose the interconnectedness of the inter-organizational relationships so that the analysis can extend to cover several representation levels of networked environments simultaneously.

Table 4.1 Integrative enactments and dyadic domain area relations

Integrative enactments / Dyadic relations	**Env/Org** control → ← emerge	**Env/Content** mediate → ← contribute	**Env/Tech** trigger → ← change	**Org/Content** use → ← support	**Org/Tech.** utilize → ← enable	**Cont/Tech** constrain → ← employ
Communication +	collaboration trust	understanding accessibility	effortless deployment	accurate information needs (3)	clear IT practices	IT fits the needs for information
Communication -	competition doubts	mis-understandings threats (1)	barriers for adoption	"don't know what we need to know"	ad-hoc solutions	IT does not suit the needs
Interaction +	commitment performance	free flow of resources	high throughput	timely allocation of resources	standardized IT solutions, learning from experience	
Interaction -	delays, information asymmetry	undesirable resource concentrations	low throughput	"decision-making in the blind"	preparatory IT governance and KM, "just-in-case"	
Semantic distance -	shared meanings	simple resource alignment	transfer services and architectures	clearer (2) understanding of core capabilities	straightforward utilization of information and tools	
Semantic distance +	(insuperable) language gaps	terminology mappings	translations and brokers	islands of (tacit) knowledge	service interfaces	detachment of IT and content
Compatibility +	tightly coupled	provides multiple views to same content	common infra-structure	benefits from customized and tailored tools	only few interoperability issues, interchanges of content manageable	
Compatibility -	loosely coupled	accessibility constrains, compartmentalization of tools		content integrity endangered	must use dedicated systems, maintenance problems	

The four categories of *integrative enactments* (corresponding to each domain-level changes) can now be mapped (Table 4.1) with the six dyadic cross-domain area relations discussed previously. In the table, the first column has two parts for each enactment; the increase of, or decrease of it. These measures are social knowledge exchanges (*communication*), organizational relationships and transactions (*interaction*), semantic integration in the content-level (*semantic distance*, the shorter the better), and addressing the compatibility and interoperability issues by technological means (compatibility). The dependencies between the integration efforts to the cross-domain relations of the target domain are shown in the six other columns. These can be effects that are the consequence of the enactments, or requirements that need to be responded to, in order to contribute to the specific level or dimension of integration.

The information in the table is best presented by few examples (marked with numbered cells). In the first case (1), the communication in the network-level for some reason decreases (e.g. the dominating enterprise makes more restrictive disclosure contracts with some of its supply chain partners). This can have impairing effect that manifest in the relation between the environment (e.g. utilization of the network-wide KMS-service solution) and the level of semantically oriented information flows (e.g. the information that is provided to partners) in such a way that content that used to available for the members of the network is not accessible anymore as it used to be, and thus misunderstandings and even security threats may follow. Another case (2), shows how the decreases in the semantic distance of intra- or inter-organizational) information content enables the organization to have a clearer understanding about its core capabilities because the linkages between the business content are more announced. The wider gap between the information and knowledge resources might be described as a situations where the enterprises core competencies are spread out around the organization (or are mostly tacit personal knowledge, and thus not beneficial enterprise-wide). The third example (3), shows that the more there is social network-wide communication, the better the organization can define its operational information needs because it has more up-to-date knowledge about the circumstances (either its partners or competitors) to base its *environment scanning* practices to.

4.5. Conceptualization of the generic domain model

The key component of the proposed solution to the research problems of this work is representation model of the overall IT-enabled knowledge-intensive organizational network domain area.. It has been developed above by identifying the core terminology used by the target communities and reviewing the related theory-based insights of the research community After this, inter-organizational environments have been further analyzed in terms of net-like structures and the outcomes presented as hierarchical and multidimensional models to enable the representation of the core domain entities and their relations. Here, these are further formalized, and the resultant conceptualized model of the target domain is presented.

The depicted set of conceptual categories encompasses the essential focus areas that were the target in all the research projects. Here, only the top-level conceptual entities (**Domain** and **Relation**) and their main sub-classes, and the key relations (***enable*** and ***integrate***) are briefly described. The identified domains are the environmental context, organizational view, contentual elements or the subject matter, and the technological perspective, represented by **Environment**, **Organization**, **Content**, and **Technology**, respectively. These key-dimensions are used to simultaneously expose the phenomenon under investigation from distinct angles. The domains and the entities that are members of them can be combined with four major types of relations (**Social**, **Pragmatic**, **Semantic**, and **Syntactic**). The stakeholders that are part of the target domain are actors (**Actor** ***belong*** **Domain**) that participate in these relations. Performing various activities they modify the domain relations {**Activity** ***modify*** **Relation**}. It is the specific combinations of all the relevant domain actors inter-connected by different types of relations that enable a set of potentially integrative enactments (**Communication**, **Interaction**, **Interoperability** and **Compatibility**). This way the overall target domain can be changed and these alterations are reflected in each layer of the hierarchical model. This enables the crossdisciplinary researcher(s), for example, to define the necessary conditions for a certain level of integration in a domain to be reached in terms of relation type characteristics.

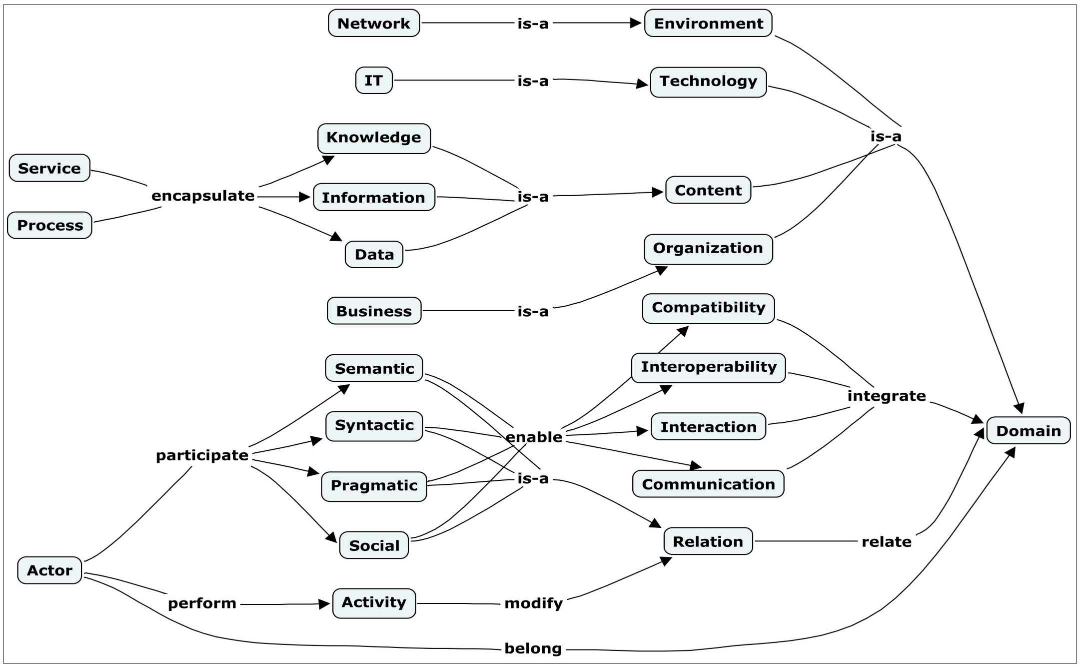

Figure 4.9 Conceptualization of the target domain (GDM)

Even though the cross-project re-use of model-artefacts was not a high-priority goal in the initial project formulations and research tasks specifications, it became apparent that to ensure effective researcher collaboration it was beneficial to agree on the methodological principles and approaches, and to start to develop at a same time a terminological baseline for scientific and stakeholder knowledge sharing and research work continuation and cumulation. While the mostly incomplete and informal research field terminology lists and simple taxonomies in the case-project contexts were considered not sufficient for cross-domain research work continuation, they acted as driving forces for the construction of the here presented generalized domain area representation. This semi-formal model enables, for example, the identification of the common cross-project denominators that facilitate cross-disciplinary research work continuation and support the development of shared models and enable the artefact comparisons.

5. Methods and tools for concept-oriented research

The overall problem area of this thesis consists of the introduced issues of concern (i.e. the crossdisciplinarity, artefact cumulation and knowledge sharing) emerging in multidisciplinary project research contexts, that are set up mainly to respond to the wide range of project-specific stakeholder needs. More often than not, when the project ends it means that the life-cycle of its research constructs also terminates. For this reason, new projects must typically be started from the scratch, despite being run by partly the same organizations and researchers focusing on similar target domains case after case. The continuity of the research is by no means easy to achieve, particularly in situations where the domain is inspected from incongruent perspectives of several scientific research fields.

The discussion thus far has concentrated on the domain-specific and general theories and models that are usable to represent IT-enabled organizational networks. The generic multidimensional model developed above provides multiple views (i.e. environment, organization. content, technology and relationships) from which the target domain can be inspected. For example, the organizational stand point emphasized both the *communicative* managerial collaborations and operational *interactions* in terms of *information flows* and *knowledge exchanges* that can be enabled by *service oriented IT* solutions. Even though preliminary conceptualization of the common domain of interest is available, practical methods and tools need to be introduced and developed so that project team members can use them to share knowledge with the colleagues.

