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RESOURCES SELECTION FOR AGILE/VIRTUAL ENTERPRISES: MODEL FOR VALUE ANALYSIS INTEGRATION

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ABSTRACT

The markets globalization requires companies to continually invest in innovation, competitiveness and excellence. It is important to create a value culture in companies, through methods such as Value Analysis (VA). Nowadays a product is often produced with contributions from several companies and the concept of Agile/Virtual Enterprises (A/V E) emerged and developed.
In this work, we propose an activity model of VA integration in the resources pre-selection process for A/V E. It was made a literary revision of the existent models of resources selection in A/V E in order to identify the main limitations and gaps of the process and assess the relevance of our work. We built the VA integration activity model and defined the VA stages to incorporate in the pre-selection process.
An integration of a methodology of the type of VA will be able to incorporate surplus value in this process and leads to a better dynamic organizational integration. The VA integration brings a systematic and organized process in order to guarantee a higher value and more confidence in the resources system, contributing to a more sustainable configuration process of the A/V E.

INTRODUCTION

Since many years ago, namely in military campaigns, the resources selection always has assumed basic importance. For example, (Tzu 2000) in its classic "The Art of War" has already emphasized the relevance of this question. The markets globalization has evolved extremely fast, which originated a bigger attention to the area of the selection of resources. The more dynamic and complex chains provoked a strong increment of the investigation in the resources selection process.
We intend to discuss the potential benefits that the use of VA can add to the A/V E. How can the value generated by an A/V E be measured and estimated? To answer this question we must then relate the A/V E with value models. In addition it is essential to identify and create procedural models and criteria for evaluating the required performance and its consequent impact on organizational change. The performance measures entail benefits for businesses from both economic, technical and social (Kaiara and Fujii 2006). The VA can play an important role and establish itself as one support tool throughout the A/V E project, which is increasingly emerging as one of the existing paradigms of organizational change.
Currently it is fundamental that companies improve their performance in order to produce products more focused in customer requirements. One method which may contribute to these goals is VA. The joint application of VA with the paradigms of the A/V E, in which we believe that companies can explore its potential as it happens in the conventional systems, goes towards the future perspective of the A /V E challenges. A/V E, which are under development and optimization involve other factors not considered in conventional companies, and the VA incorporation will bring a new support decision for the A/V E configuration process. These factors are related to the nature of inter-organizations such as: trust, integrity, dynamic reconfiguration and organizational integration of the resources (partners).

RESOURCES SELECTION PROCESS IN A/V E

An extensive literature review has demonstrated that the approaches to the global problem of resources selection in A/V E are very different (Sluga and Butala 2001, Ko et al 2001, Chu et al 2002, Ávila 2004, Fischer et al 2004, Huang et al 2004, Wu and Su 2005, Sha and Che 2005, Zeng et al 2006, Jarimo and Salo 2009, Chen et al

2007). In this process we intend to deepen the stage of resources pre-selection by integrating the VA, as well as their implications during the final selection of resource systems. This is one of the main limitations in the analysis of the whole global process of resources selection and hence the importance of this work.

Another important aspect for our work has to see with the total absence of references or incorporation of the value concept in the existing models. None of the models found and analyzed in the existent literature incorporates formally the value concept. This indicates that a current paradigm, the value creation, is not treated, analyzed, or integrated in the aspects inherent to the resources selection process.

VALUE ANALYSIS

VA is a well known structured method to increase value and support the selection of the most valuable solution (Romano et al 2010). Throughout recent decades, VA has proven able to reduce costs and ensure quality, while also contributing to the improvement of decision-making and other important organizational tasks.

VA can be defined as an organized and creative methodology that uses a functional approach and aims to increase the value of a product/service (Fowler 1990, Ho et al 2000, NP EN ISO 12973 2003). The VA provides a means to link, align and maximize the efficiency of the value chain (Rich and Holweg 2000, Boulton et al 2000). It is our belief that the application of VA into the paradigms of A/V E will bring the same contributions to A /V E performance as it has so far done in conventional systems (Pires et al 2007, Pires et al 2010, Ávila et al 2010). Furthermore, the incorporation of VA contributes additional support for the A/V E configuration process.

