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Business Innovation and Virtual Enterprise Environments

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Deliverable D 3.1
State of the Art and Mission Control Room Specification

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EXECUTIVE SUMMARY

This document reflects the Value Production Space (VPS) and the role of the so-called Mission Control Room (MCR) as a management tool to support stakeholders in managing the Virtual Enterprise (VE).

VPS is seen as a real network of enterprises that agreed to form a VE. Hence MCR manages the VE by supporting the VE creation and improvement, collecting feedback of knowledge worker during VE execution, providing features to monitor the VE and to enable creative processes in improving or enable the injection of innovations.

MCR is following concept model based approach, which means that graphical concept models are used to chart the VPS and interpret these charts as a conceptualisation of the real world. Hence it is possible to apply a set of functions on that conceptualisation such as viewing, navigating, querying, simulating, publishing, training, testing, guiding and collaboratively collecting feedback, assessing, alerting and improving.

Key challenge is to enable such a conceptualisation of the real world to enable (a) semantic enrichment from the PIKR developed in WP5 and (b) innovation injections from the Virtual Innovation Factory developed in WP4.

Figure 1 depicts the vision of BIVEE introducing the Value Production Space on the left and the Virtual Innovation Factory on the right.

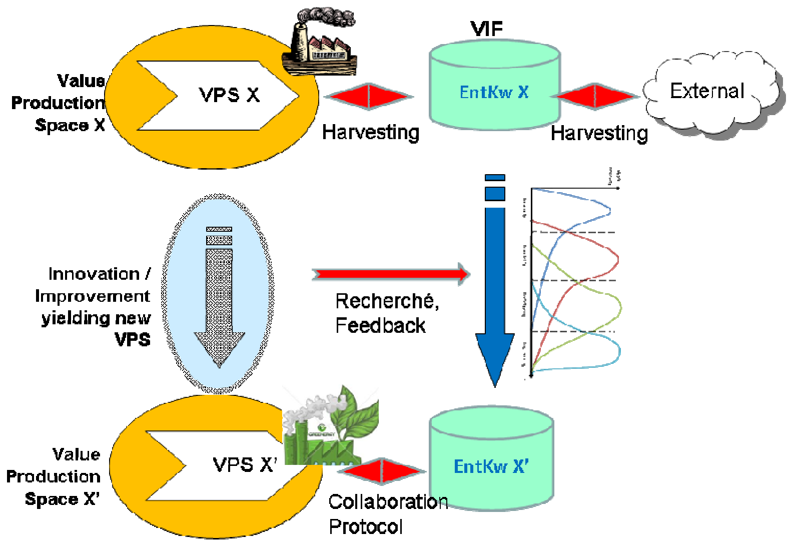

Figure 1 Overall Application Scenario of BIVEE

Hence we identify that Value Production Space is reality and hence conceptualisation of this reality must consider (a) state of the art in conceptualisation, (b) currently applied approaches of the end users, (c) a flexibility to adapt or change the conceptualisation to the specific needs of the end user and (d) enable the inclusion of unpredictable concepts using different formats, different world areas, different level of semantic expressiveness.

MCR needs a conceptual framework, which is represented in form of a modelling language and a modelling tool, which is represented in form of a Web-application.

Value Production Space is a highly complex socio-technical system including well structured and production processes and knowledge workers. Hence the conceptualisation requires: (a) to provide concepts that are sufficiently formalised enabling semantic support and (b) to tightly involve the knowledge worker and hence keep the “human in the loop”.

MCR tackle aforementioned challenges by:

(1) MCR supports a VE life cycle with a modeller enabling the creation and improvement of VE models, an assistant enabling the tight participation of knowledge worker, a monitor enabling the analysis of KPIs and finally a whiteboard enabling the feedback collection and interaction with the Virtual Innovation Factory.

Integrating the knowledge repository PIKR with the MCR - evolving the so-called Semantic Modelling Kernel - enables to introduce semantic into the MCR to support conceptualisation with semantic technology and to enable conceptual integration with Virtual Innovation Factory. This integration has a conceptual integration and a technical integration aspect.

Enabling radical innovation injections from the de-coupled Virtual Innovation Factory requires a collaboration protocol for the “hand-over”, which is conceptually supported by the PIKR and technically supported via the BIVEE platform.

(2) MCR realises the BIVEE modelling framework that is based on the common approaches such as SCOR and VRM. MCR selected the most appropriate modelling concepts but additionally offers three unique characteristics: (a) the modelling language is semantically enriched, (b) hybrid modelling is applied to enable modelling language plug-ins and (c) collaboration features for modelling are provided. This deliverable points to prototypical realisation of reference processes and to prototypical end user processes.

(3) Technical implementation of the MCR relies on (a) typical feature of the MCR-Modeller, MCR-Assistant and MCR-Monitor but enables (b) semantic enrich and (c) collaboration via own features and the coupling with the VIF.

Technical specification of MCR considers this by using a stable meta modelling platform, and developing flexible plug-in introduction the requested functionality in a Web-framework.

The combination of a state of the art concept model, applying the flexible meta modelling approach, introducing hybrid modelling and allowing semantic enrichment in a Web-based, adaptable and collaborative tool environment, makes the MCR a step forward beyond current available VE management tools.

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Abstract (for dissemination)	This deliverable presents the results of Task 3.1 concerning with the technical and conceptual specification of the so-called Mission control Room (MCR). This software supports stakeholder to manage a Virtual Enterprises (VE) by applying a concept model based management approach and providing modelling concepts in form of a modelling language and a management tool in form of a Web-application. This document specifies the conceptual and the technical framework and re-visits the state of the art. In order to do this, the viewpoint on Value Production Space as a socio-technical eco-system is introduced, and the VE life cycle supported by the MCR starting from VE creation, its execution, the monitoring and the feedback for collaborative improvement and problem solving is introduced. MCR supports this life cycle with a modeller enabling the creation and improvement of VE models, an assistant enabling the tight participation of knowledge worker, a monitor enabling the analysis of KPIs and finally a whiteboard enabling the feedback collection and interaction with the Virtual Innovation Factory. MCR is then improved by semantic enrichment via semantic annotation and hence enabling semantic queries. A flexible modelling language is worked out introducing the semantic enrichment and the Web-based modelling tool that is built on the meta modelling platform ADOxx® is described.			
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1 INTRODUCTION

This deliverable specifies conceptual and technical architecture of the Mission Control Room (MCR). To ensure an open requirement collection reflecting not only the end users view of the consortium but also a realistic representation of current market needs, the requirement collection is based on the consortium own findings of the end users and extended with findings of state of the art re-visit and realistic scenarios identified out of literature research

MCR is based on the Virtual Enterprise Modelling Framework (VEMF), which is defined within BIVEE Framework in D2.2. To capture requirements of end users of BIVEE project – which are seen as typical representatives of the market - processes of the VEMF have been modelled in more detail. The concept of Key Performance Indicators (KPI) has been introduced as a virtualisation instrument, enabling to describe identified spots within the real world with concrete sensors.

Hence chapter two re-visits the VEMF of WP2, points to the reference and use case models as well as discusses KPIS.

Third chapter introduces the Value Production Space and the viewpoint of BIVEE on the VE. After discussing master production planning within the VE, MCR is introduced as a management tool supporting the management of the VE by providing Web applications for each phase of the VE life cycle.

Hence the MCR-Modeller is introduced supporting the VE-creation and continues improvement, the MCR-Assistant is introduced supporting the testing, training, guidance and provision of feedback during production, the MCR-Monitor is introduced supporting the consolidation of KPIs and finally the MCR-Whiteboard as a special configuration of the MCR-Modeller is introduced enabling the feedback management.

Semantic enrichment of aforementioned phases and tools and innovation injection is also discussed in chapter three that provides an application scenario overview on the VPS.

Forth chapter collects all aforementioned requirements starting from the necessary concepts and technology to implement the MCR for the BIVEE VEMF, consider all requirements to integrate knowledge management via the PIKR and realise the need to technically and organisationally hand over of radical innovations.

Chapter five describes the conceptual architecture, re-visiting the state of the art, introduces the modelling method framework, and discusses the modelling language, its expressiveness and flexibility.

Chapter six describes the technical architecture of the MCR, re-visiting the state of the art and a brief tool survey and reminds the Generic Meta Modelling Platform Architecture, which has been drafted in D6.20. The user interface, functional and data persistence view point on the MCR-Modeller, MCR-Assistant, MCR-Monitor and MCR-Semantic Modelling Kernel as well as the API is introduced. Development methodology is introduced.

Chapter seven provides a conclusion to close the document.

2 THE BIVEE FRAMEWORK AS BASIS FOR THE MISSION CONTROL ROOM CONSTRUCTION

The BIVEE Framework has been developed and described in D2.2. This chapter contains a brief summary of its content as it is the basis description of the Value Production Space

2.1 Introduction of BIVEE Framework

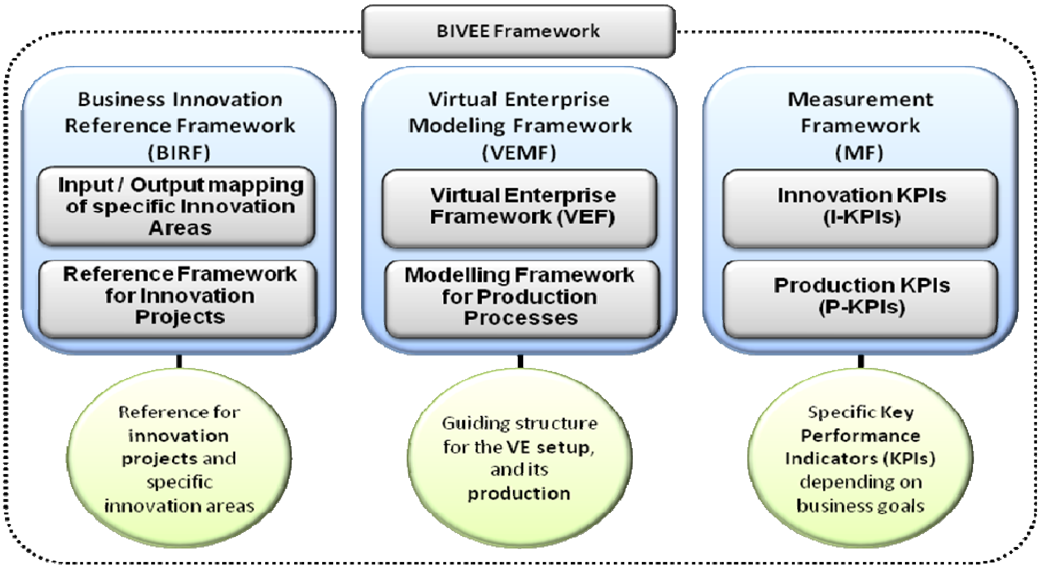

Figure 2: General contents of the sub-frameworks

As pictured in Figure 2 the BIVEE Framework consists of the following three sub-frameworks:

- The **Business Innovation Reference Framework** (BIRF) that provides a guiding structure for the Virtual Innovation's innovation projects and describes the information that is exchanged between actors while differing between different areas of innovation.
- The **Virtual Enterprise Modelling Framework** (VEMF) that describes the compliances, strategies, and objectives which have to be agreed on during the Virtual Enterprise setup phase. Second part of the VEMF is a modelling framework for the production processes within the Virtual Enterprise.
- Third part of the BIVEE Framework is the **Monitoring Framework** (MF) that contains sets of Key Performance Indicators for innovation (I-KPIs) and production (P-KPIs). Each of these KPIs is aligned business objectives.

In the following we focus on the modelling framework as it describes the production processes within the Virtual Enterprise and is hence the relevant part of this deliverable

2.2 Production Process Modelling Framework

The process modelling framework of the Virtual Enterprise Modelling Framework (VEMF) is structured into four phases that are based on the phases within the SCOR-model: Plan, Source, Build, and Deliver.

Table 1: VEMF: process modelling framework

VEMF: Value Production Space Processes and Phases		
Phases	**Processes**	**Short description**
Plan Phase	VPS-P01 Sales Trend Analysis	Results of an initial market analysis show demands for production
	VPS-P02 Order Evaluation	An order may initiate a production process - needs to be evaluated
	VPS-P03 Product Definition	Order analysis and product allocation
	VPS-P04 Network Setup	Creation of a network to fulfil production demands
Source Phase	VPS-S01 Stock Analysis	Analysis of individual stocks for purchase management
	VPS-S02 Supplier Selection	Selection of suppliers for raw materials
	VPS-S03 Purchase Management	Allocation of resources for production
	VPS-S04 Component Storage	Storage of allocated resources
Build Phase	VPS-B01 Component Manufacturing	Manufacturing of components
	VPS-B02 Finishing	Final post-processing of the production
	VPS-B03 Production Assembly	Assembly of components
	VPS-B04 Quality Control	Quality checks of manufactured goods
Deliver Phase	VPS-D01 Packing	Packaging and preparing for delivery
	VPS-D02 Order Preparation	Commissioning of ordered products
	VPS-D03 Shipping	Carrier selection and shipping of manufactured goods
	VPS-D04 Delivery	Final release and delivery of manufactured goods

The production processes of the BIVEE Framework are listed in Table 1 and are seen as the relevant set to describe VEs. In case it is necessary to identify detailed process descriptions, these processes are seen as starting point to describe concrete production processes within production units.

Research preformed within BIVEE concludes that only the processes within the VE are relevant and hence production units and their processes are seen as black boxes. In case the VE process is created using a bottom-up approach such processes from within the production unit are necessary. In case a top-down approach is selected starting from the VE, these processes may not be necessary to be described.

MCR is not concerned with concrete execution details within each production unit, but focuses on processes of the VE. Therefore it is necessary to apply a virtualisation instrument in order to identify relevant parts of the concrete process logs and read concrete values out of those logs.

Key Performance Indicators (KPIs) are applied as such virtualisation instrument that acts like filters of process logs, whereas the “process log” is interpreted in a very wide form including human interaction.

2.2.1 Reference Processes in the Mission Control Room

Based on aforementioned production processes MCR provides reference processes that can be found on the MCR mock-up[1] in the Annex II. These processes are based on the descriptions available in D2.2 and represent them using a graphical representation.

2.2.2 Use Case Processes

Concrete end users processes have been modelled by AIDIMA, starting from aforementioned reference processes based on D2.2 and adapted to the concrete end user needs.

During the workshop it quickly became evident that traditional process concepts are required, including organisational roles, document reference and the like to describe end user processes.

A public process modelling tool [2] has been used to describe current production processes from AIDIMA and identify VE relevant issues.

Current status of those processes can be downloaded from the MCR mock-up[1].

Following parts have not been considered in current process modelling tool:

(1) Modelling of VE processes that describe the VE and not each individual production unit,

(2) Semantic Lifting of all objects to introduce new and advanced semantic features.

A widely accepted instrument to monitor processes – independently if they are production processes within production units or VE processes in a VE – are KPIs that are seen as instruments to virtualise relevant figures of the VE network.

[1] MCR mockup platform can be accessed by: http://83.65.190.83/bivee/workbench/

2.3 Key Performance Indicators as Virtualisation Instrument

As part of the Monitoring Framework (MF), the BIVEE Framework contains a predefined set of 69 production Key Performance Indicators (P-KPIs) to monitor the value production of the VE. They are listed in D 2.2 [44] and are attached to the production processes inside the VEMF (Table 1). Moreover, each P-KPI follows one out of the eight business objectives as defined in D2.1 [43] of the BIVEE Framework.

As managing entity of the value production, the Mission Control Room (MCR) builds on these P-KPIs and uses them as a virtualization instrument. KPIs are therefore seen as sensors of the real world that virtualises concrete and real values into conceptualised values of model objects for further processing.

KPIs are pre-defined in form of modelling and specified within MCR. Concrete values are automatically, semi-automatically or manually collected by the BIVEE platform.

MCR provides user interaction in form of:

(1) a dashboard enabling to view, browse and search for KPIs

(2) mobile alert sending tweets, SMS' or special alerts for MCR apps and

(3) provides collaboration features where not only KPIs during modelling phase can be created in a collaborative way, but also resulting KPIs can be collaboratively be reflected.

MCR hence provides typical dashboard feature that are extended by mobile and collaboration aspects.

Interesting added value is that KPIs are semantically enriched and are referenced with other concepts of the MCR introducing a multi-dimensional sensor network that does not rely on databases or multi-dimensional data cubes but on graphical representation of externalised knowledge in form of concept models, created and reflected by domain experts. Hence KPIs can be put in context with the Value Production Space in multi-dimensional way but still provide easy to use interfaces for the domain experts.

3 Value Production Space and MCR

In the following BIVEE viewpoint on the VPS is reflected, the MCR realisation is worked out and the two major innovation items are introduced (a) the semantic enrichment of MCR and (b) the innovation injection of VPS.

3.1 Value Production Space Introduction

The creation of a VE starts with a business objective (e.g., the production of a given number of chairs) and such an objective drives the selection of the partners to be included in the VE and their local production goals. The production objectives are suitably distributed among the partners (SMEs / Production Units) and scheduled to achieve a smooth flow of material. This is the essence of the Value Production Space (VPS). There are various methods to achieve this. The most common one is based on the definition of the Master Production Plan (MPP).

In the **Setup phase** of a Virtual Enterprise (VE) it is necessary to perform two main planning exercises, in parallel and in mutual influence:

- The **Business Plan (BP)**, related to the business objectives that the VE wants to address, analyzing the products / services considered, the relevant technological issues, the market segments, the potential consumers, the social implications, and so on.
- The **Master Production Plan (MPP)**, related to the resources that have to be organized, maintained and operated in order to guarantee the flow of semi-finished items and deliver these products / services. Planning will be performed in terms of equipment, skills, money, materials, transport means, and so on.

The MPP is particularly complex in a VE environment - with respect to a single enterprise -, because of the large variety of the possible process solutions: in fact the production process is distributed among the different SMEs / Production Units (PU), each of which is generally capable of performing many of the required production and logistic operations. The decision of assigning a specific operation to one or the other depends on considerations of timelines, availability, opportunity, cost, and so on.

These planning activities have to be integrated with the analogous ones performed at each participating PU that compose the VE: even if the MCR does not get into these local planning exercises, each single local plan influences and is influenced by the MPP at VE level.

It is very important that each PU maintains and exercises its own planning capability and autonomy, as the resilience of a VE structure lies in the flexibility of re-configuring according to the dynamics of the market and unanticipated deviations in production or logistic operations. But MCR does not address what happens within the PUs.

This ability is maximized by a holonic organization: in a centralized hierarchical structure each PU (or Work Center) has rather precise role and mission, and any restructuring (performed for instance in order to adapt to production changes) can involve acquisition / dismissing of skills and resources, while in a

VE the participating PUs are assumed to have redundant capabilities, that can be totally or partially devoted to the VE in case of need.

Because of this two-level and two play-fields (business objective and available resources), the set-up phase requires a collaborative interplay of the MCR and the PUs, with hypotheses, negotiations and simulations.

The MPP has as main inputs - what to deliver and when -, as required by the business planning activity - like quantity or rate of products to be delivered in specific sites, or loads to be carried or stored on specific dates - and define how to produce and with what schedule.

Depending on the type of products, the items that constitute the delivery plan can be classes/families of products/services rather than detailed ones and the relevant delivery schedule can be tight or lose.

The MPP of a VE does not require complete details in relation to the products description - in terms of bills of material and production processes - and to the resource capabilities, but just enough for exercising different options, like the assignment of a batch production from a PU to another, or the split of a production phase between PUs.

This means that in some cases the need of additional details - in relation to a specific sub-process or to a particular material / procured item - will be required by MCR in order to propose production options.

The scheduling of production activities - that include the scheduling of the requirement of materials and procured items - is done first backward, starting from the production goals indicated by the Business Objectives.

The Backward Scheduling starts from the due dates and in a way that is called “infinite (or better unlimited) capacity” mode. It means that it starts considering the availability of required resources given for granted: this is the way the planners can determine how much of each resource is required to satisfy the delivery plan. Typically this schedule defines what and how much has to be worked, assembled, loaded, transported day by day (or week by week depending on the industry) in theory, without taking into consideration the actual production capacity of each PU. In this way for every critical resource - that is those that could become bottlenecks - the theoretical required capacity is determined.

Being in the Setup phase, the availabilities of the required resource guide the exercise of organizing which PU and with what capability will be involved in the production, and when.

As already noted, in general an interaction of the planning activity at VE level with the analogous ones performed at each PU is needed, in order to check if the decisions taken in the MCR are compatible with the capability of each PU. However, in BIVEE we follow an optimistic approach concerning PUs, hence what they declare in terms of production capabilities are seen as black boxes.

In order to compare resource requirements with available ones, as last step of master planning a forward scheduling in “finite (actual) capacity” mode is performed (that is with checks, period by period, of projected resource availability), so that the resulting schedule represents the projected product availability with the negotiated production organization. This result can trigger a new cycle of two-level business planning and production planning, in search of a better fit between desired goals and actual fulfilment.

These same planning exercises - delivery and production - need to be periodically performed also in the remaining phases of the production cycle, because of the dynamics of production and market.

The mission of the MCR is: "**support to the monitoring and correction in the Value Production Space (VPS)**".

Below, we report a (simple) concrete example to illustrate in practice what is a MPP, providing an instance of VPS, in the form of a production graph.

3.2 Introductory Sample

We can consider a very schematic example for building a MPP starting from the following **Business Plan** that consists of:

Business Objective: produce the following goods / time / deadline

- 5.000 chairs
- per week (delivery lot)
- 200 / day (final assembly lot)
- Completion on day 70

Chair Macro Bill of Material

- Back 1
- Seat 1
- Armrest 2
- Leg 4

Then, the **Master Production Plan** is developed starting from the following points, to which correspond to the VPS sketched below

- An Order for 5.000 chairs to be delivered by day 70 is entered
- The only PU that can do the final assembly has an available capacity of 200 chairs per day
- Backward scheduling is performed on the base of this daily assembly
- Material for starting the production of the backs is needed on day 38 but is only available starting on day 43
- A forward schedule is performed, forcing the daily production of the backs to twice the previously considered capacity for days 46 to 49, and the related transport for days 47 to 51
- The backs Production Unit accepts the increased production assignment being able to re-distribute its own production plan
- The Transport Unit cannot cover the additional requirement, hence an additional Transport Unit is inserted into the process to cover back transport from days 47 to 50

In the following the MCR realisation is introduces applying the diagrammatic model-based approach.