Here, the discussion concentrates on the constituents that are needed, and the approaches that are beneficial to extend the *constructive research approach* (CRA) to support creation of models that address project-specific issues, and enable the knowledge sharing and re-use in project research. The starting point is to specify conceptual structures that represent the various research constructs produced in research activities. The emphasis is here on data collection, information acquisition and domain analyzes that are phases during which conceptualizations and ontologies are most natural to build; using *concept modeling* (CM) and *ontology engineering* (OE), respectively. These concept-oriented methods are additionally supported by the existing semantic web technologies and related descriptions, specifically *metadata* sets. They can be used to semantize the *logical research space* that helps in organizing the research artefacts that are the outcomes of the research activities.

5.1. Conceptualization of research construct

In the constructive research approach (CRA) [4] the cooperation of target and the research community is explicitly required in order to create practically functional and theoretically relevant solutions to stakeholder-specific problems. The CRA can be divided into a separate phases during which the research should [72]:

1. find a practically relevant problem which also has research potential,
2. examine the potential for long-term research co-operation with the target organization,

3. obtain general and comprehensive understanding of the topic,
4. innovate and construct a theoretically grounded solution idea,
5. implement the solution and test whether it works in practice,
6. examine the scope of the solution's applicability, and
7. show the theoretical connections and the research contribution of the solution.

While this does not by itself assure research knowledge sharing even in single-project contexts, it still serves as a suitable starting point for the development of a methodological part of the proposed CMON-framework. Main justification for this is that the past research projects that forms the subject matter (or data) of this work have been based on the constructive research approach.

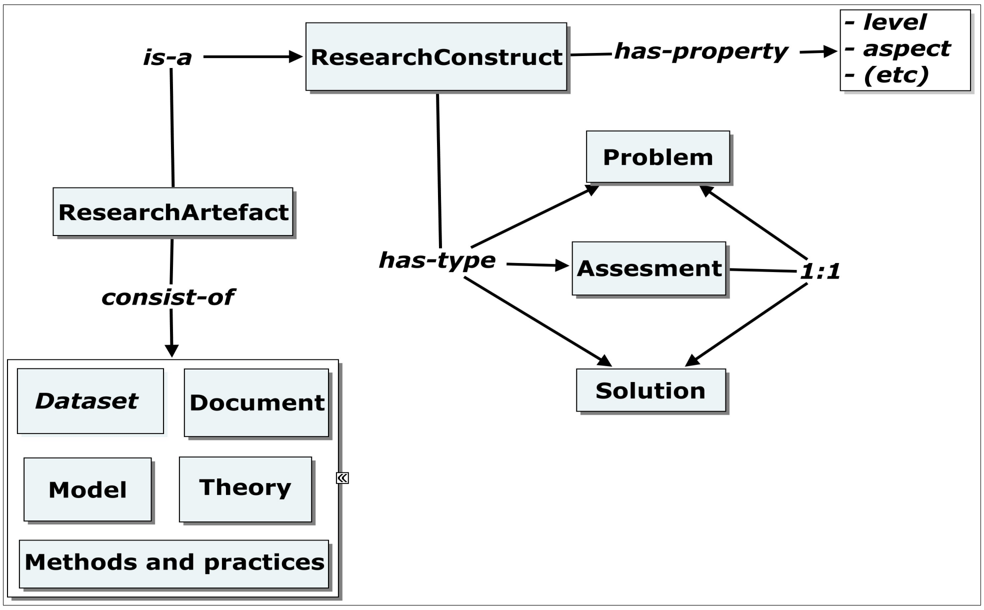

Figure 5.1 Conceptualization of the research construct

Specifically, the focus here is the cross-project research knowledge cumulation and the knowledge sharing between the project researchers, scientific community and the target stakeholders. To achieve these goals, the CRA is here refined in such a way that it supports the collection, analysis and storage of research artefacts. According to CRA the research and modeling artifacts, can be simple literature based taxonomies and glossaries, collected domain data, analyzed datasets, domain models, theoretical models, semi-formal concept models, or even ontologies. To categorize all these artefacts produced in project research and to enable different types of CRA constructs to be represented, the illustration below (Figure 5.1) shows the conceptualizations of the *research construct*. The typology of the constructs that are processed, created and evolved during CRA research are the *problem*, *solution* and *assessment.* They consist of different artefacts (e.g datasets, models, practices) that can be collected to be part of any of the main types. Because the CRA itself explicitly emphasizes the importance of showing the practical and theoretical relevance of both the research problem and the constructed solution, this implicitly means that they should also be set against each other to make sure that they one-to-one relation exists between them. This is the simple semantics of Assessment-concept in the depicted model.

Because of the importance to enable the research construct re-use and cumulation (which are only implicitly referred to in CRA), a set of properties are attached to the research construct to support this. The *level* represents the consecutive levels of research understanding as defined in the *scientific method*:

1. **description**: problem definition and exposition of the phenomenon; (What?)
2. **explanation**: analyzing the domain to explain its structure and dynamics; (Why?)
3. **control/optimize:** ability to enable improvements, optimize circumstances; (How?)
4. **prediction:** being able to tell (accurately) what is going to happen ; (When?)

This way the scientific characteristics of each research construct are formally declared and they can be aligned, for example, with the step-wise progressive nature of the scientific inquiry specifically in design sciences and qualitative research. The *aspect* refers to another similarly useful typology to categorize research constructs. In the engineering field, (specifically in the object-oriented view), the developed designs or models are based on the following different characteristics of the real-world entities under study:

1. **function** - the teleology of things (What the object is for?)
2. **behavior** - the activities and operations (What the object does?)
3. **structure** - the components and their relationships (What the object consists of?)

In the context of this work, as these many types of artefacts originate from distinct sources in different phases of the project research, the idea of this conceptualization is to provide a representation model for annotating research constructs while they are created (and afterwards). The main requirement to be successful in harmonizing the domain-specific data, analyzes and research models is that the initial project goals and research field-specific objectives have been described. The resulting semi-formal specifications of the research problem statement, for example, can then be evaluated and compared to the proposed solutions by using the methods of conceptual analysis.

5.2. Semantic engineering in project research

The main reason for the above conceptualizing of the research construct is that a definitional structure was needed so that it can be this way linked to similarly defined concept hierarchies that represent the *target domain* under study (e.g. the organizational networks), and the *research project* in which the scientific work is done. These descriptions together form the logical *research space,* and the semantization of is the *semantic research space* (SRS). It is required to provide sufficiently powerful representation model that enables the identification, comparison, analysis of research constructs and helps in managing the collections of them.

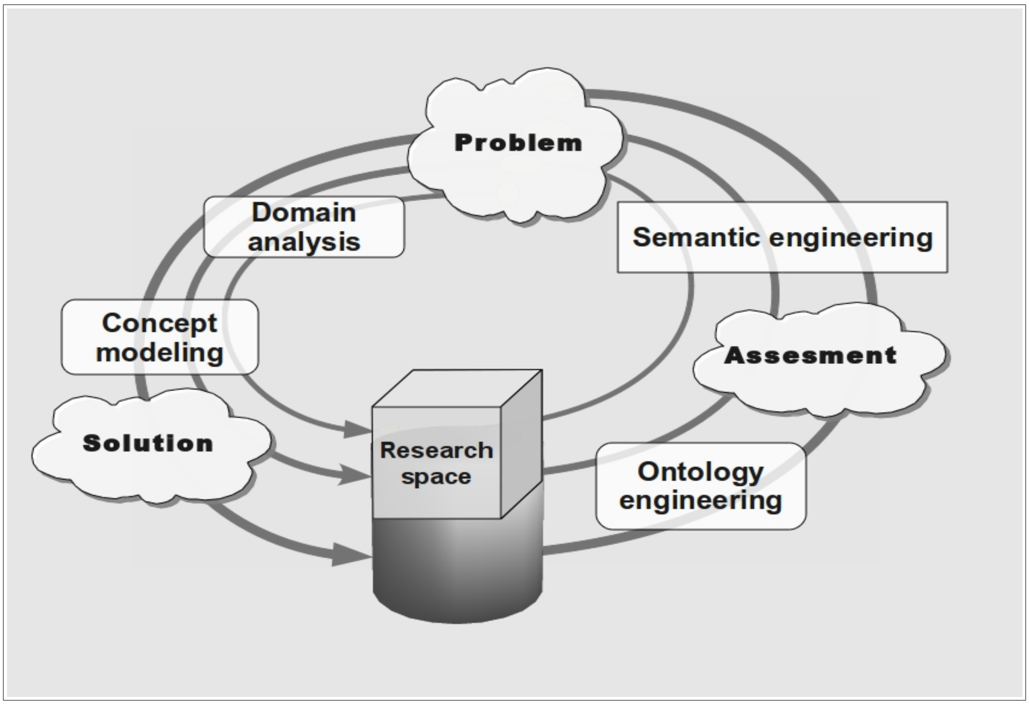

Figure 5.2 Semantic engineering and research knowledge cumulation

To achieve the goals of (i) creating sharable domain analyzes and collected data and information sets, (ii) building and elaborating domain conceptualizations and ontologies, and (iii) configuring and utilizing the semantic research space and knowledge repository, the applicable research models and methods are in this work combined to *cycles of semantic* engineering (Figure 5.2). The idea is to specify such a flow of research activities and applicable models in each phase the conceptual annotation and representation of the research constructs is enabled. These cycles consist of research community activities that are mostly influenced by the enactments with domain stakeholders during the project co-operation, but are related also the the collaborative activities to the scholarly community. The phases of a research process that mainly benefit from the adoption of semantic engineering to its methodology can be characterized by the following different areas of interest:

1) *domain analysis* - producing shareable annotated datasets and research materials by collecting data and information from the network under study, and representing it relying on the developed target domain model (GDM)
2) *conceptualizations* - building and elaborating domain terminologies, taxonomies, conceptualizations and eventually ontologies by applying existing concept modeling methods to cross-project research contexts, using, for example, the multidisciplinary research framework (MCE) developed by the author and the research colleagues during the project research work
3) *knowledge cumulation* - assessing the new project constructs by using the previously developed generic domain models of organizational network to map and align with the existing content in the semantic research space in order to enable the creation and persistence of research knowledge.

