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HOW DO IT RESOURCES SUPPORT THE VALUE GENERATION PROCESS OF THE ORGANIZATION? AN ONTOLOGY BASED APPROACH

Alessio Maria Braccini
CeRSI - LUISS Guido Carli University, Italy, abraccini@luiss.it

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Abstract

IT resources support the value generation process of an organisation by enabling or facilitating business processes activities execution. Due to nowadays complexity of IT infrastructures, identifying how IT resources impact on value generating activities is not easy. The identification of IT resources affecting value generating activities is suggested as a promising direction for deepening the understanding of the IT Business Value phenomenon, an area with a long-standing tradition in IS research. So far, no generally applicable methodology is available in literature to target the problem of the identification of the impacts of IT resources on value generating activities. With the intent to provide an artefact that can be used for such purpose, this paper introduces an ontology-based approach. The ontology proposed here originates from two ontologies available in literature (the Business Model Ontology and the OLPIT ontology). The two sources ontologies focus partially on the problem in discussion, but are not capable when taken alone to solve it. In the frame of a design research activity these ontologies have been integrated in the IT-BM ontology. A test case based on a practical real life scenario is presented in the paper to illustrate its applicability. The paper also discusses possible benefits connected with the adoption of such an approach, along with its current limitations and its possible improvements.

Keywords: IT Business Value, IT Resources Impacts, Value Generating Activities, Ontology

1 INTRODUCTION AND MOTIVATION

IT resources support the value generation process of an organisation by enabling or facilitating business processes activities execution. Identifying how IT resources impact on value generating activities is not easy (Scheepers and Scheepers 2008, Tallon 2007). Due to nowadays complexity of IT infrastructures, IT resources can easily affect more than one business process. On the basis of the degree of complexity of the IT infrastructure and of the organisation activities, identifying which IT resource impacts which activity can be either an easy or a very difficult task.

The need to identify the impacts of IT resources on value generating activities is suggested as a promising strategy to investigate and exploit value delivered by IT (Nickels 2004, Tillquist and Rodgers 2005). To be able to practically do it, a methodology to identify the relationships among IT resources and value generating activities in an organisation is required. So far, the only (limited) approach proposed in literature that goes towards this direction is due to Scheepers and Scheepers (2008).

By combining together two different streams of research (IT Business Value and Business Modelling) this paper proposes an ontology-based approach to identify the impacts of IT resources on value generating activities, to support the study and the analysis of value delivered by IT at the level of business processes. The approach proposed in this paper integrates two ontologies (the Business Model Ontology and the OLPIT ontology) in the IT-BM ontology that is capable of identifying the relationships among IT resources and value generating activities in an organization.

The structure of this paper is as follows: paragraph 2 will describe the research question followed by the research design and methodology. The related work section will then position this work in the context of relevant literature. After that the IT-BM ontology is described in paragraph 5, followed by a test case where the approach is tested in a real life context. A discussion on the contribution and on the limitations of the proposed approach, along with some information regarding future research activities, will conclude the paper.

2 RESEARCH QUESTION

This paper targets the problem of defining an artefact suitable to identify the relationships among IT resources and value generating activities in an organisation. The research question this paper aims at answering is therefore the following:

> *Research Question: How is it possible to identify, represent, and communicate the impact of IT resources on value generating activities in an organisation?*

Several elements support this research question. First of all, it addresses the problem of value generating activities in an organisation. In organisational context, value production happens thanks to repeatable patterns of actions (activities) that are necessary to deliver products and services to the final customer. Therefore, to be able to answer the research question, it is necessary to identify value-generating activities in an organisation. The following research proposition is thence formulated:

> *Proposition 1: a general method to identify value-generating activities in an organisation will be investigated.*

The second set of elements that supports the specified research question is the possibility to identify, represent, and communicate the impact of IT resources on value generating activities in an organisation. Having identified value generating activities, and given a certain set of IT resources, the problem is now how to identify the impact of the latter on the former. To do so, investigating the relationships among IT resources and activities is necessary. Activities per se are not sufficient to explain the value generation process. Activities need to use resources (a subset of which are IT resources), to generate value (Daft, 1983; Wernerfelt, 1984; Barney, 1991a; Barney, 1991b).

Therefore, a necessary step to identify, represent, and communicate the impact of IT resources on value generating activities requires the identification of IT resources that are used for activities execution. The following research proposition is then formulated:

> *Proposition 2: the identification of IT resources used to support activities execution will be investigated.*

Finally, once the value generating activities and the resources used are identified, there is the necessity to represent them, in a form that allows the sharing of the understanding gained on the phenomenon to stakeholders. Therefore a final research proposition is formulated:

> *Proposition 3: a form that enables the communication of the relationships of IT resources and business process activities among people interested in the phenomenon will be investigated.*

3 RESEARCH DESIGN AND METHODOLOGY

This paper describes the outcome of the integration of two ontologies, the BMO and the OLPIT ontology, in the IT-BM ontology. The integration has been made with the purpose to define an artefact that could be used as a support to answer the research question of this paper.

