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PARTNERS EVALUATION TO CREATE BUSINESS PARTNERSHIPS IN VIRTUAL ENTERPRISES USING KNOWLEDGE BASES

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Abstract:
Partners evaluation and selection in order to create a business partnership in virtual enterprise ia an activity that will lead first to increase enterprises competitiveness and on the other hand to increase de enterprise adaptability to market demands. In this paper two partner's assessment methods are analyzed (the notes system method and the weighted point evaluation method) in order to create a selection partners tool to achieve a business partnership. Also, this paper illustrates how can be knowledge bases built at the enterprise level for partner's selection and validation. The knowledge-based system for the partners evaluation and selection presented in this paper was realized at the PREMINV Research Centre from University „Politehnica" of Bucharest, in a university – small and medium sized enterprise partnership.

Key Words: Bbusiness Partnership, Knowledge Base, Partners Evaluation, Partners Selection, Virtual Enterprise

1. INTRODUCTION

In the 21st century, successful enterprises continuously implement ICT strategies to improve manufacture, research, products quality, sales, services and costs control. Most large enterprises have a local area network, a virtual private network, an Intranet and Internet, servers and workstations for applications, administration and management working together for the same objective: profits. Under the global economy concept, enterprises are assigning design and production environments around the world in different areas. A serious issue of information exchange emerges as companies use traditional hardware and very distinct software appropriate to their field of expertise [1]. Development of ICT leaves much more freedom to the designers and consultants to accommodate organizations to other influences, both internal and external [2]. A general requirement for an infrastructure support is that the enterprises must be able to inter-operate and exchange information's and knowledge in real time so that they can work as a single integrated unit, although keeping their independence/autonomy.

For the future, e-services and e-business, as were defined, require the enterprise re-thinking and re-modeling, with the system and applications design for an efficient use of new network technologies. At the level of production-dedicated enterprises, e-services are [3]: business-to-business (supply-side), intra-business (internal-side) and business-to-customer (customer-side).

The perspectives of this kind of manufacturing and economy, named shortly new digital economy (e-economy) could be seen in the product perspective (holistic product view,

product life-cycle, value-network integration, etc.), in the business organizational perspective (new organizational form, customers and suppliers integration, collaborating organization etc.), the technology perspective (technological building blocks, infrastructures, interoperability etc.) and the individual perspective (skills, workspaces, collaborating individual, different rolls: worker, consumer, citizen), [3, 4]. In a real meaning, an e-business is any business that uses Internet or Internet technologies to attract, retain and cultivate relationships with customers, streamline supply-chain, manufacturing, and procurement systems and automate corporate processes to deliver the right products and services to customers quickly and cost-effectively, also to capture, explore, analyze, and automate corporate processes information on customers and company operations in order to provide better business decisions.

Building an e-economy for the 21st century is a complex challenge. It requires (Figure 1):

- To transform business models and organizational structures of public and private sectors to generate continuous streams of productivity gains and product innovations, through the applications and use of ICTs;
- To create a climate of trust among consumers and businesses that fasters the growth of the e-economy in each country and creates global markets for electronic goods and services;
- To build an intelligent infrastructure to serve as the backbone of the e-economy – by encouraging investment, strengthening research, enhancing commercialization and ensuring that all persons have access to this infrastructure and know how to use it.

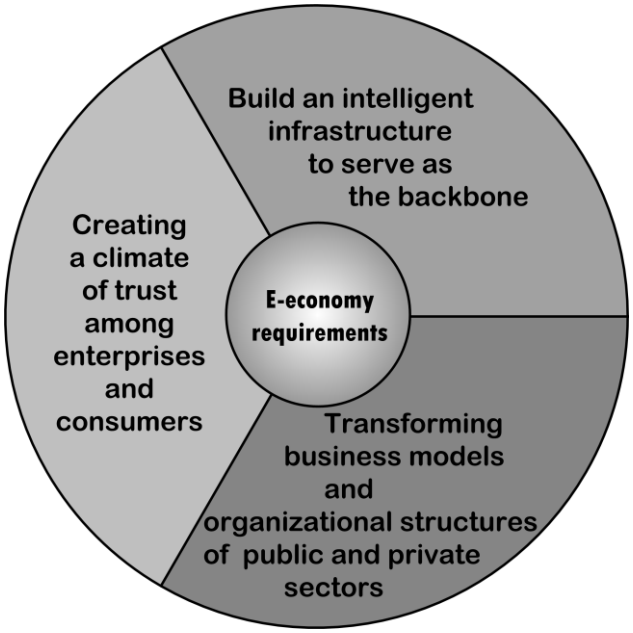

Figure 1: The new digital economy requirements.

