USING INFORMATION OF AN INFORMAL NETWORK TO EVALUATE BUSINESS PROCESS ROBUSTNESS

Malika Grim-Yefsah[1,3], Camille Rosenthal-Sabroux[1] and Virginie Thion-Goasdoué[2]
[1] *LAMSADE, Paris Dauphine University, Paris, France*
[2] *CEDRIC, CNAM, Paris, France*
[3] *INSERM, Paris, France*

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Abstract: We consider the evaluation of a business process quality, in particular the evaluation of its robustness. By robustness, we mean robustness w.r.t. the risk of loosing knowledge of persons implied in the business process. We define metrics taking tacit knowledge into account. These metrics are based on the analysis of a social network underlying the process execution. We illustrate these metrics on a –real– application case: the evaluation of an IS project management business process.

1 INTRODUCTION

T. H. Davenport and J. E. Short (1990) defined a business process as being a set of logically related tasks performed to achieve a business outcome. In order to run efficiently, a company must identify and manage its processes. Managing a business process includes, among other things, monitoring its quality. Monitoring quality means defining quality metrics for different quality dimensions and then monitoring them by measuring them periodically. Our goal is to define quality metrics for the robustness quality dimension of a business process, where robustness measures the risk of loosing knowledge necessary to the business process execution.

We consider here business processes consisting of tasks performed by persons. To achieve a task, an "official" *executor* often informally asks for help to other persons that we call *contributors*. Help consists in giving an advice, reminding a technical procedure, giving an informal validation, etc. Thus, executing a task requires not only executors' knowledge but also contributors' one, and more particularly their *tacit* knowledge. One of the peculiarities of tacit knowledge is that it is not entirely "explicitable". Consequently, the whole tacit knowledge of a person cannot be transmitted to another person or a system: tacit knowledge is inherent to a person. The underlying problem here is that if a person implied in a task execution is missing then this task can be in peril as the adequate -eventually tacit- knowledge required for the task execution is missing. In this context, it is important to be able to evaluate the robustness (of the business processes) w.r.t. the risk of loosing knowledge (including the tacit one).

Another research domain focuses on persons (and implicitly on their knowledge): the social network analysis domain, addressed by sociologists. Social network analysis consists in (1) modeling a social network, usually seen as a graph and (2) analyzing this graph in order to identify e.g. social positions, friendship groups, or central nodes. We greatly inspire of this domain to define the notion of *informal network* representing informal relations created between persons during the execution of a business process.

We propose quality metrics, measuring business process robustness, linked to the presence or absence of persons, and the risk of loosing knowledge with regard to the informal network. We illustrate our approach on a real application: the transition phase of an outsourced project management business process in a French Public Scientific and Technological Institution (PSTI).

This article is organized as follows. We first present our application case (in Section 2), as we use it to illustrate the following concepts. In Section 3 we briefly discuss the concept of tacit knowledge for business process execution. We then introduce in Section 4 the notion of informal network underlying

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a business process. Section 5 is devoted to the definition of metrics for the evaluation of business process robustness using informations of the informal network. We also discuss results of the evaluation for our application in this section. After a presentation of related works in Section 6, we draw conclusions and give perspectives in Section 7.

2 APPLICATION CASE

Outsourcing information system development has become a common practice in companies. An outsourced project usually implicates three participants: two internal participants which are the IS Department and the business direction concerned by the project, and an external participant which is a software and computing services company also called service provider. The service provider is chosen at the end of an invitation to tender. In a French public organization like a PSTI, government contract rules concerning outsourcing requires to (re)call for tenders on a contract at least each three years, leading to change the service provider during the project. This change necessitates performing a *transition* from the outgoing provider to the incoming one. Here stands our application case. We are in contact with a project manager of outsourced project in a PSTI, which describes the transition process as follows. The transition consists of six activities: (Activity 1) the *initialization* activity which marks the official start of the transition phase; (Activity 2) the *Third Party Maintenance (TPM) ending* where an inventory of internal and external documents and codes is performed; (Activity 3) the *edition and validation of the transfer plan*; (Activity 4) the *knowledge transfer* essentially consisting in transmitting documentations, applications and codes from the outgoing team to the incoming one; (Activity 5) *the maintenance in cooperation* during which outgoing and incoming service providers assume together a maintenance of the application; and (Activity 6) the *responsibilities transfer*, which marks the official departure of the outgoing provider.

