CHECKING THE FEASIBILITY OF IMPLEMENTING AN ORGANIZATIONAL PROCESS THROUGH WORKFLOW NETS

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ABSTRACT

The main objective of this paper is to provide empirical evidence for the use of Workflow Nets derived from classical Petri nets, in order to verify the feasibility of implementing a methodological approach developed to generate flexible cooperation alternative solutions for Small and Medium Enterprises (SMEs). To do this we proceeded to model the phases and stages of the solution proposed by Workflow networks and check the possibility of enforcement remedies provided in its design without invalidating situations that arise. Modeling and simulation were performed with the support of Petri net Workflow Designer (WoPeD) v 2.5.0 software; it also accompanied the structural analysis and robustness. The results obtained showed the feasibility of using this tool for these purposes, and the designed procedure guaranteed the conditions to carry out in time and with the finite resources which were planned.

KEYWORDS: Modeling; Simulation; Petri nets; Workflow Nets.

INTRODUCTION

When it comes to the design of new processes or the need for modifications to existing processes (either production or management), it is useful to perform a test or assessment before implementation is realized (ex ante evaluation), in order to verify whether the projected resources permit its effective implementation and execution (Espinoza and Peroni, 2000).

In this paper, Workflow nets derived from classical Petri nets (MOP) to model and evaluate ex ante an organizational process aimed at creating SME cooperation networks in the province of Misiones, Argentina.

To this end, first, we outlined Workflow nets derived from MOP and its application to the case of a management process, designed to create networks of flexible cooperation of SMEs. Then, the modeling of the methodological procedure is described, to advance then to the simulation, analysis, discussion of results, and finally, make the presentation of conclusions.

DEVELOPMENT

Materials and methods

From a methodological procedure available as a result of an earlier investigation (Michalus, 2011), which proposes a mechanism for networking flexible cooperation oriented SME Sustainable Local Development (DLS) of the municipalities/regions of lower socio-economic development of the province of Misiones, Argentina, stages and steps were transferred to a computer processable formal model using Petri net Workflow Designer version 2.5.0 software (WoPeD).

Each stage of the overall process is modeled following the strategy of validation XP (Extreme Programming) (Rodriguez and Bonilla, 2005), creatively adapted to the case where each stage is modeled and simulated separately, in order to check whether it is possible to achieve the last step which consists, in turn, in verifies the conditions of activation of the next stage.

Workflow nets made were implemented and verified ex – ante the procedure conditions for conducting designed, from a structurally and functionally analysis.

An approach to the modeling of workflow processes using networks arising from classical Petri nets

The MOP is a particular case of directed, weighted and bipartite graph, composed of two types of nodes: a) places type node representing conditions and resources; b) transitions type node representing events, processes or tasks that may occur depending on the conditions. The above nodes are connected through oriented arcs (Guasch et al., 2003).

In general, a MOP can be mathematically defined as the quintuple (Magaña Orúe,

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2005) shown in the expression (1).

$$MOP = (p, T, A, W, M_{0)}) \qquad (1)$$

Where:

$p = \{p_{1,} p_{2,} p_{3,}...., p_{m\}}$ node set type places

$t = \{t_{1,} t_{2,} t_{3,}...., t_{n\}}$ node set type transitions

$a = \{a_{1,} a_{2,} a_{3,}...., _{n\}}$ set of arcs MOP

$W = a_{i:} \{1, 2, 3,...\}$ weight associated with each arc

$M_0 = p_{i:} \{1, 2, 3,...\}$ number of starting labels (tokens) in each node location type

A MOP can be formally studied through mathematical structure, and graphically through its representation as a directed graph, in which it is possible to formalize customer requests and resources markings (tokens) located at the place type nodes.

Figure 1 represents a MOP, where you can see how the site and type transition nodes are connected by arcs oriented, which, in this case associated with a weight W = 1 (the unit weight is not explicitly stated in MOP by convention).