In the following, specific methods and tools that are available during cross-disciplinary project research that relies on the cycles of semantic engineering are discussed. In the domain analysis the developed generic target domain model can be used, further refinement of conceptual models is achieved relying on the MCE-methodology, and finally, based on semantic web technologies a metadata specification is introduced that can be used as the common format to represent and annotate the produced research constructs to enable their re-use.

5.3. Domain analysis using generic domain model

Typically, during the domain analysis, first, the core terminology used both by the target and research communities needs to be identified. After this, simple term lists can be elaborated to hierarchical taxonomies to enable a more detailed analysis of the core domain entities and their relations. Then, these preliminary model artefacts are aggregated, abstracted and synthesized to a conceptualization of the (organizational network) research domain by applying existing scientific theories and relevant research approaches.

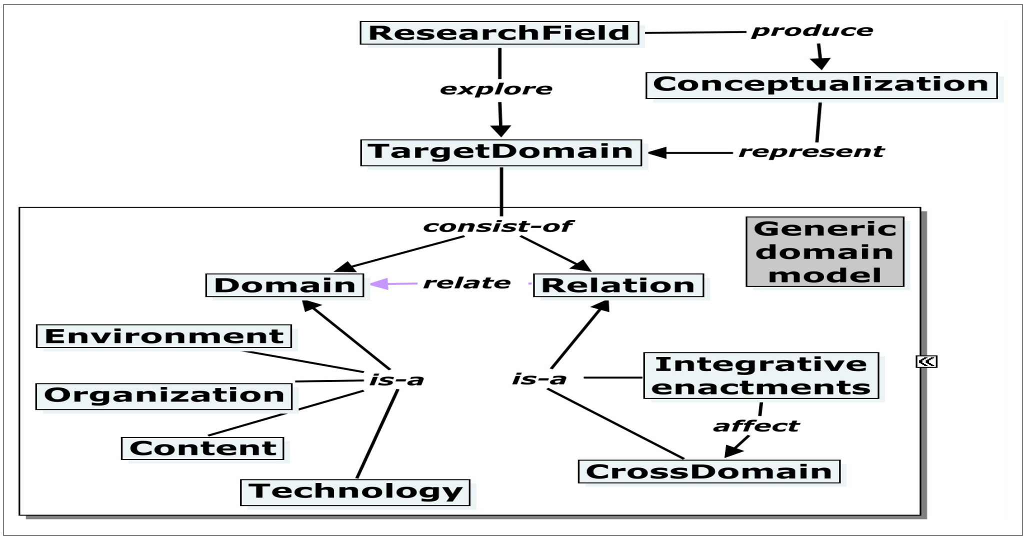

Figure 5.3 Domain analysis based on the developed GDM

Thus, this phase is one of the main activities of the here proposed conceptual research methodology. Because of this, the main part of the solution that addresses the research problems of this thesis, has been to specify a generic representation of the overall target domain areas that were studied in the past research projects. The result of this effort, i.e. the generic domain model (GDM) of inter-organizational environments, the details of which were previously presented, can be used in the research projects during this phase as the initial conceptualization. This can then be elaborated and refined relying on the other methods and tools of semantic engineering. Thus, here only the top-level elements of this model that is applicable during the domain analysis in the cross-project research setting are illustrated (Figure 5.3).

The depicted set of conceptual categories encompasses the main elements of the target domain that have been the focus of the research in the past projects. As these have been discussed extensively already, here the top-level entities of the **Domain** (i.e the environment, organization, content and technology) are only shown, and the main types of relations (**IntegrativeEnactments** and **CrossDomain**). During the domain analysis, then a particular research field explores the target domain from its own perspective (**ResearchField** explore **TargetDomain**) and produces conceptual models (**Conceptualization**). To enhance the specific inter-organizational environment under study integrative enactments (**Communication**, **Interaction**, **Interoperability** and **Compatibility**) can be enabled that then have effect on the cross-domain relations and thereby alter the overall network structure. Also it is possible for the researcher in this phase to define the conditions for a certain level of integration to be reached in terms of relation types and interconnectedness characteristics.

During the domain analysis phase, at the latest, the researcher should start to develop the terminological baseline for scientific and stakeholder knowledge sharing and research work continuation and cumulation. The utilization of this semi-formal conceptualization helps int the identification of the common cross-project denominators that facilitate cross-disciplinary research work continuation and enable the development of shared model-artefacts. This way more formal conceptualizations of the target domain can be build while utilizing the methods of semantic engineering in research, and thus enabling the alignment and comparison of the research field-specific constructs.

5.4. Building conceptual models in research

In a typical scientific research setting, there is a stage that consists of the following activities: literature review, exploration of existing theories, the review of theoretical backgrounds and the definition of the used terminology. The results of these tasks are then usually represented in some form of *conceptualization,* that can be defined as "an abstract, simplified view of the world that we wish to represent for some purpose. Every knowledge base, knowledge-based system, or knowledge-level agent is committed to some conceptualization, explicitly or implicitly" [73][74]. In another view concept models are seen as: "body of formally represented knowledge that is is based to the objects, concepts, and other entities that are presumed to exist in some area of interest and the relationships that exists in between" [75]. In enabling the communication and enhancing interoperability, the sharing of conceptualizations is equally important whether the knowledge-level agents are researchers or the stakeholders of the real-world phenomena under study. In general, the justification of exploring the issues of building conceptualizations (and specifically the sharing of them) is based on the view that they can be seen as a necessary, but not sufficient, core informational artifact in generating research knowledge.

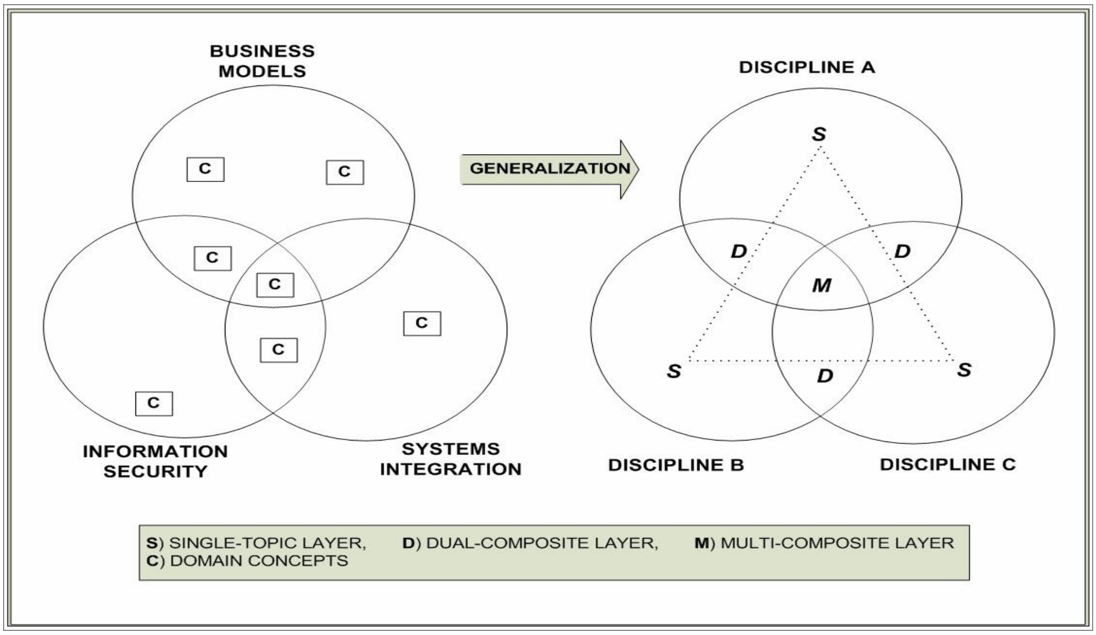

Figure 5.4 Overlapping conceptual areas in crossdisciplinary research [2]

The sharing of conceptual models became a real problem in the business network integration project where three research fields (business models, information security, and systems integration) had a common focus to explore the networks from the perspective of business processes. It became evident in project team meetings that the researcher-specific conceptions of the research domain did not match. For example, one of the key-terms in the research (i.e. *the process*) had not been defined equally. There were also other conceptual inconsistencies in the used research terminologies. on the one hand, there were concepts that had a uniform (or nearly identical) name but they still referred to a completely different (real-world) entity, or they had a contradictory meaning between research views; and on the other hand, some concepts with unrelated names appeared to be identical in their definitions or referred to the same underlying entity [2]. These misinterpretations were mostly the result of the overlapping nature in the composition of the conceptual domains of each research field (see Figure 5.4). The key-point here is that the illustrated layered nature of the domain area conceptualizations exists also in cross-disciplinary scientific environments, and not only in research scoped by project boundaries. It was specifically these issues that prompted the development of the multidisciplinary concept evolution (MCE) framework during the project research.