A rather complex diagram formalizes the transition. We will detail our reasoning for only two activities of the process: activities 2 and 3, restricted to the PSTI actor. Figure 1 presents this part of the transition process formalized with an UML activity diagram (the language chosen for business process description does not matter in the following).

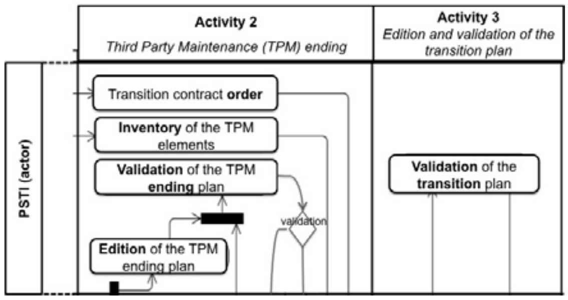

Figure 1: Part of the transition process.

3 BUSINESS PROCESSES AND TACIT KNOWKEDGE

We agree with the vision considering that (Hypothesis 1) knowledge is not an object. This vision, explained in details by Grundstein (2009), is based on the theories that deal with the construction of tacit individual knowledge (Nonaka and Takeuchi, 1995). Tacit knowledge refers to intangible elements, inherent to the individuals who bear them, like skills, crafts, “job secrets”, historical and contextual knowledge, environmental knowledge like clients, competitors, technologies, socio-economic factors, etc. Tacit knowledge generally cannot be entirely expressed (“explicited” is a more recognized term of the KM community). This means that two persons, in some cases, are not interchangeable for a task execution in a business process. Moreover (Hypothesis 2) a person executing a task often informally appeals to other persons whose (tacit) knowledge helps to a better execution of the task. These persons do not appear in the modeled business process, seen as the “official procedure” in the following. Our contribution is based on Hypotheses 1 and 2. We define metrics for *measuring the robustness, w.r.t. the risk of loosing persons’ knowledge*, in order to identify the more sensitive tasks and activities.

Intuitively, a business process is robust if its tasks are not in peril. A task is in peril if a part of the knowledge needed for its execution is missing, meaning that a person executing the task is absent or that a person informally needed is absent. This leads us to introduce the concept of *informal network*, which can be seen as a specification of *social network* for which the exchanged resource is informal help in order to execute tasks of a business process. As we are convinced that the major part of the informal exchanges between employees in an organization does not only pass through digital supports, we consider an informal network accounting for informal exchanges independently from the communication support. Discovering the structure of such a network rests on a questionnaire survey of the employees susceptible to belong to the network. Results of this survey form a network represented by a graph, which can be analyzed. This approach is called *social network structural analysis* (Degenne and Forsé, 1999). We inspire from this domain to define the concept of *interdependencies system* permitting to model and analyze the informal network underlying a business process.

4 INFORMAL NETWORK

We now turn to the definition of an interdependencies system, which is a simplified version of a social network graph. Let *Tasks* be a finite set of tasks and let *Persons* be a finite set of persons.

Definition (Interdependencies System). An interdependencies system is a directed graph $S=(Persons,Tasks,R)$ where $R \subseteq Persons \times Tasks \times Persons$ is a set of labeled directed edges.

The set *Persons* contains persons (executors and contributors) implied in one of the tasks of *Tasks*. For each t, we note r_t the relation referring to the set of transitions of the form (p_1,t,p_2), with $\{p_1,p_2\} \subseteq Persons$, noted $r_t(p_1,p_2)$ in the following. Each r_t denotes help requests between persons in order to achieve t. Intuitively, a directed edge from a person p_1 to a person p_2 labeled with task t means that p_1 needs the informal help of p_2 in order to achieve t.

Definition (Interdependencies System restricted to a Task). We note $S_{|t}$ where $t \in Tasks$, the graph S restricted to the relation r_t.

