NET-CHALLENGE PROJECT

INNOVATIVE NETWORKS OF SMES FOR COMPLEX PRODUCTS MANUFACTURING

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The Net-Challenge Consortium

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1	INESC Porto	INESC Porto - Instituto de Engenharia de Sistemas e Computadores do Porto
2	RPB	RPB – Têxteis e vestuário S.A.
3	Riopele	Riopele Têxteis S.A.
4	ONA	ONA Electro-erosion
5	RoboC	Roboconcept
6	Synesis	Synesis
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1. Executive Summary

The Net-Challenge project's main goal is to support the creation and management of non-hierarchical business networks where SMEs can join their competencies and resources to succeed in the global market in the design and manufacturing of complex products.

These business networks and market focus is expected to significantly contribute to improve the competitive position of European SMEs, ensuring a quick response, fast time to market, differentiated products and services and competitive prices.

To this end the Net-Challenge project designed, developed and validated an innovative framework to support SMEs in the creation and efficient operation of non-hierarchical collaborative business networks for the design and manufacturing of complex products.

The Net-Challenge framework provides a set of methods and tools that help SMEs to:

- Manage and develop business communities that provide a suitable environment for collaboration, by facilitating communication, information sharing and partner search;
- Create and manage collaboration projects (Virtual Organisations) for two relevant scenarios: one-of-a-kind and mass customisation of complex products.

In particular, the Net-Challenge framework is composed of the following components:

- The Net-Challenge Methodology defines the conceptual background and a practical approach designed to help SMEs in the efficient development and management of Business Communities, and in the formation and operation of collaboration projects (Virtual Organisations) to respond to specific market opportunities. Collaboration Projects for Engineer-to-Order and Customise-to-Order scenarios are supported, because they are particularly important for the design and manufacturing of complex products;
- Reference Collaboration Processes for non-hierarchical business networks, promoting and facilitating the design and implementation of real collaborative business processes. These reference collaboration processes are generic business processes that were designed to permit easy adaptation to each specific business network. The most relevant collaborative processes are defined in detail, namely: Building and managing Business Communities; Capacity management; Collaborative planning; Event management and Performance management;
- IT Infrastructure and Decision Support Tools, namely: Technical infrastructure to support the management of Business Communities and easy and reliable information exchange and sharing; A set of Decision Support Tools for collaborative product definition, collaborative planning, real-time monitoring and event management and performance management to help SMEs form and operate collaboration projects (Virtual Organisations).

Three demonstrators supported the validation, improvement and dissemination of the project results. The demonstrators were implemented in different industrial sectors to ensure the project results generality, namely: 1) textiles and apparel in Portugal, 2) footwear in Italy and 3) machine tools in Spain.

The Net-Challenge project started on the first of June 2009 and finished at the end of February 2012 and achieved the proposed objectives and results.

2. Project context and objectives

2.1. Background and needs

The importance of SMEs for the European economy and social cohesion is widely recognised, as they heavily contribute to the European GDP, employment and innovation potential.

To successfully compete in the global market, where they have to compete with larger companies and countries with lower labour costs, European SMEs will have to increase the added value of their products and services. However, to be sustainable in this context, SMEs clearly have to join forces with other companies and establish collaboration networks.

In traditional hierarchical networks and supply chains, small companies have to perform specific tasks that are defined by the larger companies. This limits their differentiation possibilities and forces them to compete head-to-head in a global market. Therefore, European industry has to focus on higher added-value segments characterised by low volume, large variety and complex and customer centred production.

In this context, the traditional strengths of European manufacturing, such us customer orientation, quality, scientific and technical expertise, design, positive brand image, flexibility and productivity are not enough. SMEs will have to adopt new business models and establish dynamic and non-hierarchical business networks to respond to market opportunities, ensuring quick responses, fast time to market, differentiated products and services and competitive prices.

However, there are currently no proven, effective methodologies, approaches or tools to support SMEs in creating, managing and dissolving this type of dynamic and non-hierarchical networks.

Such methodologies and tools should promote and enhance SME collaboration in partner identification and selection, network setup and configuration, product design and manufacturing, supporting innovative forms of distributed decision-making in aspects such as capacity management, optimisation of production resources and logistics management.

These approaches are relevant to many industrial sectors and they are especially relevant for high-variety low-volume businesses, tailored to manufacturing complex products which are composed of several parts and characterised by multiple process flows and assemblies. Such products are found in domains such as high-technology industrial machinery and new technical garment products.

In this context, Net-Challenge aims to support implementation and decision-making in non-hierarchical SME business networks and thus better harness the power of European technology and competences by providing highly innovative methodologies, processes and decision support tools.

2.2. Project concept

Temporary networks or collaboration projects (in literature also called Virtual Enterprises) are usually set up to dynamically respond to emerging market opportunities. The way companies react to specific business opportunities is critical,

and their performance along the different phases of the network life-cycle (creating, managing and dissolving) is also of major importance. The approach proposed in this project focuses on the particular characteristics of SMEs, and on the requirements of higher added value segments characterised by a low volume and a large variety of complex and customer centred products.

The major problems when dealing with complex products in traditional manufacturing environments are usually the long lead times that require long planning horizons and the multiplicative effects of dependent demands of product components. Small disturbances in higher level components can lead to important problems in the supply network (that is the "whip effect", it can have even more impact). Furthermore, high variety and low volume requirements can considerably increase the complexity of planning and imply the need for highly flexible resource configurations.

This environment, where dynamic networks of SMEs emerge to respond to market opportunities, will only work in practice if companies are provided with appropriate methods for network formation and management, reference collaboration processes and supporting ICT tools. These are Net-Challenge's main RTD objectives.

The development of regional or sectorial Business Communities, where trust can be built and communication streamlined, will be critical for the fast and efficient creation of these business networks.

The proposed approach assumes that the relations between participating companies are non-hierarchical and that the decision-making processes are decentralised. Individual companies must be able to find and receive the commitment of the required partner companies (in terms of competencies and available capacity) to respond to all potentially interesting market opportunities they are aware of in real time. SMEs will only be able to ensure differentiation and long term sustainably by efficiently and effectively forming these dynamic networks.

Innovative methods and collaborative processes are targeted at complex and customised products because they address very important market segments for differentiation and sustainability in European SMEs.

2.3. Project objectives

The central objective of Net-Challenge was to develop an innovative and integrated framework to support SMEs in the creation and efficient operation of non-hierarchical collaborative business networks for the design and manufacturing of complex products. This integrated framework includes the Net-Challenge Methodology, Reference Collaboration Processes and an ICT Infrastructure and Decision Support Tools.

Accordingly, the project addressed the following specific Scientific and Technological objectives:

- To specify and develop a methodology to help SMEs in the qualification of potential partners, and in the formation and operation of dynamic networks able to quickly respond to emerging market opportunities characterised by low volume, high variety and customer centred products.
- To specify and develop reference collaboration processes for non-hierarchical dynamic networks. These reference business processes will promote and facilitate the definition of real collaborative business processes that will support each dynamic network and will cover the following areas: partner qualification, network

formation, global network business planning; operational order and planning processes; and performance management.

- To design and develop innovative decision support tools to help companies manage manufacturing and logistic processes, including: aggregate collaborative planning; real-time monitoring with event management, allowing operations end-to-end visibility and informing management of expected as well as unexpected events and performance management.

The project's final goal is to improve European competiveness by helping SMEs to address more dynamic and demanding global markets with differentiated products. For this, the project development strategy also addressed the following objectives:

- To develop training materials and to train key users in pilot companies.
- To design, set up and assess industrial demonstrators. These pilots will implement the developed methods and ICT tools in the following industrial sectors: textile and apparel, footwear and machine tools.
- To disseminate the research results and prepare their exploitation. A comprehensive plan was created and enacted to effectively disseminate the main project results to selected audiences, including industrial companies, technology suppliers and the scientific community. The demonstrators are key instruments in this activity. Further actions include the development of dissemination materials, such as flyers and the project website. Finally, exploitation plans were developed for post-project success.
- To establish links with standardisation activities and relevant international research communities.

The project approach strongly builds on the three representative real Business Cases (Textile and apparel, Footwear and Machine tools), and on the know-how acquired in previous projects and experience in hierarchical networks. These Business Cases are typical scenarios of complex products manufacturing and intend to ensure a wide applicability of the project results.

3. Description of the main S&T results

3.1. Introduction: The Net-Challenge Framework

The Net-Challenge project designed, developed and validated an innovative and integrated framework to support SMEs in the creation and efficient operation of non-hierarchical collaborative business networks for the design and manufacturing of complex products.

The Net-Challenge framework provides a set of methods and tools that help SMEs to:

- Manage and develop business communities that provide a suitable environment for collaboration, by facilitating communication, information sharing and partner search;
- Create and manage collaboration projects (Virtual Organisations) for one-of-a-kind complex products;
- Create and manage collaboration projects (Virtual Organisations) for the mass customisation of complex products.

In particular, the Net-Challenge framework is composed of the following three components:

- The Net-Challenge Methodology defines the conceptual background and a practical approach designed to help SMEs in the efficient development and management of Business Communities, and in the formation and operation of collaboration projects (Virtual Organisations) to respond to specific market opportunities. Collaboration Projects for Engineer-to-Order and Customise-to-Order scenarios are supported, because they are particularly important for the design and manufacturing of complex products;
- Reference Collaboration Processes for non-hierarchical business networks, promoting and facilitating the design and implementation of real collaborative business processes. These reference collaboration processes are generic business processes that were designed to permit easy adaptation to each specific business network. The most relevant collaborative processes are defined in detail, namely: Building and managing Business Communities; Capacity management; Collaborative planning; Event management and Performance management;
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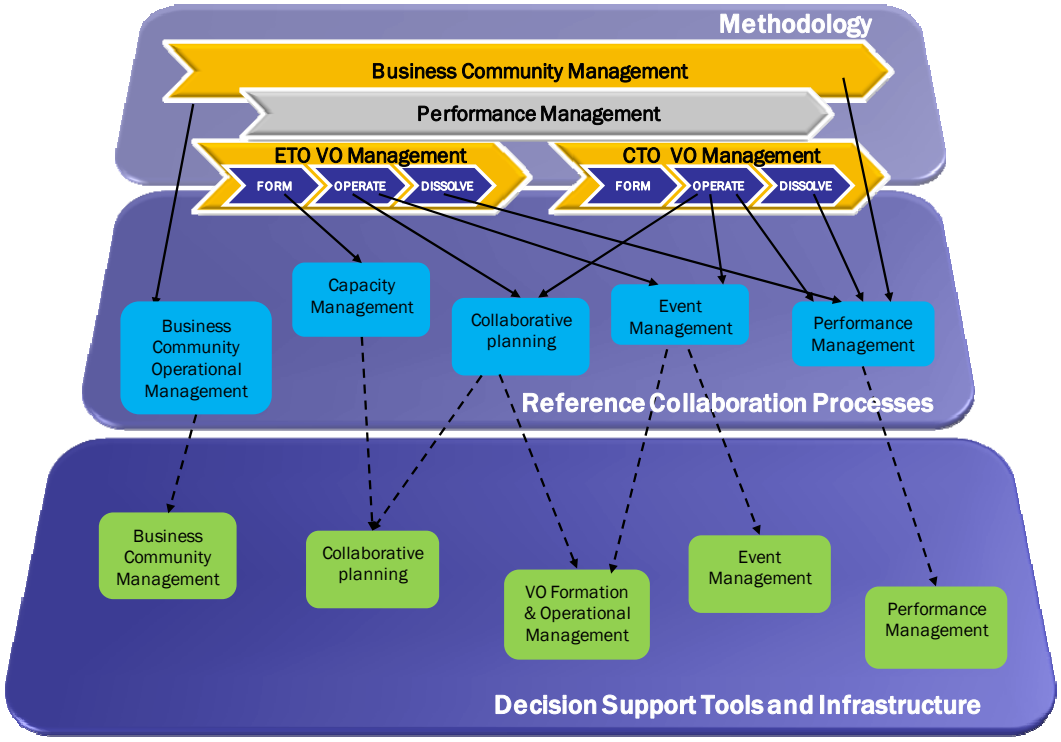

Figure 1: The Net-Challenge Framework

Three demonstrators supported the validation, improvement and dissemination of the project results. The demonstrators were implemented in different industrial sectors to ensure the project results generality, namely: 1) textiles and apparel in Portugal, 2) footwear in Italy and 3) machine tools in Spain.

3.2. The Net-Challenge Methodology

3.2.1. Introduction

The Net-Challenge Methodology defines the conceptual background and a practical approach designed to help SMEs in the efficient development and management of Business Communities, and in the formation and operation of collaboration projects (Virtual Organisations) to respond to specific market opportunities. Collaboration Projects for Engineer-to-Order and Customise-to-Order scenarios are supported, because they are particularly important for the design and manufacturing of complex products. This includes best practices, examples and templates.

This methodology supports the formation and operation of non-hierarchical collaborative networks among European SMEs and is based on the requirements collected from the case companies within Net-Challenge while considering previous work carried out on ECOLEAD and other successful RTD projects. Complex products design and manufacturing in high variety and low volume scenarios was the target environment.

The Net-Challenge Methodology is structured in three main modules that support the creation and management of:

- Dynamic Business Communities;
- Collaboration projects (Virtual Organisations) for Engineering-to-Order business opportunities;
- Collaboration projects (VOs) for Customise-to-Order business opportunities.

Each of these modules is structured in the main phases for the respective life-cycles, namely: Creation, Operation, Metamorphosis and Dissolution for Business Communities and Formation, Operation and Dissolution for Collaboration Projects (Virtual Organisations).

In the management of Business Communities (Build module), potential business partners are developed, qualified and accumulated within a Business Community (BC) and trust and information sharing is promoted. The goal is to create a suitable environment for collaboration.

In dynamic Business Communities, Collaboration Projects (Virtual Organisations) can be formed and managed to respond to specific business opportunities. To fulfil such business opportunities, VO partners can consider either the Engineer-to-Order (ETO) or Customise-to-Order (CTO) scenarios depending on the specific market requirements.

The Engineer-to-Order (ETO) scenario is used for custom made or highly customised products. This approach is customer driven and applies when a customer wants a unique solution that requires design and engineering activities. On the other hand, the Customise-to-Order (CTO) scenario is used to guarantee different levels of customisation at product level: best-fit, personalisation, product platform creation, aesthetic vs. functional customisation. In this case, customers can order customised products derived from a platform-based product family, as described below.

The Reference Collaboration Processes and the Performance Management Framework (presented in later sections) complement the project's conceptual developments.

The main modules in the Methodology are briefly explained separately in the following sub-sections.

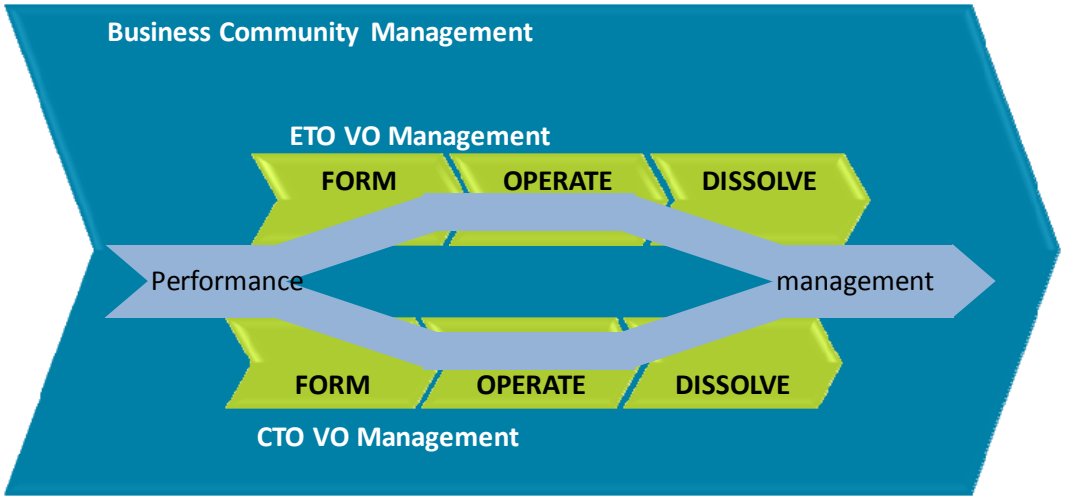

Figure 2: Main Modules of the Net-Challenge Methodology

3.2.2. Dynamic Business Community Management

The establishment of dynamic Business Communities is an important enabler for the fast and efficient formation of temporary partnerships (Virtual Organisations), able to successfully respond to specific market opportunities. In this sense, the Building of Business Communities is seen as a crucial enabler for collaboration.

