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A method to capture activity diagrams from ontological model

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Abstract

Activity Theory is a useful framework to capture the exclusive features of people's work. A minimum context must be known to understand a community's (i.e., group of people) work. This social and cooperative context is called an Activity and it proceeds within mediation, work division, tools, and social rules. The collective activity is linked to a common purpose i.e. the objective of the activity of which people, that participate on it, are not often aware.
There are several methods of using Activity Theory Diagrams to model individual's work however it is considered difficult to obtain useful Activity Diagram for Enterprises. This paper explains how to develop Activity Diagrams from an ontological model of an enterprise. The ontological model is described in DEMO The paper includes linking DEMO Diagrams with Activity Diagrams proposed by Engeström. The integration covers various components of a particular activity: the participants, work rules, social tools, goals, and motives. The paper uses a real case study to validate concepts

Keywords: Activity Theory ; Enterprise Ontology ; Organizational Modelling

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1. Outline and motivation

Activity Theory is a framework that can be a used for organization modelling through Activity Diagrams, which helps in analysing actions of people as they interact to achieve a desired result. The activity system allows capturing the exclusive features of people's work that includes mediation, division of work and tools.

Activity Theory has been used for research of social and technological aspects of human work in psychology, sociology, education, human computer interaction and organizational modelling [15][6][13][18], but it is difficult to identify useful organization Activity Diagrams and their components due to the dynamics of change within the organizations [8]. The full comprehension of an Activity can only be achieved by engaging the system under observation, i.e. becoming a native for the entirety of the process.

We will use an ontological model, developed in DEMO methodology [2][12][7] to facilitate the capturing of organization's Activity Diagrams by concentrating on basics of a problem under consideration. Ontological model describes the organization's essential aspects and tends to structure people's work, and enhances the predictability of organizational activities through robust and stable models. Also it considerably helps in preserving human capacity to cope with the realities of rapid, sometimes rather difficult, organisational changes [5].

The solution is presented as a method that helps to capture Activity Diagrams guideline from an organization model, described via DEMO Diagrams.

The validation is illustrated by a real world case study consisting of a company specializing in selling support services to seniors called True-kare (www.true-kare.com).

2. Theoretical

2.1. Activity theory diagrams

Activity Theory is used to describe the executed conscious and unconscious actions, as well as the tools used and the socio-cultural rules applied to it. In activity theory context, the notion of work goes in line with the vision of Carl Marx [17] specifying the peculiarity of human labour. For example, bee power overcomes many architectural challenges in building their hives, however there is a quality that distinguishes humans from bees (or other animals). The human being has the ability to visualise in mind before turning the visualised model into reality.

Leont'ev proposed that people's work is done through a hierarchical division of work [16]: activity, actions and operations. An activity answers the question why things happen and is developed over a long period of time within a socio-historical process. Actions answer the question what it is made of and are temporary and have a clear beginning and end, linked to specific goals of which people are aware. Actions are performed in an automatic, unconscious fashion, called operations that answer the question how they are done.

2.1.1. Activity diagram and activity system

Engeström [8][9][10] emphasizes the notion of mediation. The evolution of activity occurs through various forms of mediation, among organisms and their ecosystem, through a representation of human activity that includes various components and their interdependence: object, subject, tools, community, rules and division of labour. Individuals participate in activities (here designated as subjects) defined by conditions induced by the division of labour even without being fully aware of the objective and reasons for such activities. The model, herein named triangular model, to characterize the structure of the activity is showed in Figure 1, where the elements of activities and their inter-relationships are graphically illustrated (left picture). Figure 1 also represents the nature of Activity Diagrams where they are not isolated. Real life situations always involve a

linked and connected web of activities. We have considered two possible relations between activities: one where the result of one activity is the object, i.e. space problem, of other activity (e.g. activities 1 and 2), second, an activity can be part of a constituent element of other activity (e.g. activity 3). We describe the connected web of activities using an activity system diagram (right picture of figure 1).

