FLEXINET

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FLEXINET

Deliverable [D2.4]
Assessment and quantification of business model impact at company-level

Workpackage:	[WP 2] – [Methodology to Design Flexible Business Models for Production Network Configuration]
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FLEXINET Partners

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Executive Summary

The deliverable D2.4 "Assessment and quantification of business model impact at company-level" represents the final deliverable of WP2 "Business models for global product-service production networks". It focuses on the work done in task 4 "Designing business model scenarios for assessing the business model impact through the adoption of FLEXINET on company level". It also compares the different approaches in WP2 and WP4 "Methodology to Design Flexible Business Models for Production Network Configuration". This is done by

- Extensions of the BSC approach to a BSC network approach.
- A recommendation for a reference procedure interrelating methods and applications.
- An extended and detailed risk assessment approach.
- An end user oriented application description in terms of scenarios and sub-scenarios. This employs the prototypes developed in WP5 which implement the design specified in WP2. However applications specified in WP4 (objective and business model) and WP5 (idea management) are also incorporated.

It provides a quantification of business models related to break even analysis and BSC.

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1 Introduction

1.1 Purpose and Scope

The deliverable D2.4 summarises the work in FLEXINET WP2 "Business models for global product-service production networks". It that incorporates additional work on the design of business model scenarios for assessing the business model impact through the adoption of FLEXINET at company level, such as in chapter 3 which compares the attractiveness of different GPNs and the risk assessment of GPNs in chapter 4.A reference process is described in chapter 2 which provides a guide on how to use the FLEXINET methods. This process is used as basis for a scenario description in chapter 5 to illustrate how the methods and related FLEXINET applications can be used in a coherent way. It also summarises a set of interdependent scenarios for business models and GPNs to get a final agreed and confirmed GPN. The interdependent scenarios have been identified as new product, service, product/service or business opportunity.

1.2 Approach for Work Package

The work focuses on WP2 task 4 "Designing business model scenarios for assessing the business model impact through the adoption of FLEXINET at company-level". The work used the following approaches:

- FLEXINET meetings have been used to discuss the topics across FLEXINET (not only within WP2) including the BSC approach and the risk involvement.
- Regular WP2 telephone conferences have been used to develop the topics and monitor contributions to the deliverable. Additionally, contributions from other work packages have been invited, including from WP3, WP4 and WP5, to ensure the coherence of the work. In terms of the realisation of the applications within the FLEXINET platform of methods, close discussions were arranged between the WP2 stakeholders and the developers in WP5 especially in the area of the risk application and the strategic business model evaluation. These applications have been implemented by WP5 on the basis of the WP2 methods.
- Email exchanges were used to discuss topics in detail.
- The FLEXINET portal was very important for document exchange.

In addition to end user scenarios, data collected from end users was used to align the methods developed with end user requirements.. This work was also supported by

- Method prototypes using EXCEL sheets,
- Experimental usage of the methods and prototypes from the FLEXINET platform.

This resulted in updating the existing methods provided in WP2 and WP4. In particular the focus has strongly based towards the development of a reference process for business model and GPN evaluation that enables support for the interaction between strategic and tactical decision-making, as described in section 2 below. This has led us to the belief that rather than having a customised list of rules for each end user, as anticipated earlier in the project, that we need to provide a capability to compare internal business rules against external factors, both of which are likely to change over time.

An example of such a comparison could be a business requirement for supplying country or market to have a stable exchange rate. When a value is specified for this, say a maximum annual variation of 5%, it can then be compared with any specific country of interest (see examples in chapter 5.1.2) This set of rules is therefore generic and extensible, with those of importance to a specific company to be selected by them and provided with specific values of interest to the company.

1.3 Structure of the Document

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

- Chapter 1: The interconnection of WP2 with other WPs is discussed in this introduction as well as the targets of the approach.
- Chapter 2: Is concerned with the recommendation of a reference process or procedure incorporating methods and applications.
- Chapter 3: Considers an extension of the BSC approach. BSC 2.0 evaluates the effect of the choice of node upon the whole network and compares the attractiveness of different GPN configuarations. Chapter 4: Provides a aetailed analysis method of risks, extending the risk approach developed in WP2.
- Chapter 5: Describes the application of the methods to an end user scenario. It also provides an overview of the different sub-scenarios such as business model and GPN scenarios.
- Chapter 6: Presents a brief conclusion of the work in the work package.

1.4 Relation to previous work

The foundations of the work including business rules, BSC and risk aspects are described in D2.2: "Rulebook, documenting identified business rules" and D2.3: "Design specification for business model innovation". Further related work comes from WP4 in terms of the seamless transition between strategic and tactical levels in D4.1 and the representation of strategic objectives and business models in D4.2. Collaboration with WP3 enabled the ontology to be enriched with scenario approaches and also risk aspects. In addition work with WP5 provided the opportunity of to develop more aligned applications within the FLEXINET portal.

2 Reference process for business model and GPN evaluation

2.1 General introduction to the reference process

The various tools that were developed in FLEXINET have the overarching goal of supporting the innovation and planning process of decision makers in companies with global production networks (GPNs). FLEXINET therefore serves as a kind of "innovation funnel" that helps decision makers to select the most promising internal and external innovation ideas, to specify or fine-tune them, and to evaluate them in iterative steps. With each step, the picture of the business model and the GPNs becomes more precise until the decision makers can take informed decisions regarding the future business and GPN design. This reasoning is illustrated in Figure 2-1.

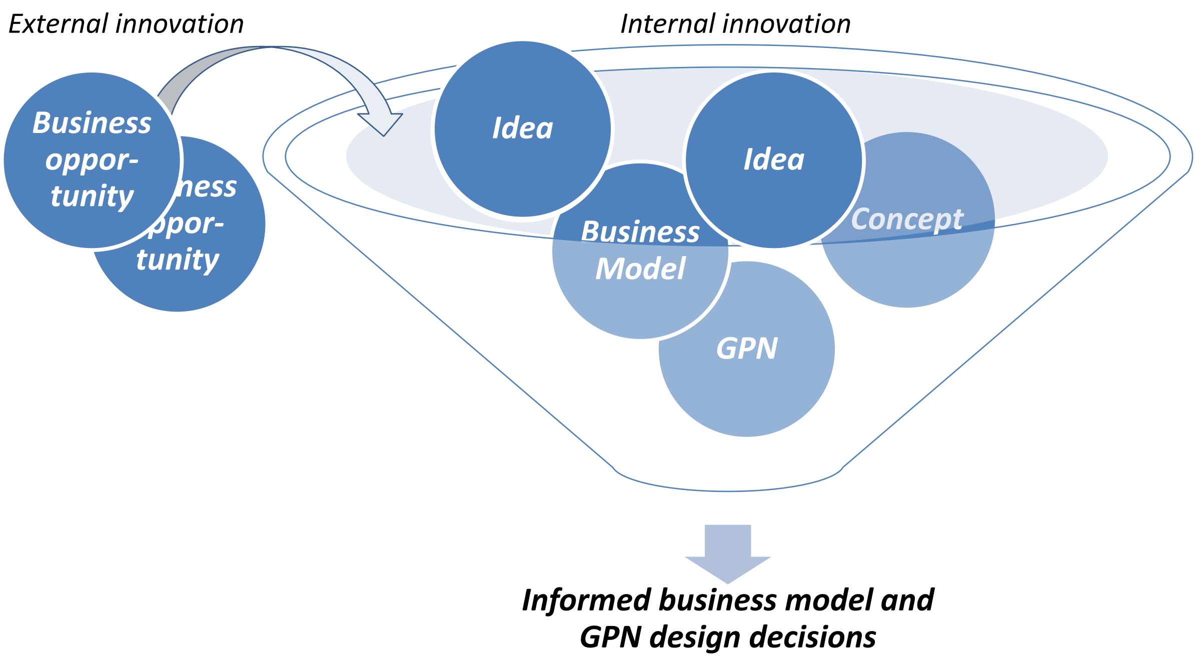

Figure 2-1: FLEXINET as an "innovation funnel"

It is important to note that the different FLEXINET tools apply to different stages in this iterative, multi-step process. To assist decision makers with choosing the right tool for a particular question or step in the process, we propose a **multi-step reference process** for the evaluation and assessment of new ideas/problems/questions regarding new business models and GPNs.

Figure 2-2 shows a simplified version of this process. The numbered blue boxes on the left of the figure indicate the steps of the reference process.

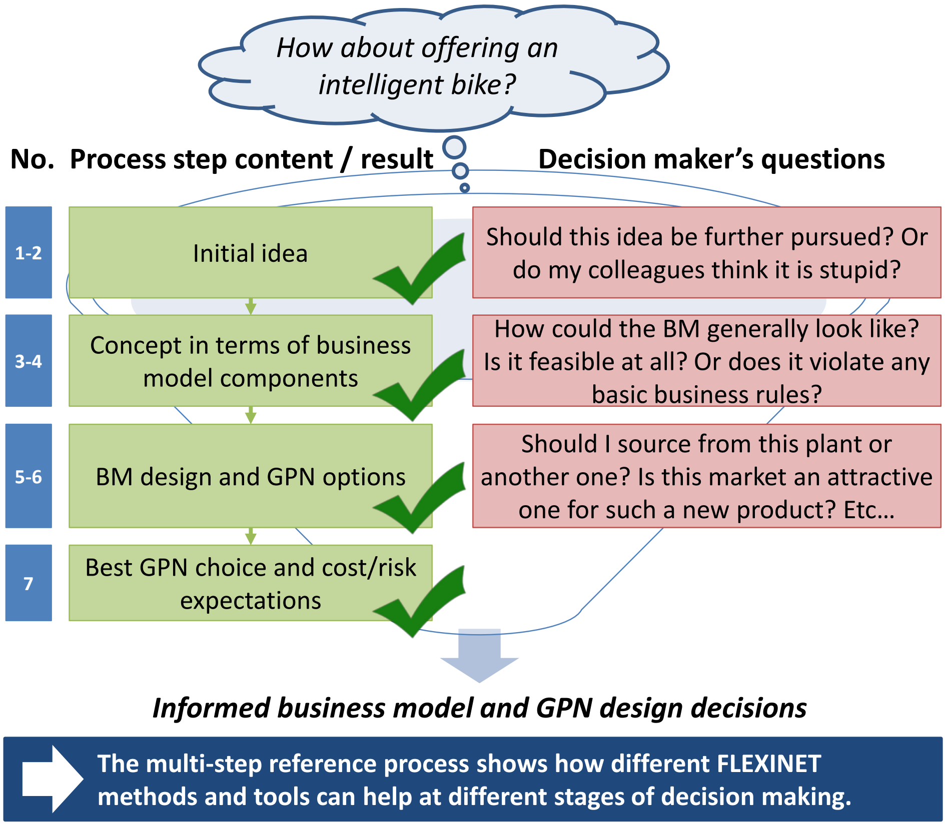

Figure 2-2: Exemplary decision process from the idea to the GPN design decision

The full reference process which extends the simplified one from Figure 2-2Figure 2-2, is shown in Figure 2-3. On the right-hand side, the figure lists diverse FLEXINET methods and tools that support the different steps. The following section briefly explains the steps of the process and gives cross-references to other FLEXINET deliverables that provide more details on the sub-steps.

The reference process can offer the following benefits to innovators and decision makers:

- It explains how the different methods and tools from FLEXINET around business and enterprise modelling and evaluation relate to each other and how they can (in combination/sequence) help with a wide range of possible questions and at different stages of a decision-making process.
- Its multiple evaluation steps (or "evaluation gates") ensure that only feasible ideas are pursued further and that no efforts are wasted on irrelevant aspects.
- Although the process suggests a logical sequence of steps, which can theoretically give advice and support to an entire idea creation and implementation process from beginning to end, it can of course be used flexibly. This means that, depending on the type of question, only sub-sections of the process can be selected, and that it may make sense to repeat some steps multiple times. The arrows on the left of Figure 2-3 hint at this iterative nature of the process. Likewise, the three main analysis types in step 7, "Evaluation 3", can and will often be used iteratively, when the results of one analysis stimulate another analysis. Summing up, this reference processes main purpose is to be reused in a way that helps decision makers in the real world with their practical design problems.