Developing and implementing these strategies will require partnership and collaboration among the private, public and academic sectors as well as other agencies and organizations that strive to link these together. It will require the active involvement of consumers and citizens.

New challenges and opportunities are reflected in global markets, global competitiveness and the global spread of engineering knowledge and with communications technologies [5]. Also, today, the critical and strategically questions are:

- What is needed to make the e-economy a priority?
- What overall strategies are needed to catalyze actions that respond successfully to the opportunities and challenges presented by the e-economy?

- Are there other factors in addition to those al-ready identified that are yet to be understood or fully harnessed, and that will enable each enterprise to benefit more fully as we progress towards a mature e-economy?
- What additional measures are needed to address the broader challenges of the e-economy?
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2. VIRTUAL ENTERPRISE AND PARTNERSHIPS

There is not much future in a single company location production process. Companies feel the need to focus on their core competence and join together in virtual industrial groups, dispersed geographically to meet requirements of new products/services required in the market [6]. Also, classic examples of organizational network can be found in several fields of economy such as automotive; agriculture and food industry. Information technology support cooperation between enterprises involved in a VE [7]. Modern enterprise with a production type virtual enterprise is a geographically distributed system with the following functions [8]:

- Receiving orders and quick response to them;
- Setting the structure on the virtual communication network;
- Global and local system planning and authorizing;
- Controlling proactively at VE level;
- Reactive controlling at alliance VE partner level.
- These functions provide:
- Verifying real-time orders, in terms of opportunities for achievement (feasibility) and terms of delivery;
- VE configuration through negotiation and determination/ verification of the ability to deliver products on time limits set by contract;
- Establishment of order necessary to meet the order, and optimization of consumption and routes to maximize profits;
- Acquisition and processing of data for monitoring the status of orders to avoid delays in delivery;
- Control at the local and VE level and the manufacturer level, aiming to maintain the virtual alliance in normal operation area;
- Exchange of information necessary virtual organization, to support all the functions provided;
- Standard interfaces to other applications that VE interconnect [9].
- Enterprises are now facing growing global competition and the continual success in the marketplace depends very much on how efficient and effective the companies are to respond to customer demands. Today, the critical and strategically questions are:
- What is needed to make the e-economy a priority?
- What overall strategies are needed to catalyze actions that respond successfully to the opportunities and challenges presented by the e-economy?
- Are there other factors in addition to those al-ready identified that are yet to be understood or fully harnessed, and that will enable each enterprise to benefit more fully as we progress towards a mature e-economy?
- What additional measures are needed to address the broader challenges of the e-economy?

The formation of a virtual enterprise network could take up momentum to meet this challenge. The virtual enterprise network is a support for virtual teams work. Enterprise virtual teams are groups of individuals collaborating in the execution of a specific project (e.g. a product development, a product modernization) while geographically and often temporally distributed, possibly anywhere within (and beyond) their parent organization [10]. Enterprise virtual teams work across boundaries of time and space by utilizing modern computer-driven technologies. Although virtual teamwork is a current topic in the literature on global

organizations, it has been problematic to define what virtual means across multiple institutional contexts [11]. This era is growing popularity for virtual team structures in organizations [12]. The virtual teams' members use technology to varying degrees in working across location, temporal, and relational boundaries to accomplish an interdependent task [13]. Virtual enterprise is a temporary alliance of partners focus on their core competencies, able to ensure cooperation, the process of innovation in network and to respond rapidly to business requirements. In this case, the essential features of VE are cooperation partners focus on their core competencies and innovation in network, which is characterized by:

- *Innovation capacity* (in the culture of the organization, power of innovation - financial strength, strategy, market knowledge, innovation management, project management, etc.);
- *Processing capacity* (dynamic organization - dynamic structures, work flow management, new information systems, expertise and technological opportunities);
- *Cooperation Ability* (teamwork ability, mentality on removing barriers in attitude/mentality on cooperation, thinking in the network, etc.).