3.2.1 Macro-Production Schema

It is conceived to present the sequencing of production / transportation activities as seen at MCR level.

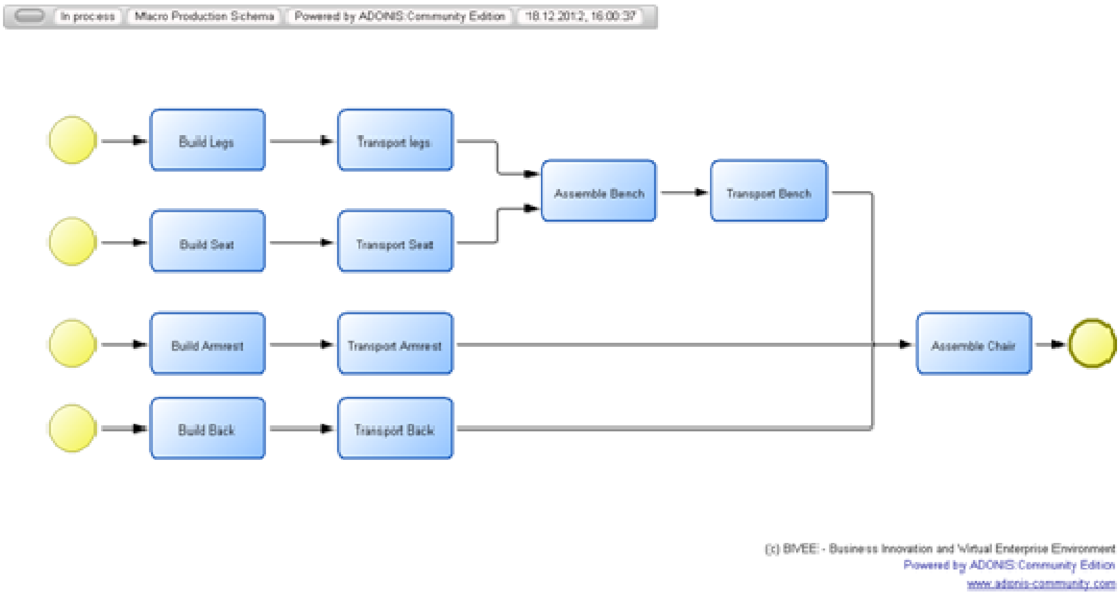

Figure 3: Macro Production schema

Figure 3 depicts the macro production schema of aforementioned sample conceptualised in the BPMN notation.

3.2.2 Theoretical Task Assignment

As introduced before tasks assignment to production and transport units are performed on theoretical lot production and transportation quantities without reflecting the reality.

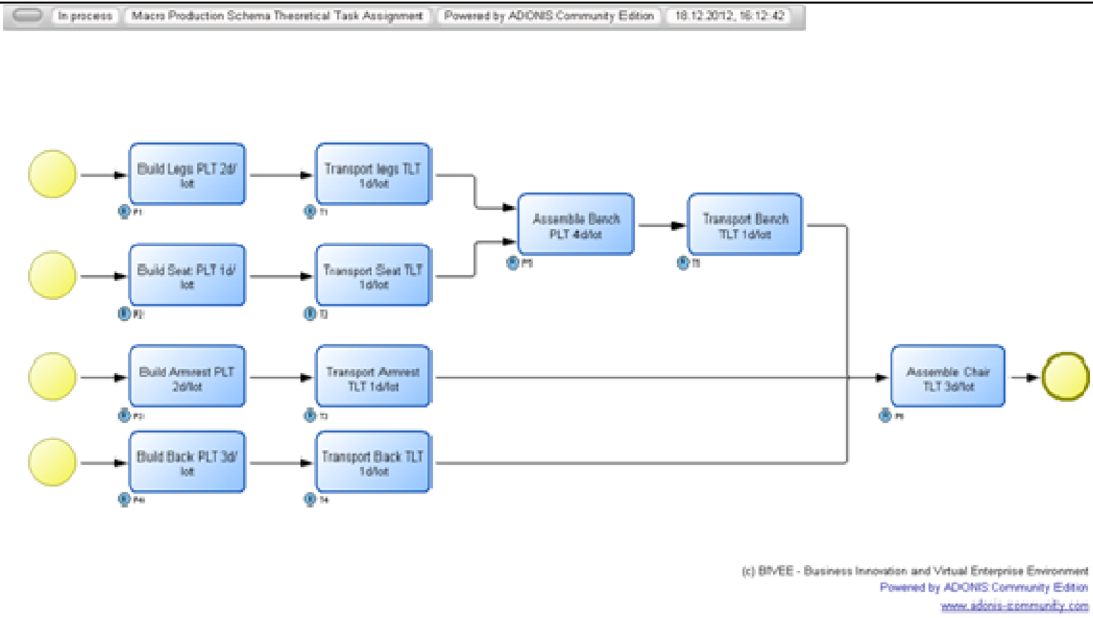

Figure 4: Theoretical task assignment

Figure 4 represents the output of the backward scheduling, tuned to the daily production rate of the final assembly PU.

3.2.3 Master Production Plan.

Figure 38 in the annex represents schematically the daily production and transport rates of the semi-finished items, obtained by a backward scheduling of the order (5.000 chairs) in the upper part of the scheme, and on a forward scheduling on the lower part. The latter forward scheduling takes account of the actual availability of the raw material required for a specific component, and is based on the decision of addressing the related additional load on the activities as early as possible.

In the example we can assume that this schedule is accepted by the involved PUs. It has to be stated that this proposed re-schedule is one of the many possible solutions, like the spread of the additional loads on a longer time period and so on. This large range of possible solutions (even in a very simple example) renders the response of a VE to market requests on one side complex to plan and build, on the other effective and efficient.

3.2.4 Actual Tasks Re-Assignment

After manually performed collaboration phases agreeing on actual lot production and transport quantities a re-assignment of concrete tasks is performed as depicted in Figure 5.

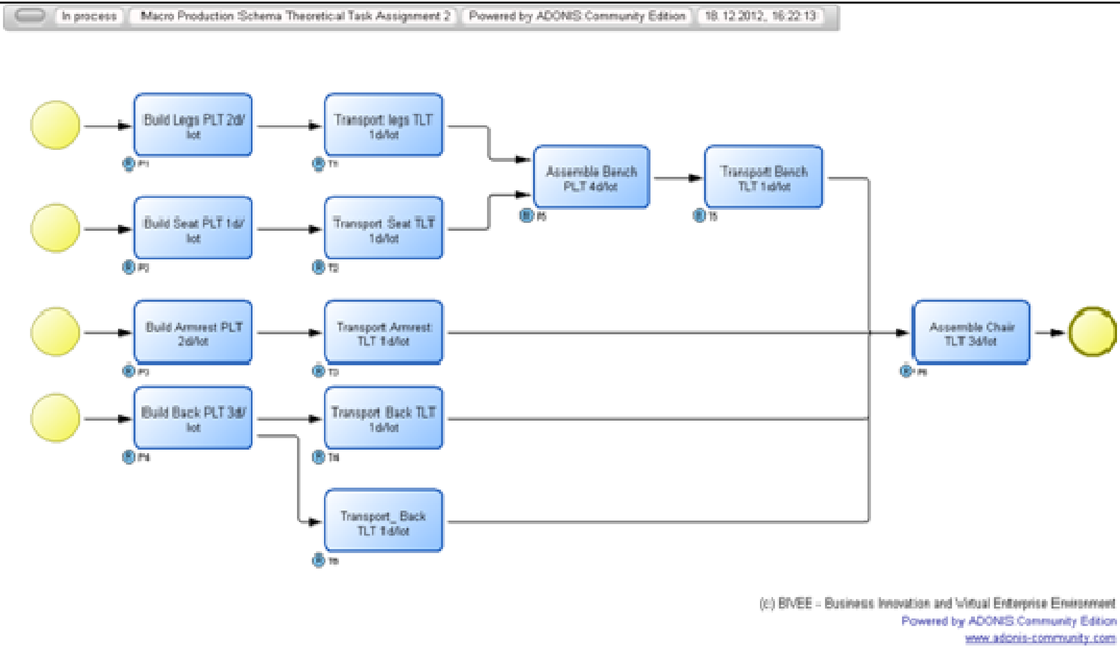

Figure 5: Re-assignment according concrete tasks

This diagram shows the re-assignment of the operations to the PUs, with the addition of a transport unit. This is seen as the final MPP emerging from the collaboration and accepted by all stakeholders.

3.3 MCR Life Cycle

Aforementioned introductory sample and the VPS introduction, highlights that the process of interactively defining the best composition of the VE in terms of production and logistics capabilities to address a Business Plan (BP), whose definition is of course the first activity of the set-up wave.

The production planning mechanism is not part of MCR, as scheduling algorithms are performed by legacy applications.

Although collaboration and negotiation phase is simplified in the introductory sample, it is a key aspect of MCR. Hence MCR must support realistic collaboration and negotiation scenarios including extended dialogues and a number of scheduling simulations with different hypotheses.

PUs participating in a VE maintains a certain degree of autonomy in terms of production, to be able to flexibly adapt to the VE requirements.

Therefore, a feasible production plan is defined in a collaborative way, where knowledge workers and domain expert participate the VE modelling.

In order to virtualise real world production, the concept of KPI is applied as sensor to observe relevant parts of production logs and human assessments.

In order to collect all requirements for MCR, the MCR life cycle is introduced and use cases and application scenarios are depicted to deduce use cases and requirements for the MCR.

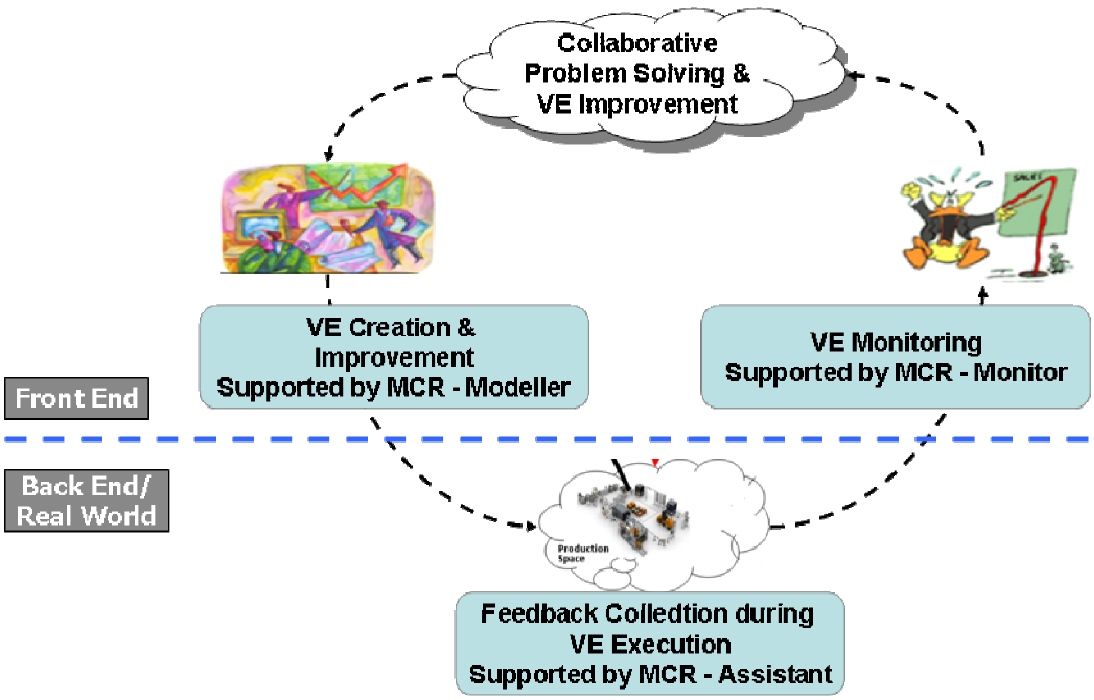

Figure 6: MCR Life Cycle

Figure 6 introduces the MCR life cycle, where the front end provides a Modeller and a Monitor as user interface. The modeller supports the creation of the VE like in the aforementioned introductory sample. The monitor aggregates the collected KPIs and enables queries in the context of the VE models.

The feedback is seen as collaborative problem solving and production improvement. MCR supports this phase by enabling collaborative design and mobile interaction. Technically spoken the modeller is not only used to create the VE but also to solve problems and enable production improvement by collaborative interaction of knowledge worker.

The back end is mainly supported by legacy applications like scheduler or enterprise resource planning systems. MCR provides a testing and training environment, where knowledge workers of different enterprises could test and train the VE processes using a stepper engine.

This concept is applied to reduce the burden of conceptual thinking, as modellers need to understand concept models and be aware of all possible concepts in the ontology and the modelling language. The Process stepper presents the models in a way similar like a platform and hence similar to a Web-application that is understood without detailed knowledge of concept models or ontologies.

In the following each phase is briefly introduced and use cases are derived as requirements.

3.3.1 MCR-Modeller for VE Creation and Improvement

MCR distinguishes between application scenarios. First is a top-down scenario, which has been discussed in the introductory sample, generating a VE starting with the Bill of Material (BoM). Second scenario is a bottom-up scenario by starting from concrete processes and assuming a transformation from existing processes.

MCR needs to support both scenarios, although typical creation of VE may be the top down approach and the typical improvement will be bottom-up. MCR does not aim to limit the user, but wants to provide a flexible modelling support. Hence both scenarios are discussed.

VE Creation by using Bill of Materials

As discussed in the introductory sample, decision makers decide on the product, quantity and production timeline and decomposes the product into sub-products and finally in a bill of material.

Hence, MCR provides a product model enabling to specify material, components, quality and a set of relevant features. Features can be freely chosen out of pre-defined, as applicable for the particular use case.

MCR has to support the product specification like in the introductory sample, and needs to enable the creation of bill of material.

Product specification leads to drafting the VE with respect to partner organisations, production and transport units, their service level agreement, material, information and money flow, input / output and transformation tasks as well as identification of relevant indicators by defining or selecting KPIs.

Hence MCR creates a product model, a representation of the VE similar like a well-known e3 value model [3], the VE process using a notation like BPMN and a representation of KPIs.

These representations are exported in a so-called "Virtual Enterprise Book", where each one of the aforementioned models is interpreted as chapters.

VE Improvement using Processes

In the following an alternative to create the VE but most likely to improve a VE is introduced as the bottom-up approach.

Modeller needs to design processes on a more detailed level, hence reference processes are used to create use case processes.

Those processes describe a sequence of tasks performed within an enterprise, so-called swim lanes enable the separation of tasks performed within that enterprise from tasks that are performed by an external partner.

Queries on the best fitting partners can be performed to query and simulate processes with alternative partner allocation.

If necessary, additional changes are made in the description of VE or KPIs.

Use Case for MCR Modeller

Considering aforementioned introductory sample as well as the top-down and bottom-up approach, MCR specification leads to the following use cases.

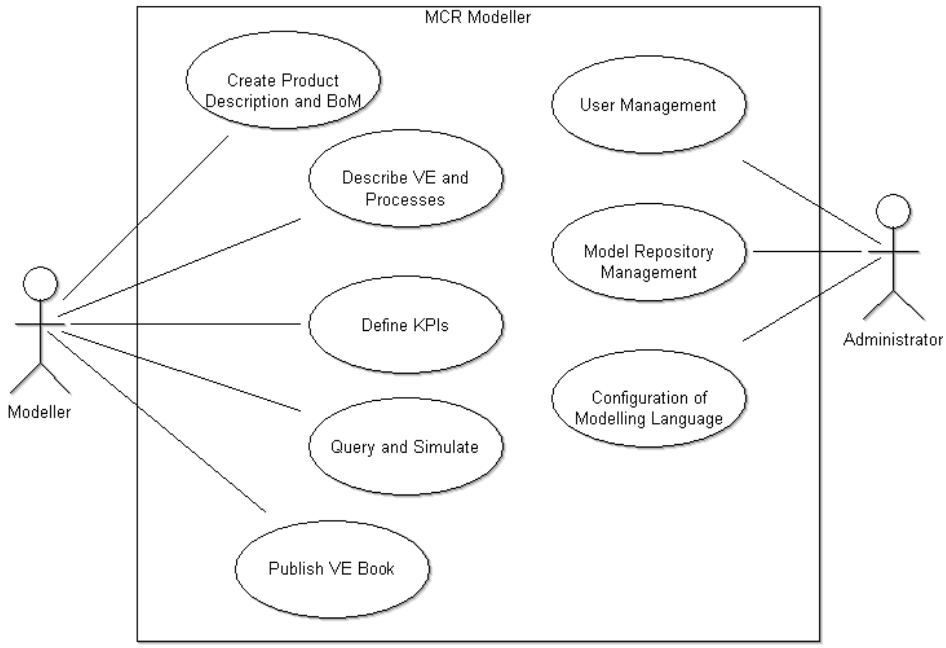

Figure 7: Use Cases for MCR Modeller

Figure 7 reflects MCR Modeller requirements by providing modelling functionalities, to create product descriptions and mechanisms to derive bill of material, to define KPIs and perform queries and simulations to check current status of models like the one presented in the introductory sample. Finally the VE Book is published.

Right side of the use case model reflects typical administer tasks in managing security aspects and users, manage the content in form of models and configure the modelling language in order to enable flexibility.

3.3.2 MCR Assistant for Production

"*Knowledge worker are the key to innovation and growth in today's organisation*.[1]" Knowledge worker undoubtedly are the driving force of successful "industrial" enterprises and are the key success factor in change management as they have the power to resist, the competence managers and colleagues rely on and of course their well established ecosystem in which they have power.

MCR must therefore provide collaboration mechanisms for knowledge workers to not only participate during the VE creation but also to participate in the continuous improvement. The process stepper engine enable knowledge worker to step through the process via a Web-platform.

As this user interface is designed to be used during execution phase, interactions with knowledge workers are realised in that assistant. Hence it consists of both a push-component and a pull-component. Push-component provides processes, a step-by-step explanation, documentation as well as contact persons, whereas the pull-component enables to feedback via Wiki, a quick poll or a mobile app. MCR provides three different settings of process collaboration:

(1) Process Training setting, in which knowledge worker can participate early process trainings, comment with their opinion and provide early feedback on the new processes. This setting is seen as early mock-ups of VE process, in which knowledge worker can express their opinion.

(2) Process Testing setting, in which knowledge workers can comment and rate the processes. Goal is to assess the new processes by entering concrete KPIs in concrete situations.

(3) Process Guidance setting, in which knowledge worker is supported by the system in form of a guiding and assistance systems and feedback is possible during concrete execution.

This interface also provides human-driven alerting, by introducing Tweets and SMS notification, in case one enterprise has trouble during production.

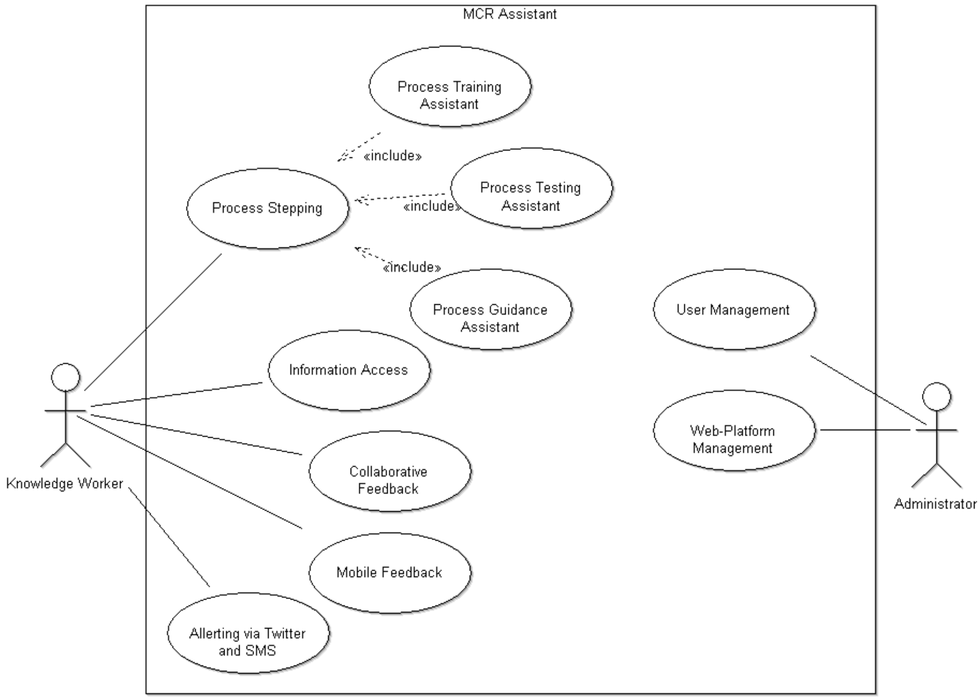

Figure 8: Use Cases for MCR Assistant

Figure 8 reflects MCR assistant use cases, where the administrator deals with user management and Web-platform management.

Knowledge worker has the possibility to step through the process and access information that is linked such as documents, videos, templates, Wiki pages, or contact person addresses. Knowledge worker has two types of feedback, one addressing the models in form of collaborative or mobile feedback, and one on instance level alerting due to the concrete real situation. Hence feedback will be forwarded to the modeller, whereas the alert will be distributed to a pre-defined set of knowledge workers.

3.3.3 MCR Monitor for Monitoring and Alerting

MCR Monitor is hybrid presentation of pre-defined KPIs and concrete set of values that are combined in an aggregated view to the user. Typically this is presented to the decision maker.

One part is the presentation of the KPIs that are typically queried and viewed according their context in the VE. The second part is the aggregation of concrete values and the possibility to drill-down the concrete values. Both parts are presented in a cockpit that has two features: (a) the viewing of KPIs, (b) the selection and filtering of KPIs.

KPI viewing will be in traffic light notation, where indicators are red, yellow or green following the notation of a traffic light. Beside this notation there are alternatives like thermometers, balances, tachometers, charts or spider diagrams. MCR selected the traditional traffic light representation.