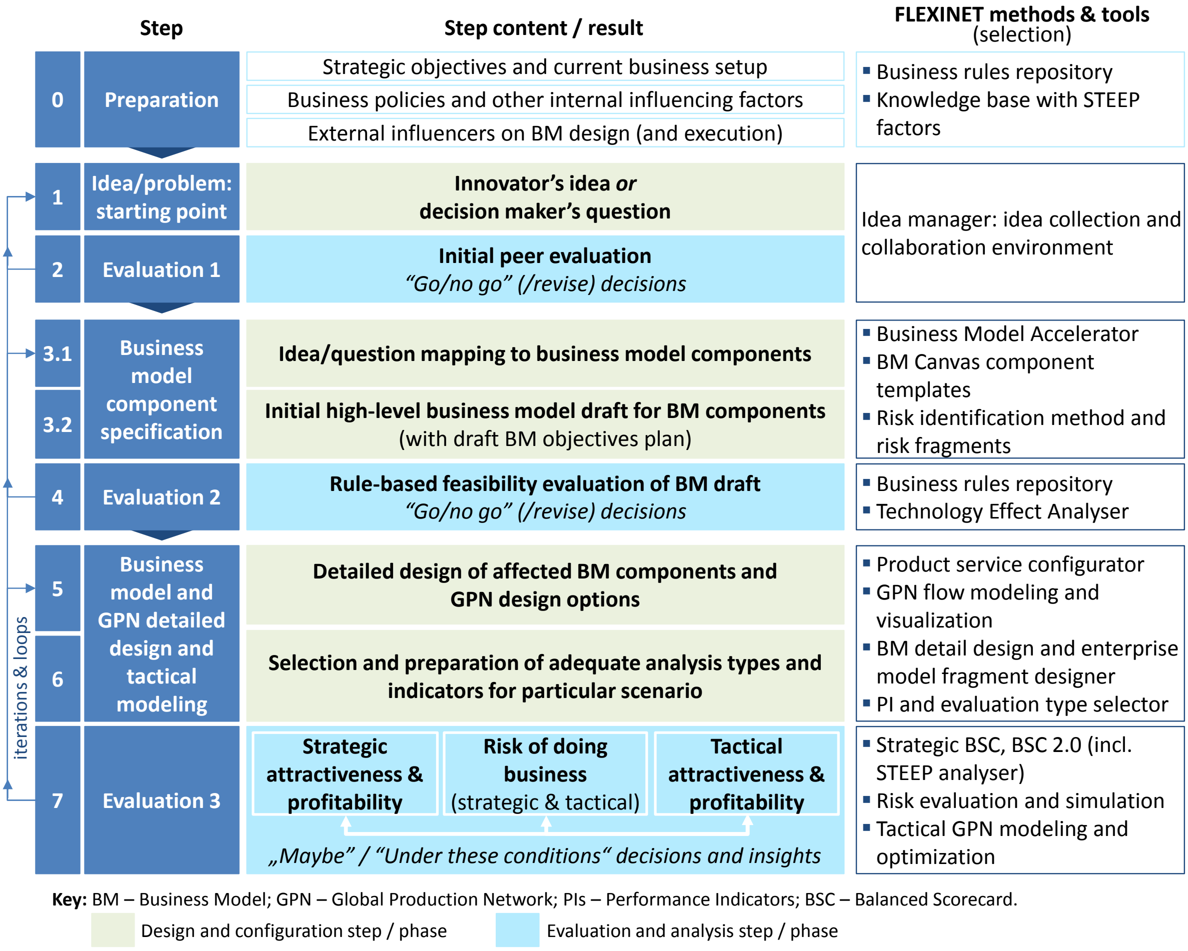

Figure 2-3: The seven-step reference process for strategic-to-tactical planning and evaluation of business models and GPNs with the assignment of FLEXINET methods and tools

2.2 Step-by-step explanation of the reference process

2.2.1 Introduction

The reference process consists of seven steps (with an initial "Step 0" as preparation phase). The preparation comes before a new idea or decision question enters the process at run time.

The process highlights that there are two types of phases or steps in the typical idea-implementation and decision-making process: On the one hand, there are design and configuration phases (steps) which specify and develop an idea further. On the other hand, there are analysis and evaluation phases (steps) which check the new idea and later the designs of the business model and the GPN for feasibility, expected economic profitability, and/or aspects of risk susceptibility. The three main evaluation rounds can be seen as quality gates for the evolving idea which gets more and more precise and realistic with each step.

FLEXINET provides methods and tools for each step of this process. They are either implemented in the software platform or available as functional prototypes and templates.

2.2.2 Step 0: Preparation

As prerequisite for the process, companies should identify and somehow formalize the internal and external influencing and limiting factors for their company's business. This is necessary because the new idea, business scenario, decision problem or question that is to be evaluated needs to be assessed against some existing knowledge about the company's objectives and relevant environment.

Three prominent groups of these limiting factors are (1), Strategic objectives of the company and information on the existing business setup (for example existing production facilities etc.), (2) ,Internal business policies and business rules,, and (3), External rules like regulations and compliance guidelines. It is recommended that these factors should be available in some central rule repository that can be queried by end users which will facilitate the evaluation steps for a particular idea/question that are following later. In FLEXINET, these factors are documented in the knowledge base (see WP3, D3.3 and D 3.5). Otherwise, one would have to identify all these influencing factors on a case-by-case basis.

2.2.3 Steps 1 and 2: Starting point and Evaluation 1

Step 1:

Step 1 is the starting point where a new idea, question, scenario or decision problem enters the evaluation process. Ideas can come from any innovative organizational member, for example engineers, business decision makers or software developers, or even from external sources like customers or business partners.For this reason, hese ideas or scenarios can be quite diverse. They can focus on strategic aspects like the launch of a completely new product-service solution, siting questions of the GPN, the introduction of new product feature or on more tactical aspects, for example regarding the optimal sourcing of a particular material. We assume that the process and its methods and tools can help various members of the organization during the different design and evaluation steps. Especially for more complex ideas / questions, it is likely that more than one person or role will go through the process.

At the beginning, the initial idea/question can be documented in a simple free text form which allows the innovator or decision maker to freely express her thoughts. FLEXINET's Idea Manager facilitates the collection and sharing of new ideas/questions with all the potentially interested stakeholders within (or even outside) the organization. It is advantageous to document the ideas even at this stage so that it is easier to know at later stages which ideas were present at the beginning.

Step 2:

Step 2 is a first informal feasibility evaluation ("**Evaluation 1**") for the new idea by interested stakeholders or peers of the innovator/decision maker.

This could mean that for a specified period others can see and comment on the idea (cf. FLEXINET's Idea Manager)[1]. The goal is to determine quickly and un-bureaucratically if a new idea should be further assessed and evaluated at all (i.e., if the idea is "valid").

Evaluation 1 would for example reveal if the idea/problem

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[1] This does not necessarily have to be realized by a software solution, but would also work in an "offline" fashion, for example by regular department meetings that allow an exchange between colleagues.

- was solved / tried out / done already somewhere in the organization;
- violates common sense or obvious rules.

If this initial "**go/no go" decision** is positive, the idea/problem will enter the more formal evaluation steps. If not, the idea could be sent back for revision or be abandoned.

2.2.4 Steps 3 and 4: Business model component specification and Evaluation 2

If an idea has successfully passed the first "go/no go" evaluation, the next step is to sketch the business model that could follow from it. This step is critical to **determine the scope** of the idea/question/scenario under consideration. We suggest using the Business Model (BM) Canvas structure to determine which areas (or components) of the business are affected by the new idea/question/scenario and which are not. Furthermore, this step specifies the general BM objectives for these areas.

FLEXINET offers the **Business Model Accelerator** (with Objective Driver Indicator Modeller) for this step and also simple **BM Canvas templates** which were developed and explained in D4.2 (Ch. 4.2). To illustrate the logic of this step, we will repeat the templates here again, using the numbering of the reference process.

Step 3.1: Firstly, the decision maker selects which components of the BM are affected. The simple template or checklist shown in Figure 2-4 supports this step. The idea is to highlight early in the process which component of the BM needs to be designed and analysed for this particular idea or question. This firstly, prevents wasting resources on areas that are not affected and secondly, helps identifying which people in the organization would need to be informed or could contribute to the further design and analysis.

Step 3.1: 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 (Step 3.2)
	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 2-4: Checklist for Step 3.1 to identify relevant Business Model components

Step 3.2: Secondly, those BM components that were selected from 3.1 should be specified in more detail to prepare the following evaluations.

The innovator or decision maker could use a morphological box as the one in Figure 2-5 to indicate which business model elements are envisioned for this idea/question/scenario. Besides choosing from these basic element categories, the decision maker provides at least one or two sentences of further explanation for these elements.

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 resulting overview constitutes the **business model objectives** of the idea/question/scenario.

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 2-5: Basic morphological box for Step 3.2 with business model design choices to indicate BM objectives for those components that were identified in Step 3.1

Furthermore, FLEXINET offers a method to identify and document risks at this point in the process, enabling documentation of historical incidents, identification of risk factors and risk scenarios, and serving as additional input for the approach in Step 4.

Step 4:

Based on the business-model level specification of the idea/question/scenario from Step 3.2 and the business rules that were documented beforehand (Step 0), the innovator or decision maker can now make an **educated feasibility evaluation ("Evaluation 2"**). This means querying key words from the specified idea against existing business rules and limiting factors.

This evaluation shows if the business model in its current state **violates** any internal or external business policies which would render any further analysis unnecessary. In FLEXINET, this evaluation is implemented with the **Strategic Business Model Evaluator** and the **Technology Effect Analyser** and also utilises the Knowledge Base and ontology and the additional risk documentation. For example, these checks show if a new component idea is **feasible** with the given suppliers or if the idea (on a larger scope) violates important internal or external limiting factors of the business (which were collected in Step 0).

This evaluation should be seen as an iterative process – if some of the planned elements of the business model scenario violate any of the rules, the decision maker (or the design team or the project management team) could go back and revise the idea until no rules are violated any more. The result of this evaluation is a "**go/no go decision**" which states whether the idea/business model scenario should be further considered[2].

2.2.5 Steps 5, 6 and 7: Business model and GPN design, tactical modelling

The previous design and evaluation steps ensured that the new idea (which has by now become a BM scenario) does not violate any basic rules of the business. The innovator or decision maker is now interested in creating more detailed designs of the business and the GPN, and in exploring and analysing the consequences of different possible designs. Steps 5 to 7 support this goal.

Depending on the type of scenario and on the perspective of the innovator or decision maker, FLEXINET offers different tools and methods for these steps. Figure 2-6 repeats this extract of the reference process.

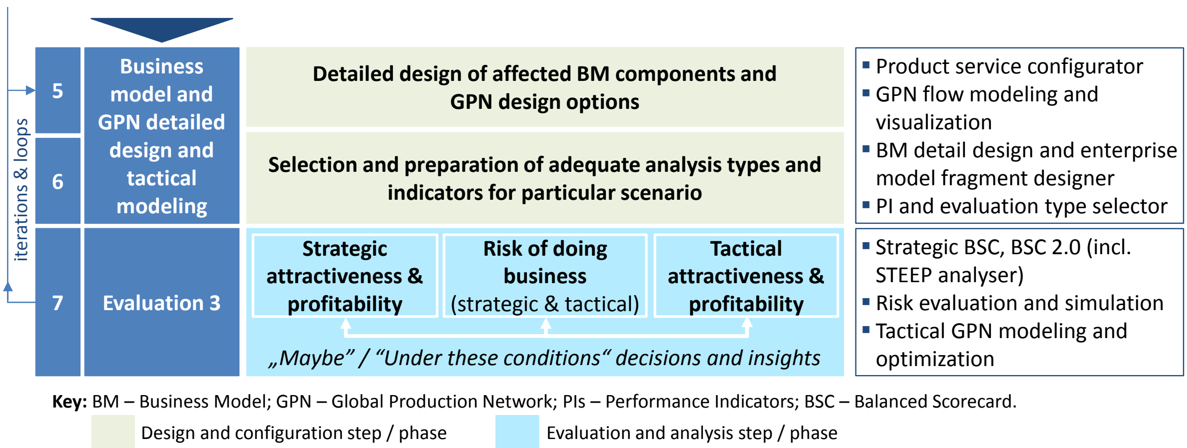

Figure 2-6: Extract of reference process for Steps 5, 6 and 7

Step 5:

For the more detailed **design** of the business of Step 5, innovators and decision makers can for example use FLEXINET's **Product Service Configurator** or the **GPN Flow Modelling and**

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[2] It should be mentioned here that although the „funnel-like" approach of Steps 3.1 and 3.2 was necessary to derived the business model objectives to be as precise as possible, Evaluation 2 should test these objectives against the ***full*** set of business rules and strategic objectives available (and not for example disregard rules related to certain markets if the "customer segment" BM component was unaffected by the idea). Otherwise, it could happen that cross-relations are not captured like the effects of a new ingredient for an existing market (resulting in a "false positive" result of the evaluation).

Visualization tool. Moreover, more business model fragments can be designed. These tools help to design the business model and the GPN and to visualize the outcomes. To prevent superfluous model complexity and effort at this step, users should consider the pre-selection of BM components and objectives from Steps 3.1 and 3.2.

Step 6:

Step 6 helps the innovator or decision maker to choose a method or tool for the next evaluation. As has been mentioned before, the reference process works for strategic and tactical levels of planning or decision making. The execution and in particular the selection of the "right" evaluation method however, depends on the perspective of the decision maker and the nature of the question or scenario to be solved. D 4.2 already included a first decision tree for the choice of evaluation methods (especially for those with BM focus) which is now extended (see Figure 2-7).

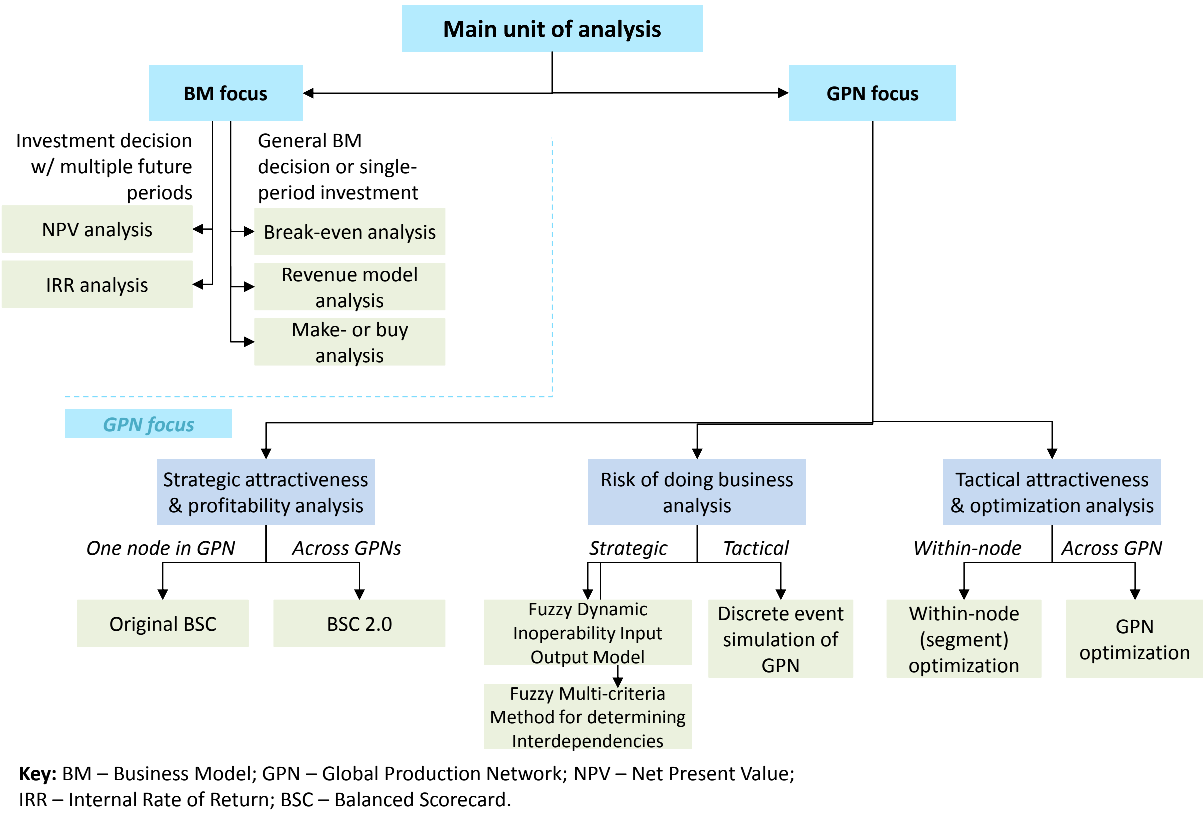


Figure 2-7: Simple decision tree for the selection of analysis and evaluation methods for Evaluation 3

Note on strategic vs. tactical perspectives

Besides the distinction into BM-level of analysis and GPN-level of analysis, we also distinguish between strategic and tactical levels of planning and decision making. As has been argued in earlier deliverables, WP 2 focuses more on the strategic level of GPN planning, whereas WP 4 focuses more on the tactical level of planning. This means that out of the coverage of the planning and evaluation of GPNs in the final deliverables in WP 2 and WP 4:

- D 2.4 provides a strategic perspective via the assessment and evaluation of general strategic attractiveness and risk factors e.g., Should I do this or do that? Where to place my sites? (described in the original BSC and BSC 2.0, and here in D2.4). D 2.4 also documents risk analyses that relate to strategic questions.
- D 4.3 will provide a tactical perspective, i.e., *assuming* this GPN configuration, how should I best operate it given the goals from my business model? (see Ch. 3 in D4.3) . Risk analyses that relate to tactical questions will also be described in D4.3.

