On the classification and management of virtual organization breeding environments

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Abstract: Wide variety of domains and application areas have realized and shown the need for collaboration among heterogeneous, autonomous and geographically disperse organizations. Virtual organizations, as adopted by both research and practice, represent a main form of network for goal-oriented and opportunity driven collaborations. Effective creation of dynamic virtual organizations requires a proper breeding environment to increase organizations’ preparedness for their effective collaboration. After introducing the basic concepts related to collaborative networked organizations, the concept of breeding environment for virtual organizations (VBE) is presented and the key elements of the environment are identified so that a semi-typology can be established. Furthermore, the requirements for a VBE support management system are addressed, identifying its initial information/knowledge modeling needs and required functionality. Finally some important open challenges are addressed.

Keywords: collaborative networks, virtual organizations, virtual organization breeding environments, VBE management, VBE challenges, VBE competency management, VBE trust management, information technology management for VBEs

1 Introduction

Advances in computer networks and related technologies have clearly facilitated the collaboration among heterogeneous, autonomous, and geographically disperse entities. Areas that more and more require organizations’ collaboration range from: product/service-based environments (e.g. for network centric manufacturing and/or tourism), to scientific developments (e.g. for drug discovery in pharmaceutical domains), and even include national/international crisis management areas, e.g. for rescue missions and recovery initiatives related to earthquake/floods, etc. A growing number of collaboration networks, including the “classical” virtual enterprises (Garita et al., 2001), (Afsarmanesh, Camarinha-Matos, 2000) virtual organizations (Camarinha-Matos et al. 2005), and professional virtual communities (Afsarmanesh et al., 2003), (Camarinha-Matos, Afsarmanesh, 2004), as well as some new organizational forms (Afsarmanesh et al., 2001) are emerging. Simultaneously, as a result of intense R&D in this area, new operating and governance rules as well as supporting mechanisms and tools are under development.

Intuitively, dynamic collaborative networks shall be able to rapidly form and adapt to changing conditions, and to provide good approaches to face the challenges of turbulent markets (Camarinha-Matos et al., 2005). A key question in practice is however how to guarantee the basic requirements to enable such dynamism. Unlike some earlier approaches, today both research and practice have concluded that the most efficient manner for the dynamic formation of any collaborative coalition is through the pre-existence of some forms of cooperative environments that prepare their members with: sharing some common and/or compatible goals, possessing some level of mutual trust, having established common and/or interoperable infrastructures, and having agreed on some common practices and values e.g. for business or otherwise. Achieving these conditions is a pre-requisite for agility during the formation stage of collaborative networks, as well as the ability to integrate organizations into such networks.

Another discussion point is the effect of the lifetime of the network on the characteristics/quality of the collaboration within the networks. Temporary collaboration networks seem to better fit the dynamics of the market and for example the typical short duration of business opportunities, while long-term collaboration
networks better cope with the trust building process among their partners and the investment on common infrastructures and practices. Traditional supply chains and extended enterprises involved in stable mass-production businesses represent examples of long-term collaboration networks. Today, some interesting cases have established a combined form of network; namely combining a long-term club of organizations that are prepared for cooperation, with a number of short-term coalitions, involving different subsets of the organizations in the club that are dynamically assembled in order to respond to emerging business opportunities. These new forms of networks are in fact early manifestations of virtual organization breeding environments for dynamic virtual organizations (Afsarmanesh, Camarinha-Matos, 2005) that have emerged as an evolution of the traditional industry clusters and industrial districts (Camarinha-Matos, Afsarmanesh, 2003), (Bremer et al., 1999), (Mejia, Molina, 2002), (Pfüß, Huber, 2005), (Mueller, 2006), (Heavey et al., 2006), (Witczynski, 2006).

This paper further discusses this existing combined approach in detail, identifying its components and requirements, establishes a semi-typology for VBEs, and proposes its necessary base modeling, functional requirements for a supporting management system, as well as extending it with further facilitating components and services. This research is being developed within the framework of the IST Integrated Project ECOLEAD which aims at creating necessary foundations and mechanisms for establishing an advanced collaborative and network-based industry society in Europe.

2 Base elements and classification approaches

Some earlier approaches, have suggested the possibility of dynamic on-demand creation of Virtual Organizations (VOs) formed out of the open universe of organizations that are accessible through the web. This assumption however overlooks a large number of important obstacles in this process among which the following can be mentioned:

- How to know about the mere existence of potential partners in the open universe and deal with incompatible sources of information?
- How to acquire basic profile information about organizations, when there is no common template or standard format?
- How to dynamically establish an inter-operable collaboration infrastructure, given the heterogeneity of organizations at multi-levels, and the diversity of their interaction systems?
- How to build trust among organizations, which is the base for any collaboration?
- How to develop and agree on the common principles of sharing and working together?
- How to dynamically define the agreements on the roles and responsibilities of each partner, to reflect sharing of tasks, the rights on the produced results, etc.?

As a basic rule, in order to support rapid formation of collaborative networks, e.g. a business consortium, it is necessary that potential partners are ready and prepared to participate in such collaboration. This readiness minimally includes common interoperable infrastructure, common operating rules, and common cooperation agreement, among others. To succeed with any collaboration, it also requires a base level of trust among the organizations.

Therefore, the concept of long term strategic alliances, which we have named Virtual organization Breeding Environments (VBEs) (Afsarmanesh, Camarinha-Matos, 2005) (Camarinha-Matos, Afsarmanesh, 2003) has emerged to respond to this need. VBEs provide the necessary context, conditions and supporting mechanisms for fluid cost/time effective brokerage of dynamic virtual organizations. We define the Virtual organization Breeding Environment (VBE) as follows:

an association of organizations and related supporting institutions, adhering to a base long term cooperation agreement, and adoption of common operating principles and infrastructures, with the main goal of increasing both their chances and their preparedness towards collaboration in potential Virtual Organizations.

A main general aim of the VBE is focused on the transition from traditional point-to-point connections among organizations to a network structure, in order to increase the chances of involving its member
organizations in opportunities for collaboration. Traditionally, breeding environments are established within one geographic region (Smith 2003), in the tradition of industry districts, with the advantage of having common business culture and a sense of community, as well as focusing on one specialty sector of the region. But, this restriction can today in most cases be overcome by the VBEs.