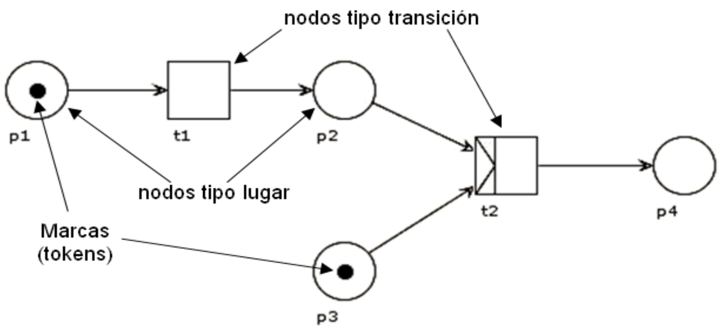

Figure N°1: Graphing a simple Petri Net
Source: Prepared by WOPED v software. 2.5.0

The status of a dial depends MOP (ie the location of the marks or tokens). A transition is enabled to trip or run when all type nodes preceding it instead have at least one mark or token. When a transition is fires, a mark or location of each input node is removed, and a token in each of the output nodes is placed. In Figure 1 the token located in p_1 enables to execute the event, the process or task transition represented by $t_{1.}$ When $run_{t1,}$ the token located at p_1 node is to be located in the $p_{2,}$ as shown in Figure node No.2.

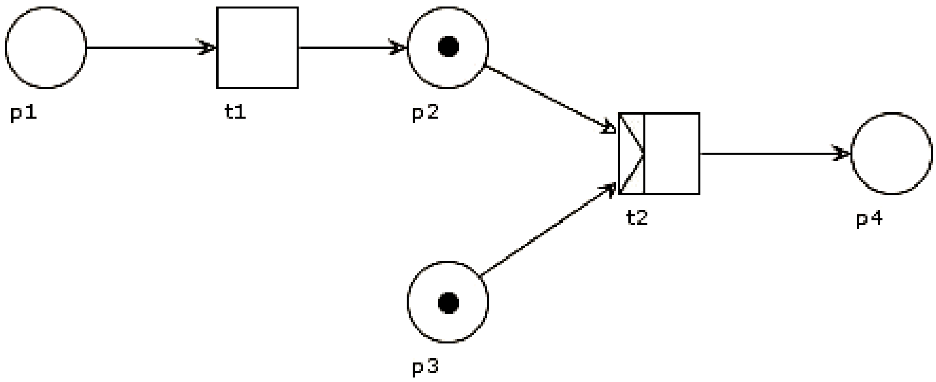

Figure Nº 2: Representation of Petri net N of Figure 1 after the execution of t_1

Source: Prepared by WOPED v software. 2.5.0

Now all nodes that precede t_2 (p_2 and p_3) have at least one mark each, which enables to run the event, process or task t_2.

A detailed description and analysis of the MOP can be found in Guasch et al. (2003), Cohen (2001), Garrido (2005), Granada (2010), among others.

To model workflow processes (Workflow) a modification of the MOP is used with a weight W = 1 associated to each arc because it considers all activities are equally important, and that the substance is to preserve the order of execution; a single initial state (identified by a token at the beginning); a single final state (corresponding to the last step of the final run stage), and all components (nodes transition type place and type nodes) must be strongly connected (strongly connected components by setting) (Solana González et al., 2006). Graphically also use operators needed to correctly represent the conditions of the process, using the following control blocks:

- AND-split (a place type node reaches to a transition node, from which come several)
- AND-join (multiple place nodes type reach a transition and only one get out)
- XOR-split (two or more transitions departing from a place node type)
- XOR-join (one place node type that connects the outputs of two or more transitions)

Combinations of these different specific node types to particular situations of processes, have led to so-called workflow patterns (Russell, 2007) and combinations thereof, used for modeling sequential, conditional, parallel and iterative routines (Castellanos, 2006).

Modeling and analysis of an organizational process by Workflow nets derived from the MOP

As part of an investigation carried out at the Faculty of Engineering of the National University of Misiones (UNAM), Misiones, Argentina in cooperation with the Universidad Central Marta Abreu de Las Villas (UCLV), Santa Clara, Cuba, we developed a model with its associated procedures for generating flexible cooperation networks of SMEs focused on sustainable local development (DLS), adapted to local businesses as an alternative pathway that may contribute to the development of municipalities and micro-regions, and improvement in operating conditions of enterprises in the province of Misiones, Argentina, in a context of relevance and economic, social and environmental sustainability (Michalus, 2011). The above procedure consists of the phases and steps shown in Table No.1.