Figure 2-8 below summarises these perspectives.

Level of Planning		**Planning topics and typical questions**	**Time Horizon**	**Coverage in FXNT**
Strategic level	**Business model and strategy development**	▪ Business model: which product and service portfolio, which customer segments, which core activities, main partners, etc. ▪ Competitive priorities for product/service portfolio and/or per product line: cost, quality, timeliness, agility priorities	Long-term (years)	WP 2
	Strategic planning	▪ High-level GPN planning: How to set up the GPN? Which sites in which markets? Which configuration is feasible (economically and risk-wise attractive) for the given BM goals?		
Tactical level	**Tactical planning**	▪ For the planned GPN: How much to produce where? How to optimize the given GPN by costs/prices, quality, time?	Medium-term (<year, months)	WP 4
Opera-tional level	**Operational planning**	▪ How to produce / source / sell in the individual sites? Operational shifts, sourcing and delivery scheduling, staffing, etc.	Short- to medium-term (weeks – months)	/

Figure 2-8: Summary of levels of business planning and their coverage in FLEXINET

Step 7:

The innovator or decision maker then performs one or more of the analyses that fit the question or scenario at hand (**"Evaluation 3"**).

The complexity of the scenario at hand may require that **multiple methods are combined or are used iteratively**. Furthermore, insights from the tactical level may influence strategic decisions. For example, consider the case where a cost-wise optimization of a GPN segment (a tactical method, see bottom right of Figure 2-7) shows that the site that was chosen from a strategic perspective (bottom left of Figure 2-7) is a bad choice when it comes to tactical planning. In this case, the GPN site could be disregarded and the strategic analysis should be repeated before another tactical optimization takes place. This iterative manner of the different evaluation types is highlighted by the white horizontal arrows at the bottom of Figure 2-6.

As most of the evaluations are future-oriented (meaning that performance and risk parameters have to be forecasted), the results of Evaluation 3 in Step 7 are usually not a clear-cut "go / no go decision" likethe previous one that was based on business rules. Instead, this evaluation results in insights regarding the attractiveness and profitability of a certain scenario **given** certain risk conditions and other underlying assumptions. Analysing the sensitivity of the result to the assumed underlying parameters can further contribute to an informed decision.

3 Extended "Balanced Scorecard 2.0" method including risk

3.1 Extension of the existing Balanced Scorecard Method or calculation model for the evaluation of GPNs

3.1.1 Rationale behind the extended "BSC 2.0"

In the last two deliverables, D2.2 and D2.3, we developed a Balanced Scorecard (BSC) to assess the strategic feasibility and attractiveness of different sites (or nodes) in a global production network. The BSC considered several cost and risk indicators that could be aggregated to derive a total site score. In the extended version (see D2.3) the model also included a fuzzy evaluation logic that allowed decision makers to indicate minimum, likely and maximum scores for the different indicators to derive a final score.

One limitation of the calculation logic and selection of indicators in this original BSC isthat it only applies to a particular type of strategic decision problem. As was illustrated with the calculation examples in D2.2 and D2.3, the practical questions that can be solved with **the original BSC** resemble the following ones:

- "Should we base a new plant in Spain or in Poland?" *or*
- "Should we source a particular component from a supplier in Asia instead of in America?"

This type of strategic decision problem compares the strategic attractiveness and feasibility of two possible plant locations in a GPN with each other. It therefore focuses on **one segment** of the GPN and evaluates **different design options for this segment** (of the same node type). Node types describe the function that a particular site or factory fulfils in the entire production network. In line with established terminology from Supply Chain Management, one can for example distinguish R&D nodes, Sourcing nodes, Make/Production nodes, Delivery nodes Selling nodes and Market-type nodes in the GPN. The upper half of Figure 3-1 shows an example of the decision question type of the original BSC.

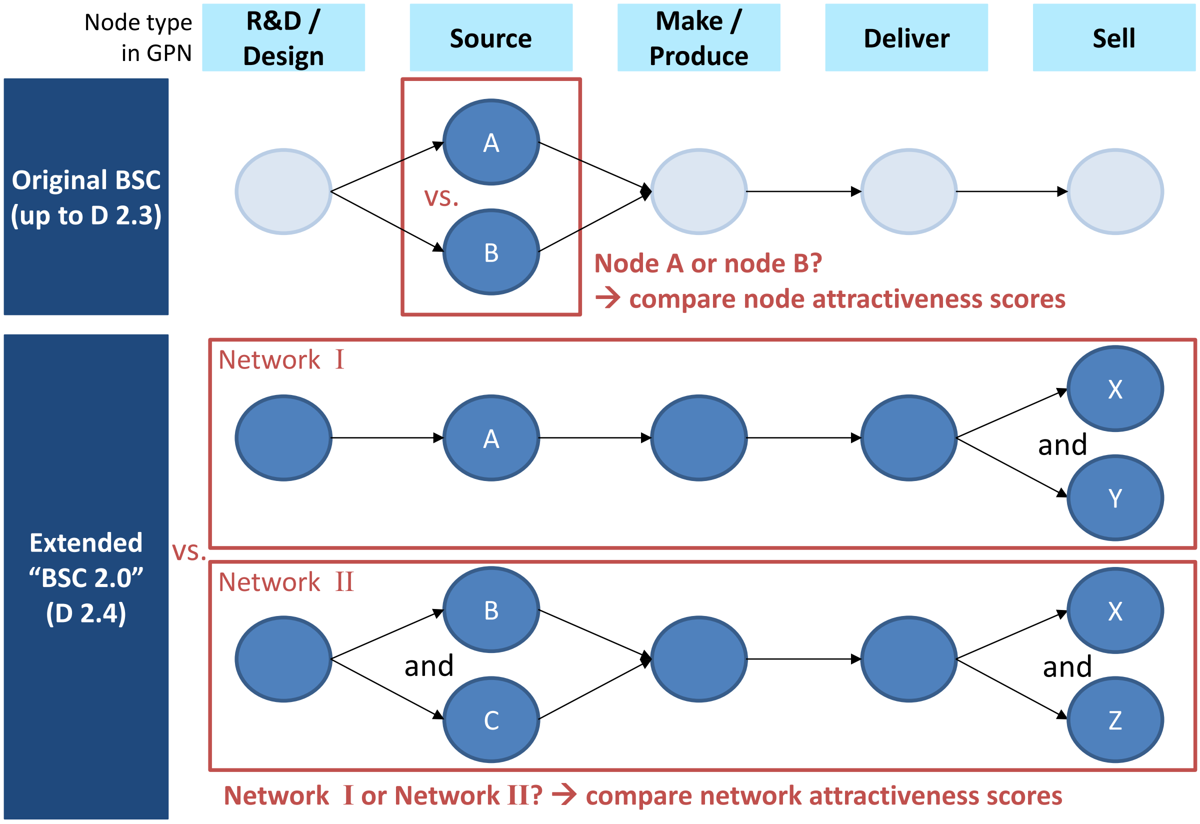


Figure 3-1: Comparison of the types of scenarios or decision questions that can be evaluated with the original BSC (D2.2 & D2.3) and the BSC 2.0 (D2.4)

Decision makers in realistic GPNs also face other questions that cannot easily be answered with the original BSC. For example, they may be interested in questions like

- "Does my entire GPN become more or less attractive (/risky) if I source from two suppliers in China and America instead of just one in China?"
- "Should we sell our products in two new markets and also introduce a new production plant in Europe or not?"

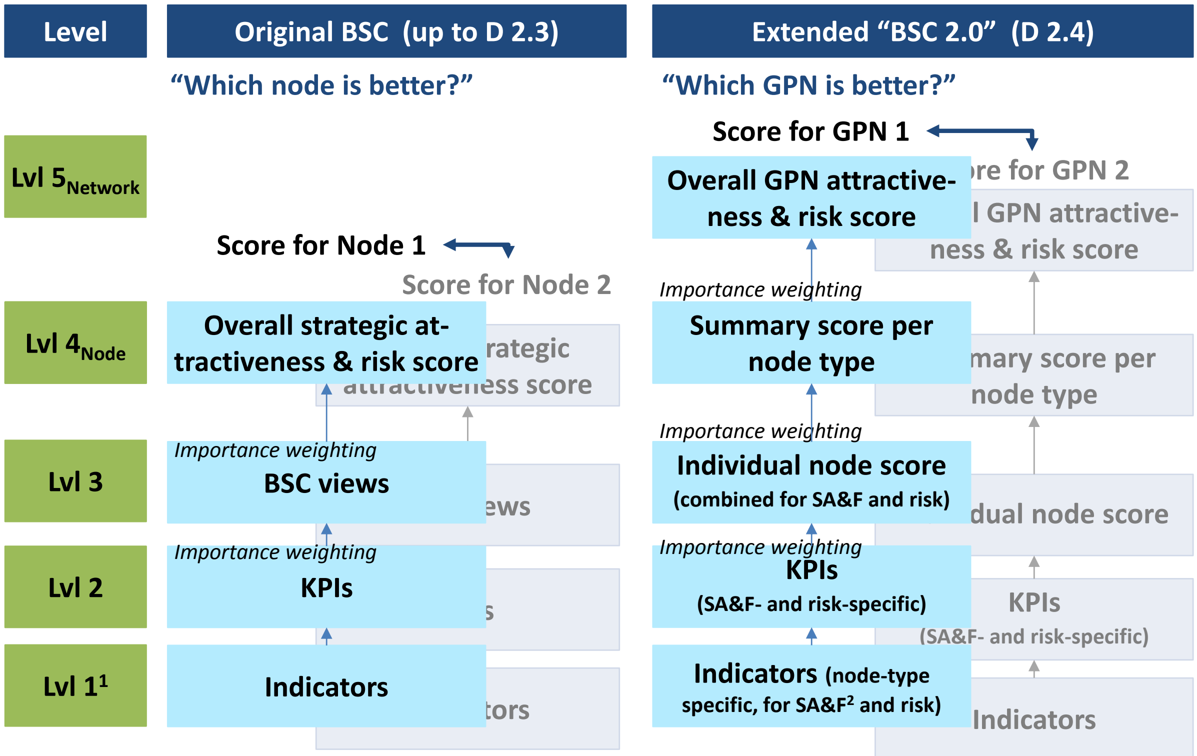
The bottom half of Figure 3-1Figure 3-1 illustrates this type of question. In order to answer these more realistic (and more complex) questions, a decision maker needs to be able to evaluate the implications of choices regarding *one* segment of the network (like the choice of one production plant location over another) for the network as a whole.

Since we wanted to keep the general idea of assessing the attractiveness of GPNs with the help of (mostly externally available) indicators, we now **assign the basic indicators to** the different **node types**. We thereby broaden the perspective to more than one segment in the GPN. For example, some strategic attractiveness and risk indicators are more relevant for Sourcing nodes than for Production nodes. An indicator like "raw material price level" is relevant for a Sourcing node, but not necessarily for the Delivery market. Likewise, an indicator like "level of tertiary education in the workforce" may be relevant for R&D nodes and Production nodes, but not for Sourcing nodes (providing the raw material or sourced assembly does not require advanced pre-processing). Obviously, a similar reasoning applies to the risk indicators.

The original BSC did not capture this kind of logic. Instead, it only classified the indicators by different "views" (financial, growth, etc.), whose indicators were essentially the same across node types. It did therefore not consider if indicators were more relevant for some node types than for others which limits its usefulness for more complex questions that need to take the entire GPN into account. Section 3.2 gives more examples on these node type-specific indicators and explains the general new calculation logic.

3.2 Description of the BSC 2.0 model

The BSC 2.0 model basically adds a new fifth KPI aggregation level for the GPN above the node level. Figure 3-2 shows the general new aggregation logic compared to the original BSC which stopped at the node level.



Notes:
[1] Please note that the level count is reversed compared to the original BSC counting.
[2] SA&F = Strategic attractiveness and feasibility

Figure 3-2: Comparison of aggregation logic of the two BSCs.

Besides a risk score, we call the other input score for the final GPN score a "strategic attractiveness and feasibility" (SA&F) score, because it measures the strategic attractiveness of a GPN segment by considering selected the externally available indicators of the macro- and micro-economic environment (STEEP factors) for the GPN segments' markets (i.e. countries).