VBEs primarily constitute two categories of regional and global. While regional VBEs mainly involve organizations (of different sizes) from one geographical region, a global VBE incorporates the involvement of geographically distributed organizations. In this paper, we address global VBEs. Furthermore, both regional and global VBEs can be either single-sector, i.e. specializing in a single focus area, or multi-sector, i.e. covering a number of focus areas.

Efficient creation of VOs is the main purpose for the existence of the VBEs. Therefore, the motivation for creation of a VBE is primarily initiated by the opportunities existing in certain area/sector, for which the configuration and establishment of VOs are desirable and profitable to the market/society. There are two kinds of opportunities pursued by a VBE, namely first those opportunities that are already announced in the market/society, and second those opportunities that can be initiated/created by the VBE with the aim of innovation. The main actors in both identification and/or creation of opportunities are either the VBE members who can for example act as a broker for the VOs, or the VBE administration itself, that can for example promote the initiation of a VO focused on an innovation, which requires a careful prior investigation of the needs and potentials in the market/society.

2.1 A systematic approach to study and model VBEs

A systematic study of the wide variety of existing and emerging VBEs, can facilitate both the modeling of their structural, componential, functional, and behavioral aspects, as well as creating a base for their reference modeling. We have conducted one such study, through both the literature and by in depth investigations of six running European clusters of SMEs that operate as VBEs.

In order to preserve the anonymity of the six SME networks under study, and in this paper they are referred to as VBE-A, -B, -C, -D, -E, and -F. The study of these clusters has provided a rich ground for our modeling aims. Representing real examples from the market and society, these six SME networks are quite varied in their VBE characteristics. A brief description of these networks follows.

1. **VBE-A** (Italy). This VBE is made up of 200 member companies that mostly constitute the information and communication sector in their respective district. This VBE is fully financially supported by the government.
2. **VBE-B** (Finland). This VBE consists of 12 member companies mostly in paper and automation industry ranging in size from big to small, and coming from close by regions. This VBE does not receive any financial support from the government. It is privately supported, by collecting a token fee of 100 Euros, charged to each member company.
3. **VBE-C** (Germany). This VBE has 28 member companies from the aircraft industry, and it has been growing both in size and in making profit continuously. It has a single customer that is a major aeronautics company in Europe, which constantly gives them many opportunities for which they can configure VOs.
4. **VBE-D** (Finland). This VBE is a one year old regional engineering and automation network consisting of 16 engineering companies as its members. Financially, it depends on small membership fees.
5. **VBE-E** (Italy). The region around this VBE in Italy represents a very old collection of more than 10,000 manufacturing companies, from a wide variety of areas that includes from sport clothing to furniture, etc. but all focused on innovation and new products. The government supports establishment of self organizing clusters, a kind of VBE, in the area.
6. **VBE-F** (Spain). This VBE has a strong consulting company associated with it. It has 23 member companies and 20 other associated supporting SMEs, mostly in the aeronautics industry. The consulting company is working as a supporting institution for the VBE, and mostly providing legal assistance. This VBE is supported financially both by the government and also through the token membership fees from its members.
that use some tools provided in the VBE for their VO internal operations.

The main aims of our study, both of the VBEs reported in the literature and the six clusters mentioned above, were threefold. The first aim was characterization of different VBEs, in order to reach a common set of characteristics for the VBE paradigm. The second aim was to use the common characteristics to classify different VBEs, and thus to reach the main categorization of the VBEs. The more challenging third aim was to investigate if based on the main VBE classification results we can identify and generate a typology for all existing and emerging VBEs, such that the attributes defining every type in the typology are true for all of its members.

The main results we reached in stepwise approach are briefly represented in the following sub-section.

2.1.1. Common set of characteristics for VBEs
Based on our previous network analysis experience, the following set of questions were considered as the base criteria for investigating these networks:

- How many sectors are involved in the VBE?
- How and which sources support the VBE financially?
- How does the VBE find the VO opportunities?
- What is the frequency of VO configuration / VBE members’ involvement in VO’s?
- How are the VBE management, administration, and governance organized?
- What are the functions performed by the VBE administration?
- How is the VBE configured in terms of roles of its actors, permitted competition, location of VBE members, etc.?
- What kind of organizations can be included or are invited to join the VBE and how large is the VBE?
- Are VO’s always configured only from the VBE members, or also consisting of some organizations from outside? And if so, under what conditions SMEs from outside can be involved?
- What is the relationship between the VO customers and the VBE?

In this step of our study and as a response to the above questions, we encountered a large number of distinguishing characteristics for VBEs that can in one way or another be further used as the purpose/criteria for VBE classification. The main identified “distinguishing characteristics”, which constitutes a subset of the identified common set of VBE characteristics, include: Multiplicity of sectors/domains, Variety of collaboration drivers, Orientation (value system), Level of dynamism, Financial support mechanism, Localization, Size, Nature of output results, Mission categories, and Application of ICT tools.

2.1.2. Main classes/categories of the VBEs
Classification is a generic abstraction mechanism used in modeling systems. Depending on the purpose of the classification and the attributes used, many different results may be produced by applying such mechanism. As such, many possible classifications can be developed to model different entities and concepts in a limited environment, depending on the considered purpose.

At this step, we used the set of VBE common characteristics as the means to reach some classification of different VBEs. Therefore, for each characteristic, we identified a number of potential classes. For example, two classes were identified for the Multiplicity of sectors/domains that included the single-sector and the multi-sector. For some other characteristics, a number of classes could be identified, e.g. for the size characteristic for example, as suggested by some of the network’s representatives, we could identify Small (under 20), Medium (under 100), Large (under 1000), Very-Large (above 1000) number of members, etc. The following list shows some of the identified classes in our study for each of main VBE characteristics addressed above.

- Multiplicity of sectors/domains: Single sector, Multi-sector, ...
- Variety of collaboration drivers: Customer induced, Capacity achievement, ...
- Orientation (value system): Business orientation, social welfare orientation, ...
- Level of dynamism: Dynamic pace (evolving), Static pace, ...
- Financial support mechanism: Publicly supported, Privately supported, ...
- Localization: Regional, Non-regional, ...
- Size: Small (under 20), Medium (under 100), Large (under 1000), Very-Large (above 1000) number of members, ...
In order to summarize our findings, Table 1 is developed to represent: (1) the main criteria/characteristics for characterization and comparison of different VBEs, (2) for each characteristic, it provides the two main potential categories for the networks, and (3) a clue to the main impact of each characteristic/criteria on the network.