As a methodological framework for the integration of the two ontologies, the interoperability processes defined by Choi et al. (2006) have been adopted in this paper. In particular, since the result of the integration process is a single ontology targeted to a specific problem emerging in the ITBV domain, the process called "integration" has been used. This process produces a single ontology in one domain starting from two or more existing (and different) ontologies, targeting different domains (Choi et al. 2006 citing Pinto et al. 1999). In the case of this paper the two source ontologies are the BMO and the OLPIT ontology, while the single integrated ontology produced as the result of the integration is the IT-BM ontology.

This integration process has been carried out following the steps described by Jiménez-Ruiz et al. (2009) that propose to identify an adequate level of correspondences between terms used in the sources ontologies, either by means of a manual process or by means of an automatic process. Since the number of the classes and of the attributes of the sources ontologies was not so large to justify the adoption of an automatic process, the integration has been made thanks to the following, human executed, steps: identification of the classes composing the BMO, identification of the classes composing the OLPIT ontology, comparison of the classes definitions of the BMO and the OLPIT ontology, identification of correspondences among classes, design of the new ontology.

The ontology integration process has been framed as a design research activity (Hevner et al. 2004). In design research, researchers develop artefacts (in the case of this paper, the IT-BM ontology) suitable to solve practical problems (in the case of this paper, the identification of the impacts of IT resources on value generating activities, as stated by the research question), and test their goodness in providing solutions to such problems. Knowledge on the phenomenon is gained through the process of building and testing the artefact (Nunamaker et al. 1991). In the case of the present paper the practical problem has been identified in the literature, and the artefact proposed for its solution has been many times discussed with practitioners and tested on a real life example.

4 RELATED WORKS

This research paper is centred on the key concept of the impacts of IT resources on value generating activities. The term "IT resource" is defined here as described by Orlikowski and Iacono (2001), a set of technological artefacts (like IT components), and IT personnel (human resources). These IT resources impact value generating activities in a business process, altering the ways these activities and business processes are executed, and producing effects like new products or services, redesigned business processes, better decision-making, improved coordination flexibility. IT impacts are necessary and sufficient conditions for IT business value (Soh and Markus 1995).

The domain of research where these kinds of problems are investigated is the one of IT Business Value (ITBV). ITBV examines the impact of IT on organizational performance (Melville et al. 2004), to evaluate profitability and effectiveness of IT investments (Seddon et al. 2002). To address this problem, literature has proposed several approaches (Melville et al. 2004), and theoretical perspectives (Oh and Pinsonneault 2007). Results are somehow controversial (Im et al. 2001), because the direction (positive/negative) of the relationship between IT investments and performance is still unclear (Wagner and Weitzel 2007).

Recently, there is a growing acceptance of the importance of analyzing ITBV from a business process-based perspective (Tallon 2007), since IT application tends to be process specific (Ray et al. 2007). Melville et al. (2004) identified that at process level, IT resources interact with complementary organizational resources contributing to organizational performance, by means of business processes and business processes performance improvements.

The identification of value delivered by IT resources to business processes requires the identification of the IT resources that impacts business processes activities (Wagner and Weitzel 2007, Tillquist and Rodgers 2005). Working towards this perspective, Scheepers and Scheepers (2008) propose to identify value-generating activities relying on Porter's value chain (Porter 2001). This approach is anyhow limited since the value chain framework is a good candidate to identify value-generating activities of large industrial firms, but it is of no help for identifying activities of service providers. To overpass these limitations of Porter's value chain framework, Stabell and Fjeldstad (1998) defined, on the basis of Thompson's (1967) typology of technology, Value Shops and Value Networks as extensions to the Value Chain framework. These value configurations are then capable of better describing the value generation process (besides industrial manufacturer) of service providers and brokers.

Recently the usage of information and communication technologies in traditional ways of doing business has offered many new opportunities to de-construct and re-construct usual value configurations, producing continuously new ways of generating value (Schweizer 2005). The theoretical concept of Business Model (BM) has been used at the onset of the new economy to synthetically describe new, actual or potential, business ideas or opportunities created by the use of ICT (Lewis 1999, Feng et al. 2001). Basically a BM describes the way an organisation "makes money" (Bienstock et al. 2002). Different organisations (sometimes also competitors) perform therefore business together to deliver value to their customers. This new way of doing business contributed to blur the boundaries of industries, making the BM a good candidate to replace the industry as a unit of analysis to investigate the value generation phenomenon in the new economy era (Osterwalder et al. 2005).