The phases and stages of organizational components procedure presented in Table No. 1 will not be described in detail in this paper. It will proceed to the modeling and simulation of the same by networks Workflow derived from Petri nets, in order to examine the ability of the procedure completed in a finite time and finite resources exploiting the generality of each of the stages and from a systems perspective (beyond the details, interested check if each of the stages can be completed).

Table N° 1: Phases and stages of methodological procedure proposed

1. Forming Unit Network Management	• Creation of Management Unit: selection process of local actors to shape the organ or to coordinate cooperation program • Setting Appointment of priority sectors for cooperation networks: selection of production or services sectors in which promote the creation of networks or cooperation
2. Configuration Sub-Networks	• Promotional and inscription of companies: realization of promotional and registration of companies interested in forming cooperative networks • Diagnostication and selection of participating companies: evaluation of registered SMEs, selection of those which are able to participate in the program of cooperation • Conformation of sub-networks: the process by which groups of SMEs should be joined up and can work in cooperation
3. Cooperation	• Concretion of initial activity in cooperation: selection of a particular activity, of short-term, to initiate cooperation between SMEs and strengthen confidence between them

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	• Strengthening cooperation: planning and concretion of cooperative activities which are more complex and with higher duration
4. Release	• Identification of mature sub-networks: evaluation and selection process of sub-networks of SMEs that are consolidated in working in cooperation • Detachment of independent sub-networks functioning: the process of separation or sub-networks of SMEs, to continue in operating outside the cooperation program

Source: Prepared from Michalus (2011)

A process conceptualized as a sequence of logical steps that require a range of resources to implement a specific start and end, can be modeled as a network of workflow (Workflow Net) (Solana González, 2006; González del Angel 2007; Amador Hernández Sánchez León, 2009; Lozada and Velasco, 2010). In this particular case, we have extended this conceptualization the case of the phases and steps of the general procedure proposed, which were transferred to a processable formal representation by computer, using analytical techniques, modeling and definition of systems comprising the decomposition into a discrete set of activities associated with human or automated actions, together with rules that govern its evolution through various activities, for the purpose of ex-ante behavior when running test, and verify that there is impracticable to do so due to failure to meet prerequisites or necessary absence of any remedy for this. To perform this analysis, the steps below are followed:

- Build a model of the phases corresponding to the general procedure design (with its procedures specific language). To do this we used the WoPeD v 2.5.0 software. Conditions and resources were identified to perform each step and subsequent firing or conditions on its execution (represented by place node type). Events, processes or tasks were represented by transition type nodes; and the transition type or place nodes were joined by oriented arcs, so that represent the logical sequence defined in specific process considered. Each step of the general procedure were model separately, decision that follows a strategy of validation, following the extreme programming paradigm (XP: extreme programming) (Rodriguez and Bonilla, 2005), where each stage is modeled and simulated, even in extreme conditions, and provided the pre-conditions for activation for the next stage is reached, there will be to tested the ability of the general procedure wholly or partially, in addition to the ex - ante check flexibility, robustness and parsimony procedures specific language.
- Define the initial condition of the process, through initial marking $M_{0.}$

- Run the workflow networks and check if the final marking M_f (defined by the execution of the last step of the general procedure proposed as final state) is reachable from the initial marking M_0, at each stage, as well as t between steps. The end-labeled at each stage within the general sequence procedure ensures have reached the pre-conditions of the next step. The final marked of the last stage represents the culmination of the execution of the general procedure.

To show how networks were built, workflow in Figure 3 shows a partial view of the developed model, corresponding to the formation of sub-networks (last stage of Phase 2: Setting up sub-networks, shown in Table No. 1), it is observed that once appointed manager -Designar Manager (UG) - this meets with a sub-group of SMEs selected - Meetings c / Manager (Sub-group) - and then the negotiation process (in which disagreements can occur leading to further negotiations) companies agree to work together and agree the legal aspects Agreeing legal- aspects, which are embodied in a contract: Contract agreed.