A partnership can be defined as a temporary alliance formed in order to achieve some common goals, created between the various organizations concerned, which may be state organizations, private organizations, NGOs and social partners. In this context, wealth happens when a Virtual Enterprise uses its own knowledge to generate more efficient and effective processes. Future partners must be able to solve a series of further needs of the organization, such as:

- *Contractual compliance;*
- *Communication and collaboration skills;*
- *Products and services at competitive prices;*
- *Availability for technological changes;*
- *Flexibility and quality standards compliance.*

Choosing partners to partnership creation in VE (Figure 2) is very important when seeking to increase the competitiveness of the enterprise in a virtual enterprise system and represent a step in the VE forming process (Figure 3).

The partnership can develop on several levels (Figure 4), and may consist of simple coordination of the partners or may be developed as cooperation and / or collaboration [14].

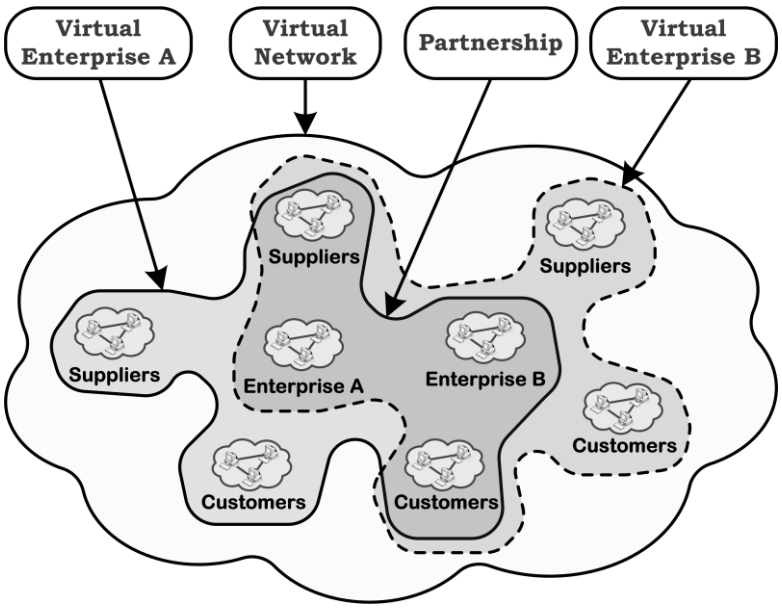

Figure 2: The virtual enterprise partnership.

Partners should look not only at a single point of view. An overview to highlight the qualities and defects of every partner must be obtained. The partner's evaluation methods can be mono-criterion or multi-criterion.

Because of the limited reality modeling possibilities the partner's assessment based on one criterion only is infrequently used. In practice more influence factors should be considered.

Analysis based on one criterion may be insufficient or even false. For example, offers with the most favourable price can generate some problems in processing the resource in question, which involves other costs.

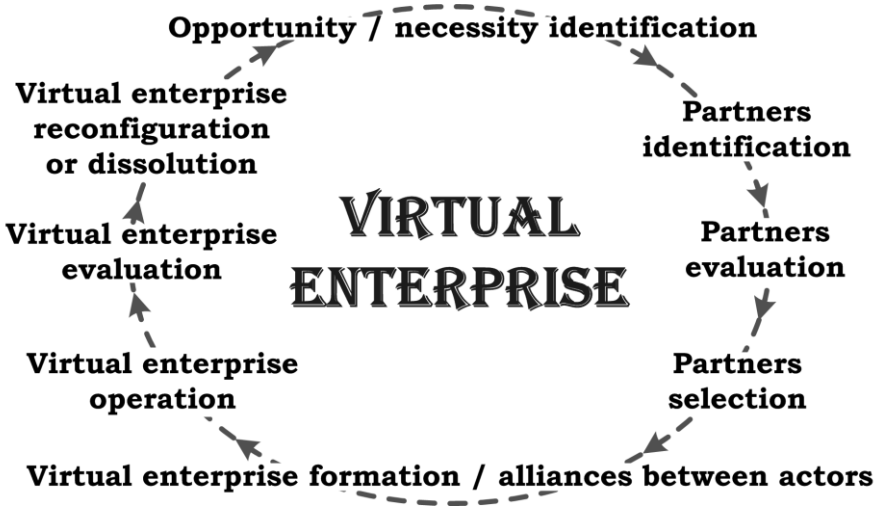

Figure 3: The virtual enterprise framework.