5.4.1. Conceptual modeling in crossdisciplinary settings

For the purposes of conceptual approach being useful in the context of multidimensional domain analysis described above, the critical issue is how to enable the sharing of semantically rich and formally consistent conceptualizations between the researchers, and also between the stakeholders of the domain under study. A major challenge then the linking of research community oriented information modeling conventions with the domain-specific methods and models. Consequently, to support the many functional requirements of concept modeling in multidisciplinary research context the following aspects of available research approaches, methods and tools should be explored:

- the usage of different *metadata* initiatives and subject-based classification techniques for providing support for management of information intensive resources (i.e. research conceptualizations)
- the possibilities of synthesizing techniques from the varying concept and information modeling methodologies
- commitment and application of the state-of-art frameworks and methodologies in ontology engineering
- feasibility of the insights and technologies of semantic web in developing a web-based application platform for utilizing the conceptual modeling tools as services in a collaborative research environment

The practical method defined in the MCE-framework is depicted below (Figure 5.5) to show one possible way to organize the research activities that combines some of the above techniques that aim to produce harmonized conceptualizations in multi-perspective research environments. The identified main parts of this method are the phases of research activities [1]: (i) theoretical research (TR), (ii) concept modeling (CM), (iii) ontology engineering (OE), and the supporting research (SR) services that can be provided by collaborative environments designed and developed using SOA and semantic web technologies. In each stage the context of the research determines the focus of the constructs (i.e. conceptual models and analyzes) that are produced in the research activities. The theory-oriented tasks are contextualized by the *research scope* (e.g. the research problem and question), conceptualizations should aim to answer specific *focus questions*, and the quality of the generated ontologies can be evaluated by their ability to respond to a set of *competency questions*.

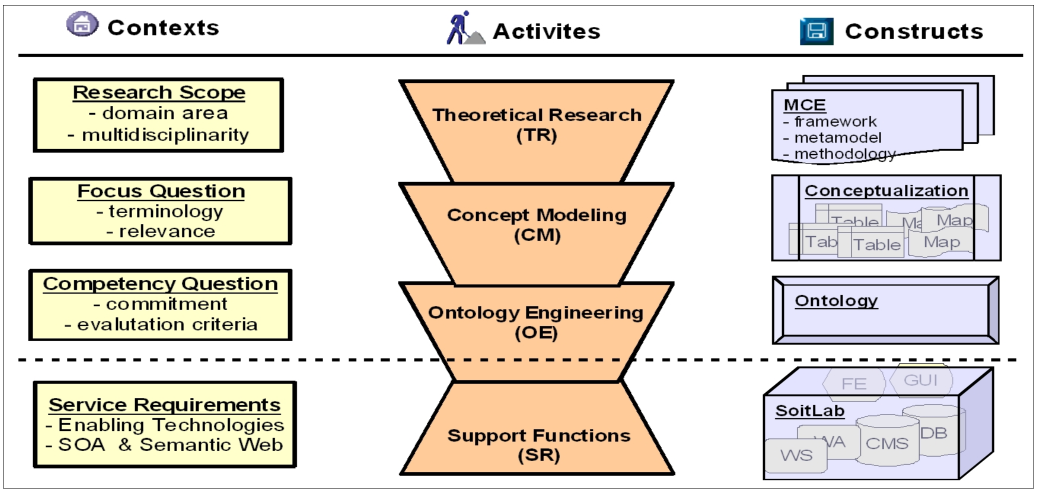

Figure 5.5 Main phases of conceptual research. Adapted from [1][2]

The methodological part of the proposed framework of this work, then, is based on the analysis and re-organization of these conceptually oriented research tasks. In the following the focus is on discussing the relevance of ontology engineering (and the related semantic web technologies), the use of which enables and supports the elaboration and formalization of the developed conceptualizations.

5.4.2. Ontology engineering

This section introduces briefly the conceptions used in the domain of *ontology engineering* in relation to the importance of *semantics* in sharing and communication (research) knowledge. As suggested above, the relevance of formalized conceptualizations and semantics in this work emerges from the fact that the organizational network research has been conducted in a multidisciplinary research setting. This means that the individual research domains generate knowledge from their own perspectives, among other things, in form of conceptualizations. To promote research collaboration it is important to try to utilize appropriate semi-formal methodologies and practices to enable the sharing of such conceptualizations between researchers. During the OE-activities the previously developed conceptualizations are transformed to actual ontologies.

An *ontology* is usually defined as an explicit specification of conceptualization [73]. As the term is borrowed from philosophy by the field of artificial intelligence, an explicit and clear definition of the term is important to avoid any misinterpretations. Further, ontologies are often equated with taxonomic hierarchies of classes or concepts, but ontologies need not be limited to these forms. For example, formal ontologies (i.e. axiomatically described), can answer questions about the capability of the ontology [76]. Especially in context of IT-enabled enterprise engineering it is important to be able to evaluate in more detail the capabilities of the ontologies by using c*ompetency and performance questions*, which are defined as questions that characterize respectively the formal and the behavioral properties of the ontologies [76] [77] .

As a set of conceptualizations can be seen as knowledge-level representations of the domain of discourse viewer by the different agents (for example, researchers or target stakeholders), it is important for these agents to agree on the use of the shared vocabularies in a coherent and consistent manner. In short, the *ontological agreement* is defined as, agreements about the objects and relations being talked about among knowledge-level agents [73], which applies to collaborations between either humans or information systems.

In constructing multi-perspective conceptualizations focusing on common domain of interest, there should also exist methodologies to explicate the associations between the entities (concepts and relations) of the individual domain area models. In the field of ontology engineering, *ontology mapping* refers to the techniques, procedures and formalisms to find and describe a set of mapping functions between the individual concept classes [78] [79]. Using these kind of mappings it is possible to classify the relations of the entities in one ontology to another to categories like: equivalent and inequivalent, similar and dissimilar, or related and not-related.

In the organizational network research context, it is possible to extend the typical business process modeling methodologies to gather the stakeholders` impressions on the constructed models and analyzes, and merge them to the developed conceptualizations. The results of these surveys are then to be used to expose the universe of discourse from the perspective of the target domain. [2] To ontology authoring, this stakeholder or community view provides valuable input about the capabilities and weaknesses of the existing research conceptualizations. Ontologies produced in research of a particular network of a specific industry sector (*local ontologies*), can also be evaluated, not only from the inside of the domain area but also by comparing them to other domain representations (*domain ontologies*) or upper-level ontologies (*universal ontologies*). Additionally, during the ontology engineering activities the research conceptualizations can be be persisted in local repositories or linked to related external ontologies. [1]

5.5. Representations based on semantic web

The on-going semantization trend of the Internet has produced technologies by which the meaning (i.e. the semantics) of the many types of (web) resources has been attempted to be represented. Examples of these are the structured XML-based document formats, various metadata sets (Dublin Core Metadata Set, DCMS), resource description formats (e.g RDF), and ontology languages, like the Web Ontology Language (OWL).

Table 5.1 From the web resource descriptions to knowledge representations

Technologies	Representation languages (examples of the elements)	Description
Web page meta-elements	<meta> tags in the <head> elements of the HTML-documents	Meta tags that are used to annotate HTML-pages
Dublin Core Metadata Initiative	dc:creator, dc:topic, dc:date, ..	Metadata set that consists of 15 basic terms that can be used to describe generic resource properties
Microformats	XFN, Semantic (X)HTML, hCalendar, hCard	Bits of HTML that represent things like people, events,.. Event/calendar format, contact/address-book information
Resource descriptions	RDF(S): <Subject Property Object> SPARQL query language	RDF(S)-triplets represents a statement of a relationship between the things denoted by the nodes that it links (nodes for S and O, and arc for P)
Ontologies	various OWL-dialects, SWRL,..	".. an explicit specification of a conceptualization" [73]
(and other forms of) **Knowledge Representations (KR)**	KIF, KAON, .. SBVR (Semantics of Business Vocabulary and Rules) [80]	Based typically in the notions of KR-field in artificial intelligence to describe the concepts and relationships that can exist for an agent or a community of agents.

Some of these technologies (Table 5.1) are here outlined from the perspective of adopting and applying them in the context of research that aims to produce conceptualized target domain models. Further, the idea is to find ways to represent, organize and persist the research constructs so that they can be re-used in future research projects.

5.5.1. Metadata

Metadata is generally defined as data about data, and in content management and information architectures it usually means data about objects [81]. One widely used metadata element set is proposed and maintained by the Dublin Core (DC) initiative [82], which defines a vocabulary for cross-domain information resource description. It has been accepted in 2003 by the International Organization for Standardization (ISO) as the ISO:15386 standard. At its core, it consists of fifteen metadata elements that are here categorized into two groups (content management and content semantics) according to their possible purpose of use, even though the standard itself does not impose any such division. The preliminary analysis of the DC-metadata definition and its feasibility for representing research constructs has been conduct during the project research work while specifying the metadata set for the MCE-framework [2][1]. Based on this, the information depicted in the content management-related DC-elements (e.g **Identifier, Creator, Publisher, Contributor, Date** and **Rights)** are more suited for the organizing and administering the content that they refer to (i.e. the information resources) by, for example, software applications. For the task of communicating the meaning and conveying the semantics of the content between varying stakeholders the following DC-elements are more useful: **Title, Subject, Description, Type, Coverage, Source, Relation, Language** and **Format**. Furthermore, the purpose of the Dublin Core standard is not to define the detailed criteria by which the element set will be used in specific projects and applications, instead, that the element set can be used as a starting point for the creation of more complex descriptions. As such the DC element set is thus fairy well suited to be extended and re-used in context of conceptual modeling.

Another related initiative, which takes a more technical approach to the management of conceptualizations, is the Simple Knowledge Organization System (SKOS) that provides a model for expressing the basic structure and content of the concept schemes in a machine-understandable way. It defines the concept schemes very broadly (and in consensus with the above definition of conceptualization), referring to any set of concepts and the semantic relations between them. [1] The SKOS User Guide [83] further lists thesauri, classification schemes, subject heading lists, taxonomies, and other types of *controlled vocabulary* as examples of concept schemes.