VALUE ANALYSIS INTEGRATION

The performance of the resources pre-selection systems is very important, considering that the integration in the A/V E is a key factor (Cunha and Putnik 2005). This performance depends on each type of A/V E project, but the resources pre-selection systems should be prepared to have quality, be quick and cost-attractive to the major requirements. The VA integration should have a positive contribution in this pre-selection in particular:

- Evaluate and quantify the parameters associated with the requisites of pre-selection;
- Evaluate the validation criteria for the resources selection to the A/V E project (validation of algorithms, inputs and solutions).

The overall process of pre-selection with VA integration is represented in figure 1.

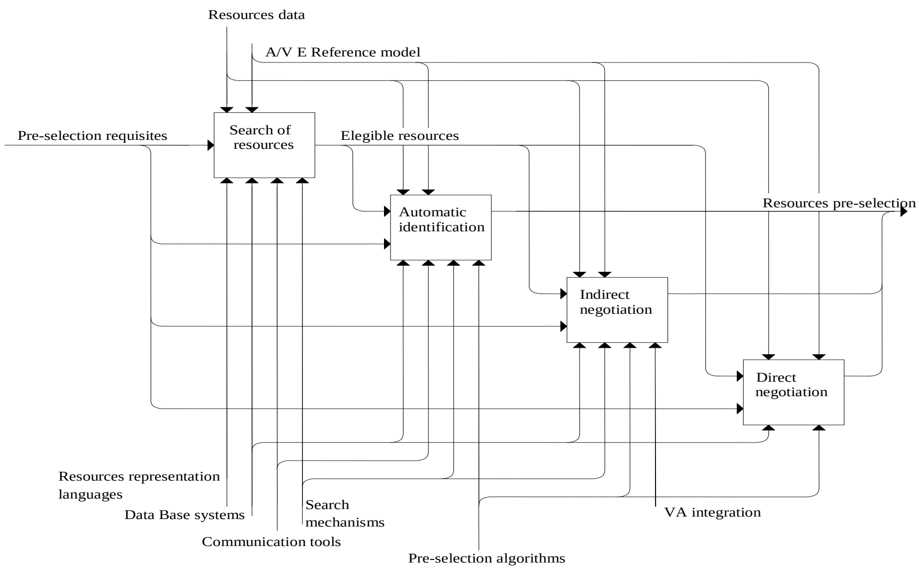

Figure 1: Representation of Resources Pre-Selection Process with VA Integration

Adequacy of Indirect Negotiation Phase to the VA Incorporation

In the context of A/V E, indirect negotiation phase is the most used to make the pre-selection of resources, because it is flexible and adjusts to the different requirements of each A/V E, and presents itself as the most appropriate stage to make the VA integration.
In the indirect negotiation phase, are made offers of tasks and their requisites for the eligible pre-selecting resources (bid solicitation) and where the resources candidates involved respond and carry out its proposals for each task (reception). The proposals are then reviewed and accepted/rejected (analysis/evaluation). The main stages of indirect negotiation which we established and defined are: bid solicitation, reception and analysis/evaluation.

Pre-Selection Requisites

The pre-selection requisites to consider in our model are associated with the following systems that are grouped into two levels of analysis and treatment. At level 1, the systems of requisites take precedence over the systems of the subsequent level. In the phase of analysis/evaluation of proposals, if the candidate resource does not meet these requisites, it is rejected and the evaluation ends here.
Systems of requisites of level 1: Product/Task; Product/Task Project; Production Process; Production Planning.
Systems of requisites of level 2: Quality System; Financial System; Synergies System.