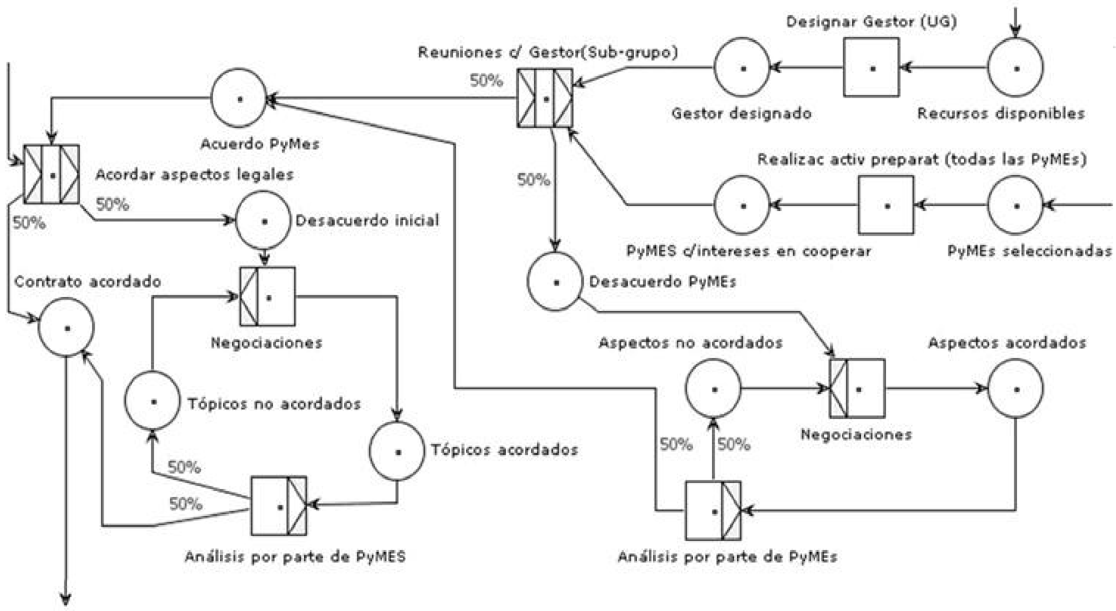

Figure N° 3: Partial view of the network corresponding to Workflow Step 2.3: creating sub-networks
Source: Prepared by WOPED v software. 2.5.0

Workflow networks corresponding to each of the phases and stages listed in Table 1 were prepared in a similar manner as described, and are presented below (see Figures 4, 5 and 6).