Common metadata format to describe research space

The methodology for multidisciplinary research (MCE) presented above, also includes a metadata specification for representing domain elements as conceptual classes and relations. It is based mostly on the widely used generic metadata set (DCMS) defined by the Dublin Core Metadata Initiative [82]. It is generic metamodel in the sense that it is useful as a representation model for any "domain" that needs to be conceptualized. The models top-level element **mce:Entity** (and its sub-classes **mce:Concept** and **mce:Relation)** can here be used as the super-class from which the entities needed to represent the research space inherit from. The notational convention here is to use a colon to separate the *namespace* name from the entity name. The namespaces usually correspond to each domain that is to be represented. In the MCE-model, each entity (i.e. concept or relations), is to be described by a set of properties (e.g. **mce:Name, mce:Description, mce:Definition, mce:Proposition**) that are defined below (Table 5.2). Originally this metadata set was used during the project research to declare the relevant concepts and relations used in domain-related concept maps. In practical research, building these specification translates to simple forms or tables to be filled by the researcher; concept per one row, the columns denotating its properties.

Table 5.2 Common metadata to describe research constructs Adapted from [1]

Entity (cardinality)	Type	Description	Example s: Concept Relation
mce:Name (1)	Identifier	Name of the concept or relation (the inverse relation in parentheses if applicable)	Artefact has-part (is-part-of)
mce:Definition (1)	Text	Semi-formal description that can for example include a dictionary definition of the entity.	Research construct as defined in CRA. Relates an element to a aggregate or composite whole.
mce:Description (1)	Text	Textual description of the entity.	Any research related construct that can be studied, created, analyzed or processed.
mce:Examples (1..*)	Comma-separated list	List of instances or sub-classes of this entity	Data, Model, Theory, Method has-type, has-level, has-aspect
mce:Proposition (1..*)	Textual (propositions) separated with line-feed.	List of concept-relation-concept sentences of each relation that this entity belongs to.	Dataset is-a Artefact Artefact is-a ResearchConstruct Researcher produces Artefact Artefact has-part MediaFile
mce:Language (1..*)	Used language	Language code (for example, according to RFC- 3066	fi, en-us, ..
mce:Documentation (0..*)	An URL or a literature reference accompanied with textual explanation	A link to external documentation or theory that further describes the concept.	Labro & Tuomela, 2003, "On bringing more action into ...", European Accounting Review Discussion about artefact based research constructs.
mce:Property	mce:Entity	Another (entity) that is a property that extends the description of this entity	Artefact has-property MediaType (paper, video, interview, ..) Artefact has-property Privilege
mce:Type (0..*)	Comma separated list of keywords.	Category, topic or subject of this entity (outside the conceptualization hierarchy)	paper, video, image, interview,..

The concept maps presented previously in this work have already relied on the semantics of the property **mce:Proposition,** which exists simply to provide a textual (and a formal) specification of each concept-relation-concept triplet that shows in the graph-like visualizations of the concept maps as an annotated edge (i.e. the relations) connecting the nodes (i.e the concepts). In alignment with ontology representations, like the OWL-specification, the relations in this specification are at the same abstraction level than the concepts, not only "linking phrases" between them. Thus, they can have a hierarchical structure, too, and inherit the attributes of the more abstract relation class. A set of typical top-level relations that are used in object-oriented modeling approaches are available, such as ***is-a*** or ***instance-of*** for modeling a typical hierarchy or subsume relation of entities, and ***has-part*** and ***consist-of*** (the inverse relations respectively, ***is-part-of*** and ***belongs-to***), for describing elements that are aggregates or composites of the whole (i.e. a container-component -relation). In the table below, an example is provided from the domain of this work that shows the mechanism to extend the set of MCE-descriptions. This is enabled by using the attribute **mce:Property** (and the ***has-property*** -relation) to attach additional descriptions to the entity. Here, the descriptions of media type and resource access privileges are added to the exemplified concept of the CMON-framework that represents research artefacts (**cmon:Artefact).**

Various metadata sets, vocabularies and terminology lists are especially useful when they are used to represent the various types of research constructs by, for example, annotating collected datasets and other research materials. Tagging the document files that are the models and analysis produced by the project researchers, enables them to be organized to many co-existent hierarchies, and not only based on a fixed folder structure. Also, estimations about the semantic proximity of the research artefacts can be made based on these meta-level representations.

5.5.2. Resource description framework

The Resource Description Framework (RDF) is based on the graph data model to represent statements made of triplets of the form : <subject property object>. The three parts (S, P and O) are identified with Web based identifiers URIs (Uniform Resource Identifiers), that refer to anything that needs to be described in the statements: (i) network accessible things (documents, images, services), (ii) things that are not network accessible (human beings, buildings, etc), and (iii) abstract concepts (that do not exist physically). To address to need to define vocabularies or terms that are used in RDF-triplets the RDF-schema (RDFS) specification is used. It extends the RDF by providing generic descriptions of types, categories, resources and hierarchical constructs:

- **rdfs:Resource** - the class of everything, other are subclasses of this
- **rdfs:Class** - types or classes or categories of things
- **rdfs:subClassOf** - used to state that all the instances of one class are instances of another.

The RDF(S) does not provide a vocabulary of application-specific classes like **mce:Concept** or, **cmon:ResearchArtefact**, instead it does provide the facilities needed to describe such classes and properties, and to indicate which classes and properties are expected to be used together. In relation to the needs of this work, the metadata specification used in the MCE-framework that is utilized and extended to describe project research-related conceptualizations, does not currently rely on the RDF(S). Instead, it relies on more expressive (and intuitive) but less formal (and more difficult to process automatically) interpretation of the same triplet that the RDF is based on; in concept map conventions these statements are propositions that represent any kind of relation between two concepts, which do not have to be identified with URIs. However, fairly straightforward mapping from these kind of concept map notations to RDF(S) formalism is possible, because in practice they both are models by which any relationship between two objects can be represented.

5.5.3. Knowledge representations and reality

The origins of the word *ontology* is in the philosophical tradition according to which it has been defined as: "the subject of existence", "the science or study of being", or "a theory concerning the kinds of (abstract) entities that are to be admitted to language system". It is the last sense that have been used in the fields of artificial intelligence and knowledge representation, that it is: "a description of the concepts and the relationships that can exist for an agent or a community of agents". The specific characteristics of ontologies then depend on the interpretation and the selected description language. In relation to semantic web technologies, the Web Ontology Language (OWL) specification bases on XML representation syntax that extends the RDF(S). It adds more vocabulary for describing properties and classes, including:

- relations between classes (e.g disjointness),
- cardinality (e.g "exactly one"),
- richer typing of properties and characteristics of them (i.e. symmetry),
- enumerated classes

These languages, are designed for use by applications that need to process the content (and the descriptions of meaning) of information instead of just enabling it to presented to humans. The ontology representation languages, in general, facilitate greater machine interpretation of Web content than that supported by for example XML, RDF, and RDF(S) by providing additional vocabulary along with a formal semantics. In the OWL specifically, three increasingly expressive sub-languages have been defined OWL-Lite, OWL-DL (Description Logics), and OWL-Full. Because of the additional capabilities that these knowledge representation languages provide compared to metadata and RDF, they provide many useful features, like: ability to be distributed across many systems, scalability to Web needs, compatibility with other Internet standards, and openness and extensibility. Additionally, tools can perform automated reasoning, providing many services to applications: conceptual and semantic search, decision support, knowledge management, and intelligent databases.

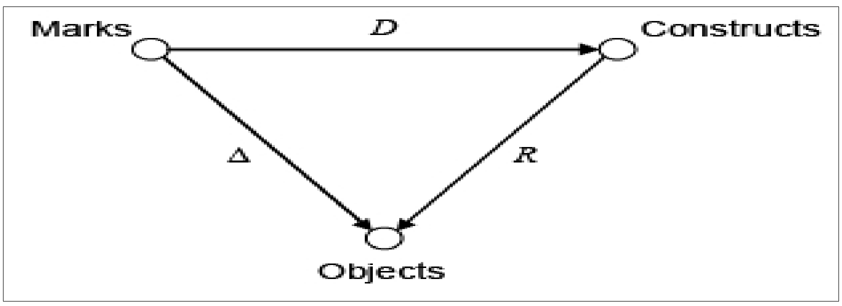

Figure 5.6 Semiotic triangle [84]

Here, the main interest on analyzing the ontology languages lies in the possibilities and constrains that they impose on the expressive power, intuitiveness, or preciseness of representing the semantics of information. A critical issue here is the validation of conceptualizations (e.g concept maps, ontologies, etc) in respect to the real-world entities that they represent. The situation is clearly shown in the *semiotic triangle* [84] that depicts (see Figure 5.6) the logical relations of:

i. *marks*, that are physical signs or symbols, or modeling languages (e.g OWL),
ii. *constructs,* that are concepts and relations in conceptualizations, i.e. fictional objects, with the
iii. *objects,* that are factual; i.e. the real-world entities.

The expressiveness or weakness of models that aim to represent real world phenomenon and the objects therein can now be estimated based on the following: "marks *designate* (**D**) concepts and these *refer* (**R**) to objects. If both the designation and a reference are given, then a *denotation* (**Δ**), can be constructed as the relational product of **D** and **R**." [84]. This is applicable to *knowledge representation* (KR) languages [85], as well. So the same holds; because they are representations consisting of marks (i.e. the language symbols) they should define and identity (designate) the constructs that are the elements of the conceptualizations, to be meaningful. Further, the KR-model corresponds to reality (or makes sense), if additionally the concepts (and the relations) refer the factual objects of the domain. In practice, the biggest challenge in evaluating and assessing conceptualizations is in showing that the reference-relation holds, i.e. that the constructs of the model (concepts and relations) do actually point to the real-world phenomenon under study.