4.1 Identifying value generating activities: the Business Model

The BM is a recent addition to the literature and is mainly an outcome of the dot-com era (Feng et al. 2001, Keen and Qureshi 2006). The BM concept is understood in many different ways. Since they are studied by many disciplines under different perspectives, BMs are *boundary objects* that cross several intersecting social worlds satisfying the informal requirements of each of them (Doganova and Eyquem-Renault 2009 citing Starr and Griesemer 1989).

As a result research on BMs covers several different topics and domains (Pateli and Giaglis 2004). Among the several contributions that try to address this phenomenon there are some that try to define what a BM is, proposing models that can be used to describe a BM of an entity or an organization. These contributions have made use, so far, of ontologies to define a BM. The approaches available in literature are: the Resource Event Agent (REA) ontology (McCarthy 1982, Andersson et al. 2006), the e-3 value ontology (Gordijn and Tan 2005), and the Business Model Ontology (BMO) (Osterwalder et al. 2005). The characteristics of the different ontologies are confronted in tab. 1.

None of the available ontologies for business modelling can be used to answer the research question of this paper. The one that is most close to this goal is the BMO since it focuses on the internal aspects of a BM, directly considering resources, activities, and (obviously) the value generation.

	BMO	e3-value	REA
Origins	Business Model Research	E-Business	Accounting
Theoretical perspective	RBV	Value Network	Value Chains
Supported Value Configurations	Chain/Shop/Network	Network	Chain
Focus	Internal	External	Internal
Constructs for Value Activity	Yes	Yes	No
Constructs for IT Resources	No specific construct	No specific construct	No specific construct
Plus	Guidance Definition Layered representation	Profit analysis Modelling freedom Supporting tool	Model simplicity Relational Database
Minus	Complexity Partially fixed model Lack of supporting tools	No guidance	Accounting perspective

Tab. 1. *A comparison among available ontologies for Business Modelling*

Pillar	Building Block	Component
Product	Value Proposition	Offering
Customer Interface	Target Customer	Criterion
	Distribution Channel	Link Actor
	Relationship	Mechanism
Infrastructure Management	Value Configuration	Activity Actor
	Core Capability	Resource Actor
	Partner Network	Agreement Actor
Financial Aspects	Cost Structure	Account
	Revenue Model	Revenue Stream and Pricing

Tab 2. *The structure of the BMO[1] - based on Osterwalder et al. (2005)*

The BMO describes a BM as composed by a set of classes and subclasses, hierarchically organized in pillars, building blocks and components, as shown in Tab. 2.

Even if it is a good candidate to identify value-generating activities of organisations, no matter which is the value configuration they adopt, it is not capable, alone, of identifying the impacts of IT resources on these activities, mainly because this ontology does not contain specific constructs to model IT resources.

4.2 Identifying IT resources that impacts on activities: the OLPIT ontology

Due to the lack in the BMO of specific constructs that can be used to model the relationships among IT resources and activities, the Ontology for Linking Processes and IT (OLPIT) (vom Brocke et al. 2009) has been taken into consideration to integrate the BMO.

The OLPIT ontology has been developed to identify the relationships among IT resources and value generating activities. To do so, the OLPIT ontology describes the IT infrastructure of an organization as composed by physical and virtual hardware, and by human resources. The capabilities of these resources are offered, by means of a set of services (infrastructure services, application services, and business services) to activities in business processes.

[1] For readability reasons, properties and attributes of each class have not been included in the picture.

The structure of the OLPIT ontology is shown in Fig. 1. Even though the OLPIT ontology addresses the problem of identifying the relationships among IT resources and activities, it does not include a true value perspective since there are not chances to tell, using it, how these activities relate to the value configuration of the organization.