KPI selecting and filtering will be in a tree-structure like notation, where KPIs are structured according a tree. Selecting a part of the tree, results in a selection of all KPIs that are categorised accordingly. Alternative selections are filters, search engines or configurations. MCR aims for a multiple-tree structure and a search engine that focuses on the relation of KPIs to other elements of the VE.

Similar to the aforementioned MCR modeller and MCR assistant, decision maker who analyse the MCR monitor are invited to provide feedback either for the modeller, using the same collaboration mechanisms like the modeller, or for other decision maker using the alert feature.

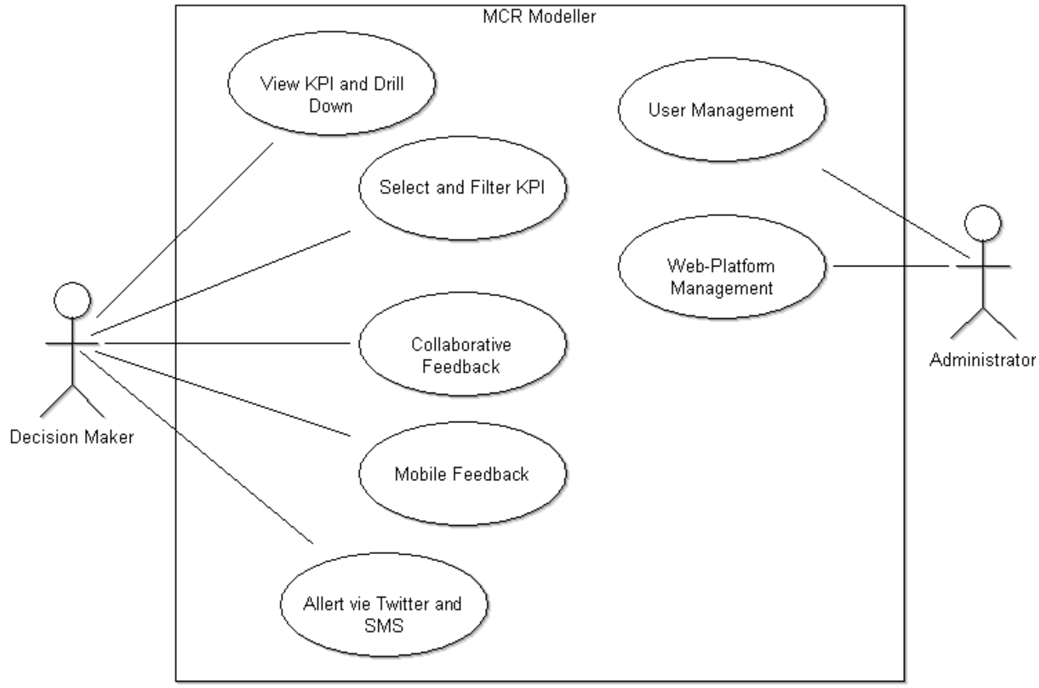

Figure 9: Use Cases MCR Monitor

Figure 9 reflects the MCR monitor use cases, where the administrator has similar tasks like before in managing user access rights and managing the Web-platform.

Decision makers are able to select, filter and view KPIs and to drill down to the concrete values. Feedback for the modeller is in form of collaborative and mobile feedback, whereas alerting other decision makers in case of immediate actions are via Twitter or SMS.

3.3.4 Feedback

Feedback phase is more correctly the reflection phase of the feedback, as the feedback is continuously harvested. Hence MCR provides a mechanism to enable to work with harvested feedback.

Hence the mechanism of a whiteboard is introduced that is placed across all aforementioned components and enables the structuring of the individual feedback. Each feedback is provided in form of a "post-it" that is placed in context of a model from the MCR.

Hence this phase enables to search, select, visualise and categorise all posted feedbacks, rate them and hand them over to the modeller with the goal to improve the VE accordingly.

This phase is probably the most attractive phase to interact with the Virtual Innovation Factory a key component within BIVEE.

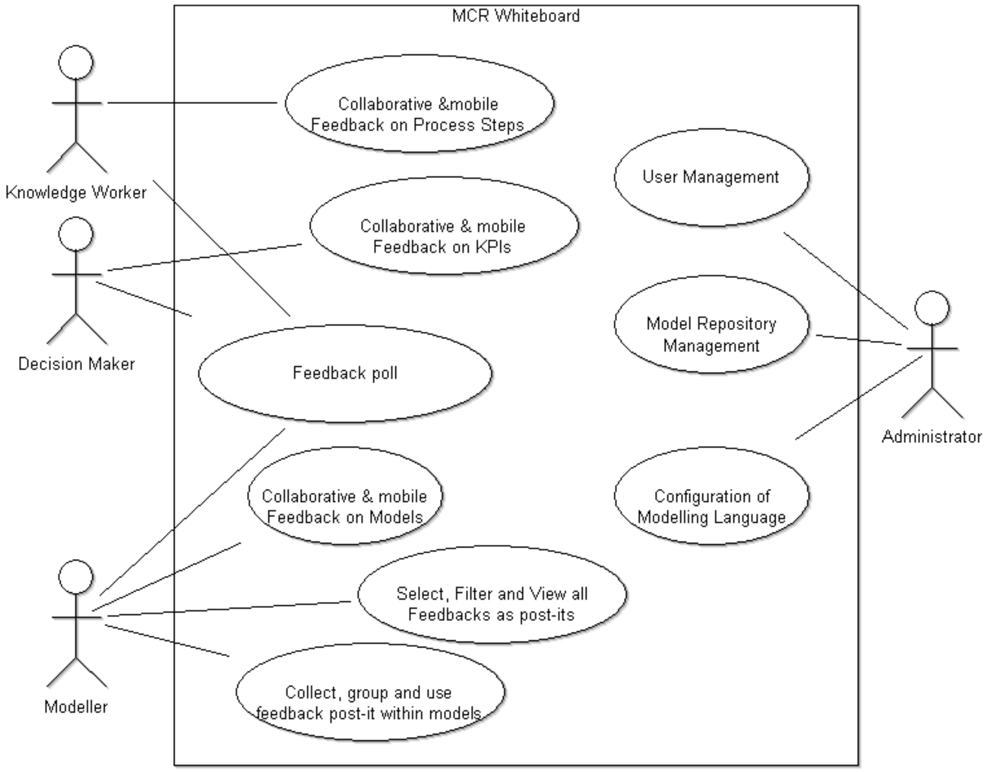

Figure 10: MCR Whiteboard Use Cases

Figure 10 reflects the whiteboard, which is basically a special model editor with a strictly limited modelling language using existing models and enabling post-its to be used within those models. Hence knowledge worker and decision maker have a pre-defined channel to send feedback, whereas the modeller has the task to select group and prepare the feedback appropriately to enable feedback pools on it.

3.4 Semantic Enrichment of MCR

Aforementioned analysis focused on the opportunities to apply the concept model based approach in the domain of value production space. In the following section the added value of BIVEE for such approaches is highlighted by introducing the semantic enrichment of the aforementioned MCR.

It is based on the approach Karagiannis, Woitsch [4] and has been adapted to the BIVEE modelling framework introducing three level of semantic injection of the MCR (a) the conceptual framework itself, meaning to integrate semantic into the meta model approach, (b) into the methodology, when applying VE management in a real value production space and (c) in the deployment environment of the production process.

3.4.1 Semantic Enrichment of MCR on conceptual framework

There are different approaches to link different meta models [5], [6] here we propose the semantic transit model. This approach requires an extension of

MCR meta model, introducing a semantic model, which enables ontologies to be copied into the MCR using this “transit”.

The conceptual specification explains this principle in more detail, but here it can be compared with caching semantic concepts within the MCR for further usage inside the MCR models.

3.4.2 Semantic Enrichment of MCR-Modeller

Semantic enrichment of MCR modeller enables to use a harmonized language while modelling and to annotate each object in a model with a pre-defined taxonomy of the PIKR. Hence every model designed with MCR will be semantically lifted with concepts of the PIKR.

Semantic queries are an extension of conventional queries that apply semantics to resolve the query, apply semantic inferences and combine the results in appropriate way. Details on the provided mechanisms are worked out in WP5, as for the end user of MCR it is transparent, if the query is handled by MCR or passed on to the PIKR.

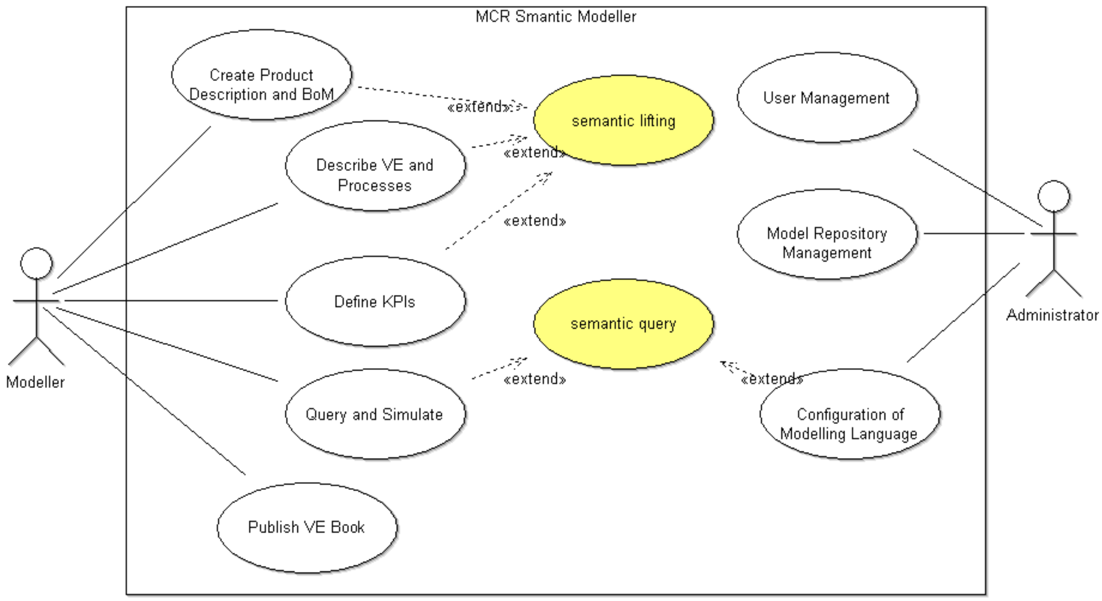

Figure 11: MCR Semantic Modeller Use Cases

Figure 11 reflects the use cases of the MCR Semantic Modeller by adding the semantic lifting of all models and by adding the semantic query.

Semantic lifting will be realised with an additional function, where the modeller can select concepts from the PIKR to annotate an object.

Semantic query can be pre-configured for special cases. Considering the introductory sample, a query for Bill of Material will send a template of the Bill of Material to the semantic query and expect a list of recommended production units for this bill of material.

Reflecting semantic query for the improvement scenarios, where a task is moved from within the enterprise to another unit, a similar semantic query can recommend production units for that particular task. Properties of the task such as quality, time or reliability may be selected as query parameters, and PIKR will provide results although those inputs are not explicitly modelled but can be inference by the PIKR using semantic relationships.

3.4.3 Semantic Enrichment of MCR Assistant

MCR Assistant provides a process stepper enabling the knowledge worker to step through the process and receive information. MCR provides fixed relation between process step, user and provided information.

Semantic Enrichment of MCR Assistant introduces loose coupling between process steps, users and provided information.

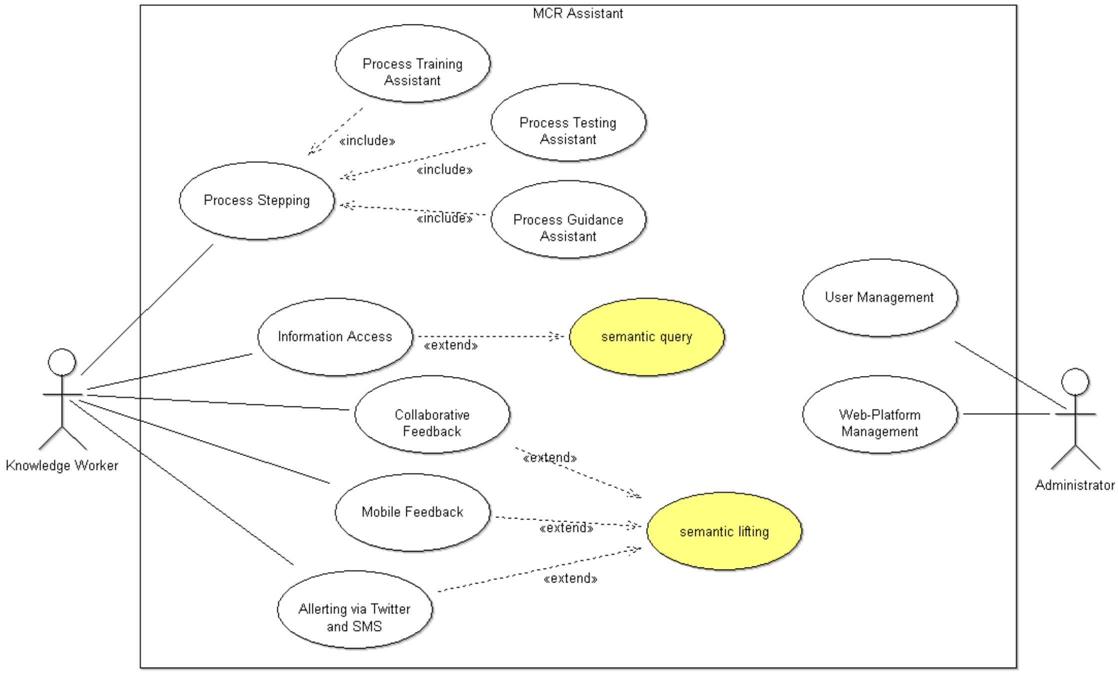

Figure 12: MCR Semantic Assistant Use Cases

Figure 12 reflects the additional uses cases provided by PIKR. Semantic query will be applied in a special configuration to enable loose coupling for information, users and process steps.

In case a knowledge worker provides feedback, it is a modelling task consisting of adding a “feedback object” into the model; hence the same aforementioned mechanism of semantic modelling is applied to enable semantic lifting of each feedback and alert.

3.4.4 Semantic Enrichment of MCR Monitor

Semantic enrichment of MCR Monitor enables extended queries by using semantics and hence extending traditional KPI queries. This will be transparent to the user, as the user simply selects the filter, or search function and is unaware that MCR corresponds with PIKR in order to improve the search.

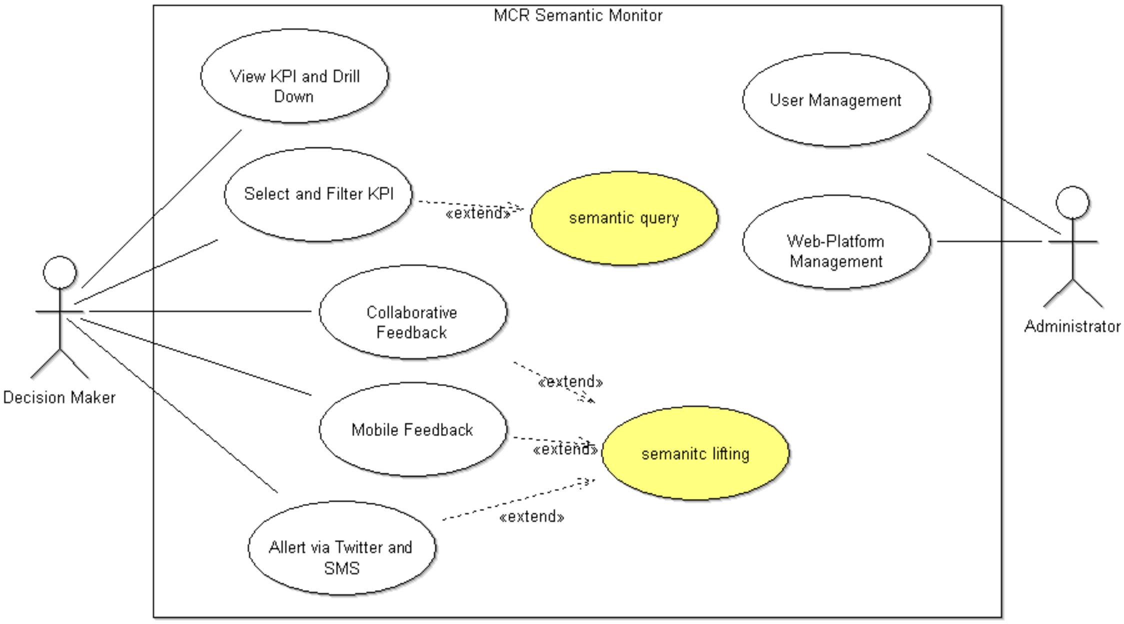

Figure 13: MCR Semantic Monitor Use Cases

Figure 13 reflects the use cases of the MCR Semantic Monitor by introducing the semantic query, when searching for KPIs and by introducing the semantic lifting in the same way as introduced in the assistant.

3.4.5 Semantic Enrichment of MCR Whiteboard

MCR Whiteboard is a special configuration of the MCR Modeller and hence everything mentioned as semantic enrichment of the modeller holds true for the whiteboard.

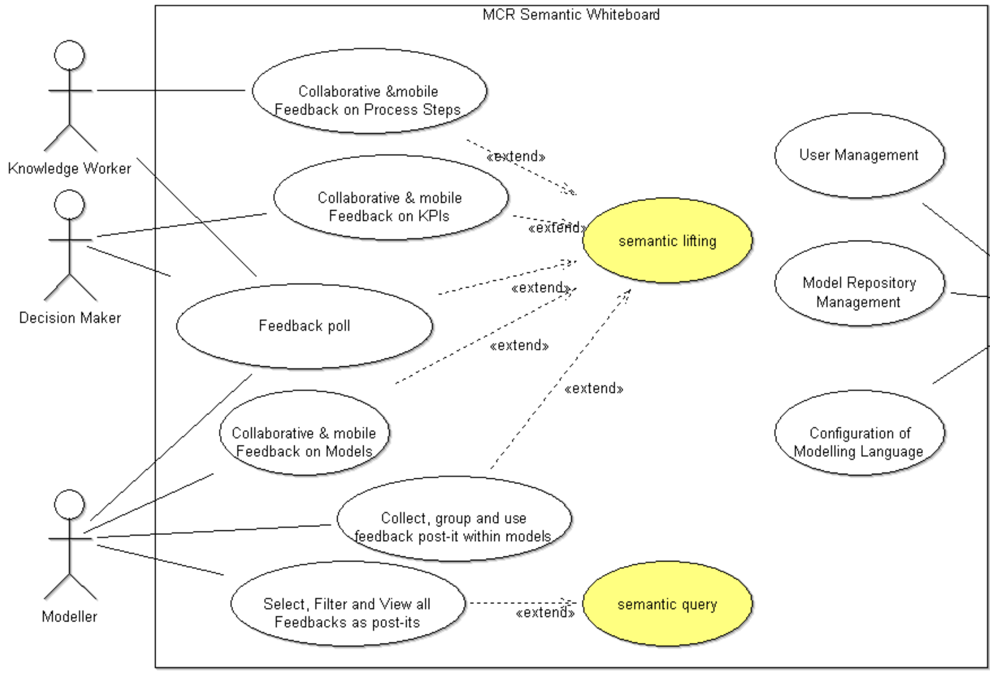

Figure 14: MCR Semantic Whiteboard Use Cases

Figure 14 reflects the MCR Semantic Whiteboard use cases by highlighting that every feedback, poll or alert is semantically lifted and hence able to be semantically queried.

The semantic supported analysis of the feedback is probably one of the core advantages of the semantic enrichment of the MCR, as feedback, polls and collaboration input can not only be analysed in the context of a concrete model, but also in context of each other.

3.5 Innovation Injection of MCR

Injection of innovation into the MCR is another key aspect of BIVEE. In the following the interaction and the resulting MCR requirements are briefly discussed.

MCR and VIF are decoupled to enable independency of the VIF and hence radical innovation without influence of current production space.

To identify requirement for MCR - VIR interaction, basic collaboration protocols need to be identified that enable the “hand-over” of radical process innovation from the VIF via the MCR into the production space.

Starting point is the interaction paradigm, where VPS is depicted on the left side and VIS is depicted on the right side.

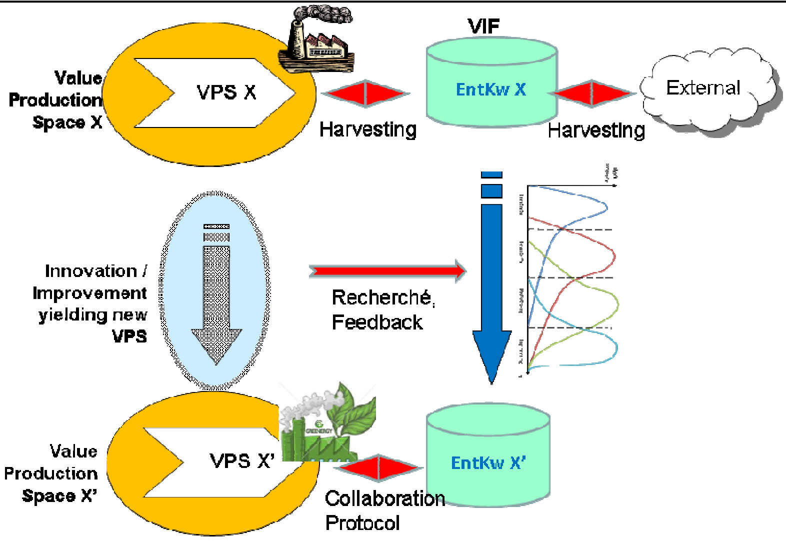

Figure 15 Enterprise Knowledge transformation

Basically three are three interaction interfaces:

1. At the beginning of an innovation
2. During the innovation there is a unidirectional interaction
3. At the end of an innovation

(1) VIF harvests ideas from anywhere, which includes but not limits to also the MCR. Hence the whiteboard as a pre-defined model editor reflecting existing documents and their feedback is foreseen as interface between MCR and idea harvesting as the first wave of the VIF.

(2) Interaction during the innovation is most likely applying semantic queries, or simulations of the MCR-Modeller or the MCR-Assistant. Hence VIF is seen as a potential user of the MCR in order to analyse the model repository and the harvested feedback.