Table 1 – Summary of the main characterization and categorization of VBEs

2.1.3. A semi-typology for existing and emerging VBEs

Our third and more challenging aim was to investigate if based on the main VBE classification results we can identify a typology for all existing and emerging VBEs, such that the attributes that characterize every type in the typology are true for all of its members. As described / argued below, reaching this aim was quite challenging and we could finally achieve not one, but a number of semi-typologies for VBEs.

Typology is a classification of all elements in the domain, based on the definition of particular types or categories in that domain, where the members of each type or category are identified by postulating their specified attributes. Typically, types/categories in a typology are: (1) mutually exclusive, and (2) collectively exhaustive. For example in the biodiversity area, the taxonomy defined for the “limited”, though large, collection of animals on earth, although it took a few centuries to establish, has followed a straightforward procedure to create the typology classifying them, as well as to identify the few exceptions where the defined types are not mutually exclusive.

Considering the above definition, in our study, it became clear that defining a typology for a new “paradigm” such as the VBE, is a big challenge if at all possible. This is simply due to the fact that first the VBE paradigm is not a limited environment, although it already has a large variety of manifestations. Second, every VBE has distinctly unique “intangible” specificities. And third, there is a wide diversity of purposes and perspectives that can be considered through which the existing and emerging VBEs can be classified.

Therefore, prior to our efforts towards identification of a VBE typology, we became aware of the fact that we will not identify a set of mutually exclusive types to classify the VBEs. Consequently, we chose to aim at the identification of a VBE semi-typology to tackle the challenge of identifying a number of types that can collectively exhaust both the existing and the forthcoming VBEs.

Such a semi-typology defined for VBEs, even though does not provide clear cut categorization of VBEs, as for instance exemplified above for the Bio-diversity area, is still valuable, since it provides an insight into the characterization / understanding, and thus better modeling of the VBEs. Furthermore, if one of our identified semi-typology has an “intuitive” appeal for categorization of VBEs, and gets adopted by the research and practice community in this paradigm, we have reached a common base for understanding and co-working among the researchers in this area.

For this purpose, we have identified three main perspectives as more dominant and intuitive in representing and classifying the VBEs, which are also validated by the networks involved in our study. Below, for every considered perspective, a list of references are also made to the rows in Table 1, which represent its related characteristics and classifications.

I. **Domain categories** (1, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 19, 20, 21)
II. **Main Collaboration Drivers** (1, 2, 3, 4, 5, 7, 9, 10, 11, 13, 14, 15, 16, 17, 20, 21)
III. **Orientation/Value Systems** (1, 2, 3, 5, 7, 11, 12, 13, 14, 15, 16, 17, 20, 21)

As an example for the VBE semi-typology, here we only address the VBE semi-typology based on the **Domain Categories** perspective above. We have listed below the four specific types defined in this semi-typology, as indicated by T1 to T4 below (characterized in Table 2), and briefly described below. More detailed description
of this and the other two semi-typologies defined for VBEs, as a result of our systematic study, can be found in (Afsarmanesh, Camarinha-Matos, 2007).

Table 2- VBE Domain Categories

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type1</td>
<td>Stable products/services domain (e.g. VBE-C, VBE-B, VBE-D)</td>
</tr>
<tr>
<td>Type2</td>
<td>Stable one-of-a-kind domain</td>
</tr>
<tr>
<td>Type3</td>
<td>Emerging domain (e.g. VBE-F, VBE-A)</td>
</tr>
<tr>
<td>Type4</td>
<td>Innovation driven domain (e.g. VBE-E)</td>
</tr>
</tbody>
</table>

These types are briefly addressed below:

- **Type1- Stable products/services domain VBE type**: This VBE type is primarily characterized by substantiated sectors or domains, business or social oriented, traditionally regional but nowadays more with a mix of regions, and constituting VBEs of different sizes (from large to small), and using some IT related tools (e.g. VBEs to support traditional manufacturing and services industry). Some general principles for this type of VBEs are already established both in research and in practice. In several business oriented domains some body of knowledge as well as practiced regulations are already created and instantiated, that provide a strong base for the current study of this type of VBEs. These VBEs are operation-based, meaning that their daily activities are known and repetitive, and thus do not require new or innovative solutions for each product and service (Bremer et al. 1999), (Mejia, Molina 2002), (Pluss, Huber 2005). Nevertheless, this type of VBE still lacks proper mechanisms and semi-automatic tools for the management of its competency and profile, establishing trust, developing generic ontology, and enhancing the potential of the VBE in responding to the market/society demands.

- **Type2- Stable one-of-a-kind domain VBE type**: This VBE type is typically identified with substantiated sectors and domains focused on longer term VOIs to develop one of a kind products/services - typically with a mix of business & possible social orientation, constituting medium size regional VBEs with a high trust level among the members from multi-sector and complementary organizations, using IT related tools (e.g. VBEs to support traditional construction industry, environmental cleansing of wastes). Similar to the stable products/services domain, also for the one-of-a-kind domain in some areas, e.g. construction industry, there is a rich body of knowledge and formal definitions of some general principles that can be used as the base. Despite the fact that these VBEs are well established, their products are always unique, e.g. a bridge, an airport, etc. Thus, they have a project-based working style where some unique ideas are necessary for every new product. Once developing proper IT tools for trust establishment among VBE member organizations, this type of VBE can benefit from extending its boundaries to include new non-regional members that may increase its level of competency.

- **Type3- Emerging domain VBE type**: This VBE type is primarily characterized by the merge of organizations from several substantiated domains in order to respond to some new market/society demands. The VBE for emerging domain will constitute organizations from different sizes with complementary capabilities, established knowledge, culture, and practice tradition. A number of challenges rise due to the merge of these heterogeneous domains, e.g. the integration/inter-linking of their substantiated and formalized knowledge, developing rules of cooperation and establishing trust and recognition among the involved organizations. Examples of this type of VBEs include the merge between the housing and ambient intelligence domains to address the house of the future, merge between the broadcasting, mobile devices, and the entertainment industry to address the entertainment of the future, or the merge between the public safety and environmental scientists/engineers to address the environmental cleansing of the future.

- **Type4- Innovation driven domain VBE type**: This VBE type is mostly identified with the establishment of its short term VOIs to deliver innovation for the
market or society’s benefit, constituting a number of organizations potentially from different sectors with complementary competencies. The degree of readiness of the organizations in this VBE must be very high and typically, due to the role that these VBEs play in a region and the risks involved in innovation-based VOs, there is usually public support available to these VBEs. The new line of products in clothing, e.g. from Italy, and in computer hardware, e.g. from California, are examples of this type of VBEs.