6. Research implications in cross-disciplinary project research

The overall problem area of this thesis consists of the introduced issues of concern (i.e. the crossdisciplinarity, artefact cumulation and knowledge sharing) that emerge in multidisciplinary project research contexts. These initiatives itself are set up mainly to respond to the wide range of project-specific stakeholder needs. Thus, there very often does not seem to be foreseeable future beyond the ongoing project, which means that new projects must typically be started from the scratch, despite being run by partly the same organizations and researchers focusing on similar target domains case after case. The continuity of the research is by no means easy to achieve, particularly in situations where the domain is inspected from incongruous scientific perspectives.

Now that the concept modeling oriented methods and tools for research in cross-disciplinary projects have been described as phases of semantic engineering, the practical research activities that combine all these is here presented. The focus here is in the suggested research community (RC) activities that support the scientific knowledge acquisition and sharing. This part of the CMON-framework has been developed by:

1. separating all the related actors that participate in the collaborative research activities to target (TC), research (RC) and scholarly communities (SC) based on their functional roles
2. extending the CRA-based scientific process with previously introduced semantic technologies and concept modeling techniques.

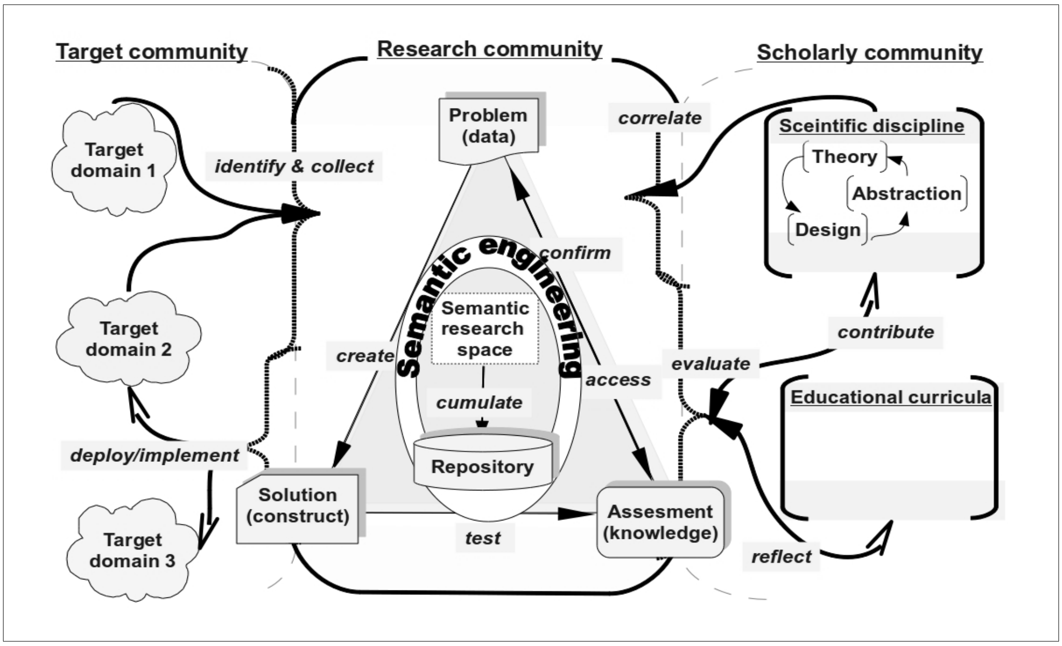

Figure 6.1 Overview of the research activities

The practical project research (that is based on the CRA) is typically carried out by performing the following tasks: understanding the domain and identifying the problem (identify), collecting data (collect), constructing the solution (create) and implementing it (implement), and evaluating and assessing the relevance of it (evaluate) against the target domain (test) and scholarly community (contribute and reflect). With the help of the schematic (Figure 6.1) of the research process, the flow of these activities (the annotated arrows indicating the direction of information and knowledge and control flows) during co-operative research embedded in multidisciplinary scientific context can be illustrated.

Here, the co-operative interactions of the research community with the target community and the researcher enactments in direction of the scholarly community interactions are following the general phases of scientific study outlined in the introduction (collection, analysis and evaluation). The methods and tools of the semantic engineering are linked to these research activities to support the research knowledge sharing and re-use. Here it is also shown how the problem and the solution are assessed by confirming that one-to-one correspondence between the holds (as was proposed in conceptualizing the research construct).

In contrast to such a research work where the domain understanding and problem definition, or data collection and solution deployment are conducted in ad-hoc -fashion, to aspire the cross-project crossdisciplinary objectives of this work, an analysis of the remaining elements of the conceptual research space is still needed. This is done to enable the research construct alignment and re-use by conceptually integrating to this methodological part of the framework the target domain models and the project research process itself. In the following the nature of the interactions during both the project co-operation and scholarly collaboration are presented in order to specify these key definitional structures that represent them.

6.1. Interacting communities

The top-level feature of the here proposed research framework is that all the related actors are separated to three distinct but interacting parties of interest: i.e. the target stakeholders (TC), researchers (RC) and the scholarly communities (RC). This division is based on the divergent responsibilities and different epistemological conceptions leading to disparate behaviors dependent on the specific roles of the individual representatives or groups of these communities. They are linked in terms of collaborative and co-operative exchanges of research-driven data, information and knowledges. The concrete contents in these interactions ranges from various types of target domain materials and set of research constructs, to a theoretical disciplinary abstractions, models and practical designs.

From the perspective of the research community, there are two kinds of activities: (i) behavioral patterns related to external communications, and (ii) internal research task-oriented knowledge and work flows. The external interactions with the target domain stakeholders happen during *project cooperation*, and the scholarly collaboration takes place in various scientific forums (like the *communities of practice)* or in educational and teaching situations. The internal activities consist on the one hand of the practically oriented regular research work where domain data is collected, analyzed, solutions created and implemented, and on the other hand of the theoretically oriented evaluations of the relevance and scientific contributions.

6.1.1. Project co-operation

The temporal context of project cooperation is defined in terms of typical research tasks during the life-time of single work-package, one project or a collection of them, or a continuum of successive research initiatives or programs conducted by various research organizations, institutes and consortia. The time-span can thus be anything from few weeks to several years. It should be noted, however, that the boundary condition for the most demanding research challenges to emerge (e.g. the knowledge cumulation), is reached just when the temporal dimensions of research extends the life-cycle of single project.

In project-oriented collaboration, the contracts made with the partner organizations set the temporal, cooperative and resource-based conditions for the research work The scoping of the target domain area and establishing the main research fields in the project research between universities and commercial enterprises is nowadays dominantly based on these agreements. In organizing and managing the research project content, and in analyzing the knowledge exchanges and information flows during the research cooperation, structured representations of a the composition of the research project, and its temporal life-cycle are required.

Properties of the research project

In the scope of this work, it suffices here to briefly overview the essential characteristics of the conceptualization of project research in order to advance the cooperative research activity analysis. The metadata set in the MCE-conceptualization described above is here used by extending it with required attributes and elements. Some project management-specific specifications also exists, but the review to determine whether they are applicable to cover the needs of this work has not been conducted because the research-related MCE-specification was already available. By using the MCE-based conceptualization tabular format to define the concepts and their relations, the following metadata elements are sufficient here to describe a *research project* (see Table 6.1):

- identification (name, description, type, docs,..): these can described by the mce:Entity properties
- duration (the start date and end date of the project)
- partner consortium (profile of each member organization including the appointed key-personnel),
- problem statement and project goal (the specific issues, needs and expected outcomes from the project collaboration), and
- the research fields and the corresponding researchers (their target domain scope, goal, also the relevant theories and methods).

Table 6.1 Metadata for describing research projects

Concept: (namespace=cmon)	**Description**	**Examples**	**Proposition triplet**
ResearchProject (Identification)	The research project that explores the domain and produces conceptualized constructs	The research projects that are addressed in this work: (BNI/OVI..)	**ResearchProject *is-a* mce:Concept** **ResearchProject *explores* TargetDomain** **BNI *is-a* ResearchProject** **PROVEM *is-a* ResearchProject**
Duration	The duration of the project	01.01.2007-31.05.2009	**ResearchProject *has-property* Duration**
Partners	Members of the project consortium	Travel companies, manufacturing enterprises	**ResearchProject *has-property* Partners**
Goal	Overall goal of the research project		**ResearchProject *has-property* Goal**
Researcher (1..*)	The project researchers	Jukka Aaltonen, N.N, ..	**Researcher *belong* ResearchProject** **Researcher *focus* ResearchField**
ResearchField (1..*)	The research fields that make up the focus area of the project	Business models, information security, systems integration,	**ResearchProject *consist-of* ResearchField**

Also, to provide support for effective partner interaction, and specifically, to enable the documentation and analysis of the knowledge exchanges and information flows to and from the research community, the selection of the *communication channels*, and *collaborative forums*, if any are used, could be documented. Additionally, a general account about the requirements of possible supporting information technology environments and infrastructures can be part of this specification.

6.1.2. Scholarly collaborations

The range and depth of the analysis of wide range of scholarly communities is scoped such that the discussion here only outlines the common set of characteristics and inter-relations of such scientific disciplines that most closely relate to research fields by which organizational networks are studied and developed (e.g. network and organization theory, and information technology). The focus is on the interactive characteristics of the scientific disciplines, and on possible forums for research and development collaboration between academic organizations (e.g. communities of practice). The main emphasis here is to extract useful insights and specifications to develop a model that represents the scientific research-related entities as part of the logical research space conceptualization. This means that, also the researcher interactions inside the project-scoped research community are to represented.

