FLEXINET

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Deliverable [D4.2]
Impact analysis and assessment of new business models

Workpackage:	[WP 4] – [Methodology to Design Flexible Business Models for Production Network Configuration]
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Executive Summary

The deliverable is based upon the methodology described in deliverable D4.1. It covers the work of Task 4.3 and 4.4 on reference structures, impact of complex technologies and the quantification of business model impact on global production network level. It provides specifications for services/applications supporting these approaches. Regarding technology effects and impact analysis two aspects are targeted:

- The impact analysis on business model scenarios is realised by an analysis of technology attributes of the business model elements.
- The impact analysis on the global production network is realised by a specific application "Technology Effect Analyser" (TEA) in WP5.

The approach to the definition of detailed reference structure fragments is described in combination with a definition of a model fragment library structure and of predefined reference structure fragments. In a first attempt generic fragments are used, such as a reference fragment of a supplier to establish business models. This means every time a supplier is added to the business model an instance of the supplier fragment needs to be generated in the enterprise model. This instantiation concept is part of the described approach.

Assessing and quantification of the business model impact on GPN are analysed in detail. Methods are identified and described in detail. A first example has been worked on and is presented. In terms of application, the initial methods are used in the scope of the business model accelerator to create an evaluation between different business model scenarios.

All WP4 partners have actively participated in the work via telephone conferences, meetings and contributed especially well to the work items described above. Close cooperation has been established between WP2, WP3 and WP4 as well as with WP5 and WP6 to facilitate and deliver the work.

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1 Introduction

1.1 Purpose and Scope

The deliverable D4.2 summarises the work done related to reference structures, business model impact analysis on global production networks and related services. It has been carried out in strong relationship with:

- WP2, to create a common vocabulary especially related to "indicators" and "external factors" with support to the FLEXINET ontology in WP3. Also the analysis methods selected and further developed in WP2 are used as the basis for the impact analysis.
- WP3, to ensure synchronisation between the concepts, relationships and rules developed in WP3 and the demands arising in WP4. This has been already started in relation to the modelling of "model fragments" described in D4.1. At this time the focus was on concepts such as "System" in terms of process. Related to D4.2 further concepts are focused such as "Indicator", "Objective" and "Scenario". This provides the basis in WP5 for interaction between applications using the Highfleet knowledge base.
- WP5, to implement required prototypes of the services in terms of applications.
- WP6, to get adequate data for further method development (D6.2) and feedback for the usage of the methods and services (D6.3).

The deliverable covers also the initial work on the technology impact analysis on global production networks which will be finally described in D4.3.

1.2 Approach for Work Package

The work in WP4 (task 3 and task 4) uses the following approaches:

- FLEXINET meetings have been used to discuss the topics across FLEXINET not only within WP4.
- Regular WP4 telephone conferences used to develop the topics and monitor contributions to the deliverable. Additionally, to invite other work packages especially WP2 and WP3 to ensure the coherence of the work. In terms of the implementation of the method, partners involved in WP5 and WP6 have contributed to these telephone conferences.
- Email exchanges are used to discuss topics such as aspects related to the definition of "Indicator", "External Factor", "Performance Indicator" between WP2, WP3 and WP4 (see **Error! Reference source not found.**). Furthermore, to exchange knowledge about experiences regarding end user perspectives.
- Discussions with FLEXINET end users, especially KSB and Indesit, but also CustomDrinks about the methods were very useful in terms of understanding the needs of the end users in more detail and to get further detailed test data for the methods.
- The FLEXINET portal was very important for document exchange.

In addition to the end user scenarios and data in D6.2 which are used to align the methods with requests from the end users. A small example has been provided by KSB for quick experiments. The example covers four GPN partners with details of indicators and business rules (see Figure 1). The GPN depends on knowledge and capacity of potential suppliers, in conjunction with risk aspects of incidences during the transport between Germany and India are relevant such as delays or loss of products. Therefore, a fifth logistic partner is needed but not directly modelled. It is required to model the risks and quality of the delivery.

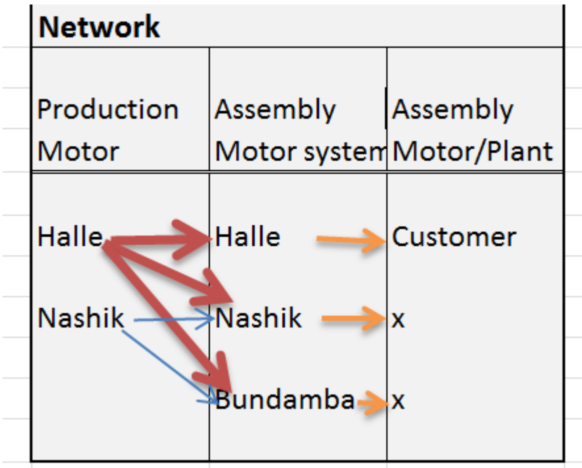


Figure 1: Small GPN with 4 partners

In fact currently Nashik can only produce pumps with lower technological background. The high technology parts needs to be delivered by Halle. However, this example is not a real case but similar to real cases appearing in KSB. The example has been used to understand better the interrelationships between GPN, business rules, indicators in terms of needed model fragments.

1.3 Structure of the Document

The following describes each of the six chapters in this deliverable:

- Chapter 1: The interconnection of WP4 with other WPs is expressed in the introduction as well as general aspects of the approach.
- Chapter 2: Examples of the reference structures as well as its internal structure are presented. This also covers the instantiation method for fragments.
- Chapter 3: The initial approach on the technology impact analysis is described in chapter 3.
- Chapter 4: Refers to assessment and quantification of business model impact on GPN.
- Chapter 5: The use of the methods especially in terms of applications.
- Chapter 6: The annex consists of references used in the document, glossary of terms and concepts.

1.4 Relation to previous work

D4.1 laid the foundation for the seamless transition between strategic and tactical levels by introducing different existing tools and methods for each of the levels (see D4.1, Chapter 2). Among the tools for the strategic perspective were the Business Model Canvas and the SWOT analyses, whereas for the tactical level, enterprise modelling was comprehensively presented. Business rules were suggested as one method to bridge the levels. The general concept of how the global production network relates to strategy is reproduced from D4.1 in Figure 2.

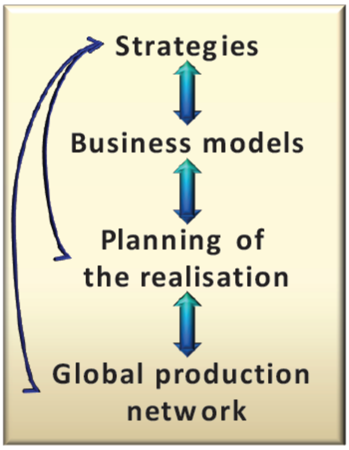


Figure 2: General concept related to WP 4 (from D4.1, p. 17)

The business model approach was been derived from the CANVAS approach (see Figure 3) after several discussions with end users and research partners. In fact, the CANVAS components provided the initial set of areas to take into account, especially after considering the direction of how, what, who, costs and revenues. The components within the model can be extended by further aspects or even substituted related to specific demands. Building on this view, Figure 3 illustrates that these internal business decisions are affected by the global external environment, which offers both opportunities and risks for the enterprise.

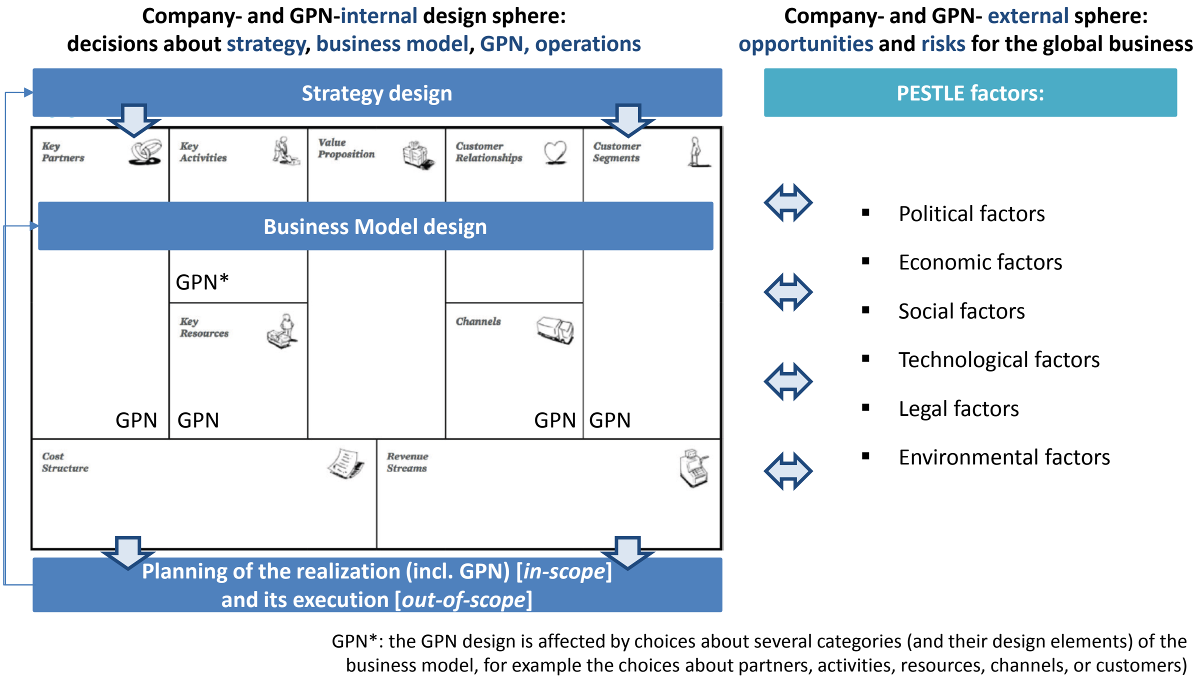


Figure 3: General business design areas with external influencing factors

The GPN design is affected by different choices of business model, for example choices about business partners, activities, resources, channels, or customers. These business elements will directly appear in other views of the enterprise model such as the process view or the organisation view (OBMC). From here the details of the GPN can be defined and in the next step the flows between the GPN partners can be analysed (GPN configurator).

2 Reference structure fragments

D4.1 considers the foundation for the model fragments in terms of methods and interrelations such as the integrated enterprise modelling method and the definition of risk fragments. This has been experimented upon utilising data coming from the end users. Additionally, the ontology has been extended accordantly in cooperation with WP3. The following sets out the focus on the definition of generic model fragments which can be used as a reference to create the specific fragments for the GPN.

2.1 Motivation

The model fragments are just building blocks providing details of the partners within the global production network. The objectives of this are:

- To reduce the effort needed to model the process.
- Frontloading (experiences from the past), using company specific fragments of GPN partners already known in more detail.
- To ensure the coherence of all activities.
- To support the incremental growth of the data related to a new business especially using new data immediately to revise the previous analysis on the basis of predefined indicators and their relations to data sources.

To reduce the modelling effort, different degrees of detail are provided for a model fragment. Using the example "Supplier fragment", at an abstract level it covers only reference processes, objectives, risks and indicators. For the defined processes the first level of Supply-Chain Operations Reference-model (SCOR) is used, together with the indicators from further detailed level of SCOR (see chapter 4) and risks are added according to the definitions in D4.1. This creates a fragment which is independent from a specific organisation or specific industry. It is intended to provide them together with the FLEXINET package. These fragments can then be further detailed in terms of specifics of an industry e.g. having melting suppliers, electronics suppliers, service suppliers, etc., these are more specialised, but are still related to specific industry, albeit at a generic level. In a company this can be further detailed utilising their specific suppliers if more data about is needed.

The company specific detailed model fragments are pieces of knowledge from former projects or studies of GPN partners. The expectation is that they are structured in terms of libraries and can be used in earlier phases of GPN modelling. This follows the notion of so called "frontloading". Frontloading approaches try to bring information from later development phases into earlier phases. This was also an end user requirement collected in WP1. This can be seen in the KSB example (see Figure 1) with the suppliers Halle and Nashik. The suppliers have indicators such as:

- Knowledge to produce
- Training demand

These indicators belong to each KSB supplier. In terms of being able to create model fragments of Halle and Nashik the indicators can be set on the basis of current values. In the example the values are the following:

- Halle
  - Knowledge to produce = proved for all products, fully functional
  - Trainings demand = 5%
- Nashik
  - Knowledge to produce = Engine building experience
  - Trainings demand = 70%

These indicators help in understanding effort in terms of training which is needed if a specific supplier is selected as well being able to identify which products can be supplied. For example Halle can deliver any product without additional training effort for the staff but Nashik can only produce engines. All other products require a high amount of training effort. In addition to these qualitative indicators also quantitative indicators can be defined e.g. to be used in the FLEXINET balance score card approach or in specific business model analyses which are described in chapter 4.

Having the model structure fragments with all related information accelerates the modelling of the process structures for the GPN. This is important for the interrelation of processes, indicators and objectives with the business model to get faster feedback about the economic feasibility of a business model.

In the early stages of new businesses and the development of processes from scratch, most of the values related to indicators are just approximations. But these must be updated if and when more accurate data is available. Therefore, the coherence of the data within a fragment is essential and its interconnection with other fragments needs to be consistent.

2.2 Meta model aspects

The Meta-model of the model fragments have been initially drafted in D4.1 and further detailed and discussed related to the FLEXINET ontological approach. The general structure of the model fragment in terms of processes (systems), inputs, outputs, controls and resources are provided by the "FLEXINET Ontology Level 1". Also, other elements such as "organisation" are in the "FLEXINET Ontology Level 2". Specific aspects are described below. They are facets of the whole model and express specific relationships which are important for evaluations or further development. They are related to:

- The interrelations between objectives and business model elements.
- Model fragment libraries.