3 Actors and life cycle

VBE is a regulated environment representing an open, but controlled-border association of a set of members. It aims at improving the preparedness of its member organizations for joining potential future VOs, hence providing a cradle for dynamic and agile establishment of opportunity-driven collaborative networks. As represented in Fig. 1, it is far less costly and much more effective to quickly build a VO in a breeding environment context (branch 1b) than through a generalized partners’ search (branch 2). In other words, VBEs substantially contribute to the increase of the level of preparedness of their members for participation in potential collaborative processes.

Figure 1 - Two approaches to the formation of virtual organizations

It is necessary to have controlled boarders for VBEs, but VBEs do not need to be closed boarder; namely at any time new members can join the VBE association by complying with its general operating principles. Therefore, there may be different levels of membership defined and supported by the VBE administrator as illustrated, each corresponding to different set of rights and responsibilities. In principle, different levels of VBE membership may constitute a range, with loose-membership on one end and tight-membership on the other end of the spectrum. For instance, a loosely associated member of the VBE may need to adhere to nothing more than a minimum level of organization “preparedness” that is necessary for getting involved in a VO, and to making some minimum information available to the VBE administration, e.g. about their activities related to the VO. At the same time, typically a fully active member of the VBE contributes to its promotion, growth, and the enrichment of its bag of assets, and can take an active role from brokerage and planning of VOs in a niche market, to being involved in the expansion of the VBE into new sectors, and initiating VOs towards innovation.

Similarly, for the formation of a VO that is initiated within the VBE, while preference will be given to the VBE members, it might become necessary to find some external organizations, for example when some skills or capacities are not available inside the VBE. Nevertheless, before becoming a partner in such a VO, an external organization shall be invited to join the VBE, at least at the loosest level (e.g. as a loosely associated member), in order to cover its minimum necessary VBE compliance. In some cases, it may be even desirable (either by organizations or by the VBE administration) that the names of the restricted members (e.g. the loosely associated members) of the VBE are not publicized as the VBE members. For instance if the association of an external organization with the VBE is only due to the fact that they are currently involved in one running VO initiated by the VBE, and this membership will not continue after the VO dissolves.

In addition to the enterprises, a VBE might include other kinds of organizations (such as consulting/research institutes, sector-associations, governmental support organizations, etc.) and even free-lancer individual workers if they represent a one-person small organization. Furthermore, VBE can include and serve as the hosting environment for some support-institutions that will provide some specialized related services/expertise to the VBE members, such as the legal services, marketing expertise, etc. for the VOs configured within the VBEs, or the insurance services, training support, etc. (also called “life maintenance” support) for example for the freelancers involved in the VBE.

Members of the VBE are the organizations that are registered at the VBE (traditionally bound to a sector). In summary, organizations in VBE may represent:
- **Business entities of a variety of sizes**, providing products and services to the market that get involved in the VOs to gain quantitative profit.
- **Non-profit institutions** that get involved in the VOs to gain qualitative profit.
- **VO Support institutions**, for example: legal and contractual service providers, companies supporting life maintenance to individuals (e.g. insurance and training companies), ministries, sector associations, chamber of commerce, environmental organizations, etc.

VBE members must comply with the general VBE rules and policies, e.g. adopting the common ICT infrastructure. At the same time, once joined the VBE, member organizations shall benefit from a wide range of facilities/possibilities supported within the VBE environment that are managed by the VBE administration. Below we have listed and exemplified in Table 3 the **10 main advantages** that in principle VBEs can provide to their member organizations. More details can also be found in (Afsarmanesh, Camarinha-Matos, 2005).

Table 3- Advantages of VBEs

A variety of roles can be assumed by a large number of actors in the VBE, where an actor represents either a VBE member organization or an individual representing a VBE member organization (Camarinha-Matos, Afsarmanesh, 2003), (Camarinha-Matos et al., 2005). Due to the autonomous nature of the VBE member organizations, at different times (or even simultaneously) the same organization may assume different roles, e.g. acting as a VO participant, a VO coordinator, etc. where each role requires assigning different rights/responsibilities within the VBE. Supporting these actors with their roles is a high priority in the VBE, and providing needed information and assisting tools for their support is among the VBE environment challenges.

The following main roles are considered for the VBEs:
- **VBE Member** – this is the basic role played by those organizations that are registered at the VBE and are ready to participate in the VBE activities.
- **VBE Administrator** – performed by the organization responsible for the VBE operation and evolution, promotion of cooperation among the VBE members, filling the skill/competency gaps in the VBE by searching and recruiting/inviting new organizations into the VBE, daily management of the VBE general processes, e.g. assignment/reassignment of rights to different actors in the VBE based in their responsibilities, conflict resolution, preparation of a bag of VBE assets, and making common VBE policies, among others.
- **Opportunity Broker** or simply **Broker** – performed by a VBE actor (a VBE member organization or an individual representing a VBE member) that identifies and acquires new collaboration opportunities (of business nature or others), by marketing VBE competencies and assets and negotiating with potential customers. There is also the possibility of this brokerage function being played by an entity outside the VBE as a service to the VBE.
- **VO Planner** or business integrator – performed by a VBE actor that, in face of a new collaboration opportunity (designed by an opportunity broker), identifies the necessary competencies and capacities, selects an appropriate set of partners, and structures the new VO. In many cases the roles of opportunity Broker and VO planer are performed by the same actor.
- **VO Coordinator** – performed by a VBE actor that will coordinate a VO during its life cycle in order to fulfill the goals set for the collaboration opportunity that triggered the VO.

A number of other roles might be also useful to be considered in a VBE, including: the VBE Advisor (or an advisory board), the VBE Service Provider, the VBE Ontology Provider, the VBE Expertise Provider (through a support institution) involved in the VBE, and the last but not least is the role of VBE Guest played by an organization outside the VBE that is interested in finding general promotion information about the VBE, either interested to become a VBE member or interested in contacting the VBE in relation to a business opportunity, etc.