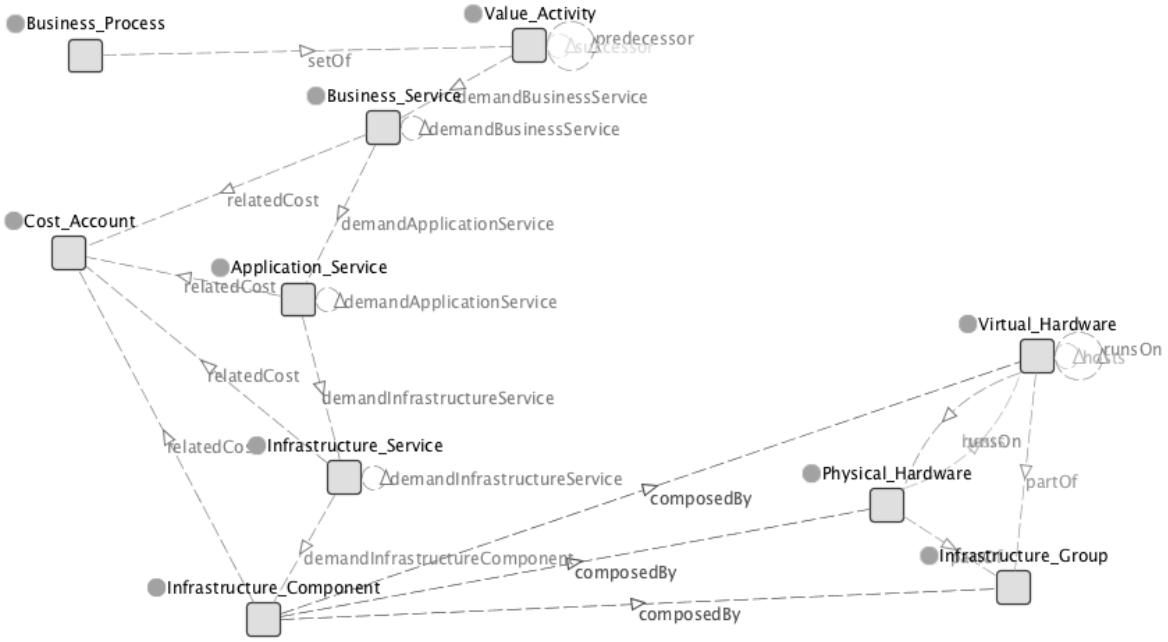


Fig 1. *The OLPIT ontology (vom Brocke et al. 2009)*

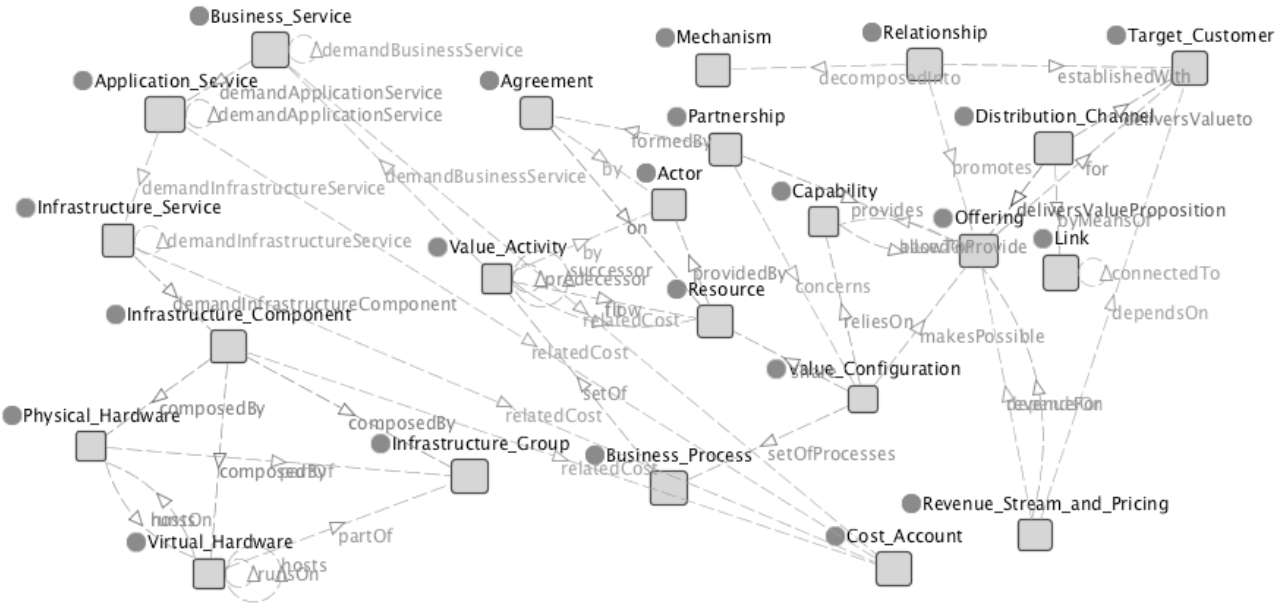


Fig. 2. *The IT-BM ontology schema*

5 THE IT-BM INTEGRATED ONTOLOGY

In the integration process that leaded to the construction of the IT-BM ontology, the two sources ontologies have been integrated by means of their common contact point: the business processes and

the activities, and the resources. Both the BMO and the OLPIT ontology contain constructs to model activities. In addition, the OLPIT ontology classifies these activities in business processes. The activity class (present in both ontologies) was then the first point of integration. As a result, the IT-BM ontology contains both the concept of activities and the concept of business processes that is defined as a set of activities.