2.2.1 Interrelations between objectives and business model elements

The presumption is that an objective is described and measured by performance indicators. These indicators are also related to business model components. This gives the relation of how a business model component contributes to the objective. It seems not related to the definition of model fragments, but, if the fragments consist of a predefined indicator then the idea is that these indicators should have their roots within the objectives of the organisation. For example, if we have the case of Halle and Nashik and the objective is to increase the sourcing in India (Nashik) then the increase of production knowledge would contribute to this objective. Therefore such an indicator expresses the contribution to the company objectives. The idea to fix these relationships is the following (see Figure 4):

- Each indicator needs to contribute to an "objective". Otherwise it has to be checked why the indicator is needed.
- Each business component as well as each related business model element has to contribute to the objectives via indicators.

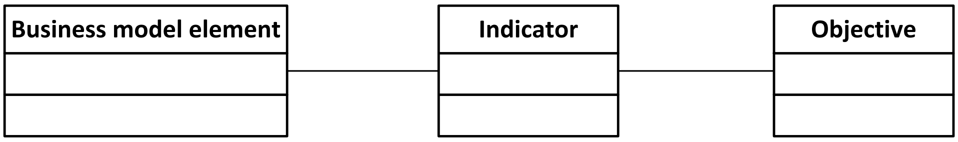


Figure 4: Further relation in consideration about indicators

However, this relationship is only optional because it might change over time and an organisation could decide to just have performance indicators and place importance upon the objectives. The meaning behind this relation is that any business model element can have a relation to an objective via an indicator. This belongs to key partners as well as to key actions and their details.

A related concept is "Driver" which contributes to an objective such as the results of FLEXINET to the decisions around a GPN configuration. Here Drivers are required to support the fulfilment of the objectives, therefore, they contribute to the objectives (see Figure 5). Figure 5 expresses a subset of the objectives and drivers in FLEXINET.

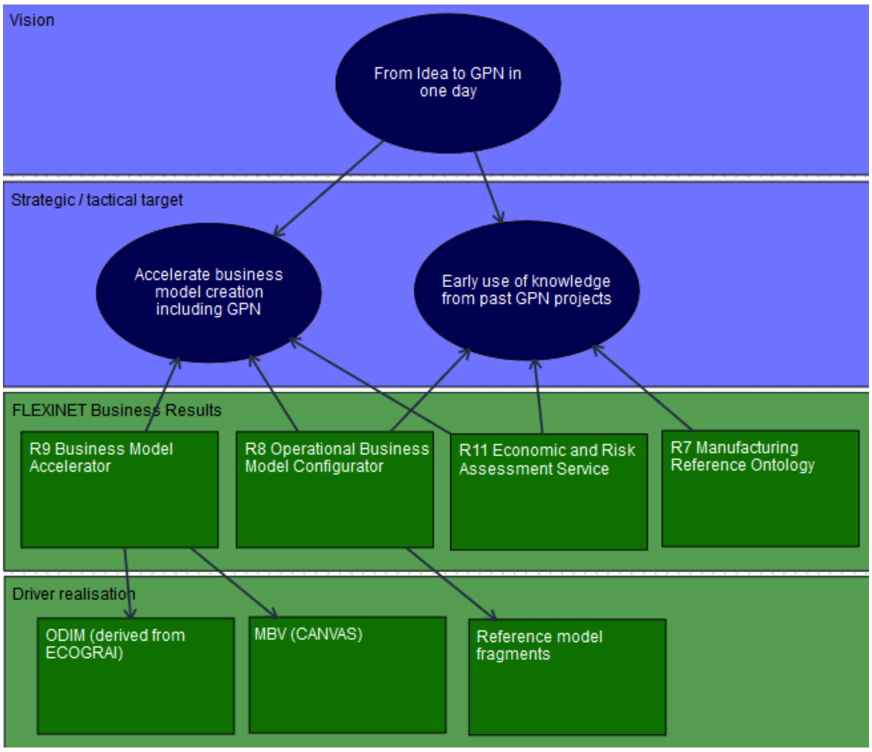


Figure 5: Relation between Objectives (blue) and Drivers (green)

The Objective-Driver relation has already been expressed in the ontology with the relation that an objective has drivers. However, it is also expressed that a driver can be viewed in the business model CANVAS (see Figure 6). Here, for example, the driver can be an element of the value proposition as well as a key resource.

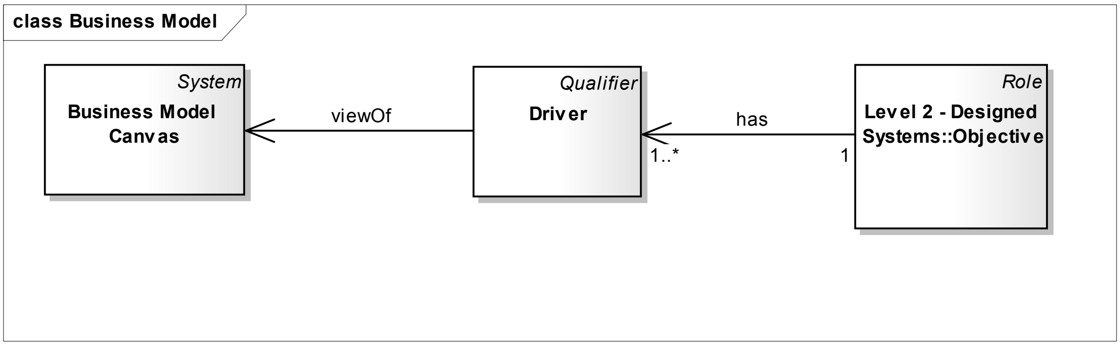


Figure 6: Part of the business model area in FLEXINET Ontology

2.2.2 Model fragment libraries

D4.1 identified sets of libraries required such as for indicators but especially for model fragments. The library is currently out of scope of the knowledge base but will be realised outside the knowledge base. This is not a critical issue because the important aspect in FLEXINET is that the results of the modelling approach are interconnected with the knowledge base. It means the model elements in terms of facts are in the knowledge base and evaluation results can be used from the knowledge base. However, the library data structure needs to be expressed in better detail to support its implementation. In fact, different **library sets** should be feasible e.g. model fragment libraries, existing GPN libraries and reference model libraries. Within each of these library sets specific **fragment libraries** are defined such as:

- Generic reference model fragment library.
- Company reference model fragment library.
- Library of specific actors such as suppliers.

Each of these libraries consists of a set of **fragments** belonging to the scope of the library. These fragments are specified by related meta-data such as descriptions and intended usage. It refers to one or more anchors which provides access to the related model data and thus implements the fragment definition. The model data is a set of facts represented by using a subset of or the whole ontology. This ensures that an orchestration of instantiated fragments can be synchronised with the FLEXINET knowledge base. A summary of details of the library data model can be seen below (see Figure 7):

FXNT_Library_Set

The class "FXNT_Library_Set" supports the access to different types of fragment libraries from one entry point. Types of libraries might be generic fragments, domain fragments, company specific fragments.

FXNT_Fragment_Library

A fragment library contains a set of model fragments related to the type of the library. It has the following attributes:

- Library_Type (identifies the specific type of the library) and
- Library_Description (supports a specific description of the library).

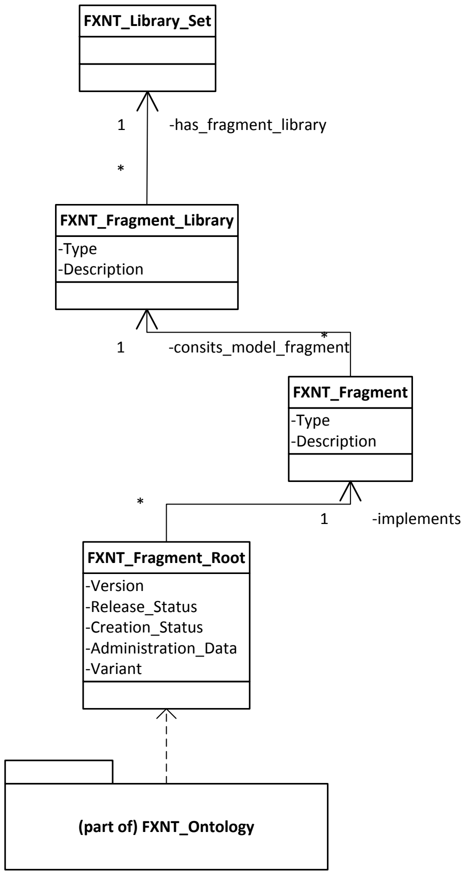


Figure 7: Library structure (derived from ref. D2.1 FACIT-SME)

FXNT_Fragment

The model fragment describes a GPN partner or specific business process. It can have a set of constraints as well as indicators or risks related to the fragment. To implement the fragment different sets of facts (models) might be adequate and connected.

Attributes are:

- Model_Type, indicating a specific type of the model via an enumeration.
- Model_Description, free text which might contain graphics from the user.

Fragment_Root

The fragment root class supports the handling of model fragments. Each model fragment should have one entry point which refers to the whole set of facts related to the ontology. It represents a set of facts using the FLEXINET ontology.

Attributes are:

- Version, the version of the fragment is documented to support a kind of history.
- Release Status, the status of the fragment is an enumeration type such as released, drafted, negotiation, in progress.
- Creation_Date, the creation date of the model is stored.

- Administration_Data, further data for model administration can be necessary for a specific usage such as the name of the creator of the fragment.
- Model_Variant, if different variants of a fragment exist. It is recordable.

2.3 Reference structure fragment instantiation

The instantiation of a model fragment is needed because a fragment is used as a building block several times in one model. In a first attempt the simplest way is the tagging of each fact in the model to distinguish one building block from another one of the same fragment. This is not sufficient if we use for example the IEM/MO²GO approach because the fragments also consist of facts which are common across all fragments such as class/object structures. A simple example is the class "objective" by itself. It is a higher level class belonging to all fragments and should not be tagged or changed during the instantiation.

This requires instantiation rules as well as user interaction in cases which are not deducible by the instantiation rules. Examples of instantiation rules are as follows:

- Only classes which have no subclasses are countable as objects/facts and can be tagged, but, all higher classes count as types and will not be changed during the instantiation process.
- A specific name space is defined of classes which will not be changed because they belong to a common class structure across all fragments.

In cases where rules cannot be defined, the user can be asked to provide a specific tag for the instantiation e.g. the name of the specific supplier. Also, the user should be able to select facts which are to be explicitly changed during the instantiation process. Currently, lists of the following facts are intended to be provided to the user:

- Processes/System.
- Organisation.
- Resource.
- Control.
- Risk.
- Objective.
- Indicator.

If the user selects them, it should be possible to define the instantiation explicitly. The user can remove the element, change the name or change the properties. The ontology and especially the related type structure are not changeable. All changes relate only to facts in the model fragment.

The consideration so far belongs to using a copy of a fragment as building block. Another approach is to use it as a reference point. This means that the structure of the facts within the reference point is the same for all building blocks. This approach is currently seen as out of scope because the decision was to follow one approach within the project to be able to provide show cases.

2.4 Reference fragments

D4.1 defines a set of potential reference fragments which are specifically analysed in terms of risk aspects. These fragments are taken as starting points to define more detailed fragments in terms of building blocks for global production networks. Here, the fragment "Supplier" is used to demonstrate the content of the fragment in terms of a process view. Behind the process view an additional information view exists, which, finally provides the anchors for the synchronisation with the reference ontology (see Figure 8). Each of the class/objects is related to the FLEXINET reference ontology level one or two. The risks of a specific object are directly related in terms of facts. Each of the risks is finally directly related with the reference ontology.

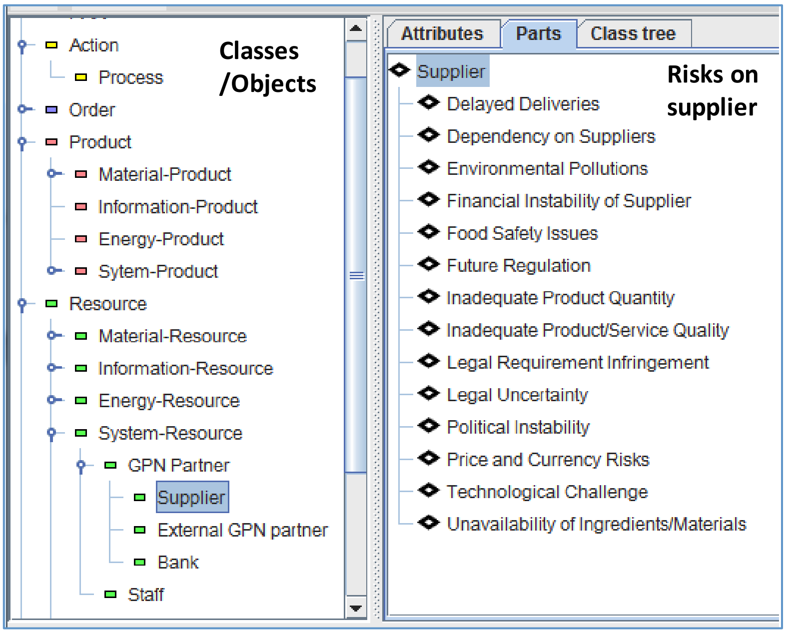


Figure 8: Information model to synchronise with the reference ontology

These class/objects are used to model the business process structure of the fragment. In the process view the fragment is represented by a process with inputs, outputs, controls (blue) and resources (green) (see Figure 9). This belongs directly to the definition of "System" in the ontology but, here facts are expressed. Material is the input of the process/system as well as non-conforming products. The output is the Product in its state of being delivered. Additionally, alternatives are possible, such as material received is a non-conforming product from a supplier of the supplier. Another alternative is that a product is just recycled because it has been damaged during production. In terms of the control the incoming information stands for all information related to specific customer orders, inquiries and change requests. The outgoing information is related to computations and offers. The resources are generic for this generic fragment and directly related to the ontology with material, energy, information and system resources. It also has added financial resources in terms of ability to react to an order which might need pre-financing.