3.2.1 Indicator assignment

The indicators in the BSC 2.0 cover several criteria relevant for the ease of doing business and the businesses expected profitability in the target markets of a GPN. They consider aspects like the expected cost attractiveness, the revenue potential (in the case of sales markets or "Selling nodes") and the existence or absence of barriers and risks in these markets.

Earlier deliverables and the STEEP analyser already provide lists of indicators that are relevant for doing business in the context of GPNs. For the BSC 2.0, we chose from these existing STEEP factors and added a few new ones and assigned them to the node types (see Table 3-1). Some of the indicators of course apply to all node types.

Table 3-1: List of indicators assigned to GPN node types

Node type Indicator type	R&D node	Source node	Production node	Delivery node	Market / Selling node
SA&F indicators (valid across node types)	- CPIA transparency, accountability, and corruption rating - Ease of doing business index - Economic development status - Existing strength of market presence / prior market experience[1]				
SA&F indicators (node type-specific)	- Literacy rate - High-technology exports - Labour force with higher education - R&D expenditure - General labour cost level[2] - Broadband internet coverage	- High-technology exports - Cost to export - General raw material or assembly cost level - General raw material or assembly quality level - Goods and services export volume - Quality level of trade and transport-related infrastructure - Cost of transportation - Supplier power	- High-technology exports - Labour force with higher education - General labour cost level[2] - Power / electricity costs - Cost to import - Cost to export - General raw material or assembly cost level - Goods and services export volume - Goods and services import volume - Quality level of trade and transport-related infrastructure	- Cost to import - Goods and services import volume - Quality level of trade and transport-related infrastructure - Cost of transportation / delivery	- GDP - Annual GDP growth - Household discretionary income[3] / purchasing power - Consumer price index - Relevant market size[4] - Expected market growth[4] - Broadband internet coverage - Level of competition[4]
Risk indicators (valid across node types)	- Foreign direct investment barriers - Low level of cultural proximity/understanding - Risk of political unrest - Risk of inflation / inflation rates				
Risk indicators (node type-	- Risk of IP theft / lack of foreign IP protection - Data security	- Risk of supplier insolvency - Degree of supplier	- Risk of IP theft / lack of foreign IP protection - Data security level	- Risk of cargo theft / loss - Risk of transportation provider	- Data security level - Degree of product/service s-relevant

specific)	level	reliability - Risk of cargo theft / loss - Risk of transportation provider insolvency	- Risk of machine failure / production material quality	insolvency	regulation - Risk of customer insolvency / payment defaults

Notes

SA&F - strategic attractiveness and feasibility

1 exception because no external indicator. Relevant because prior business experience in a market generally means easier market entry and operations.

2 relevant for all sites/nodes with own employees.

3 relevant for B2C business.

4 exception because most likely not available as external indicator. Needs expert guess/assessment, e.g. with small (low) – middle – large (high) assessments.

We then selected a sub-set of indicators from this list for the actual BSC 2.0 Excel model (see Section 3.3). This prevents excessive model complexity and limits the effort needed for applying the model to real-world examples.

Criteria for indicator selection were

- Relevance for several facets of strategic attractiveness and feasibility of doing business at a certain node type
- Understandability
- Availability of data from reliable external sources (e.g. World Bank)

3.2.2 Aggregation and calculation logic

The aggregation and calculation logic of the BSC 2.0 is shown in Figure 3-3. The input for the BSC 2.0 model is of course a possible GPN configuration that is the outcome of a business model design. This means that the decision maker firstly needs to determine in which countries (we currently still assume the country as the level of analysis for all the indicators instead of possible sub-entities like states) he would like to place which node type or function of the GPN. He then populates the model with data from external sources and makes a few personal assessments to receive a final overall score for the GPN attractiveness and risk which can be compared to the scores of other GPN configurations.

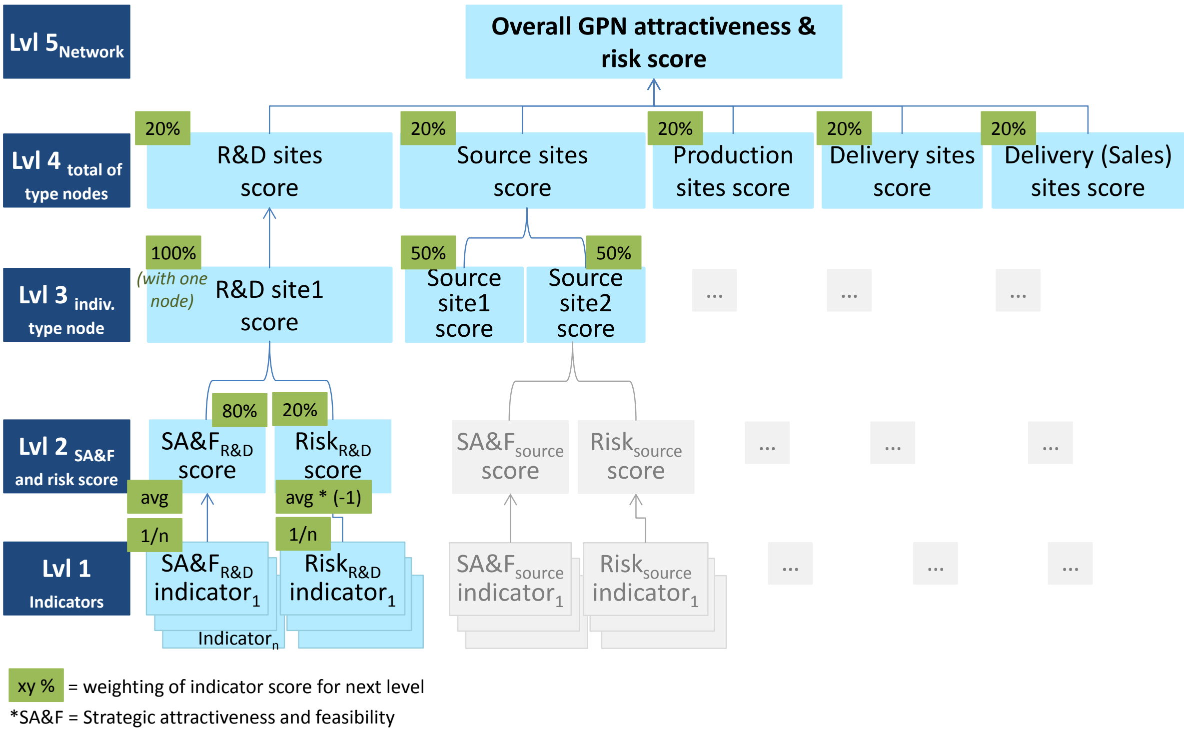


Figure 3-3: Aggregation and calculation logic of the BSC 2.0

The following list explains the five levels of the adapted model and how to derive the overall GPN score:

- **Level 1** contains the individual indicator scores by their applicability to node types (R&D, Sourcing, Production, etc.) as explained in Table 3-1.
- **Level 2** calculates two separate summary scores for all SA&F scores and all risk scores, respectively, of an individual node. In the standard model, we assume equal weightings for each indicator. This means that in the case of 10 SA&F indicators assigned to R&D nodes, each has a weighting of 0.1 or 10% for the Level 2 $SA\&F_{R\&D}$ score.
- **Level 3** combines the SA&F scores and risk scores from Level 2 into a single summary score for each node. In the standard model, we assume that the positive SA&F KPI counts for 80% of the total site score and risk is valued as negative value and counts for 20%. Other weightings are of course possible (also see the discussion section below).
- **Level 4** serves as an additional summary layer for GPNs with multiple nodes from the same type. If there is just one node per type (e.g. only one R&D node in the network), as in Figure 3-3, the Level 4 score is equal to (100% of) the Level 3 score. On the other hand, the GPN in Figure 3-3 features two Source nodes, whose individual summary scores from Level 3 go into the total node type summary score of Level 4 with equal shares of 50% each. As our GPN model has five node types in total (R&D, Sourcing, Production, Delivery, and Sell/Market), we end up with five summary scores at Level 4.
- **Level 5** then calculates a single attractiveness & risk score for the total GPN based on the five node type-specific scores from Level 4. We assume equal weightings of each node type.

3.2.3 Discussion of assumptions, limitations, and possible model variants

3.2.3.1 Assumptions

The individual indicator scores have to be normalised or normalized to a 0-100 or 0-1000 point score range at Level 1 because they are all measured in different units and can have completely different value ranges. This normalisation makes these different indicator values comparable at Level 1 so that the further aggregation works. The same idea was already implemented in the original BSC from D2.3.

As was mentioned earlier, we assume that most of the values are available from external data sources so they can be propagated automatically into the model as soon as the decision maker has determined the configuration of the GPN and the different countries involved. Some of the indicator scores, however, (especially in the "Market / Selling" type of node) need to be judged by the business decision maker or domain expert beforehand. Similarly, the risk scores sometimes need expert judgement.

3.2.3.2 Limitations

This standard version of the BSC 2.0 model contains some simplifying assumptions which limits its usefulness for more complex real-world scenarios. The main limitations are discussed below.

Firstly, not all indicators are equally important for different types of business models and strategic priorities. For the sake of simplification, however, we assume equal weightings of these indicators in the standard model. In a real-world application, decision makers would "switch on" or "switch off" indicators for certain scenarios, or assign different importance weightings to them. In order to capture this in a tool one could (1), either implement some automated business logic based on choices of the business model and its competitive priorities (e.g. in the sense of "if the value proposition is to provide a *premium* product experience, *increase* the importance weighting of the quality-related indicators and *decrease* the weighting of the cost-related indicators". The opposite would hold true for a budget or low-cost value proposition. Alternatively (2), the decision maker could adapt the indicator weightings manually for each new evaluation.

Secondly, the magnitude or direction of the indicator scores is not always unambiguously "good" or "bad". For example, a low GDP growth rate could generally be seen as a sign for a less attractive market. However, if this low growth rate comes from a high base-line GDP level and comes together with a high expected market share it may not necessarily be a reason against a particular market. Our model of course cannot guarantee that these dependencies are entirely balanced or fit for any business but we try to alleviate the importance of individual scores by proposing a multi-criteria model in the first place. This model can potentially be extended by any number of indicators that fit the individual business.

Thirdly, the model considers the scores of the individual node types on their own without explicitly capturing dependencies or interactions between them which exist in complex GPNs. For example, the total transportation costs of the entire GPN do not only depend on the transportation costs within the individual countries (coming from import/export tariffs or from road tolls), which we do currently capture with our indicators, but also from the proximity of the sites to each other. A network that is entirely based in Europe (or North America) would obviously have lower transportation costs (which should be reflected in the total network score) than a network with sites in both Europe and China.

Although we chose against implementing these kind of dependencies, there are various options how to do so. For example, one could add an additional Level 4 score besides the five individual node type scores which could potentially capture something like "network coherence". Such an indicator could add some bonus score for GPNs that are mostly located in in the same market (such as the EU or the NAFTA). Alternatively, this could be added as another risk indicator for the entire network.

Fourthly, we simplify by basing the indicator scores at Level 1 on country-level data. In reality, different regions within the same country are more or less economically strong and therefore more or less attractive for the GPN. For example, the North of Italy will most likely achieve a higher SA&F score for most businesses than will Sicily. However, the general validity of the indicators does not change even if a more granular perspective is taken. As long as the user of the BSC 2.0 is able to collect meaningful data for these indicators for sub-country units like states or regions, he or she can still apply the model in the same way as for the country-level perspective.

Despite these limitations, we are confident that the general decision support for judging strategic attractiveness and risk of a GPN in a relatively fast and simple way can be of great value to decision makers in the early planning stages of a GPN. It is clear that the tool needs to be applied with caution and reason, but it can definitely give a first indication of the attractiveness of different GPNs. It could, for example, help to compare a set of different GPNs to rule out totally infeasible ones early on, so that no further efforts are wasted on these GPNs. Furthermore, it could help to develop a feeling for GPNs with comparable attractiveness and feasibility scores which would then stimulate a more detailed analysis of other qualitative and quantitative factors of the remaining choices.

3.2.3.3 Further variants of the model

Some possible variants or extensions of the model were already discussed in the limitations section. In addition, other variants are imaginable depending on the use case and the preferences of the decision maker. Regarding risk, for example, we chose to combine SA&F and risk scores into a single score quite early on the node level (at Level 3). This means that for the higher aggregations the decision maker can no longer directly see at which risk the attractiveness score of the entire model comes. Our idea was to have a single, expressive final score at the top level, but one could also argue in favour of separate SA&F and risk scores at GPN level. If SA&F and risk scores were given separately, the decision maker had the transparency of the "upside" value of one GPN (expressed as SA&F score) and the "downside" value of the GPN (expressed as the risk score) at the same glance.

In any case, it would be reasonable to provide the decision maker with the option to set his risk tolerance to "low", "medium", or "high" to show changes in the final score(s). This risk tolerance profile would then impact the importance of risk for the Level 3 aggregation which is set to 20% (as a negative score) in the default model.

Finally, decision makers could of course always add additional indicators that are important to their own business. Alternatively, one could imagine several pre-configured sets of indicators for the different nodes that are suitable for different industries, e.g. a "B2B and production industry" indicator set or a "B2C and consumer industry" indicator set.

3.3 Application with a practical example

3.3.1 Preparation

We chose two example production networks to demonstrate the BSC 2.0 with the Excel-based calculation model. These two alternative production networks could, for example, be considered by a company like INDESIT. The two assumed production networks are shown in Figure 3-4.