(3) Interaction at the end of the innovation phase is challenging as it deals with change management. It requires special focus on knowledge workers before and during the “hand-over” of the innovation into production space.

The nature of radical innovation is that they are unpredictable hence the way the process innovation is handed-over is unique.

There are basic principles that are common praxis such as:

(a) a **project-oriented hand over** by testing out the new processes in pilot projects as well as

(b) **participatory involvement of knowledge worker** that are key success factor of this change management.

In the following both scenarios are discussed and requirement for MCR are derived.

3.5.1 Innovation Injection of MCR

It has to be considered that the management of the innovation phases strongly depend on the enterprise goals. This leads to the fact that the “hand over” of innovation items into the production space can follow different purposes and hence collaboration between MCR and VIF must be adaptable.

There are different approaches to hand over innovation items into the production space. Here we have to state that an innovation item in our understanding consists of a complete set of all final documents from the engineering phase.

The challenge is to "hand over" the package of finalised engineering documents into the production space, which consists of (a) a technical aspects, the hand-over of electronic files, (b) the organisational aspect, as part of the documents describe processes that change but most importantly (c) a cultural aspect, as knowledge worker have to be tightly involved and support those changes.

Technically spoken VIF provides documents describing innovative production processes embedded in a full compiled engineering document package. In order to create or change a VE using these models, MCR proposes a project-oriented hand-over approach performing this "hand-over" in either a VE creation of VE improvement in form of change management.

Typical approach is to realise a pilot project, in order to evaluate the result before setting up a full fletched VE. Fast approach is to directly impose the innovation item into production space, without considering pilot projects.

Alternatively to the aforementioned fast or slow project based approaches, there is the distribution approach where innovation factory takes the role of an innovation shop, offering ready to use solutions without the need to impose any project but enabling to "pick" innovation items.

MCR hence acts as tool that realises the VE model hand-over, independent on the selected approach.

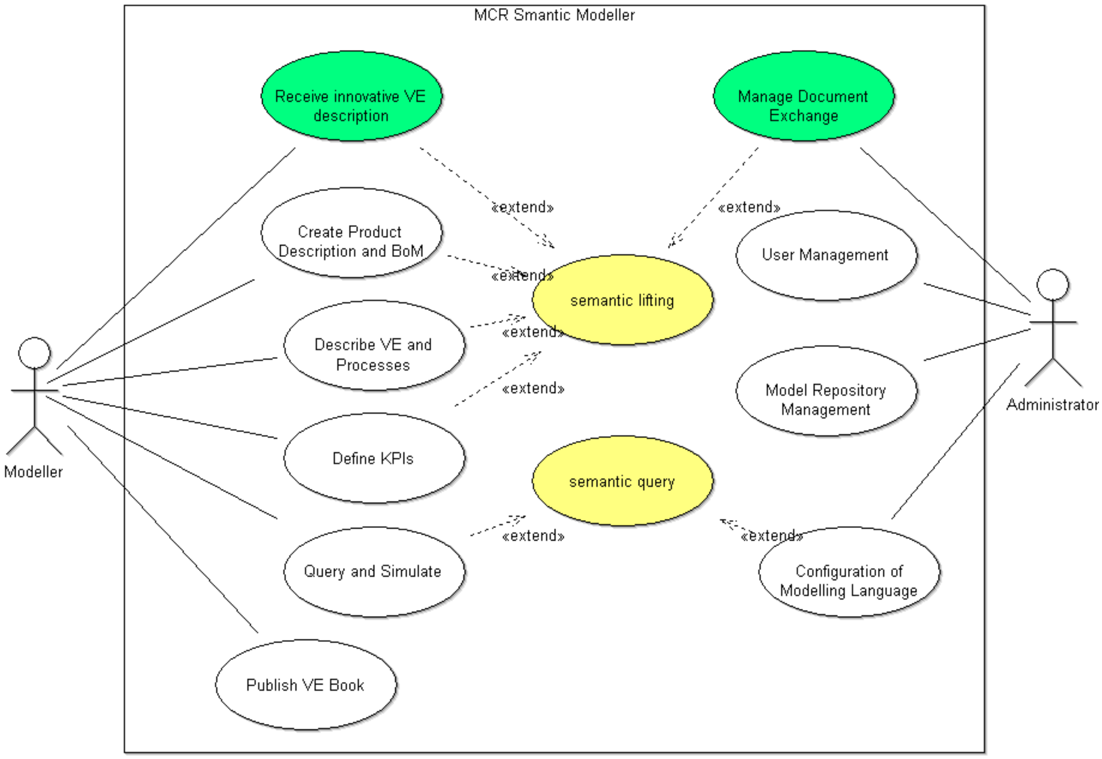

Figure 16: MCR Semantic and Innovation injected Modeller

Figure 16 reflects the use cases of MCR Modeller considering the exchange of documents with the VIF. Technically spoken, it is an exchange of documents, but conceptually spoken, VIF provides a full VE specification, which is received by the modeller and applied using the MCR Modeller functionality. As pointed out in the above figure, semantic lifting is also applied when receiving the VE description, hence each VE model can be traced back into the VIF.

3.5.2 Production Feedback for Innovation Input

Interaction between MCR and VIF is technically spoken an exchange of annotated documents but conceptually MCR provides VIF user to semantically query within all models, describing the VE, all KPIs that are semantically annotated and describe the relevant world area of the VE processes and the semantically lifted feedback from the knowledge workers.

Hence the VIF user is provided with the Whiteboard, which is a special configuration of the MCR semantic modeller and gets the same functions as a modeller.

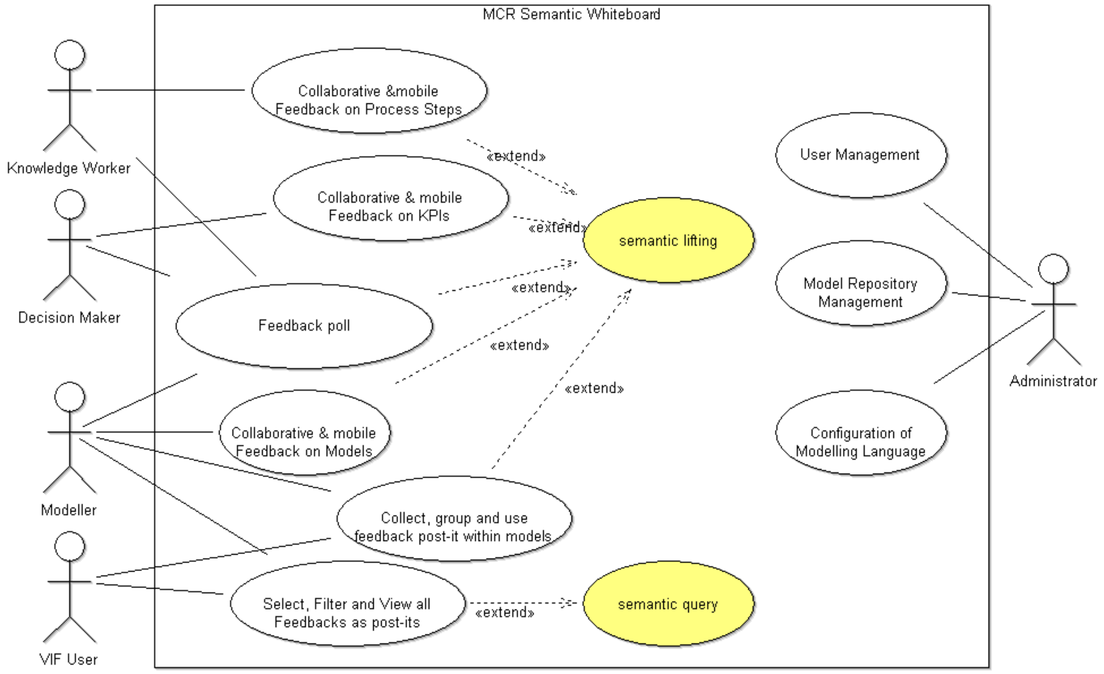

Figure 17: MCR Semantic Whiteboard as Innovation Trigger

Figure 17 reflects the VIF User similar to the MCR modeller enabling collect group and change feedback correlating with the original model, as well as being able to select, view and semantically query not only the models but also the feedback of the knowledge workers.

This whiteboard is seen as the trigger for new innovations from knowledge worker feedback out of the value production space.

3.6 Remarks

Value Production Space has been introduced focusing on Master Production Planning and discussing the MCR-Modeller, MCR-Assistant and MCR-Monitor that is provided to the end user.

MCR Modeller acts as a management tool that support the design of VE, its queries and simulations are applied to support the creation and negotiation phase and produce documentation in form of the VE book.

MCR Assistant enables the tight involvement of knowledge workers providing feedback to decision makers and modellers as well as alerting in urgent cases other knowledge workers.

MCR Monitor provides an aggregated view on relevant parts of the log file and relevant expert assessment in form of knowledge worker polls.

MCR Whiteboard is a special configuration of the MCR modeller, enabling only to add post-its with feedback to models or more concrete to objects in models.

Semantic enrichment of modeller, assistant, monitor and whiteboard enables (a) semantic lifting of all models, (b) semantic query in the modeller for specific queries, in the assistant for loose coupling, in the monitor for better KPI queries and in the whiteboard to search within feedbacks.

Innovation injection is executed just before the VE creation, by providing a full set of documents to the modeller enabling the modeller to start a new life cycle based on innovations from VIF, or to inject innovation into an existing VE.

Innovation trigger is provided by MCR in form of the whiteboard during the feedback phase.

A list of MCR requirements can be found in the next chapter, that analysis not only the use case but also reflects the necessary concepts and models.

4 REQUIREMENT COLLECTION

This section observes aforementioned scenarios and identifies MCR requirements based on four sources:

(1) Results of WP2 are revisited and reference processes based on additional Internet and literature research including KPIs have been reflected to collect requirements as source 1 [43], [44].

(2) Concrete use case processes and scenarios have been worked out with AIDIMA in form of use case processes, which have been reviewed and elaborated by visioning the future BIVEE usage scenario as requirement source 2 [46], [48].

(3) Application scenarios on possible semantic extension with PIKR have been reflected as source 3 [45]

(4) Application scenarios on interfaces and change management of innovation "hand-over" have been worked our as requirement source 4.

(5) Finally concluding requirements re-visiting the vision of BIVEE and considering review comments as source 5.

Table 2 : List of Requirements

Number	Name	Description	Source
1	Modelling Processes according the four phases	Modelling of phases defined by VEMF in process phases and relate concrete processes. Enable to create graphical model for the process landscape.	1
2	Modelling KPIs in Measurement Frame work	Create KPIs with a unique annotation or identifier to synchronise MCR with PIKR. Describe KPIs and design mathematical calculation. List production processes and business objectives to link KPIs to processes and objectives.	1
3	Capture process from real world (VPS) and collect reference processes	Provide reference processes to be used when describing the real world. Adapt reference processes through modelling activity. Collect reflection of real world through reference processes	1
4	Modelling processes on sequential level	Provide modelling concepts for BPMN process sequences. Provide mechanisms to display, create, edit, and delete processes.	2

5	Describe documents in a document pool	Define document by a unique identifier (URI) and specify creator, timestamp, type of document type and a textual description. Consider UBL standard to describe documents and use UBL XML to exchange the document pool description	2
6	Describe the network of production units	Describe the network of production units, their roles, performers and actors. Enabling both Business units are described with their input, output, transformation capacity, geographical location and responsible persons. Roles within the network and within organisation are described.	2
7	Describe performers and skills	Provide the option in particular cases to describe performers and skills. Typical organisational attributes should be added, skills are introduced on a flexible topic-oriented base.	2
8	Provide mechanisms to display, create, edit production maps.	Modelling the production units, input, output and transformation and describe capacity, costs and quality in an e3 value like model. Reflect geographical position and dependencies like in thread models.	2
9	Visualise concrete process measure	Provide mechanisms to display values about the processes including the input, output, cost, time.	2
10	Provide document assignment to production maps, processes and KPIs.	Provide mechanisms to display and attach documents and resources to a process in the production map.	2
11	Enable model annotation	Provide a semantic mechanism that helps the creation and analysis of production maps, processes and KPIs.	2
12	Apply semantic partner search and analysis	Provide mechanisms to search for partners according to a set of criteria including name, type, date, price that are semantically annotated.	2
13	Apply semantic product search and analysis	Provide mechanisms to search for products according to a set of criteria including name, type, date, price through semantic structures	2
14	Model logs	Logging model changes by authors, to the relevant part the type of change and a timestamp	2
15	What-if Simulation	Provide simulation mechanisms to see possible outputs when the displayed data on the production map is changed.	2

16	Provide Model Repository	Provide mechanisms to browse, search within a repository of all models.	2
17	Cost calculation	Provide mechanisms to calculate costs per process, per production plan and per product.	2
18	Scenario assessment	Assess changes on supplier, location, carrier, product configuration, price, product features,	2
19	Start VE-Creation by BoM	Modelling of Bill of Materials B={ raw materials, sub-assemblies, intermediate assemblies, sub-components, components, parts, quantities} Enable to drill down to sub-components for decomposition/configuration of product, Enable the distinction between “make” and “buy” (make sub-component vs. buy raw material)	3
20	Enable Backward Scheduling	Enable backward scheduling of the production plan, starting from requested delivery date and analyse, if VE is necessary to raise capacity.	3
21	Assign best matching partner to sub-processes according to their competences	Enable to allocate capacities, skills and capabilities to processes, products, production units and persons. Provide mechanisms to assign best matching skills to products or processes. Enrich best matching mechanisms with semantic.	3
22	Graphical representation of production map	Create graphical overview of flow of material, value, information, costs, and business units.	3
23	Production map analysis and simulation.	Enable mechanisms to query the production map. What-if simulation on process and network enterprise level.	3
24	Design and manage KPIs	KPI classification A = {priority dimension, classes and sub-classes, unit of measures, inputs, calculation rules, calculation formula} KPI measure values A ={ unique id, unit of measure, business objective, professional, value}	1

25	Alignment of document models and DocOnto	Enable the specification of documents. Enable the exchange of document references. A= { title, description, creator, contributor, delivery date, format, language, sender, receiver, transfer type}	3
26	Document dependencies and relations	Enable pre-defined dependencies among documents such as: Prerequisite_of, Feedback_to, Update_to, Part_of,Includes as well as related to	3
27	Enable annotation with PIKR concepts	Provide mechanisms to annotate documents with concepts of the DocOnto. Provide mechanisms to annotate processes with ProcOnto.	3
28	Alignment of KPI model and KPIOnto to enable exchange	KPIs are modelled within the MCR and need to be aligned with KPIOnto and need to be annotated with KPIOnto concepts	3
29	Flexibility of conceptual model framework	Enrich meta modelling framework with semantic and enable a flexible, plug-in concepts to enable adaptation on end user site.	5
30	Skill management	Enable skill management in order to provide input for high performance team building in the VIF	5
31	Whiteboard	Enable whiteboard mechanism for all models and all layers to enable improvement in all phases and considering all aspects	5
32	Collaboration	Introduce collaboration in designing, experimenting, monitoring and continuously improving the value production space.	5

5 CONCEPTUAL FRAMEWORK SPECIFICATION

"To treat something as a process is to impose a formal structure on it [1]". Applying business process management within the Value Production Space with the MCR is imposing a formal structure with a given set of concepts. BIVEE relies on the findings of the project plugIT [7], which research exclusively on the interaction between meta models and ontologies.

MCR in BIVEE is using those results and applies the findings in the domain of Value Production Spaces, by a meta model and enabling ontology integration.

Hence MCR is a hybrid approach in integrating meta models and ontologies.

First a quick state of the art re-visit puts the document into the context of the literature.

5.1 Revisit of State of the Art

This section re-visits the MCR relevant state of the art in conceptualising the Value Production Space. As already discussed in D2.2, SCOR and VRM are two major frameworks that are widely used to describe Value Production Spaces. The EU-project ComVantage [19] – also part of the FINES cluster – is currently developing a conceptualisation framework similar to the MCR

The e3 value model is commonly applied when describing networked organisations having its origins in the e-business management. Hence it is considered as an important conceptualisation approach across enterprises.

There exists some enterprise modelling frameworks such as CIMOSA, Zachmann or TOGAF. These frameworks aim to describe enterprises focusing on IT integration. As this is not the goal of MCR, these frameworks are not considered in more detail.

5.1.1 SCOR

D2.2 already reflects established modelling frameworks, such as SCOR and VRM, hence this section briefly re-visits the discussion for completeness reasons. Supply chain operations reference (SCOR), a product of Supply Chain Council (SCC) is a process reference that proposes standard guidelines for supply chains management [8]. SCOR provides a common view all activities associated with the supply chain, from demand to order fulfilment, and their corresponding flows and interactions. Recent expansions consider product design (DCOR), customer interaction (CCOR) and market modelling (MCOR) [9].

The framework has its focus on the reference processes, taxonomy and KPIs. Hence the required concept models are typical process chains and related modelling concepts such as process landscape, organisational charts and resource pools. KPIs models are also reflected in most tools that realise SCOR on concept model basis.

Following the reference process approach SCOR provide supply chain content that are semantically detailed throughout the lower levels of the taxonomy and leaves the adaptation of the enterprise to the user.

Selection of processes and metrics for BIVEE is identified in D2.1 and discussed in D2.2.

5.1.2 VRM

Value Reference Model (VRM) is provided by the Value Chain Group and has a similar structure as SCOR but covers the wider scope of value chain, by integrating aspects of product design, market research and customer relation.

As already pointed out in D2.x, there are four levels describing different levels of detail.

Similar to SCOR, VRM provides compliance recommendation and a semantic metric taxonomy.

These similarities between SCOR and VRM allow approaching both with process modelling, introducing thread model as a specific model concept.

5.1.3 SixSigma and Lean

Considering the application domain of MCR with focus of production improvement, we identified SixSigma and Lean as two quality assurance methodologies that can complement the mentioned standards, and have converging goals:

- SixSigma places process outputs within 6 standard deviations (or 4.5 according to some practices) from the mean of a normal output distribution;
- Lean aims to minimize waste and considers modelling techniques such as value stream mapping to compare value-adding time to total lead/cycle time[12], [13].

SixSigma proposes strict process control to restrict the number of standard deviations between the mean process output and its closest specification limit. According to how many standard deviations are between the mean and the limit, companies can be diagnosed along the SixSigma ranking:

Error rates are normal process outputs/indicators that fall outside the specification. SCOR and VRM define activity and process types to be executed along a supply chain/value chain and semantically define target indicators to be tracked. Hence the goal of SixSigma and Lean can be approached with such frameworks.
Lean has its origin as a management philosophy defined by Toyota, focused on eliminating waste. Waste is approached in its most general sense, hence waste

is classified based on several categories of "waste-able" resources [14], which can be reduced to the following enumeration: Production; Inventory; Processing activities; Time; Logistic motion; Human motion; Defects; Rework; Competence.

Key requirement for Lean modelling support is to allow the description of waste attributes for activities and processes.
Process control approaches are discussed in the context of methodologies such as DMAIC [15] where the following phases can be identified: Define, Measure, Analyze, Improve and Control.

5.1.4 e3 Value Model

There is a set of modelling concepts that compliment the two aforementioned popular frameworks. e3 Value model enables the analysis of networked enterprises. Goal is to support the design of the value chain. A popular tool on the modelling products market [15] realises the concepts in an abstract way to allow the design of networked enterprises in a domain independent way.

Figure 18 shows an example model indicating different companies; their money and product / service flow and enable the representation of some logic. The model describes a Train company providing the service of a ride and a Food company offering food.

The model expresses that from the 10 customers consuming the train ride only half of them also are willing to consume food. This is indicated by the *OR* splitting the two groups of 5, where the first only want the train ride and the other wanting both the ride *AND* the food. Another *OR* groups the group of 10.

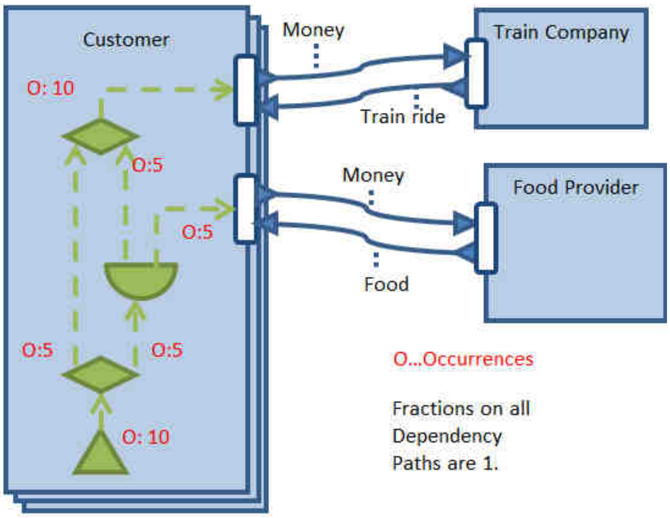

Figure 18: Example showcasing an OR in a Business Model depicting Train rides and Food provision.

5.1.5 CIMOSA

Computer Integrated Manufacturing Open System Architecture is an enterprise modelling framework focusing on the integration of machines, computers and people and has been developed based on the results of a European research project.[16]

Basic Characteristics are generation, insanitation and deviation of enterprise operations that are monitored for daily controlling.

CIMOS cube is the trade mark of the architectural framework of CIMOSA introduction the dimensions (a) Generation, (b) instantiation and (c) derivation. There are different modelling approaches for each dimension to holistically describe the enterprises activities based on those three dimensions.

For the purpose of BIVEE this modelling framework is less feasible, as organisational descriptions are indicated as “black boxes” as the inter-organisational aspects are of importance.

5.1.6 Zachmann Framework

Zachmann framework [17] is a well known enterprise modelling framework describing the enterprise with two dimensions, the perspectives and the aspects. The goal of the Zachmann framework is to again describe the inter-organisational aspects with the focus of business and IT alignment.

Hence the goal is to support the tight coupling between business models and IT solutions.

Similar to the argument for CIMOSA, BIVEE modelling framework is focused on the VE level and less on the inter-organisational level.