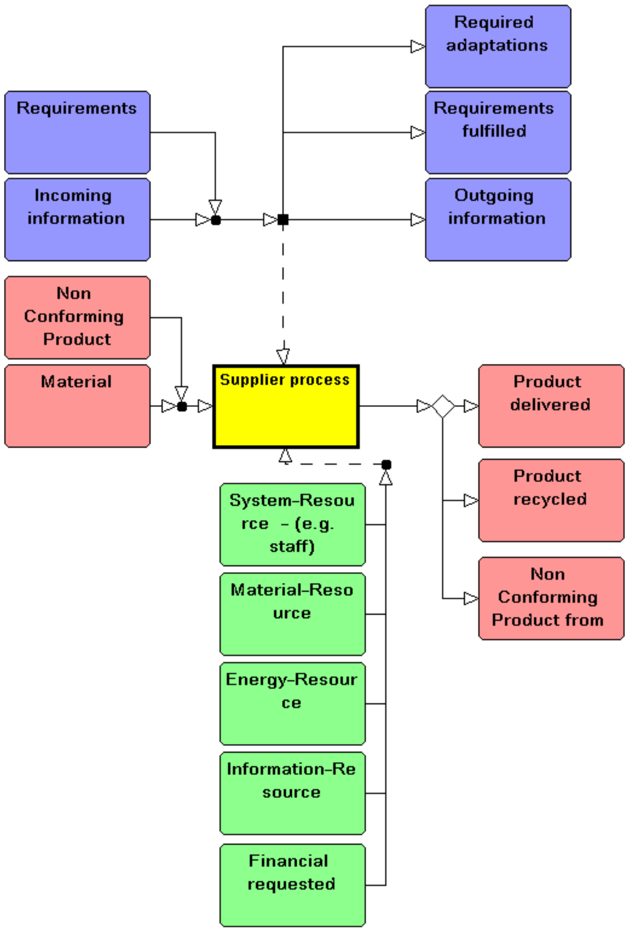


Figure 9: Process / system interfaces of the "Supplier" reference structure fragment

Figure 9 illustrates a high level view of the "Supplier" fragment, the detailed structure for the "Supplier process" element is shown in Figure 10. It follows score with source, make, deliver, plan and handling non-conforming products, but, it also has some further processes related to the GPN partner role such as the "perform audit" process which is performed by a partner e.g. the "owner" of the GPN. It also consists of the preparation of resources required to perform the objectives of the supplier.

An additional aspect within the model is the blue elements with the red rectangle illustrate general risks connected to specific activities of the supplier. These risk factors affect different processes of the individual nodes within the GPN. Their adverse effect is on the operation of the process. For example, the risk of 'unavailability of ingredients/materials' can have an impact on the 'source' sub-process within the supplier reference fragment. The impact can be measured as a reduction in the process output from its normal level such as the percentage of procured supplies. Different organisations have different risk profiles, which are identified in the relevant risk scenarios. For instance, one supplier may be more likely to be affected by the 'unavailability of ingredients/materials' than another supplier. This needs to be determined for each organisation historically through relevant Performance Indicators, such as 'percentage of ingredients/materials availability', and then it is used to constitute the risk scenarios. It is also possible that a risk factor is dependent on the geographical location of the organisation, the risk factor being 'political instability' that affects organisations within a country. In such cases, the scenario is determined through the measurement of external factors.

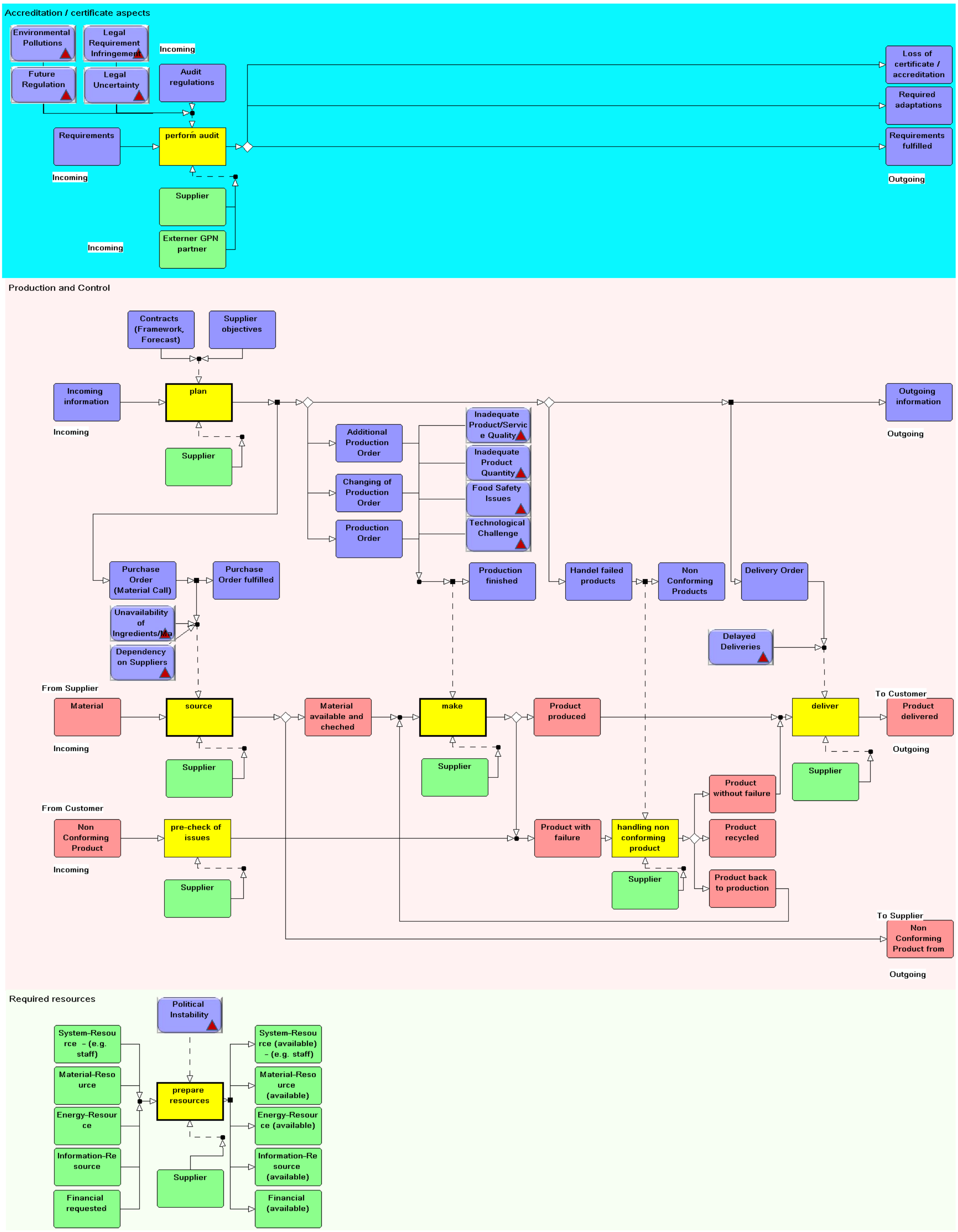


Figure 10: Process structure of the reference fragment "Supplier"

Identification of the relationships between risk factors and the affected processes allows a more precise analysis of the impact of risk on the network and its individual organisations. This is essential in progressing toward a tactical model of risk. However, it is also important for all perspectives, such as risk, cost and revenue, that it is integrated into one analytical model. The next steps are specialisations of these fragments related to demands of the end users as well as the instantiation of GPN scenarios using the FLEXINET applications and the knowledge base.

3 Impact of complex technologies

The technology impact has been roughly drafted in D4.1. During the development of Task 4.3 one main focus has been upon the description of the complex technologies and their interaction with the remaining definitions of the products, processes and resources, this has been done by incorporating industrial requirements. Additionally, a close relationship has been established with WP3 to support the ontology development. The task is also related to the PNES application regarding technology analysis in WP5. Therefore, the method is also discussed with WP5 members. A dynamic and scalable reference methodology for evaluating the impact of new technology has been targeted. This will be further addressed in Task 4.5.

3.1 Definition

Increased product sophistication, novel processes and changing customer demands often require new innovative complex technologies. Complex technologies are characterised as a "system of systems" having a large number of related and multidisciplinary technological parts and elements. They interact with the production environment in a dynamic way with uncertain impacts and dependencies, which challenges the configuration of the Global Production Networks and Business Models. An important step to consider this impact is through the creation of an information model that considers the complexity and strategic orientation, but also the interrelations to the Products, Resources and Processes within the FLEXINET production networks.

The Global Production Network and the Business Models are affected by the dynamic of the innovative complex technologies. This mainly results from the following:

- Multidisciplinary Nature: The fast pace of technological change demands a cross discipline approach so economic development can occur in an effective and efficient manner.
- Shortened Product Life Cycles: The rapid pace of technological development and the increasing sophistication of consumers have shortened product life cycles.
- Shortened Lead Times: There is a need to cut product development times as well as to develop more flexibility in organisations.
- Globalised Competition: Increasing international competition demands that organisations must maximise competitiveness by effectively using new technologies.
- Lack of Tools: As technology changes, the tools of management must change, but the process of determining what those new tools should be is in its infancy.

Based on these five factors, there is a case for technology management tools that are cross-disciplined, proactive, fast and effective that support decision making. The elaborated model for technology analyses could be used to develop the technology analyser (developed in WP5) in the context of global production networks and evaluation of business models. This should provide a basic to answer to the following questions (also see Figure 11):

- How and to which extent does the new complex technology as a whole or its parts affect the configuration of the Global Production Network?
- How and to which extent does the new complex technology as a whole or its parts affect the Business Model?

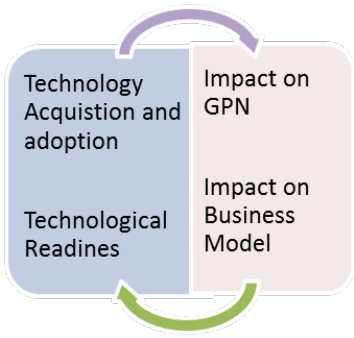


Figure 11: Technology cycle

3.2 Technology Interaction with Product, Processes and Resources

Technological dependencies are created continuously within the production network affecting processes, products and resources. An innovating entity is planning or already implementing a technology implementation. The integrated nature of the value chain means that the technology will have upstream and downstream impacts which also means that requirements may exists in value chain partners in order for the technology to provide the desired benefits at the innovating entity.

In the following example, the configuration of the Global Production Network for one of the use cases shows the interrelation between products, processes and resources (see Figure 12).

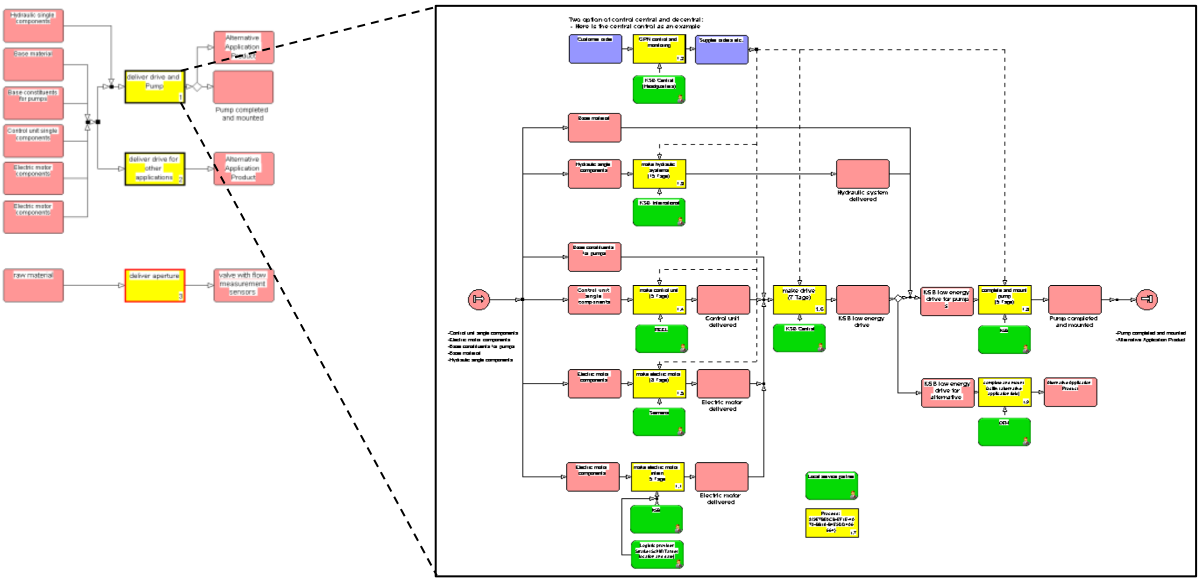


Figure 12: Product, process and resource dependency within the GPN for KSB – Use Case

The main elements are (see also 1):

- **Product or Service:** The Product attribute describes the product-technology interaction. Not all technologies are directly related to the product or service and are related more to achieve efficiency of the manufacturing process. As the technology impacts certain product components or systems designed and/or manufactured by different members of the value chain. Consideration of the dependencies between the product and other product areas affects is necessary to manage the process of integration of the technology into a product at different stages and the horizontal and vertical dimensions of the global production network.

- **The Process** attribute describes the way the technology affects the existing processes or initiates and creates new processes. The processes can be considered internally within a single company, but also one process can involve multiple partners of the GPN. The process analysis in this case involves different members of the GPN and creates different business model options and alternatives. Some examples of technology affected process parameters are: cost (e.g. a change in the production cost per piece), performance (e.g. change in the process cycle time), flexibility (e.g. reduced changeover times) and quality (e.g. less process variability).
- **Resources**: The resource attribute encapsulates the interaction of the technology with the existing or new organisational structure and organisational competencies including human factors. Some technologies may require that the firm reorganise itself to leverage the functionality provided by the technology and have an impact on the ability of the firm to reorganise and gain benefit from the new technological requirements.