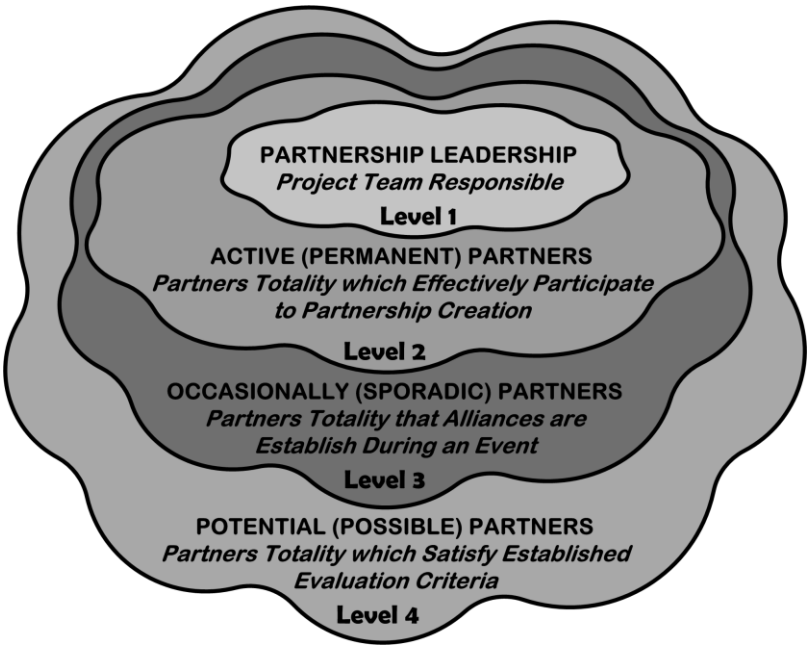

Figure 4: The partnership levels.

In practice there are a number of assessment methods based on more criterions such as: *notes system*, *the weighted point evaluation method*, *process with rates*, *process with indices*, *determining a profile*, *a three-dimensional analysis*, etc.

In this paper we will focus on the notes system method (NSM) and the weighted point evaluation method (WPEM).

3. THE NOTES SYSTEM METHOD

In the NSM the partners' performance (e.g. enforcement activities necessary to achieve project goals, financial discipline, etc.) are valuated with notes. The average note resulting after taking into account the chosen criteria provides a partner's evaluation. An example of a system with three grades is outlined in Table I.

Table I: The partner's evaluation based on three differentiated notes.

Key variable	**Associated factor**	**Partner A**		
		2 pts	**1 pts**	**0 pts**
1. What are the deadlines for the partner?	Presenting the offer is made:	Immediately	At time	After some time
	Sending samples is made:	Immediately	At time	After some time
	The delivery time of products is:	Short	Average	Big
	Technical changes are made:	Immediately	After a time	During much
	Contractual deadlines are met:	Strictly	Small delays sometimes occur	Often delays occur
Score		**4 + 3 = 7 pts**		
Partial Assessment - Qualifying		**GOOD / AVERAGE / UNSATISFACTORY**		
2. How good it is working?	Behavior in discussions, negotiations is:	Good	Acceptable	Bad
	Respect given word:	Strictly	Generally yes	No
	Management team participation in solving problems is:	Permanent	Sometimes	Rarely
Score		**2 + 2 = 4 pts**		
Partial Assessment - Qualifying		**GOOD / AVERAGE / UNSATISFACTORY**		
3. Price level of products ?	Products price is:	Small	Average	Big
	Price policy is:	Very good	Good	Bad
Score		**2 + 1 = 3 pts**		
Partial Assessment - Qualifying		**GOOD / AVERAGE / UNSATISFACTORY**		
4. How flexible is the partner?	Adapting to beneficiary requirements:	No problems	With minor problems	With problems
	Partner's reaction to beneficiary requests is:	Quick	Normal	Delayed
	Technological changes depending on the orders occur:	No problems	With minor problems	With problems
	…	…	…	…
	…	…	…	…
…	…	…	…	…
Total Score		**7 + 4 + 3 + … = …**		
General Assessment - Qualifying		**GOOD / AVERAGE / UNSATISFACTORY**		

The simplest NSM is the system with three levels at which evaluation criteria is based on attributes (e.g. *immediately*, *at time*, *after some time*, *good*, *acceptable*, *bad*, *small*, *average*, *big*, *permanent*, *sometimes*, etc.). Verbal descriptions could be replaced by points (e.g. 2 for *good*, 1 for *acceptable*, 0 for *bad*). The disadvantage of this method is that it allows few possibilities for partners performance differentiation.