CONCEPTUAL FRAMEWORK MODEL OF VA INTEGRATION

The main objectives of building the VA integration model into the indirect negotiation phase of resources pre-selection in A/V E appear listed below:

- Integrate the VA at the pre-selection using their techniques and phases;
- Develop the tool of qualitative and quantitative evaluation for resources candidates for pre-selection.

A primary objective to be achieved in the pre-selection process is to undertake a qualitative and quantitative assessment of the candidate resources. This evaluation, using the VA, is not only a final evaluation of the candidate resources quantitative features in this pre-selection, but also a qualitative evaluation inherent to the final selection of the system. As mentioned before, in this indirect negotiation, proposals are analyzed/evaluated and accepted/rejected. This will pass then, by setting minimum acceptable values and their acceptance levels, which should be defined in the algorithm, for the various requirements for pre-selection analysis. For those resource candidates that are considered "fit" given the requisites level of treatment and their objective functions, the VA integration in their overall evaluation (i.e. for all pre-selection requisites), including the incorporation of VA steps, could play an important role and position itself as an extremely useful tool to this pre-selection.
The framework for the VA integration in terms of conceptual architecture is represented in table 1, which shows the VA steps that are incorporated into the indirect negotiation stages as well as their main objectives.

Table 1: VA Steps in Indirect Negotiation

INDIRECT NEGOTIATION STAGES	VALUE ANALYSIS STEPS
BID SOLICITATION	ORIENTATION AND PREPARATION
	FUNCTIONAL ANALYSYS - IDENTIFICATION
	FUNCTIONAL ANALYSYS - CHARACTERIZATION
RECEPTION	INFORMATION SEARCH
ANALYSIS / EVALUATION	FUNCTIONAL ANALYSYS - CHARACTERIZATION
	FUNCTIONAL ANALYSYS - WEIGHTING
	FUNCTIONAL ANALYSYS - EVALUATION

Next, will be described in more detail this VA integration, explaining what are the objectives and main steps for the process.

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ACTIVITY MODEL FOR THE VA INTEGRATION IN INDIRECT NEGOTIATION

The indirect negotiation process with VA integration is represented, in IDEF0 language, in figure 2.

Definition of Activities of the Indirect Negotiation Phase

The indirect negotiation process (A0), consists of three main activities (A1 – Ask for Bids, A2 - Reception and A3 - Analysis/Evaluation). In figure 3 appears represented the three main phases of the indirect negotiation process with their VA integration as a common mechanism.