The Equipment attribute refers to how the technology impacts existing equipment or incorporates new equipment. Equipment may take the form of utilities, information and communication, quality measurement, logistics, assembly and manufacturing equipment. This attribute is closely related to the process attribute since many processes are performed through equipment.

The Human attribute encompasses the instances of human participation with the technology. Technology usability, training requirements and user learning curves are aspects of this attribute.

The Firm Competencies refers to how the technology impacts the existing competencies. Many complex technology products require that firms invest time and money in learning how to operate and maintain the technology. A technology that destroys the knowledge that the firm has built up has a smaller chance of being adopted than one that enhances knowledge and skills.

Table 1: Technology impact elements

Technology Impacts and Requirements on Products, Processes and Resources	
Products	Does the technology involve new product or a change in existing products? How does it affect their architecture, components and complimentary product features? What partners in the value chain are involved?
Process	Does the technology involve a new process or a change in an existing processes? How does it affect its throughput, cycle times and other relevant indicators?
Resource	Does the technology involve new equipment or alterations in existing equipment? Organization: Does the technology create or change a current way of organizing? What new ways of working are need to leverage the new functionality provided by the technology? Human: Does the technology empower or destroy current capabilities? What type of training is required to use the technology? Firm Competencies: Does the technology enhance or destroy established competencies Compatibility:Does new technology enhance complementary technology currently in use? Does the new technology use existing firm assets or does it require a modification or completely new assets?

3.3 The perspective of the technological analyses

In order to be able to answer to the key question of the technological analyses, the following perspectives are considered set out in Table 2 below:

Table 2: FLEXINET perspectives on technology analyses

Technology Acquisition and Adoption Criteria	Describes the advantages and the opportunities and the constraints of implementation of a new complex technologies **IMPACT on the GPN and BUSINESS MODEL**
Technology Composition	Describes the structure of the technological steps, technological suppliers **IMPACT ON GPN**
Technology Readiness	Technological Readiness Levels (TRL) adapted to the achievemnt of certain product or service within the produciton network **IMPACT ON GPN**

3.4 Technology Acquisition and Adoption Criteria

Technology based firms rely on renewal of existing technological resources and exploitation of new technologies to remain competitive. Technology acquisition[1] is becoming more difficult due to increasing technology complexity, convergence of technologies, richness of technological options, higher cost of technological development, and rapid diffusion of technologies. Current approaches to the technology selection decision have usually been focused on assessment of the financial viability of technology options, or conventional investment justification factors. Therefore, the following inefficiencies regarding technology selection processes[2] occur:

- Many technology acquisition processes do not provide support for the inclusion of inter-organisational factors in the technology selection decision-making environment.
- Many technology acquisition processes fail to assess potential problems before introducing a technology into an organisation.

The technology acquisition process usually covers scanning, selection, acquisition and implementation of technological solutions. A traditional resource allocation model considers resource allocation as a rational, top down decision-making process based on the weighting of alternative proposals for investment in innovation and fund projects. A criteria-based technology acquisition model indicates how suitable the technology is for adoption. It is divided into five sub filters (see Table 3):

- Integrability: refers to whether the technology can be integrated into the company and the value chain.
- Usability: means whether the technology can be used for its designed purpose in the firm's context.
- Supplier: suitability refers to whether the supplier is acceptable to the firm (past experience, track record, possible relationships going forward)
- Strategy: alignment which considers whether the adoption of the technology is aligned with the firms strategic goals.
- Risk: deals with the uncertainties associated with the technology

[1] Shehabuddeen, Noordin, David Probert, and Robert Phaal. 2006. "From theory to practice: challenges in operationalising a technology selection framework." Technovation 26 (3): 324–35. doi:0.1016/j.technovation.2004.10.017.
[2] Farooq, Sami, and Chris O'Brien. 2010. "Risk calculations in the manufacturing technology selection process." Journal of Manufacturing Technology Management 21 (1): 28–49. doi: 10.1108/17410381011011470.

Table 3: Technology Adaptability and Acquisition

Technology Adaptability and Acquision Filter	
Aspects	Guiding Questions
Integrability	To what extent can the technology be tried in a controlled environment before full implementation? To what extent can the technology be observed in other similar contexts?
Supplier Suitability	Service: Does the service provided by the technology supplier satisfy requirements? Partnership: To what extent does the technology supplier partner with the innovating firm to achieve results?
Strategic Alignment	To what extent does the technology support my strategic value chain goals?
Risks	What are the technology risks in operational, technological and commercial area?

3.5 Technological Composition

The Technology Composition dimension describes the internal elements and structure of the technology. The dimension does not relate to the technology implementation context but, is based on the working principle as an initial attribute. For example, the internal combustion engine is based principally on the theory of fuel combustion. It may have different configurations, such as two-stroke and four-stroke engines, but they are based on the same working principle. Identification of the working principles is important because it clarifies and establishes the scientific disciplines that the people related with the technology must have. This is important in complex technologies that tend to have more than a single number of working principles.

The two-stroke and four-stroke internal combustion engine example introduces the second attribute. This is the 'Configuration' of the technology. It refers to the multiple ways the technology can function using the same working principle. For example, wind turbines may have a synchronous or asynchronous generator. Both of the generators use the working principal of electrical induction to transform movement into electrical energy. But they offer different configurations, each with its particular benefits and setbacks.

The third attribute provides the distinction between Modular and Integrated technology. This attribute describes the relationship between technology components and architecture. Herewith the complex technology has a dual nature composed of components and architecture. The components perform functions and are related through architecture. Components perform functions through the application of a working principle. As described in the Technology Relevance model (chapter 3.2), there may be several working principles available to perform the function. In a fan, for example, the motor is a component, it is designed to deliver power to turn the fan. There are several working principles available to deliver power. The component uses one of these working principles to achieve its function. In the fan, an electric motor may be used. In that case, an electric motor is component that uses electro mechanic working principle to provide power to the fan.

3.6 Impact on Business Model

From the consideration related to the Technology Relevance model the elements affecting the impact upon business models can be derived. The business model approach which is used is based on CANVAS (see Figure 13). The technology aspects are added in terms of new processes, new technologies but, also in terms of attributes of the business model elements describing the technology such as attributes expressing the maturity of the technology such as the reached Technical Readiness Level (TRL). This could also relate to specific business rules because of a threshold value e.g. the technology has to reach already TRL 8. Other attributes are experiences in the market such as evaluation report from users of the technology.

The values of these attributes can be evaluated across the whole business model and give an indication about the impact of the new technology. However, risk aspects also need to be considered, such as the effects of substitution of existing technologies by new ones. An effect could be that the trained personnel needed to handle or use the new technology are just not available.

The impact analysis will be further experimented upon in the use cases related to the next deliverable D4.3 in the scope of Task 5 and related to simulation aspects.

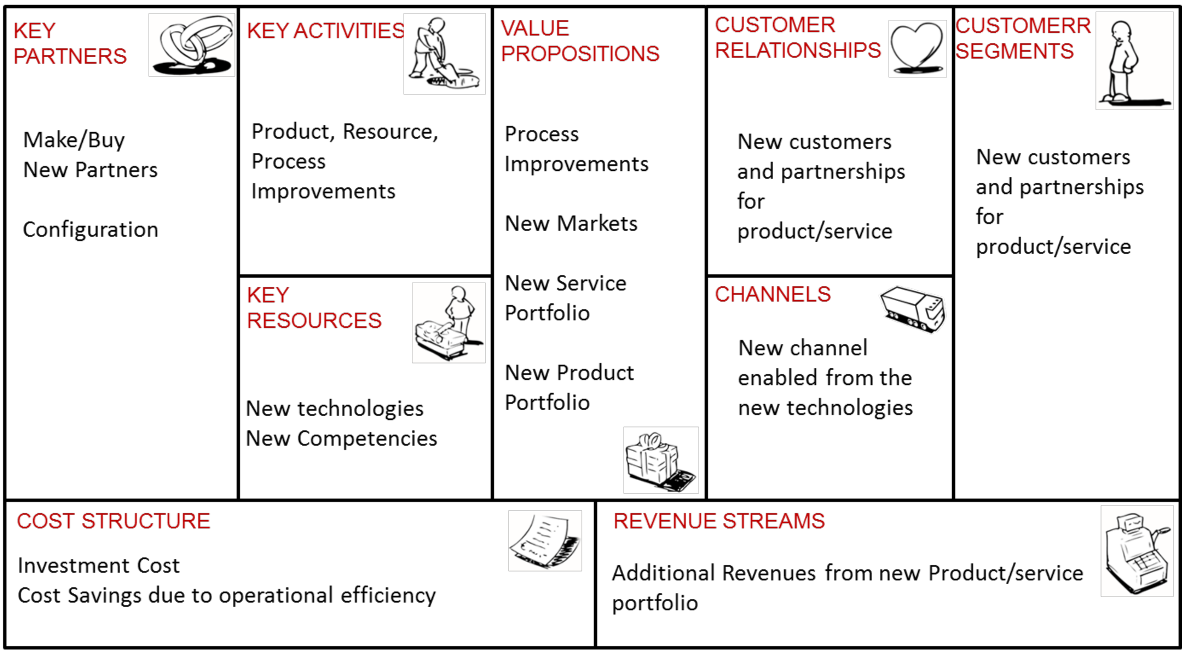


Figure 13: Relation between business model and technology aspects

4 Assess and quantify the business model impact on GPN

The goal of this chapter is to demonstrate how new business models can be evaluated in terms of performance indicators and risks. The chapter pays particular attention to the question how to identify adequate evaluation methods and indicators for questions that affect the tactical planning level. Multiple factors cause ambiguity or uncertainty in the evaluation process, typical sources of ambiguity in the process stem from identifying the right aspects, those being:

- element(s) of the business model that is(are) to be assessed,
- planning horizon,
- evaluation/calculation method or tool, and
- indicators for the evaluation method of a particular question.

In addition to this, the right internal and external risk factors need to be considered. If determined correctly, these factors can (1) reduce the complexity of the evaluation and (2) improve the reliability of the evaluation result. This section provides guidance as to how these sources of ambiguity can be reduced, it does the following:

i. discusses an approach of how a strategic question can be systematically broken down to the tactical level of decision making for global production networks,
ii. helps identify "the right" evaluation methods and performance indicators for a particular question,
iii. applies the approach to a practical use case.

The following sub-sections address these points. The chapter builds on existing work from D4.1 (M18), and reflects the progress of T4.4 (running until M33). D4.1 introduced different tools and methods for strategic and tactical modelling and explained their relation or possible sequence on a general level. It also presented initial ideas for a strategic cost analysis for assessing the financial and competitive consequences of strategic decisions. T4.4 focuses especially on the question which scenarios should be evaluated by which methods and the characteristic features of decision making at the tactical level and in global production networks.

4.1 Requirements for a reasonable and cost-efficient evaluation

The term "evaluation" may carry different meanings when used in the context of "business model impact evaluation". Firstly, it can be understood in retrospect. This means that a manager reviews past performance of their unit of interest to see if performance objectives were met after some business model decision was implemented. Secondly, an impact evaluation may also look into the future. In this case, the starting point is usually a new opportunity or threat whose impact on the business is to be estimated. Examples for such opportunities or threats are new business ideas, new customer requirements, or new technologies. They lead to a specific question or scenario for the decision maker.

In this section, we are mainly interested in the second case, the look into the future. This kind of decision making under uncertainty means that the elements of the scenario should be carefully chosen because the complexity of the evaluation grows rapidly if the scope is too wide. The following sub-sections therefore emphasise the selection of the right evaluation approach and indicators based on the type of question.

4.2 Evaluation approach: Breaking down the strategic question into its tactical elements and selecting the right evaluation method

4.2.1 Determining the scope: selection and specification of business model components

The Business Model (BM) Canvas structure helps to determine which areas of the business are affected by a new idea/question/scenario and which are not. Only these areas should be considered in the performance evaluation following later. **The BM components can be selected** with a simple **template** or checklist as the one shown in Figure 14.

BM component selection			Check with "X" if true		
Input: **New…** • **Idea** • **Decision problem** • **Question**	**Int. elements of conceptual model**	**BM Canvas components**	**Same as existing?** (irrelevant for further evaluation)	**New or to be changed?** (relevant for further evaluation)	**Output:** **List of relevant BM components to be analyzed further** → Proceed to next specification step
	Value concepts	Value proposition			
		Customer segment			
		Customer relationship			
	Value creation concepts	Distribution Channels			
		Key activities			
		Key resources			
		Key partners			
	Financial concepts	Cost structure/model			
		Revenue structure/model			

Figure 14: Checklist to identify relevant Business Model components

Afterwards, those **BM components** that were selected during the previous step **should be specified in more detail** to allow for the next evaluation. To facilitate this step, the decision maker can use a **morphological box** such as the one in Figure 15 **to indicate which business model elements** are envisioned for the idea/question/scenario.

Besides choosing from these basic element categories, the decision maker will be expected to **describe the respective business model element a bit further**. For example, when the idea is about a new product which needs a new material, one would choose "Individual business partner" from the "key partners" component row and then specify it according to the objective of the scenario (e.g., "individual business partner: new supplier for material XY"). The resultant overview summarises the business model objectives of the idea/question/scenario.