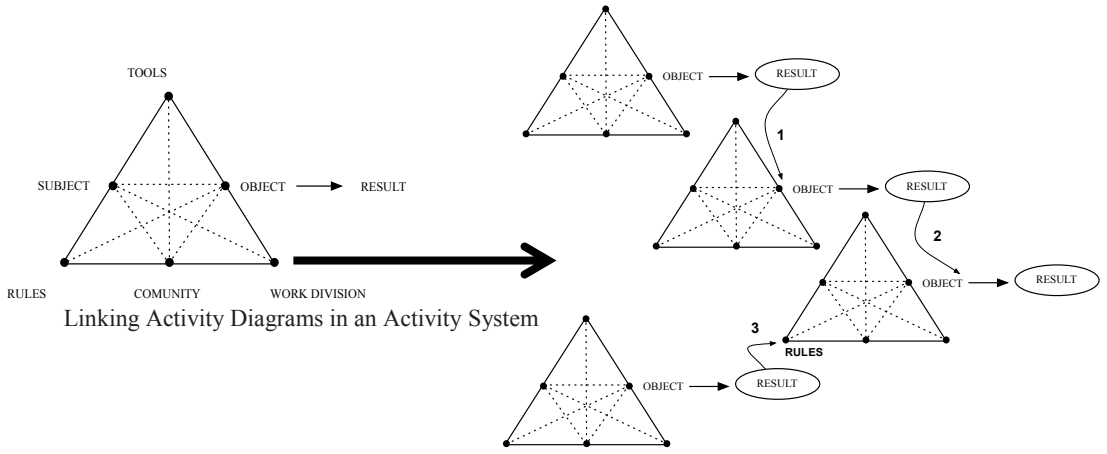

Fig. 1. Engeström Activity Diagram and Activity System Diagram [8].

The Activity Triangular Diagram suggests the possibility of multiple relationships within the triangular structure activity. However, the main task is always to understand the whole rather than their separate connections. The constituent elements of activities are defined below[14][11] [8]:

- **Subject:** Represents the individual and the social nature of human activity. Includes discussion and collaboration to achieve a common result. Subjects are involved in the activity that is guided by a purpose i.e. the objective. Subjects are part of the same community, distinct from others, when they share the same general objective;
- **Tools:** The relationship between subjects and the object is mediated by the use of tools. Tools are resources used to transform the object in order to get a result. They can be any resource used during the transformation process: hardware, software, models, methods, theories or even language;
- **Object**: This component reflects the nature of human activity, which enables the control of behaviour in order to meet the identified results, it represents the space problem that are the focal point of people engaged in this context;
- **Rules, Norms and Sanctions:** Boundaries (rules and regulations) affecting the direction of the development of activities. Rules can be explicit and implicit (e.g. standards of social behaviour within a specific social community;
- **Community**: Social and cultural context of the subjects in which the activity is developed. The community consists of all individuals sharing the same object and, hence, including all activity stakeholders;
- **Division of labour:** Refers to the allocation of responsibilities. Framing the role to be played by each subject in the development of an activity in the community. Both the horizontal division of tasks between the members of the community, and the vertical division of power and status;

In the Activity Triangular Diagram the focal point of the analysis of an activity is the midpoint of the right side of the triangle (the production of something), which happens when the activity takes place. In the

production of outcomes any activity participation includes: the subject, the object of the activity, the tools used and the actions and operations that act on the object and produce the result [8].

2.2. DEMO

DEMO models human ability to produce goods or services through commitments, abstracting from the technology used, the particular actions performed and people that perform such actions (called in DEMO terminology the Organization Implementation).

The DEMO methodology's goal [1][7] is to provide a way to deal with the organizational complexity, its representation and dynamics. It favours the Complexity Theory [20] to the detriment of deterministic models of organizations. DEMO provides an immaterial specification of the organization through an ontological model of organizations that emphasizes the description of the core business of the organization and is based on the stable Ψ theory.