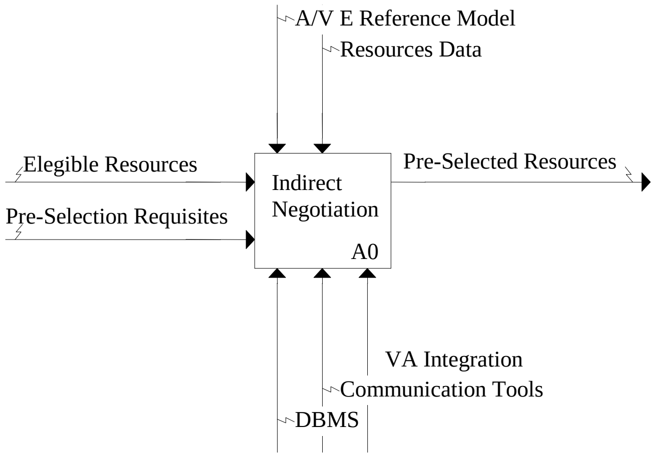

Figure 2: Representation of Indirect Negotiation Activity with VA Integration

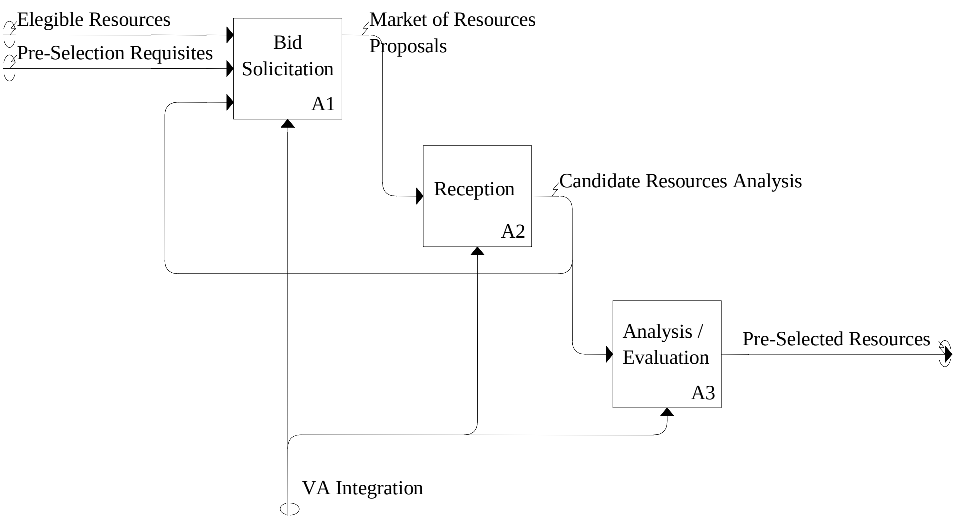

Figure 3: Representation of Indirect Negotiation Phases with VA Integration

Bid Solicitation

The Bid Solicitation (A1) corresponds to the initial phase of the indirect negotiation process and includes the activities of Preparation of Bid Solicitation (A11) and Launching Bids (A12), and is represented in figure 4.
In this stage is applied the VA step of orientation and preparation and is a prior stage to the launch of bids itself. It consists of a preparatory phase.
Objectives (A11): Provide the best possible conditions to the process.
Main Steps (A11): Define the VA subject matter; Define the main goals and constraints; Schedule of resources (human, physical, temporal, financial, etc.).
Figure 5 represents the VA integration step in the functional analysis (identification and listing) of requisites (A121) and their respective minimum levels (A122), during the activity A12.
Objectives (A12): Identify and list the pre-selection requisites; Define the minimum levels for the pre-selection requisites.
Main Steps (A12): Analyze the product/service using functional analysis methodology.

Reception

This is an intermediate stage of the indirect negotiation process and consists of two activities (A21 and A22) i.e. the reception and formatting of proposals and the search for additional information after receiving the proposals and make any necessary adjustments. The reception, with their activities, is represented in figure 6.
Objectives (A21, A22): More and better information; Gain knowledge of the current situation.
Main Steps: Gather all information relevant to the project.

Analysis/Evaluation

This is the final phase of the indirect negotiation process, including of five activities and consists in evaluating the objective function (F.O.) of level 1 (A31); if necessary, definition of flexibility degrees for this level (A32); the evaluation of the F.O. of level 2 (A33); the weighting of requisites and systems (A34); and in determining the value (A35). This final phase of indirect negotiating is represented in figure 7.