BM component specification

BM Component	**Design choices (*select all that apply and describe*)**						
Value propositions (benefits)	Newness / Style	Usability	Performance / Getting the job done	Quality	Cost reduction	Customization / Individualization	Price
Value objects	Physical product	Service	Product/Service bundle	Intangible			
Customer segments	*Describe or use existing company-own classification (B2B vs. B2C…; preferences; socio-demographic characteristics; location, etc.)*						
Customer relationships	Sale only	Personal lifecycle assistance	Self-service usage/info offering	Community/ network building	Co-creation	After sales service	
Distribution channels	Sales force	Own store (offline)	Own store (online/web)	3rd party distribution (offline)	3rd party distribution (online)		
Key activities	Design	Source	Build/Make	Sell / Deliver	Service	Learn/ plan/ manage	
Key resources	Hardware (product/ facility/ equipment)	Software	Human resources	Intangible (IP, brand)			
Key partners	Individual business partner	Business network (GPN)	Public/ societal partner(s)				
Cost structures (*analyze above*)	Up-front costs / one-time investments	Ongoing costs: fixed	Ongoing costs: variable				
Revenue models	Sale	Renting / licensing / subscription	Brokerage fee	Advertising	Freemium / bundle	Free	
Pricing models	Fixed	Dynamic					

Figure 15: Basic morphological box with business model design choices to indicate BM objectives for those components that were identified in the previous step, in Figure 10

Of course, if the idea/question/scenario is not completely clear yet, the decision maker can also use the morphological box to highlight business model variants. Again, just ticking the boxes is not enough, but the objectives per element should be described, too.

4.2.2 Selecting the right evaluation method based on the perspective and the initial question

In general, the approach described here can be applied to both strategic and tactical levels of planning or decision making. The execution, however, depends on the perspective of the decision maker and the nature of the initial question.

If the decision maker is a **tactical planner** of the production network in a certain market or for a certain component, then she will go into the details of the key activities and key resources of the case (the process details). In this case, she may turn to the enterprise model fragments that were mentioned earlier in this deliverable to model and specify what will change with the idea/question/scenario in comparison with the status quo. In this case, performance indicators for the medium-term will be considered instead of others that are more relevant in a strategic case with a long-term planning perspective (see Section 4.3).

If, on the other hand, the user of the methodology is a **strategic planner** like a business unit head, a product key account manager, or a regional manager, they are unlikely to go to the process or information level of modelling. Usually, these types of questions do not ask *how* something should be done, but rather *if* something should be done at all. In this case, suitable evaluation methods answer questions with a more general ("yes/no") or long-term perspective.

In either case, **the pre-selected elements and their objectives from Step I serve as input for the following evaluation**. The main difference is that for the medium-term, tactical cases, there is a need for a more detailed BM draft (or BM scenario) for the affected BM components that includes tactical objectives. On the other hand, for the strategic case, the level of detail after Step I may be sufficient to proceed to the evaluation.

The decision maker now **decides what kind of "profitability evaluation"** is **required** for the case at hand to select a representative set of performance indicators (both financial and non-financial). A **decision table with typical evaluation method types** for different use cases is given in Table 4. An initial list of different calculation models has already been presented in D2.3. Here, the initial list is both streamlined and extended to derive a concise set of evaluation types which are suitable for different decision scenarios or use cases. The goal is to enable the decision maker to more easily (eventually automatically) select the model for their case of interest as well as the right indicators.

Table 4: Typical evaluation methods by decision problem / use case

Evaluation method type	Explanation: type of question	Typical calculation approach	Main input parameters	Evaluation outcome
Investment profitability analysis	Evaluation if a planned investment (i.e. project) will pay off (generate a positive return) over a defined number of future time periods.	Net Present Value analysis (NPV analysis)	- upfront costs - forecasted cash inflows and outflows - discount rate	Absolute value: profitable or unprofitable investment
Break-even analysis	Evaluation at which quantity (or price) a particular planned product/service/solution sale becomes profitable.	Break-even quantity (or revenue) calculation	- target selling price - *OR* target selling quantity - *AND* unit costs, fixed costs	Minimum selling quantity *OR* minimum price for profitability
Scenario comparison	Compares the (real or expected) costs and/or revenues of two or more alternative scenarios.	*Various*: NPV, break-even, full cost/ revenue calculation, or BSC	*See above/below*	The more profitable of two (or more) scenarios
Supply Chain / GPN planning	A special type of scenario comparison to choose between multiple Supply Chain (SC) or Global Production Network (GPN) scenarios.	Different modelling approaches:[3] - analytical - artificial intelligence - simulation - hybrid modelling	- supply chain costs - production or delivery quality - demand, supply, or other uncertainties (/risks)	The preferable (in terms of cost and/or quality) of two (or more) SC scenarios
Make-or-buy analysis	A special type of scenario comparison to determine whether to produce something in-house or to source externally.	Full cost calculation	- fixed costs - flexible costs (*maybe plus* non-financial factors quality, reliability, etc.)	To buy or not to buy
Revenue model analysis	A special type of scenario comparison to determine which revenue model is more profitable.	Full revenue calculation; e.g. using present values	- forecasted cash inflows with different cash inflow structures - discount rate	How to sell
Profitability threshold analysis	Assesses whether an investment will be profitable in terms of its rate of return (compared to an alternative return rate).	IRR (internal rate of return)	- forecasted cash inflows and outflows - discount rate - interest rate (for refinancing)	Profitability of the investment's rate of return
Market attractiveness analysis	Evaluation if a particular target market or target group is attractive for continuing or starting doing business there.	PESTLE and derivatives	- selection of political, economic, social etc. factors (past and forecasted)	Relative attractiveness of one market over the other
Hybrid (including	Evaluation for cases where	BSC	- financial parameters	Relative

[3] See Peidro et al. 2009 for a comprehensive overview of different supply chain planning modelling approaches.

both financial and non-financial indicators) analysis	a decision should/may not be based on financial indicators alone (allowing for an importance rating/ weighting of individual indicators for a final score)		(costs, revenues) - non-financial indicators *by discretion* - uncertainty/ risk indicators	target performance value
Miscellaneous financial *or* non-financial analysis	Evaluation of either specific financial or non-financial indicators only	Any type of assessment (quantitative or qualitative)	- revenues - costs - non-financial indicators like quality	Miscellaneous case-specific information
Retrospective evaluation	Evaluation of the past performance of a certain area of the business.	- actual profit - actual full costs - BSC	- actual profit and cost values - other non-financial indicators (quality, lead times, etc.)	Realised profitability / performance

Table 4 does not explicitly distinguish between strategic and tactical methods because in reality this may be difficult (and even unnecessary) to state with any certainty. As indicated earlier, the classification of a question or scenario as either "strategic" or "tactical" depends on the position of the decision maker and on the timespan involved. For example, the method "investment profitability analysis" by Net Present Value (NPV) analysis could theoretically be used both for investment projects with a planning horizon of 5 – 10 years (making them "strategic" by most definitions) and for others with a planning horizon of less than a year (making them "tactical"). Here, the *a priori* definition as strategic or tactical is less relevant than the type of question itself: The type of question requiring this evaluation method asks for a profitability assessment of a certain investment project covering cash inflows and outflows over ***multiple*** time periods. The second column of Table 4 gives some information on the type of question. Figure 16 provides additional help for the decision maker for choosing an appropriate evaluation method by arranging all the methods from Table 4 into a simple decision tree, divided by question type.

The complexity of the question that is to be solved may require multiple methods to be combined. One should however try to select the simplest solution that serves the purpose to avoid unnecessary effort. The more parameters that are included, the more complex the evaluation becomes. This holds for different parameters of one type (for example, different cost indicators), but also for financial and non-financial indicators. While the consideration of both financial and non-financial indicators usually leads to a more balanced assessment (hence the name "balanced scorecard"), one should carefully consider whether the added complexity for this balanced evaluation is really necessary for a particular case.

The chosen evaluation type and the objectives that were specified earlier determine which performance or profitability indicators are relevant for the case at hand. The decision maker **then gathers data for these indicators to calculate the evaluation**. Additional information regarding the selection of performance or profitability indicators is given below in Section 4.3. The evaluation results in a relative statement regarding the profitability or attractiveness of a certain scenario given a set of risk conditions and other underlying assumptions. The degree to which the result depends on these underlying assumptions can be made explicit by means of a sensitivity analysis.

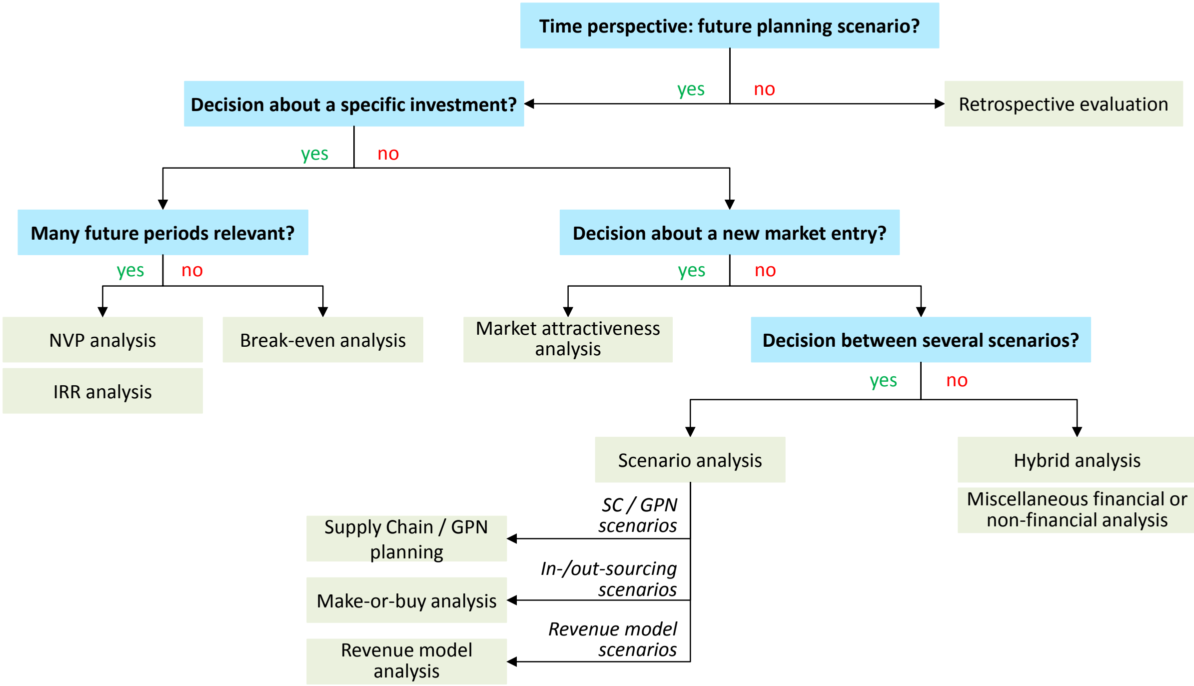


Figure 16: Simple decision tree for selecting an evaluation method depending on the type of question

4.3 Types of performance indicators for the evaluation and impact on global production networks

There is abundant literature from academia as well as from the field of practice on possible indicators for performance assessment. Lists of KPIs have for example already been presented in D2.1 (Chapter 5) and D2.2 (Chapter 6). The goal in this section is therefore *not* to reproduce long lists of performance indicators from different sources. Instead, it firstly summarises general information about indicators that is necessary for using the above-mentioned evaluation methods. Secondly, it moves on to the topic of indicators for the tactical level and how they can be used to assess global production networks.

Performance indicators specify desirable targets or objectives of a business (at any level). They should always come with certain **metrics** or **measures** to be able to evaluate the extent to which these objectives are met. Put differently, while the performance indicator says ***what*** should be achieved, the metric says ***how*** to assess whether the goal has been achieved. Please refer to the Glossary of this deliverable for an explanation of how to exhaustively describe performance indicators.

A comprehensive set of performance indicators that reflects all relevant objectives of a business (again, on any possible level) does the following:

- helps to plan and control the business,
- helps to monitor performance developments over time,
- enables benchmarking of performance with the performance of a peer group.

Performance indicators can be used both retrospectively (to see what has happened after certain actions or decisions) or for planning purposes (to see what might happen). As mentioned above, in the case of FLEXINET we mainly focus on performance indicators (and their metrics) for planning purposes. The metric values are then used as parameter values in the evaluation method's formula or algorithm. Since values have to be estimated based on past performance or need to be guessed entirely, uncertainty is introduced into the evaluation.

At a very basic level, one can distinguish between two types of performance indicators: financial and non-financial indicators.

4.3.1 Financial and non-financial indicators

Financial indicators ultimately capture all indicators that influence the **profit** of a company. Simply put, they include:

a) **Revenue drivers**,
b) **Cost drivers**.

Revenue drivers (or direct value drivers) influence revenue by either affecting the unit selling price of a company's products and services or the selling quantity (sales).

Cost drivers influence a company's costs in terms of variable or fixed costs or the efficiency with which the company turns inputs into outputs. For publicly traded companies, many financial indicators are reported in a company's financial statements, including a wide range of derivative and specialised indicators for specific stakeholder groups such as investors or regulators. These indicators are not in the focus of FLEXINET.

When financial indicators are used for scenario forecasting as opposed to retroactive evaluation, methods of capital budgeting are used to estimate the Net Present Value (NPV) of future cash inflows and outflows. The NPV calculation assesses the profitability of a future investment adjusted by the interest rate (see D2.3, Section 4.3 for an example of an NPV calculation).

Figure 17 provides a quick orientation for the decision maker who applies the approach to find out whether either revenue or cost drivers (or both) should be considered for a given change in the business model (that is, for the affected BM component that is the outcome of the initial analysis described in Section 4.2.1).