The objective of the Build Module of the Net-Challenge Methodology is to provide conceptual background and Methodological guidance to organisations that want to create and manage Business Communities supported by advanced ICT tools (similarly to the virtual organisation breeding environment - VBE concept Camarinha-Matos and Afsarmanesh, 2003). These Business Communities are business environments that comprise a significant number of organisations (mostly SMEs), where trust is developed between its members and communication mechanisms are established. There should be easy mechanisms to find business partners and to Form Virtual Organisations (or partnerships) to respond to specific market opportunities.

These dynamic Business Communities in practice can have several configurations, from a small group of companies (from 20 to 50 companies) to a larger number of companies (even several thousand). Business Communities can be regional, they can be related to a specific industrial sector, or they can link companies with complementary competencies using the Internet.

Business Communities can be open or closed. Some Business Communities may also decide to be essentially closed and the entrance of new members would only be possible after the approval of the Community members. The Net-Challenge Methodology supports both open and closed Communities.

The BC life cycle starts with the creation of the business community, where various needs and possible opportunities are identified, evaluated and defined in terms of developing the prospective business model and governance model. The next phase of the BC life cycle addresses the operational activities within the BC. In this phase, the necessary promotional activities are established along with trust among BC members and organisations are prepared in terms of available capacity, qualification, risk and event management and performance management. The third phase of the BC life cycle deals with the metamorphosis where the BC strategy, business model and governance model are revised and redefine the infrastructure if suitable. In the final phase of the BC life cycle the MC concentrates on dissolving the BC, assets are shared and the community is closed.

For each phase of the BC life cycle, guidelines, best practices, templates and business processes are proposed to support organisations in implementing the activities and initiatives necessary to ensure the desired performance.

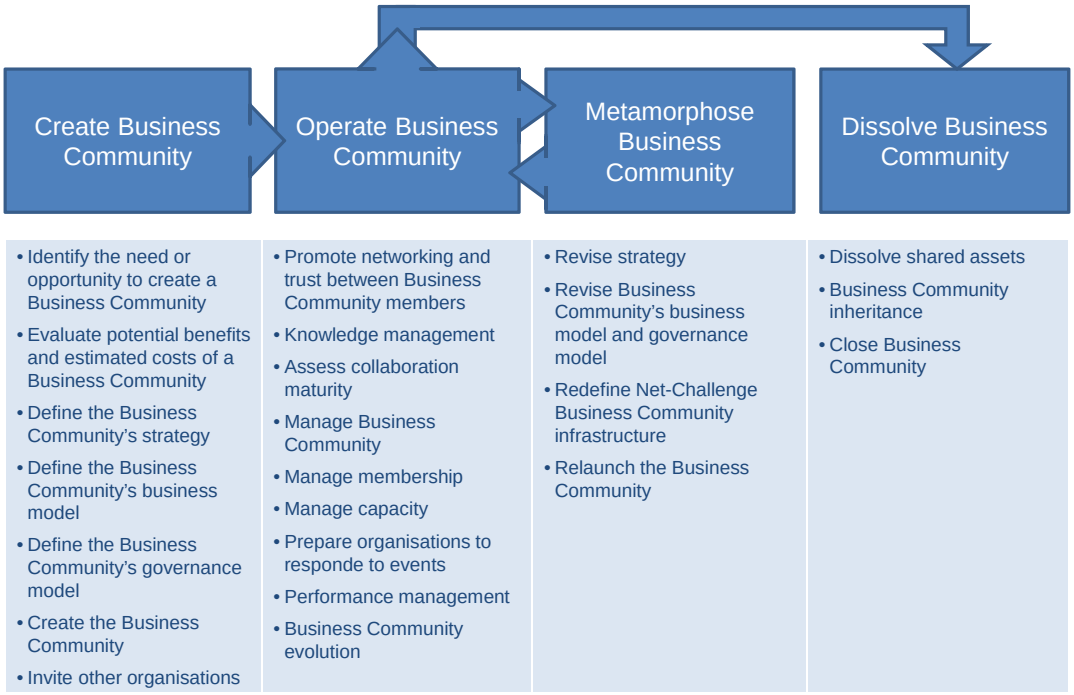

Figure 3: High level structure of the dynamic Business Communities

3.2.3. Management of ETO Collaborative Projects

The Engineer-to-Order (ETO) Module of the Net-Challenge Methodology is used to support the management of projects for the collaborative design and manufacturing of custom made and complex products.

The ETO scenario is applied when: the customer wants a unique solution that requires design and engineering activities; the project is not just an update of an existing solution but requires specific functionalities; the ordered quantity may be one single product or a large quantity of the new product developed; detailed cost calculation is needed; lead time calculation is needed; order specific engineering services.

3.2.4. VO Formation in ETO scenarios

In the ETO scenario the objective of the Formation phase is the collaborative definition of a product concept and the respective quotation for the customer, including the definition of the lead time.

The Formation phase (FORM) starts by collecting the customers' requirements, analysing and prioritising them after exchanging information with the Broker and the customer (the Broker is the VO partner that coordinates the VO and establishes the link with the customer). The second step defines the necessary contractual agreement among the VO partners, and in the third step the high level product concept is defined and the required Bill-of-Materials (BOM) and routing of operations are prepared. In the following step, collaborative planning is conducted, defining the delivery date and price so that a quotation can be prepared. The final phase of the life cycle takes place after the customer order confirmation and is responsible for the formalisation of the VO between the selected partners.

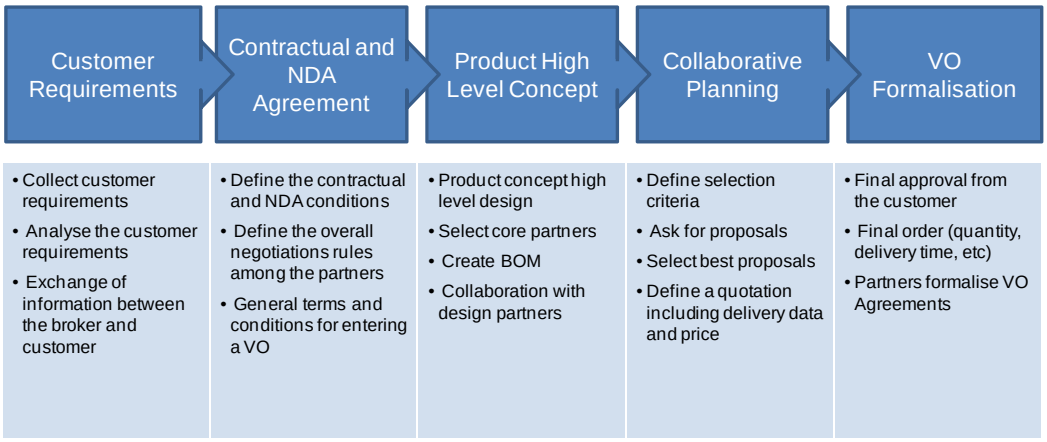

Figure 4: High level structure of ETO VO Formation

3.2.5. VO Operation in ETO scenarios

In the ETO operation phase (OPERATE), the VO activities start by deploying the confirmed customer order, which initiates by converting a customer order into a production order and detailing the work break down structure and confidential settings for the VO for the respective partners. In the second step, the intended product is engineered with respect to conceptual, architectural and detailed design. The following step, defining the detailed plan, includes the calculation of the product development lead time based on materials available and planned routing. The execution step of the ETO VO operation is responsible for necessary internal scheduling and the operations executed. In the final step, the operations are monitored and possible risks and events are managed, as identified and characterised during the first steps of VO operation.

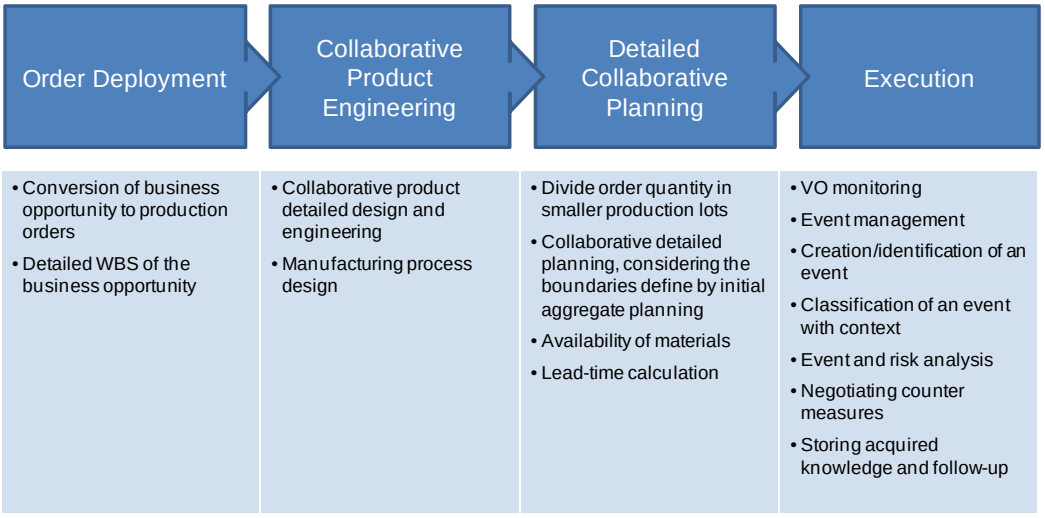

Figure 5: High level structure of ETO VO Operation

3.2.6. Management of CTO Collaborative Projects

The Customise-to-Order (CTO) Module of the Net-Challenge Methodology is used to support the management of collaboration projects where a group of partners decide to

offer on the market the possibility to configure and customise a platform based product family at a competitive price and with a reduced lead time.

A basic requirement for implementing a Mass Customisation strategy (MC) is the ability to configure a product according to the specific needs of each customer, balancing the needs of personalisation with the level of flexibility and adaptability of industrial production. To support the MC paradigm, a product must be designed in order to permit fast delivery after being ordered with specific customer requirements. All of the tasks that differentiate the product for a specific customer must therefore be postponed until the latest possible moment in the production flow.

In the CTO scenario, a product platform is designed and engineered by the selected partners and represents the basis for collaboration. Product variants are manufactured and delivered to different customers according to their specific requirements.

The CTO scenario is applied when: a group of companies want to give their customers the possibility to configure and order variants of a complex product; potential customers value the products that match their specific requirements; there is a need to deliver customised variants of a complex product with a competitive price; none of the partner companies is able to deliver the product by itself, and there is a need for collaboration between companies with complementary capabilities.

3.2.7. VO Formation in CTO scenarios

In the CTO scenario, the VO formation process starts by analysing the market needs that is based on demographics and geographical regions and also on the historical data on past market trends. In the second step, the necessary contractual agreements among partners are made, which is followed by defining the product platform. In this step, the strategy and architecture of the product platform is defined according to proposed products variants. A business plan is defined where product development related costs are estimated along with possible risk and revenue sharing. In the final step, the VO is formalised. In the CTO scenario the partners involved act as an internal client and the VO is Formed when they decide to offer on the market a product that can be customised for different customers.

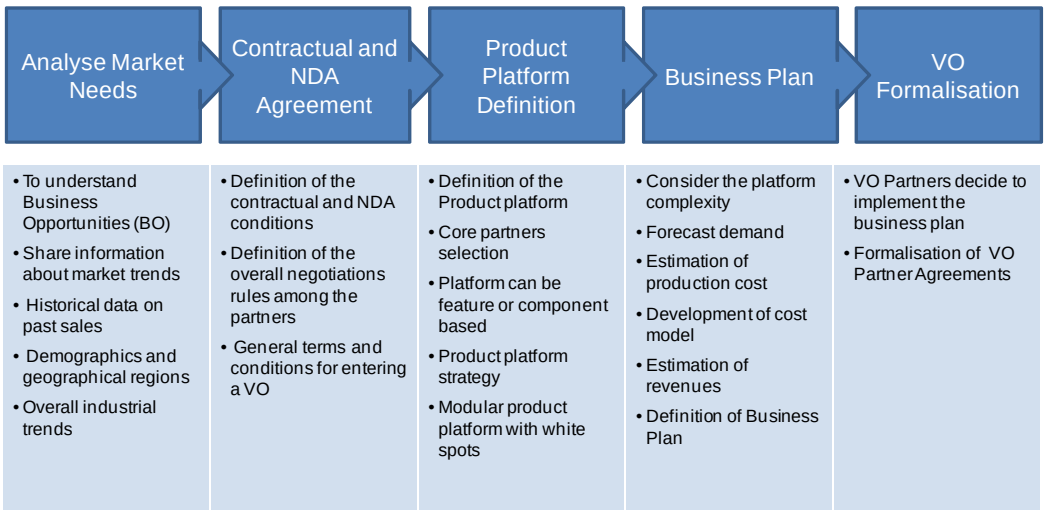

Figure 6: High level structure of CTO VO Formation

3.2.8. VO Operation in CTO scenarios

Similarly with the ETO scenario, the CTO VO operation starts with the development of the detailed engineering of the platform-based product family, including the definition of the platform architecture. After the platform detailed engineering, the product is offered on the market and different customers are able to order different configurations. The proposed approach includes the possibility for the customer to specify certain modules of the product (white spots). After the confirmation of each customer order, the operations are managed following the same approach as is the ETO scenario.

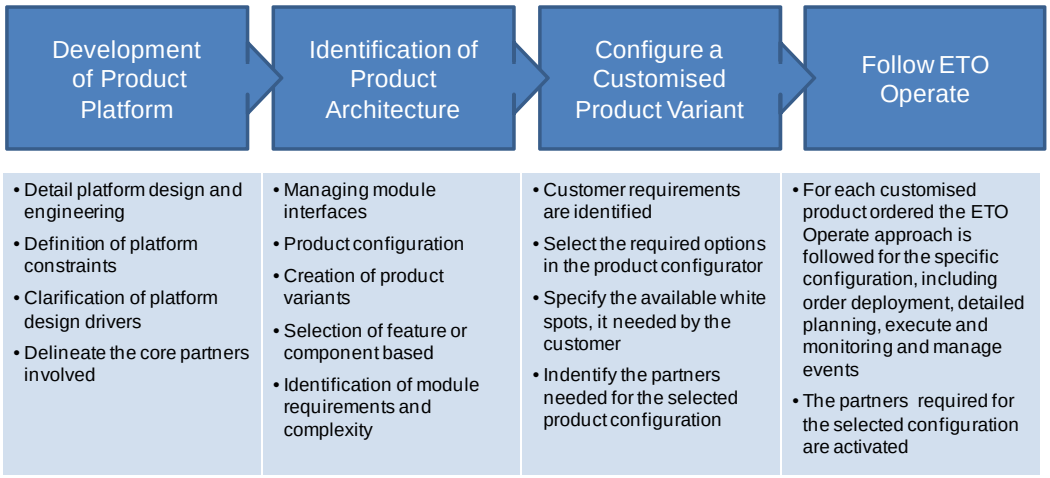

Figure 7: High level structure of CTO VO Operation

3.2.9. Dissolution of the VO

The VO, as formed and operated following either ETO or CTO production scenarios, is dissolved after fulfilling the indentified business opportunities. In this phase of the VO life cycle, all of the assets and liabilities are shared among the VO partners following the initial agreements and the overall profit and loss balance is distributed. In the dissolution phase, the performance of each VO member is also assessed and valuable knowledge is stored for future use. In the case of the CTO scenario the VO is dissolved when partners decide that the developed product-platform ceases to be profitable.

