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Abstract: The notion of service-enhanced product brings new perspectives for value creation and differentiation in manufacturing. The existence of complex and highly customized products, the inclusion of business services that add value to the product typically require the collaboration of multiple stakeholders. It is natural that each stakeholder has its own set of values and preferences and as a result, conflicts among them might emerge due to some values misalignment. Therefore, the Value System Alignment assessment should be included when selecting partner for the formation of long-term collaborative networks for the operation and management of the product life-cycle. This paper presents the implementation of a Value System alignment assessment model, as a component of the cloud-based collaborative environment designed to support a mix of collaborative enterprise networks involved in the solar energy sector.

1   Introduction

The notion of service-enhanced product offers new perspectives for value creation and differentiation in manufacturing. In the case of complex and highly customized products, the association of value-added business services to the product typically requires the collaboration of multiple stakeholders. On the other hand, decision making as well as the individual and joint behavior in a collaborative network depend on, and are reflected by the underlying value system of network participants. Therefore, the identification and characterization of the value systems of the networks as well as of their individual members are fundamental when attempting to improve and sustain a collaborative process.

Manufacturing networks typically involve heterogeneous and autonomous entities, such as: product / project designers, manufacturers, service providers etc., configuring a kind of virtual organizations breeding environment (VBE). Thus, it is natural that each network member has its own set of values. In the presence of different sets of

values, conflicts among partners might emerge merely due to misalignment of values [1-3]. With different value systems, partners might have different perceptions of the outcomes of the collaborative processes that might in turn lead to a non-collaborative behavior, such as reluctance to share knowledge and other inter-organizational disagreements. Since values are one driver of the behavior of the involved entities, identifying partners with more compatible or common core values during the consortia-formation is important to the success of the consortia [4, 5]. The level of alignment can serve as a predictive indicator of the potential level of collaboration as well as the capability to reach agreements in the case of conflicts. However, tools to assess or measure the level of alignment among value systems are lacking.

A theoretical approach to model value systems alignment which adopted elements from the graph theory and causal reasoning to model the causal relationships among organization's core values in order to analyze their interrelationships has been previously proposed [6, 7]. This paper explores the application of this theoretical Value System alignment assessment model, as a component of a cloud-based collaborative environment designed by the GloNet project to support a mix of collaborative enterprise networks involved in the solar energy sector.

2   Concept of Value Systems Alignment

Alignment is a very broad concept which is related to consistency, fitness, and similar ideas. Therefore, in order to propose methods to analyze the alignment between Value Systems in a collaborative context, it is necessary to consider the factors that contribute to core values alignment and misalignment in that context. One of the most common criteria for alignment assessment is the identification of shared core values among network members and between the network and each member. Nevertheless, the shared values criterion might not be enough to assess values alignment, since the shared values are not the only elements contributing to the sustainability of the collaboration. Therefore, in this work, the adopted approach for the assessment of the value systems alignment considers not just a comparison between core values and priorities, but also an estimate of the impact of a value system onto another. In short, the proposed analysis of the alignment between value systems considers the following parameters: (i) the shared core values between value systems; (ii) the positive impacts between core values of the two value systems; and (iii) the negative impacts between core values of the two value systems. The assessment can be performed at two different levels: (i) the alignment among network members; (ii) the alignment between the network and the network members.

The indicators to implement these alignment criteria are proposed taking as reference the V-align framework [6]. This framework supports the analysis of the following relationships: (i) Core-values to core-values – in order to understand how core-values influence each other; (ii) Core-values to organizations – in order to know which core-values are held by each organization; (iii) Core-values to collaborative networks – in order to understand which core-values are held by each network. Starting from the set of maps obtained from the use of the V-Align framework, three

indicators were proposed: Shared Values Level, Potential for Conflict Level, and Positive Impact Level (see [7] for a detailed characterization of these indicators). The implementation of these indicators assumes the existence of a Reference Core-Values Ontology, which contains a description of the possible core-values that an organization can hold. Such knowledge can be directly provided by experts or result from surveys and interviews (see [4, 8], as examples).

In order to have an indication about the global alignment level among the Value Systems of a set of members a new indicator is proposed: the network Value System Alignment Level, which is expressed as an average of the Value System Alignment Level between each pair of members, where the Value System Alignment Level between two members is expressed as the aggregation of the Shared Value level, the potential for Conflict Level and the Synergies Level, as follows:

$$VSAlignmentLevel(i,j)$$
$$= SharedLevel(i,j) - PotentialConflict(i,j) + SynergiesLevel(i,j)$$

Considering n, as the number of members in the network:

$$NetworkVSAlignmnetLevel = \frac{2}{n^2 - n} \sum_{i=1}^{n} \sum_{j=i+1}^{n} VSAlignmentLevel(i,j)$$

In Table 1 the proposed Alignment Level indicators are summarized.