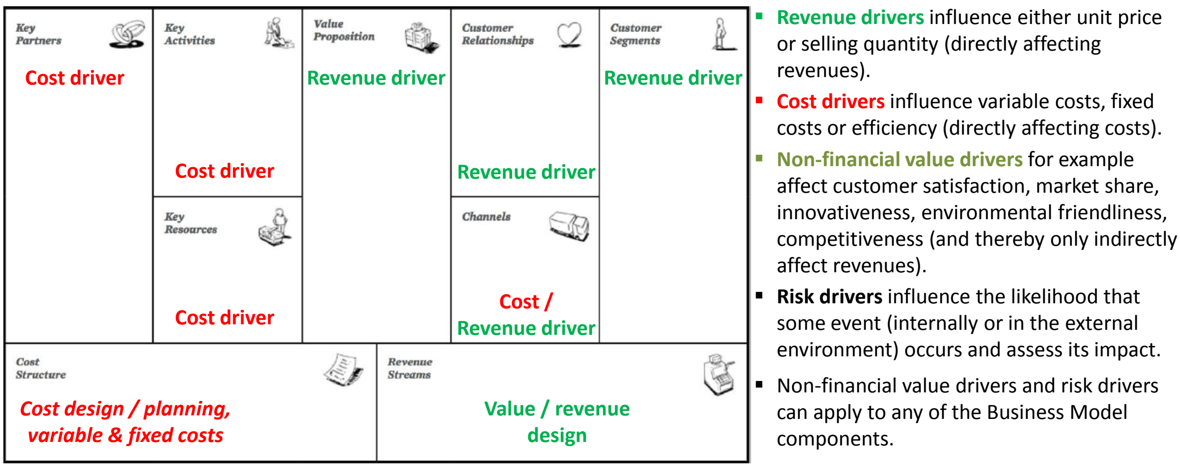


Figure 17: Quick orientation for identifying which types of indicators are affected by decisions/changes to different business model components

Non-financial indicators (or **indirect** value or cost drivers) capture other desirable goals a business may pursue besides profit maximisation. They reflect the fact that the long-term health of a company does not depend on profitability alone, but also on several other indicators. Furthermore, non-financial indicators may internalise external performance expectations that are raised towards a company, for example regarding its role for society as a whole or regarding its value for a national economy, by capturing ideals like environmental friendliness/sustainability, corporate governance, or employment stability.

Typical **examples** of **non-financial performance indicators** are:

- Market share.
- Reputation or customer satisfaction.
- Product and service quality.
- Lead times (possible measure for both speed and quality).
- Agility (the ability to quickly react to internal or external changes).
- Compliance.
- Risk-resilience.
- Innovativeness.
- Growth (may also measure financial growth of course).
- Sustainability.

These non-financial performance indicators can be relevant for both strategic and tactical levels of decision making. The following overview in Table 5 shows which indicators are usually important at which level.

Table 5: levels for non-financial performance indicators

Indicator	Strategic	Tactical
Market share	X	
Reputation	X	
Product and service quality	X	X
Lead times	X	X
Agility	X	X
Compliance	X	X
Risk-resilience	X	X
Innovativeness	X	
Growth	X	
Sustainability	X	X

Non-financial indicators will usually only indirectly affect revenues or costs. For example, higher customer satisfaction may lead to higher revenues given that the product or service is available at the right price at the right time for the right customers. On the other hand, a severe reputation loss, for example caused by ill-treatment of employees or operations that pollute the environment, will make customers turn away, resulting in revenue losses. Thirdly, inability to meet compliance rules may result in fines. Non-financial indicators are often more difficult to measure/forecast, to interpret, and to change with short-term business actions.

Finally, **risk drivers**, which are a core concept in FLEXINET, influence the likelihood that some event (internally or within the external environment) occurs and help to assess its impact, for example on processes of a production network. Previous deliverables contain comprehensive descriptions of the role of risk, individual risk indicators, and methods how to measure the impact of risk on production networks, so we will not repeat this here for the sake of brevity. It is only relevant to mention that during the planning stage on either strategic or tactical levels, ***any*** performance or profitability indicator is susceptible to different risk influencers. The likelihood of occurrence of a risk event in combination with the magnitude of the positive or negative effect of the considered financial or non-financial performance indicator determines whether a planning scenario will be considered attractive or not by the decision maker.

4.3.2 Selecting the "right" indicator and managing complexity

As argued in Section 4.2.2 and shown in Table 4, the right indicator selection depends on the type of question and the evaluation method. To a certain extent, they will tell or at least inform the decision maker which indicators need to be available to conduct a meaningful calculation.

Furthermore, the level of planning (strategic, tactical) and the corporate function influence whether a manager will be more concerned with either revenue (value) or cost drivers. **Strategic goals**, for example, will usually more often look at **revenue drivers** ("Which new services to offer to new markets or to new customer segments for higher sales" etc.). In contrast, the **tactical level** usually focuses more on **cost optimisation** (because they can influence neither unit price nor sales volumes directly) **for a desired quality level** (e.g. delivery quality).

The goal should usually be to choose only those indicators for those organisational areas that are actually affected by the scenario to be implemented and to disregard all others. Otherwise, an unrealistic or unnecessarily complicated outcome will be estimated. Another way to manage complexity during performance evaluation is to only evaluate those indicators that *differ* across two alternatives. This keeps the number of performance indicators that need to be estimated smaller and gives a more transparent and easier to understand picture for the decision maker. For example, if indirect costs are expected to be similar between two scenarios, this cost category does not need to be included in the evaluation calculation.

Adding to the complexity, many of these performance indicators naturally come as trade-offs of each other. The relative importance of these indicators and their target values should therefore be derived from company strategy or from the specific goals of a specific partial business model. Typical trade-offs are *cost vs. quality* or *time vs. quality* that need to be solved with care for each business model scenario. A performance measurement system (the collection of all performance indicators) will therefore be unique for any company. The approach described in Section 4.2 aims at helping decision makers to narrow down the choice space of evaluation methods and indicators

The seven-step evaluation reference process suggested here shall however narrow down the choice space for FLEXINET users and help them decide which evaluation approach and which indicators to choose for which situation.

4.3.3 Performance indicators for the tactical level

Performance indicators at the tactical level will usually look at costs on the one hand and a set of non-financial indicators on the other hand that can be influenced by tactical planning and implementation. A comprehensive and well-structured collection of suitable indicators comes from the Supply Chain Operations Reference model (SCOR model).

The most recent update of the SCOR model, edition 11.0, suggests five so-called **performance attributes**, which represent sub-goals of a successful supply chain, along with three levels of **metrics** (or diagnostic metrics), that are the standards of measurement for these attributes (SCC 2012). Metrics are modelled at different levels, of which the lower-level ones help identify root causes of performance gaps in a higher-level metric. Figure 18 summarises the SCOR performance attributes along with their 10 level-1-metrics.

Attribute	Level-1 Metric
Reliability	Perfect Order Fulfillment
Responsiveness	Order Fulfillment Cycle Time
Agility	Upside Flexibility
	Upside Adaptability
	Downside Adaptability
	Overall Value-at-Risk
Cost	Total Cost to Serve
Asset Management Efficiency	Cash-to-Cash Cycle Time
	Return on Fixed Assets
	Return on Working Capital

Figure 18: SCOR model performance attributes and metrics (SCC 2012, p. 1.0.2)

These SCOR model indicators are well-suited for the FLEXINET discussion because they were continuously improved by the Supply Chain Council at its member companies over many years to fit the requirements of modern, global supply chains. They therefore directly fit to the needs of global production networks such as those in FLEXINET. We therefore suggest using these performance attributes in combination with the FLEXINET-specific risk perspective to evaluate concrete business model scenarios on the tactical level. It should however be mentioned that the primary application of these metrics is the retroactive evaluation of performance/profitability (the evaluation of past performance). They can of course also be used to evaluate the performance of forecasted scenarios, but estimating the required data may be challenging for an individual case.

4.4 Demonstration of the evaluation approach with an example use case

This section demonstrates the approach from Section 4.2 (using one of the evaluation methods) with a practical use case. The example use case is the "CD Use Case 1: New energy drink for Spain" (see D1.3).

4.4.1 Example evaluation Part 1: Determining the scope: selection and specification of business model components

The initial idea of the use case is reproduced here from D1.3 (p.55):

"A potential Client, owner of around 300 Chinese stores all over Spain, contacts CustomDrinks through its Sales Department and suggests the possibility of producing and packing a bespoke Energy Drink with a high content of potassium sorbate and a high degree of sweetness. Regarding the

packaging the query is for a big aluminium can (volume > 330 ml) with a special end (reclosable cap, Ball Resealable End technology), which allows consumers to open and close it again and again. The Client claims that the initial order might be around 100.000 units."

The decision maker firstly needs to check which BM categories are relevant in this use case (see Figure 19).

Step 3.1: BM component selection

Input:	Int. elements of conceptual model	BM Canvas components	Check with "X" if true: Same as existing? (irrelevant for further evaluation)	Check with "X" if true: New or to be changed? (relevant for further evaluation)	Output:
New idea / question: New custom drink	Value concepts	Value proposition		X	List of relevant BM components to be analyzed further → Proceed to next specification step (Step 3.2)
		Customer segment	X		
		Customer relationship		X	
	Value creation concepts	Distribution Channels		X	
		Key activities		X	
		Key resources		X	
		Key partners		X	
	Financial concepts	Cost structure/model		(x)	
		Revenue structure/model		(x)	

Figure 19: Business Model component selection

This shows that the case is fairly complex and requires changes in almost all areas of the current business model (it could therefore be called a new business model scenario). Only the Customer Segment remains unchecked because this client is not seen as a special new segment by the decision maker.

The decision maker then needs to enrich this basic selection with some additional information from the scenario by specifying the Business Model elements (see Figure 20).

Step 3.2: BM component specification

BM Component	Design choices (*select all that apply and describe*)						
Value propositions (benefits)	Newness / Style	Usability	Performance / Getting the job done	Quality	Cost reduction	Customization / Individualization	Price
Value objects	Physical product	Service	Product/Service bundle	Intangible			
Customer segments	*Describe or use existing company-own classification (B2B vs. B2C…; preferences; socio-demographic characteristics; location, etc.)*						
Customer relationships	Sale only	Personal lifecycle assistance	Self-service usage/info offering	Community/ network building	Co-creation	After sales service	
Distribution channels	Sales force	Own store (offline)	Own store (online/web)	3rd party distribution (offline)	3rd party distribution (online)		
Key activities	Design	Source	Build/Make	Sell / Deliver	Service	Learn/ plan/ manage	
Key resources	Hardware (product/ facility/ equipment)	Software	Human resources	Intangible (IP, brand)			
Key partners	Individual business partner	Business network (GPN)	Public/ societal partner(s)				
Cost structures (*analyze above*)	Up-front costs / one-time investments	Ongoing costs: fixed	~~Ongoing~~ costs: variable				
Revenue models	Sale	Renting / licensing / subscription	Brokerage fee	Advertising	Freemium / bundle	Free	
Pricing models	Fixed	Dynamic					

Figure 20: Selection of business model elements from the morphological box

Subsequently, the elements that are selected from the morphological box need to be described to provide more details (specifying the BM objectives of this case) for the subsequent evaluation (Table

6). The table uses the information from the original case and assumes some knowledge about the existing business. This may therefore be performed by a team of subject-matter experts.

Table 6: Description of the chosen business model elements

BM Component	Design choices for BM elements	Information about BM element (BM objectives)
Value proposition	Newness / style	New Energy Drink with a high content of potassium sorbate and a high degree of sweetness
	Performance / Getting the job done	Innovative resealable cap
Value object	Physical product	New drink
Customer relationships	Sale only	Sales relationship with this new client
Distribution channels	3rd party distribution (offline)	Distribution to end consumer by the new client's stores. Distribution to this client from current production network.
Key activities	Design	Design beverage formula; [Design (→ better: source) new cap]
	Source	Source potassium sorbate Source >330ml aluminium can Source resealable cap Source other beverage formula ingredients (water, sugar,+..)
	Build/Make	Produce and fill 100,000 units
	Sell/Deliver	Deliver to 300 stores in Spain
Key resources	Hardware (material/equipment)	Production capacity for 100,000 units of special can.
	Human Resources	Cap design specialist (not available in-house, therefore ext. sourced)
Key partners	Business network	Supplier 1 (for ingredients): potassium sorbate Supplier 2: can Supplier 3: cap New supplier and client relationship
Cost structure	Up-front costs	Up-front fixed costs for supplier selection, machine retooling for new can size
	Variable costs	Variable costs for bulk order; see key activities and resources
Revenue models	Sale	Order size: 100,000 units
Pricing models	Fixed	Bulk order for one client

4.4.2 Example evaluation Part 2: Selecting and applying the right evaluation method

The decision maker now chooses one of the evaluation models from Table 4. The core question of this use case that is to be answered by the profitability analysis is whether fulfilling this order from the new customer will be profitable for CustomDrinks or not. In terms of the decision tree in Figure 16, the case at hand is a future scenario that looks at a specific project investment with only few future periods. The typical evaluation type for this question is a **break-even analysis.** Theoretically, other evaluation types could of course be used, too. For example, the scenario could also be considered as an investment project with *several* future periods relevant for cost and income streams, which would be evaluated by an NPV analysis. The choice of the evaluation model should however be based on basic effort-to-value considerations. Because the target selling quantity is given by the client's request and as the case is a simple one-time order, a break-even analysis can be achieved comparatively easily, while an NPV analysis is more suitable for cases with several cash inflows and outflows over several future periods, and is also more difficult to calculate.

The parameters of a break-even calculation are fixed costs, variable costs/unit costs, selling quantity, and selling price. It is clear that in this case the selling quantity is already given by the order of the client (100,000 units). The expected cost parameters need to be determined. In order to do so, the decision maker can build on from the previous step, which highlights those areas of the BM that require more detailed modelling. It can be seen that the focus lies on the **key activities** in the **sourcing, production,** and **delivery processes**. The costs will therefore be determined by the up-front and variable costs of the new sourcing, production, and delivery processes.

In our case, for example, the sourcing or design process for the resalable cap needs to be modelled and assessed. If none of the existing suppliers can supply the required material, a "new supplier selection process" will be needed. After the initial search activity to find a suitable supplier, a new supplier master data record will need to be created in CustomDrinks ERP system. Likewise, serving a new client means that a new customer master data record is created in the ERP system. Furthermore, necessary changes to the production line should be modelled for the machine retooling for the larger bottle.