3.3. Reference Collaboration Processes

The Net-Challenge reference collaboration processes help organisations form and operate collaborative networks, providing them a comprehensive set of process descriptions. The Net-Challenge reference collaboration processes address the main processes that are intended to be executed in collaboration and where collaboration is enhancing the competitive potential of non-hierarchical networks. Their objective is to support the design of effective collaboration processes and to speed up the network setup, pointing out relevant aspects and presenting advanced concepts.

A reference process is a set of interrelated activities to produce an outcome expressed in generic terms, so that they are valid in a given domain. This is complemented by a guide on how they can be applied to define a real process in the context of that domain. The application of a reference process to design a business process is what is frequently called instantiation.

The reference processes were designed for the the Business Community Operation phase (BC) and for the Formation, Operation and Dissolution of Virtual Organisations (Collaboration Projects), aiming to provide complete coverage of the collaboration in non-hierarchical business networks.

Reference processes for BC Operation cover:

- The general processes for the management of the business community, providing support to operational activities;
- The processes specific to the membership;
- The long term capacity planning, including improvement of capabilities and qualification;
- The preparation of member organisations to deal with events.

VOs can be created for two different scenarios, Engineer-To-Order (ETO) and Customise-To-Order (CTO), each one imposing specific requirements. Therefore, different sets of reference collaboration processes address each of the scenarios.

Reference processes for VO Formation (ETO scenario) cover:

- The protection of information through a non-disclosure contract;
- The conceptual design of the product and product engineering;
- The aggregate planning of operations and their cost estimation;
- The establishment of an agreement binding partners in a VO;
- The initial risk assessment and the preparation of the VO to respond to events.

Reference processes for VO Operation (ETO scenario) cover:

- The design and detailed engineering in of the product;
- The detailed planning of operations;
- The execution of the operations;
- The management of risk and the handling of events.

Reference processes for VO Formation (CTO scenario) cover:

- The analysis of market needs;
- The protection of information through a non-disclosure contract;
- The conceptual design of a platform-based product family and engineering;
- The development of a business plan for the project;
- The establishment of an agreement binding partners in a VO;
- The initial risk assessment and the preparation of the VO to respond to events.

Reference processes for VO Operation (CTO scenario) cover:

- The detailed design and engineering of a platform-based product family;
- The customisation and remaining execution of customer orders.

Reference processes for VO Dissolution (ETO and CTO scenarios) cover:

- The fulfilment of contractual clauses for dissolution;
- The execution of pending tasks;
- The closing of financial accounting;
- The evaluation of performance and information archiving.

These processes are described in detail, according to a common structure, using diagrams and textual descriptions.

Processes implicitly define the requirements that guided the development of supporting ICT tools.

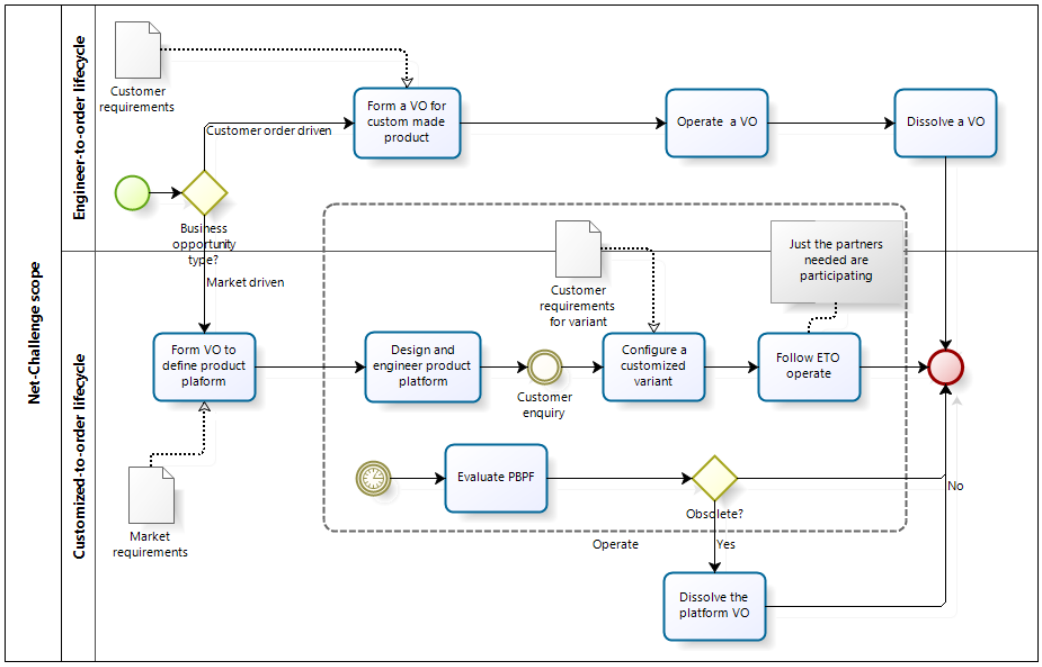

Figure 8: Reference macro-processes corresponding to the VO life cycle phases

Several typical processes extend throughout several phases of the BC and VO life cycles. That is the case of capacity planning, operations planning, event management and product design, etc.. In fact there are two overlaid views. As a result of the approach taken to align methodology and reference processes, which overlaps macro-processes and life cycle phases, these processes were split and the segments were included in the macro processes they cross.

Reference processes were developed in direct alignment with methodology. Consequently, the main line of research and development followed aimed to further develop the processes, with the main concerns:

- To address the collaborative processes and activity aspects, particularly those raising new challenges in the state-of-the-art;
- To develop the knowledge beyond the state-of-the-art;
- Cover all processes, although not in depth when the previous conditions were not valid;

- BC formation, metamorphosis and dissolution would not be further developed because of their uniqueness in application, not initially planned and sufficient coverage in previous research.

The reference processes proposed result from the R&D work conducted in the analysis of current processes in the project industrial case companies and in the state of the art.

The development was made collaboratively by all R&D partners, each taking responsibility for the development of certain processes and all reviewing the processes and proposing adjustments.

The description of the Reference Collaboration Processes (RCP) follows a unique structure so that the same sections can be found in all RCP descriptions. The section "Parent process name" makes it possible to link a RCP with its parent, considering that any RCP's activities can be developed and described as an RCP.

The main processes were validated through discussions with the industrial partners.

The RCP developed include: Operate BC; Manage BC; Manage Membership; Process Membership Request; Expel BC member; Process request to leave BC; Invite Organisation; Search for Organisation to Invite; Ask for Recommendations to BC Members; Manage Capacity; Forecast Demand; Improve Capabilities; Qualify; Prepare Organisations to Respond to Events; Form VO (ETO); Design Product Concept; Search for Partners; Select Partners for Design; Define Aggregate Plan; Prepare VO to Respond to Events; Make Initial Risk Assessment; Operate VO (ETO); Engineer the Product; Create BOM; Define Detailed Plan; Manage Risk.

3.4. Framework for Performance Management

The Net-Challenge project proposes a framework for performance management in collaborative networks, addressing the two environments: the Business Community (BC) and the Virtual Organisation (VO), aiming to guarantee the alignment and achievement of strategic and operational business objectives. It also supports the evaluation of alternative system configurations and, contributing to the robustness of processes, enables network reliability and service level. This framework is based on an external perspective in order to ensure that the organisation's performance is tightly linked with competitiveness.

The change from previous organisational forms (manufacturing companies with clear boundaries, limited relationships with other companies and a focus on internal efficiency and effectiveness only) to networks must be supported by new performance management practices. Though the single organisation performance management concepts and recommendations have been applied to networks and are to a large extent valid, the new challenges presented require dealing with a larger domain, including new processes, new stakeholders and a less clear concept of internal and external to virtual and real organisations. Other specific issues of networks which will be analysed are: duration of their life, their virtual nature and their implications in strategy.

In general terms, performance management is concerned with setting and sharing the goals to be achieved and developing and managing resources and initiatives, in order to achieve the goals set.

The Net-Challenge Framework for Performance Management covers objectives, strategies, performance measurement and evaluation, monitoring, learning and

improvement. However, special emphasis is put on the specific aspects of performance management in collaborative networks still lacking research support.

The Net-Challenge performance management framework complements the methodology and the reference collaboration processes and is integrated with them, driving the BC and VO performance through processes' performance.

The following diagram depicts the performance management approach and the framework roles.

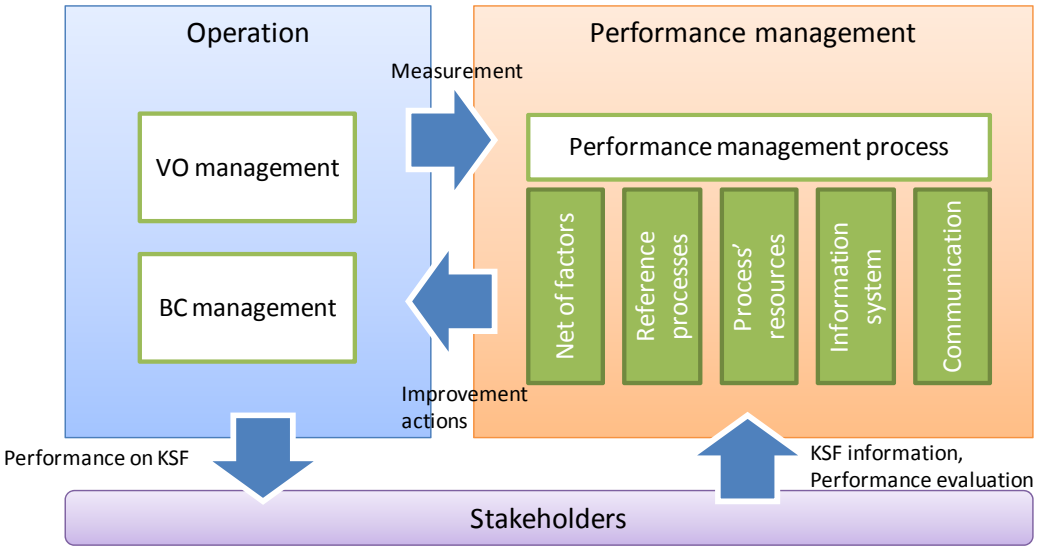

Figure 9: Performance management and the framework roles

The main components of the Net-Challenge framework for performance management are:

- A stakeholder's perspective of value which defines what performance is (external environment);
- The factors in the organisation which can be acted upon in order to change performance (internal environment);
- The reference processes to define a strategy and make it succeed;
- The information system that conveys rewards and penalties;
- The process resources;
- The communication processes (internal and with stakeholders).

Performance can be changed by taking actions in the two environments, which means in two time horizons. One is the BC, where members develop their capabilities, sharing knowledge and try to get to know each other. The other is the VO, where partners aim at maximum efficiency in delivering the product or service.

Two reference processes for performance management in the BC and in the VO are part of the Net-Challenge Framework for Performance Management. In order to expedite the processes, particularly in the VO, some resources are provided – scenario templates which characterise typical business scenarios and propose sets of factors to be monitored which are relevant in that business context, lists of factors, the corresponding performance indicators and their definitions.

The information systems collect data from VO and BC members, convey evaluations of performance and feed a central repository of information (BC member's and VO's profiles). Aggregated and disaggregated data makes it possible to analyse the performance of the VO, VO partners/BC member and the whole BC.

The internal and external communication of performance is essential to convey the BC strategy, to mobilise organisations for improvement and to reward the members. If BC members and VO partners perform well, they will often be invited to take part in business opportunities.

Performance is determined by the stakeholders, which is a founding concept in the Net-Challenge framework. Knowing who the key stakeholders are is fundamental to know what they are expecting from the organisation and to be able to fulfil their expectations. The same criteria used by stakeholders to evaluate performance have to be used by the entity to evaluate itself and to plan strategically. The identification of stakeholders and of key stakeholders requires the consideration of the new entities that come into play and their nature. The Net-Challenge methodology identifies and addresses two types of collaborative networks: BCs and VOs. The Net-Challenge framework for performance management identifies the BC' and VO key stakeholders and the relations between the organisations and stakeholders.

The proposed approach relies on establishing a strategy for the key stakeholders based on key success factors (KSF) and on identifying and cascading them internally in alignment with the strategy.

The key success factors are those "things" that the key stakeholders expect from an organisation and value most. The organisation's evaluation of its own performance must be based on the same factors used by the key stakeholders to evaluate the organisation's performance.

The identification of the most important factors that affect the key success factors – the key performance factors (KPF) – make it possible to act on the processes and measure them in alignment with the strategy. Key performance indicators (KPI) make it possible to monitor the performance of the organisations on the selected key factors (success and performance factors). A set of KSF, KPF and KPI were developed in this project which, with specific templates and scenarios for Business Communities and Virtual Organisations constitute the process resources. Their purpose is to speed up and guide organisations in the analysis process and in the identification of KSFs, KPFs and KPIs and also to clarify the concepts used.

Both the identification process and the definition of KSFs and KPFs form an important component of the framework since they create a common language and are a communication tool in the Business Community. The diverse vocabulary is a major obstacle to implementing a strategy in single organisations and must receive special attention in CNs.

Collaboration, trust, flexibility and other commonly addressed important issues in the context of collaborative networks are equated as performance factors impacting some KSFs and are analysed in that condition within a net of causal factors.

The VO performs well if its stakeholders get what they want and get higher value from it than they would from its alternatives. However, the evaluation of the global performance of the VO may be insufficient and the individual partners' contributions must be evaluated. Therefore, a second dimension, besides factorisation (going from effect to cause), is analysed, which is disaggregation (the contributions from the

different members to a global performance. The disaggregation of one KPF into KPFi makes it possible to expose the performance of individual partners through individual KPIs. It also establishes the interface between the internal and the network's performance measurement systems.

3.5. ICT Distributed decision support tools

3.5.1. High level concept

The Net-Challenge integrated framework includes an ICT Platform with a set of decision support tools that supports SMEs in managing Business Communities and collaboration projects (Virtual Organisations) for complex product design and manufacturing, thus supporting the following two major processes:

- The creation and management of Business Communities, promoting the creation of business relationships and trust between SMEs. At this level, knowledge between members in the community is shared, trust is promoted and the search for partners is facilitated.
- The creation and management of ETO and CTO collaboration projects (Virtual Organisations) targeting customised or custom made product design and manufacturing. To this end, functionalities like the collaborative definition of the bill of materials or operations, collaborative planning, monitoring and event management and performance management are included.

The following are the main modules of the Net-Challenge ICT Platform:

- Collaboration Infrastructure for managing Business Communities. An infrastructural component that supports all business community related activities;
- VO Formation and Operations Management. Constitutes the environment supporting all VO specific activities;
- A set of decision support tools, namely Partner search and Product Concept, Collaborative Planning and Monitoring and Event Management;
- The Product Platform & CTO Module is responsible for managing CTO Collaboration projects and integration with a standard and previously existing product configurator;
- A Gantt-chart and Calendar component, shared by some decision support tools and responsible for the graphical representation of Gantt charts;
- Finally, a component that supports Performance Management, both in Business Communities and Collaboration Projects.

The following sessions present the main components of this ICT Platform in further detail.