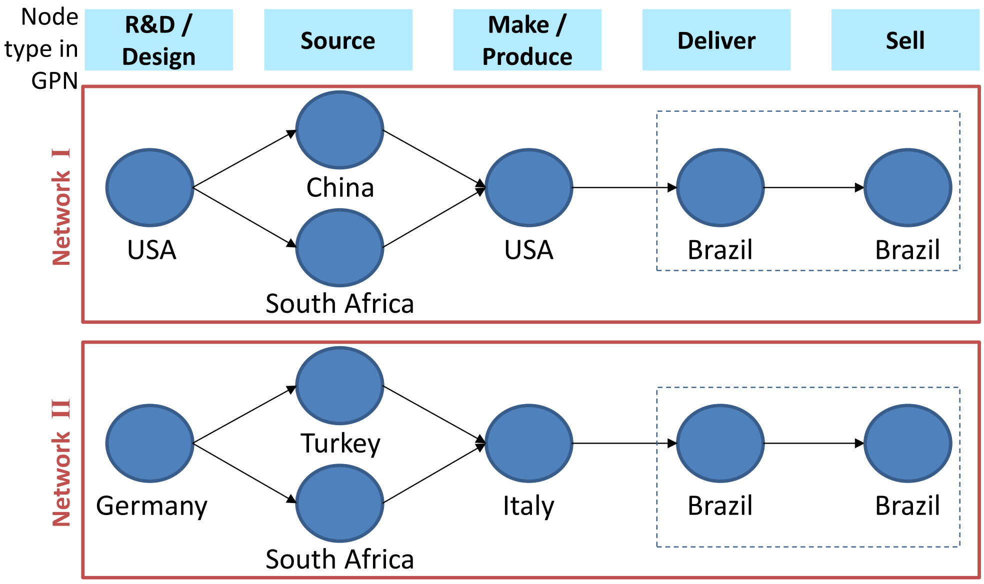


Figure 3-4: Two alternative GPNs for the demonstration of the BSC 2.0

Network I assumes the following node locations: an R&D node in the USA, two different Source nodes in China and South Africa, the Production node again in the USA and the Sales market (equalling the Delivery market) in Brazil.

Network II, on the other hand, assumes a slightly more Europe-based GPN layout with the R&D node in Germany, sourcing markets in Turkey and South Africa, the Production node in Italy and again Sales (and Delivery) markets in Brazil.

The calculation logic in the Excel model was set up as explained in Section **Error! Reference source not found.**. We selected a subset of indicators per Node type because of data availability and indicator expressiveness. Of course the same indicators were used for both Networks. For this example, we chose between 8 and 10 indicators for the Strategic Attractiveness and Feasibility (SA&F) scores and between 3 and 4 risk indicators. Most of the country values for these indicators were taken from the World Bank databank.

Some of the indicators that were chosen for the model, for example, "existing market presence" or "market attractiveness", need to be estimated by experts. To keep things simple for users of the tool we suggest using a five-point Likert scale for these indicators. For the example at hand, we assumed the following values for "existing market presence" for the markets under question of the two Networks as set out in Table 3-2:

Table 3-2: List of indicators assigned to GPN node types

Country	0 Very low --	1 Low -	2 Medium o	3 High +	4 Very high ++
USA					x
Europe (Germany, Italy)				x	
China		x			
South Africa		x			
Brazil			x		
Turkey			x		

3.3.2 Results

After filling in all LEVEL 1 indicator scores, the model calculates the total Network LEVEL 5 scores. In the example at hand, Network 1 achieves a network score of ***37.2*** points and Network 2 of ***32.4*** points. Based on the given indicators and the current data, the GPN configuration of Network 1 can therefore be seen as more strategically attractive and feasible than Network 2.

The top aggregation levels are shown in Figure 3-5 and in Figure 3-6, respectively. Figure 3-7 also shows the example LEVEL 1 indicator results.

Level 5 Network 1 final score	37.2	(final score)										
	R&D: USA		Source: CHINA & SOUTH AMERICA				Production / Make: USA		Delivery: BRAZIL		Sales / Market: BRAZIL	
weighting 4 -> 5	*0.2*		*0.2*				*0.2*		*0.2*		*0.2*	
Level 4 Node Summary score per node	42.8		37.2				47.3		29.9		28.8	
weighting 3 -> 4 (either 0.5 or 1 - depen	*1*		*0.5*				*1*		*1*		*1*	
Level 3 Individual node type scores	R&D_1		Source_1		Source_2		P/M_1		Deliv_1		Sales_1	
	42.8		42.0		32.4		47.3		29.9		28.8	
weighting 2 -> 3	*weight SA&F*	*weight Risk*										
	0.8	-0.2										
Level 2 SA&F and risk scores	R&D_1 SA&F	R&D_1 Risk	S_1 SA&F	S_1 Risk	S_2 SA&F	S_2 Risk	P/M_1 SA&F	P/M_1 Risk	D_1 SA&F	D_1 Risk	Sales_1 SA&	Sales_1 Risk
	74.3	83.3	62.5	39.9	53.2	51.1	76.4	68.7	48.4	44.1	47.0	44.1

Figure 3-5: Network 1 total score

Level 5 Network 2 final score	32.4	(final score)										
	R&D: GERMANY		Source: TURKEY & SOUTH AMERICA				Production / Make: ITALY		Delivery: BRAZIL		Sales / Market: BRAZIL	
weighting 4 -> 5	*0.2*		*0.2*				*0.2*		*0.2*		*0.2*	
Level 4 Node Summary score per node	35.4		36.4				31.7		29.9		28.8	
weighting 3 -> 4 (either 0.5 or 1 - depen	*1*		*0.5*				*1*		*1*		*1*	
Level 3 Individual node type scores	R&D_1		Source_1		Source_2		P/M_1		Deliv_1		Sales_1	
	35.4		40.4		32.4		31.7		29.9		28.8	
weighting 2 -> 3	*weight SA&F*	*weight Risk*										
	0.8	-0.2										
Level 2 SA&F and risk scores	R&D_1 SA&F	R&D_1 Risk	S_1 SA&F	S_1 Risk	S_2 SA&F	S_2 Risk	P/M_1 SA&F	P/M_1 Risk	D_1 SA&F	D_1 Risk	Sales_1 SA&	Sales_1 Risk
	66.4	88.4	56.6	24.5	53.2	51.1	58.5	75.5	48.4	44.1	47.0	44.1

Figure 3-6: Network 2 total score

Level 1 Indicators								
R&D Node, GERMANY						input value	standardized value	
	weightings	indicator content	Source	range (worst)	range (best)	score	(points of 100)	weighted value
R&D SA&F Indicator 1	0.13	CPIA transparency	http://data.world	5	0	2.0	60.0	7.8
R&D SA&F Indicator 2	0.13	Ease of doing business	http://data.world	189	0	15.0	92.1	11.5
R&D SA&F Indicator 3	0.13	Economic development status	http://data.world	0	100	100.0	100.0	12.5
R&D SA&F Indicator 4	0.13	Existing market presence strength	***own estimate***	0	4	3.0	75.0	9.4
R&D SA&F Indicator 5	0.13	Level of higher education	http://data.world	100	0	13.2	86.8	10.9
R&D SA&F Indicator 6	0.13	Number of high-technology exports	http://data.world	0	100	16.1	16.1	2.0
R&D SA&F Indicator 7	0.13	Innovation / research excellence cluster	http://data.world	0	100	2.9	2.9	0.4
R&D SA&F Indicator 8	0.13	General labour cost level, growth	http://stats.oecd	10	0	0.2	98.0	12.7
							R&D, SA&F total	**66.4**
R&D Risk Indicator 1	0.33	Risk of political and social unrest	http://info.worldl	0	100	79.1	79.1	26.1
R&D Risk Indicator 2	0.33	Risk of IP theft / lack of IP protection	http://www.wipo	99	0	5.0	94.9	31.3
R&D Risk Indicator 3	0.33	level of inflation	http://data.world	10	0	0.9	91.0	30.0
							R&D, Risk total	**88.4**
	count SA&F indicators: 8 (thus weighting 0.13)							
	count risk indicators: 3 (thus weighting 0.33)							

Figure 3-7: Example result for R&D node, Network 2

By checking the lower levels of the summary pictures, the decision maker can track down the reasons for the different scores. For example, the comparison of the lines "Level 2 SA&F and risk scores" in Figure 3-5 and Figure 3-6 shows that the SA&F scores for the R&D nodes differ (higher attractiveness for USA than for Germany) which had an impact on the total score.

Based on these results, the decision maker could now either chose the Network 1 GPN configuration or even do further analyses with another network configuration to check if he finds a network that performs better than Network 1.

4 Risk and uncertainty analysis

In D2.1 and D2.3 we introduced the foundations for the documentation, identification, assessment, analysis and evaluation of risks in global production networks (GPNs) by proposing the following methods: Fuzzy Dynamic Inoperability Input Output Model, Fuzzy Multi-criteria Method for Interdependency Analysis and relevant methods for the documentation of incident, risk factors and risk scenarios. In this chapter we will focus on the management of uncertainties in the methods proposed in WP2, particularly the strategic risk evaluation approach for GPNs and how that can help reduce efforts necessary for data collection. Also, we will revisit the strategic risk evaluation methods briefly and look into how they can contribute to the overall process of risk management within the manufacturing companies. Finally, some future directions for using big data in risk identification and assessment are explored.

4.1 Epistemic Uncertainty Modelling using Fuzzy Arithmetic

The literature differentiates between two types of uncertainties (Kiureghian and Ditlevsen 2009): (1) Aleatory uncertainties, uncertainties that exist due to the probabilistic and stochastic nature of events and cannot be reduced until the event takes place; (2) Epistemic uncertainties, these are due to the incompleteness of our knowledge and they can be reduced by gaining new knowledge. Aleatory uncertainties are usually represented by probabilistic distribution functions while epistemic uncertainties can be represented in different forms, such as intervals or fuzzy numbers. Epistemic uncertainty can also incorporate unknown data about probabilistic events; they are especially useful when statistical data is not available to determine probabilistic distribution functions. In this work package we are mainly concerned about epistemic uncertainty, how they can affect our analysis, and how we can use them to minimise the data collection efforts.

Fuzzy set theory is an extension of the classic set theory that permits partial membership of elements to the sets and represents a partial or incomplete degree of belief that the element belongs to the set. In classic sets, an element either belongs to the set or not (0 or 1) and this theory is based on the assumption that we can have precise knowledge about such membership. On the other hand, in fuzzy sets, it is possible to have a degree of membership which allows for epistemic uncertainties to be modelled. Fuzzy numbers are defined on the domain of real numbers and can be utilised to represent uncertain quantities. Calculations with fuzzy numbers can be carried out using fuzzy arithmetic.

Different forms of fuzzy numbers are introduced in the literature (Pedrycz and Gomide 1998). Just as a reminder from D2.3, a triangular fuzzy number (TFN) is one of the most popular and simple forms of fuzzy numbers that is identified by a 3-tuple. The 3-tuple represents the modal or peak value of the number which corresponds to the most likely real number that belongs to the fuzzy number. It also has a component for the lowest possible value and a highest possible value. This is usually represented as $\tilde{X} = (X_1, X_2, X_3)$ where $X_1 \leq X_2 \leq X_3$, X_1 is the lowest possible value, X_2 is the most likely value and X_3 is the highest possible value. X_2 has a membership degree of 1 while X_1 and X_3 have a membership degree of 0. The membership of all other values is determined by a linear function.

Fuzzy numbers can be represented in the LR form. This representation uses two functions to define the left hand side $L_{\tilde{X}}(\alpha)$ and right hand side $R_{\tilde{X}}(\alpha)$ of the membership function, respectively. These functions determine the lowest and highest possible points in the fuzzy number that have the membership value α. For a triangular fuzzy number, these functions will be as follows:

$$L_{\tilde{X}}(\alpha) = \alpha X_2 + (1 - \alpha) X_1$$

$$R_{\tilde{X}}(\alpha) = \alpha X_2 + (1 - \alpha) X_3$$

4.2 Utilising Experts' Judgements specified by Linguistic Values

Whenever statistical and quantitative knowledge about the parameters of the models is not readily available we can utilise experts' judgements and estimates. This is of particular importance when we are dealing with strategic decisions and the parameters of the potential partners and the network hhas not been measured yet, and data collection would be either impossible, costly or very difficult. In these scenarios, experts can use their experience and knowledge to provide an estimate of the parameters using linguistic terms such as low, medium and high. Also, their confidence in the parameter value can be the basis to estimate the uncertainty in the parameter value. Additionally, it is further possible to use their track-record, seniority and reliability to fine-tune the uncertainty measure on a personal basis. However, the latter suggestion is not investigated further in the FLEXINET project.

Using linguistic values is a convenient way to ask for experts' opinion as it is understandable and familiar to human participants. Different approaches to defining linguistic terms have been proposed however, we use a straightforward, easy to use list of these terms, including very low, low, fairly low, medium, fairly high, high and very high. These can be used in relevant risk methods as well as the balanced scorecard method and wherever experts' opinion needs to be incorporated. The experts are asked to provide their estimate of the value of the parameter as well as their confidence in the provided estimate value. Using these two linguistic values, we can now create a triangular fuzzy number for the parameter.

For normalised parameter, in the range of 0 to 1, we use the mapping to the numbers provided in Table 4-1.

Table 4-1: Mapping between linguistic terms and quantitative values

Linguistic Term	Value
Very Low	0
Low	0.167
Fairly Low	0.333
Medium	0.5
Fairly High	0.667
High	0.833

Very High	1

Then, the following formula is used to determine the triangular fuzzy numbers:

$$\tilde{p} = \left(max(v - (1 - c), 0), v_{r,l}, min(v + (1 - c), 1)\right)$$

where $\tilde{p}$ is the triangular fuzzy number modelling the parameter, v is the estimated value of the expert of the parameter (quantified through Table 4-1) and c is the quantified value of the confidence of the expert in the estimate. Since the value is assumed to be normalised (range of 0 to 1), we need to make sure that we do not violate the extremes which is done by using the min and max functions.

In Figure 4-1 the membership functions of different linguistic terms, assuming that the confidence of the expert in the values is 'high', are illustrated.