The decision maker **chooses the relevant cost indicators for these processes** and **needs to obtain cost estimates for them**. Table 7 shows a basic list of indicators for the break-even calculation in this case.

Table 7: Example application of break-even analysis to use case

Evaluation parameter	Indicator in the case	Further explanation
Profit = p*Q – (FC + VC*Q) Break-even selling price: p = (VC*Q + FC)/Q		P: unit selling price Q: production/selling quantity FC: fixed costs (upfront costs) VC: variable costs (unit costs)
Production/selling quantity	Q = 100,000	Given from order
Fixed costs (upfront-costs)	$FC = FC_1 + FC_2 + FC_3 + FC_4$ FC_1= drink formula design costs FC_2= new supplier selection costs FC_3= new supplier and customer record creation cost in IT system FC_4= machine retooling costs for new can size	FC: sum of all up-front costs
Variable costs (for the given order Q)	$VC*Q = VC_s + VC_p + VC_d$ VC_s= purchasing costs for drink formula ingredients + purchasing costs for can + purchasing costs for cap (all for the order lot size Q) VC_p= production costs (labor + machine) (for the lot) VC_d = delivery costs (for the lot)	VC: sum of all variable costs for the given order lot size q VC_s: sum of all sourcing costs

Under the assumption that cost estimates for the input parameters are available, the break-even formula for the selling price [p = (VC*Q + FC)/Q] reveals the minimum selling price per unit which makes this customer order profitable (that is, the minimum price at which revenues equal costs).

Subsequently, the **interpretation of the evaluation result** (and the final decision) again depends on the company's strategic and tactical objectives. It also needs to be negotiated with the client if he is actually willing to pay more than this calculated break-even minimum price. If not, a sensitivity analysis would be helpful to assess under which conditions (higher order volume, lower costs, etc.) the order could become profitable.

Even if the break-even analysis leads to a result that is unlikely to be profitable by financial considerations, other evaluations that also take non-financial indicators into account could of course be done afterwards or in parallel. If this client is for example considered an important strategic future client, who is expected to order regularly and on a large scale in the future, it may be reasonable to accept this first order even though it is not profitable by itself. As this explanation shows, the evaluation of business model scenarios usually requires common sense and a good awareness of the company's strategic objectives and can rarely be solved by a single calculation (no matter which evaluation method is used).

5 Applications

The methods considered in WP4 are implemented into applications for business modelling and evaluation in the Business Model Accelerator (BMA), Business Model Configurator (OBMC) and the Technology Effect Analyser (TEA). The BMA uses the morphologic box approach to compare and evaluate business models this leads to the BMA-Morphologic Box View (BMA-MBV). This view is closely related within the BMA with the definition of objectives, drivers and indicators. This leads to the BMA-Objective Driver Indicator Model (BMA-ODIM). OBMC is mostly provided by the enterprise model use for bringing strategic and tactical methods together. It also provides the basis for the model fragment approach. The approach in chapter 3 suggests the technical impact analysis in a very early phase during the business model development which can be integrated in the evaluation methods used. However, the option of the analysis related to an existing or approaching GPN is also required to support a better understanding of the effects of new technologies. A related application is available with the TEA application provided in WP5.

5.1 Reference workflow for applications initiated by WP4

The reference workflow illustrated in Figure 21 relates the workflow between the definition of objectives and the definition of business models with the final output of a business process structure for the GPN. This is just a potential subset of the whole FLEXINET workflow and is focused on components presented in the deliverable D4.2. ODIM can already be used to define and document strategic company objectives with indicators and drivers. MBV is used to define business model alternatives taking into account the already existing strategic company objectives. But, for a specific new idea the objectives of the company needs to be related to the objectives for the new business related to the new idea. This is done again in ODIM and will be the basis to select a specific business model. The business model evaluation provides an indication of the impact of the business model. A potential evaluation is the breakeven analysis presented in chapter 4. A prototype has been developed on the basis of the data collected in the MBV.

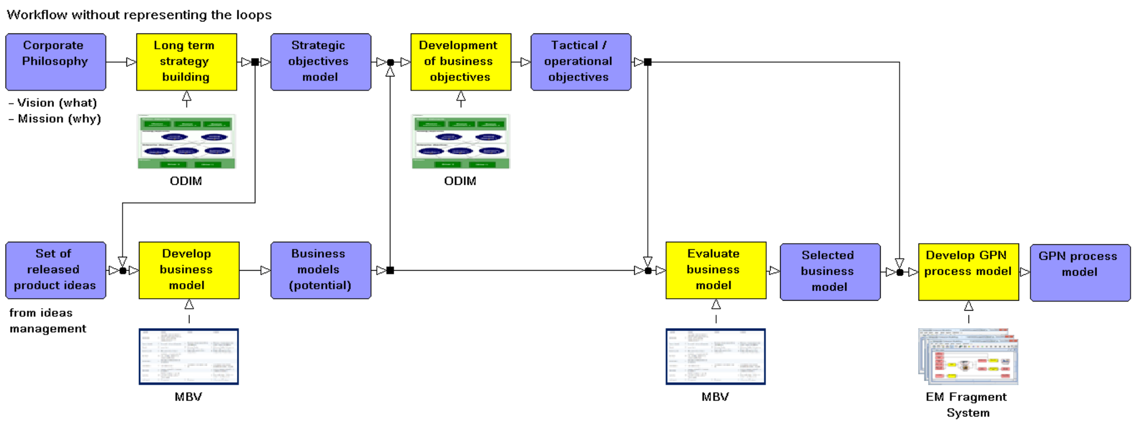


Figure 21: Reference workflow between objectives and business model

The evaluations in the very early stages of business model development are just an approximation of indicator values such as cost and time. In later stages more information arrives from the planning of the realisation of the business model. Therefore, the indicators become more accurate. This requires a relation between the indicator value and the knowledge base.

For some indicators the data can be derived from existing sources on the internet such as the data the STEEP analyzer provides or from sources existing in the enterprise applications. However, it is important to ensure that the indicator values can evolve over the time.

The data in the following examples of the applications is fictitious, but, the structures have been derived from real end user scenarios. The BMA-ODIM and the BMA-MBV are exemplified. OBMC covers model fragments, it is illustrated by the enterprise modelling tool already presented in previous documents.

5.2 Objectives

The relation between a CANVAS model taken from D6.2 and ODIM is illustrated in Figure 22. It exemplifies the relation between indicators of a business model component such as "Key partners" with indicators in ODIM which can be added to objectives or drivers. In fact the indicator "distance" can be an indicator of cost reduction to reduce logistic costs. In the CANVAS model a key partner could be measured by its distance which contributes to the objective "Cost reduction". This is an artificial example and is only used to demonstrate the approach.

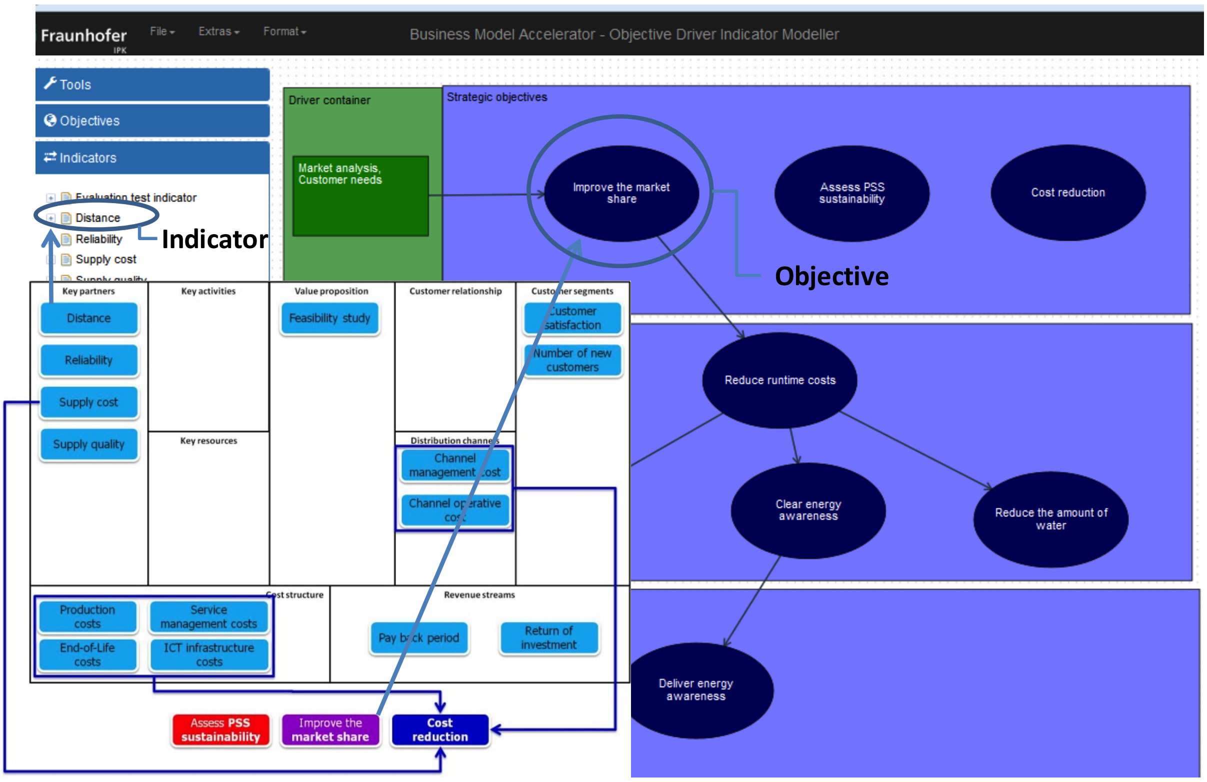


Figure 22: indicators and objectives (derived from Indesit example in D6.2)

5.3 Applications for Business model and Evaluation

The MBV example uses the small KSB case described in chapter 1. Three potential business model scenarios are drafted. It also illustrates potential evaluation features to distinguish between business model scenarios on the basis of the consideration in chapter 4. The numbers are also artificial because of the public nature of the deliverable. On the left side the CANVAS components are defined, followed by the 3 scenario columns. Each cell in the table consists of business model elements such as the key activity "hardware check" or "product management". On the right side different attributes are available for each of the business model elements. For "product management" the expected production rate is set to 1575. These numbers behind all the business model elements are used for a potential calculation. The BM evaluation is a prototype which implements the evaluation method used in the example in chapter 4.

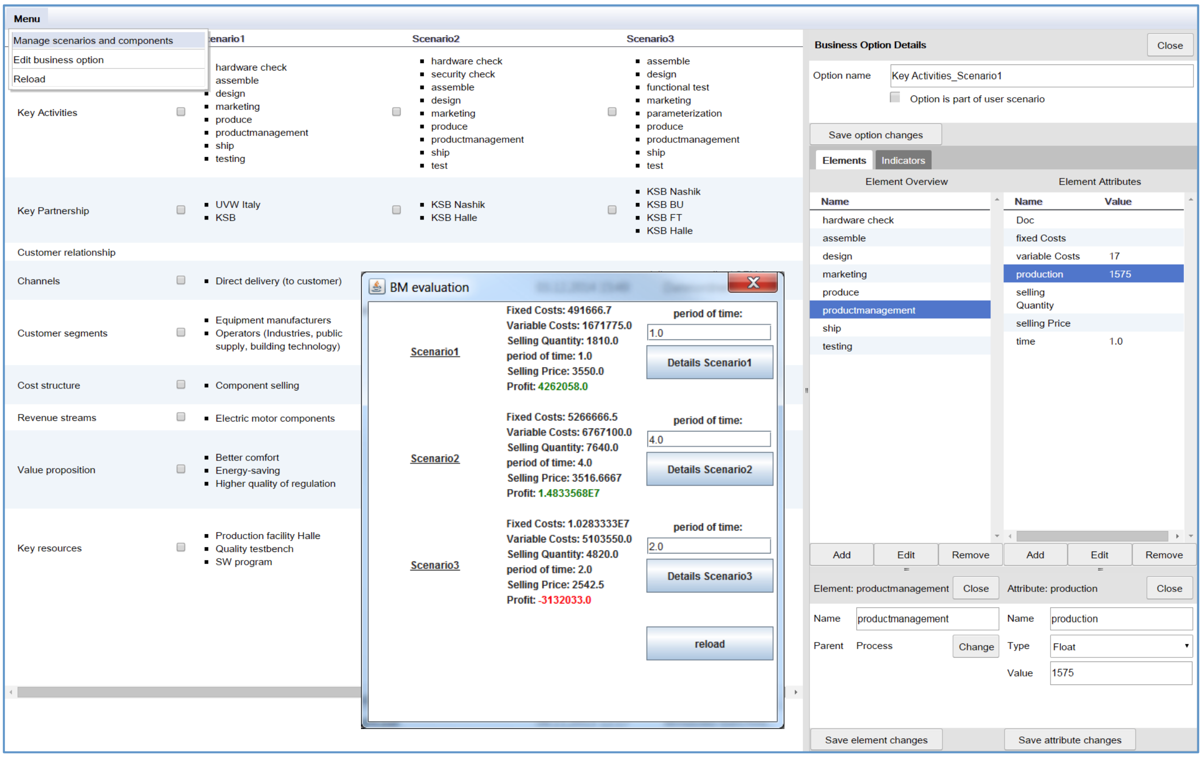


Figure 23: Initial impression of the evaluation related to chapter 4

These application examples express the relation between WP4, WP5 and WP6. The final integrated implementation of these applications is progressing within WP5.