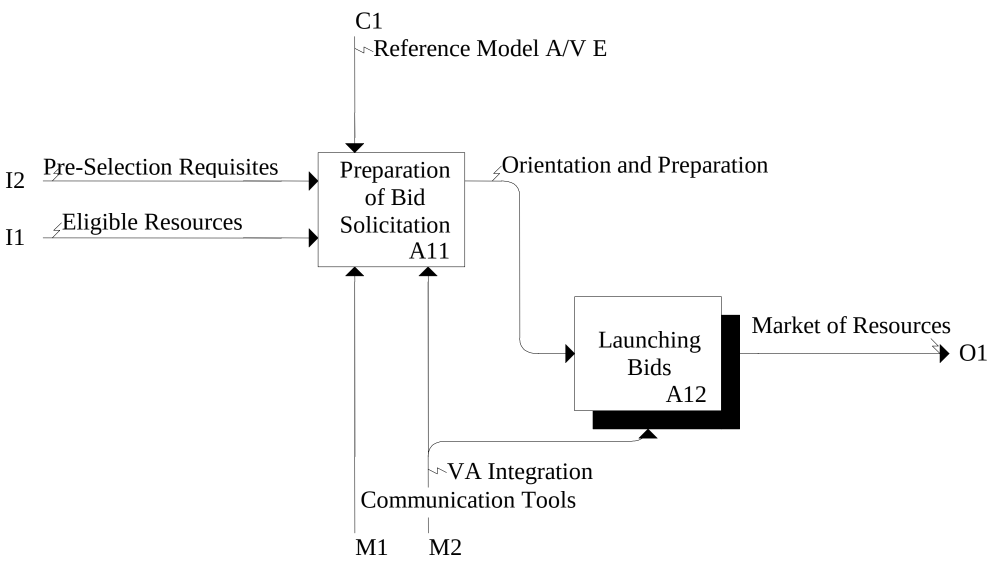

Figure 4: Representation of Bid Solicitation (A1)

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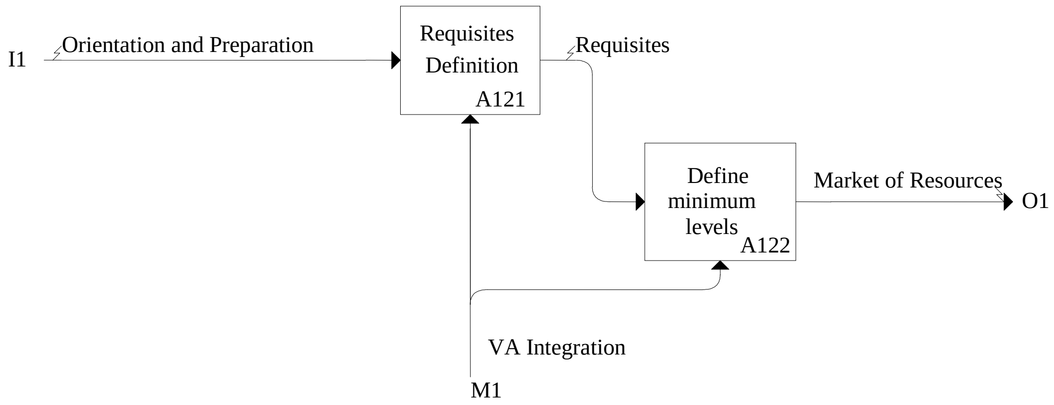

Figure 5: Representation of Launching Bids (A12)