For our application case, *Tasks* is the set of tasks appearing in the transition process. Figure 2 shows the interdependencies systems restricted to the *Inventory* task (of course, persons' names were anonymized). By definition, the *Inventory* task labels each edge. *Henry* (project manager) is an executor of the task. He is responsible of making the inventory of the elements manipulated in the TPM. At is own initiative, Henry informally asks for validation or completion of the inventory to Mola, expert of the applicative architecture; Marion expert of the software architecture, who herself informally asks for help to Arnold (database administrator), Sallah (front office), and Elsa (JAVA developer); René, expert of the hardware architecture, who himself informally asks for help to Walter and George (system and network engineers); and Marcus functional contact, who himself informally asks for help to three business experts: human resources (Charles), application (Irina) and scientific (Indiana). It is important to note that options and alternatives cannot be expressed in an interdependencies system. (we one cannot express that a person is optional for the execution of a task or that a person can substitute another). In order to be as specific as possible, we consider that if $r_t(p,p_i)$ for all i in $[1..n]$ then every p_i where i in $[1..n]$ is necessary to p in order to achieve t.

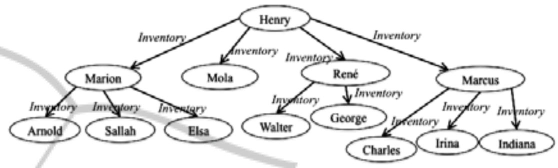

Figure 2: $S_{|Inventory}$ (S restricted to the Inventory task).

For the illustration of our application case, we also present the interdependencies system restricted to the *Ending validation* task in Figure 3.

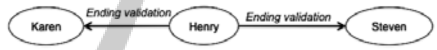

Figure 3: $S_{|Ending}$ validation (S restricted to the Ending validation task).

Definition (Accessibility). The person *p'* is accessible from the person p for a task t in the interdependencies system S, noted *Needs(S,p,p',t)*, iff there is a path form p to *p'* in $S_{|t}$.

For our application (see Figures 2 and 3), one has for example *Needs(S, Marcus, Charles, Inventory), Needs(S, Henry, George, Inventory), Needs(S, Henry, Karen, Ending validation)* and also *Needs(S, Henry, Steven, Ending validation).*

5 ROBUSTNESS EVALUATION

Conceptual representations like business processes usually come from a conception phase based on needs analysis. In this kind of representations, actors are described at the **role** level. This suggests that two persons having the same role are interchangeable. In practice, this hypothesis is approximate (see the complete discussion in Section 3). In our application case for example, if *Marcus* needs the help of *Charles* (HR expert) in order to achieve a task then another HR expert usually cannot replace *Charles* without negative impact on the task execution quality. In other words, *Charles*'s knowledge is the only knowledge that helps *Marcus* as efficiently as possible. An informal network identifies which **person** needs informal help from another. These two visions are complementary but the level of granularity in an interdependencies system is the *person* while it is the *role* in the business process. Thus, it is necessary to map persons and tasks in order to map the informal network and the business process. Let's note ***Execute (p,t)***, where $p \in$ *Persons* and $t \in$ *Tasks* be the relation denoting this information (*p* executes task *t*). This relation, instanciated thanks to the interviews, intrinsically maps interdependancies system and business process.

For our application case, we identified several executors: *Henry* (project manager), *Earl* (administrative assistant), *Wu* (administrator) and *Wilhelmina* (project co-manager), with *Execute (Henry,Inventory)*; *Execute (Henry,Order)*, *Execute (Earl, Order)*, *Execute (Wu, Order)*, and *Execute (Wilhelmina, Order)* meaning that *Henry*, *Wu*, *Earl* and *Wilhelmina* are co-executors of the task; *Execute (Henry,Edition); Execute (Henry,Ending validation) and Execute (Wilhelmina, Ending validation); Execute (Henry,Reversibilty validation).*

One has to note the fundamental distinction between an *executor* and a *contributor*. An executor appears in the official procedure associated to the task. For example, according to the official procedure, *Henry* is an executor of the *Ending validation* task. The official procedure also stipulates that *Henry* must ask for *Wilhelmina*'s validation for the execution of this task. In this context, *Wilhelmina* is also an *executor* of the task. Contributors are *Steven* and *Karen* (see Figure 3) who are persons that an executor (*Henry*) informally ask for help to. *Wilhelmina* does not appear in Figure 3 this shows that she does not ask for help to anyone. *Steven* and *Karen* are the only contributors for this task.

5.1 Definition and Measurement of Metrics for Robustness Evaluation

We present here some metrics, at the task level.

Definition (Metric "Global Sensitivity of a Task"). For a task, this metric counts the number of persons implied in the task: executors plus contributors (that appear in the interdependencies system). The higher is the measure, the riskier is the task. For a task *t*, this metric, noted *global_sensitivity(t)* is defined by *Cardinality(I)*, where *I* is the set *defined by* $\{p' \in Persons \mid Execute(p',t)$ *or there is* $p \in Persons$ *such that* $(Execute(p,t)$ *and* $Needs(S,p,p',t))\}$.