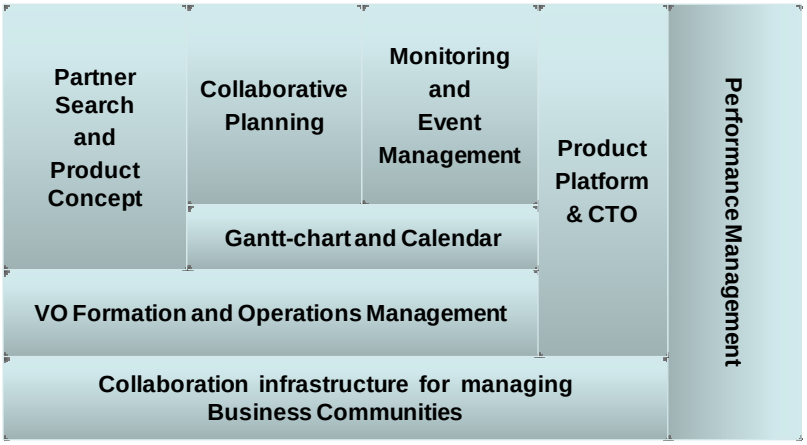

Figure 10: Main components inside the Net-Challenge ICT Platform

3.5.2. Collaboration Infrastructure for managing Business Communities

This module (Collaboration infrastructure for managing Business Communities) supports the creation and management of dynamic business communities, including partner qualification and network formation.

To create a new Collaborative Project (or Virtual Organisation according to scientific literature), the best partners must be found for it, and for that a trusted environment is needed where the companies can be searched based on different criteria and their information provided, such as their technical capabilities, availability and resources.

Net-Challenge makes it possible to create and manage Business Communities, where a set of companies share similar profiles, objectives, markets, resources, but mainly share business, exchange information, and look for contacts and new business opportunities.

In a Business Community, collaboration opportunities emerge constantly, and this is the place for one to find a suitable partner to create a new organisation for a specific business, searching for its specific needs.

Net-Challenge provides different tools to qualify, evaluate and verify the members' capabilities, providing a valuable knowledge base from the different past member's interactions.

Different types of Business Communities are supported, where new members can enter freely, or go through a selection process or enter following invitation, giving the chance to shape the acceptance conditions to the community requirements.

Functionalities are available to define and maintain member profiles within a Business Community including support for generic profile attributes (line target markets, products, primary/secondary activity codes, etc.), technical capabilities, capacities, and qualifications (like the technical characterisation of processes and product development, type of manufacturing equipment, available production capacity, etc). Creating communities, joining communities and helping the community Facilitator manage membership are also available, among other functionalities.

The Liferay open source Portal and Content Management system was customised and extended in order to implement the necessary functionalities. Information templates are used whenever possible to allow users of the Platform (and its Facilitator in

particular) to easily start using the functions available. For instance, the following main templates are available:

- BC and VO templates: these templates are used in the Platform to instantiate business communities and virtual organisations. A BC or VO created from the corresponding template assumes the structure and information contents defined by that template. This allows for the immediate creation of BCs and VOs, with content and structure. Future users of the Net-Challenge Platform may change these templates, thus creating new configurations for BCs and VOs;
- Member Profile templates: this template specifies the generic attributes that characterise a given member in the community;
- Capabilities template: this template allows the facilitator to specify the features that will be used by members in the community when declaring their capabilities and qualifying the capabilities of others;
- Customer Requirements, Evaluation Criteria and Risks templates: these sets of templates are used during the formation of a collaboration project and allow the Facilitator to specify the usual attributes to use in such instantiations.

The following pictures show the main screens of the end user interface.

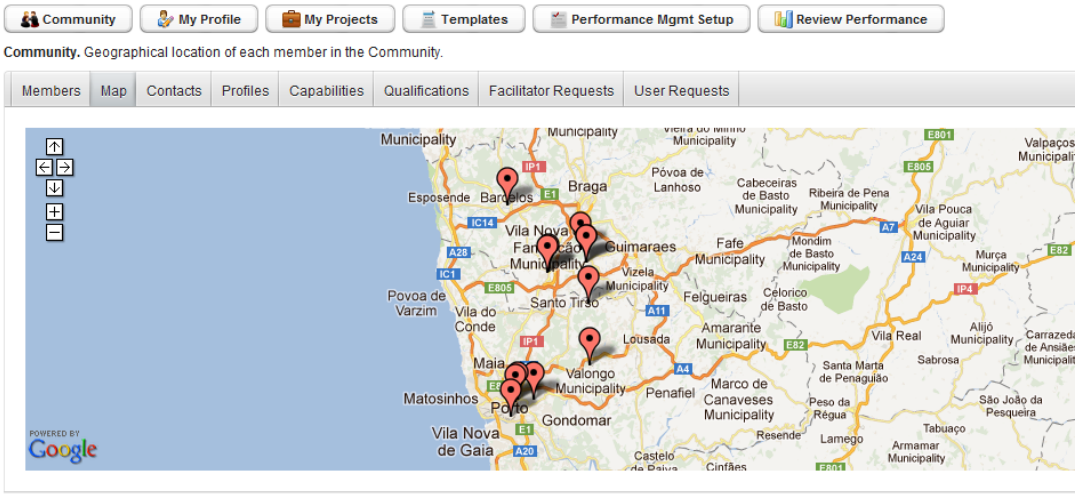

Figure 11: Map of members in a BC

Figure 12: Members in a BC

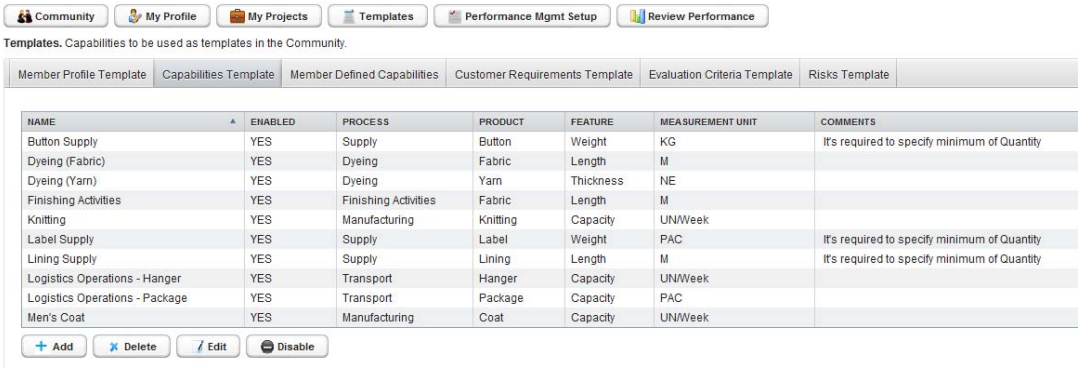

Figure 13: Capabilities template

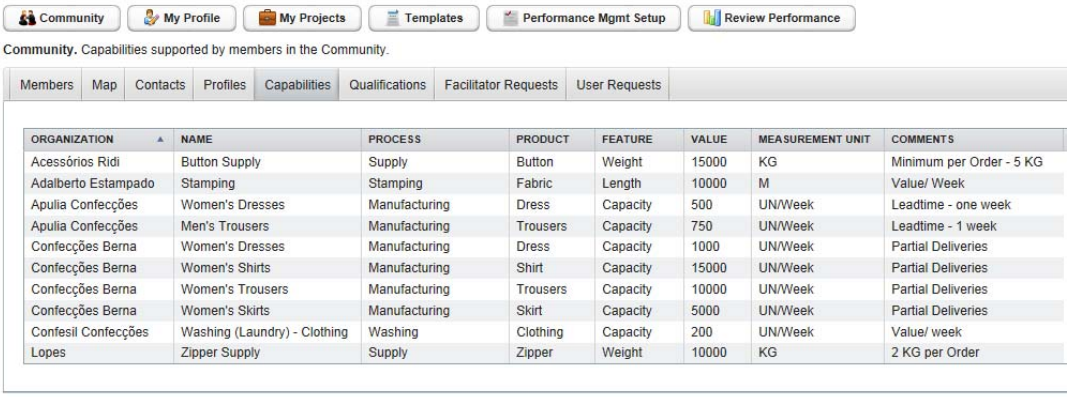

Figure 14: Capabilities in a BC

3.5.3. VO Formation and Operations Management

This module implements the infrastructure needed to run the VO specific decision support tools and a set of other minor components, like a document repository for a given VO or a wiki area for users to share knowledge during the collaborative product concept definition.

When creating a VO in a given business community, a template is used to instantiate the specific environment where all VO related activities are managed. This template specifies the functionalities that will be available in any VO and their relationship.

The Project Home contains the access to the decision support tools in the Formation, Operation and Dissolution phases of the VO. The Documents and Product Wiki areas implement a VO specific document repository and wiki-based area to support product concept and engineering activities.

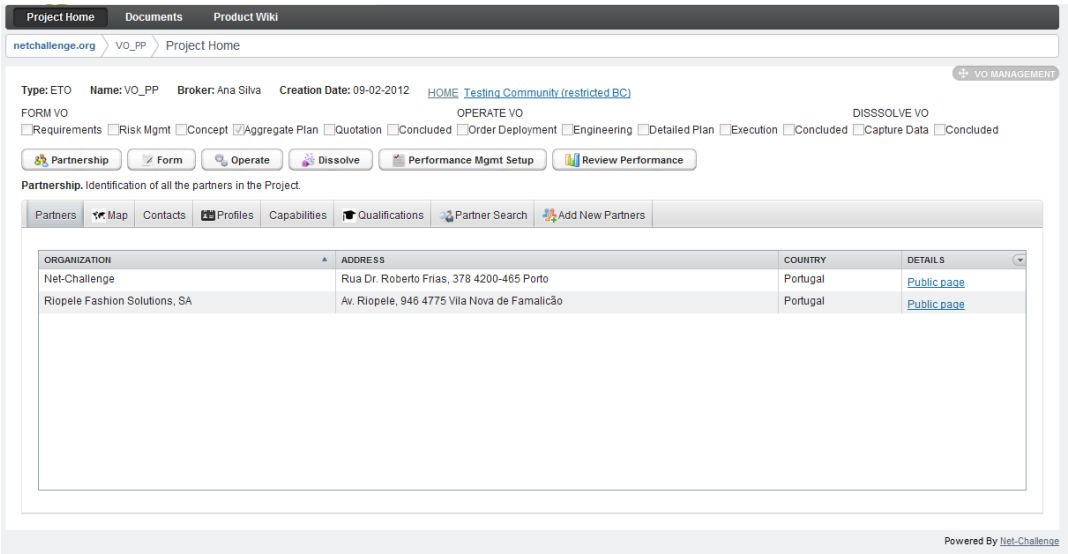

Figure 15: VO Formation and Operations Management area

3.5.4. Product Concept collaborative definition

The first Module to support the management of collaboration projects is the Product Concept module that includes the following main functionalities:

- The search and selection of partners, using the Business Community as main source;
- The collaborative definition of the product concept between the partners in the Virtual Organisation, based on the definition of a shared ontology of product properties;
- The management of a cooperative, multi-level and multi-supplier bill of components or operations.

Different partners collaborate in the same collaboration project (i.e. Virtual Organisation), sharing their expertise for a common goal. One of the main issues in a design environment is the specification of the Bill of Materials (BOM), as every partner knows which resources they need in order to achieve the proposed goals.

This tool supports the management of the Bill of Materials or Operations in a collaborative way, giving the partners the chance to suggest and discuss the resources needed (key materials and operations) and check them against the goals of the project in terms of time and cost.

The following pictures show the main screens of the end user interface.

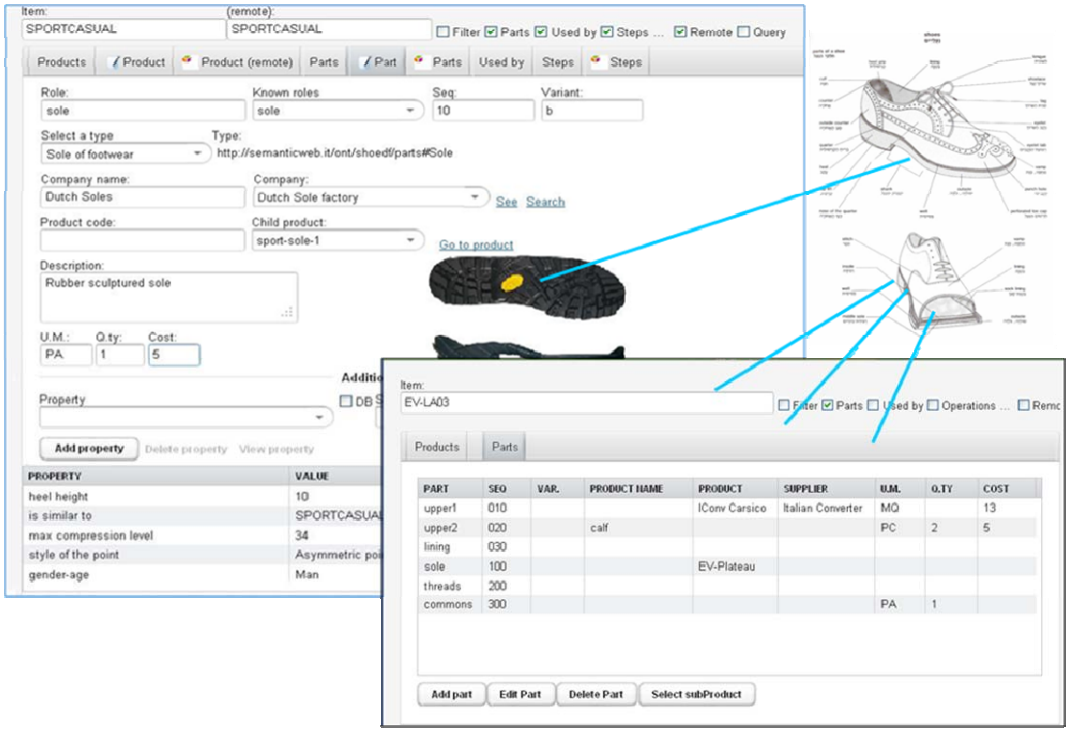

Figure 16: Product concept and cooperative bill-of-components

3.5.5. Collaborative operations planning

Collaborative networks, such as Virtual Organisations, need different tools to help their members work together as a single company in order to quickly respond to a given business opportunity. This means that many of the activities in a Virtual Organisation should be performed collaboratively by all its partners.

This module allows companies to plan the manufacturing and logistical operations in a collaborative way, by enabling real time information sharing on the capacities available inside the Virtual Organisation, the respective production costs, commercial conditions and order status.

In Net-Challenge, the production plan, the prices and the deadlines can be suggested by every actor in the production workflow, and discussed / negotiated by all of the partners, reviewing the VO goals and preventing the risks and issues that can be faced.

The collaborative planning module includes two planning approaches, based on a truthful collaborative environment, which promote active participation and negotiation between partners in the VO. The first planning approach (aggregate planning in the Formation phase) responds to the need to quickly answer a customer request for a quotation and it considers the high level operations taken on by each partner. In a second planning approach (detailed planning in the Operation phase), the main allocated operations are divided into several smaller sub-operations, which make it possible to enhance the definition and synchronisation of the materials to be used in the different sub-operations. It also allows for the division of each customer order into smaller transportation lots.

This planning framework is based on negotiations between the core partners (the ones that participated and invested in the product concept definition) and potential partners

(not yet chosen as partners in the VO and addressing operations not allocated to core partners), based on the quotations proposed by each partner. The selection of proposals includes a multi-criteria decision algorithm that makes it possible to evaluate partner quotations according to several variables and objectives, such as delivery date, cost, reliability, capabilities and qualification of each partner. This functionality is extremely important because it promotes a swift evaluation of the best proposals, considering the overall acceptance and encourages fairness, transparency and confidence in the collaborative network.