A notes system based on differentiated assessment can be used, where notes range from 0 to 2 or from 0 to 10. The main advantage of this sistem is that it is very easy to use.

Its critical points refers to assessing the parameters importance and the high degree of subjectivity. The NSM is used for quality criteria evaluation, where:

- An accurate measurement of the objective fulfillment degree is not possible;
- Assessor can see systematically various dimensions of partner characteristics.

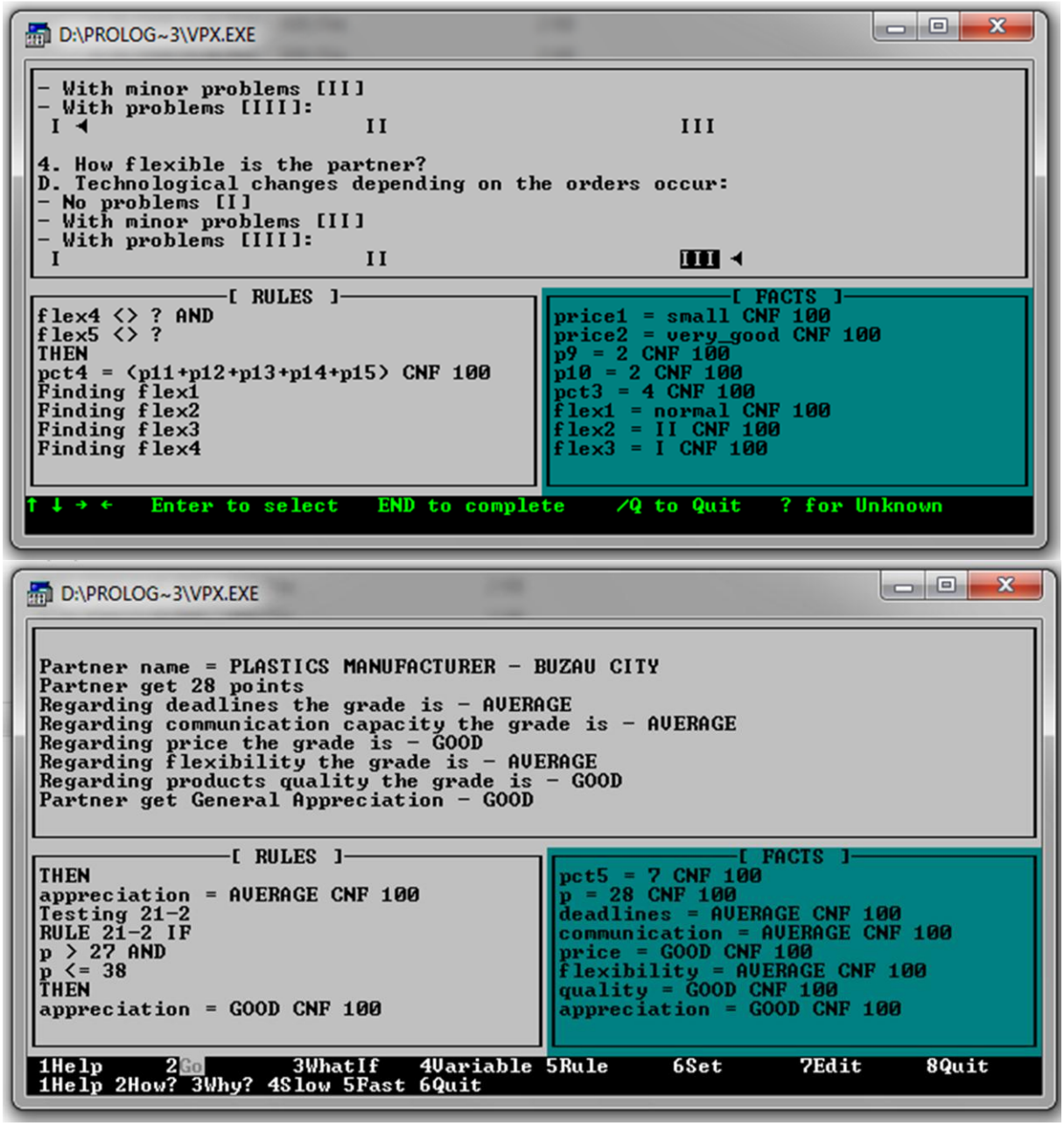

Figure 5: The *NSM.KBS* interrogation and view results.