The Ψ theory finds its roots in the systemic ontology of Bunge [4]. It recognizes the dynamics, the incompleteness and uncertainty of the reality of the organization, as well as the multiple connections between the components of this reality, and focuses on the use of language to achieve mutual agreement and understanding between people. People are an important component of organization, since they are able to perform social interactions which engage them in obligations relating to acts to be taken and agree on the results of the actions [7]. This is done via language acts of coordination. By uttering the act, the announcer does not describe or even state the performance of an action he or she is really performing. This means: when we say something, through a locutionary act, with the intent or effect of changing the world (or act upon the world), we are somehow performing illocutionary and perlocutionary acts that cause the intended change.

The Ψ theory consists of four axioms and one theorem (e.g. organization theorem). A complete overview of the theory and associated methodologies is available in Dietz's book [7]. We will explain the transaction axiom that is in the base of proposed method.

Transaction axiom indicates that the acts performed by agents occur only in universal standards and business transactions and call for the result of the execution of a transaction, which is a fact [7]. The default transaction consists of the following acts: request, commitment, statement and acceptance of acts of coordination. It features two actors, each with a distinct role: The initiator, who initiates and completes the transaction; and the performer, who performs the act of production acts. Figure 2 presents an example of a construction model of an enterprise that contains all business transactions. It also describes business transaction T01, which explains the negotiation between a client and enterprise actor role (i.e., product deliver) to acquire a product at a shop.

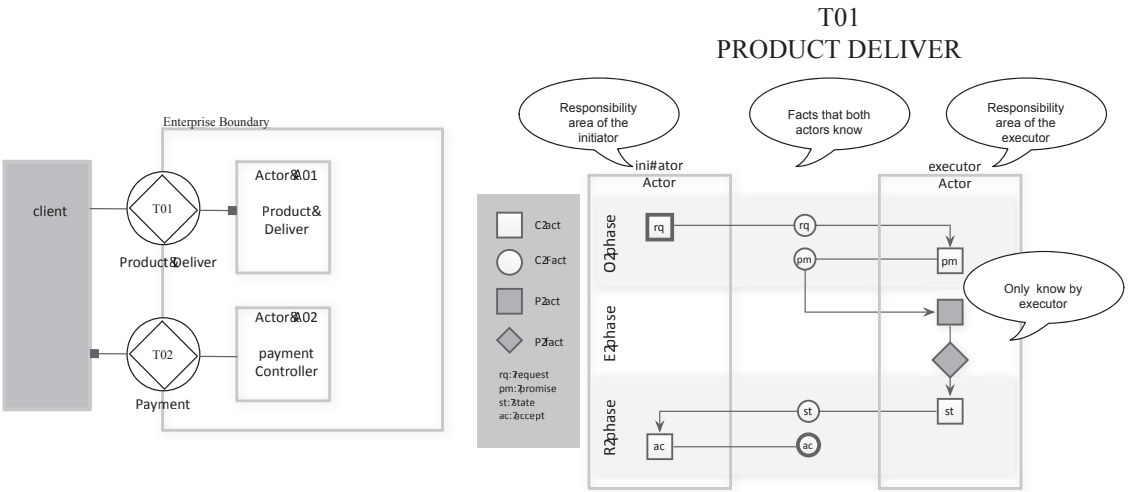

Fig. 2. Constructor Model and Standard Business Transaction [7].

A transaction is a journey through this whole pattern composed of several phases (i.e., Order-phase, Execution-phase and Result-phase). In Order-phase, an actor, that plays the role of initiator, makes a request for a product to another actor (that plays the role of executor) promise and the executor actor make a commitment that will deliver the requested product. In the Execution-phase the executor actor, realizes its commitment of make the product and lastly in the Result-phase the executor actor presents the initiator actor with the product manufactured and the initiator accept the product. Each phase represents a number of communicative acts or interactions between actors. An organization can be described as a collection of transactions linked together in different phases.