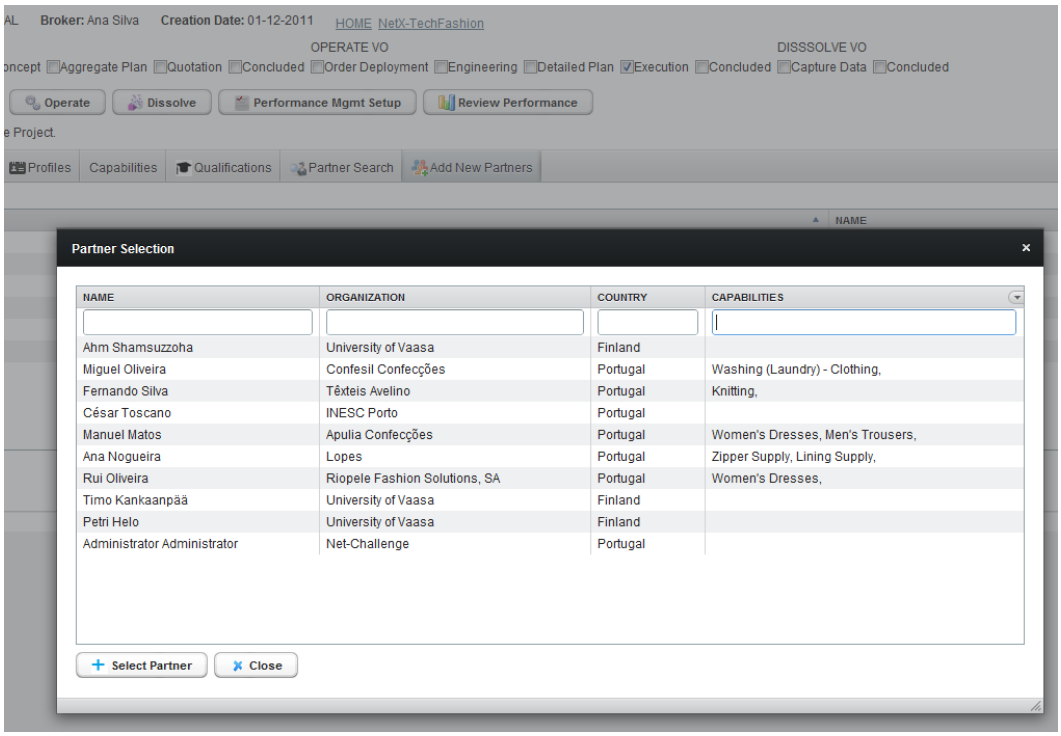

Figure 17: Partner search

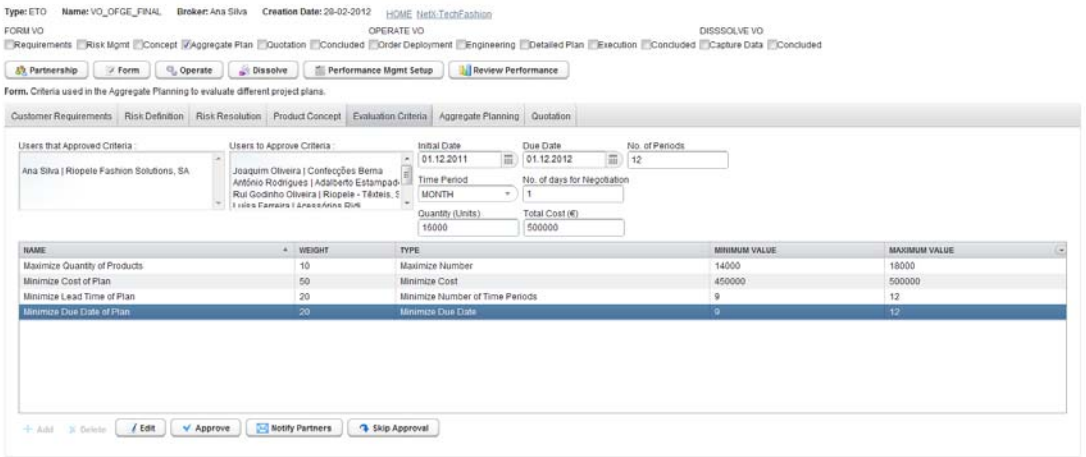

Figure 18: Evaluation criteria specification

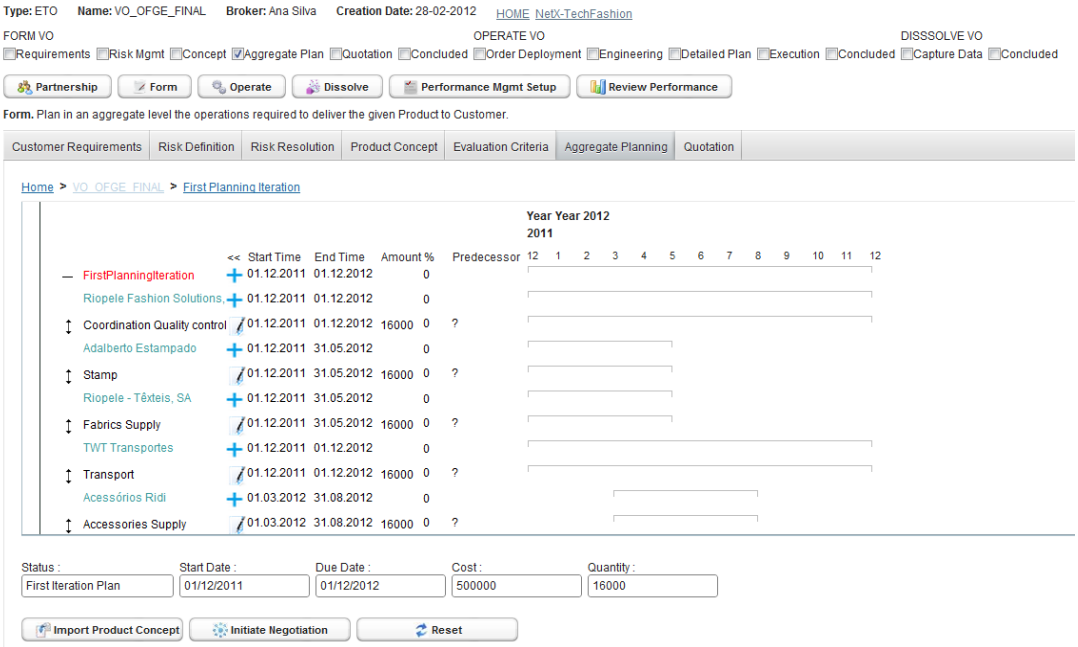

Figure 19: Plan setup

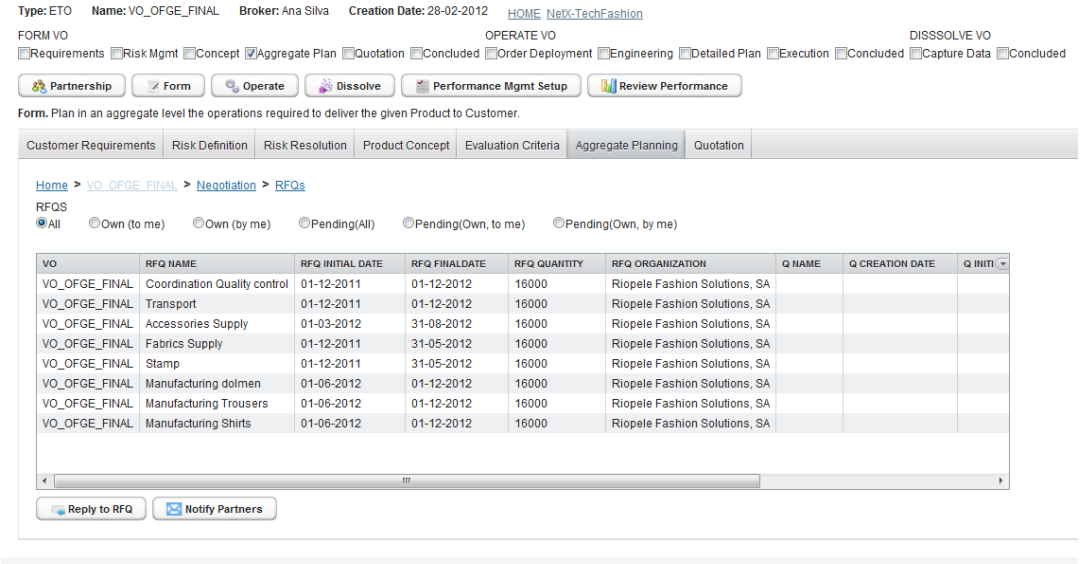

Figure 20: Requests for Quotations in plan negotiation

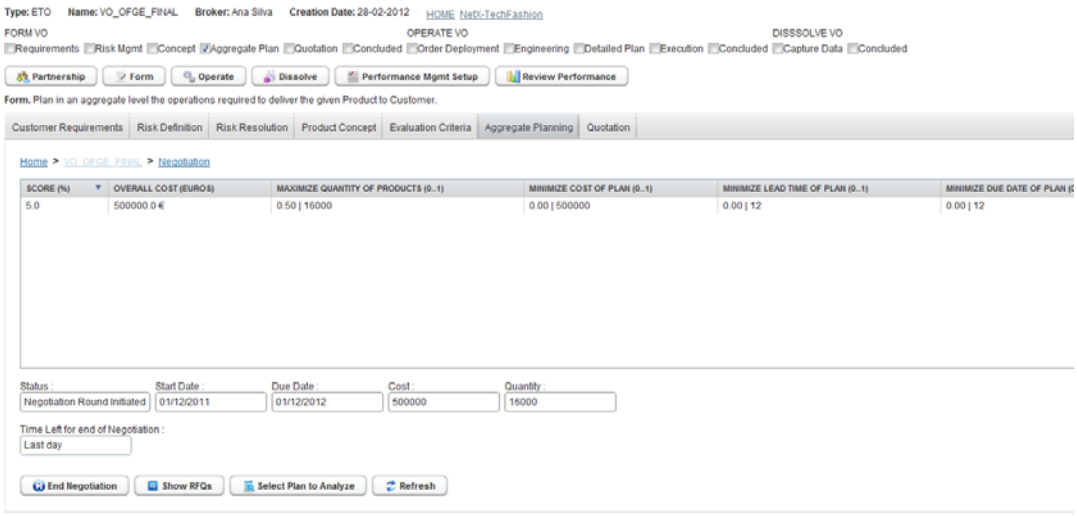

Figure 21: Evaluation of plan

Figure 21: Detailed planning

3.5.6. Monitoring and event management

The Module entitled Monitoring and event management supports the monitoring of the planned operations, it monitors deviations and unforeseen events and supports human-based decision-making in the resolution of such events in non-hierarchical business networks.

Collaboration projects (or VOs) can face different unexpected events and deviations from the execution of its plan, such as late deliveries, or the occurrence of critical problems, such as strikes at a production facility. The event management module tracks all actions conducted within a VO to identify, detect and analyse event occurrences and identify and manage the implementation of counter measures to minimise their negative consequences.

The event reaction planning activity identifies possible events to which VO is subject and defines counter measures on how to react to them. This is closely related to risk management since an occurred risk can be identified with an event. The event monitoring activity supports the event management process by detecting deviations in operations by sensing the information managed by ICT systems of VO partners.

This allows VOs to be prepared for most of the situations they can encounter, or at least have actions defined for different cases. The architecture of the Net-Challenge ICT Platform consists of system elements which offer the described functionalities to support the complete life cycle of a Virtual Organisation.

One element of monitoring and event management is production monitoring. It consists of different views to monitor the Virtual organisation's operation -phase. Each partner can see the status of all operations (including the status of other partners) and prepare for possible delays or problems. Production monitoring supports three different methods to update the production status: updated manually in product monitoring view, using SMS or RFIDs. One partner can also request another partner to update his/her status.

Another element is risk and event management. It includes new risk creation, defining deviations for it and the initial creations of resolutions and the possible actions in case the risk becomes an event. To support Virtual Organisations to better learn from previous experiences, risk management also has a risk template functionality. It adds default risks from the Business Community level (risk templates) to new Virtual Organisations. Event management includes new event creation, mapping it to foreseen risk, and defining additional deviations and initial resolutions for it. It provides a separate discussion forum, Wave, for each occurred event, where partners can collaborate together in finding possible resolution.

Event management uses Ontologies to analyse data and support decision-making in case of events occurred.

One of the main advantages of monitoring and event management is the structuring of the risk analysis processes and the planning and automation of the resolution of foreseen events.

Form. Identification of all risks the project may face in the operation phase.

Customer Requirements | Risk Definition | Risk Resolution | Product Concept | Evaluation Criteria | Aggregate Planning | Quotation

Import risks from other VOs + Add new risk

VOs identified risks

NAME	TYPE	DESCRIPTION
Quality defect	Operational Risk	Quality defect in any production phase
Material price increased	Credit Risk	Supplier informs about increasing of material prices
Shortage of supplies	Market Risk	Shortage of supplies due to supplier's problem and failure to delivery
Late delivery	Operational Risk	Delivery time is not as promised

Figure 22: Risk definition

Order Deployment | Product Engineering | Detailed Planning | Activity Progress | Project Monitoring | Event Management

NAME	DEC 2011	JAN 2012	FEB 2012	MAR 2012	APR 2012	MAY 2012	JUN 2012	JUL 2012	AUG 2012	SEP 2012	OCT 2012	NOV 2012
Accessories Supply				2500 | 0	2500 | 0	2500 | 0	2500 | 0	3000 | 0	3000 | 0			
Coordination Quality Control	4000 | 0	4000 | 0	4500 | 0	7500 | 0	8000 | 0	8500 | 0	13300 | 0	10800 | 0	10800 |	7800 | 0	7800 | 0	7800 | 0
Fabrics Supply	2500 | 0	2500 | 0	2500 | 0	2500 | 0	3000 | 0	3000 | 0						
Manufacturing Dolmen							2600 | 0	2600 | 0	2600 | 0	2600 | 0	2600 | 0	3000 | 0
Manufacturing Shirts							2600 | 0	2600 | 0	2600 | 0	2600 | 0	2600 | 0	3000 | 0
Manufacturing Trousers							2600 | 0	2600 | 0	2600 | 0	2600 | 0	2600 | 0	3000 | 0
Stamp	1500 | 0	1500 | 0	2000 | 0	2500 | 0	2500 | 0	3000 | 0	3000 | 0					
Transport	0 | 0	5000 | 0	5000 | 0	5000 | 0	5000 | 0	6000 | 0	16000 | 0	0 | 0	6000 | 0	0 | 0		0 | 0

Edit

Figure 23: Activity progress (tabular view)

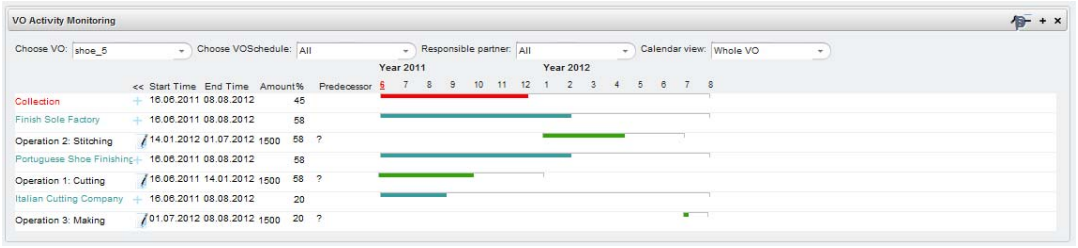

Figure 24: Activity progress (gantt view)