Even though the internals of the multitude of scientific fields are not extensively reviewed in this study, some useful general properties and typologies of disciplines are presented here. For example, in research work mostly related to computer sciences and engineering (CS/E), it has been proposed [86] that it is beneficial to characterize a particular discipline (and its core substance areas) by identifying its prevailing scientific way of thinking, which can be either 1) theoretical and formalism-driven), 2) abstraction and model-centered), or 3) design and methodology-oriented. Another related categorization of the scientific fields divides them according to their interest areas to: [87][86] physical sciences (focusing on non-living matter), life sciences (focusing on living matter), and social sciences (concentrating in humans and their societies). In the philosophy of science, then, broader and more extensive paradigmatic schemes are used (including, among other things, also the epistemological and ontological foundations) in establishing yet another (but similar to the first) form of partitions of the scientific landscape to: formal sciences (like mathematics), natural sciences (including, for example, physics and human sciences), and engineering or design sciences. Additionally, exploring the existing schemes used to typify the various relationships between scientific fields, yields important insights and has practical relevance in respect to the core matter of this work. The starting point, once again, is found in the IT-related research literature, where specifically the relationships between CS/E and other scientific fields are of three kinds [87]: 1) implementation (applying methods of one field to implement a function in the other), 2) interaction (symmetric peer-type collaboration), and 3) embedding (integrating fragments of fields into another).

In the field of *knowledge management in organizations* (KMO) some work has been done to study various forums for scientific collaboration between research organizations and specifically universities [8]. In the conception of the Communities of Practice (CoP) "groups of people share a concern or a passion for something they do and learn how to do it better as they interact regularly" [7]. The identity of the CoP depends on the common *domain of interest* that can be scientific collaboration, learning and education, or also any non-academic thematic substance around which a particular community gathers, and aims to develop practices to enhance their mutual interactions and knowledge exchanges. Thus, they are also known under various other names, like learning networks or thematic groups. In the context of this work the literature focusing on scientific CoPs provides metadata and ontology specifications to represent research-driven collaborations and to define conceptual elements, such as ResearchTopic, Subject, Researcher and ResearchGroup [88].

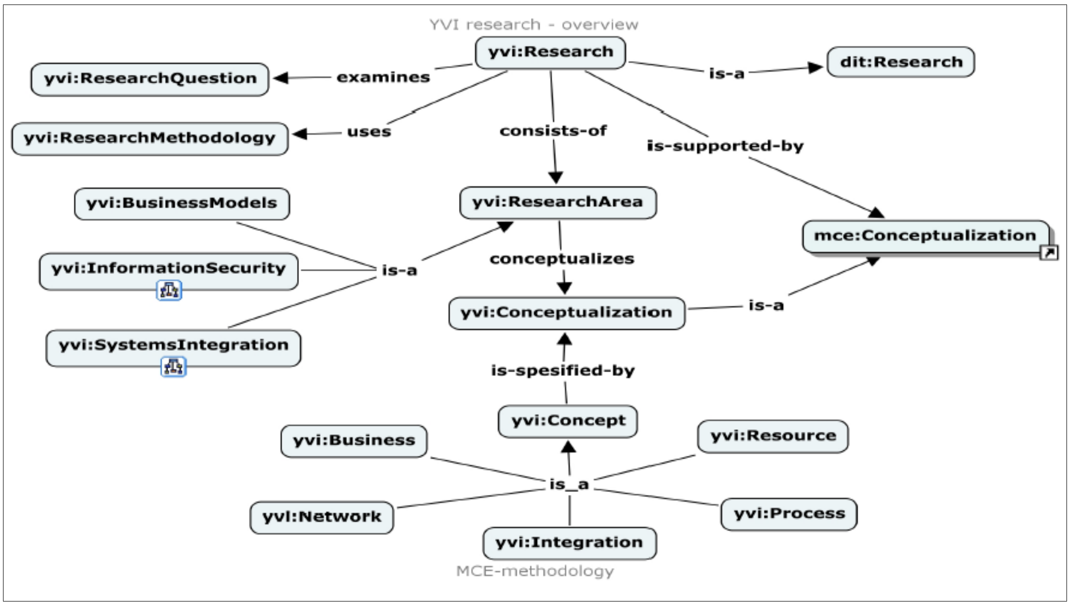

Figure 6.2 Research area concepts in the MCE-metamodel [1]

The main source for conceptualizing the project research space in alignment with the aims of this work is available in the MCE-metamodel specification [1][2] that defines the meta-level entities to describe research-related elements such as r*esearch area, research question,* and *conceptualization* (see Figure 6.2). The main point here is that this metamodel defines the linkages between the individual domain concepts, the overall research area representation, and the scope and methodology of the research process that produces and specifies them. As a further note, the map above is the abstracted part of the conceptual model produced by the author during the YVI/BNI-project, in which the focus was on the systems-level integration issues of an industrial business network.

6.2. Conceptualization of the research space

Above, by outlining the research-related activities, and by analyzing the interactions between target, research and scholarly communities, the needed definitional structures to represent the overall research process have been identified. Here, the conceptual model of the outcome, i.e. the top-level entities of the logical *research space* are presented. As it was pointed out previously the main concept hierarchies that define this conceptual space are:

- *research project -* defining the researchers and goals of the project (e..g. **Goal**, and **ResearchField)**
- *research construct -* describes the various types of constructs produced in research (e.g. **Problem**, **Solution**, and **Assessment)**
- *target domain -* represents the domain under study, and in this work corresponds to the generic domain model (GDM) of organizational networks

The model of the research space depicted below (Figure 6.3) shows how all these parts are linked with the research process. The research construct represents the outcomes of the main phases of progression of the scientific inquiry (**ResearchProcess** ***produce*** **ResearchConstruct**). Thereby it reflects the research understanding attained from the real-world particulars of the domain under study (**ResearchConstruct** ***represent*** **TargetDomain**). This is achieved in form of conceptual models when the project researchers are following the proposed process (**Researcher** ***commits*** **ResearchProcess**) in exploring the target domain from the perspectives of their own research field. In alignment with the CRA, specific sets of research artefacts together describe the *problem*, and the *solution* of the research. The one-to-one relation between them is established in assessing that they correspond each other. By using the properties of the research construct (e.g the *aspect* and *level*), they can be annotated with additional semantic information that describes, for example, whether a specific model is *structural*, *behavioral* or *functional*. Most importantly, this research space model here clearly shows how the implementation of the solution in the target domain is achieved through the *integrative enactments* that were analyzed as part of the generic domain model. These furthermore can have effect the dyadic cross-domain relations (see Table 4.1) and thereby can alter the networked environment that is studied.

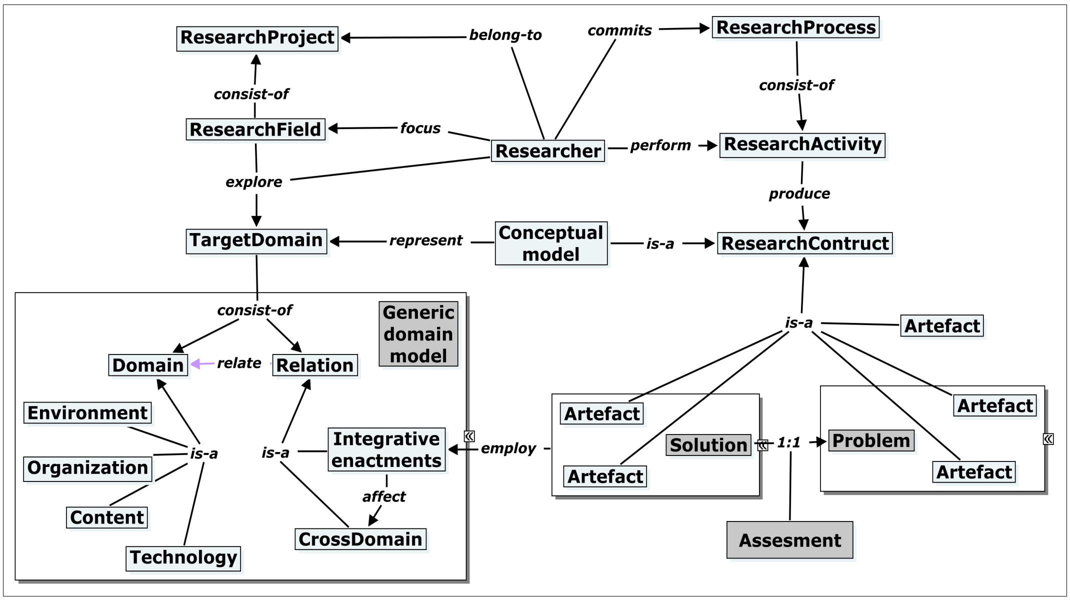

Figure 6.3 Project research space linking domain model and research process

6.3. Research community activities

An overview of the proposed research community activities can now be described that benefit from the models, methods and tools developed so far in this work. The main phases of the research are also mapped to the relevant representational elements of the conceptual research space. This research process has been devised in alignment with the theoretical orientation of conceptual analysis, and semantic and concept-oriented extension of constructive research approach (CRA) (i.e. the cycles of semantic engineering). Also this progression maps naturally also to the step-wise building of consecutive levels of research understanding as defined in the scientific method, i.e. description, explanation, control or optimization, and prediction. These activities are usually initiated by the target community (consisting of various types of networked organizations) where the demands and requirements for project co-operation originate from external environmental changes or internal reasons for improvement.