5.1.7 The Open Group Architecture Framework (TOGAF)

TOGAF [18] is based on the Zachmann framework and aims for a common enterprise architecture. It is a framework that integrates domain specific modelling concepts with information technological concepts and uses different viewpoints and levels.

Similar to aforementioned arguments, the goal of MCR is the inter-organisational modelling, hence TOGAF may be an appropriate extension, if an organisation aims for enterprise modelling, but is not the core focus of MCR.

5.1.8 Next Generation Modelling Framework

“Plug your business into IT” was the vision of the plugIT European research project, developing a Next Generation Modelling Framework that enables the plug-in of modelling languages.

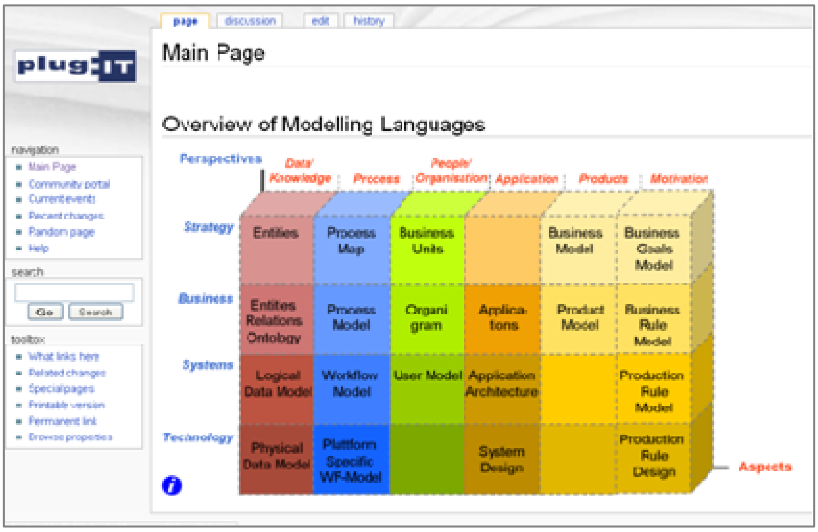

Figure 19: plugIT Modelling Language WIKI source: http://plug-it.org/plugITwiki

Figure 19 introduces the Next Generation Modelling Framework applied in the domain of business and IT alignment following the Zachmann framework. An interactive list of identified modelling languages can be depicted in the wiki: www.plug-it-project.eu covering the main aspects of inner organisational concept models.

As MCR focuses on VE processes that are not covered in this framework, this framework will not be applied, however it provides a fruitful list of concept models, when defining an enterprise.

5.1.9 ComVantage Identification of Modelling Concepts

ComVantage is an EU projects that runs in parallel with BIVEE and also contributes to the FINES Cluster. For a list of well-established concept models, deliverable D3.1.1 [50] – “Specification of Modelling Method Including Conceptualisation Outline is referred as it lists nicely the construction of a concept model for Virtual Enterprises:

- “the **voice of the customer**” describes the market structure
- **Product configuration** models specifies products and its configurations
- **e3** business model type, describes the virtual enterprise
- the **scope model** describes the members of the virtual enterprise, partly also including geographic information
- thread model identifies the key processes in correlation with the organisations.
- Process models are typical process chains like BPMN (a full list is provided in the plugIT Modelling Language WIKI)
- Organisational structure model, describes the organisation
- Causality model, is recommended by SixSigma and DMAIC to identify cause and effect in case of process failures
- Funnel model and Value Stream Models identifies the compilation of values for a product

5.2 Generic Modelling Method Specification Framework

MCR relies on a conceptual framework that is instantiated from a generic framework to the particular domain of production processes. Hence, MCR applies the Generic Modelling Method Specification Framework to derive the BIVEE specific modelling method.

The Generic Modelling Method Specification Framework has been researched at the University of Vienna [5], [6] and is now used in the Open Models Initiative [20] as a generic framework to specify modelling methods.

In contrast to other approaches this modelling method identifies not only the modelling language but also the modelling procedure and mechanisms and algorithms.

Typically model-based approaches only focus on modelling languages and the functionality that are directly related to graphical editing. Modelling methods in contrast also deal with full fletched functionality for model processing and hence introduce with the processing an additional value to graphical models.

Therefore graphical concept models – as they are used and applied in MCR – are not use to create software or to orchestrate software components, the graphical concept models in MCR are seen as an enterprise knowledge platform bridging human knowledge – in form of the user interpreting the graphical models – and machine interpretable knowledge – in form of semi-formal or formal structure that are provided for model processing.

Figure 20 depicts the relevant parts of a modelling method, consisting of the modelling language, the modelling procedure and mechanisms and algorithms.

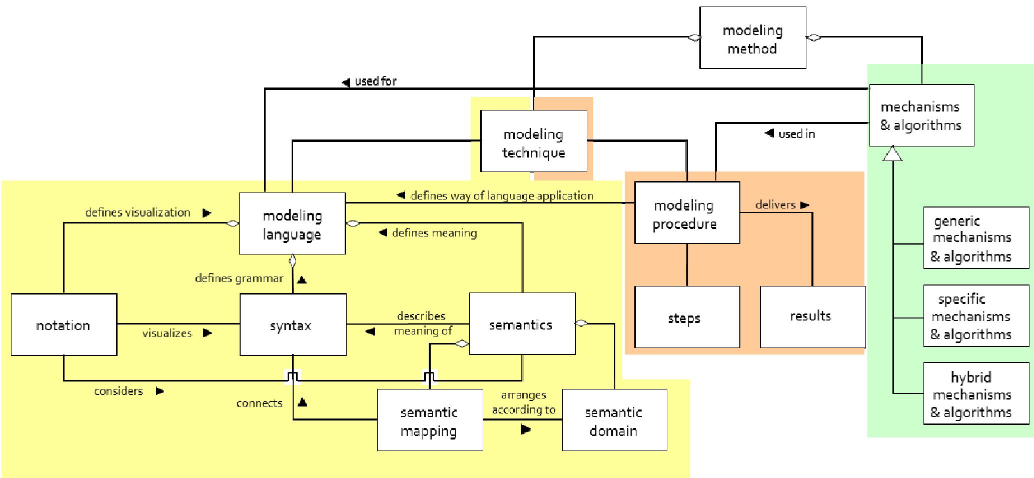

Figure 20 Generic Modelling Method Specification Framework

Modelling language is seen as a pre-defined set of concepts that are use to formalise the real world – in our case the value production space. The fact that concepts are pre-defined does not imply that this approach is inflexible, as there are many modelling language such as OWL, ERM, topic maps or UML-class diagrams that introduce domain-independent concepts and hence enable to model in a flexible way.

It is well known that flexibility on modelling language raises complexity and dependencies on the mechanisms and algorithms. Approaches to overcome this challenge are e.g. UML profiles or meta models.

MCR is based on a meta model platform, hence the challenge is to identify basic concepts of the modelling language that must be pre-defined in order to provide domain-specific functionality, but also identify parts that need to stay flexible, in order to semantically enrich the modelling method.

Modelling languages consists of concepts that are specified as model types, classes, relations and attributes, whereas each of these concepts consists of syntax, semantic and notation.

Syntax is the description of the concept, semantic specifies the meaning for the processing and notation defines the graphical appearance.

As mentioned before most model-based approaches only cover the modelling language. MCR applies a modelling method approach that also includes mechanisms and algorithms that enable the processing of models.

Algorithms are predicable functionalities, meaning for a given input set the output set is predictable. Most of calculations, queries, linear programming and the like belong to this category. Mechanisms are not predictable like end user interaction during processing like ratings or selections as well as simulations using probabilities.

This processing of models enriches the modelling method to provide added value to the user and hence make MCR a supporting and assistance system. Here we distinguish between generic processing that are domain independent and hence work independently, if we model a production process of an enterprise or model the structure of a community. Typical samples are the model transformation from one format into another format, the generation of graphical appearance, the query within the models etc.

Domain specific processing only makes sense for a particular and pre-defined set of concepts in a particular and pre-defined situation. A sample is the interpretation and analysis of KPIs that include KPI – hence modelling domain – specific characteristics that the same processing for KPIs does not make any sense to apply for a production process. The visualisation of a KPI cockpit indicating, which values are below or under threshold is a typical functionality that is KPI specific.

Modelling procedure is a methodology that guides the user in applying the modelling language and the mechanisms and algorithms. It is a step by step guideline, how designers are supposed to use modelling language. This guideline varies from rigor to flexible, depending on the object under observation. MCR has enterprise knowledge as within production process as object under observation, hence the procedure is flexible and open.

After introducing generic aspects of conceptualisation frameworks, we introduce the specification of the BIVEE modelling language according this generic modelling method specification framework.

5.3 MCR Modelling Languages

MCR modelling language is specified considering the following principles. First principle is to cover all conceptual requirements, which have been collected in chapter 4 covering BIVEE and reasonable similar use cases.

Second principle is to introduce the plug-in concept enabling to the current identified set of modelling concepts in order to adapt the modelling language to alternative application scenarios and to stepwise extend if necessary.

Third principle is to include semantic concepts to realise hybrid modelling. This means that concepts from the PIKR are imported into MCR in order to enable a user friendly annotation of models, enabling the annotation in one tool.

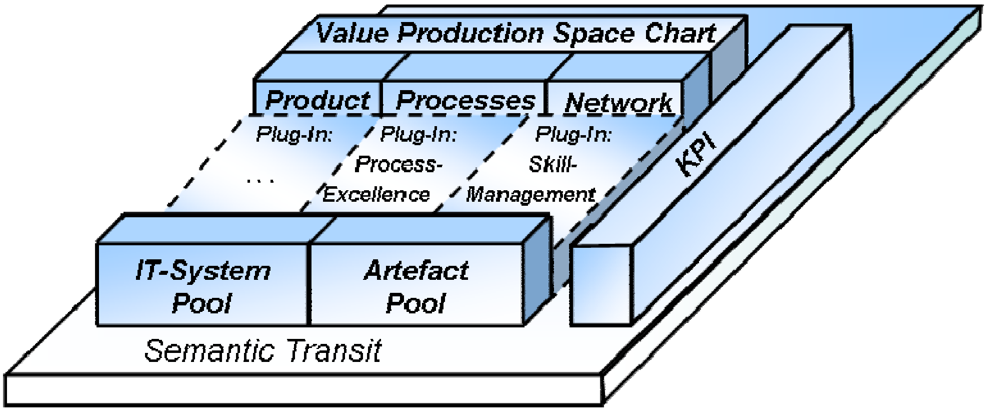

Figure 21: MCR Modelling Language building blocks

Figure 21 introduces the building blocks of the MCR modelling language. The Master Production Plan can be charted using the Value Production Space Chart.

As MCR provides the flexibility to create the VE using different paths, the core building blocks are provided to either start from product definition or from already existing processes or network of the Virtual Enterprise. Hence these three building blocks of MCR modelling language are provided as either a detailed description or the starting point of the Value Production Space.

A conceptual interface to more technical diagrams, such as workflows or software architecture – which are out of scope of MCR – are provided by the building blocks IT-System pool and Artefact pool. IT-System pool identifies IT-System interaction with the business process. Artefact pool is a necessity to collect artefacts such as documents, which are required when using the other MCR modelling building blocks.

Semantic transit building block enables conceptual interface with semantic systems like the PIKR. Semantic transit building block enables to integrate as much semantic as necessary to have annotations and similar functionalities in one modelling tool.

Plug-ins enable the extension of the aforementioned described building blocks by additional building blocks, concepts or functionalities.

5.3.1 Value Production Space Chart

This part provides the overall overview with a geographical model and enables to identify key partners on the geographical landscape. This modelling language building block has therefore different graphical representations (a) geographically or so-called scope model as well as (b) e3 value model.

This modelling language building block therefore requires a notation of a “Virtual Enterprise Process” that considers traditional e3 value business model and a geographical model.

Furthermore it enables the representation of the Business Ecosystem, the Virtual Enterprise and enables to place pre-defined KPIs into the model.

Starting points of the specification of the Value Production Space Chart are the concepts displayed in Table 3.

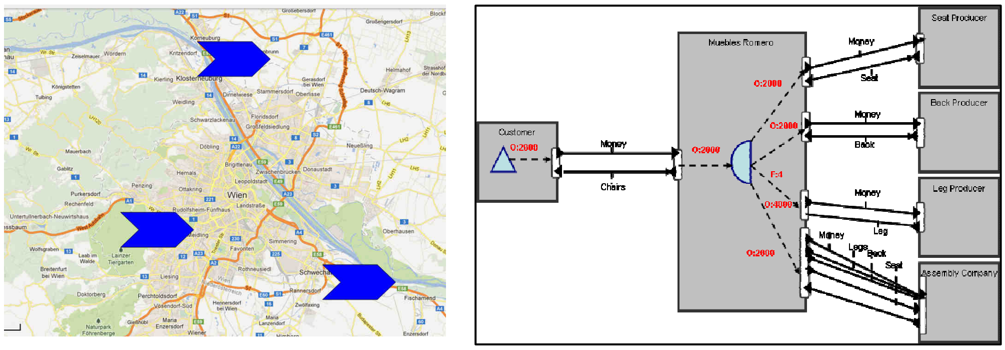

Table 3 Concept Models for Overall Value Production Space Chart

Relevant concepts are: (a) geographic area, describing the geo-location, relevant transport options, risk factors such as weather (b) production unit, describing the organisation of the Business Ecosystem, including properties such as capacities and capabilities, input and output parameters and transformation parameters (c) KPI, specifying the target and identifying the indicators which virtualizes (d) relation between production unit, (e) relation between KPI and any other object.

As a graph is imposed, additional concepts such as start, end, parallelism or decisions need to be added in a different view.

Business Ecosystem is specified by a list of enterprises that can be used when designing the VE.

Additional to aforementioned representation of the VE the well-known e3 value model may be integrated as an additional set of concepts to detail the interaction between production units, such as information or material flow.

Using this modelling language building block starts with a defined set of Business Ecosystem and KPIs that may come from the PIKR or is defined by MCR directly.

Then production units are designed either using the geographical view or as e3 value model view.

5.3.2 Process

Process maps are entry point in business process management within the organisation. BIVEE modelling framework categorised processes in phases and levels comparable to SCOR and VRM.

Although BIVEE follows the black-box principle stating that processes inside of production units are basically not of interest to the MCR. However the well-known thread-model that can be seen as a more detailed view on the aforementioned scope model provides sufficient concepts to describe the sequence of VE processes. Referring to the WP2, a similar representation as represented in Table 4 will be used.

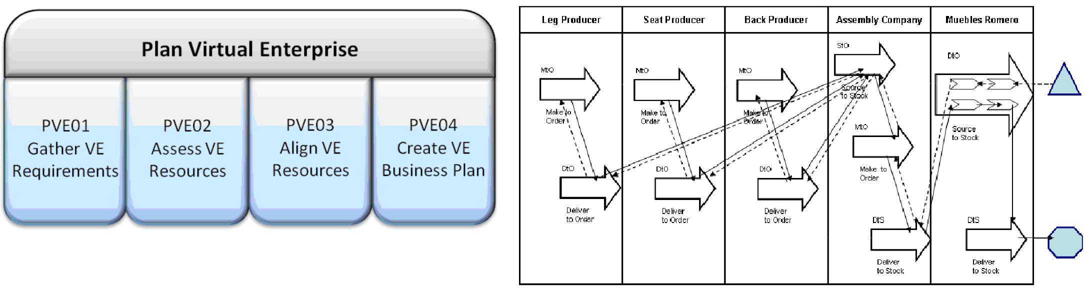

Table 4 Concept Models for Process Maps and Thread Models

Processes are interpreted as nodes of a directed graph applying the same paradigm of directed graphs on all SCOR levels.

Detailed levels of process design are supported by providing well-established BPMN format. Here it has to be stated that BIVEE is not interested in modelling all levels of processes but MCR provides a possibility for doing so. Hence Figure 22 depicts a possible business process using the BPMN form.

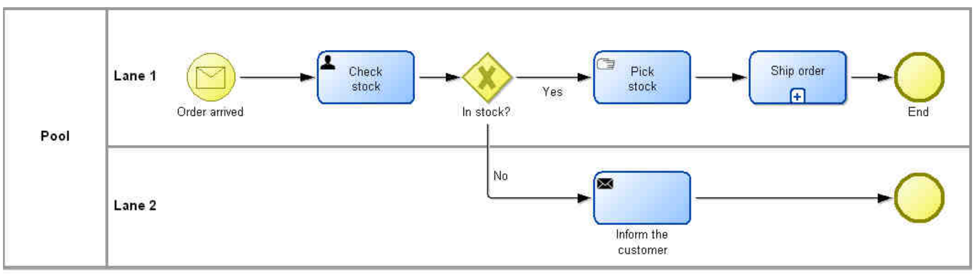

Figure 22: BPMN as Concept Model for Business Process Models

The concept of swim lanes must be applied in order to represent different enterprises taking care of different parts of the process.

In case the virtual enterprise is developed using a bottom-up approach by starting from an existing process parts that are outsourced are moved onto swim lanes from other enterprises.

5.3.3 Bill of Material or Product model

A challenging path to create a VE is by starting from the Bill of Material and decompose the product in sub-products and finally in material.

Product models define products, their components as well as their configurable sub-components. They are tightly interwoven with bill of material lists, hence BoM and corresponding product model have a graphical representation and a table based presentation.

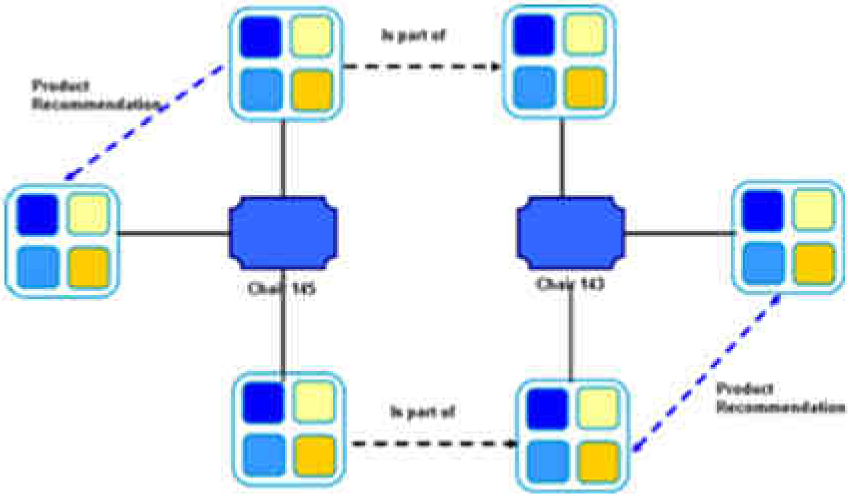

Figure 23: Concept Models for Product Configuration

Figure 23 depicts a possible graphical representation of BoM. Each product part has features and corresponds to material and required transformation steps on the material.

Hence required capabilities of production units need to be derived out of this models, in order to identified necessary participant of the VE.

Goal of this model is to systematically support the decomposition of the products and store relevant decisions that may influence the selection of production units.

5.3.4 Virtual Enterprise Network and Business Eco System

Similar to organisational structure or working environment, the VE processes require a corresponding structure of participating enterprises. The scope model is a prominent representative of concepts describing the different enterprises, their role within the network, their location and dependencies.

Service Level Agreements, capacities, capabilities and reliability are properties describing each enterprise on more detail in order to enable the query and identification of appropriate enterprises.

Figure 24 indicates a typical organisational structure and a scope model identifying the network partner enterprises, and their roles.

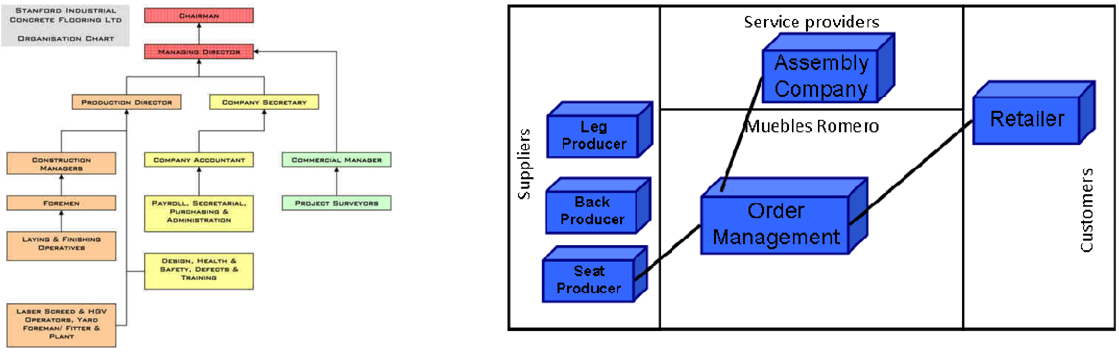

Figure 24: Concept Models for Virtual Enterprises and related Partner model

Aim of this modelling language building block is to identify all participants of the Business Ecosystem, select the Virtual Environment and identify the roles, service level agreements and requested capabilities.

5.3.5 Information Technology and Knowledge Resource Model

Aforementioned model describe the Virtual Enterprise, its players and where necessary processes and products. In order to describe aforementioned models with concepts those enable the "connection" to the real world, so-called pool models are introduced that can be seen as pointers to concrete entities of the Value Production Space.

Two elements have been identified in BIVEE that are necessary to be described: (a) the IT-Systems and (b) artefacts like documents and sources.

IT-system identifies relevant IT-systems, where user interaction or computation is significant to the designed processes. It has to be stated that only the interaction with IT systems are identified, hence details required for automatic configuration are not in the focus of the MCR. Goal is to identify relevant systems enabling a further modelling applying a specific modelling approach such as IT-architecture management, software development or specification or IT-system orchestration. Hence, MCR deals with the content level and provides conceptual "interfaces" to more technical model-based approaches.

Second pointer is the reference to documents that are available in the Value Production Space and relevant to the Virtual Enterprise. Here the MCR distinguishes between schema documents that describe part of the schema of the Value Production Space and production content document that keep a part of a concrete production instance.

MCR therefore deals only with schema documents such as guidelines, templates, documentation of the VE or description of enterprises, service level agreements and the like.

In case a concrete order is triggered, the concrete order and corresponding sub-orders, work schedules, working reports etc. are inside the various enterprise planning systems of each individual enterprise and hence out of scope for MCR.