Because of the dynamic nature of both the VBE’s environment and its member organizations, the defined roles for member organizations cannot be static. Every role taken by a VBE member organization represents: a
set of responsibilities, a set of required rights/authorization, and further requires a set of assisting tools for the actor in that role. For instance, a VBE member, acting in the role of a VO broker, has accepted the responsibility to configure and negotiate a VO, for which it requires a set of access/visibility rights to the information regarding competency/past-performance of other member organizations available in the VBE, and requires an assisting tool to search for best fit organizations matching the required skills.

Considering the rights that need to be associated with every role of an actor in the VBE, it is necessary that the VBE members request the VBE administrator for every new role they plan to assume (starting with becoming a VBE member organization) in order to get the proper rights assigned to them.

The life cycle of the VBE represents all the stages that a VBE may go through, from its creation stage, to its operation, and possible dissolution (see Fig. 2 for VBE life cycle stages). In fact, VBE, being a long-term alliance, and considering its valuable bag of assets gradually collected in the VBE, its dissolution is a very unusual situation. Instead, it is much more probable that the VBE goes through another stage, that we call the metamorphosis stage, where it can evolve by changing its form and purpose. The creation stage can be divided into two phases, namely (i) initiation and recruiting, dealing with the strategic planning and initial incubation of the VBE; (ii) foundation, dealing with the constitution and start up. The VBE creation needs to be properly supported considering the increasing variety of VOs, and the fact that usually every VBE serves a specific sector/domain and has specific aims. In the coming time, there will be a large number of different sector/domain-dependent VBEs needed to be established, in order to better support the creation of different forthcoming VOs. The VBE life cycle stages, as seen in Fig. 2, include: the VBE creation – composed of the VBE initiation/recruiting and the VBE foundation, the VBE operation/evolution, the VBE metamorphosis, and the VBE dissolution.

Figure 2 - VBE life cycle stages

4 Information and knowledge modeling and management

In order to design and develop a management system for VBEs it is necessary to first identify and model the main distinct components and subsystems for this collaboration environment. A wide variety of entities and concepts co-exist in a typical VBE environment, as graphically represented in Fig. 3. VBEs include heterogeneous organizations of different sizes and a number of support institutions. The VOs are from time to time created and will interact with the VBE. Furthermore, the VBE management system controls the base running environment enforced by a number of policies and regulations, as well as providing a set of general common tools, facilities and information that constitute the bag of assets for the VBE. Therefore, a large variety of information and knowledge must be properly modeled, organized, and applied to manage the VBE.

Figure 3 – Main categories of information/knowledge in a VBE management system

For most components in the high level categories identified in Fig. 3, generic sector-independent/application-independent specifications can be provided, namely a common ontology can be defined for those categories and included in the VBE management system, to be used for all sectors and applications. However, some of the identified elements in Fig. 3 cannot have a common sector-independent/application-independent definition. These elements include the competencies, resources, products and services of the VBEs, for which their modeling and ontology need to be handled differently, as addressed below.

VBE Products and services specification is widely varied among different sectors. Furthermore, different products or services have different specifications and their respective properties describing each product or service differ widely, and thus their definition/conceptualization (ontology) will be completely different as well.
In the best case, if there are standard meta-data / ontology defined for a specific sector for which the VBE is established, these standard models can be adopted and stored within the VBE as a part of its general assisting information, in its bag of assets. Otherwise, an alternative approach is needed to generate/derive their ontology. For this purpose, some text mining tools can be developed to help with discovery and derivation of ontology-related concepts and keywords from the environment of the VBE and its member organizations. **Semi-automatic advanced mechanisms** need to be developed to mine and derive concepts from the online corpus related to VBE member organizations, generating such ontology to be validated by the human experts in the sector, and thus gradually / incrementally building up such meta-data and ontology for the VBE.

Similarly, competencies and resources offered by the VBE are also not easy to generalize. Consider for instance the differences in competency definitions (meta-data/ontology) that describe the skills / knowledge / potential of the organizations related to examples provided in Table 1. Furthermore, consider and notice the wide variety and heterogeneity among resources owned, such as facilities/machineries related to different domain/sectors. Clearly neither Competencies nor resources of the organizations in the VBE for example for Healthcare (e.g. hospitals, care centers, Doctors’ practice office, insurance companies, ambulance services, etc.) can be defined by the same ontology (specification) that defines these aspects of the organizations in the VBE for production and assembly of bicycles (e.g. the raw material provider, mould maker, paint manufacturer, factory, marketing firm, packaging company, etc.).

Therefore, the common/generic meta-data / ontology for VBEs only addresses the minimum common concepts and entities that need to be defined and modeled, as the starting point for defining the more detailed competency and resources meta-data, etc. Therefore, it constitutes the generic upper ontology of the VBEs plus some minimum profiling information common to all potential VBE member organizations. From that point on, similar to the product/services, some semi-automatic mechanisms need to be applied to the VBE to support the derivation/discovery of its domain/sector meta-data, and incrementally build and expand some common ontology for the competencies (and resources) of the organizations involved in that sector. For instance, semi-automatic mining of on-line texts, either directly through the responded questionnaires and on-line brochures provided by the current VBE members or indirectly through crawling over their web sites, can discover common elements of the competency related to the VBE sectors.

Nevertheless, it is important to notice that for proper modeling of the VBEs information and knowledge, development of a strong and detailed ontology for organizations’ competency (related to the sector represented in the VBE), as well as the proactive management of the competency catalogs are significant. This is primarily due to the need to support the opportunity brokers and to increase the effectiveness of the search/match-making process, necessary for creation of VOIs within the VBE.

5 Base functionality and VBE management

Defining a comprehensive and generic “reference model” for VBEs is a big challenge. Nevertheless, based on the initial empirical knowledge gathered from existing cases, it is realistic to design the first steps for gradual definition of a “**reference framework for VBEs**”, addressing aspects such as the VBE’s structural, componential, functional, and behavioral elements and their bindings Camarinha-Matos, Afsarmanesh, 2006, 2007).

In this direction, in addition to identification of constituting entities and concepts in VBEs, in order to support its management, a list of **required functionality** for the VBE management **system** can be identified in relation to different stages of its life cycle. A subset of this list is addressed below and partially represented in Fig. 4.

**Base functionality supporting the VBE creation** – This phase includes two main steps: (1) **initiation / recruiting**, which requires the establishment and setup of a common base ICT infrastructure, and establish some base ontology / thesaurus of the domain, once the vision and strategic objectives of the VBE are defined; (2) **VBE foundation**, requiring support for parameterization of the used systems, setting up the necessary links,
recruiting potential organizations to join the VBE (founding members), creation of the necessary databases (with initial meta-data / ontology), and populating these information structures.