A knowledge-based system for partners evaluation and selection, using NSM, was developed by us (see Figure 5) based on the rules defined in Table I and implemented in VP-Expert and Prolog (we used the expert system generator VP-Expert version 2.1, by Brian Sawyer, Educational Version distributed by Paperback Software International).

The knowledge base *NSM.KBS* includes a set of rules dedicated partners evaluation criteria.

A possible partner is making more assessment - in terms of deadlines, communication skills, price, flexibility and product quality.

For each evaluation criterion the partner will get a score. Depending on its value, valued partner will receive a qualifying (a partial assessment).

Finally, depending on the total score obtained, the partner will receive the final qualifying (general assessment) which can be *Good*, *Average* or *Unsatisfactory* (see in Figure 5 a partner evaluation - we eliminate the manufacturer name from the complete company name for advertising reason).

4. THE WEIGHTED POINT EVALUATION METHOD

The WPEM is the most used method of evaluating partners and corresponding reasoning cost-utility analysis. Assessment involves going through the following steps:

- Establishing a criteria for evaluating partners;
- Establishing a degree of importance of each criterion and grant for each criterion;
- An assessment notes the benefits (e.g. note from 0 to 1);
- Weighting the degree of criterion importance with the assessment note for partner benefits and assessment of the partner, through the special valuation information;
- Comparing results of the partner's evaluation.

Point models are based on a maximum score assigned to the criterion chosen - see an example in Table II.

Table II: The partner's evaluation using WPEM [14].

Key variable	**Weight**	**Associated factor**		**Weight**	**Partner A**	
					Points	**Weighted value**
1. What are the deadlines for the partner?	2	Presenting the offer is made:	Immediately	0.1	1	0.1
			At time		0.5	…
			After some time		0	…
		Sending samples is made:	Immediately	0.1	1	…
			At time		0.5	0.05
			After some time		0	…
		The delivery time of products is:	Short	0.2	1	0.2
			Average		0.5	...
			Big		0	...
		Technical changes are made:	Immediately	0.6	1	...
			After a time		0.5	0.3
			During much		0	...
		Contractual deadlines are met:	Strictly	1	1	...
			Small delays sometimes occur		0.5	0.5
			Often delays occur		0	...
Weighted Value 1				**2**	**1.15**	
2. How good it is working?	1	Behavior in discussions, negotiations is:	Good	0.4	1	0.4
			Acceptable		0.5	…
			Bad		0	…
		Respect given word:	Strictly	0.4	1	…
			Generally yes		0.5	0.2
			No		0	…
		Management team participation in solving problems is:	Permanent	0.2	1	…
			Sometimes		0.5	0.1
			Rarely		0	…
Weighted Value 2				**1**	**0.7**	
.. ..	…	... ...	... ...	...	...	...
Total Score				**10**	**1.15 + 0.7 + … = …**	
Qualifying:			**GOOD / AVERAGE / UNSATISFACTORY**			

The advantage compared to other systems is that to the individual criteria may be assigned a different matter. Criterion with the highest importance received the highest weighting factor. Assessment of performance objectives is done in two stages, by awarding points.

The maximum value can be freely determined, but it must be the same for all criteria. In phase II note with weight is multiplied and the highest value obtained corresponds to the best partner.

We analyzed this partner's evaluation method and built the *WPEM.KBS* knowledge base (Figure 6). Weighting factors for each factor associated with a variable key is inserted from the keyboard.