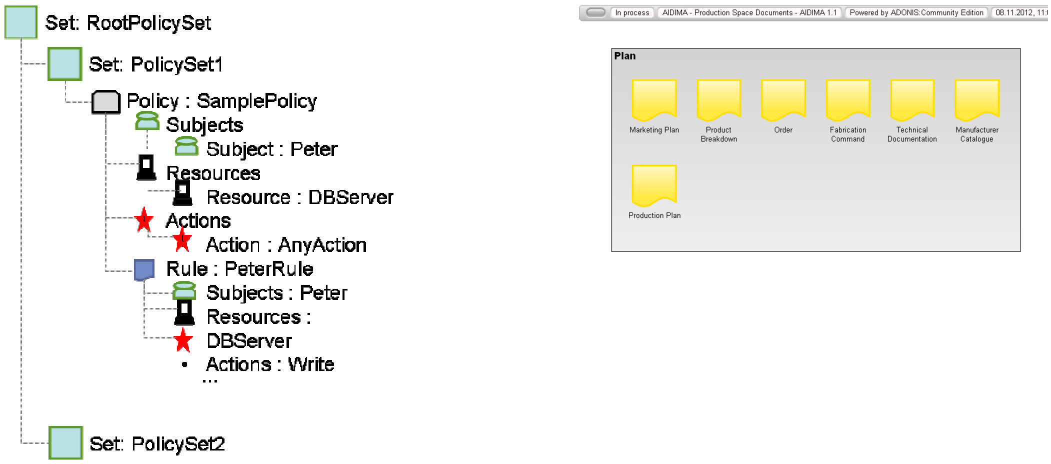

Figure 25: Pointers to IT systems and documents

Figure 25 indicates sample models of IT-systems and documents consisting of a list of objects that point to concrete IT-system user interface or concrete documents.

In order to enable the identification of relevant parts of aforementioned concrete production processes, parts of the process log files are conceptualised and hence transferred into MCR using KPIs.

5.3.6 Key Performance Indicators

Key Performance Indicators (KPIs) are seen as a virtualisation instrument enabling to conceptualise relevant parts of the concrete instances of the production processes.

MCR is the end user interface and hence is responsible to (1) put the KPIs and its concrete values in context with other concepts such as processes, production units, supply chain etc.; (2) present a user interface to view, browse and query KPIs as well as (3) define the KPIs with the help of the PIKR.

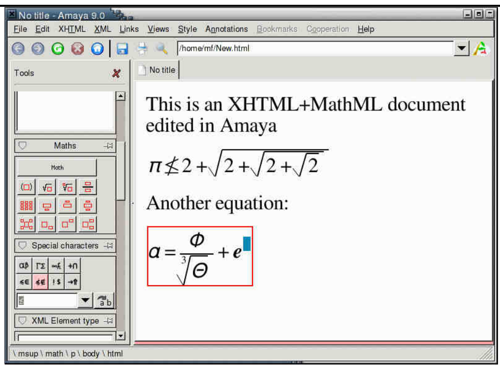

Figure 26 MathML Editor source: www.w3.org/Amaya

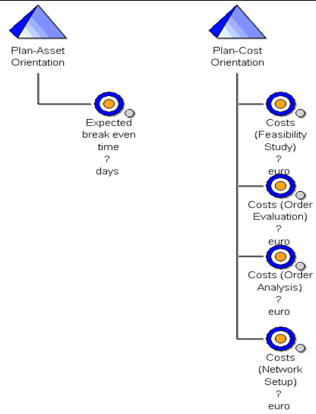

Figure 27 Sample of KPI model

First the mathematical formula that defines the calculation of the KPI is defined using the MathML format. Figure 26 shows a screen shot of one of available MathML editors [21] to give an impression how MCR defines the formula.

Figure 27 depicts a sample KPI model, where the blue pyramids are KPI collections comparable to goals whereas the target icons represent KPIs. KPIs in MCR represent necessary properties like should-values, thresholds and characteristics of reaction in case an is-value triggers an alert.

The black lines describe the context of the KPI, hence they can be related to a process, production unit, actors or the like. Hence these relations enable the link a KPI to any model object of the MCR modelling language.

5.3.7 Semantic Transit Model

This model enables the semantic enrichment of all aforementioned models and hence acts as a transit model to the PIKR. Ontology concepts are used to annotate aforementioned models. Hence only the object “concept” is provided that duplicates concepts of the PIKR.

This duplication can be seen as a caching as concepts are pre-loaded to be provided for the end user during the design. Hence it is necessary due to performance and user interface issues.

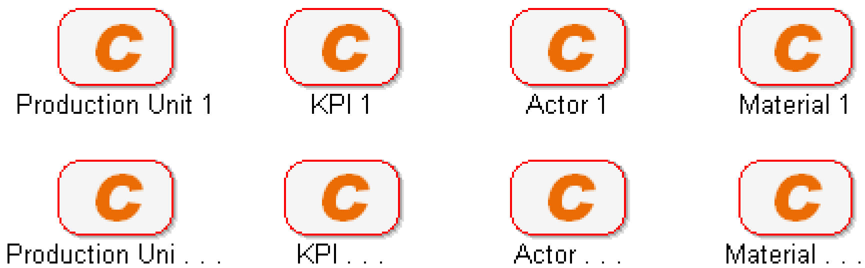

Figure 28 Sample Model of semantic transit model

Figure 28 introduces a sample model indicating that concepts can be imported from any ontology that is provided by the PIKR.

Advanced mechanisms enable the transfer of high level concepts, whereas low-level concepts that inherit from the high level one still remain in the PIKR and need to be accessed via additional mechanisms. Such a configuration may be necessary, if caching is inappropriate.

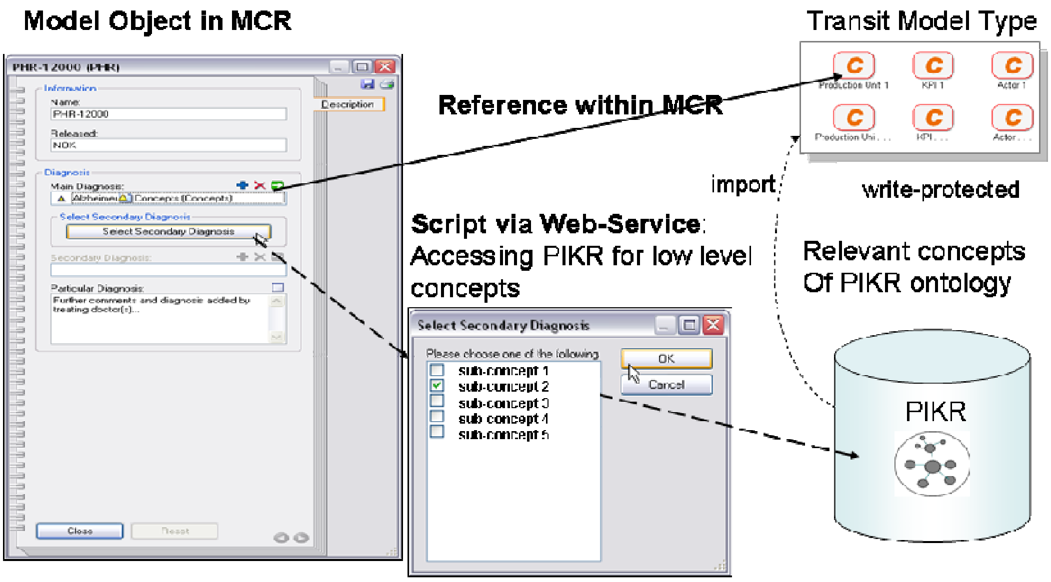

Figure 29 Semantic lifting of MCR model object

Figure 29 introduces a mock-up of an advanced semantic lifting. First relevant concepts of the PIKR are imported in a write-protected transit model of the MCR. Hence similar like the aforementioned semantic lifting, relevant concepts are cached in the MCR.

Left side of the figure shows a notebook and the possibility to reference within MCR. This reference is called inter model reference pointer and relates the object form the MCR with another object of the MCR.

Advance semantic lifting is introduced when a script window enables, e.g. via the use of Web-service, the direct access to the PIKR and provides the user a set of sub-concepts for additional selection/refinement. Hence depending of the first object reference pointer, there are corresponding sub-concepts able to be selected.

5.4 Plug-ins

Plug-ins introduces flexibility to plug-in concepts and corresponding functionality into the modelling method.

5.4.1 Production Process Improvement Plug-In

Process optimisation has been raised as a BIVEE use case requirement; hence the plug-in production process excellence is introduced with the aim to provide concepts and functionalities to manage the excellence of the production process.

Production process improvement can be realised using (1) calculations or (2) simulations. Calculated process optimisation is an algorithm as by a given snap shot of a process it always calculates the same result. Simulated process optimisation is a mechanism as by a given snap shot of a process it most likely simulates different results depending on the values of the probability distribution.

Calculated or simulated process excellence:

- Maximum throughput analysis is graph based algorithms that calculate maximum throughput for transport.
- Critical path analysis is graph based algorithms on critical path.
- Earliest / Latest deadline introduce time and into the graph enabling to assess the risk of accepting and order or committing to a service level agreement.
- Work plan analysis are functions to calculate effects of accepting an offer
- Two phase optimisation are applied from inside and outside to conclude with realistic assessments.
- Production planning of composed products.
- Material planning includes ordering, transport and cutting of material.
- Dispatching analysis calculates the work load within a graph.

Aforementioned functionalities are based on graphs, which are represented as process chains. Hence this plug-in introduces process chains with appropriate properties to realise these functionalities.

5.4.2 Skill Management Plug-In

Skill management is introduced to support knowledge management aspect of BIVEE and hence may support the innovation waves in the VIF.

At this stage it has to be stated that skill management and capacity analysis are different functionalities, whereas capacity analysis is concerned with the production capabilities of the enterprise and skill management is concerned with the intellectual capacity and know how of individual persons as knowledge carriers within the enterprise.

Skill management provides algorithms to navigate within skills and is realised using two concepts.

- Skill profile

  The skill profile is a concept that is annotated to a person and collects the four profiles (a) factual knowledge (b) personal skills, (c) social competences, and (d) methodological competence.

  Those dimensions are stored as weighted references to so called skill items.

- Skill item

  A skill item is a topic that sufficiently describes knowledge, so it can be identified and system border of such knowledge can be identified.

This plug-in relies on the modelling method, as the challenge is the generation of the skill item list and the appropriate level of detail, as if the knowledge is described on too detailed level, the effort in modelling is extremely high and the if the level of detail is to high, the applied processing are meaningless.

Typically skill models start with the production process in question and list all organisational roles that are references with the individual activities in the process. Workplace descriptions are created for each role introducing tasks that correspond to that particular workplace description. Tasks are seen as skill items, so work place descriptions correspond to a set of tasks that are described in such detail that is understood within the enterprise.

Based on this starting point, the skill management algorithms are performed and checked if the results are of useful granularity. Now starts an iterative approach in refining the descriptions and checking the results till an acceptable result with acceptable effort can be achieved.

Calculations on skills:

- Search for particular skill
- Identify stable skills that are covered by several persons
- Identify risky skill that are covered only by few or only by one person
- Identify communications hub that are persons bridging different domains and can act as mediators between domains.
- Identify required skills for a production process
- Analyse if a production process is stable concerning available skills.

This plug-in provides all required concepts and functionalities to walk through aforementioned methodology.

6 Technical Framework Specification

This chapter deals with the technical specification derived of the aforementioned requirement analysis.

Starting point of the technical specification was the state of play in the field of modelling tools for production processes to conceptualise Value Production Space. Well established technology is the meta modelling platform that may be combined with advanced technology such as semantics.

Aim of BIVEE is to enable a flexible approach by introducing so-called hybrid modelling that enables flexibility in meta models. BIVEE approaches this by combining of meta modelling platform technology, applying plug-in mechanisms and extending the meta modelling platform with semantic extensions.

Technical solutions for hybrid modelling have intensively been researched in the EU project plugIT [7] therefore BIVEE will use findings of this project.

In the following the architectural design principles are briefly mentioned, key concepts of MCR are identified, overall architecture is revisited, before the traditional three layer tiers are reflected: (1) user interaction discussing about user interface of the tool as well as graphical representation of models, (2) functional building blocks that are reflected in so-called plug-ins, (3) data persistence tier that represents the model repository.

6.1 Re-Vision of state of the art and tool market

This section re-visits diagrammatic modelling tools for VE creation, monitoring and improvement.

The tool ADOlog® [22] from BOC is not listed, as MCR will evolve out of ADOlog® and supports the development of the next version; hence all features and technologies of ADOlog® are automatically included in MCR.

In the following MCR relevant tools and players are listed.

6.1.1 Arena [23]

Arena is a well established simulation software by Rockwell Corporation and is used for simulations in (a) Manufacturing, (b) Supply chain including logistics, warehousing and distribution, (c) Customer services, (d) Strategies and (e) Business processes.

SIMAN is a domain-specific simulation language, which is used to configure the Arena input analyzer, the process analyser and the output analyzer. Run time animation and CAD drawing import mechanisms are provided.

Interesting feature are the use of flowchart modelling environment, spreadsheet interfaces for data definitions, resource animations, detailed activity-based cost analysis, reporting capability using crystal reports and a free model library.

6.1.2 Aris SCOR [24]

Software AG and IDS Scheer is well known in the area of business process management. ARIS SCOR has special focus on managing SCOR models and could be used in combination with ARIS Process Performance Manager and / or

ARIS MashZone. This is a comprehensive toolset for SC-specific controlling cockpits.

Figure 30 depicts the process landscape of SCOR or the ARIS tool. The ARIS repository based tool enables to use the SCOR reference processes model and adapt them to the customers needs.

Collaborative feature like whiteboards and brainstorming support are provided and influence the requirements of MCR.

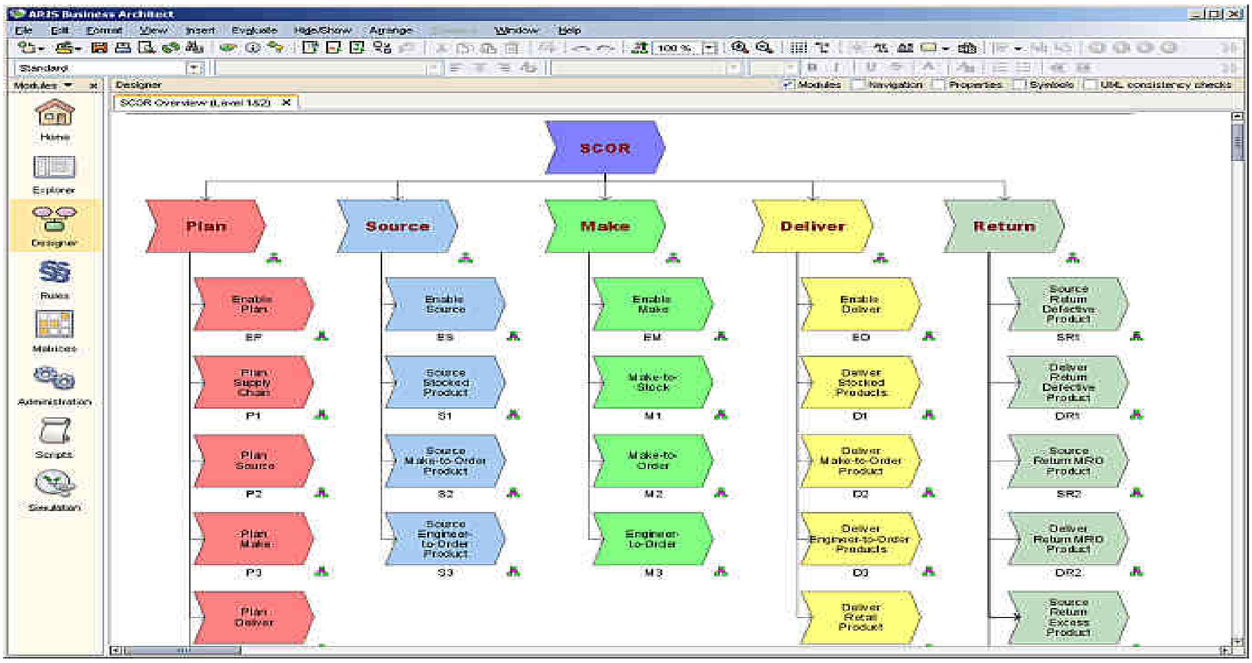

Figure 30: ARIS Distribution Strategy

6.1.3 Barloworld Supply Chain Software: CAST Aurora [25]

CAST Aurora is a supply chain planning software supporting supply chain network modelling, network design and supply chain optimisation. Figure 31 depicts a geographic model, enabling centre of gravity modelling considering location costs and capacities as well as transport costs including regional warehouses.

Analysis of the models include service lead time analysis including geo-coding, mapping customers service levels and transport lead time across road networks and optimise supply chains using mixed integer programming. A reporting engines enables the configuration of export formats like the typical HTM, PDF, XLS file formats.

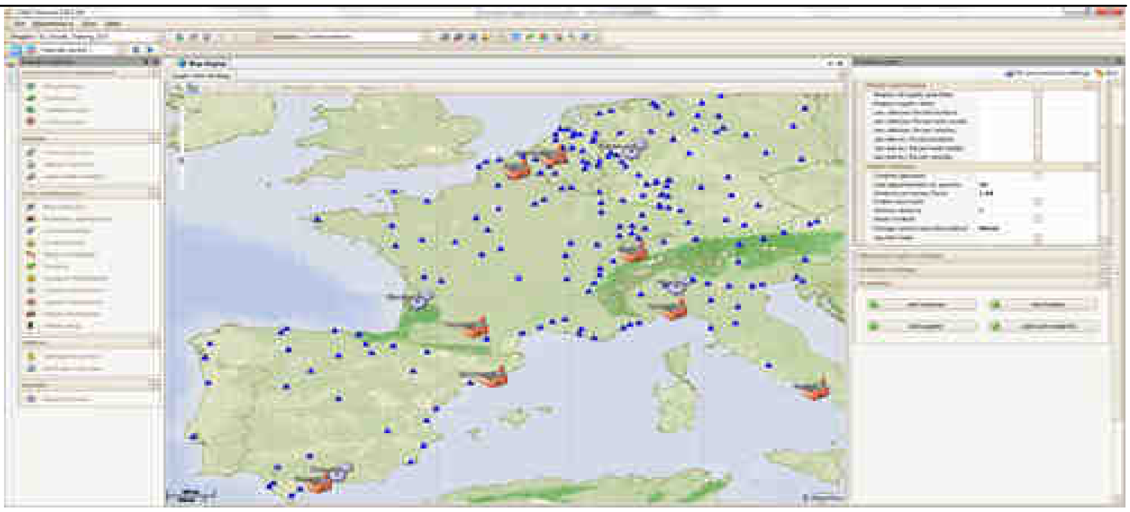

Figure 31: Map for the supply chains

6.1.4 eVSM [26]

eVSM software is a visualisation and value stream charting tool. It supports sketching of diagrammatic model, connecting activities to create sequences, validate data, calculate time / quality and costs, visualise the value stream and support Kaizen for improving the map. Visualisation on the map is a nice feature for MCR.

6.1.5 Flexsim [27]

Flexsim provides a 3D simulation in order to visualise real processes from manufacturing and supply chains. Common spreadsheets or databases are the input for the software.

6.1.6 GoldSim [28]

GoldSim provides simulation features on the basis of concept models such as business processes, supply chain models and resource management. Based on concept models, graphical probabilistic simulation framework is proposed. It allows simulating future behaviour of supply chains and business systems; risk assessment in case of unexpected events such as warehouse fire enables the data exchange with databases and provides a graphical interface.

6.1.7 iGrafx [29]

iGrafx is a nice charting tool that also realises Value Stream Mapping. It provides BPMN notation for charting and extends its modelling language for lean manufacturing.

6.1.8 KPI-Monitor® [30]

The KPI-Monitor® automatically reads booking data from deliberate pre-systems into KPI database warehouse.

It calculates and visualizes KPIs along existing business' individual algorithms. Personalized KPI-Cockpits® and dashboards display gathered information the way as it is needed – for an accurate and on-time analysis.

Customizable reports and graphs with drill down functions and integrated alarm features support the optimized usage of the information available. Integrated Microsoft Office® applications support intuitive handling.

Based on SQL or Oracle databases, application allows to easily integrate customers data sources from SAP to Excel sheets. Achieve transparency and steer y organization's processes with the KPI-Monitor®.

6.1.9 OpenText ProVision [31]

Metastorm ProVision was a powerful meta model based tool for SCOR, before Metastorm was bought in 2011 by OpenText. Although ProVision has less importance since then, the basic concepts are very close to MCR and hence should be reflected.

Graphical modelling provide a huge modelling language for VE and Supply Chain Management. Simulation and analytics uses Monte Carlo and discrete event simulators simulating costs, timing and resource analysis.

Similar like MCR, it is built on a meta meta model representation and hence enables the adaptation of the meta model using an external tool called Model XTender. BusinessObjects™ Crystal Reports are integrated into the tool.

Figure 32 indicates a set of modelling languages similar to the MCR.