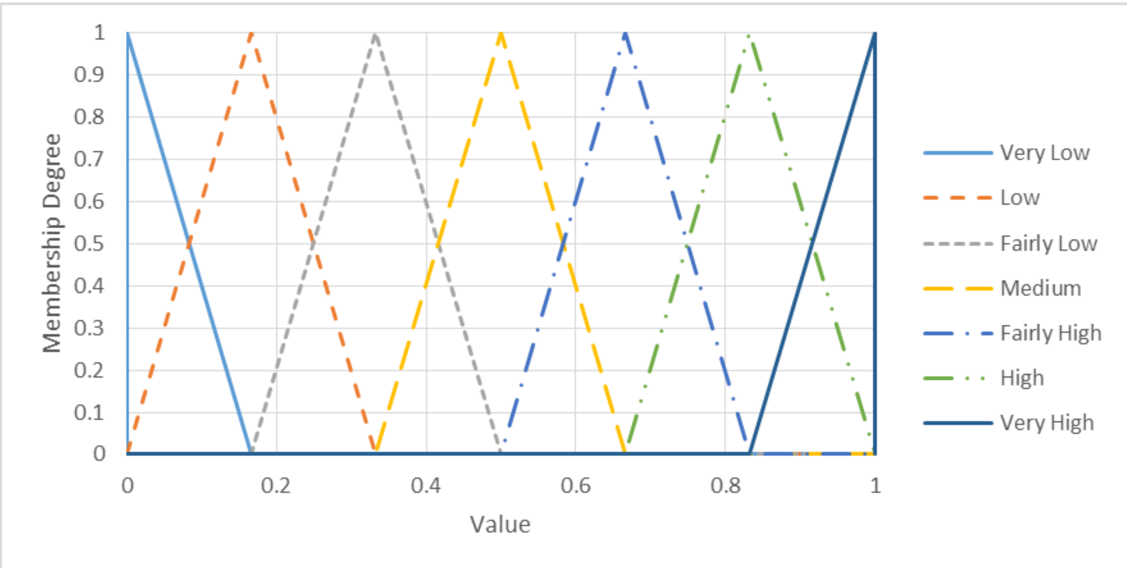


Figure 4-1: Example of membership functions of linguistic terms for High confidence

4.3 Uncertainty Measures

The purpose of an uncertainty measure is to determine the level of uncertainty in a fuzzy set or a fuzzy number as a numerical value. A number of measures has been proposed in the literature for measuring uncertainty in fuzzy sets and numbers. Here we will introduce a few of the most used measures including fuzziness (Delgado, Vila, and Voxman 1998a), specificity (Yager 2008) and vagueness (Delgado, Vila, and Voxman 1998b).

Fuzziness considers the difference between the membership function of a fuzzy set and its complement set (Delgado, Vila, and Voxman 1998a). The membership function of the complement fuzzy set is typically determined as 1-membership function of the original fuzzy set. The further the original and the complement fuzzy sets are apart in value the crispier the set is considered to be. For crisp sets, as the membership degree can be either 0 or 1, the difference is always 1. While for sets that contain 'fuzziness' the difference can be less than one For example, when the membership degree is 0.5 the difference will be 0. The following formulation can be used for determining fuzziness for a fuzzy number:

$$F(X) = \int_0^{\frac{1}{2}} [R_X(\alpha) - L_X(\alpha)]d\alpha + \int_{\frac{1}{2}}^{1} [L_X(\alpha) - R_X(\alpha)]d\alpha$$

where $F(X)$ is the fuzziness of fuzzy number X, and, $R_X(\alpha)$ and $L_X(\alpha)$ are the right-side and left-side of the α-cut of X, respectively.

An α-cut of a fuzzy number is a crisp set of values that have a membership degree of at least α to the fuzzy number. As the membership function of a fuzzy number is convex, any α-cut of a fuzzy number is an interval and can be identified by its lower and upper points.

Specificity is a width-based measure of uncertainty that looks into how wide the membership function of the fuzzy set is compared to the support of the fuzzy set (Yager 2008). The support of a fuzzy set is the crisp set of domain values provided that the membership of the fuzzy set to those values is not zero. Specificity will equally consider all degrees of membership and look at the length of the α-cut interval at this level. Please note that, unlike fuzziness, specificity has an inverse relationship with the uncertainty of the set. We can also use the following formula for the specificity:

$$SP(X) = 1 - \frac{1}{R_X(0) - L_X(0)} \int_0^1 [R_X(\alpha) - L_X(\alpha)]d\alpha$$

where $SP(X)$ is its specificity of the fuzzy number.

The ambiguity measures the divergence of a fuzzy number from its peak value (Delgado, Vila, and Voxman 1998b). It is similar with the specificity in that it takes the α-cut intervals into account. However, it will put more emphasis on the α-cut interval with the higher α value. Also, its value is absolute and is not normalised with respect to the support of the fuzzy sets. Ambiguity can be measured using the following formula:

$$A(X) = \int_0^1 \alpha[R_X(\alpha) - L_X(\alpha)]d\alpha$$

where $A(X)$ is the ambiguity of fuzzy number X.

We often use triangular fuzzy numbers for input parameters. The uncertainty measures a triangular fuzzy number $\tilde{X} = (X_1, X_2, X_3)$ and can be calculated as follows:

$$F(X) = \int_0^{\frac{1}{2}} [(\alpha X_2 + (1-\alpha)X_3) - (\alpha X_2 + (1-\alpha)X_1)]d\alpha + \int_{\frac{1}{2}}^{1} [(\alpha X_2 + (1-\alpha)X_1) - (\alpha X_2 + (1-\alpha)X_3)]d\alpha$$

$$= \int_0^{\frac{1}{2}} [(1-\alpha)X_3 - (1-\alpha)X_1]d\alpha + \int_{\frac{1}{2}}^{1} [(1-\alpha)X_1 - (1-\alpha)X_3]d\alpha = \frac{1}{4}[X_3 - X_1]$$

$$SP(X) = 1 - \frac{1}{X_3 - X_1} \int_0^1 [(\alpha X_2 + (1-\alpha)X_3) - (\alpha X_2 + (1-\alpha)X_1)]d\alpha$$

$$= 1 - \frac{1}{X_3 - X_1} \int_0^1 [(1-\alpha)X_3 - (1-\alpha)X_1]d\alpha = \frac{1}{2}$$

$$A(X) = \int_0^1 \alpha[(\alpha X_2 + (1-\alpha)X_3) - (\alpha X_2 + (1-\alpha)X_1)]d\alpha = \int_0^1 \alpha[(1-\alpha)X_3 - (1-\alpha)X_1]d\alpha$$

$$= [X_3 - X_1]\int_0^1 (\alpha - \alpha^2)d\alpha = [X_3 - X_1]\left(\frac{1}{2} - \frac{1}{3}\right) = \frac{1}{6}[X_3 - X_1]$$

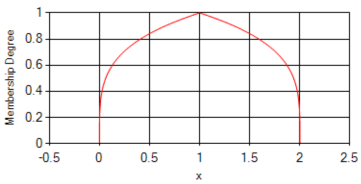
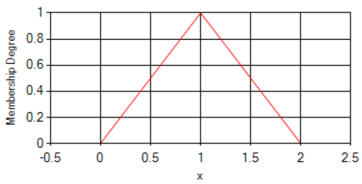
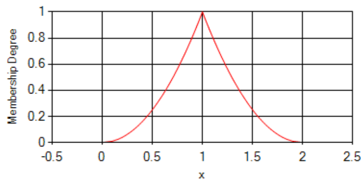
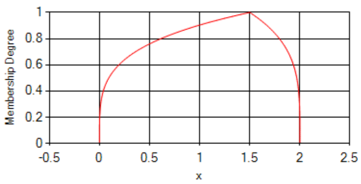
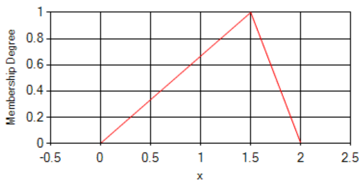
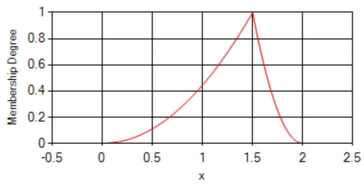
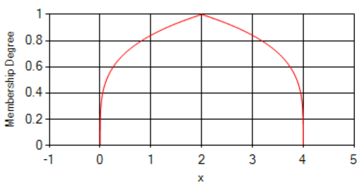
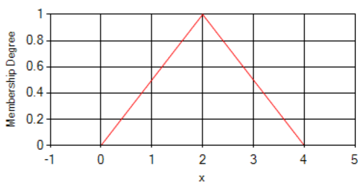
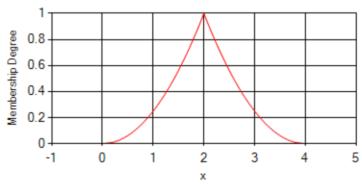
While fuzziness and ambiguity of a TFN only differ in a multiplier the specificity, interestingly, stays constant at 0.5 for any TFN.

For general LR fuzzy numbers we can approximate the uncertainty measures by considering a discrete set of α-cuts. The integration can be approximated using the trapezoidal integration rule on $N+1$ equally spaced α-cuts. As an example, the ambiguity is determined as follows:

$$A(X) \cong \frac{1}{2N}\sum_{k=0}^{N-1}\left(\frac{k}{N}\left[R_X\left(\frac{k}{N}\right) - L_X\left(\frac{k}{N}\right)\right] + \frac{k+1}{N}\left[R_X\left(\frac{k+1}{N}\right) - L_X\left(\frac{k+1}{N}\right)\right]\right)$$

We have provided a few examples of fuzzy numbers with corresponding fuzzy measurements in Table 4-2 to illustrate the differences.

Table 4-2: A few examples of fuzzy numbers with uncertainty measurements

$\tilde{X} = [\alpha^4, 2-\alpha^4]$  A = 0.67, F = 0.38, SP = 0.20	$\tilde{X} = [\alpha, 2-\alpha]$  A = 0.33, F = 0.50, SP = 0.50	$\tilde{X} = [\sqrt{\alpha}, 2-\sqrt{\alpha}]$  A = 0.20, F = 0.39, SP = 0.67
$\tilde{X} = \left[\frac{3}{2}\alpha^4, 2-\frac{1}{2}\alpha^4\right]$  A = 0.67, F = 0.37, SP = 0.20	$\tilde{X} = \left[\frac{3}{2}\alpha, 2-\frac{1}{2}\alpha\right]$  A = 0.33, F = 0.50, SP = 0.50	$\tilde{X} = \left[\frac{3}{2}\sqrt{\alpha}, 2-\frac{1}{2}\sqrt{\alpha}\right]$  A = 0.20, F = 0.39, SP = 0.67
$\tilde{X} = [2\alpha^4, 4-2\alpha^4]$  A = 1.33, F = 0.75, SP = 0.20	$\tilde{X} = [2\alpha, 4-2\alpha]$  A = 0.67, F = 1.00, SP = 0.50	$\tilde{X} = [2\sqrt{\alpha}, 4-2\sqrt{\alpha}]$  A = 0.40, F = 0.78, SP = 0.67

Examining Table 4-2, one can see that the specificity does not differentiate between the numbers in the first and the third columns. However in the Flexinet context, intuitively we consider the numbers in the first column to have a higher uncertainty than the corresponding numbers in the third column. Also, the specificity of the fuzzy numbers in the first row are the same as the corresponding specificities of fuzzy numbers in the third row. However, as the support set of the fuzzy number is larger, we expect the uncertainty to have increased within it. Hence, we consider the ambiguity measure to be the most suitable option for measuring uncertainty of fuzzy numbers in the Flexinet context.

4.4 Strategic Risk Evaluation of Global Production Networks

FLEXINET project provides a strategic risk evaluation framework for GPNs that considers different aspects of risks and provides an evaluation of GPN configuration's risk. It can be used to make decisions about the involved parties in a GPN at the strategic level. Most of the elements of this approach have been introduced in D2.3. Hence here we will focus on an overview of the framework proposed, some brief reminders of the main methods and an overview of the application process.

4.4.1 Framework Overview

The objective of strategic risk evaluation of GPNs is to evaluate the impact of risks on alternative GPN configurations to be able to make informed decisions at the strategic levels. The risk factors that can potentially affect the production firm are defined as a set of risk scenarios. The analysis is done using all risk scenarios imposed on each of the GPN configurations and the results obtained for all risk scenarios for a GPN configuration are aggregated to determine the risk indicator for the GPN configuration including average inoperability and expected loss of risk. Both of these aspects are supported by information about eco-systems as well as a generic risk catalogue (provided in D2.1), incident logs and the interdependency model.

The framework of this evaluation is shown in Figure 4-2.

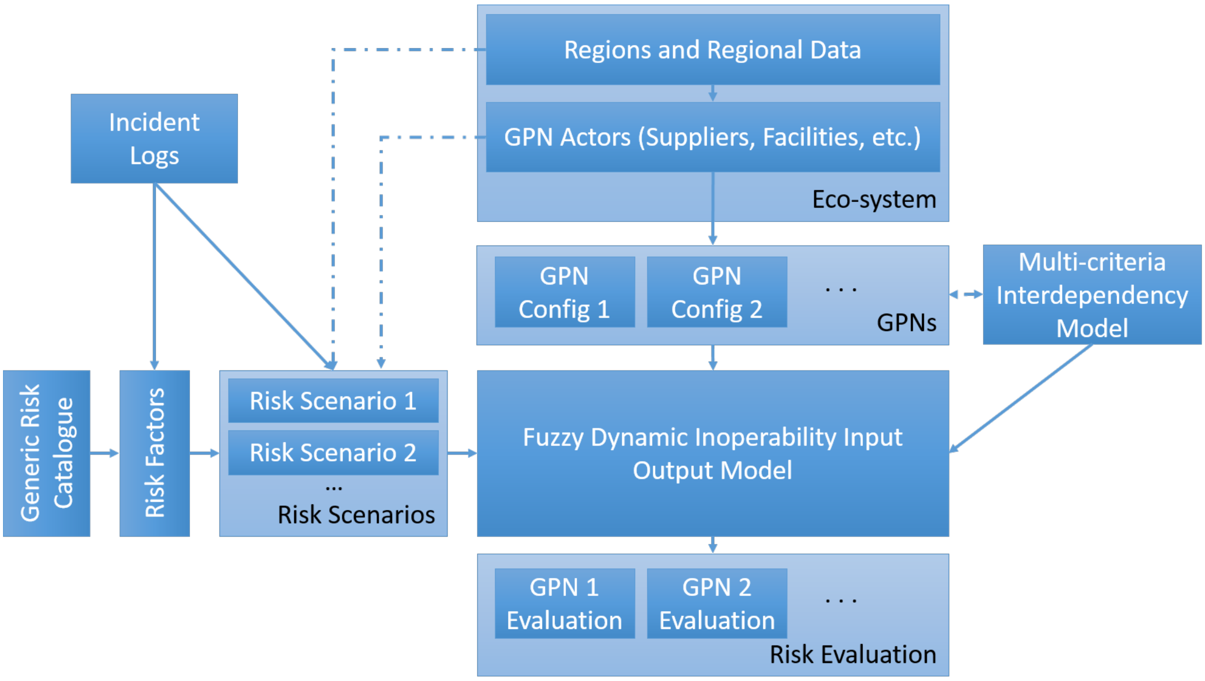


Figure 4-2: Overview of the strategic risk evaluation framework

For the purpose of the risk evaluation it is necessary to have the interdependency values of all the GPNs' nodes, perturbation impact and timings for all scenarios, the intended revenue of each node, resilience of the nodes to risk, regions and locations of each node within regions, and also likelihood of each scenario. Furthermore, the risk evaluation determines the inoperability value of nodes in each risk scenario as well as the expected loss of risk in all risk scenarios.