A second point of integration concerned the resource class. In this case the OLPIT ontology contains a much more rich description of resources (since it considers several kinds of IT resources like infrastructure components and IT services), while the BMO contains only a generic class for resources.

The resulting IT-BM integrated ontology schema is shown in Fig. 2.

6 IT-BM TEST CASE

The use of the IT-BM ontology has been tested on a real life scenario. The ontology has been used to identify the impacts of IT resources on value generating activities in ITHUM Srl, an Italian SME working in the ICT market. This test case has been built on the basis of data gathered with interviews with key figures in the organisation. All the data gathered from the interviews with ITHUM's management have been used to instantiate an IT-BM ontology schema. A set of software based supporting tools has been used to store data gartered from these interviews: Protégé OWL v. 3.4.1 (build 537), and one of its plug-ins, Jambalaya v. 2.7.0 (build 69). These pieces of software have been used (besides the ontology engineering process) to query the ontology and to obtain a visual representation of the impacts of IT resources controlled by ITHUM on its value activities.

ITHUM Srl is an Italian SME that offers consultancy and training services in the ICT field. The company is located in Rome, in the central part of Italy. It is composed of professionals and partners with a long lasting and certified experience in the ICT market.

ITHUM carries out these activties either directly, or by means of its partners: the consortium “Accademia del Levante”, the spin-off Enetech Srl, and the no-profit organisation ICT Academy.

In brief, ITHUM's BM is centred on the provision of training and consultancy services in the Italian ICT market. ITHUM is therefore a service provider that supplies its services in the ICT market.

6.1 ITHUM’s Value Proposition

ITHUM’s value proposition is basically composed by four different service: consultancy on networking, consultancy on new technology, training, and design of training initiatives.

ITHUM offers consultancy services on CISCO Systems networking hardware appliances or on new technologies in general. ITHUM takes care of aspects like installation, configuration, and maintenance of CISCO Systems hardware located in customers' offices.

ITHUM offers also training services on several topics pertinent to the ICT domain. ITHUM's training activity is directly supported by ITHUM's consultancy experience that renders ITHUM's training services up to date and in line with the state of the art of the IT market.

Besides training services, ITHUM also offers the design of training initiatives as a service. With it, ITHUM offers its experience in training in the IT domain to the customers, supporting them in the design and in the creation of training initiatives on the basis of customers' specific training needs.

6.2 ITHUM’s Customer Interface

ITHUM sells its services mainly to two groups of customers: small medium enterprises (prevalent in terms of annual turnover), and individuals. The services are delivered to customers by means of several channels: direct contact (face-to-face, telephone, e-mail, websites), and intermediary partners. The relationships with customers are mainly managed by means of service provisioning activities and after sales support. Service provisioning activities are all those that ITHUM requires to practically

deliver the services to its customers. They include all activities necessary to identify customers' needs, to identify a solution that suits them, and to deliver such a solution to the customers. After sales support includes instead all the activities executed when the service has already been sold.

6.3 ITHUM's Infrastructure Management

ITHUM has established partnerships agreements with the following organisations: Accademia del Levante, CISCO Systems, Enetech, ICT Academy, SUN Microsystems, and ZyXEL. Regarding the service delivery, the value activities used by ITHUM to deliver its services are shown in Tab. 2.

Regarding the infrastructure, ITHUM's staff is mainly composed by 3 full-time workers (two of which are also ITHUM's co-founders), plus all the ITHUM's co-workers (about 80 in total), and the administrative personnel (2 persons).

Service	Activities	Activity Level
CONSULTANCY ON NETWORKING AND NEW TECHNOLOGIES		
	Analysis of Customer's Needs Identification of the Solution Configuration Implementation Support	Problem Finding and Acquisition Problem Solving Choice Execution Control and Evaluation
DESIGN OF TRAINING INITIATIVES		
	Analysis of Training Needs Identification of Training Needs Design of Training Initiative Identification of Training Resources	Problem Finding and Acquisition Problem Solving Choice Choice
TRAINING		
	Preparation of Didactic Material Delivery of Didactic Material to Instructor Delivery of Didactic Material to Students Lecture Follow-up	Choice Execution Execution Execution Control and Evaluation

Tab. 2. *ITHUM's Value Configuration*

IT Infrastructure Services	**Application Services**	**Business Services**
VOIP Hosting Service Moodle Hosting Service Intranet Web Hosting Service Microsoft Hosting Service Network Service 1 Network Service 2	Apache App Exchange App File Server App Moodle App Sharepoint VOIP Agent	