Figure 4 – Examples of life cycle related functionalities in VBE management system

*Base functionality supporting the VBE operation and evolution* – This phase requires support for: management of competencies and assets, registration of new members (including incremental profiling, characterization of competencies, products, services, etc.), assisting VO creation, incremental generation / evolution of ontologies for the domain / sector, keeping records of past performance and collaboration processes, assessment and assistance tools, collaboration support (e.g. newsgroups, discussion forum, common information repositories, etc.), management and evolution of working and sharing principles and rules, acquisition and management of common knowledge and assets.

*Base functionality supporting the VBE metamorphosis* – This phase will require assistance for the design of the aimed new organizational structure, selection and reorganization of the information and knowledge collected during the VBE operation, and that might be transferred to the new organization, analysis and adjustment to the new context, etc.

*Base functionality supporting the VBE dissolution* - In the case of dissolution there is a need to plan the transfer of its collected knowledge, information, bag of assets, etc. to its members, or another entity based on defined agreements.

Clearly, considering the existing technological approaches, more than one system architecture can be designed for the VBEs, and many different ICT tools and mechanisms can be applied to develop this architecture (Camarinha-Matos, Afsarmanesh, 2004).

6 Other challenges

A number of important challenges can be identified in the design and development of a replicable VBE framework, where competency management, value systems, system of metrics, and trust management are among its main elements.

**Competencies Management:** Competencies in a VBE represent the “capacity” for existing resources plus the available capabilities/skills at its member organizations, to perform some task or activity. VBE competencies are thus basically the combination of **capabilities and capacities**. Furthermore, once claimed by an organization, a proof of its existence shall also be provided within the VBE, e.g. in forms of a certificate, patent, news clip, or even customer’s reflection letter etc., and thus competencies must also accompany their **conspicuities**. Proper management of the set of competencies together with the profile of the organizations is fundamental for a VBE management system (Galeano, Molina, 2005), (Ermilova, Afsarmanesh, 2006), (Odenthal, Peters, 2006). The VBE Profile/Competency Management System (PCMS) shall include a catalog of competencies and a set of functionalities to manage it. In VBE, potential users of the PCMS include the VBE Administrator, Broker, VO planner, VO Coordinator, and VBE Adviser. Table 4 summarizes some of the important issues needed to be considered in the CMS.

Table 4. Issues in Competencies Management

**Value Systems.** It is commonly accepted that the behavior of an individual, society, or ecosystem is determined by the underlying value system. It is intuitively understood that the values considered in a business-oriented VBE are different from those in a non-profit context (e.g. disaster rescue and incidence management network). Taking the simplified view that the goal of a VBE is to maximize some “attribute” of its value system, within a
business context the dominant value is the profit (in economic sense), while in other cases the objectives are altruistic and compensated by the amount of prestige or social recognition, etc.

A value system is in essence the ordering and prioritization of a set of values that an actor or a society of actors holds. However, the values that a group or an actor holds may fall into several different categories since the concept of value is multifaceted. In order to define a value system for a VBE, we need to first define the characteristics of values that could be represented in a value system. A number of characteristics can be considered for the values of a value system:

- **Subjective** – For an identical context, distinct members may apply different values.
- **Personal vs. social** – The personal values can be applied only to one member (e.g. assets, capacity, and price) while social values can be applied to a set of members at VBE or VO level (e.g. ethical code, cooperation agreements, contracts).
- **Normative** – The purpose of normative values is to define a set of rules ("rights/duties") that contribute to assure the stability and the cohesion of the group since they transmit norms in a persuasive way and present an unquestionable form (e.g. trust, ethical code, and law).
- **Exchange** - The purpose of exchange values is to “measure” the objects exchanged among partners in a certain context and moment.
- **Dynamic** - The values can change along the time. They can fade out, increase their worth or can appear for the first time.
- **Measurable** - The values can be measured using a quantitative or a qualitative scale.

Definition of a value system in a VBE context is based on the notion that each product/service requires a set of value creating activities to be performed by a number of actors, forming a “value creating system” through a VO. As a result, value system needs to be defined at the VBE level, to provide:

- A regulation mechanism – for instance, to assure social cohesion, to understand members’ behavior and to build performance indicators.
- A transactions mechanism between partners – such as, to assure an equality utility between objects exchanged.

For managerial purposes it is important to identify which values (within list of values) shall be part of the value system for each specific VBE (or application domain) (Romero et al. 2007). Another related research challenge is the elaboration of some significant performance indicators - for VBE members, VO, and the VBE as a whole – to be computed through some combination of values / variables of the adopted value system. Also, a related issue is the elaboration of procedures for distribution of profits resulted from some activities in the VBE (and VO) (Camarinha-Matos, Abreu, 2004).

**System of incentives:** The definition of a system of incentives is important for attracting and maintaining partners and members (Galeano et al., 2005). In general, for business-related contexts, the key incentives to participate in a VBE are **business benefits** and **knowledge**. Incentives for members are mainly associated with costs, and some examples could be: (i) Guaranteed participation in a given number of VO during a given period of time (although difficult to materialize in practice), (ii) A set of basic tools provided in the VBE bag of assets, (iii) On-demand VBE Product and Services, (iv) Tutorials, Courses and Conferences to enhance productivity (and core competencies) in companies, (v) An initial evaluation of the member and a commitment for constructive suggestions/advice to better its status in a given period of time.

The development of a set of performance indicators, as mentioned above, can complement these incentives by providing a more objective measure of the benefits of being involved in a VBE. As an incentive for member organizations to become more active in the VBE, a set of rules can be defined to collect points (e.g. a broker collects X points when...

Incentives for government involvement are directly related to the social and economic impact of the VBE. Examples of this type of incentives are the increase in employment rates, increase in gross product, better infrastructures, and SMEs' development. For universities, the key incentives for participation in a VBE are the openness of VBE projects looking for student practices and an early introduction to industry practices. A better
link between industry and academia can also be offered in order to improve research results. For R&D organizations, the key incentive is the exploitation of their technological advances. This link between research and market is needed in order to sustain the research and development activities. Brokers are closely involved in materialization of this incentive.

**Trust management.** Trust is a critical antecedent for more efficient and effective communication, collaboration and knowledge creation. In fact innovation cannot be managed hierarchically because it depends on knowledge being offered voluntarily rather than on command. Therefore knowledge creation is social in nature; social exchange that embeds trust among the involved partners is a core process in knowledge creation.