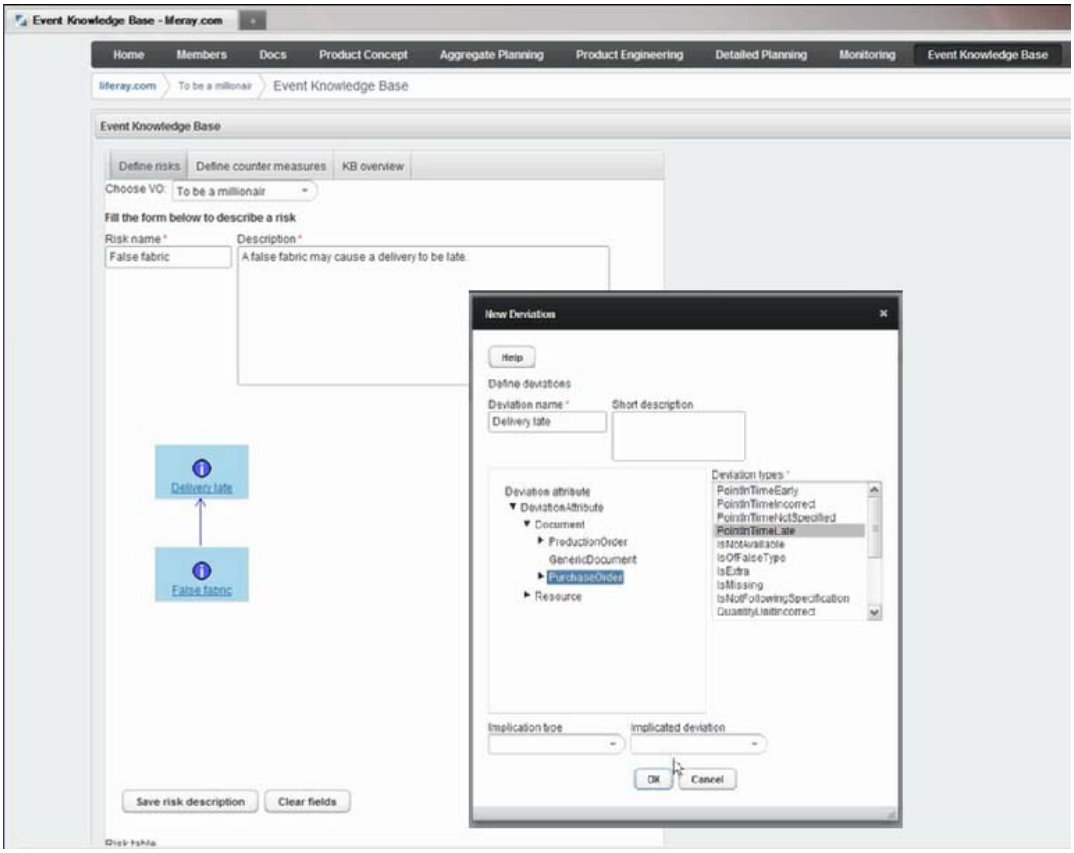

Figure 25: Event knowledge base

3.5.7. Gantt-chart and Calendar

This module presents the graphical visualisation of Gantt charts in the user interface. It is a common module to both the Collaborative Planning and Monitoring / Event Management modules.

3.5.8. Product Platform and CTO

The Product Platform and CTO module supports the formation and operation of Customise-To-Order collaborative projects. The module implements the infrastructure needed to run the specific decision support tools, namely a Product Variety Analysis, a Product Platform and a Product Configurator component. These components existed before the Net-Challenge project and were integrated in the Net-Challenge Platform following the Methodology.

When creating a VO in a given business community, a template is used to instantiate the specific environment where all VO related activities are managed. This template specifies the kind of functionality in the form of portlets that will be available in any VO and their relationship.

The Project Home contains the access to the Net-challenge decision support tools in the Formation, Operation and Dissolution phases of the VO. The Documents and Product Wiki areas implement a VO specific document repository and wiki-based area for supporting product concept and engineering activities. The remaining three areas;

Product Variety Analysis, Product Platform Analysis and Configure Variant host the product platform specific tools.

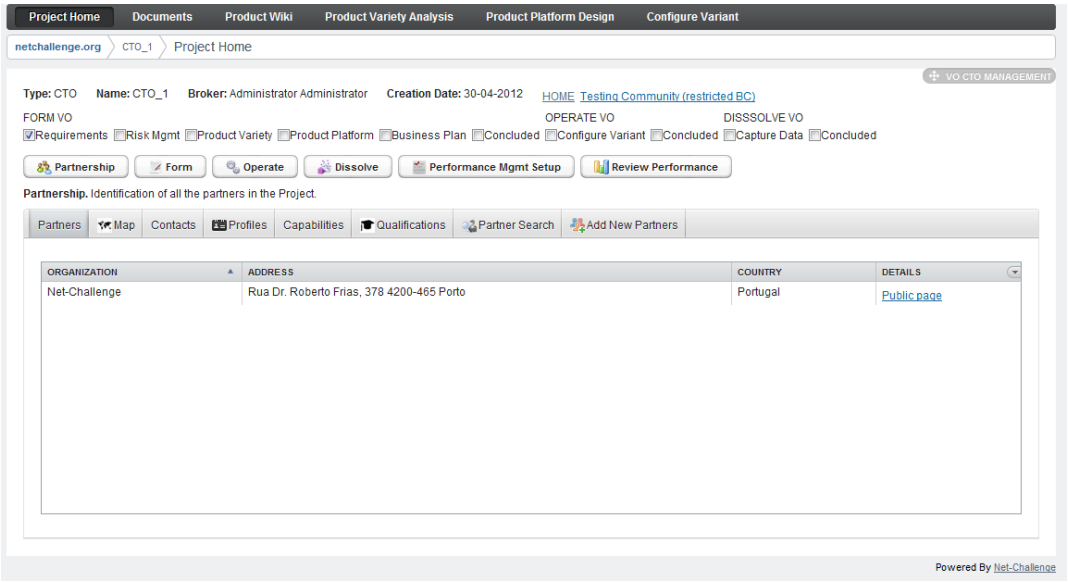

Figure 26: Product Platform and CTO area

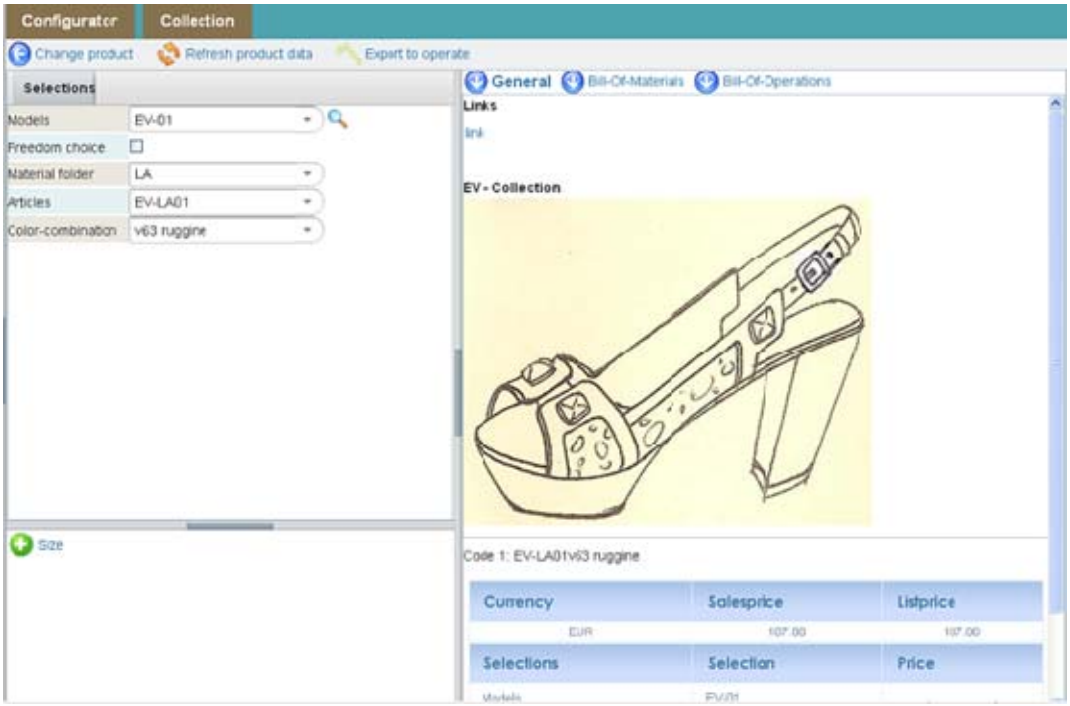

Figure 27: Product Configurator component

3.5.9. Performance management

Performance management is crucial to evaluate the accomplishment of success factors by a collaborative network, either a Business Community or a collaboration project (Virtual Organisation). For each, the Net-Challenge Performance Management module allows for the definition of the specific process that supports performance management along the complete life cycle of that organisation (BC or VO).

Key stakeholders are the entities that have an interest in the organisation's activity or in its outcomes. In the case of a Business Community, the stakeholders are the members of the community, society and customers of VOs. For VOs, the stakeholders are its partners, customers and society.

Each key stakeholder defines a limited number of Key Success Factors (KSF). Each KSF is characterised by a name, a description, a description of the organisation's current situation ("as-is") and a description of the desired level of satisfaction ("to-be").

To achieve the desired level of KSF satisfaction, the organisation must concentrate on the internal processes that affect its performance. Key Performance Factors (KPF) model these internal factors and are characterised by a name and a description. A KSF can be affected by one or more KPF and a KPF can affect one or more KSF. In order to measure each partner's contribution to a certain KPF, a KPF may be disaggregated.

Each KSF and KPF is measured quantitatively by one or more Key Performance Indicators (KPI). Inversely, each KPI measures one or more KSF or KPF.

A KPI has an owner (manager), a person that belongs to the organisation being measured (a BC, VO, BC member or VO partner) and who is responsible for its management and measurement. The KPI is defined by a name, a description, a measurement frequency, a formula, a target, a value and other elements. The value results from the application of a formula, expressed in a given unit, that uses data collected by the KPI owner (in a given a certain frequency) from specific sources inside each BC or VO member. Some KPIs are considered automatic as their values can be automatically retrieved from the Platform itself (when the necessary information is available in the platform, like delivery dates, the respective KPIs are calculated automatically, according to the frequency defined).

The KPI owner compares the value against the target (the desired value for that KPI), according to the measurement frequency. If a difference is detected, corrective actions must be defined.

Since a VO has a shorter life time than a BC and needs to respond very quickly to a business opportunity, the Net-Challenge Performance Management Framework defines a set of scenarios to assist a VO in the initial definition of KSF, KPF and KPI. Each scenario represents a typical business context and is characterised by a certain type of customer and a predefined set of KSF for each key stake holder. These scenarios (similarly with templates) can be adapted to each real situation.