Table 1. Values System Alignment Indicators

Members		
	Shared Values level	*This indicator quantifies the level of similarity between two value systems.*
	Potential for Conflict level	*This indicator quantifies the level of negative impacts that two value systems have on each other.*
	Positive Impact level	*This indicator quantifies the level of positive impacts that one value system has on another value system.*
	Synergies level	*This indicator quantifies the level of positive impacts that the members value systems have on each other.*
	Value Systems Alignment level	*This indicator quantifies the overall level of alignment between two members, aggregating the levels of: potential for conflict, synergy, and shared-values.*
Network	**Network Value Systems Alignment level**	*This indicator gathers the input concerning the indicators of the Value System Alignment between each pair of network members towards providing a measurement indicator for the Value System alignment of the network as a whole.*

3   A Support Tool

In one-of-a-kind production industries products and services are typically delivered through complementary competences shared between different project participants. A key challenge in this case is the design and delivery of multi-stakeholder complex

services along the product life cycle. To fulfill the global interests of the involved stakeholders, a set of main services have to be available to support the management of networks, either long-term strategic networks or goal-oriented networks. This includes among others: VBE creation; VBE Members Management; VBE Competence Management; VBE Groups Management, Dynamic Consortia Creation, Dynamic Consortium (VOs) Creation, Risk forecasting and Management. Moreover, with the aim to enrich the base services to VBE Management, advanced management services are also proposed in GloNet: the Trust Assessment and the VBE Value System Alignment Analysis.

This section focuses the implementation of the VBE Value System Alignment Analysis services, and its integration with the other available services provided to support collaborative network management (see Fig. 1).
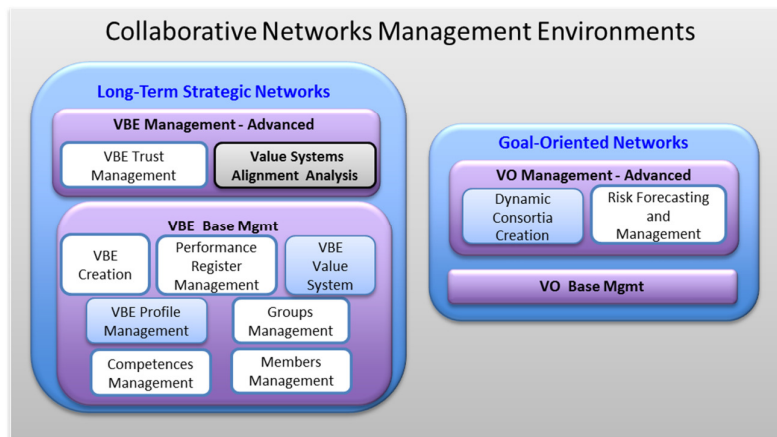

Fig. 1. Collaborative Networks Management Environments Framework

The VBE Value System Alignment Analysis components aim to provide a way to assess the Value System Alignment, according to the model previously presented, and it is composed of the following services:

- VBE Value System Alignment Assessment - This service is used to assess the alignment between specific Member Value System and the VBE Value System. This service receives the network Value Systems and the Value System of a member and computes a set of indicators about the alignment level, and generates an aggregate network core-value map (see [6] for the maps specification).
- Members Value System Alignment Assessment - This service is used to support the Value System alignment assessment of a set of members according to the V-align framework. This service receives the value systems of a set of members in order to generate a complete aggregate map and a set of alignment indicators that allow making an analysis of the alignment level among a group of members.
- Manage Values Knowledge Base Management - This service is used to retrieve the list of core-values and their description.

The services described above do not work in a standalone basis, they rather use information provided by other upstream subsystems and produce information to be used by downstream subsystems. Fig. 2 shows an adapted i* Rationale Strategic model representing the involved actors and their dependency objectives concerning the other sub-systems. Moreover, the services and sub-services within Value System Alignment Analysis boundaries are presented.
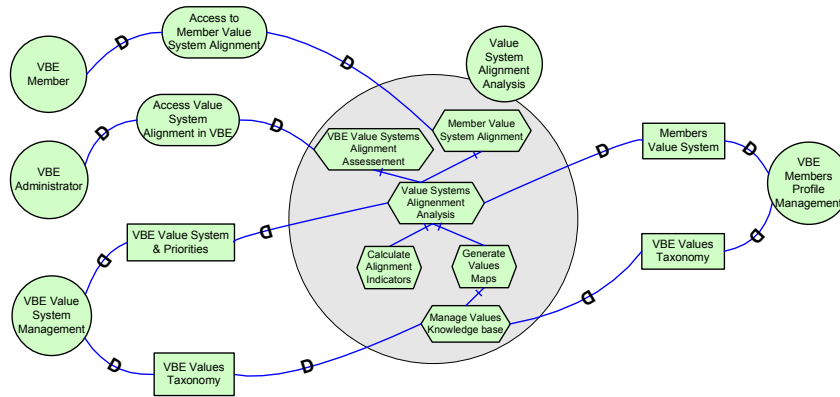