For instance, for the *Ending Validation* task (see Figure 3 and the instanciation of the *Execute* relation), one has *I={Henry, Wilhelmina, Karen, Steven}*, so *global_sensitivity(Ending validation)* =4. For the *Inventory* task (see Figure 2 and the instanciation of the *Execute* relation), one has *global_sensitivity(Inventory)*=13.

Definition (Metric "Sensitivity by Depth of a Task"). For a task, this metric measures the maximal size of a path going from an executor to a contributor. Intuitively, the larger is the path, the riskier it is to go from an executor to a contributor (if a person is missing then the path is "broken"). In the following, *Max(s)*, where *s* is a set of integers, returns the higher element of *s* (and returns 0 if *s* is empty); and *Max_path(executor,contributor,S')*, where $\{executor, contributor\} \subseteq Persons$ and *S'* is an interdependencies system, returns the size of the larger path from *executor* to *contributor* in *S'*. For a task *t*, the sensitivity by depth metric, noted *sensitivity_by_depth(t)* is defined by *Max(depth_paths)* where *depth_paths* is the following set:

$$\bigcup_{\substack{\{(executor,contributor) \mid Execute(executor,t) \\ and\ Needs(S,executor,contributor,t)\}}} \{Max\_path(executor,contributor,S_{|t})\}$$

For instance, for the *Ending validation* task (see Figure 3), *sensitivity_by_depth(Ending validation)=1*. For the *Inventory* task (see Figure 2), *sensitivity_by_depth(Inventory)*=2.

Now, let's consider a metric measuring the density of the informal network underlying a task *t*. The density is a well-known metric used in the social network analysis community. It measures the number of *non oriented* connections devided by the number of possible *non oriented* connections (number of non oriented connexion in the corresponding strongly connected graph). The highter is the measure, the denser is the network and so the more tolerant is the network to the absence of a person, as persons are very connected (they "know each other"). Contrary to previous metrics, performing the measurement with the graph restricted to the considering task would be limitative because, if persons know each other, that is not necessary via this specific task execution. We then define the density for the whole informal network *S* limited to the *persons* (but not the relations) implied in the task. We decide to measure a *dispersion* (1-density) for uniformization with the other metrics preserving the *highter is riskier* convention for results interpretation.

Definition (Metric "Dispersion of the Informal Network underlying a Task"). For a task *t*, this metric noted *dispersion(t)* is defined by:

$$1- \frac{|E_t|}{|Persons_{|t}| \times (|Persons_{|t}|-1)/2}$$

where $|Persons_{|t}|$ is the number of vertices from $S_{|t}$ and $|E_t|$ is the number of pairs of the set E_t defined by { $\{p_1,p_2\}$ | $p_1 \in Persons_{|t}$ and $p_2 \in Persons_{|t}$ and ($r_t(p_1,p_2)$ or $r_t(p_2,p_1)$ with $t \in Tasks$) } i.e. the set of pairs of persons, implied in the task *t*, connected by a task -any task- of *Tasks*.

As an activity or a business process consists of a set of tasks, metrics for business process robustness can be defined by aggregation of the robustness metrics of its tasks (e.g. by sum, average, maximum, weighting tasks metrics according to the task importance, etc., eventually taking decision nodes into account). By lake of place, we do not consider such metrics here.

Table 1 presents the results of metrics evaluation for the tasks of activities 2 and 3. These measures show that the *Inventory* task is more sensitive than the majority of the other tasks. Indeed it implies a large number of persons (*global_sensibility*) with a high dispersion of the network (*dispersion*), meaning there are lots of persons implied in the *Inventory* task and they are poorly connected together. One can observe the same phenomenon for the *Edition* task, which additionally presents a longer path executor-contributor (*sensitivity_by_depth*) than the other tasks.