Risk scenarios that define the perturbation to the GPN are generated by the experts by considering information about risk factors and historical log of incidents as well as regional information from the eco-system. The historical log of incidents can help identify which types of risks affect the GPN (risk factors), what the typical impact of those risks are and also their duration and likelihood. The risk factors identification is aided by a generic risk catalogue for GPNs as well the information we have about the incidents.

GPN configurations are defined based on the eco-system data, which includes GPN actors' data (such as suppliers, production facilities, etc.), and regional data of various actors' locations. Also, the multi-criteria interdependency model is used to determine the strength of dependencies between GPN actors which was introduced in D2.3.

Individual risk scenarios define perturbations that affect parts of the eco-system (either actors or regions). Eco-system information is required to be able to generate risk scenarios. However, GPN configurations are defined independently so we can analyse the relevance of a risk scenario for a GPN configuration. It is quite possible that due to an actor not taking part in a particular GPN configuration, all risk scenarios for that actor to have no effect at all on that particular GPN configuration.

Most inputs and outputs of the framework, such as interdependencies, perturbation impact, intended revenue, resilience, likelihood, inoperability and loss of risk, are assumed to be uncertain, and are modelled using triangular fuzzy numbers as discussed. The analysis method, described in the following section, keeps track of the uncertainty which we will later analyse and use to improve speed and efficiency of data collection.

4.4.2 Fuzzy Dynamic Inoperability Input Output Model

The fuzzy dynamic inoperability input output model (FDIIM) has been introduced in D2.3 in detail. It determines the inoperability of individual nodes in a GPN by considering the initial perturbations as well as the propagation of the perturbations to the related nodes. The level of inoperability shows the deviation of the node operation from its intended operation level. Just as a reminder, the model can be formulated in a vector format as follows:

$$\tilde{q}(t+1) = \tilde{K}\widetilde{A^*}\tilde{q}(t) + \tilde{K}\widetilde{c^*}(t) + \left(I - \tilde{K}\right)\tilde{q}(t)$$

where $\tilde{q}(t+1)$ is the vector of fuzzy inoperability of nodes at time period $t+1$, $\tilde{K}$ is the fuzzy diagonal matrix of resilience, $\widetilde{A^*}$ is the fuzzy interdependency matrix and $\widetilde{c^*}(t)$ is the fuzzy perturbation of nodes in the risk scenario under consideration at time period t. Resilience represents the speed that the node is able to recover from disruptions.

Also, the expected financial loss of risk for all risk scenarios is calculated as follows:

$$\tilde{Q} = \widetilde{x^T}\sum_{s=1}^{S}\widetilde{p_s}\sum_{t=1}^{T}\widetilde{q_s}(t)$$

where $\tilde{Q}$ is the fuzzy loss of risk in the GPN configuration, $\widetilde{x^T}$ is the transposed vector of the fuzzy intended revenues of the nodes, S is the number of risk scenarios, $\widetilde{p_s}$ is the fuzzy likelihood of risk scenario s, T is the number of time periods in the time horizon and $\widetilde{q_s}(t)$ is the fuzzy inoperability vector of nodes in scenario s at time period t.

4.4.3 Process Overview

The strategic risk evaluation approach described is being supported by the FLEXINET software services and applications that can facilitate the data collection, analysis and evaluation for the end-users. An overview of the application process model for this risk evaluation approach is presented in Figure 4-3.

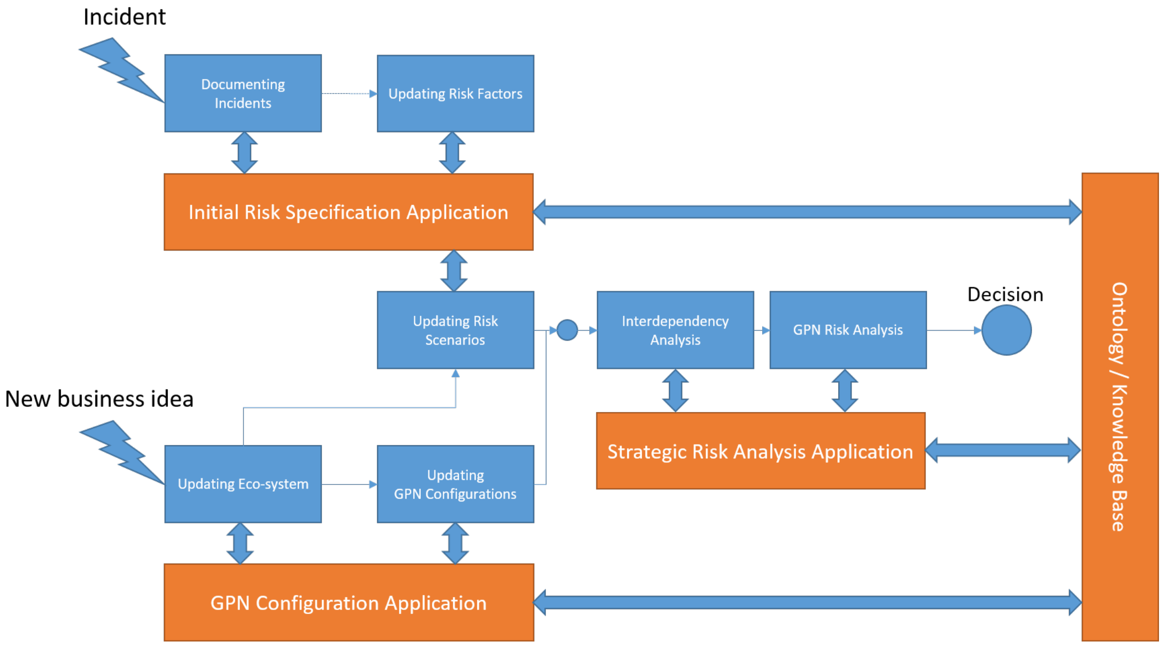


Figure 4-3: Application process model for the strategic risk evaluation approach

The process can be triggered in two ways: (1) an incident or disruptive event happens which should be documented and recorded into the system by using the Initial Risk Analysis and Specification Application. Once recorded, it might also be necessary to update the list of risk factors and scenarios. (2) a new business idea is raised and needs to be analysed through the risk evaluation approach to facilitate the decision making. For this purpose, it is necessary to update eco-system information first, making sure that all involved actors and regions and their relevant information are included. Then, in parallel, the risk scenario and GPN configurations are created and updated, as necessary, using information about eco-system and risk factors. Then, using the information collected, the interdependency analysis is carried out and the financial loss of risk is calculated using the Strategic Risk Analysis Application.

4.5 Analysis of Sensitivity

To measure the impact of different parameters on the results obtained by the proposed methods, we can apply sensitivity analysis. We are particularly interested in sensitivity analysis with regard to two aspects of the input parameters: (1), their modal (peak) values, and (2), the uncertainty in the parameter. The former shows the impact of the parameter itself on the result obtained as well as the impact it can have on the uncertainty of the result. The latter helps us understand how much uncertainty is contributed by each individual parameter to the uncertainty of results. As we will discuss later, this is useful in determining an efficient path for data collection.

These two types of sensitivity analysis are described below. We will extensively investigate the results for the FDIIM method in this deliverable. For this method, the expected financial loss of risk is considered to be the output that the sensitivity analysis is performed on. In these experiments, input parameters (such as interdependencies, resilience, intended revenue, impact and likelihood of risk scenario) to FDIIM are considered one at a time.

4.5.1 Measuring sensitivity to parameters

The sensitivity of the method's output to the individual parameter's modal value is considered. For this purpose, the input parameter's TFN is changed by multiplying its TFN parameters by 1 plus the percentage of change. For example, for 10% increase, we should multiply the TFN parameters by 1 + 0.10 = 1.10 or 1 – 0.1 = 0.9 for 10% decrease, as it is illustrated in Figure 4-4.

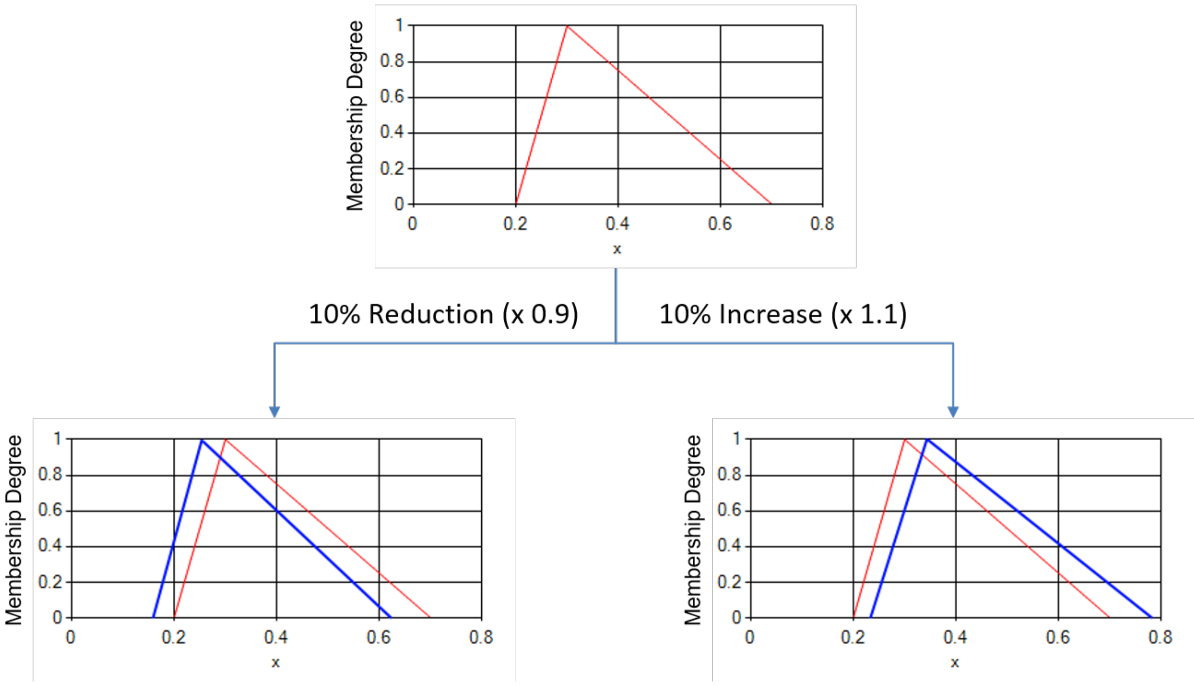


Figure 4-4: Examples of changing the modal value of a TFN by -10% and +10%

Once the parameter values are changed as described, we now need to determine how much the output value, and also the ambiguity of the output, would change as a result. The results are then analysed.

It is worth mentioning that by using the multiplication method described above the ambiguity of the parameter will also change by the same percentage. Assuming that the parameter is identified by a TFN ($\tilde{X}$), we can use the following lemma:

$$A(\lambda\tilde{X}) = A(\lambda(X_1, X_2, X_3)) = A((\lambda X_1, \lambda X_2, \lambda X_3)) = \frac{1}{6}\lambda(X_3 - X_1) = \lambda A(\tilde{X})$$

Hence, by multiplying the TFN by λ we have also multiplied its ambiguity by the same percentage. This side-effect should be noted when interpreting the results of the sensitivity analysis.

Furthermore, we may sometimes need to consider a maximum limit for parameter values. For example, in the FDIIM method, parameters such as interdependencies, resilience and impacts, have a maximum limit of 1. As the changes in the sensitivity analysis can invalidate values of these parameters, it is necessary to check the resulting value and if the increase leads to numbers higher than 1 they should be replaced with 1.

4.5.2 Measuring sensitivity to uncertainty in parameters

The sensitivity of the ambiguity level of the method's output to the ambiguity of input parameters is considered. We want to measure how much each of the model's parameters contribute to the ambiguity of the output. For this purpose, we reduce the ambiguity of the input parameters by various percentages, e.g. 100%, 50% and 10%, and measure the ambiguity of the method's output. This is then compared with the original ambiguity level to measure the relative impact on the ambiguity.

In order to reduce the ambiguity of the parameter value, we will move the lowest point and the highest point of the TFN nearer to the modal value, by the degree specified, i.e. $\tilde{Y} = (Y_1, Y_2, Y_3) = ((1-\lambda)X_1 + \lambda X_2, X_2, (1-\lambda)X_3 + \lambda X_2)$. This is illustrated in Figure 4-5.