Fig. 2. Adapted i* Rationale Strategic Model for the VS Alignment Analysis System

The implementation of these services faced a set of challenges:
- Develop a user interface that fulfills the needs of the different users-devices (smart-phone, tablets, PCs, etc.), and that provides dynamics graphs rendering.
- Develop a set of web-services that guarantee the integration of the three subsystems: Value System Alignment Analysis, Value System Management, and Members Profile Management.
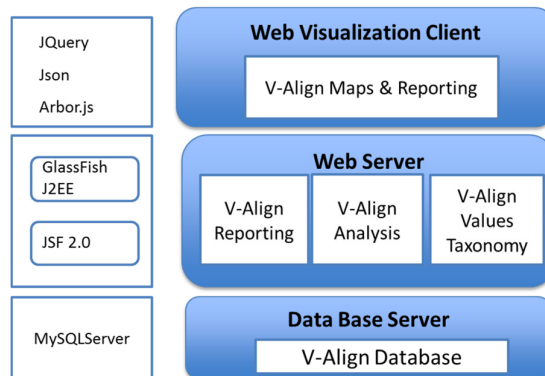

Fig. 3. V-Align Software Tool Architecture

In order to fulfill these main requirements the following technology was adopted: (i) Java script with Jason files, used to render the V-Align maps, from the client side, (ii) JSF 2.0 framework to implement the alignment assessment methods, generating alignment reports, and the management of core-values taxonomy (Fig. 3).

4   Application in Virtual Organization Creation

In dynamic consortia formation of goal-oriented networks, which typically assume the form of either a short-term Virtual Organization (VO) or long-term Virtual Organization, the selection of appropriate partners assumes a crucial step for the success of these networks, as mentioned in [9, 10]. These kinds of networks have the particularity of being composed of not only members of the long-term strategic alliances of manufacturers but also of the customer and local suppliers (customer's network) in order to support the notions of co-creation and *glocal* enterprise [11]. In the context of solar energy plants, these goal-oriented networks might be created for different purposes: the Product Development Network is a short-term virtual organization responsible for the design and creation of the physical product, the Product Servicing Network is a long-term virtual organization responsible for the operation and management of the product life-cycle and finally, the Service Co-creation Network is a short-term virtual organization dynamically created with the aim of co-creating new innovative business services to add value to the physical product.

Effective creation of VOs faces a large number of challenges, considering the wide diversity and large number of organizations active in the global market, the main challenges limiting the success of VOs include: (i) finding the most suitable partners worldwide, (ii) building trust and cooperation spirit among partners, (iii) effective formation of VOs, through both division of rights / responsibilities and reaching necessary agreements on co-working and system of values, as well as (iv) establishing the needed commonality on concepts / models / infrastructure etc., which set the foundation for interoperation and collaboration among independent, heterogeneous, and autonomous organizations.

Having taken into account the environmental characteristics of collaboration, every VO has a certain level of associated risks. These risks can have different drivers and sources. Therefore, if the VO planner could know more about the potential risk of a certain consortium, then the decision about the final consortium for the VO formation can be more accurate. In order to assess the risk level of a potential VO, the Members Value System Alignment Assessment services introduced above can be used. However, the use of this service for partner selection, assumes that each of the potential VO members is registered in the VBE system and that its Value System was already set on its profile. During the VO creation phase, the VO planner identifies a set of possible lists of members to form the VO, and for each list of members uses the Members Value System Alignment Assessment service to:

   (1)   Determine the Network Value System Alignment level, the higher this level, the lower is the risk level.

(2) Obtain the aggregate Members Value map, in order to identify the synergies between members, and the conflict values.

5   Product Servicing Network Application Example

In this application example, we aim to illustrate how the Value Alignment Assessment Model presented in Section 2, and the Software Tool presented in Section 3 can be used in the decision-making process aiming the selection of a set of partners.