Building trust is not an easy task, it requires mechanisms supported by the VBE, and usually takes time. Trust can be generated as an outcome of organization’s past/present performance information recorded in the VBE. Therefore, trust is an important component of the desired preparedness of organizations in VBEs to participate in VOs (Blomqvist, 2002), (Msanjila, Afsarmanesh, 2006a), (Seppanen, Blomqvist, 2006). Traditionally, in business sectors, trust has played a major role in creation of competitive advantage, by reducing the governance costs (management costs), costs for internalization (acquisitions) and transaction costs between organizations, and has impacted positively the knowledge creation. Trust enables open communication, information sharing, and conflict management in a clear way, and also helps to speed up the contract process (Afsarmanesh, Camarinha-Matos, 2000). A set of well-established policies and criteria to follow in collaborative processes can help in creating / increasing trust among partners (Msanjila, Afsarmanesh, 2006b).

Several other challenges also need to be also addressed including VBE marketing, ethical issues, management of VBE assets, contracts/collaboration agreements (Rocha, Oliveira, 1999), (Jarimo et al., 2006), business models and governance rules (Romero et al., 2006), etc.

**7 Conclusions**

 Organizations must continuously organize their people and processes for competing effectively in today’s rapidly changing business environment, to enhance responsiveness and flexibility, and to quickly react to business opportunities. Advances in ICT and cutting edge web technologies have enabled new possibilities for organization structures. Boundaries of location, time and individualization have become less confining, allowing dramatic changes in the current work environments in form of Virtual Organizations.

The Virtual organization breeding environment (VBE) is an emerging challenging area of research. Most elements comprising VBEs are not yet properly defined and developed, and there are no reference models or reference architectures addressing the environment characteristics as well as the complexity of its interaction with the market/society in which it is involved. The multidisciplinary research needed for VBEs further adds to its complexity. Consequently, even discovery and identification of VBEs’ requirements and proper definition of this problem area itself becomes challenging. There is a need to better categorize and address the typology of VBEs. This paper contributes to the above subjects.

Furthermore, to handle its wide variety of requirements, innovation is required in several areas. Among others, endogenous to the VBEs, there are a number of key characteristics that need careful attention, and some of these are addressed in this paper. First, VBE entails the development of relationships with a broad range of potential partners, each having particular competency, resources, products, services, etc. that complement each other. Second, VBEs shall be regulated by a set of governing rules and principles for participation, and enforced by the VBE management system. Third, the life cycle stages of VBEs determine its required functionality and services. And finally, there must be trust relationship established between the VBE actors separated in space, to support effective VO creation and operation.

In the above directions, this paper contributes to the definition and establishment of a framework for VBEs that can be replicable to different application domains.
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References


“Open universe” of organizations

Getting ready to collaborate
• Cooperation agreement
• Common infrastructure
• Common principles
• Base trust

1.a VO Breeding Environment

Open VO creation
• Wide partners’ search & selection
• Establish common infrastructures
• Common principles
• VO planning
• VO partner selection
• Collaboration agreement
• Contract negotiation
• VO setup
• Base trust

1.b VO Creation in VBE

Collaboration Opportunity

Ready to collaborate

Goal-oriented

Figure 1- Two approaches to the formation of virtual organizations
VBE Initiation & Recruiting – planning and incubation
VBE Foundation – constitution and start up
VBE Operation – the “normal” phase of the VBE existence
VBE Evolution – small changes (in membership and daily operating principles)
VBE Metamorphosis – major changes in objectives, principles, membership
and/or mergers, leading to a new cooperation form and purpose
VBE Dissolution – Ceases to exist (to preserve its valuable gained assets and
knowledge, usually this stage is replaced by the metamorphosis stage)

Figure 2- VBE life cycle stages

1. Member Organizations and
   Member Directories
   - Registration records
   - Member administration

2. VBE Management
   - Profiles
   - Competencies/catalogs
   - Trust assessment
   - Performance analysis

3. VBE bag of assets
   - General policies
   - Templates
   - Shared info/software/tools
   - Lessons learned

4. Created VOs
   - Configuration
   - History

5. Support Institutions
   - Announcements
   - Qualifications

Figure 3- Main categories of information/knowledge in a VBE management system
Figure 4- Examples of life cycle related functionalities in VBE management system

Table 1 - Summary of the main characterization and categorization of VBEs

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Potential network categories</th>
<th>Criteria impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Finance</td>
<td>Public support</td>
<td>Own support (members fee or % of turnover)</td>
</tr>
<tr>
<td>2 Orientation / Value system</td>
<td>Profit</td>
<td>Non-profit</td>
</tr>
<tr>
<td>3 Localisation</td>
<td>Regional</td>
<td>Non-regional</td>
</tr>
<tr>
<td>4 Customer</td>
<td>One or few</td>
<td>Many</td>
</tr>
<tr>
<td>5 Product / service</td>
<td>One or few</td>
<td>Large diversity of products / services</td>
</tr>
<tr>
<td>6 Sector / domain</td>
<td>Single sector</td>
<td>Multi-sector</td>
</tr>
<tr>
<td>7 Collaboration aim</td>
<td>Cost reduction</td>
<td>Innovation</td>
</tr>
<tr>
<td>8 Dynamism level</td>
<td>More static</td>
<td>Multidynamic</td>
</tr>
<tr>
<td>9 Member Competencies</td>
<td>Based on complementarities</td>
<td>Based on both complementarities and competition</td>
</tr>
<tr>
<td>10 Integrating new members</td>
<td>Loose alliance – limited firm / conditional alliance</td>
<td>Tight alliance – permanent full members</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Potential network categories</th>
<th>Criteria impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 Origin</td>
<td>VBE with strong historical roots</td>
<td>New VBE</td>
</tr>
<tr>
<td>12 Focus</td>
<td>Product / service oriented</td>
<td>Market / society oriented</td>
</tr>
<tr>
<td>13 Stage of VBE’s life cycle</td>
<td>Creation / Operation</td>
<td>Evolution / Metamorphosis</td>
</tr>
<tr>
<td>14 Size</td>
<td>Small &lt;20</td>
<td>Medium &lt;100</td>
</tr>
<tr>
<td>15 Role in VO</td>
<td>None</td>
<td>Full domination</td>
</tr>
<tr>
<td>16 Current use of technology and ICT tools</td>
<td>Low / Medium</td>
<td>High</td>
</tr>
<tr>
<td>17 Members types</td>
<td>Business companies only</td>
<td>Business – non-business organizations</td>
</tr>
<tr>
<td>18 Broker</td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>19 VO</td>
<td>Recruit</td>
<td>Formal with new members each time</td>
</tr>
<tr>
<td>20 Profile (management)</td>
<td>Informal Limited (Excel)</td>
<td>Database</td>
</tr>
<tr>
<td>21 Competencies (management)</td>
<td>Informal Limited (Excel)</td>
<td>Database</td>
</tr>
</tbody>
</table>
### Table 2- VBE Domain Categories