DEMO contains four aspects models that describe the organization as a coherent structured of transactions [7][19]: The Construction Model (CM) identifies the actor roles, types of transactions; The Process Model (PM) details each single transaction type of the CM. It contains the causal and conditional relationships between transactions; the Action Model (AM) specifies the business rules that serve as guidelines for the actors in dealing with business events and finally, the State Model (SM) specifies the object classes and fact types.

3. Proposed solution

The central awareness of the proposed solution is to be able to: 1) Identify the main Activity Diagrams; 2) To be able to start the identifications of main components of each activity and finally to be able to link the activity Diagrams in an Activity system Diagram.

We base our solution using concept mappings between Demo Diagrams and Activity Diagrams. The concept mapping between the DEMO model and the Activity Diagram is done at the horizontal level and vertical levels. Meaning that at horizontal level we consider convergence between elements in DEMO Diagram and Activity Diagram and at vertical levels we consider convergence of relationship between elements of both Diagrams. By doing this, we propose the following guidelines: Guideline G1 (Identification of Activities): Every Transaction is mapped to an activity diagram where the result of the Transaction, i.e. accepting the fact of production is mapped with the results of an activity; Guideline G2 (identification of the way that Activity is connected): We consider two ways of linking Activity Diagrams in an Activity System Diagram. When one Transaction is enclosing to other (e.g. Transaction TA02 is enclosed to Transaction TA1) then the enclosed Activity Diagrams will be link as part of rules component of outside Activity Diagram in the Activity System Diagram. (e.g. corresponding Activity Diagrams of TA02 will be link as part of rules component of corresponding Activity Diagrams of TA01). All other case will be connected as an result of one Activity will be the object of other Activity; Guideline G3 (Operational Rating of Activity Actions): For each coordination act (e.g., request, state, accept and promise) it is associated with an Activity Diagram Action. The corresponding actions goals are mapped to achieve the results of performa coordination acts, i.e., Coordination fact in DEMO; Guideline G4 (Classification of Operations): Activity Diagrams operations are the procedures associate to Actions. We link operations to the informa and forma acts of an Enterprise; Guideline G5 (Life Cycle of an Activity): In Activity, actions and operations are organized according to transaction pattern phases (O-Phase, E-Phase and R-Phase); Guideline G6 (Subjects and Community): The people who initiate and execute a transaction are mapped on the subject of the activity and the rest is part of the Community and Guideline G7 (Policy Rules): The people that execute the actions and operations follow an agenda that tracks the business rule of transaction.

The result of applying the rules is the identification for each activity of its main elements: actions, operations, subject community and its articulation. The use of rules promotes the sharing of explicit and tacit knowledge that each individual possesses and which is usually difficult to be formalized or explained to others, because it is subjective and inherent to the abilities of a person.

To be able to use the guidelines as a method, is also proposed, to facilitate the process of developing Activity System Diagrams from DEMO transactions diagrams.

3.1. Method description

To apply the guidelines to guide the construction of Activity Diagram from DEMO it is proposed a method, which follows the vision of the Boyd Decision Cycle [3]. According to Boyd, continuous improvement occurs in a recurring cycle of observe-orient-decide-act. Based on this perception, we define the following steps that incorporate the guidelines rules:

1. **Observation:** includes the collection and compilation of information about the DEMO model of organization. Particularly we start with the information present in the Construction Model (CM) and Process Model (PM). It is our belief that all the necessary information to initiate an activity diagram can be started from the interpretation of the information contained in the CM and PM and follows in the next step with AM model. From the CM and PM we can map each DEMO Transaction to an Activity Diagram as defined in the **Guideline G1 and G6**.
2. **Orient:** is to interpret scenarios based on observations, previous experience, an organizational view, an organizational culture, viewpoints, etc. The orientation results in the construction of Activity System diagrams that represent reality in order to make sense of the actions to be performed. The orientation is highly dependent on the existing view, which in turn is dependent on the tacit knowledge that each element of a team has. Helping a team to observe and get a global sense of what is observable, respecting the particular vision of each element is a key task. Through observation of each identified Activity Diagram from DEMO transactions, it is possible to identify the way that Activity are connected and for each Activity decomposes the stages of the cycle of DEMO acts (O-step, E-step and R-step) and the list of people who perform the actions. This implied the use of **Guidelines G2, G3 and G5**.
3. **Decision:** for each Activity Diagram associate of identified actions with operations and conditions This step encompasses: 1) finding the operation associated to each action identified in the orientation step and 2) defining the conditions that should be present in order to be able to accomplish the operation. The outcome of the decision may flow in two directions: immediate identification of the proposed operations and conditions, or a return to observation if there is not enough information for a decision. This step, for finding the operations, uses the **Guidelines G4 and G7**;
4. **Action:** We can use an Activity System Diagram to understand the organization in order to operate in it.

The method encompasses two different concerns: the identification of Active Diagrams and the identification of Actions and Operations in the finding of Activities. The activity and actions should be related to the organization business transaction and actions give semantic meaning to the operation, that are concerned with the capture and store of information and data, used the in the context of its actions.

4. Case study

We illustrate our approach by applying the method to a service provided by a company named True-Kare. The main purpose of the True-Kare service is to facilitate the support from family or institutions, of senior people with some level of dependence. The service has two main steps: the purchase of mobile equipment and the service subscription, after the purchase of the equipment. To purchase the equipment a customer has to fill out a purchase form in the True-Kare portal. In effect, it is necessary to mention some personal information, including the equipment delivery address and some billing information. The equipment is shipped only after receiving of the payment invoice from the customer to the company. There are two departments involved in this operation: the receipt of payment department and the shipping department. When the customer receives the equipment, he must activate the service. To this end, he must use the True-Kare portal to activate it, introducing

an identification code that accompanies the equipment he received. Only after activation can he or she use the service. Once the service is activated the customer will have to pay a monthly value to continue using it. Each month he will be issued with a warning about the payment of the service and the invoice relating to the service. Invoices will be sent by email to be paled If payment is not received by True-Kare, the service will be blocked. The client will only have access to the service again after the payment of all overdue invoices.

The starting point is the Ontological Model of the organization, which was built using the DEMO methodology. Figure 6 provides a general view of transactions, which in this example are transactions T1 (Equipment Order) and T2 (Equipment Payment). Both transactions involve the actors A1 (Client) and A2 (Organization). Transaction T1 is initiated by actor A1 and executed by actor A2 (i.e. the Bouquet Order transaction is initiated by the Client and executed by the Organization). Conversely, transaction T2 is initiated by actor A2 and executed by actor A1 (i.e. the Equipment Payment transaction is initiated by the Organization and executed by the Client).

4.1. Observation and orientation

The starting point is the DEMO Model of the service provided by trueKare. Fig. 3 provides Construct and process Models of TrueKare and table 1 provides the transaction description and results. From the analyses of those diagrams it is processed the activity diagrams of table 2 and an Activity System Diagram of fig. 4.