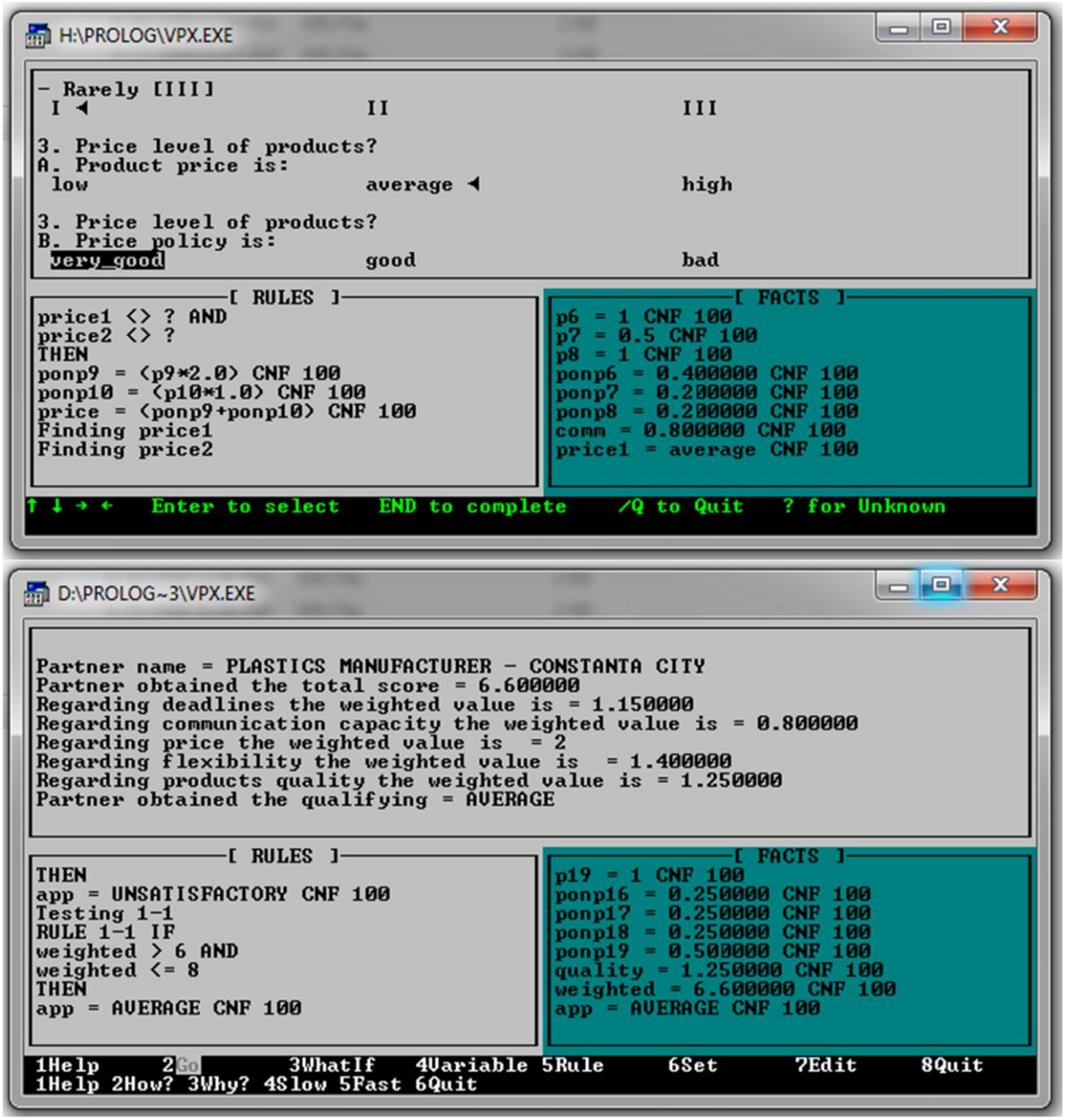

Figure 6: The *WPEM.KBS* interrogation and view results.

Finally, depending on the score, partner receives final assessment. A partner can be classified as *Good*, *Average* or *Unsatisfactory*, depending on the total score obtained at the end of the query (Figure 6).

In case you have several partners who obtain the qualification *Good,* choice can be based on the number of *Good* grades obtained in the assessment criteria. In this work are used production rules forming the knowledge representation model. The application of the rules direction is back chaining return [15].