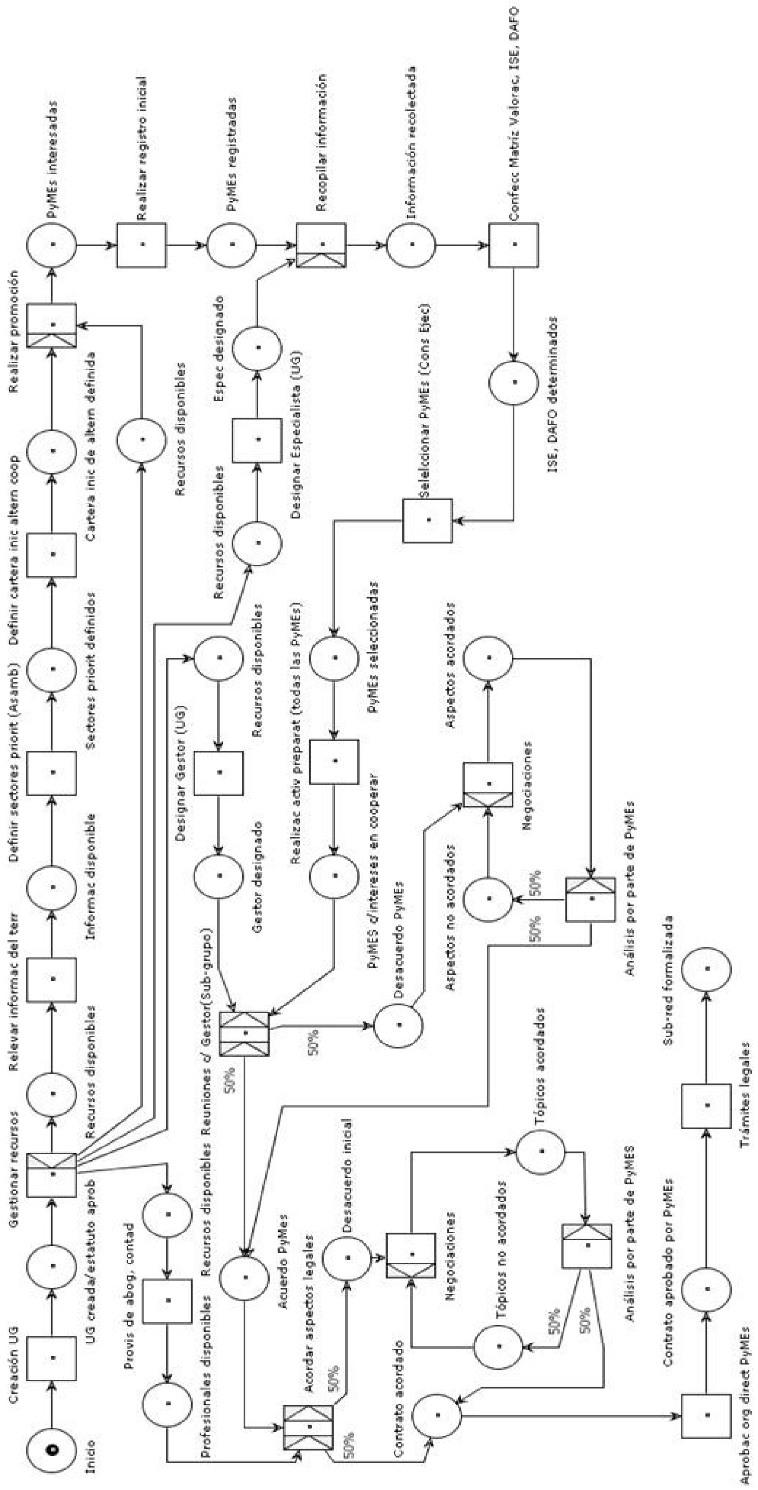

Figure N° 4: Red Workflow corresponding to Phase 1: Establishment of the UG network, and Phase 2: Setting up sub-networks for the proposed methodological procedure