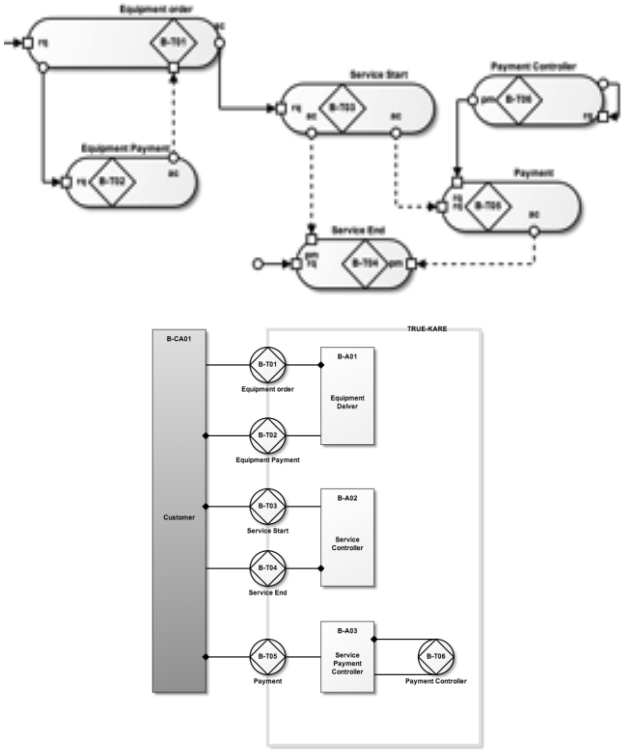

Fig. 3. Constructor and Process Models of TrueKare [7].

Table 1. Transaction description table.

T#	Transaction	Result (fact)
B-T01	Equipment Order	[EQUIPMENT] has been Ordered
B-T02	Equipment Payment	[EQUIPMENT] has been Paid
B-T03	Service Starter	[SERVICE] has been Started
B-T04	Service End	[SERVICE] has been Ended
B-T05	Service Payment	[SERVICE] has been Paid
B-T06	Payment Control	[SERVICE] Payment Control for [MONTH] has been done

Table 2. Activity Identification

ACTIVITY INDETIFICATION			
ACTIVITY	**SUBJECT**	**OBJECT**	**RESULT**
Order Equipment	Client; TrueKare deliver	EQUIPMENT ORDER	EQUIPMENT is
Equipment Payment	Client; TrueKare account	EQUIPAMENT PAYMENT	EQUIPMENT is Paid
Start Service	Client; TrueKare service controller	EQUIPMENT	SERVICE Started
Service Payment	Client; TrueKare account	SERVICE PAYMENT	SERVICE is Paid
Service Payment Control	Client; TrueKare account	SERVICE PAYMENT	SERVICE is Paid