Before making the knowledge base, we establish the code variables: *deadline*, *communication*, *price*, *quality*, etc. In the *WPEM.KBS* knowledge base (KB) there are *if-then* structure rules (excluding the rules for inference engine operations), such as:

```
RULE 0-1
IF   coll1<>?        AND    coll2<>?        AND    coll3<>?
THEN   FIND p6     FIND p7          FIND p8
     ponp6=(p6*0.4)
     ponp7=(p7*0.4)
     ponp8=(p8*0.2)
     comm=(ponp6+ponp7+ponp8);
RULE 0-2
IF   price1<>?   AND    price2<>?
THEN   FIND    p9  FIND    p10
     ponp9=(p9*2.0)
     ponp10=(p10*1.0)
     price=(ponp9+ponp10);
... … … … … … … … … … … …
RULE 0-5
IF   deadlines<>?    AND    comm<>?   AND
     price<>?        AND    flex<>?     AND
     quality<>?
THEN   weighted=(deadlines+comm+price+flex+quality);
... … … … … … … … … … … …
RULE 1-1
IF   weighted>6  AND
     weighted<=8
THEN   app=AVERAGE;
... … … … … … … … … … … …
ASK coll1 : "2. How good is the collaboration?
A. Respect given word:";
CHOICES coll1 : strictly, generally_yes, no;

RULE 7-0
IF   coll1=strictly
THEN   p6=1;
RULE 7-1
IF   coll1=generally_yes
THEN   p6=0.5;
RULE 7-2
IF   coll1=no
THEN   p6=0;

ASK coll2 : "2. How good is the collaboration?
B. Behaviour in discussions, negotiations, is:";
CHOICES coll2 : good, acceptable, bad;

RULE 8-0
IF   coll2=good
THEN   p7=1;
RULE 8-1
IF   coll2=acceptable
THEN   p7=0.5;
RULE 8-2
IF   coll2=bad
THEN   p7=0;

ASK coll3 : "2. How good is the collaboration?
C. Leadership participation in the problems solving is:
- Always [I]
```

- Sometimes [II]
- Rarely [III]";
CHOICES coll3 : I, II, III;

RULE 9-0
IF coll3=I
THEN p8=1;
RULE 9-1
IF coll3=II
THEN p8=0.5;
RULE 9-2
IF coll3=III
THEN p8=0;

ASK price1 : "3. Price level of products?
A. Product price is:";
CHOICES price1 : low, average, high;

RULE 10-0
IF price1=low
THEN p9=1;
RULE 10-1
IF price1=average
THEN p9=0.5;
RULE 10-2
IF price1=high
THEN p9=0;

ASK price2 : "3. Price level of products?
B. Price policy is:";
CHOICES price2 : very_good, good, bad;

RULE 11-0
IF price2=very_good
THEN p10=1;
RULE 11-1
IF price2=good
THEN p10=0.5;
RULE 11-2
IF price2=bad
THEN p10=0;
... … … … … … … … … … … …

5. CONCLUSIONS

In this paper two partner's assessment methods were analyzed (the notes system method and the weighted point evaluation method) aiming to create a business partnership selecting tool for a virtual enterprise. According with the two evaluation methods two knowledge bases as part of a knowledge-based system has been developed. Partners selected to be evaluated are two companies from Romania. It was found that each of the two studied evaluation methods have both advantages and disadvantages. The decision to choose a more efficient method of assessment belongs to each organization in part and depends on the nature of its activities, the purpose and the means to achieve objective.

Developing new products is difficult but vital for organization to succeed [16]. The ability to create, transfer, assemble, integrate, protect and exploit knowledge assets is a main factor for existence and successful work of the industrial companies [17].

A partnership encourages developing new and effective ways of achieving goals - so the partners plan evolves as a partnership, becomes more understandable, and their programs are integrated into larger entities. Efficient partnership involves joint decision making and functional interaction focused on process development. However, in order to conclude that a partnership is good we consider necessary for the partners to be evaluated by several

methods in order to make a clear distinction between them and to determine the partnership potential. Also it is indicated that all the results obtained from the assessments will be kept for the future, not necessarily for a possible cooperation but to track trends over time.

The knowledge-based system for partners' evaluation and selection presented in this paper was realized at the UPB-PREMINV Research Centre. The validation of this solution by a case study was realized in the PROGPROC research project (CNMP 11014/2007, 2007-2010) meant to determine a new organizational architecture able to integrate the virtual enterprise behavior and to outsource shared resources from UPB-PREMINV to industrial partners. We intend that our future work in this area includes building other knowledge bases to support eventually all SMEs departments' activities.

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