Table 1: Measurement of metrics on the application case.

	global_ sensitivity	sensitivity_ by_depth	dispersion
Activity 2 - *TPM Ending*			
Task *Command*	7	2	0,5
Task *Inventory*	**13**	2	**0,8**
Task *Ending validation*	4	1	0,3
Task *Edition*	**12**	**3**	**0,8**
Activity 3 - *Edition and valid. of the transition plan*			
Task *Transition valid.*	4	2	0,5

Metrics presented here allowed identifying sensitive "zones" (activities and tasks) of a business process, this identification being explained by objective measures. The study points the *TPM ending* activity as being the most sensitive one of the business process. Within this activity, two tasks were noticed particularly sensitive: *Inventory* and *Edition* ones. We can draw several conclusions: 1- these tasks are more complex to achieve than we thought before the study, the executors seeking for a lot of informal help (besides the official procedure), 2- the absence of persons (not appearing in the official procedure), could negatively impact the execution quality of these tasks.

Based on the results on this study, we can consider several business perspectives:

(1) *Monitoring of the sensitive tasks execution quality.* As a rule, a very special attention has to be paid to the execution quality of sensitive tasks and activities, even more particularly if a situation can create departure or moving of contributors (e.g. reorganization of the entity a contributor belongs to, or more simply to tasks performed during summer vacation periods).

(2) *Improvement of the procedures.* Informal contributors whose knowledge is absolutely necessary to a task should appear in the official procedure (adding new official "sub-tasks"). Nevertheless, the precision level of the business process description is delicate to find. Indeed a very precise procedure insures a best execution of the process but often slows its execution. Furthermore a very complex procedure is often hardly accepted because it is more difficult to execute and can make the job "off-putting".

6 RELATED WORK

Quality metrics of interest were proposed for business processes (Vanderfeesten et al., 2007). In particular, lots of contributions concern the complexity metric, which can be seen as a factor for the understandability dimension. One can also cite the cyclomatic number (McCabe, 1976) (Gruhn and Laue, 2006), (Cardoso et al., 2006), the Conrol-Flow Complexity (Cardoso, 2008), or the size (Cardoso et al., 2006) (Gruhn and Laue, 2006). The robustness factor is well-studied in the multi-criteria decision aiding domain (see (Aissi and Roy, 2009) for an overview) but, as far as we know, not in control flow oriented processes. Another close work is (Hassan, 2009). In this work, N. Hassan measures IT-enabled business process performance by evaluating the impact of an IS evolution (i.e. the implementation of a new technology). Considering the IS system as an IT actor, he analyses a social network of IT actors before and after the implementation of the new technology. Based on this analysis, he draw conclusions concerning for instance the adoption of the new IS system or the evolution of the business job.

Concerning the knowledge facet, we point that none of all these works explicitly consider persons and their tacit knowledge implied in the business process execution. We believe that our method brings a complementary vision by focusing on persons' tacit knowledge.

7 CONCLUSIONS AND PERSPECTIVES

In this article, we deal with the quality evaluation of a business process, in particular its robustness evaluation. We propose metrics for the evaluation of –a part of– the robustness using information coming from the analysis of an informal network (a social network for which the resource is informal help). We illustrate metrics on a real application case: the transition phase of an outsourced project management in a French PSTI. We also discuss some business perspectives based on results of this evaluation.

The application case illustrating the metrics constitutes a "proof of concept". One has to note that we could consider lots of other metrics and quality dimensions for the definition of a business process quality (or even just robustness). A second more detailed study aiming at defining the quality more comprehensively (and consequently considering other dimensions and metrics) on the same application case is in progress. For this second study, we use the GQM paradigm (Basili, Gianluigi, and Rombach, 1994) that gives a methodology for quality requirements elicitation.

Metrics definition can be improved through different ways. (1) Metrics are defined in function of the system of interdependencies only. We could go further by using results of the analysis of the system -performed by sociologists- in order to define other metrics. We think about *stability* of the network (the stabler is the network, the easier a person can find help through it), *centrality* of persons (if there is a central person, communication between persons is facilitated), or *similarities* of persons (if a person p_1 is absent, a similar person p_2 could eventually replace p_1, minimizing the impact of the absence of p_1). (2) As discussed in Section 4, the formalism used to model the interdependencies system does not permit to express alternatives or options. Another more expressive formalism should be considered (e.g. and/or graphs) in order to enrich the interdependencies system thus refine the definition of metrics. (3) Social network analysis domain deals with a notion of *resource*, which is what a person needs from another one. Thus, a network is not simply a graph, but a set of graph, one for each resource. For our application, the only resource to be observed between persons was the need of informal help. It would be interesting to characterize different resources in order to express more astute metrics.

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