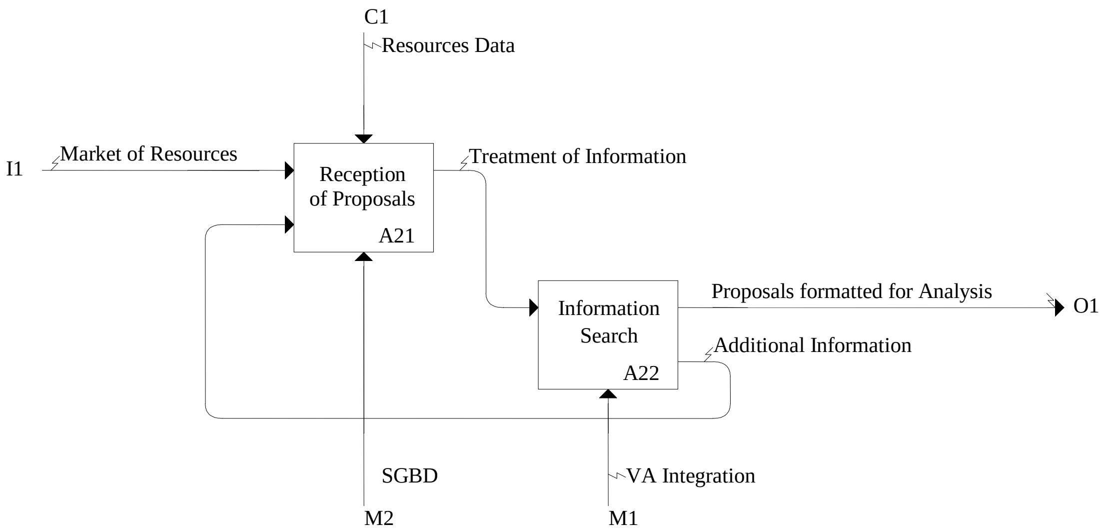

Figure 6: Representation of Reception (A2)

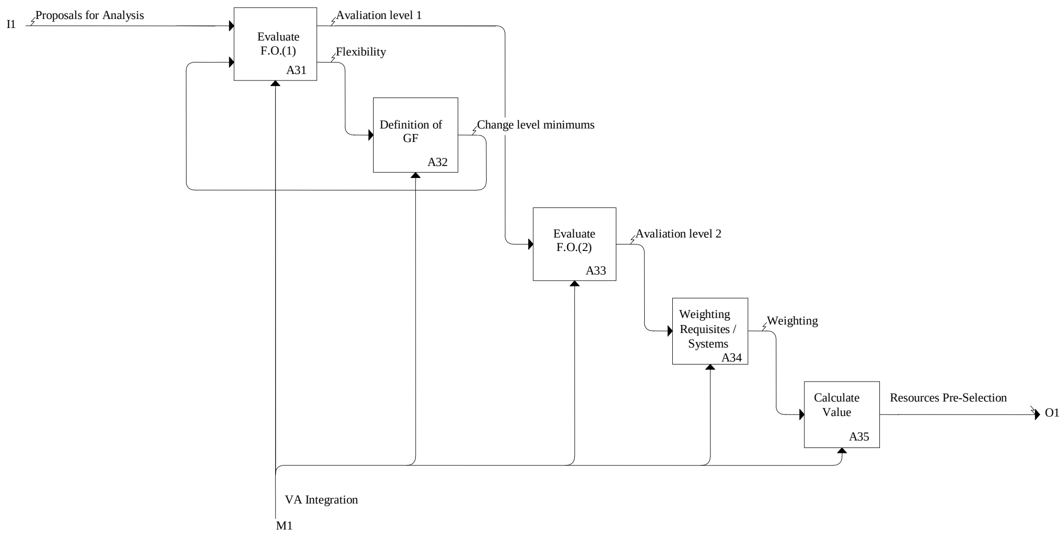

Figure 7**:** Representation of Analysis/Evaluation (A13)

At this stage the candidate resources are evaluated to the F.O. of level 1 (A31). The objective function of the level 1 systems are generally of the boolean type.

Objectives (A31): Analysis/Evaluation of the level 1 systems.

Main Steps (A31): Analyze and evaluate the pre-selection requisites of level 1 systems and their objective function.

If for any system of requisites, is not reached the minimum level for any candidate, then we can define degrees of flexibility and reset the minimum values of acceptance for some or all of the requisites considered (A32). If the resources are within the level of acceptance they pass to the level 2 evaluation.

Objectives (A32): Define, if necessary, degrees of flexibility.

Main Steps (A32): Reset the minimum values of acceptance for some or all of the requisites considered.

This activity proceeds with the candidate resources evaluation of the F.O. of level 2 with the evaluation of requisites associated with the level 2 systems: quality, financial and synergies (A33). One type of evaluation that can be used in our model follows a numerical quantification for each system of requisites, with ranges of between 0 and 10, respecting the usual scale used in the VA (Pires et al 2007, Ávila et al 2006, Pires 2011). The objective is after this quantitative numerical evaluation to weight the system requisites, to then calculate the objective function of the system. This will be a function of maximizing the parameters to consider, in which may be defined, for example, a minimum level of acceptance.