Source: Prepared by WOPED v software. 2.5.0

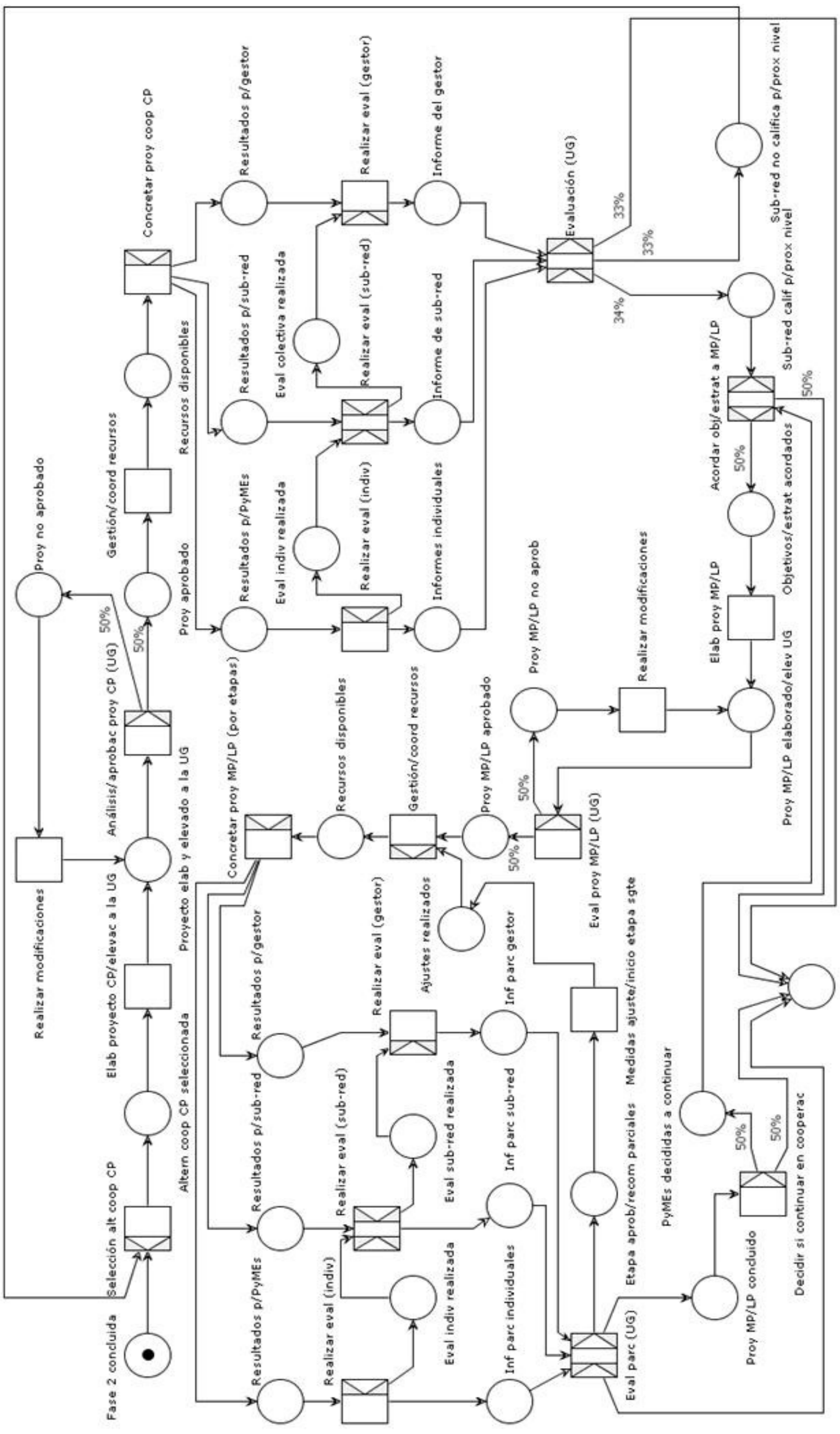

Figure N° 5: Workflow Network corresponding to Phase 3: Cooperation for the Methodological procedure proposed