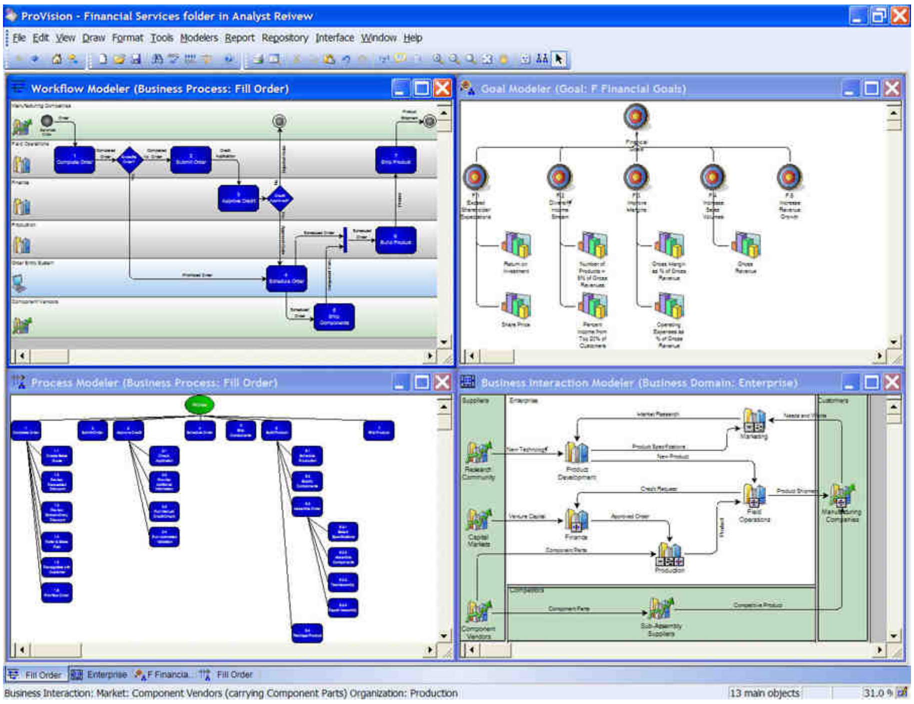

Figure 32: Model in ProVision

6.1.10 SigmaFlow VSM [32]

SigmaFlow is a Value Stream Mapping Software providing lean analysis for multi-level value stream maps.

Typical visual charting is used for value stream mapping. It provides scorecards for what-if improvements. Extending Six Sigma to Lean enables capturing cycle time and Six Sigma calculation. Quick assessment - to identify if a process is lean or fat -, workload balance, multi-level stream map and process simulation is provided.

6.1.11 Simio Supply Chain Simulation Software [33]

Simio enable fast modelling using so-called intelligent objects, similar to MCR and PIKR. An attractive feature is the 3D visualisation that represents the final concept modelling results not in a diagrammatic view but in a 3D simulation. Costs, variance in business, labour, material shortages or capital shortages may be analysed. Simulation is also applied for forecasting variance. It includes simulation and planning functionalities. The scheduling component uses stochastic simulation results, which is a quite new approach. For optimizing it also includes the OptQuest Engine.

6.1.12 SimPlan

SimPlan provides a set of simulation and corresponding charting tools based on the Siemens PLM Plant Simulator.

SimChain [34] support the management of complex supply chains and logistic networks. It is built to support modelling of network alternatives and simulate their outcome.

SIMChain is the simulation platform that is built on top of Plant Simulator from Tecnomatix.

Simul8 [35] is a powerful simulation tool enabling simple charting but extensive simulation features. Graphical model interface and visual simulation language are used to specify and query key process elements.

Simulations can be performed on cycle times, production rate, capacity of production equipment, production rates and statistics on production failures or arrival / order rates.

Anylogic [36] is a concept modelling tool that provides supply chain and process management concept models. Beside flow charting features there is a set of simulation and optimizations performed by the Optquest tool integrated in Anylogic.

Interesting aspect is the use of agent based discrete event modelling and simulations. Stat-Fit is a simulation tool based on statistics analysis to provide input date into the model.

A simulation model is also provided as a kind of standalone applet which can be, for example, sent to a customer or even be distributed on a webpage.

6.1.13 Tecnomatix Plant Simulation [37]

Tecnomatix Plant Simulation from Siemens is the most well-known and widely used plant simulation platform supporting the whole product management life cycle.

Discrete-event simulation tool creates concept model of logistic systems with the goal to optimize the networks performance. What-it scenarios, queuing and operation research are typical challenges of plant simulations.

Although Plant Simulation covers many areas that are not relevant to MCR, the fact that it acts as a platform for other simulation and charting tool and the provision of the component Rulestream Engineer-to-Order makes it interesting for this reflection.

Rulestream Engineer-to-Order established a closed-loop learning system to promote lean processes and innovation.

6.1.14 Xelocity Process Wizard [38]

ProcessWizard™ is business process management tool enabling the use of process methodologies and frameworks. Supply chain improvement is one of the focuses of ProcessWizard™ implementing the Supply Chain Excellence SCE and SCOR through its strong affiliation with the Supply Chain Council.

Modelling framework includes concepts strongly related with SCOR, with knowledge and skills as well as with balanced score card principles.

Interesting feature of this tool is the transformation from geographic maps in material flows.

6.2 Architectural Design Principles

MCR is a modelling tool that provides concepts to describe the Value Production Space and offers functionalities enabling the user to interact with the models.

As MCR has a set of BIVEE specifics, but in general overlaps with typical modelling tool features, it is **based on a meta modelling platform** that enable the use of a large set of available functionalities and therefore focus on the implementation and enrichment on BIVEE specific items.

"ADOxx is a meta modelling platform that enables the configuration and development of modelling tools."[39] It is provided in as open use and hence can be used to develop the MCR on top of it, benefiting from large functional sets and work out only the MCR specific features.

Hence first design principle is that MCR is a modelling tool that is based on the ADOxx meta modelling platform, using already existing functionalities and adding MCR specifics. Information on the ADOxx development environment can be retrieved from the ADOxx portal [39], the Open Models Initiative Laboratory [40], and an open source portal from the project plugIT [41], where a whole set of open source features have been implemented on ADOxx and are currently provided.

Hence MCR derives functionality of the open use meta modelling platform ADOxx and adds MCR specific functionalities. Therefore the architecture design was twofold:

(a) to identify already existing functionality, which is used in the MCR.

(b) to design MCR specific functionality that needed to be implemented as as special add on that was requested by MCR.

In the following this chapter will only briefly mentioned identified and already existing functionality for completeness reasons of this document but will refer to public documents that describe in more detail generic functionality.

MCR specific functionality, which has been identified, designed and will be implemented within BIVEE will be elaborated in more detail.

6.3 Identification of Key Concepts

Although modelling tools are mainly used in form of rich clients within enterprises, new front end modelling tools are based on **Web technology**. There is a mass of graphical editors that can be used as Web-based applications, but very few modelling tools that provide full fletched functionality over the Web. Hence MCR will tackle this challenge by developing not only a Web-based graphical editor, but also a full fletched modelling tool that provides and interacts with modelling functionality via Web-Services and hence enable the Web-based integration.

Additional to this development flow, MCR meets the collaboration needs by introducing mobile platforms. Charting via **mobile Apps** is not new, but MCR is a full fletched modelling tool for managing Value Production Space and hence integrates a whole set of apps that go beyond simple charting but include messaging, alerting, documentation and mainly collaboration mechanisms, such as documentation or information harvesting features.

Web 2.0 and social networks raised new challenges enterprises have to deal witt. Hence modelling tools such as MCR need to reflect this new reality by enabling **collaboration, participation and networking**. The technical challenge is therefore not to re-invent the wheel implementing collaboration and networking features that already exist but find the balance between using external tools via interfaces and integrating part of the functionality inside the tool. Service-oriented infrastructure and user interface mashups have in general fuzzy borders between tools, but in the end MCR needs to define collaboration and networking functionality that resides inside MCR services.

There are different possibilities to enable tool flexibility. Traditional component oriented approaches, **plug-in concepts or service oriented** realisations. Complex software such as MCR typical realise some of aforementioned approaches. MCR hence uses the plug-in concept, providing a plug-in framework and corresponding deployment and monitoring mechanisms to use conceptual and technical extensions. This concept is called “Multi Functional Building Block (MFB)” and is a special realisation within ADOxx. Service orientation is provided in form of Web-Service with a generic interface providing more than one thousand APIs via the Web-Service. Potentially the full MCR can be “taken-over” by an external application or vice versa by using the Web-Services.

As a core challenge is the service discovery, negotiation and enactment, which are typically handled by other platforms such as the BIVEE platform. MCR provides Web-Service to be managed by other tools in case MCR functionality is integrated in other applications. Hence **MCR is embedded in the BIVEE platform** using the service-oriented approach. In case MCR integrates external functionality – such as by integrating the PIKR - it writes a plug-in that is responsible of the service enactment. Hence, service orientation is potentially fully available, due to separation of concerns, ADOxx deals with modelling functionality and leave service orchestration for other platforms such as the BIVEE platform.

6.4 High Level Architecture of Mission Control Room

This chapter revisits for completeness reasons the high level architecture that has already been described in detail in the D6.20.

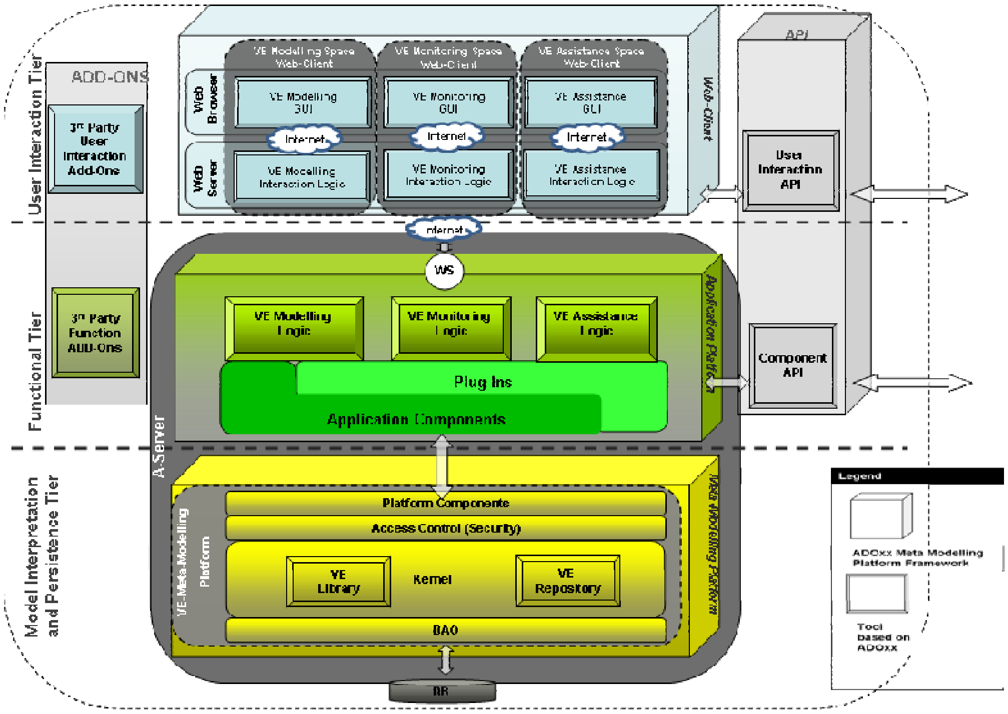

Figure 33 MCR Overall architecture

Figure 33 explains the division of MCR three tiers, whereas the ADOxx meta modelling platform provides different support in all three tiers.

In the following the overall MCR architecture is discussed from bottom to top.

Data is stored in a DBMS, whereas the database is twofold:

(1) based on the ADOxx meta2model, the meta model database is structured and the concrete meta model that has been specified in chapter 5 is stored as data inside this database.

(2) Based on the ADOxx meta2model, the instance database is structure and the concrete models like the reference models and the use case models introduced in chapter 2 are stored as data inside this database.

Hence, in order to access these instance data, a kernel that is aware of the meta model – the so-called VE library – can interpret the instance data and hence can provide the VE repository.

In order to access VE repository, the kernel needs to be accessed via a user interface layer and methods are provided in form of a platform.

MCR entirely uses the plug-in concepts that are built on top of the platform. Functionality that already exists can either be used via inclusion of components or by inclusion of other plug-ins.

There are five plug-ins that create the functionality of MCR:

(a) Modelling plug-in provides all features that are typically required for a graphical modelling editor in order to view and edit graphically models.

(b) Assistant plug-in provides features to train, test and propose processes to knowledge workers. Features that allow improving processes, and collaborating with knowledge workers are provided.

(c) Monitoring plug-in provides features to collect, aggregate and calculate KPIs. Hence functionality to analyse, drill-down and search for KPIs, descriptions and concrete values are provided.

(d) Semantic Modelling Kernel wraps relevant functional parts of the PIKR, so all other plug-ins in MCR can use PIKR by accessing SMK. Besides the functional “wrapping”, the PIKR must also be “conceptually be wrapped”, which has been explained in chapter 3.4 and considered in chapter 5.3.

(e) Web Service interface provides an API to external tools that interact with MCR. It is introduced as an own plug-in in order to provide external interfaces. External interfaces have the aim to simplify internal interfaces in order to ease the use of MCR form outside, without the necessity of insight knowledge.

These functional plug-ins contain the business logic and follow the Model Control View (MCV) concept. The control part is taken over by a controller that is implemented in each plug-in to forward the method invocations. The models are populated mainly from platform interactions, but also from Web Service Interface interaction and rarely from end user interaction. The view is prepared and handed-over to the user interaction tier.

User interaction tier is applied in the Web-environment by providing a Web-framework. This Web-framework creates the user sessions and hence the user authorisation to the user interaction tier and establishes a framework for user interfaces. To achieve this, the framework relies on the single sign-on (SSO) and user identity management services made available by the BIVEE platform. More specifically, the Web-framework integrates with the SSO service by means of a standard Central Authentication Service (CAS) client, and delegates the management of user identities and credentials to the BIVEE application server, which is a Liferay instance.

Each user interface is implemented for each plug-in and activated by the Web-framework. The whole Web-.framework can be wrapped into an iFrame and ported to a Liferay user interface. This is required in order to have a common user interface in the BIVEE platform.

In the following the plug-in framework is briefly mentioned before each functional building block is introduced and the user interactions are discussed.

6.4.1 Implementation of Collaboration

Concept modelling is a well-established discipline when it comes to externalise knowledge and to distribute it in a human-interpretable way. Typically graphical models, table based models or sometimes structured text are used to publish concept models.

The need to collect feedback from knowledge workers was traditionally differently covered, but in recent years the trend is clearly to integrate well known Web 2.0 or social network functionality.

MCR will implement and test a set of collaboration tools, with different levels of experience.

First **Wikis** are introduced as a well-established collaboration platform. Integration with concept models by using Wiki as the collaboration and knowledge harvesting platform of knowledge workers has been realised in the project Immigration Policy 2.0 [42], hence MCR can benefit from this integration.

Tweets and Messages have been derived from the necessity to alert members of the Virtual Organisation in case a Key Performance Indicator passes a critical threshold. Hence messages via tweets are seen as an interesting approach. However, reliable alerts via SMS notification will in parallel be implemented as an alternative.

Participation of knowledge worker require possibilities of feedbacks, hence **questionnaires** and as an extreme form single question polls will be incorporated into MCR. This single or multiple questions polls enable a quick feedback of envisioned production processes and enable a first feedback.

In order to provide also an interaction feature with VIF during the innovation waves, the concepts of **whiteboard** will be implemented. It is a version of a black board, where everybody can stick notes on. In context of MCR, this will be a model, where everybody can stick notes on. Notes are annotated to differentiate between claims, ideas, innovation potential etc. Hence, visual charting will be used as one source for the VIF provided by MCR.

6.4.2 Wiki

Wiki and MCR interaction are based on the principles that every model corresponds to a unique URI in the Wiki, hence is an own Wiki page.

Light integration can be performed that the URI of a Wiki pages corresponds with the Unique ID of the model. Hence the Wiki page is an add-on to the model, and can be referred as via hyperlink from the model.

Medium integration can be performed when the Wiki page additionally to the aforementioned coupling also shows some of the model content. Here the Wiki page becomes the distribution platform of the model.

Interaction between MCR and WIKI requires the exchange of the model structure, so that user can select a model from the WIKI. Graphical image of the model needs to be sent to the WIKI, so it can be displayed and made interactive.

Tight integration is, if the Wiki is seen as the user interface and implements in a UI technology the model interaction and invokes via Web-Server the full API.

MCR starts with light integration and aims to achieve medium interaction.

6.4.3 Tweets and Messaging

Tweets and SMS messaging are mainly seen as a push technology out of a model rather than a knowledge harvesting instrument. This means that in case a threshold has been passed an event is triggered to either send a tweet or to send a SMS message.

On-Change-Events are caught in MCR and checked if after the model change a critical threshold has been passed. If this is the case, a configuration file sets the parameters for sending the tweet or SMS (such as password, telephone number etc.) and via a PROGRAMCALL from ADOxx such messaging service is invoked.

6.4.4 Questionnaires

Questionnaires are typical collectors for KPIs, hence questionnaires store their results in structure text files. These structure text files are parsed to translate them into KPIs.

MCR provides a questionnaire engine that allows different configurations of questionnaires. An extreme format is the configuration of a single question poll.

MCR will use a pull mechanisms that needs to be manually triggered in order to collect all created structure questionnaire files, transform them and introduce the KPIs values.

Hence the trigger will be a UI-event such as the menu item selection. The file reader will read the structure text files and identify the resulting values. A configuration file relates the values to concrete KPIs, so KPIs can be set via a questionnaire.

6.4.5 Whiteboard

The whiteboard in MCR is a special behaviour of a model. In principal all models that can be modelled, can be used as whiteboard. So the whiteboard is a special directory of models, where the selected model is copied.

The user has only one single object – the so-called note – which is compare able to a post-it. Each user can therefore post notes on a selected model, without being able to change the model.

On-Creation-Events will identify the user credentials and automatically place them in the note, similar like the Microsoft Office notes copies the author in the first line. Additionally to this, taxonomy can be selected to indicate, if the note is a complaint, an idea, a proposal of improvement or a comment. Search functions provide statistics, on new ideas, new comments and the like per selected model.

6.5 MCR User Interaction Tier

In graphical modelling tools such as MCR it is important to distinguish the graphical user interface of the modelling tool and the graphical notation of the represented model.

In the following the graphical user interface of the tool will be discussed, as graphical notation of the modelling language is covered in the modelling specification.

6.5.1 User interaction with the toolkit

This section discusses the user interaction with the tool introducing three navigational concepts:

- Fixed navigational instruments such as the menu bar, the tool bar, the navigation bar and the frameset.
- Plug-in related navigational instruments that are introduced, when selecting a “component”. Component is in quotes as technically spoken a plug-in is selected, but for the user it typically means that one out of three components is selected.
- Graphical notation of the model. Although this is not a graphical user interface of the tool but a representation of the content, the nature of graphical symbols as part of the modelling language and the content is sometimes misunderstood as graphical concepts of the tool.

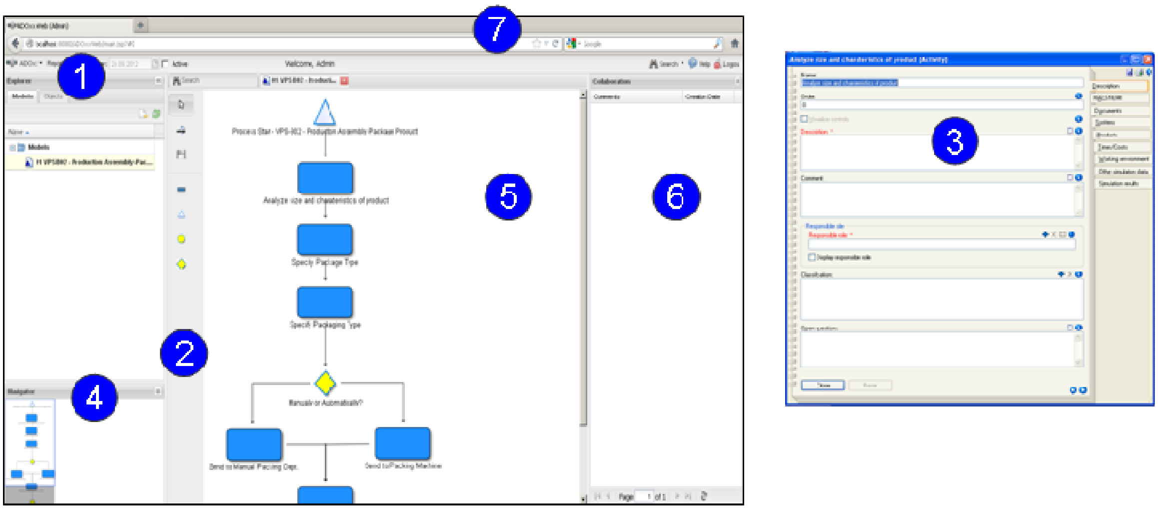

Figure 34 Screen Shot of the Graphical user Interface

Figure 34 depicts a mock-up of the MCR-Modeller of the MCR. In the following major topics are high lighted:

1. **Fixed navigation**: Topic 1 identifies the menu bar that is arranged using typical editor styles according the behaviour of modelling tools. There is a table of content tree that enables the navigation through the models.
2. **Modelling language**: Topic 2 represents the so-called model bar, where graphical concepts are provided to be used in the modelling language. There is a selection mechanism depending on the so-called model type, but this is all defined in the modelling language.
3. **Fixed navigation and modelling language:** Topic 3 represents the so-called notebook, which is detailed information on an object and displays the information of that object. Hence this user interface is a hybrid combination of tool user interface and graphical notation of the modelling language. The tool user interface defines the notebook as such, the colour, the styling, the interaction buttons and the appearance of the notebook and the properties. The graphical notation of the modelling language defines the properties, the arrangement, the content and the partly the appearance.
4. **Fixed navigation**: Topic 4 is a navigation window that enables zooming and navigating in very large models.
5. **Modelling Language:** Topic 5 is the content window that represents the graphical notation of the model. Hence this window is provided by the tool, but filled by the graphical model. Hence the graphical appearance is not implemented in the tool, but in the modelling language.

   Domain specific graphical notation is an interesting research topic, so that this representation is de-coupled from the modelling language and can be mashed with domain-specific representations. Research results have been produced in the project plugIT [7], and on the Open Models Initiative [20]. Currently MCR is not dealing with this complexity. However, if the necessity during the first prototype phase may arise, this concept may be added to make graphical representation dynamic.
6. **Plug-In-specific:** Topic 6 is a collaboration space, enabling blogging and messaging for a particular model. Each model has therefore a history of blogs that are either public or personally addressed, so either the blog entry is seen by any user or only by a selected one. This enables a communication between different modellers.
7. **Fixed navigation:** Topic 7 is the Web-framework in which MCR will be developed. Each plug-in is placed in this framework and hence uses the same look and feel.

Aforementioned topics, introduced key topics of the user interface base on one screen shot of the MCR-modeller.

The MCR modeller is one out of three MCR components with an user interface. The other two components (a) the MCR Assistant and (b) the MCR Monitoring are introduced.