Tab. 4. *ITHUM's IT Services*

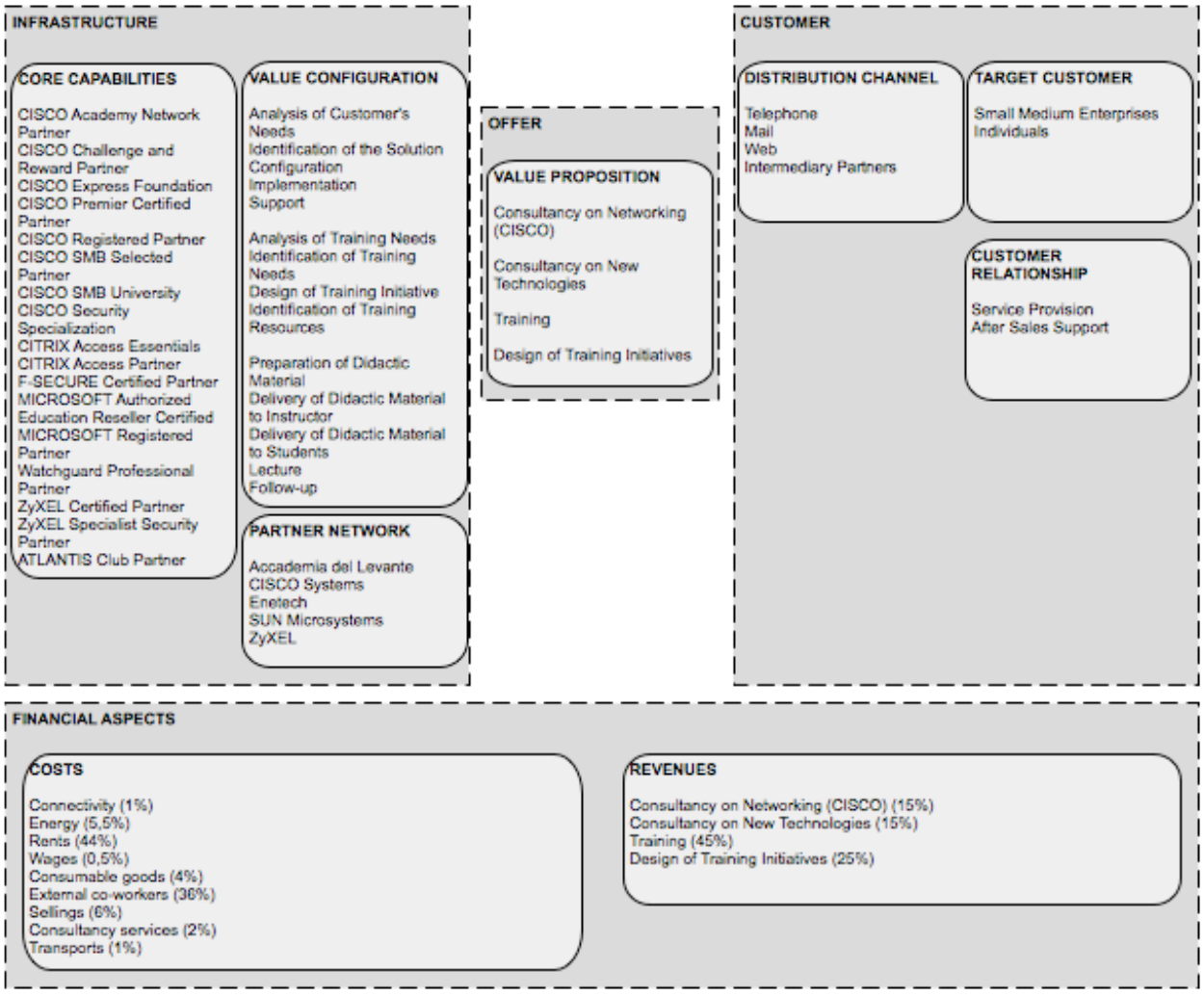
Being a service provider, whose services are mainly human based, ITHUM possess no complex IT infrastructure. Under a geographical point of view, ITHUM's IT infrastructure is divided in two main locations (both of them are located in Rome).

In the first location, ITHUM has 3 servers: a VOIP server, a web intranet server, and a web server that hosts the Moodle e-learning platform. In the second location ITHUM has 1 server and 4 desktop workstations. This server is used to run Microsoft software like Microsoft Exchange, and Microsoft Sharepoint, and to act as a file server. The four desktop workstations are used to support employers' and administrative personnel's work. Network appliances are used to establish LAN/WAN and internet connectivity in both locations. In terms of IT services, tab. 4 lists all those offered by ITHUM's IT infrastructure.