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Domain</th>
<th>Main Collab- driver</th>
<th>Example VO</th>
<th>Degree of org. readiness</th>
<th>Customer</th>
<th>Finance</th>
<th>Typical VO’s duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE 4 - Innovation driven domain</td>
<td></td>
<td></td>
<td></td>
<td>Very high</td>
<td>One/many</td>
<td></td>
<td>Short</td>
</tr>
<tr>
<td>TYPE 3 - Emerging domain</td>
<td></td>
<td></td>
<td></td>
<td>High</td>
<td>Many</td>
<td>Need public support</td>
<td>Medium</td>
</tr>
<tr>
<td>TYPE 2 - Stable one-of-a-kind</td>
<td></td>
<td></td>
<td></td>
<td>Medium</td>
<td>One</td>
<td>Self support</td>
<td>Long</td>
</tr>
<tr>
<td>TYPE 1 - Stable products/services</td>
<td></td>
<td></td>
<td></td>
<td>Medium</td>
<td>One/Many</td>
<td>Self support</td>
<td>Medium</td>
</tr>
</tbody>
</table>

### Table 3- Advantages of VBEs

**10 Main advantages of VBEs:**

1. **Agility in opportunity-based VO creation**
   - Supporting reduction of needed efforts and complexity, flexibility for VO re-configurability, and cost effectiveness

2. **Provision of base effective IC technology infrastructures for members**
   - The common grounds for interoperability / inheritability / collaboration

3. **The VBE bag of assets, providing properties of interest for its members**
   - General sharable information/knowledge (e.g. standardized product definitions and processes), software tools, lessons learned

4. **Provision of mechanisms, guidelines, and assisting services to both motivate and facilitate configuration and establishment of VOs**
   - Creating system of incentives, mechanisms to create positive reputation, and services for partners search, contract negotiation, etc.

5. **Proactive management of competencies and resources available in VBE**
   - Assuring coverage of the needed competencies/resources within the VBE

6. **Provision of related consulting / life maintenance support for VBE members through its support institutions**
   - Supporting insurance, branding, training, improving the trust level, etc.

7. **Introduction of approaches/mechanisms to build trust among members**
   - By recording the performance history, and definition of criteria for organizations’ trust worthiness

8. **Provision of general guidelines and norms for collaboration**
   - Constituting rules of conducts, working and sharing principles, value systems, collaboration ethics and culture, IPR protection, etc.

9. **Increasing the chances of VO involvement for VBE members, even from remote geographic regions**
   - Through provision of members’ profile in VBE catalog, including their competencies, resources, products, services, etc.

10. **Improving the potential / capacity of risk taking by the VO initiators**
    - Due to the reduction of the VO setup efforts/time, availability of both a wide variety of competencies/resources as well as indicators of the level of trust worthiness and past performance of the VBE members
Table 4- Issues in Competencies Management

<table>
<thead>
<tr>
<th>Competencies catalog:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Ontology of competencies / skills – competencies need to be properly specified and organized in some taxonomic structure, supported by suitable navigational interface</td>
</tr>
<tr>
<td>- Related competencies/ skills must be identified as means for replace-ability or equivalence of skills</td>
</tr>
<tr>
<td>- Some hierarchy of competencies must be defined and supported for search, for instance the more generalized (e.g. welding) as well as some specializations (e.g. spot welding).</td>
</tr>
<tr>
<td>- Furthermore, the inter-relationships (e.g. the IS-A, the whole-part, etc.) among competencies / skills must be defined.</td>
</tr>
<tr>
<td>- Properties aggregation to characterize each competency.</td>
</tr>
<tr>
<td>- Basic catalog entities manipulation – flexible search (multi-criteria), add, remove, edit, etc.</td>
</tr>
<tr>
<td>- Internal Core and some non-core – For each member we can distinguish between the core and the non-core competencies.</td>
</tr>
<tr>
<td>- External valuation of VBE competency – Considering the global market level of the competency of the VBE as a whole.</td>
</tr>
<tr>
<td>- From an “operational” point of view, how to determine / collect competencies? Automatic? Manual? How to update them?</td>
</tr>
<tr>
<td>- Dynamic properties?</td>
</tr>
<tr>
<td>- It may be interesting to consider levels of competencies / skills. For a given competency C, does our VBE master it to the level of setting strategic developments, or is it only able to “follow” what is suggested by a customer, for instance.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Competencies Management functionalities:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Competencies appraisal functionality - How “robust” or “sustainable” is the competencies base?</td>
</tr>
<tr>
<td>- Skills’ gap analysis. What if one member leaves? Specific indicators of skill robustness? Skill robustness inside an organization – skill possessed by one employee or part of the “culture” of the organization? How to rate the skills base?</td>
</tr>
<tr>
<td>- Marketing support functionality - How to “sell” it to the outside?</td>
</tr>
<tr>
<td>- Identification of strengths and weaknesses? (Dynamic) Identification of new potentials?</td>
</tr>
<tr>
<td>- Acquisition of complementary skills? Which support functionality?</td>
</tr>
<tr>
<td>- Internal competencies &amp; external but “easily” accessible competencies</td>
</tr>
<tr>
<td>- What is the “unit”? Enterprise? Department? Group?</td>
</tr>
<tr>
<td>- Relationship to processes and roles</td>
</tr>
<tr>
<td>- Endorsement / “accreditation” of competencies. Or rating their quality/past performance?</td>
</tr>
<tr>
<td>- Notion of joint competency (when one specific competency results from the contribution of 2 or more partners, and such competency cannot be provided by a single partner). Or is this represented by the notion of complex competency (see above)?</td>
</tr>
<tr>
<td>- Others to be determined.</td>
</tr>
</tbody>
</table>