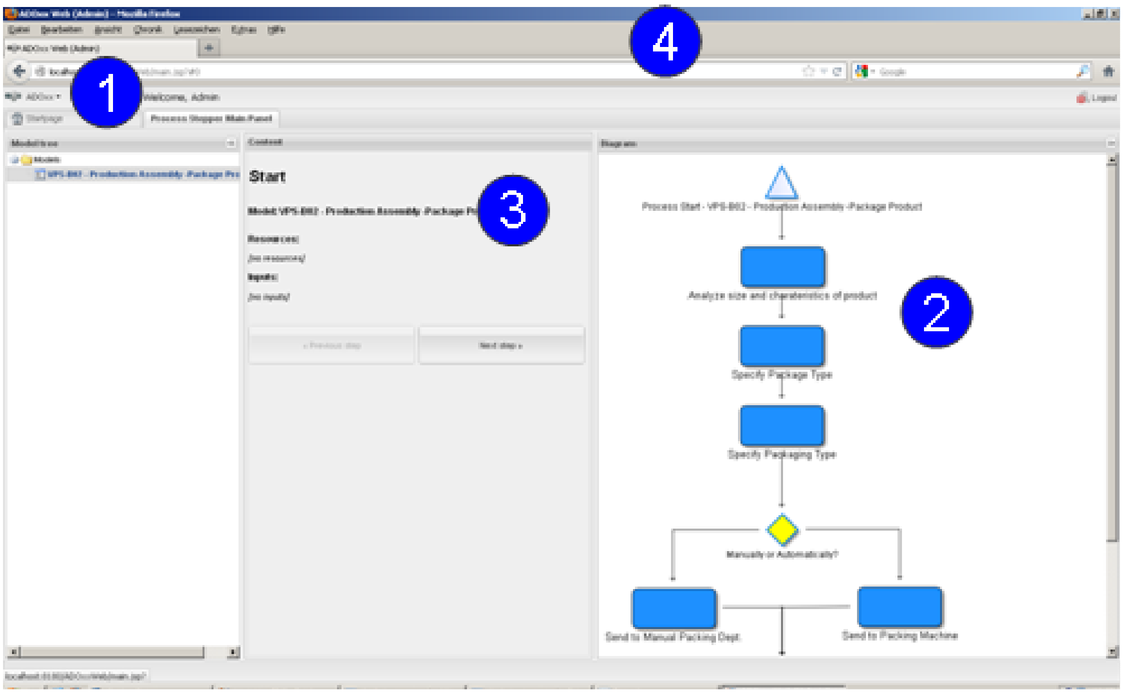

Figure 35: Mock-up of MCR Assistant

Figure 35 depicts a mock-up of the MCR-Assistant. In the following major topics are high lighted:

1. **Fixed navigation**: Topic 1 identifies the menu bar similar to aforementioned model editor.
2. **Modelling language**: Topic 2 represents the process that is about to be stepped through.
3. **Plug-In-specific:** Topic 3 represents the stepper logic, enabling the user to step forward or backward and enables the linkage of resources such as documents, videos, programmes or contact persons. Hence this logic enables to navigation within available information.
4. **Fixed navigation:** Topic 4 is the same Web-framework as in the model editor, as MCR has a common user interface framework.

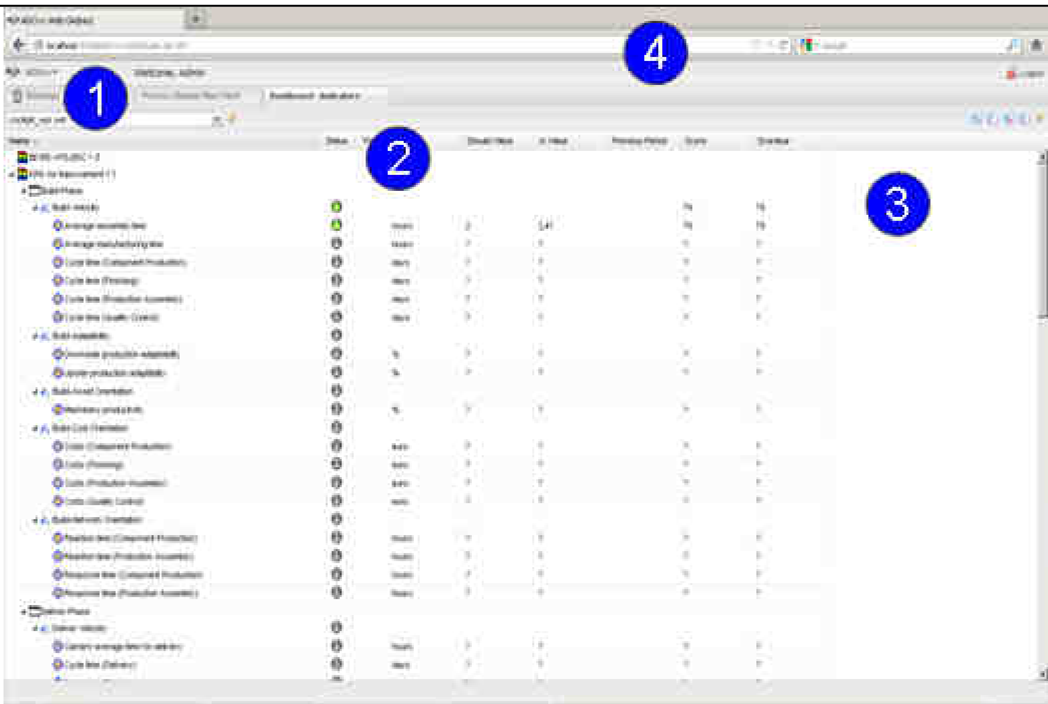

Figure 36: Mock-up of MCR Monitoring

Figure 36 depicts a mock-up of the MCR-Monitor of the MCR. In the following major topics are high lighted:

1. **Fixed navigation**: Topic 1 identifies the menu bar similar to aforementioned model editor.
2. **Plug-In-specific**: Topic 2 represents the user interface representation and the user interface logic of the monitoring component. It represents a structure view of the KPIs, indicates the core values and enables to view the corresponding notebooks.
3. **Plug-In-specific:** Topic 6 is a collaboration space, enabling blogging and messaging for a particular model. Each model has therefore a history of blogs that are either public or personally addressed, so either the blog entry is seen by any user or only by a selected one. This enables a communication between different modellers.
4. **Fixed navigation:** Topic 4 is the same Web-framework as in the MCR Modeller, as MCR has a common user interface framework.

Aforementioned user interfaces depict the user interaction with MCR on tool level. As MCR mainly displays graphical models, the graphical notation of the modelling language is also strongly influencing the graphical user interface; hence in the next section this is briefly recapped.

6.5.2 User interface technology and integration framework

MCR uses the Web-user interface of ADOxx, as this framework already provides the user event handling and automatically starts an event controller and configures the port.

Hence using this user interface framework the event handling, the implementation of the event controller and the deployment will be performed by the underlying ADOxx platform.

MCR components only have to register the user interface events while implementing the plug-in. This will generate the event controller and the corresponding web-methods that are listened.

The user interface itself is implemented using the HTML 5 technology with ExtJS.

MCR Web client serves as GUI, consists of GUI functionalities and is representation of the repository content. MCR Web client based on HTML using for DOM manipulation and dynamic representation of content JavaScript (ExtJS framework), for data transmission AJAX, for rendering of shapes and images using canvas element.

MCR Web server is a middleware to enable communication with the application server. MCR Web server is based on Apache Tomcat web server consisting of Servlets and ADOxx Web classes to communicate with application server.

BIVEE application server offers a SOAP-interface via which its functionality can be accessed. The SOAP interface is used by the web server that takes the data provided by application server and transfers it to the web-browser of the web-client.

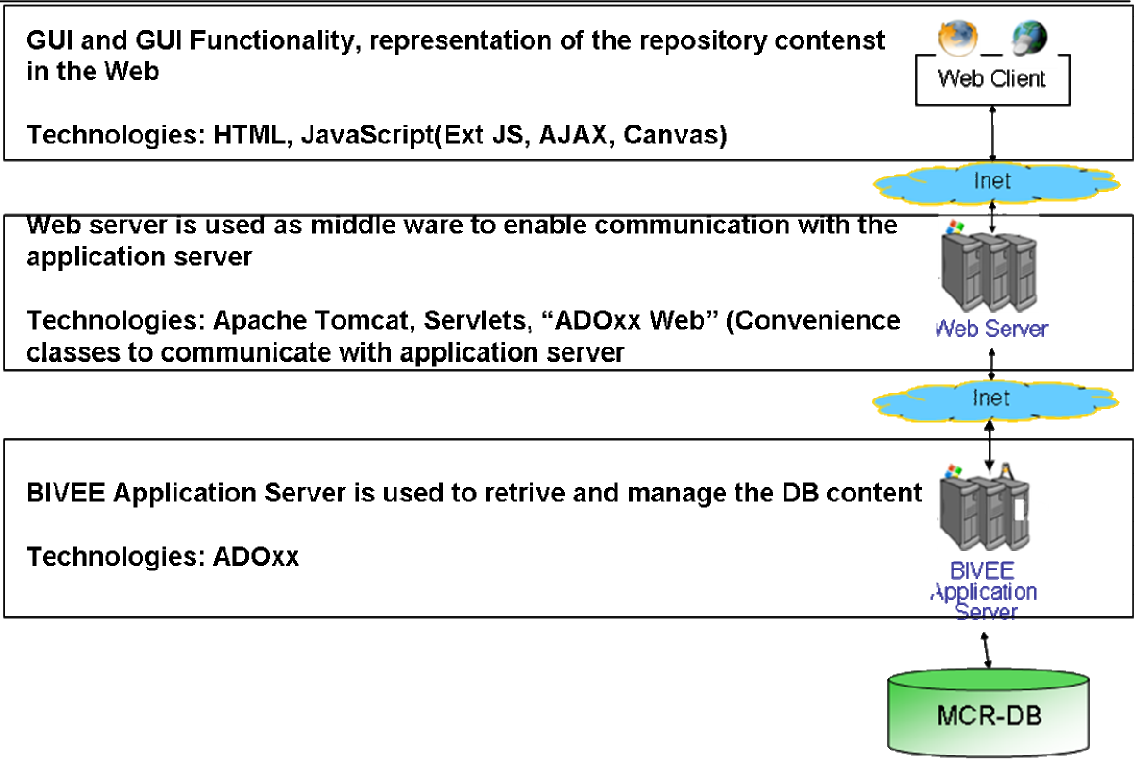

Figure 37: Three Tier Architecture

So-called user interface events, these are events that only change parts of the user interface (e.g. the encapsulation of a menu, or encapsulation of a tree) is implemented in the web-interface of the plug-in.

So-called functional or data events, these are events that either trigger a function (e.g. the re-arranging of concepts) or trigger a data access (e.g. a query, a data change) are using one of the pre-defined web-methods, which are invoked and caught at the server side from the controller.

MCR targets the integration inside an overall BIVEE platform; hence the Web-user interface framework will be placed inside Liferay using iFrames and integrated with the BIVEE single sign-on service.

This allows the autonomy of the MCR but for the end user this appears as part of the same user interface.

6.6 MCR Functional Logic Tier

In the following the five MCR-components are described. Technically spoken they are implemented as plug-ins into the ADOxx framework.

6.6.1 MCR Modeller

Description	MCR Modeller consists of set modelling features and hence strongly distinguishes from a design editor, which exclusively covers only the graphical design part. MCR Modeller provides a full fletched modelling tool for concept models. The MCR modeller therefore allows visualisation of models, storage and manipulation like, the creation of models and model objects, editing of models' and objects' properties, etc. This includes also user interactions like drag and drop, zoom, grid snap, print or graphic generation. Additional to aforementioned design functionality, MCR Modeller provides the possibility to apply functionality on the models such as the simulation of directed graphs, query of models, transforming models as well as publishing models in form of reports. MCR modeller is configured on the MCR modelling language, as well as some special setting. 1. The whiteboard requires models that are displayed, but can not be edited. Instead of changing the model, it is only possible to place post-its on to the model. The post-its have a relation with the objects of the underlying model. 2. The transit model requires that no objects can be changed by the modeller, but only the complete set of concepts can be updated with the PIKR. In case objects have been deleted in the PIKR, MCR modeller needs to react accordingly to avoid missing annotation. The MCR modeller is implemented as a plug-in providing a controller as a Java Servlet that receives requests from the MCR Modeller UI. The UI and Java Servlet interaction is provided by the ADOxx® platform. MCR modeller controller is a single entry point of the Java Servlet and forwards GUI requests to JavaScript packages that interact with the persistence layer.
Objectives	The objective is to support the design and modelling tasks, by providing modelling features for human end users, according to their access rights.
Functional capabilities	• Browsing in the model repository. • Creation of new models • Management of models, including removing, moving,

	renaming, versioning. • Editing of existing models • Querying models • Simulation of models • Publishing models in form of a text document • Whiteboard feature for post-its on an overlay of a model • Transit model feature to synchronize with PIKR
Non functional capabilities	• User-friendly GUI • Desktop-like look and feel • Web Service Interface

6.6.2 MCR Assistant

Description	MCR Assistant is a process stepper and feedback collection tool that can be configured for three scenarios: 1. Training enables the knowledge worker to see the process, investigate possible problems and introduce the responsibility of the company in a serious game like setting. 2. Testing enables the knowledge worker to test the process before execution. User can step through the process and at the end provide feedback via polls and comments. The difference to the training is in the provided material or the maturity of the process model. 3. Guidance support to the knowledge worker during process execution. It provides checklists, information material, templates or contact persons. In case of troubles knowledge worker can alert via Twitter and mobile devices. Feedback can be provides via poll or comments. The MCR Assistant is implemented as a plug-in providing a controller as a Java Servlet that receives requests from the MCR Assistant UI. The UI and Java Servlet interaction is provided by the ADOxx® platform. MCR Assistant controller is a single entry point of the Java Servlet and forwards GUI requests to the stepper engine that keeps an own meta model of directed graphs. There is a configuration file that maps the MCR modelling language to this directed graph meta model. Interaction with external resources are implemented in Java, interaction with the persistence layer and ADOxx® repository is forwarded to JavaScript packages that interact with the persistence layer.

Objectives	The objective is to realistically represent the process to the knowledge worker to either enable training, testing or guidance during real execution. Feedback can be provided and execution alert can be triggered.
Functional capabilities	• Starting the process and step through • Accessing relevant information for the particular step • Provide user feedback in form of polls and comments
Non functional capabilities	• User-friendly GUI • Desktop-like look and feel • Web Service Interface

6.6.3 MCR Monitor

Description	MCR Monitor enables a user interface to monitor KPIs by viewing and querying. Viewing of KPIs will be in tree-structure dashboard, enabling the categorisation of KPIs and presenting the relevant information such as target vs. achieved value, the trend or figures that represent current status of KPIs for the current period. Drill down functionality enables to view the history of the KPI, access documentation or external tools as well as drill down to the sub-indicators or the concrete values. Querying of KPIs will be in search engine and filter style, where the user selects form the categories or indicate keywords. Feedback on KPIs is possible by using comments, Tweets or mobile alert. The MCR monitor is implemented as a plug-in providing a controller as a Java Servlet that receives requests from the MCR Monitor UI. The UI and Java Servlet interaction is provided by the ADOxx® platform. MCR monitor controller is a single entry point of the Java Servlet and forwards GUI requests to the monitor manager, who performs features such as comparison, calculation of values and result set management. In case external applications are required, monitor manager forwards the request to external application, otherwise access JavaScript packages, when accessing the persistence layer
Objectives	Provide an overview of KPIs and enable personalised dashboard.

Functional capabilities	• Browsing through KPIs • KPI drill down • Selecting and searching for KPI
Non functional capabilities	• User-friendly GUI • Form-based user interface • Web Service Interface

6.6.4 MCR Semantic Modelling Kernel

Description	MCR Semantic Modelling Kernel introduces the functionality of the PIKR into all other MCR components. Hence aspect-oriented code in the MCR Modeller, MCR Assistant and MCR Monitor accesses the MCR Semantic Modelling Kernel, who coordinate these requests and establishes the interaction with PIKR. As MCR Semantic Modelling Kernel schedules the requests between PIKR and MCR components. A Java controller receives events from the Web-Service and forwards them to individual Java packages that deal with that particular PIKR interaction. In case of transit model synchronisation, a JavaScript package is invoked to establish communication with persistence layer, in case of results of semantic query, the results are first entered into the model and then sent to the UI.
Objectives	Establish a PIKR proxy inside MCR.
Functional capabilities	• Receive PIKR ontologies • Synchronise transit model with PIKR • Annotate models with PIKR • Forward semantic queries • Receive PIKR results • Schedule and MCR and PIKR interaction
Non functional capabilities	• Web Service Interface

6.6.5 MCR Component API

Description	MCR Component API offers an interface to external applications and services. It will offer a set of APIs sufficient to allow the access to basic functionality of the framework to any external application. BIVEE platform will use this services, which is provided as a Web-service, in order to communicate with the MCR. APIs is provided by a generic script language in JavaScript, hence JavaScript packages used by aforementioned components are directly provided via the Web-Service.
Objectives	Offer a generic API for a model repository
Functional capabilities	• Access to model data • Access to metamodel data • Access to mechanism data • Access to procedure model data • Access to semantic schemas
Non functional capabilities	• Web Service Interface

6.7 MCR Data Persistence Tier

MCR Data Persistence tier is provided by the ADOxx® platform offering a meta modelling platform with vast functionalities, and a stable repository.

Description	**Model Base Access** Model Base Access manages the access to the model instances data. It allows read and write access to the model data repository, browsing of the repository structure and editing of models. **Metamodel Base Access** Metamodel Access provides read and write access for the metamodel repository that defines the modelling languages. It allows the querying of the definitions of modelling constructs. **Mechanism Base Access** The Mechanisms Base Access provides access to the mechanisms and algorithms used for evaluating and using models (e.g. simulation algorithms that can be applied etc.). The

	mechanism model base is based on the meta²model. **Semantic Schemas Access** Semantic Schemas Access provides access to the semantic schemas which are tightly coupled with the meta²model. They describe the semantics of each method element defined by using the meta²model.
Objectives	Exchange of models across different model repositories using a file-based approach.
Functional capabilities	• Access to model base • Access to metamodel base • Access to mechanism base • Access to semantic schemas base

6.8 MCR Implementation

MCR is a domain-specific configuration of ADOxx and hence combines implementation of the plug-ins and configuration of the platform.

It has to be stated that ADOxx is available in two platforms 1.x and 2.x that differ significantly in terms of configuration and implementation environment, functionality and applied technology.

ADOxx 1.x has been successfully applied in commercial products and in a series of EU-projects. Therefore this platform is used to create early mock-ups and rapid prototypes in order to present the aimed functionality of the MCR.

ADOxx 2.x platform will be used to transfer the initially sketched rapid prototype on the old ADOxx.1.x platform into the MCR, which is based on the new platform.

This will be achieved by continuing the rapid prototyping approach in for the first iteration, migrating one part after the other onto the new platform, in order to have a simple migration after the first iteration.

Second iteration will concerned with the realisation of MCR specific functionality such as collaboration, alerting, PIKR and VIR integration as well as the integration of external analysis and simulation engines.

7 Conclusion

This document reflects the Value Production Space (VPS) and the role of the so-called Mission Control Room (MCR) as a management tool to support stakeholders in managing the Virtual Enterprise (VE).

VPS is seen as a real network of enterprises that agreed to form a VE. Hence MCR manages the VE by supporting the VE creation and improvement, collecting feedback of knowledge worker during VE execution, providing features to monitor the VE and to enable creative processes in improving or enable the injection of innovations.

MCR is following concept model based approach, which means that graphical concept models are used to chart the VPS and interpret these charts as a conceptualisation of the real world. Hence it is possible to apply a set of functions on that conceptualisation such as viewing, navigating, querying, simulating, publishing, training, testing, guiding and collaboratively collecting feedback, assessing, alerting and improving.

In order to provide these features, MCR needs a conceptual framework, which is represented in form of a modelling language and a modelling tool, which is represented in form of a Web-application.

The conceptual specification revisited current modelling framework for that domain, referring to the results of the ComVantage project. MCR selected the most appropriate modelling concepts but additionally offers three unique characteristics: (a) the modelling language is semantically enriched, (b) hybrid modelling is applied to enable modelling language plug-ins and (c) collaboration features for modelling are provided.

In order to realise aforementioned features, a flexible Web-based modelling environment needs to be developed. MCR is based on the ADOxx® meta modelling platform and realises the three user components MCR-Modeller, MCR-Assistant and MCR-Monitor. There are two additional components in form of the MCR-Semantic Modelling Kernel and the API.

MCR-Modeller and MCR Monitor are two components that can be compared with a set of tools currently available. The semantic enrichment and the collaborative aspects are challenging aspects that are researched in WP3.

Collaboration is not only provided with a set of features like the Wiki, poll, whiteboard or alerting via Twitter and SMS but also by the process stepper.

The combination of a state of the art concept model, applying the flexible meta modelling approach, introducing hybrid modelling and allowing semantic enrichment in a Web-based, adaptable and collaborative tool environment, makes the MCR a step forward beyond current available VE management tools.

Development steps using rapid prototyping are applied to transfer early mock-ups into rapid prototypes.

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ANNEX I

Chairs production planning

back scheduling

Day	Total	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
P6 Build Chairs	5000																200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	
T5 Transport Benches	5000													200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200				
P5 Build Benches	5000												200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200					
T1 Transport Legs	20000								800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800									
P1 Build Legs	20000							800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800										
T2 Transport Seats	5000								200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200									
P2 Build Seats	5000							200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200										
T3 Transport Armrests	10000													400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400				
P3 Build Armrests	10000												400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400					
T4 Transport Backs	5000													200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200				
P4 Build Backs	5000												200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200					
Required availability of material for Backs										X																																
Earliest availability of material for Backs														X																												
Forward scheduling																																										
T2 Transport Backs	4200																	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200				
T6 Transport Backs	800																	200	200	200	200																					
P4 Build Backs	5000																400	400	400	400	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200					

Production and transport activities not feasible

Additional production capacity negotiated

Additional transport Unit involved

Figure 38: Sample Master Production Plan