6.4 ITHUM's Financial Aspects

Finally Tab. 3 shows ITHUM's main costs accounts and revenue streams. For each item the table shows its relevance as a percentage on the total amount of costs and revenues of the year.

Costs	**%**	**Revenues**	**%**
Connectivity	1,0%	Training	45,0%
Energy	2,0%	Design of Training Initiatives	25,0%
Rents	3,5%	Consultancy on New Technologies	15,0%
Wages	50,0%	Consultancy on Networking	15,0%
Consumable goods	0,5%		
External co-workers	4,0%		
Sales	36,0%		
Consultancy services	2,0%		
Transports	1,0%		
Total	**100%**	**Total**	**100%**



Tab. 3. *ITHUM's costs and revenues*

Fig. 3. *ITHUM's BM at glance*

6.5 ITHUM's BM at Glance

The overall picture of ITHUM's BM is shown in Fig. 3 using the bird eye view. Such a view is anyhow not capable of identifying the impacts of IT resources on value generating activities. In order to do so, a different form of visualization has to be used.

6.6 The impact of ITHUM's IT infrastructure on its value activities

After having instantiated an IT-BM schema, the relationships among IT infrastructure components and value generating activities in ITHUM can be identified by querying it. Due to lack of space, the test case showed here focuses only on one service (the "Training" service). This particular service has been chosen since it is the more relevant among ITHUM's revenues (45% over the total as shown in Tab. 3). The IT resources impacting the activities necessary to deliver the Training service are then shown in Fig. 4. To make the figure more readable, since the output of the software used is not so stylish, the figure has been reworked a bit.

Fig. 4 shows a large part of ITHUM's BM modelled with the IT-BM ontology. Starting from the left part, the figure shows that one of the three parts of ITHUM's IT infrastructure supports one of the four ITHUM's value propositions (Training). The part of the infrastructure that supports this value proposition is composed by network hardware, an intranet web server, two applications (Apache and Moodle), and the business service that delivers Moodle's functionalities to the business process with which ITHUM provides training services. Out of the five activities that compose this business process, only the second and the third (the distribution of the didactic material to instructors and to students) make use of the IT infrastructure.

The business process in discussion (which is called "Training_Giving" in the figure) supports the Training offering. The right part of the figure shows that the Training value offering is directed to two groups of customers (individuals, and SME), through two distribution channels (the direct channel, and the intermediary partners). The relationships with the customers are managed by means of the service provision activity and the after sales support.