Let's consider the manufacturers of solar parks as a long-term base network (a VBE) that is constituted of a number of companies involved in different positions of the value chain, such as Project development firms, Engineering, Procurement & Construction companies, Photo Voltaic equipment manufacturers, Monitoring & Control companies, Construction & Commissioning companies, etc. As support institutions, we can consider training institutions, regulators, insurance companies, lending organizations (banks), etc.
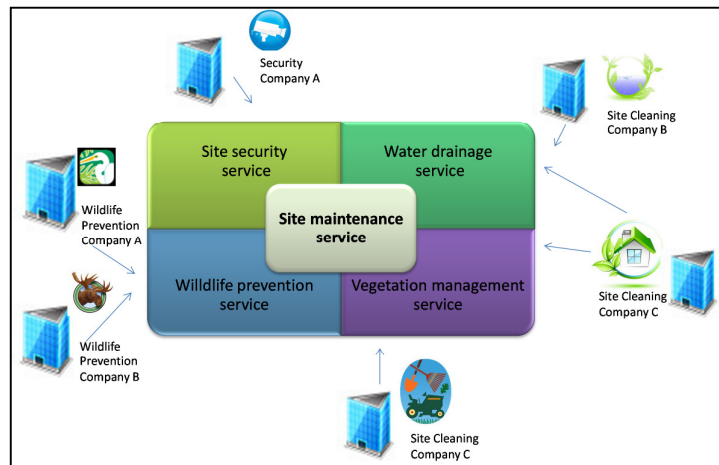

Fig. 4. Application Scenario

In this application example we consider the existence of a Product Servicing Network, which was created to perform the operation and maintenance of the solar park after the conclusion of the development of the physical product. The partners that constitute this long-term network were first recruited from the manufacturers network (VBE), naturally considering those that were involved in the manufacturing phase, and additional partners were added both from the customer's network and from local stakeholders. It is considered that during the operation of the solar plant, the customer is interested in an integrated site maintenance service that includes various simpler services: site security service, wildlife prevention service, vegetation management service, and water drainage service. The various services that compose the site

maintenance service might be provided by different companies, as illustrated in Fig. 4. In order to create this VO, the Product Servicing Network has to recruit the appropriate partners. In the example, it is assumed that the VO planner has found three distinct sets of members that satisfy the competencies required to provide the site maintenance service (see Table 2). In order to assess the risk level of each VO configuration, the Network Value System Alignment Level will be evaluated for each one of the three possible VO configurations.

Table 2. Network Value Systems Alignment Level for multiple consortium configurations

Network Value Systems Alignment level		
Configuration 1	**Configuration 2**	**Configuration 3**
Wildlife Prevention Company A Security Company A Site Cleaning Company A	Wildlife Prevention Company B Security Company A Site Cleaning Company B Site Cleaning Company C	Wildlife Prevention Company B Security Company A Site Cleaning Company A
50	**114**	**144**

During the registration process, each company has set its own Value System on its member profile. According to this information, and using the software tool presented in Section 3, the three VO configurations are set and the Network Value Systems Alignment is analyzed for each one, according to the method presented in section 2. The identification of shared values, synergies, and conflicting values in each consortium can be easily identified in the Members Core-Value Map. Fig. 5 illustrates the tree steps performed to analyze each of the three configurations. According to the results obtained (see Table 2) the consortium based on Configuration C is the one that presents a higher alignment level index, and as a result is assumed as the one with a lower potential risk.
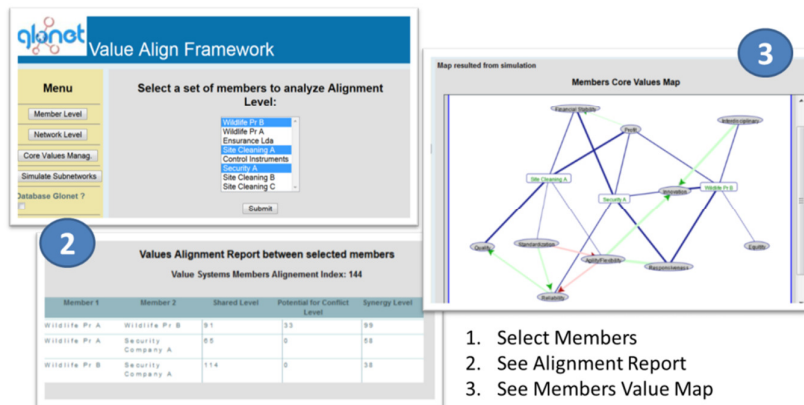

1. Select Members
2. See Alignment Report
3. See Members Value Map

Fig. 5. V-Align Software Tool

6   Conclusions

This paper explores the application of a Value System alignment assessment model, as a component of the cloud-based collaborative environment designed to support a mix of collaborative enterprise networks involved in the solar energy sector. Starting with a Value Systems Alignment model previously proposed to specify and analyse the alignment of Core Value Systems in collaborative environments, it has been explained how a set of software services can be developed to provide Value Systems Alignment assessment services. Moreover, it was defined how these services can be integrated with other main services in order to provide an integrated Collaborative Networks Management Environments System that supports the management of a mix of collaborative enterprise networks.

   In order to illustrate how the Value Alignment Analysis Services can be applied to support the selection of partners in VO creation, an application example for a Solar Park Product Servicing Network was presented.

The work done so far suggests that the presented artefacts have a practical and theoretical relevance in the partner selection during VO creation, thus, the integration of the Value System Alignment Service in the Dynamic VO Creation Service will be the next step.

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