Objectives (A33): Analysis/Evaluation of the level 2 systems;

Main Steps (A33): Analyze and evaluate the pre-selection requisites of level 2 systems.

In this phase (A34) it will be then the weighting of the level 2 requisites and systems in order to evaluate the resources candidates, based on relative importance. We can use the VA weighting matrix or leave open the weights, i.e. using similar weights. It is intended in our model leaves this option open to A/V E promoter, depending on their assumptions and circumstances of each project.

Objectives (A34): Analysis/Evaluation of the level 2 systems; Weighting of the systems and requisites of level 2

Main Steps (A34): Weight the requisites of level 2 on the basis of relative importance within each system; Weight the level 2 systems.

The weighting of requisites and systems can be made on a relative percentage basis, as usual in empirical studies in companies, or using the weighting matrix of the VA.

Example: Objective function of the quality system:
Being

r_{ij}, ($_j$ = 1, n), ($_i$ = 1, k): resource candidate $_j$ for the task $_i$

F.S.Q.: objective function of the quality system

ΦSQ_i, ($_i$ = 1 to 5): weighting of the requisites $_i$ of the quality system

PQi_rij; rij, ($_j$ = 1, n), ($_i$ = 1, k) ($_i$ = 1 to 5): parameter of resource candidate $_j$ to task $_i$ to the set of requisites Q_i

$$F.S.Q.\_r_{ij} = (\Phi SQ_1 * PQ_1\_r_{ij} + \Phi SQ_2 * PQ_2\_r_{ij} + \Phi SQ_3 * PQ_3\_r_{ij} + \Phi SQ_4 * PQ_4\_r_{ij} + \Phi SQ_5 * PQ_5\_r_{ij})$$

That is, in simplified form:

$$F.S.Q.\_r_{ij} = \sum (\Phi SQ_i * PQ_i\_r_{ij})$$

Finally we will determine the overall value of the resources candidates (A35) in order to prioritize/rank the candidate resources by implementing all the objective functions of level 2.

QUALITY SYSTEM: $F.S.Q.\_r_{ij} = \sum (\Phi SQ_i * PQ_i\_r_{ij})$

FINANCIAL SYSTEM: $F.S.F.\_r_{ij} = \sum (\Phi SF_i * PF_i\_r_{ij})$

SYNERGIES SYSTEM: $F.S.S.\_r_{ij} = \sum (\Phi SS_i * PS_i\_r_{ij})$

The evaluation of the candidate resources may be made initially, system by system, pre-selecting those who obtain a value above the minimum level of acceptance for this system (e.g. positive value) or a higher value for its objective function. This evaluation will then be carried out globally by determining the value of the resources candidates for the overall value objective function.
The value objective function (FV) will be:

$$FV = \sum ((\Phi SQ_i * PQ_i\_r_{ij}) + (\Phi SF_i * PFi\_r_{ij}) + (\Phi SS_i * PS_i\_r_{ij}))$$

Objectives (A35): Determine the overall value of the candidate resources.
Main Steps (A35): Calculate the overall objective function (FV) of the candidate resources.

ALGORITHM FOR VA IN THE RESOURCES PRE-SELECTION FOR AGILE/VIRTUAL ENTERPRISES

The main steps of the pre-selection algorithm model are described below as pseudo code, according to the model's conceptual framework and the IDEF0 representation. Consider:

PTP_i *= {$TP_1, TP_2, \ldots TP_n$} - set of tasks of the processing Task Plan;*
TP_i *– processing task, i = {1, 2, …, n};*
Rps_1(TP_i) *– set of pre-selection requisites of level 1 for task TP_i;*
Rps_2(TP_i) *- set of pre-selection requisites of level 2 for task TP_i;*
Sma *– minimum value*
DS_Rps_1(TP_i) *– solution domain for pre-selection requisites of level 1 for task TP_i;*
Drp_{ij} (TP_i) *= {$rp_{i1}, rp_{i2}, \ldots, rp_{in}$} - set of candidate resources to pre-selection of the task TP_i;*
rp_{ij} *– candidate resource j to pre-selection of the task TP_i;*
F.O. (Rps_1)(TP_i) *– objective function of level 1 requisites associated to the pre-selection systems of task TP_i;*
F.O. (Rps_2)(TP_i) *– objective function of level 1 requisites associated to the pre-selection systems of task TP_i;*
F.S.Q. *– objective function of quality system;*
F.S.S. *– objective function of financial system;*
F.S.S *– objective function of synergies system;*
Pps(rp_{ij}) *– pre-selection parameters of resource j, that candidates to task TP_i*
gf *– flexibility*
Φ *– weighting*
Global F.O. *– global value of resource candidate*

```
Begin
For PTP:
        For each TPi do
        Define Rps_1 (TPi)
        Define Rps_2 (TPi)
                For each Rps_1 (TPi)
Define Sma or DS and continue

For the Drpij (TPi) execute:
Evaluate F.O. Rps_1 (TPi)
If Pps(rpij) ≠ Sma dos Rps_1 (TPi) or If Pps(rpij) ≠ DS_Rps_1
Then Sma = Sma + gf (redefine Sma with gf)
                Evaluate F.O. Rps_1 (TPi)1
        Pre-Select rpij and continue

% ---------- End Evaluation level 1 ---------%

For the Drpij (TPi) fulfilling F.O. Rps_1 (TPi) execute:
Evaluate F.O. Rps_2 (TPi)
Φ Rps_2 for each system
Evaluate F.O. Rps_2 (TPi) for each system and continue
F.S.Q._rpij = ∑ (ΦSQi * PQi_rpij)
F.S.F._rpij = ∑ (ΦSFi * PFi_rpij)
F.S.S._rpij = ∑ (ΦSSi * PSi_rpij)
Pre-Select rpij and continue
```

% ------ End Evaluation level 2 per system---------%

Determine *Global F.O.* of rp_{ji} to the TP_i and continue

$\sum ((\Phi SQ_i * PQ_{i}\_rp_{ij}) + (\Phi SF_i * PF_{i}\_rp_{ij}) + (\Phi SS_i * PS_{i}\_rp_{ij}))$

% ------- End Evaluation level 2 -------------%

Pre-Select rp_{ij} for the TP_i
End

CONCLUSIONS

In the literature review we found a full range of methods and techniques used in the selection of resources. It is noteworthy that we found no explicit and formal models that approached the pre-selection process in a detailed and systematic way. We identified the gaps and limitations in this area and assessed the relevance of the development of our work. It is also to highlight the fact that there are no literature references to the VA incorporation in this process. We think that in this area there will be space and relevance for a more deep and efficient investigation that leads to a better integration of the VA in the whole process of the resource selection of an A/VE project. It is our objective the integration of the VA application, where we expect that this application provides an important surplus value for an A/VE project.
We created a model of VA integration, represented in IDEF0 language, which covers all the resources pre-selection and propose an algorithm to apply the model. We define three main phases for pre-selection: bid solicitation, reception and analysis/evaluation. We explain the VA steps to incorporate in the resources pre-selection. We develop new systems (quality system, financial system and synergies system) within the pre-selection, based on literature reviews on the subject.
It was demonstrated the validity of our goals because we verified the type of VA applicability in the selection process and resource integration of A/V E, i.e. we incorporated the VA on the configuration process of A/V E. This involved the creation of a model that incorporated the AV in the activities assigned to the pre-selection of resources. This model is likely to be measured on their performance. We defined, in the algorithm, the parameters for characterization and performance of the system.
As a final conclusion it can be said that VA integration on the entire process of A/V E configuration, especially in the pre-selection and consequent final selection of the resources system incorporates a whole range of benefits and gains in all this process.

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