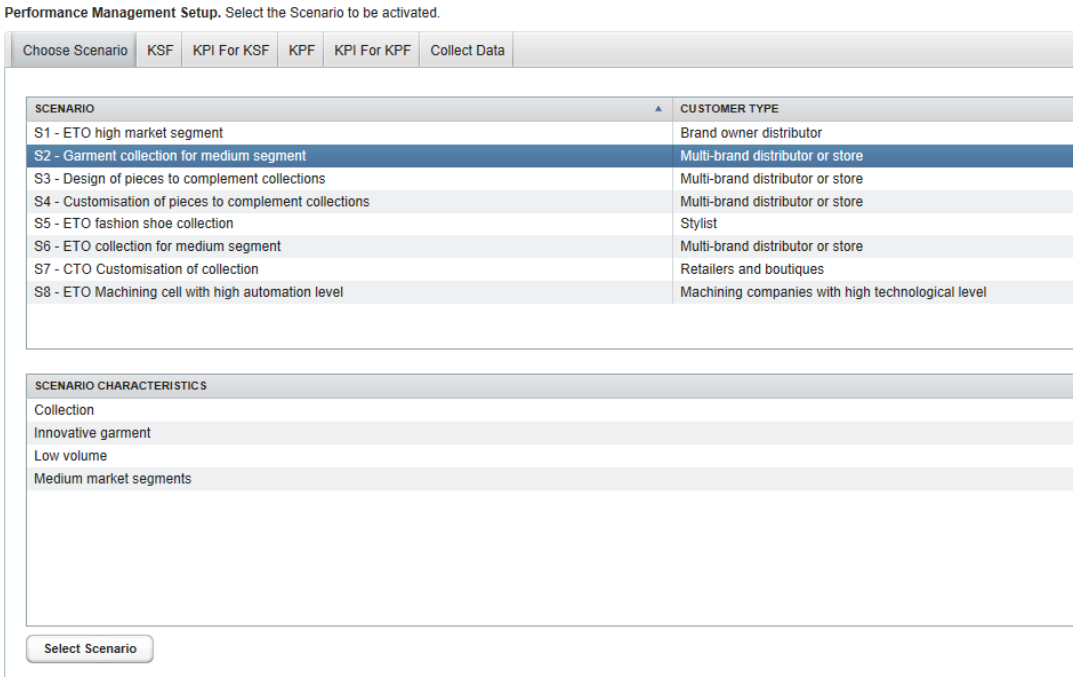

Figure 28: Selection of a performance management scenario

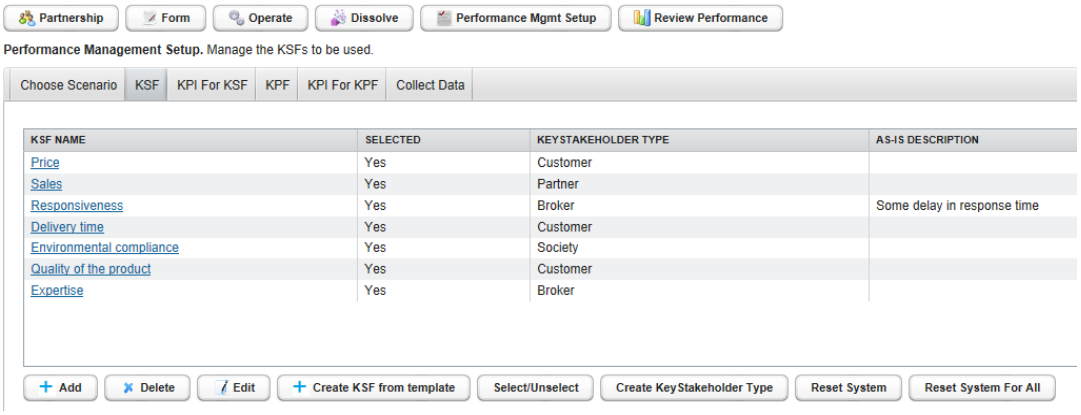

Figure 29: Setup of Key Success Factors

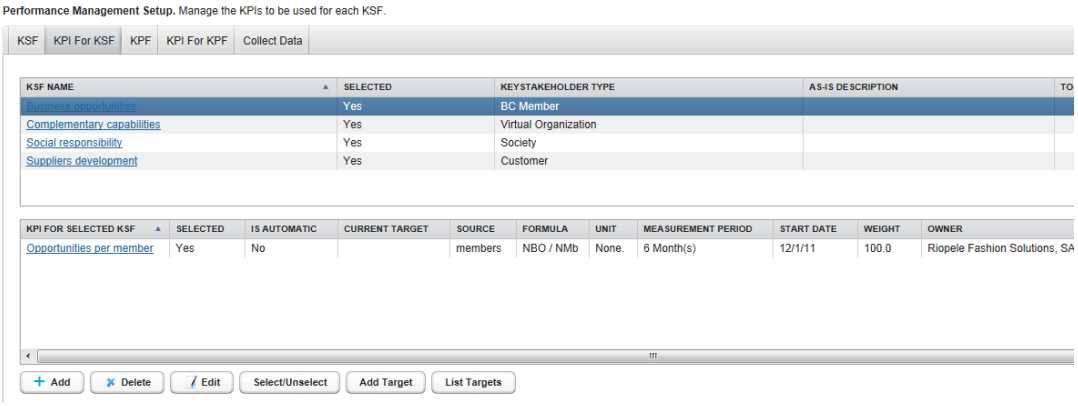

Figure 30: Setup of Key Performance Indicators

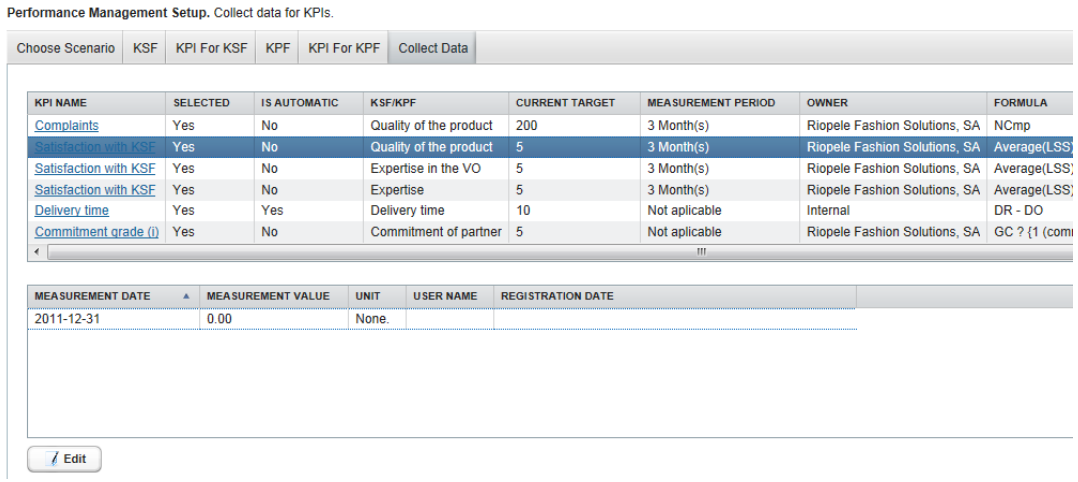

Figure 31: Collect data

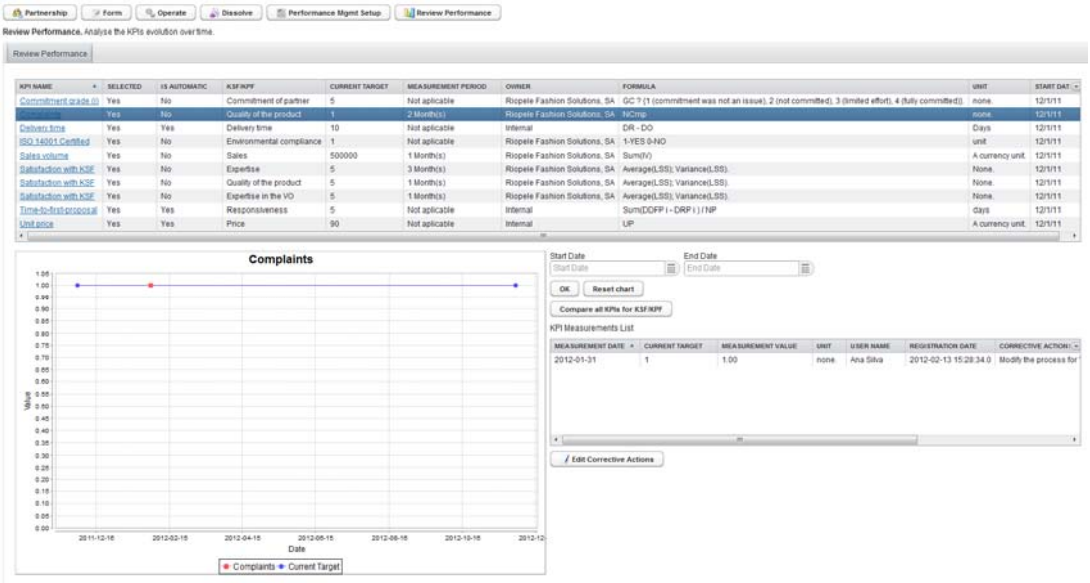

Figure 32: Review Performance

3.5.10. Technology adopted

A number of technological elements were selected to facilitate the implementation of the Net-Challenge Platform and Decision Support Tools and to enrich its future usage and exploitation potential. A brief identification of the main technical elements follows:

- Liferay technology – This constitutes the foundation of the Net-challenge infrastructure. All of the software components developed are fully integrated in this environment allowing Net-Challenge users to have at their disposal a vast number of applications (content management, document management, blogs, calendar, wiki, news, etc.). Some of these applications are already used by Net-Challenge (according to the needs of the Net-Challenge Methodology and Business Reference Processes) and thus integrated in the Net-Challenge Platform but others remain for future selection and usage, thus increasing its exploitation potential in the future.
- Google Web Toolkit – This constitutes the software architectural foundation of the Net-Challenge Platform and Decision Support Tools. The software is divided into three major levels, the core object model and data access level, the services level and the presentation level. The Google Web Toolkit makes it possible to run the presentation level components in the browser of the user.
- Vaadin framework – This framework facilitates the implementation of software for the Google Web Toolkit, allowing software developers to program in the Java programming language despite the fact that the software is afterwards compiled into Java Script before running it in the user's browser.
- Hibernate – This constitutes the object-relational mapping framework that was used to facilitate the management of data in a relational database management system.
- Google Maps, Google Wave – These application components are used in some parts of the Net-Challenge Platform to give the user a graphical visualisation of the geographical location of companies in a given Business Community and/or in a given Virtual Organisation.
- XML, Web Services – XML is used to manage the configuration of several features of the Platform while the Web Services are used so that interaction with external systems are possible (ERP and Business2Business systems).
- Java Platform – the Java Standard Edition constitutes the basic foundation of the Net-Challenge Platform, working as a kind of operating system, so that Net-Challenge Platform may be deployed and run in several computing platforms (Windows and Linux for instance.)

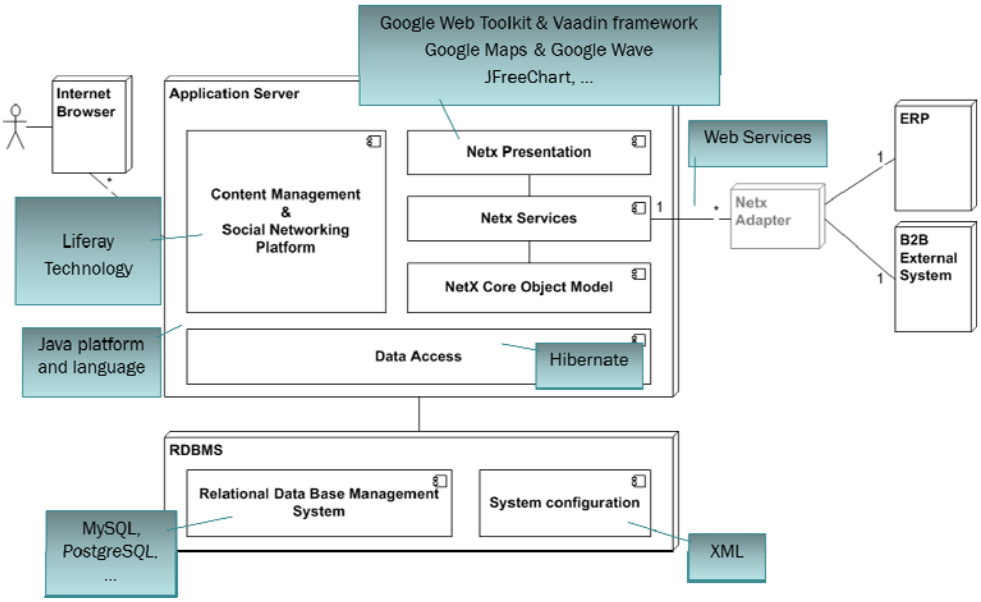

Figure 33: ICT Platform internal organisation and technology adopted

3.5.11. Training Materials

The Net-Challenge users will have several different profiles within each organisation. Similarly, the nature of user companies, their technology and their approaches will be different. To cover the training needs of different user profiles the training materials developed include a multimedia training tool, PowerPoint presentations, user guides and Video Screen animated walkthroughs. The purpose is to be able to provide both material on a one-to-one and group basis, but also to ensure there is sufficient material for 'back-at-base' guided learning. The multimedia training course includes and combines the other training materials (including text, images, PowerPoint slides and video). The course will take into account the different profiles of the platform users. Each user profile will go through a course with suitable content.

In order to create a course with suitable content, several basic profiles were identified:

- Basic users and advanced users;
- First time users and regular users;
- Textual learners and visual learners.

A concept of the training was built using a software tool that is used to create personalised courses. This software, GRAPPLE, is based on the concept of adaptive hypermedia, in which the course website looks at the visitor's behaviour and profile (e.g., by using a small survey or user preferences page) to change the content and navigation accordingly, namely:

- Visual learners will be provided with more visual information;
- Beginners will see indicators for suitable and less suitable content, and indicators of recommended content;
- Repeat visitors will be provided with a more condensed version of the course.

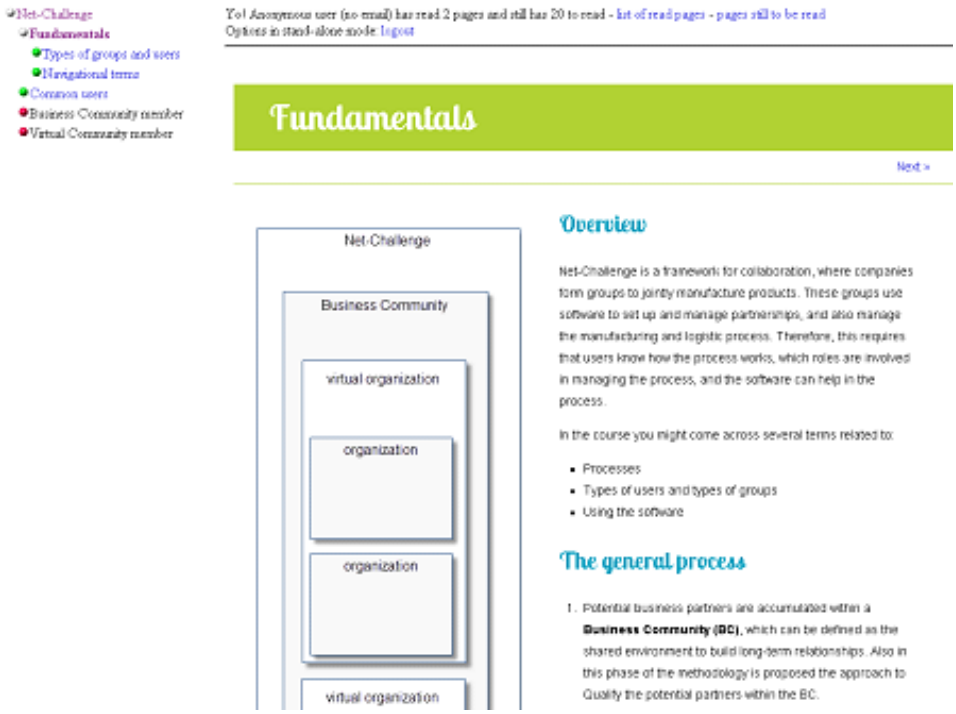

Figure 34: Multimedia training course

Each page adapts its content based on the user profile, showing more or less content and/or more/less illustrations. Each page shows different colours for the topics that are recommended and for the topics that were already seen by each user.

3.6. Demonstration

3.6.1. Textile and apparel demonstrator

The testing activity was organised starting with the current cooperation needs and perspectives of the companies involved. A Business Community (BC) was defined focusing on the business goals of the project partners Riopele and RFS (previously named as RPB). The community was named NetX-TechFashion and was defined as a closed BC involving a total of ten companies. The community aims to bring together textile and apparel companies and sectors with related activity in order to promote the creation of partnerships to design and manufacture technical apparel for several working areas, such as the military, police forces and airline crews.

In this context, a Virtual Organisation (VO) was formed involving members from the BC to develop a real and specific business opportunity. This Business Opportunity is related with the production of thousands of uniforms that are made up of three pieces of clothing – a shirt, a dolman and trousers. The objectives of this collaborative project were to produce thousands of pieces that respect functional and technical aspects and to obtain good prices and the best delivery dates.

The Net-Challenge Framework was used following the project approach, including the methodological aspects proposed to address the creation and management of these networks, the reference processes and the ICT Platform which supported the collaboration during the whole life cycle of the BC and VOs. This implementation was crucial for the identification of improvement opportunities that were promptly developed.

The results achieved and the specific experiences gained during the validation activities proved that the tools developed provide clear added value in several activities, including:

- The approach proposed to manage business communities is a good instrument to manage the relations and the information exchange and sharing with the partners and subcontractors of a virtual manufacturer like RFS or a large company like Riopele. The ICT tools to manage these business communities were also a good entry point for the other functionalities available.
- Good support to manage Engineer-To-Order (ETO) collaboration projects to design and manufacture custom made and customised apparel. The following aspects were especially relevant:
  - The availability of a single document repository, shared by all partners, allowing them to easily share the technical documents regarding the specification of customer requirements, technical characteristics about the product being designed and produced, the contract that binds together the partnership, etc;
  - Search of partners to invite to a given Virtual Organisation, based on reliable information available at the community level and captured from the capabilities stated by the members and their third-party and independent qualification;
  - Definition of the plan required to manufacture a given ETO product, letting the companies involved negotiate the best way to conduct the plan and allowing any partner to propose alternatives and actively participate in the plan definition;
  - Tracking the production on each partner so that exceptions to the normal execution of the plan are detected as soon as possible and it is possible to react in a formal way, involving all of the affected partners in the resolution process;
  - The Framework for performance management promotes continuous improvement and partner alignment in the long term. A significant set of key performance indicators made it possible to measure the performance of collaborative projects and the partners participating. Performance information will improve the partner search.

The support provided by the Net-Challenge Framework was found to reduce the lead time associated with defining a quotation and agreeing on an operations plan, the costs associated with the coordination of activities and the risks associated with critical events and non quality problems.

3.6.2. Footwear demonstrator

In the Footwear Demonstrator, a business community (BC) was defined focusing on an elective interest of the project partners, Synesis and Italian Converter, namely the outset, design and production of footwear with “healthy” characteristics. This is in fact a very interesting market segment where the consumer requests combine the demand for fashion and the need for specific functional characteristics which could ensure the wholesomeness of the product. In addition, several quality values related to the sustainability of the product were included among the distinctive interest of the BC, like ecological values, care during product dismissal, measurement of the environmental impact of the production process and the product life. The BC was given the name 'Healthy Shoes'.

Moving from this set of interests, some Virtual Organisations (VO) were formed around the development of specific business opportunities involving members from the BC.

The objectives then focused on collecting shoes with specific healthy features, following the requests of a stylist. The output of the VO would have been the design of the footwear collection, the completion of the prototypes and the overall organisational information to support the subsequent industrialisation.

The Net-Challenge platform was tested following the various axes of the project outcomes, moving from methodological aspects, related to the general behaviour and distinctive values of the BC and derived VOs, to the processes to be followed to ensure the smooth and controlled development of cooperation among BC members and VO partners, up to the usage of the Net-Challenge platform, which supported the cooperation experience during its whole life cycle, by means of specialised tools for specific operations.

A specific effort was devoted to the definition of common concepts aimed at the description of footwear products in terms of their structural and functional attributes. This was achieved by developing a simple ontology of product properties and inter-relations to be used in particular by the Product Concept and Partner Search tools. This experience highlighted the importance of sharing a common vocabulary among partners in the same community, which in turn represents a good example of a broader standardisation effort, necessary for the whole footwear industry.