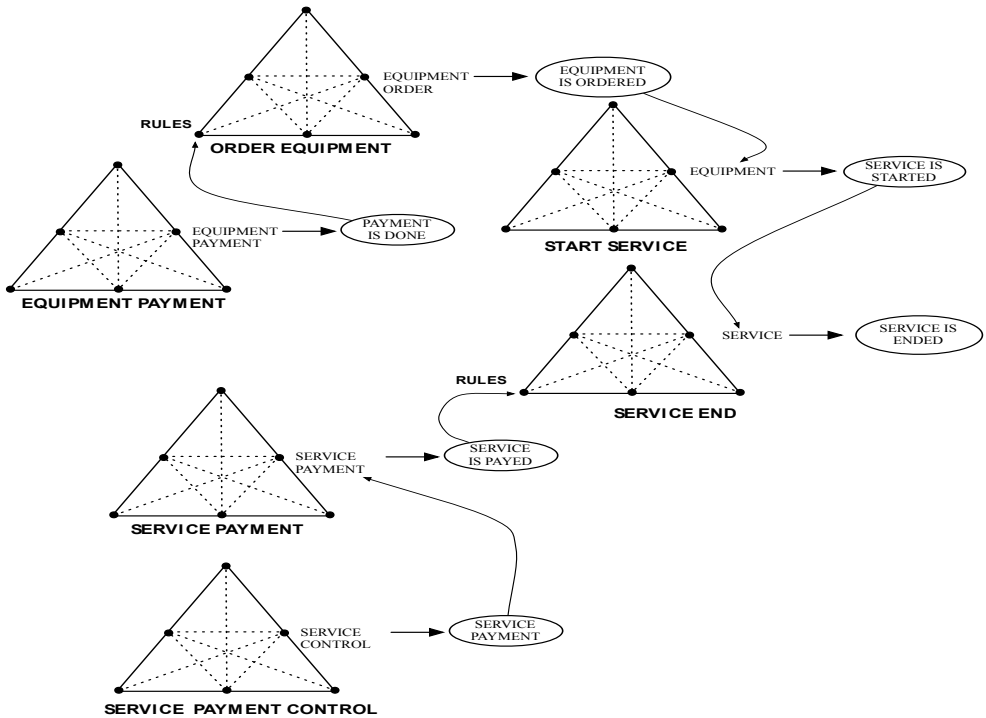

Fig. 4. Activity System Diagram.

4.2. Decision and action

At the decision step each activity is detailed. Each action is identified with its connection to the life cycle of a transaction. As an example, we present the results obtained from the analysis of activity "Equipment Order", where actions and the information needed to accomplish their work are identified. The outcome is mapped in actions and each action is linked to their information needs through operations. Finally it also identified the main tools used to mediate between Subjects and Object of each Activity. The result is presented in table 3.

Table 3. Identification of actions and operations of Activity Order Equipment Diagram.

PHASES	ACTIONS	OPERATION/CONDITION	TOOLS
ORDER PHASE	CLIENT REQUEST	Get equipment information/access equipment list	TRUE-KARE PORTAL
		Choose equipment / access way to register the request	TRUE-KARE PORTAL
	TRUE-KARE PROMISSE	Ask for payment of equipment/access equipment choose by client	TRUE-KARE PORTAL
		Register that the equipment will be delivered/ Information that client had paid equipment	TRUE-KARE PORTAL
EXECUTION PHASE	TRUE-KARE DELIVER EQUIPMENT	Deliver Equipment/ Access to information where to deliver equipment	TRUE-KARE PORTAL
RESULT PHASE	TRUE-KARE STATE THE DELIVER OF EQUIPMENT	True-kare confirms the delivering of equipment/Access register of delivering	TRUE-KARE PORTAL
	CLIENTE ACEPTED EQUIPMENT	Client confirms the reception of equipment/access to equipment activation	TRUE-KARE PORTAL

5. Conclusion and future work

This paper proposes an approach to describe activities diagrams from ontological transactions, based on Ψ theory and DEMO methodology. In order to achieve this, we adopted a set of rules for transforming Ontological Transactions into Activity Theory Diagrams. The aim is to have a baseline of concepts, present in the Engeström triangular diagram and capture information contained in the Construction Model and Action Model (AM) of DEMO.

Despite DEMO leavening the implementation and platform specific aspects out of the scope, it can useful to guide the identification and construction of Activity Diagrams due to the following: 1) Establish the limits of the area of operation of an organization through the concepts of components, environment and structure; 2) Defines the components of an organization through the actor concept that fulfil actors roles, where the ability to interact in getting commitments will be enforced; 3) Delimit the environment consisting of people within the same category, which may or may not be contained in an organization, but who act or are conditioned by them; 4)

Define the structure of an organization as a set of relations that mutually influence people´s behaviour within an organization and identify outsiders, who are directly related to those belonging to the organization and 5) Described essential business processes throw ontological model and AM model, that guide the identification of actors in the dimension of implementation (e.g. helps to start modelling Activities diagrams), identifying those, who initiate and accept a request and those, who execute and deliver a service or one product.

As a conclusion, we can state that defining the activities from the Ontological model provides a basis for an initial analysis of people´s practices within an organization. However, some aspects are not present in the DEMO model, including the tools that mediate the action of subjects with the object of the activity. In future, we are planning to expand the application of method to investigate its use as a means for continuously improving the organization according to the DEMO and Activity models. Our purpose is to include the resolution of Activity Theory contradiction in the proposed method to define a systematic and flexible approach of organizational analysis through a redesign so that it is possible to inter-relate abstract models with concrete situations through critical discussions, rejections, reformulations, and the proposal of proper solutions.

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