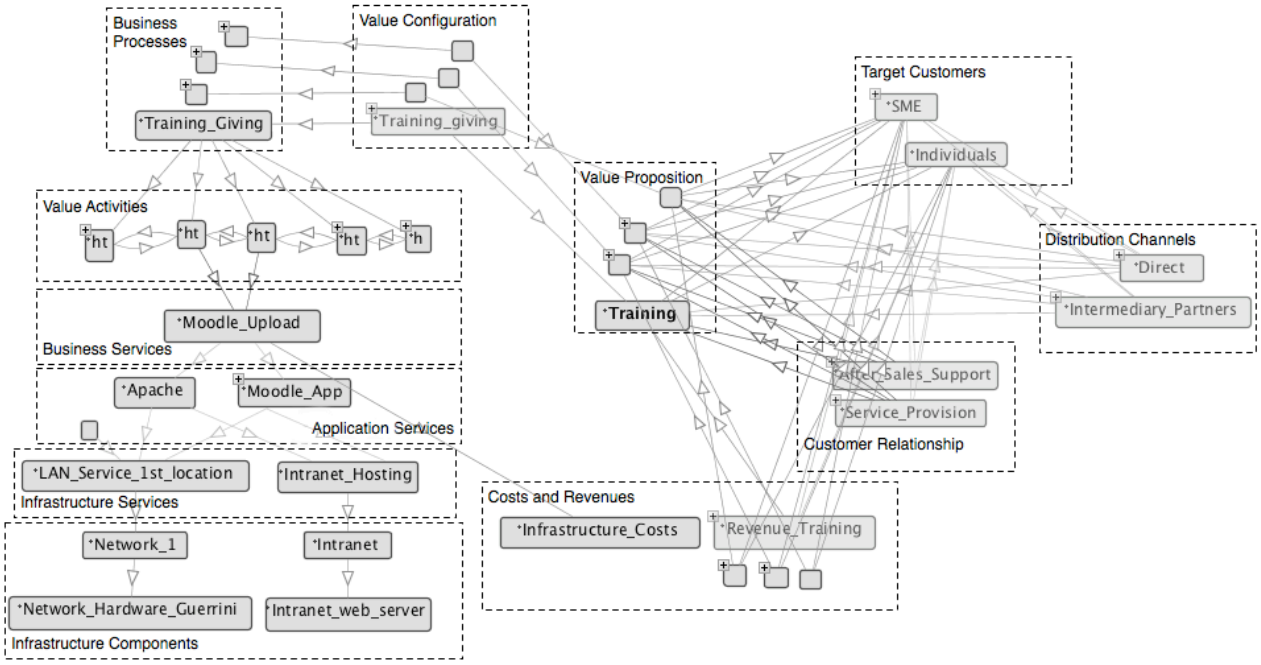


Fig. 4. *The impact of ITHUM's IT infrastructure on value generating activities*

7 DISCUSSION ON CONTRIBUTION AND LIMITATIONS

The main contribution of this paper is the definition of an approach to support the identification of the impacts of IT resources on value generating activities in an organisation. Answering the research question, the IT-BM ontology, as testified by the ITHUM case, is a suitable artefact to identify, represent, and communicate the impact of IT resources on value generating activities in an organisation.

The identification of the impacts of IT resources on value generating activities can be of support for several applications. A first possible application of the proposed approach could be the identification of which IT resources are necessary for the execution of value generating activities. Since the proposed method groups activities on the basis of the value delivered to the customer, and also indicates their contribution to the total profitability of the company, it could be possible to identify which are the key strategic IT resources that better contribute to the value generation process of the organisation. This could allow managers (both IT and not) to take decisions on the IT infrastructure on a profit, or customer, oriented base.

To be able to identify the impact of IT resources on value generating activities, the proposed approach requires a certain amount of investigation. When the approach has to be applied in a real life scenario, there is the necessity to investigate the structure of the BM and the structure of IT resources in the organisational context. Usually knowledge on these aspects can be found in many places inside an organisation. In any case, the application of the approach requires a global effort, which involves both the IT management and the business management side. The proposed approach has therefore the capability of putting IT and business managers around the same table, to discuss about a common problem, and to share a common understanding on the IT/Business relationships, fostering a shared understanding, crucial to derive competitive advantage from IT resources (Ray et al., 2007).

Finally, as seen from the IT perspective alone, the proposed approach can help IT management in explaining and communicating, in a more comprehensive way, which is the contribution of the IT division to the organisation.

7.1 Limitations

Even though the approach proposed in this paper has been many times discussed with practitioners and tested on a simple real life scenario, being on its “first release”, its limitations along with possible future improvements have also to be taken into consideration. Regarding the research itself, a possible limitation of the approach proposed here, regards the limitations of the different amount of scenarios in which the approach has been tested. IT resources can impact value generating activities in different ways in each of the three possible value configurations defined by Stabel e Fjeldstad (1998). The proposed approach has been mainly tested on value shops. Since IT resources could impact activities in a different way when they are part of a value chain, a value shop, or a value network, even though the approach is general, considerations on its outcomes on any kind of value configurations require further research.

A second set of possible limitations regards the scenarios in which the proposed approach can be applied, the conditions in which it can be applied, and the level of understanding that it contributes to gain on the IT/activity relationships phenomenon.

For example there are (also in the case of ITHUM) some IT resources that are not directly involved inside business processes (for example, the act of sending and e-mail). Being not part of a business process execution, they are unlikely to be captured by the IT-BM approach.

A final remark regarding the practical application of the proposed approach regards eventual supporting tools. Even if it is simple, the test case presented here is based on a conspicuous amount of data representing the reality investigated. These data have been collected by means of interviews or direct observations, and they have been used to instantiate an IT-BM ontology schema, using the Protégé ontology editor software. The Protégé software acted therefore as a supporting tool for the application of the IT-BM. This software offers a lot of functionalities that are mainly targeted to

support the ontology engineering process. The software supports the development activity in a proper way, but it is a bit limited (and in some cases it is even too complex) for the everyday usage of the ontology. Thence to be able to fully exploit the potential of the proposed approach, a dedicated supporting tool should be identified (or developed).

8 CONCLUSIONS

This paper introduced an approach to identify the IT resources that impact on value generating activities inside an organization. The proposed approach makes use of the IT-BM ontology, stemming from the integration of the BMO (Osterwalder et al. 2005) and the OLPIT ontology (vom Brocke et al. 2009).

The paper has introduced and discussed an artefact that is capable of answering the research question, demonstrating its capability by means of a test case based on a real life scenario. Further research will be addressed to improve the proposed approach, to test it on different scenarios, and to overpass the discussed limitations.

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