The final results and the tools developed were considered to cover the main requirements for collaboration in the scenarios defined for the Footwear case. The main added value found in the proposed Framework includes the following aspects:

- The proposed approach to manage business communities is a good instrument to share information, select the right partners for each opportunity, advertise internally to the community and to the outside the capabilities and products of the members, and to define a common background of knowledge and language which is the enabler for effective cooperation;
- Good support to manage ETO collaboration projects to design and manufacture custom made and customised footwear, especially regarding the ability to share design ideas from the very beginning of the product concept, the efficient organisation of cooperative work with respect for all of the partner needs and availability and the safe management of risks and contingency connected with normal and cooperative activities;
- Smooth connection from ETO project and their CTO evolution, through a natural commonality of concepts and tools.

3.6.3. Machine tools demonstration

In the Machine Tools Demonstrator, a Business Community (BC) was defined focusing on the interest of the project partners, ONA and RoboC, namely the automation of manufacturing lines composed of different types of machines and processes. These are complex services and products that can be seen as interesting opportunities for SMEs. Big corporations specialise in automation solutions focus on turnkey projects for markets and customers that involve a very high volume of investments. If the budget is reduced, only standard pre-packed solutions can be offered for SMEs. Many small-medium scaled projects for automation have been detected where the customised part is really important for the customer. Such a kind of standard pre-packed solution does not fit the customer requirements because in fact, the customised part has to do with the final value added for the customer.

The proposed “Machine Tool” BC virtually includes any company in the manufacturing area that is interested in collaborating in complex projects that exceed their capability and/or capacity. Exploring this scenario of collaborative processes developed by Machine Tool manufacturers fits the aim of the Demonstration phase of the Net-Challenge project.

Some virtual organisations (VO) were formed around the development of specific business opportunities involving members from the BC, but the demonstration was bounded to the fields that ONA and RoboC are more concerned. ONA has some experience in Automation lines for the moulding industry, based on EDM machines where the automatic manipulation of work-pieces and tools across the line is one of the key points. This type of robotised environment is well known by RoboC. The “Automated EDM Cell” VO proposed in the Machine Tool Demo case fits perfectly in the ETO concept and associated Net Challenge methodology.

What seems to be problematic in Machine Tool turnkey projects (like the Automated EDM Cell VO) is how to quickly develop the product concept in a safe way starting from the set of customer specifications and requirements. The target is to be reasonably sure that the VO can be implemented in the terms described in the offer (*viability*) and according to cost and time-to-market constraints. In this environment, Risk/Event management and Product Concept modules have been proven to be interesting tools for managing complex turnkey projects in the automation and machinery industry, offering real added value in relation to the solutions that are currently available.

It was found that the platform could be used to build a kind of knowledge database for solving problems that have already happened. The basic mechanism for this consists of defining and identifying risks and connecting them to their solutions. The pre-defined templates are considered as a tool to transmit experience and application content for the developer/user. If there is a real aim of collaboration and sharing information extracted from that experience, after a certain number of projects, every partner will have obtained basic knowledge that can be used to reach a better position, minimising associated risks. Technically, risk templates at the BC level let the VOs export such knowledge and close the loop for improving business practices.

Although it is not clear that VOs would always share their experience inside the BC, the Net Challenge platform and associated methodology promote business relationships under a *transparency* concept that can help to overcome such difficulties.

4. Potential impact

4.1. Overall impact

The Net-Challenge Framework supports the implementation of non-hierarchical SME networks for complex products design and manufacturing. The implementation of these networks aim to support European SMEs in better responding to market opportunities, ensuring a quick response, fast time to market, differentiated products and services and competitive prices. European SMEs join forces to compete better in the marketplace and to be able to increase their margins and long term sustainability.

The dissemination of these non-hierarchical networks and the increased networking levels of European SME's will impact on Competitiveness, Innovation, Efficiency and Employment as follows:

- Increased Flexibility:
  Net-Challenge allows industrial SMEs to network in an agile manner in order to adapt to the rapid evolutions of existing and future markets. The dynamic Networking effect will allow companies to quickly react to the latest trends without having to completely change internal processes. Changes in demand levels can be managed by increasing or decreasing the activities internally and the activities delegated in business partners.
- Increasing Production Capacity for European Enterprises:
  The provided methods, concepts and tools will enable efficient network operation for complex products, which is also a key and sustainable differentiation factor for European companies. For these complex high added value products Net-Challenge will also enable a significant increase in production capacity and capabilities within the network or manufacturing ecosystem.
- Cost Reduction:
  Faster and efficient partner selection will provide better and lower cost solutions for market demands. Companies will be able to find and select the partner that optimally fits their needs. This will reduce the possibility of not finding suitable partners and will generally allow companies to reduce the number of failing projects. The Net-Challenge framework will also reduce the costs associated with the management of the relations in the network.
- Improved Innovation Potential:
  Joining the unique competencies of several SMEs, with the support of the collaborative product concept and design, SME networks will be able to develop new products faster than when working separately. This will positively impact the business margin and/or market share.
- Cooperating Globally:
  Net-Challenge will foster global collaboration by providing the necessary infrastructure and networking capabilities, lowering the barriers to global interaction. This will allow companies to act as global players even if they are small in size and spread out in terms of their physical location. This will be especially beneficial for European SMEs and even for Micro-Enterprises.
- Enhancing Competiveness:
  Improved competiveness by addressing more dynamic and global markets with differentiated products. As of today, only highly organised and skilled companies

with the right support tools are able to target these market segments. With Net-Challenge, this barrier will be lowered for European Companies. This is a strong differentiation factor when competing against large companies and countries with lower labour costs and it is difficult to copy.

- Meeting Demands Just-In-Time:
  Better planning and coordination of activities will improve reliability of delivery dates & customer service. European Enterprises may use Net-Challenge to seamlessly communicate and to adopt just in time demands allowing partners to be instantly notified about changes and updated requirements.
- Lowering Complexity:
  One of the main challenges today is increasing complexity. Markets have developed into complex entities involving many partners. Paradigms, such as outsourcing require a more globally distributed supply chain and an excellent capability of managing messages and relationships. Net-Challenge lowers the complexity by automating many steps, and by easing the global communication between business partners, it allows even smaller companies to participate in this process.
- Increasing Knowledge and Experience in Information Society opportunities:
  Although technology and especially the Internet has been established as a base for many companies, the deeper understanding is still limited and many companies are slow in adopting new technology trends, especially smaller companies. Net-Challenge increases the technical understanding of companies by showing them the benefits of new approaches and by fostering the bi-directional collaboration of companies, which leads to a learn-effect when exchanging information and knowledge between participating organisations.
- Increasing Employment and Social Cohesion:
  The previous impacts, like increased competitiveness, added value and flexibility, have a positive impact on the SMEs sustainability and growth rates. More competitive SMEs with relevant growth rates will need more employees and will be able to create better conditions for its employees. This will naturally impact on the level and quality of employment and social cohesion in Europe.

4.2. Dissemination

The dissemination activities within the Net-Challenge project were considered a vital part of the project and aimed to spread the project vision, objectives and results achieved to all relevant audiences. As a basic starting point, all communication and dissemination activities followed the rules and processes defined and agreed by all partners in the project Description of Work and signed Consortium Agreement.

This section presents the dissemination plans and objectives, and also the activities implemented and the results achieved.

Aligned with the Net-Challenge project objectives, different target groups and audiences have been defined, allowing for the definition of specific dissemination objectives and actions for each group. In spite of the definition of different communication and dissemination actions and channels, mass media was one of the most important channels to reach the defined four Net-Challenge target groups: the business world, the research community, the general public and policy makers.

Some of the actions planned were not exclusively limited to the duration of the project since all partners agreed that activities should not cease with the project end. In this

case, individual partners will perform their own dissemination activities, in order to motivate new SMEs to implement advanced forms of collaboration. This will also allow them to continue transferring and applying the most important work performed in the project in industry, such as the methodology, collaboration processes and software tools.

To ensure that Net-Challenge fulfils its ambitious purpose of reaching the target audiences mentioned, the dissemination activities that were planned and implemented during the project were the following:

- Project identity and merchandising. This basic but important action implemented, included the definition and creation of the project logo and identity manual as well as master slides, posters, brochures and leaflets. Templates for project documents and presentations were produced to support dissemination activities.
- Web portal. A visible and dynamic web portal was developed, maintained and made available at the web address, www.netchallenge.org. This web portal includes an open and publicly accessible general section where information about the project can be dynamically added and updated, including news regarding or related to the Net-Challenge project and relevant information for SMEs and other relevant actors. Additionally, the web portal allows internal collaboration and document sharing between project partners under private sections that are properly protected with security and authentication mechanisms. The content in the portal is dynamic and any new public information related to the Net-Challenge project is published there.
- Newsletter: As part of Net-Challenge's dissemination strategy, an electronic newsletter was designed. In addition to the electronic format, this newsletter was designed to be suitable for distribution in printed format, targeting more specific audiences such as SMEs, fairs or other events. The first issue of the Newsletter was launched in March 2011, when significant results were achieved. The second issue was released in November 2011 and the last issue in April 2012.
- External communication: Dissemination of project results in the international and local mass media was considered on a case by case basis and when opportunities were identified. The objective was to spread the results achieved as quickly and widely as possible. When results and outcomes were considered relevant, press releases, articles, publications and presentations were put forward.
- Net-Challenge published a total of 25 papers in international journals, conferences and books (as detailed in the respective tables).
- The Net-Challenge Interest Group. The Net-Challenge project planned the creation of an Interest Group (IG) that was set up with a limited number of external interested organisations. The main objective of the IG was to provide a wider perspective of the industrial requirements, to validate results achieved and mainly to disseminate the project results. To fulfil this purpose, companies from diverse sectors and different countries were targeted. The Interest Group was advertised on the project website and other direct contacts. The interest group is implemented in the project portal and will continue operating after the project end.
- Workshops. This very powerful dissemination task achieves its highest potential when real and relevant results are available; therefore, the organisation of specific workshops was planned after the availability of demonstrable results. This kind of event allowed the project to increase its visibility and gain an audience among SMEs. During the project, the Net-Challenge project was involved in the

organisation and co-organisation of 5 Workshops and attended 4 other dissemination events (see list for details).

- Social media marketing actions. The Net-Challenge Consortium planned to use social media and marketing tools to spread the voice of the Net-Challenge project as much as possible and interact with the target audiences. In this line a twitter account was set up and managed. A direct link to this twitter was added in the project portal.

4.3. Exploitation of results

4.3.1. Net-Challenge Target Markets

The Net-Challenge Framework was designed to target the specific requirements of SMEs in building non-hierarchical business networks for complex product design and manufacturing. In this context Non-hierarchical networks are business networks where SMEs have a significant participation in the decision-making process and are not restricted by the bargaining power of large organisations.

Complex products in the context of the Net-Challenge Framework are considered products with a large number of components (normally with a large number of suppliers and several levels of supply) or complex manufacturing processes associated with the product customisation.

In this context, key target industrial sectors include:

- Machine tools;
- Metal working;
- Textile and Apparel;
- Footwear;
- Construction;
- Furniture;
- Sport Goods;
- Specialized Electronic devices.

A profound analysis of the experience during the implementation of the demonstrators and preliminary contacts with potential users of the Net-Challenge Framework allowed for the definition of the main target markets, namely:

- Individual SMEs (both to create and to participate in ETO and CTO projects);
- Industrial associations;
- Long term business networks (clusters, etc.);
- Large companies (to manage their SME partners);
- Technology providers that supply the Net-Challenge framework as a service;
- Consulting companies.

4.3.1.1. Individual SMEs

Individual SMEs are the main target of the Net-Challenge Framework, especially those coming from the industrial sectors identified above that design or manufacture complex or customised products or their components.

Individual SMEs from these sectors will use the complete Net-Challenge Framework to manage the relationships with their business partners and to manage specific collaboration projects (VOs) for the design and delivery of complex products.

Medium enterprises may implement the Net-Challenge framework on their own initiative to manage the relations with their business partners and their collaboration projects. However, this will be difficult for most small companies (in terms of the human and financial resources needed). In practice, industrial associations, long terms business networks created among SMEs, large companies and technology providers will be in better conditions to implement the Framework and make it available to smaller companies as a service.

4.3.1.2. Industrial associations

Industrial associations will be very interested to use the modules to manage the Business Communities composed of their associate companies.

For them it is important to promote communication between their members, to distribute information and promote knowledge creation. Other important functionalities include:

- Promoting member competencies and products in their target markets. This is possible because the Business Community Management module permits the dissemination of the members competencies to the outside world;
- Disseminating information about business opportunities identified between the associate companies;
- Facilitating the search and selection of partners between the association members to respond to specific market opportunities.

Industrial associations can also offer their members the service to manage specific collaboration projects. This can be offered as an additional service included in the normal membership fee or as an additional service that may be charged separately to the companies that want to use it.

From the analysis conducted so far, industrial associations will be a key partner in disseminating the use of the Net-Challenge framework.

4.3.1.3. Long term business networks (clusters, etc.)

Long term business networks, including clusters or groups of SMEs will use the Net-Challenge Framework in a similar way to industrial associations, as described above.

4.3.1.4. Large companies

Large companies can use the Net-Challenge Framework to manage their relations with strategic partners and suppliers. The most relevant functionalities in this scenario will be:

- Management of the closed business community composed of the strategic or most relevant business partners and suppliers;
- Management of collaboration projects with their partners, where they can collaborate on the definition of the product and the operations plan, and update and share the status of the operations, including event management;
- Performance management.

4.3.1.5. Technology providers that supply the Net-Challenge framework as a service

Technology providers, including software houses, telecom operators, internet service providers and similar organisations can implement the Net-Challenge Framework in dedicated servers and offer the platform as a service. SMEs will be able to use the platform by paying a fee for the real usage of the system.

This is possible because the platform developed supports the implementation of several Business Communities and an unlimited number of member companies and users.

This will also be an important route for the wide dissemination of the Net-Challenge Framework to SMEs.

4.3.1.6. Consulting companies

Consulting companies and RTD centres will use the Net-Challenge Methodology and Reference Processes to support their consulting services that are related with the creation of Business Communities and collaboration projects between SMEs.

The Methodology and ICT platform were developed to be user friendly and easy to use, including suitable training materials. However, advanced forms of collaboration as proposed by the Net-Challenge project are still not a reality among industrial companies, especially among SMEs. Since a change in attitude is needed, a significant effort is needed to implement the proposed collaborative networks. In this context the offer of consulting services is highly needed in the creation and launch of these networks.

These support consulting services to SMEs are a significant opportunity for consulting companies and RTD centres working in this field.

4.3.2. Business Model

The Net-Challenge Framework will be utilised following three complementary business models:

- Software licenses;
- Software as a service;
- Consulting and training services.

4.3.2.1. Software licenses

From the target markets identified above, industrial associations, long term business networks (clusters, etc.), Medium and Large companies and technology providers that supply the Net-Challenge framework as a service will have the possibility to implement the Net-Challenge framework inside their organisations.

In this case The Net-Challenge partners will sell custom implementation projects that will include in terms of cost: the licence fees for the tools used, implementation and training services to ensure the Framework applicability in the specific environment.

Several Net-Challenge partners will be involved in these projects, depending on the modules considered relevant for each customer and the geographical location of the customer.

4.3.2.2. Software as a service

Small companies and also larger organisations may prefer to adopt the framework in a model of Software as a service.

The IT consortium partners (TIE and Wapice) and other interested external technological partners will be able to implement the Net-Challenge ICT platform in dedicated servers and offer the platform as a service in a Pay per Use business model. This is possible because the platform was designed and developed with this requirement in mind.

4.3.2.3. Consulting and training services

In addition to the above two business models, complementary consulting and training services will be made available.

These consulting services will cover the conceptual and methodological components of the Net-Challenge Framework and will help SMEs create and manage collaborative business networks.

This will be an important step to motivate SMEs in the implementation of such networks and develop the skills, awareness and maturity necessary for the implementation of the complete Net-Challenge Framework.

5. Contacts

Project web portal: www.netchallenge.org

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