Table 6.2 Proposed research activities

Research activities	**Stakeholder co-operation (research project work)**	**Research community** **(research space elements)**	**Scholarly collaboration (scientific relevance and contribution/reflection)**
0. initial: - set up, - orientation, - kick-of	Forming the partner consortium, applying for funding, and writing the project plan that includes the work-package descriptions and researcher task lists. (**ResearchProject**)		
	Project partner descriptions, Composition of the research fields forming the overall research area. Specifying the goals of project and individual researchers	Configuration of the research space with project and research area descriptions Determining the domain areas that are to be focused on in the research. **ResearchProject** **ResearchField** **TargetDomain:Domain**	Recruiting the researchers and matching their expertise to project problem areas and goals.
1. *identify* - problem identification	Understanding the domain, Defining the problem statement(s) of each research area	Specifying the problem and goals of the research. Analyzing the nature of integrative enactments. **ResearchConstruct:Problem** **TargetDomain:Relations**	***correlate*** Correlating the issues in the target domain with existing model-theoretical backgrounds
2. *collect* -information acquisition, - domain analysis	Collecting data, acquiring information and materials from the networked environment under study	Collections of data, materials, datasets, interview and documents. Refining the domain analysis **ResearchConstruct:Artefact**	Selection of applicable data collection methods, Comparing the research data to existing datasets
3. *create* - construct the solution	***implement*** or ***deploy*** Describing, explaining, analyzing the phenomenon Developing novel solutions and implementing them.	Combining the research data and all the developed models and recommendations that are part of the solution. **ResearchConstruct:Solution**	Focusing on the existing general and domain-specific model and methods that support in designing the solution
4.*assessment* **-** testing and evaluating the solution	***test*** The developed and implemented solutions is tested and its results measured in the target domain	***confirm*** Comparing the generated solution to the initial problem thus confirming its value and applicability. **ResearchConstruct:Assessment**	***evaluate*** and ***reflect*** Evaluating the solutions theoretical relevance, Making contributions to scientific community and reflecting research in education.

After the initial project set-up and kick-off activities, the research then progresses thru the following stages (see Table 6.2):

1. identification and specification of the problem by gathering the basic understand about the target domain to be able to *describe* it,
2. collection of data, analyzing the domain and conceptualizing it while trying to *explain* the domain,
3. creating the solution while elaborating the analyzes and conceptual models in order to be able enhance and *optimize* the behavioral patterns in the stakeholder community,

4. assessing the cumulation of novel research knowledge by testing the practical value of the outcome, confirming it against the initial problem-specific success criteria, and evaluating the theoretical relevance and contribution.

Already during the establishment of the research collaboration contracts and project consortia, the focus should be in to recognize the target community needs and start translating them to specific research problems (***identify)***. For example, in the terminology of the networked organizational stakeholder, the goal of the project co-operation might be expressed simply as the need "to benefit more from the supply chain collaboration". In formulating the research problem, also the main goal along with the success criteria should be described. Most importantly, this should be done using vocabulary that is meaningful in target domain. For specifying the problem statement, some semi-formal business rule-based descriptions (e.g. SBVR), can be used. The benefits of these are that they can be mapped to the developed conceptualizations of the target domain in later phases.

As the concept-oriented aspects of the next phases (***collect, create*** and ***assessment***) have been mostly covered previously in relation to the cycles of semantic engineering, the discussion here only describes the assessment phase to show what it in practice means to make sure that conceptual one-to-one relation (***confirm)*** between the research problem and the created solution actually holds. This can be exemplified by inspecting networked target environments that are characterized by the *transaction cost economics* (TCE) [89], in which enterprises in economic markets are seeking to maximize the profits and minimize the costs. Typical organizations, then, in this kind of setting are private sector business companies operating in complex network of partner and competitor relationships. Here, a successful assessment of implemented network-wide enhancement means that in conducting surveys and measurements of the created research outcomes and solutions (***testing***), the results of these should show more efficient work flows (minimal cost), or measurable time reductions in the product and service delivery (maximal profit). In accordance with the traditional CRA, besides ensuring the practical stakeholder-specific value of the identified problems, the scientific importance and research potential also need to be estimated by correlating (***relating***) them to relevant disciplinary theories and models. This is strongly linked to the typical behavioral pattern of research communities in general seeking to advance and evolve the discipline(s) they belong to, and thus on their part to have a positive effect (***contribute)*** to the progression of the overall scientific knowledge.

6.4. Example of the benefits of research space semantization

One way to show the utilization of semantic web technologies is to use them to further elaborate the defined *research space* that is a conceptual structure specified in this work. Already in its current form it enables the annotating of research artefacts and preliminary categorization of them. To semantize this space, the developed conceptual model of the shared domain of interest (the organization networks) is essential, because it makes it possible to configure and initialize the semantic space with the gathered domain understanding.

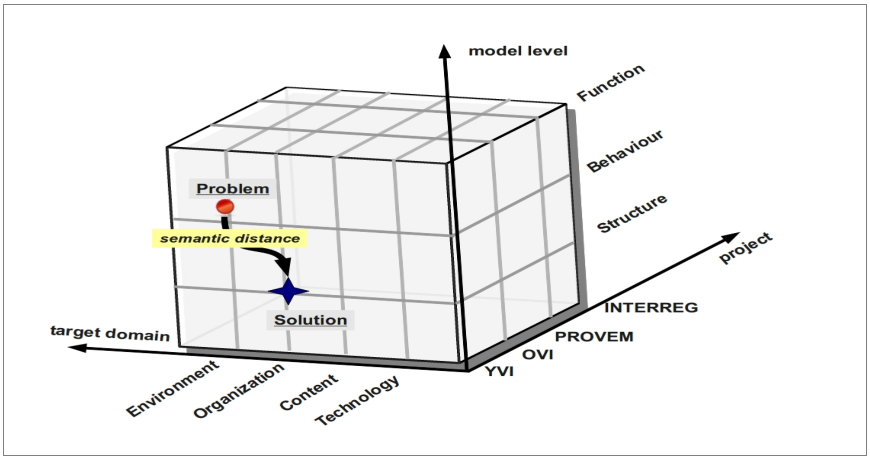

Figure 6.4 An example of semantic research space

Here, to exemplify how research artefacts could be meaningfully positioned in these kind of semantic spaces, and in this case organized based on: (i) the *project* from which they originate, (ii) the *level* of research understanding that they exhibit, and (iii) the mapping of their content to the *target domain* areas, i.e. environment, organization, content, and technology. These categories form the axes of the 3-dimensional space above (Figure 6.4) that shows two research constructs (i.e the problem and the solution) from the YVI/BNI-project. The interpretation of this illustrated example, based on actual research experience in the project, is that:

- the problem was to evoke functional and behavioral enhancements in the overall manufacturing supply-chain environment, but
- the solution that was provided actually addressed mostly issues in the organization structure and process-based operational efficiency of the focal company only.

So, event though the assessment showed that the problem and solution did correspond (they were in one-to-one relation), the *semantic distance* in the visualization of the research space indicates that the quality of this particular solution was not satisfactory, and that further research and actions were needed to complement and improve it.

In more general account, the benefits of these kind of semantized spaces in project research is naturally more pronounced when it is employed during the research activities in such a way that most of the relevant domain data, model artefacts, designs, and analyses are annotated appropriately. Further, interface mechanisms could be developed based on more detailed research work use-case models, for example, and implemented as web-based services of the collaborative research environment (CRE). This way, continuous access, search and re-use of research constructs originating from the past and on-going projects could be enabled, relying on the *repository* of the research knowledge where semantic descriptions of its constituents can be persisted.

7. Conclusion

In the work conceptual models and related approaches have been presented that support the research of organizational networks. These are needed to align the research constructs originating from studies where shared target domain is explored from the perspectives of crossdisciplinary research fields. The common feature in the past research projects conducted in Applied Information Technology Unit, University of Lapland, is that they all describe, explain and analyze business networks that want to benefit from IT in their information-intensive operations and management. The problem is that the new projects cannot easily benefit from the results of the previous projects because the research constructs are not be found, or they are not understood. These constructs are many forms of artefacts resulting from data collection, domain analysis, solution creation and their implementation to the target community. Also, these results of the past projects are difficult to align with the objectives of the new projects, because the models have been created by researchers from different scientific fields relying on their own methods and approaches. Appropriate models, methods and tools are thus needed to enable research knowledge sharing, accumulation and re-use.

The solution to the main problems has been developed relying on the methods of conceptual analysis to develop in this work the framework that supports the research knowledge building inside a research community that participates in these kind of projects. The framework consists of the general domain model of inter-organizational networks (GDM), the *research space* model and a proposed research process that supports the conceptualization of the research artefacts. The research space is a conceptual model specifying the needed definitional structures to represent the target domain, the project in which it is studied, and the research constructs that are the outcomes of the research activities. Thus, the end-result of this work is a model and a technique that supports the creation and representation of the research artifacts that can be organized, referred to, and optimally re-used in different projects.

Additionally, preliminary metadata description and a set of controlled vocabularies have been introduced that may be used in annotating the constituents of the conceptual research space. This way, also, various mapping approaches and semantic web techniques are available to align the projects and research constructs produced in them, with the domains that have been studied and the level of scientific understanding attained. For example, if the project researchers describe their problem-statements and the solutions they create this way, it is possible to assess them not only by inspecting their practical and theoretical relevance, but also by the position of their representations in the semantized research space.

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