Source: Prepared by WOPED v software. 2.5.0

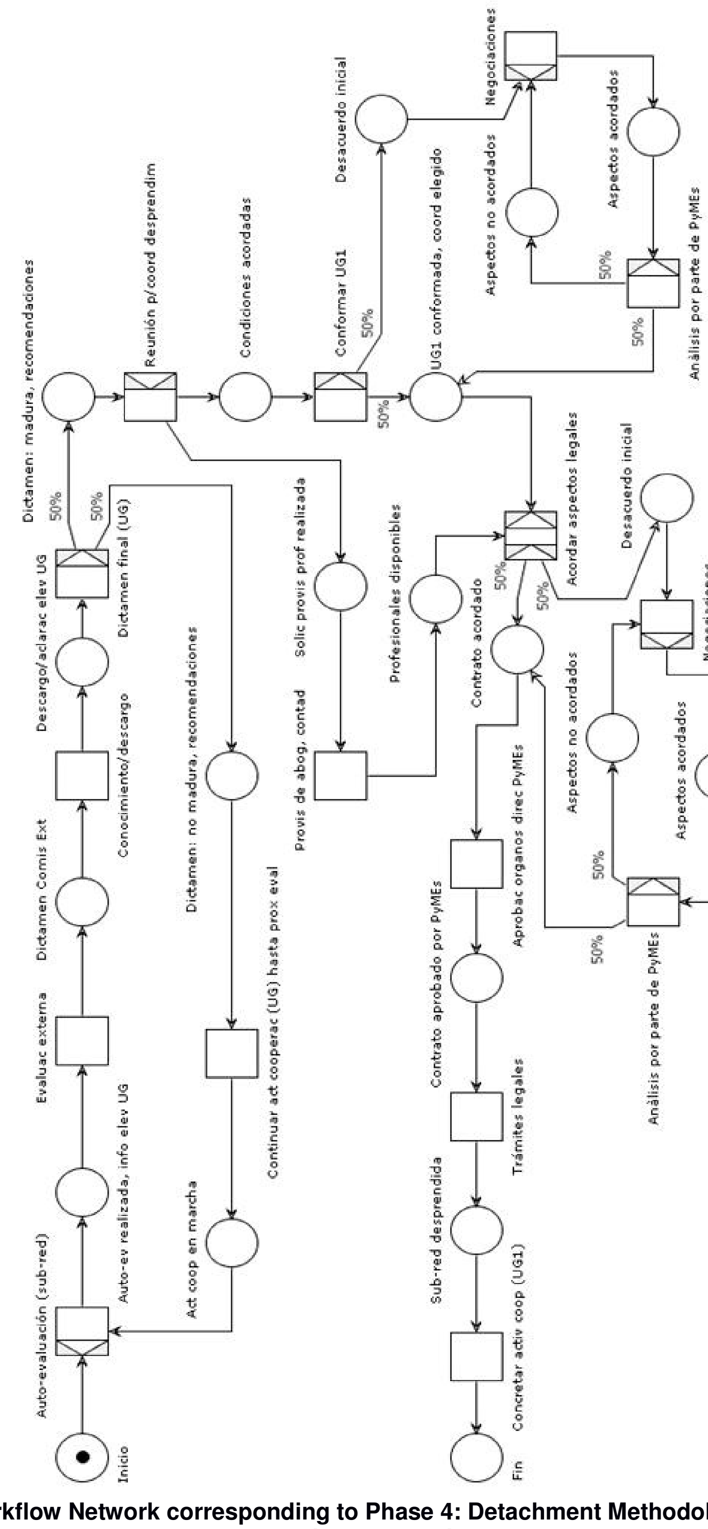

Figure N° 6: Workflow Network corresponding to Phase 4: Detachment Methodological Procedure for the proposed

Source: Prepared by WOPED v software. 2.5.0

Next, it was verified that the developed model is fitted exactly to the steps of the methodological procedure developed, then the simulation was run and found that it is possible to reach the final score M_f from $M_{0,}$ with the proper sequence of shots the transition type nodes and network properties built work flow (Table No. 2).

Table N° 2: Properties of network flow of work relating to the phases of the methodological procedure proposed

Type of analysis	Items scanned	Phases 1 and 2	Phase 3	Phase 4
Structural analysis	Node type place	31	37	22
	Node type transition	30	36	25
	Operators	09	16	09
	Arcs	68	88	52
	Operators used wrongly	0	0	0
	Violations of free choice	0	0	0
Sturdiness (Soundness)	Initial Location	01	01	01
	Final Place	01	01	01
	Connected components	51	56	37
	Strongly connected components	51	56	37
	Places unbounded (boundness)	0	0	0
	Transitions dead (dead-lock)	0	0	0
	Nonliving Transitions (non-live transitions)	0	0	0

Source: Prepared from the software application WOPED v. 2.5.0

From the structural point of view, in Table No. 2 major metric of each of the partial nets (amount of type and type transition nodes instead, many operators and number of edges), and the absence of present operators misuse or violations of free choice. This last check ensures that the dynamics of execution does not add or impose additional conditions or restrictions, which validates the logical consistency of the overall process, as well as specific procedures.

From a functional point of view, the robustness analysis presents basic characteristics (initial and final locations only, and all strongly connected components) and allows you to check that the networks constructed are limited (lack of type node -boundness- unbounded place) this confirms that the conditions and resources are bounded within the obtained model (as they are in practice), and the absence of dead transitions (dead-lock) and nonliving (non-live transitions), which guarantee the absence Crash execution and verifies liveness property of these networks, making it possible to run the events, activities and / or processes derived from the general method proposed by programmed resources also validating the absence of competitive conditions limited resources.

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No conditions that invalidate execution (interrupts and / or blocks), taking into account the sequence defined by the phases and steps of the proposed procedure, consuming the available resources allocated were detected. In practice, this means that no overrides another step and the process are not going to stop because of lack of resources, ensuring their implementation.

CONCLUSION

It has been adequately model all phases, stages and activities components of a methodological procedure, prior to its implementation, using Workflow nets derived from the MOP.

Empirical evidence for the application of the formalism of workflow nets organizational procedures, where it is difficult to prove or ex-ante implementation capacity at the time the various stages to qualify (especially for potential loops presented) was provided.

The strategy following the paradigm of extreme programming to verify that each of the phases and stages can be completed, it proved to be relevant and appropriate to the ends sought to argue for its logical consistency of the information sufficiency and demonstrate their time, the implementation capacity of the organizational process as a whole.

Workflow Networks derived from MOP revealed as a robust tool for modeling and simulation of methodological procedures, which allows ex-ante feasibility check from structurally and functionally, and thus verify the design in order to prevent is inadequate and / or incomplete regarding the provision of the resources necessary for its practical implementation.

BIBLIOGRAPHY

Please refer to articles in Spanish Bibliography.

BIOGRAPHICAL ABSTRACT

Please refer to articles Spanish Biographical abstract.