6 Conclusions and next steps

Impact analysis on technologies and business models has been defined and experimented upon. The Technology Effect Analyser has been specified in terms of an analysis of business models within chapter 3 as well as an analysis of Global Production Networks. The analysis of business models relies upon the breakeven evaluation which has been presented in an example in chapter 4 and prototyped in chapter 5. Model structure fragments and reference structures are designed in detail within chapter 2. This also covers the definition of a data model for the model fragment libraries. This is a prerequisite for an effective usage of the model structure fragments. But, the instantiation of the fragments to derive building blocks for the GPN process model is also important and has been defined in chapter 2.3. The definition of the reference model structure fragments has been carefully related to the FLEXINET ontology and synchronised with the FLEXINET knowledge base.

Task 4.3 has finished but, the work will continue in Task 4.4 with a specific focus upon the evaluation and simulation of business models. An important aspect will be the evaluation of the business models according to expected economic effects and related risks based on the implementation of technology options. This will be performed using simulation techniques considering the overall description of the business models and business process model. Technological options influencing the introduction of new products in the market will be analysed.

Chapter 4 presented the current status of work in Task 4.4, which continues until M33. A core result was the evaluation approach with the explanation of which evaluation methods are useful for which types of questions, which was presented in Section 4.2.2. For the remainder of Task 4.4, the work on developing a concrete example for scenario analysis with a Supply Chain / GPN planning use case (see Figure 24) will be performed.

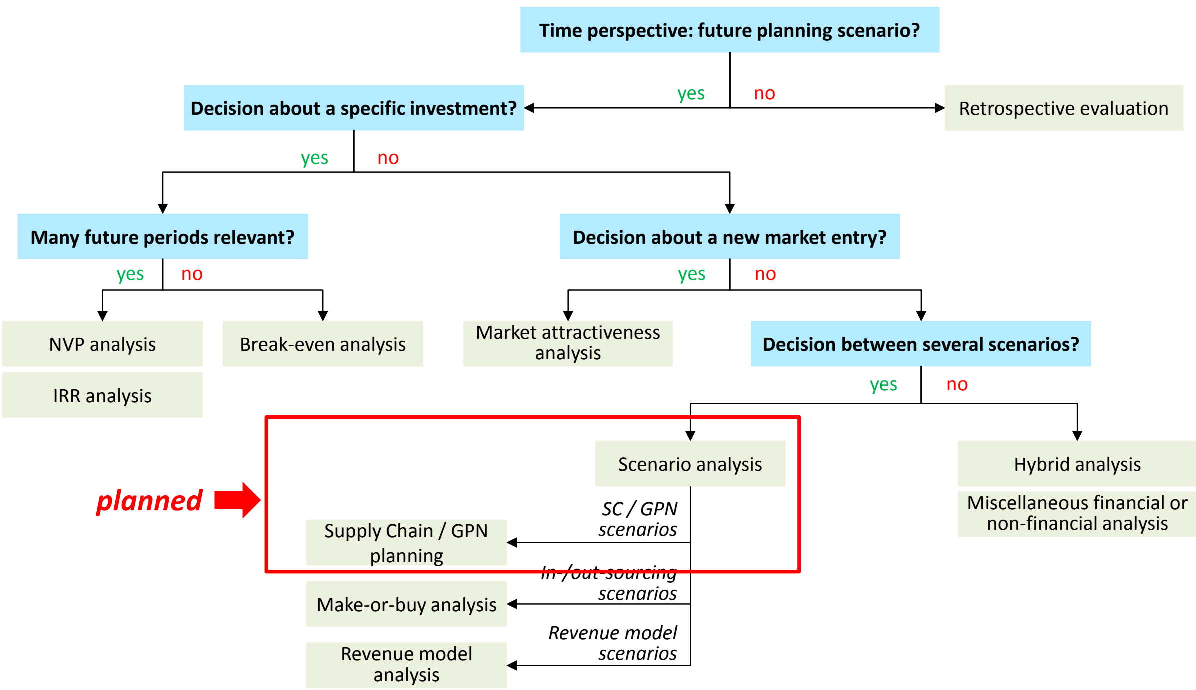


Figure 24: Planned evaluation in T 4.4

Further expected WP4 results along Task 4.5 are related to requirements derived from the application field and the end users such as:

- Extension of business model evaluation,
- Simulation of risks and technical impact in the business process structure of the GPN,
- Providing an initial model fragment library,
- Experiments within the end user scenarios.

Deliverable 4.3 will document this work especially in relation to simulation concepts and methodology adaptation.

Annex A: References

Garcia-Flores R., Wang X.Z. (2002): A multi-agent system for chemical supply chain simulation and management support. *OR Spectrum*, No. 24(3), pp. 343–370.

Peidro, D., Mula, J., Poler, R. & Lario, F-C. (2009): Quantitative models for supply chain planning under uncertainty: a review. *The International Journal of Advanced Manufacturing Technology*, No. 43, pp. 400-420.

Frank-Walter Jaekel (Editor), Gorka Benguria, Xabier Larruzea, Elisa Gallo, Gianni Parini, Giuseppe Tarsitano, Reka Moksony, Leire Orue-Echevarria. FP7-SME FACIT-SME PROJECT N° FP7-243 695 - D2.1 ORM Architecture and Engineering Models. 17.10.2010.

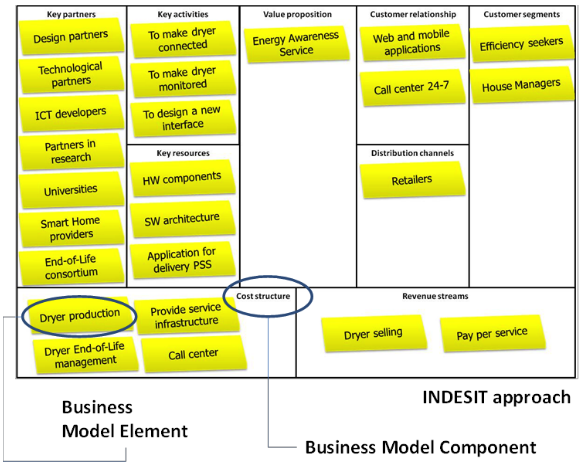
Annex B: Glossary

Indicator	According to D4.1 indicators are defined in the following way: PIs are grouped to KPIs. The **key performance indicators (KPI) are also just called indicators** in the document. They can be a standard set or company specific. If a standard set is used then they can be predefined in terms of parameterisation and evaluation. However in terms of the concept and method the specific parameterisation and evaluation of the parameters has to be adaptable. Moreover the standard indicators for a specific organisation need to be extendable. The descriptions of indicators are derived from ECOGRAI such as: • Indicator Name is a unique identifier of the indicator. • Purpose represents a description of the indicator. • Format stands for the possible values such as integer, text, real, enumeration. • AS IS value is the current value of the indicator. • Information needed to evaluate the indicator e.g. the parameters. • Calculation Processing represents the evaluation method for the indicator. • Required evolution (Target) represents the value to be archived. • The owner (Who measures) points to the responsible organisation unit. • Period is the time span required to evaluate the indicator. • Actions to react depending on the value of the indicator such corrective actions. • Should have a weight indicating its importance e.g. related to an objective. This defines a form for the minimum description of each indicator. The form will support to create a library of indicators. Therefore indicators can be selected by demand and related to objectives. For example they can be used to describe a specific strategic objective in more detail. The objectives are related to drivers or other model elements such as resources, products or processes. An important extension of indicator description is the definition of evaluation functionality for each indicator. This needs to be related to the environment the indicator is used and invokes other elements such as objectives and processes. One option is to use the FLEXINET ontology to feed the parameters of the calculation function. An indicator can have a relation with one or more drivers which are responsible to improve the indicator. Indicators can be external or internal properties and values which allows the evaluation of business ideas, business objectives, business models and / or global production networks. From the perspective of the balanced scorecard evaluation framework a

	performance indicator (PI) or simply indicator is located at level 3. Together with the external factors (see next section) both types together group the key performance indicator (KPI) on level 2.
External factor	According to D2.1 and the additions inD2.2 and D2.3 external factors are defined in the following way: An external factor (EF) is a country-related set of values. Usually, the values of external factors cannot be significantly influenced by a company – in contrast to the performance indicators (see above). An external factor or a set of different external factors can also be called as external data. External data means data describing the environment of a GPN. External data is retrieved via external data sources, e.g. EU open data, world bank open data, and others. In the STEEP application external factors are organised into five categories • Social • Technical • Economical • Environmental • Political • Legal External factors are used to evaluate a node in a GPN within the balanced scorecard framework. The second level of the below shown BSC framework has different KPI blocks, which consist of indicators and factors. The descriptions of external factors are derived similar to indicators such as: • External Factor Name is a unique identifier of the External Factor, e.g. Industrial electricity prices. • Description represents the description of the indicator. • Unit stands for the possible measures, such as %, annual %, €/a, total, or €/kWh for industrial electricity prices • Value is the value of the factor, e.g. 0,1185 €/kWh industrial electricity price for Spain • Min (worst) value is the lowest border of the external factor set, e.g. 0,186 could be the most expensive country for industrial electricity prices Max (best) value is the upper border of the external factor data set, e.g. 0,042 for the cheapest country in terms of industrial electricity prices Note: the lowest border can be the lowest value or the highest value, depending on what is appreciated (low electricity prices are usually good, whereas high growth rates are welcomed) • Period is the time span required to evaluate the indicator, e.g. Yearly GDP growth rate would require a duration of one year. • Data availability describes the currency of the data, e.g. 2013 or 2014. To enable an evaluation based on different external factors with different units, the values have to be normalised in dependency of the factors sample space.

Driver	Decision variable
Objective	Relates to **business objectives** as well as **strategic objectives**
Vision	**From Wikipedia:** A vision statement is a company's road map, indicating both what the company wants to become and guiding transformational initiatives by setting a defined direction for the company's growth. Vision statements undergo minimal revisions during the life of a business, unlike operational goals which may be updated from year-to-year. Vision statements can range in length from short sentences to multiple pages. Vision statements are also formally written and referenced in company documents rather than, for example, general principles informally articulated by senior management.
Vision statement	**From Wikipedia:** Mission statements and vision statements fill different purposes. A mission statement describes an organisation's purpose and answers the questions "What business are we in?" and "What is our business for?" A vision statement provides strategic direction and describes what the owner or founder wants the company to achieve in the future.
Business model component	A business model component is an area of interest in the business model e.g. taking the CANVAS model represents is one of the fields in the CANVAS model such as "key partners" or "key activities".
Business model element	A business model option represents one entity within a business model component. In terms of tacking "key partner" as an example for a business model component a specific key partner X is one business model option.
Process	Represents the dynamic behaviour of a system such as an enterprise
Business rule	A business rule is a directive or a guideline, which is believed to affect or to lead the business behaviour. Thereby it is always an entrepreneurial goal that is followed, which is the motivation for the business rule. Examples for business rules are below: • A good customer is a customer with a volume of sales in excess of 500.000 Euro in the last 12 month. • A good customer must receive a discount of 5% at any order. • Orders in excess of 1.000.000 Euro must be authorised by the sales director. • A customer with outstanding invoices must not enter new orders. • If the inventory of an item secedes under its minimum stock, the item should be ordered at the supplier. All these rules are dealing with the business and by those regulating aspects of the

	business. Therefore, it can be generally. Business rules are commonly classified in three different categories, see the : • Deriving rules are business rules which are deducing a new information out of existing information, e.g. "A supplier is a preferred supplier, if the adherence to delivery dates within the past 12 months is higher than 98%." Here the information "preferred supplier" is derived. • Restrictions as business rules are statements about the business which throughout have to be true, like prohibitions or directives, e.g. "A customer is never allowed to order above the line of credit. • Process rules are business rules which are launching, preventing or allowing actions, e.g. "If a new customer places an order, the creditworthiness has to be checked." This examples point one thing out: Every enterprise has business rules, even if they are sometimes not documented. And, also, business rules are implemented in every IT system. One aspect of the strategic level is the definition of business rules. These rules can directly affect the planning and operational level such as: • Compliance rules e.g. "gifts are only allowed if they are fewer than 25 Euros". • Organisational rules e.g. "orders higher than one million euros requires the signature of the director" • Economic rules e.g. "A change of a location will be only taken into account if the cost reduction is higher than 25%. Such rules will easily effect the global production network configuration but also the guidelines of implementation projects. On the other side it is also important that the guidelines are known and applied. However, it needs also mechanism in the management systems to adapt these guidelines if the environment changes. From WP2 the proposal is to code the business rules in a standard XML format which allows using and updating the business rules across different levels and applications.

Business model element **Business model component**		
Revenue driver	6.1.1	Revenue drivers (or direct value drivers) influence revenue by either affecting the unit selling price of a company's products and services or the selling quantity (sales).
Cost driver	6.1.2	Cost drivers influence a company's costs in terms of variable or fixed costs or the efficiency with which the company turns inputs into outputs. For publicly traded companies, many financial indicators are reported in a company's financial statements, including a wide range of derivative and specialised indicators for specific stakeholder groups such as investors or regulators.

Annex C: End user requirements addressed in this deliverable

The following requirements are related to WP4 in D1.2. It extends the list given in D4.1. The simulation related requirements will be addressed D4.3.

Req. ID	Business Requirement	Method /Tool
6	Standard for the description of the level of technical challenge	D4.2: defines an approach for reference structures and the description of technical challenges as well as the use of TRL (chapter 3)
7	Intuitive check list about new business models	D4.1: The reference structure with the related assistant will give the guideline. In this guideline the checklist can be included.
51	Synchronisation support for heterogeneous IT and machine configurations	D4.1: A mechanism for standard workflow will be provided by the model fragments.
55	New Business Model definition	D4.1/D4.2: The method is defined with objectives, business model options and reference structure
56	Business Model evaluation	D4.2: Chapter 4 and Chapter 5
58	Risk assessment	See D4.1 chapter 4
64	Tangible and intangible assets modelling	D4.1: The modelling approach takes into account services and products
75	Standardised and documented workflows	D4.1 Chapter 3 and 5