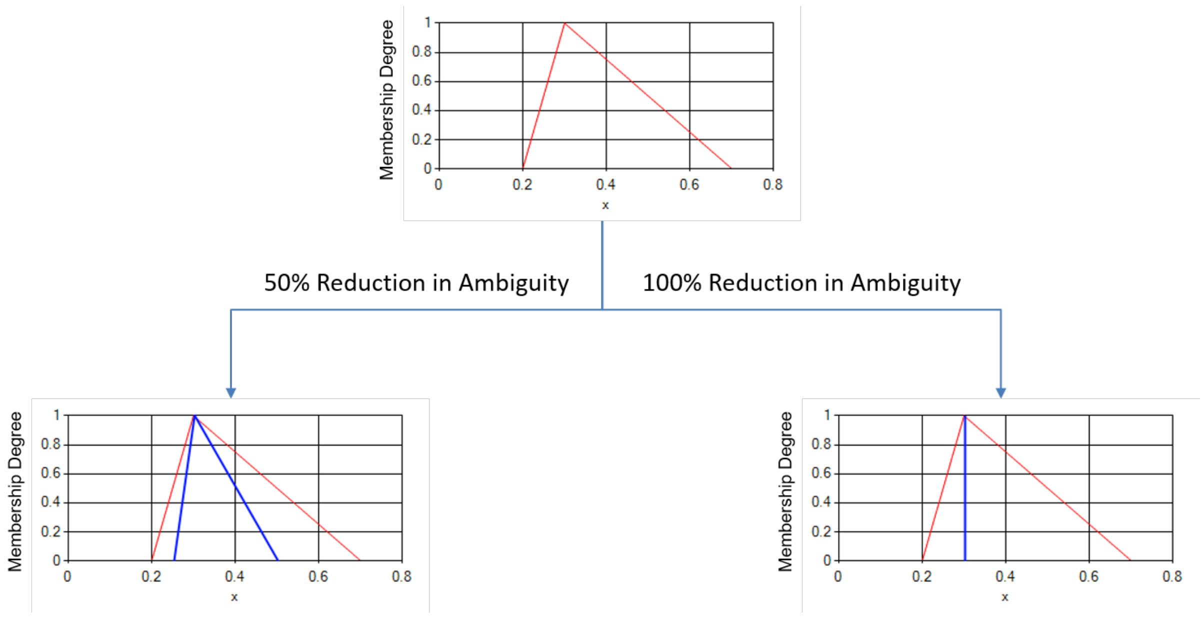


Figure 4-5- Examples of changing the ambiguity of a TFN by -50% and -100%

The following lemma shows that the ambiguity is modified as is expected. Let the initial parameter be $\tilde{X} = (X_1, X_2, X_3)$. By moving its boundaries to $\tilde{Y}$, the ambiguity of the fuzzy number $\tilde{Y}$ is:

$$A(\tilde{Y}) = A\big(((1-\lambda)X_1 + \lambda X_2, X_2, (1-\lambda)X_3 + \lambda X_2)\big) = \frac{1}{6}((1-\lambda)X_3 + \lambda X_2 - (1-\lambda)X_1 - \lambda X_2)$$

$$= \frac{1}{6}((1-\lambda)X_3 - (1-\lambda)X_1) = \frac{1}{6}(1-\lambda)(X_3 - X_1) = (1-\lambda)A(\tilde{X})$$

4.6 Evolution of Uncertainty

Uncertainty measurement can help us understand the reliability and accuracy of the information. However, in FLEXINET, in addition to this general benefit, we are aiming at utilising uncertainty measurement to guide and target data collection and focusing our efforts on the most important and influential parameters to avoid the unnecessary use of resources. . This could prove crucial as many of the network parameters are difficult and costly to measure and this approach could help eliminate or postpone the collection of precise data. An overview of the evolution of data collection in the GPN analysis is provided in Figure 4-6 . Figure 4.6 describes the steps which need to be made in order to use uncertainty measurement to reduce information collection efforts.

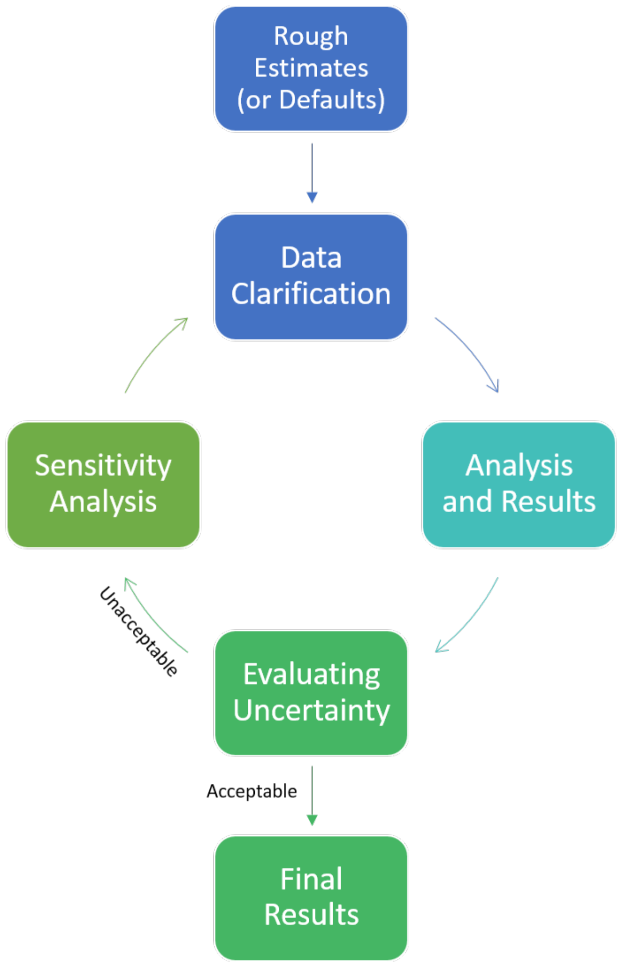


Figure 4-6: Overview of the evolution of uncertainty in the analysis

The process described in Figure 4-6 starts with a rough estimation of the required parameters, possibly provided by experts using linguistic terms, which can also be supplemented by default values, with maximum uncertainty, where even the expert's estimate is not readily available. In the next step, such information can be further enhanced by minimal data collection and clarification, where necessary, to have an initial draft of the parameter values. At this point it is now possible to carry out the analysis with the methods provided by FLEXINET (such as FDIIM) and retrieve the relevant results. The next step is to look at the results and evaluate the uncertainty within them and how much that uncertainty can influence the final decision. If the uncertainty is not high enough to be able to influence the outcome there is no need for further data clarification and the results could be considered as the final results.

However, if the decision cannot be made confidently, the uncertainty in the obtained results is unacceptable and further investigation is necessary. This is where we can use sensitivity analysis to see which parameters have the most influence in the results and the uncertainty of the results. Using sensitivity information it is possible to identify the most influential parameters on the uncertainty and target them for further data gathering efforts. Now the cycle can be repeated with the clarified parameters until an acceptable level of uncertainty in the results is achieved.

It is worth noting that 'data clarification' can also refer to refining and clarifying the data gathered through experts' opinion. For example, use of the knowledge of experts from different backgrounds and skillsets allows them to discuss the subject and form a consensus within a meeting. This makes it possible to reduce the uncertainty of such information.

4.7 Application of Big Data

The GDELT project (Leetaru and Schrodt 2013) is a big data initiative to collect information from globally published news articles in over 100 languages with the aim of identifying the events, locations, themes and emotions through the use of natural languages processing methods and sentiment analysis. This data collection effort considers all the locations world-wide and aggregates information about events in a near real-time database that is publicly available for download or can be queried directly using Google BigQuery platform.

As a possible extension of FLEXINET methods, we are proposing an application of this dataset to extract risk scenarios and also potentially to measure interdependencies among GPNs' actors. External risk factors, such as political and economic issues, can be readily extracted by looking at the relevant events in every country reported in the news. These events have been conveniently categorised with event type codes by the GDELT project. An example is provided in Figure 4-7 where the risk of armed conflict on a country level has been determined by looking into the number of significance of news articles in each country reporting an armed conflict and comparing it with the total number and impact of articles published in that country. In this way a normalised number of relevant reports is generated.

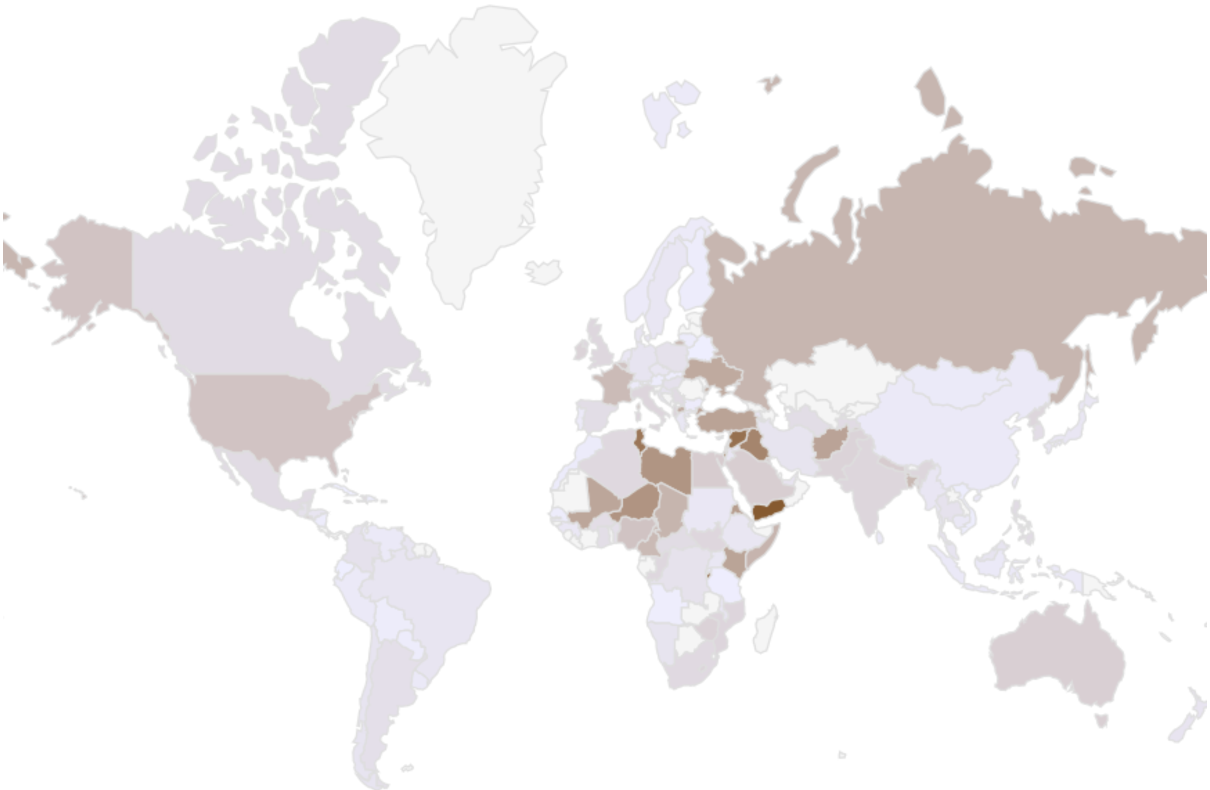


Figure 4-7: Risk of armed conflict measured by querying the GDELT dataset in Jan 2016

In this way it is possible to measure different political, economic, environmental and legal risks on a country level. Using this measurement the system can automatically identify the countries at risk (perhaps by using a pre-defined threshold) and create a risk scenario for each of those countries. The other parameters of the risk scenario, such as duration, likelihood, impact, can also be identified utilising the news data. However we believe that, while these automatically generated risk scenarios can facilitate data collection and improve user experience, it is still necessary for the experts to review them, adjust and fine-tune them as necessary through the facilities that are provided for the risk analysis in FLEXINET. In this way experts can incorporate their opinion about issues that might not have been captured by the news due to confidentiality, concerns about future events that have yet to happen and, more importantly, the company's view and attitude toward risks.

It is also possible to look into actor-specific risks, such as insolvency, which may have been reported in the news. For example, disagreements between companies can be reported in the news which, in combination with other relevant themes such as financial issues, can be used to estimate actor specific risks. However, there are data availability and also data quality issues that need to be considered and require further investigation.

Another area for future research would be to use the data to measure interdependencies among GPNs' actors. In the GDELT project, as part of the GDELT Global Knowledge Graph, the links between various entities in the news are captured. These links are also categorised into themes, such as financial transactions, agreements, etc. This could be used to estimate interdependencies between different companies. Again data availability and quality are among the outstanding concerns. An additional concern is that the interdependencies change in different GPN configurations due to potential links as opposed to current and actual ones. So experts' input into the analysis would still be necessary.

5 Application of the methods to the scenarios

The application of the methods within business model scenarios aims to express the use of the methods in terms of

- Assessing and quantifying the business model impact at company-level,
- Interrelations between the methods covering WP2 and WP4,
- How to use the methods,
- How evaluations are performed,
- How reliable the evaluation is.

The application will consider the methods, procedures and software applications proposed by FLEXINET. The focus of the scenarios is on business strategy, business modelling and tactical planning related to the strategy.

WP2 and WP4 are closely coupled because the creation of the strategy and its realisation has no fixed borderline. In WP4 we have business modelling which could be seen as a strategic task but in WP2 we have risk and BSC analyses of already defined GPNs which can be seen as a tactical planning approach. Therefore in the business model scenarios we will have both perspectives. Some aspects such as the management of ideas are provided by WP5 and will also be used here as a starting point. FLEXINET developed several end user scenarios and also a common demonstration scenario "buzz bikes". Furthermore, the exploitation results of FLEXINET could also be seen as a potential scenario. We selected one end user scenario "KSB" to show a potential industry case in order to demonstrate the application of the method. The scenarios will follow the process described in Chapter 2 Figure 2-3 which is an extension of the rough process described in D4.1.

5.1 Illustrative scenario

5.1.1 Introduction

As an illustration of the application of the method the KSB scenario, identified during the work in WP1 and further enriched in WP6 and WP7 has been used as shown in Figure 5-1:

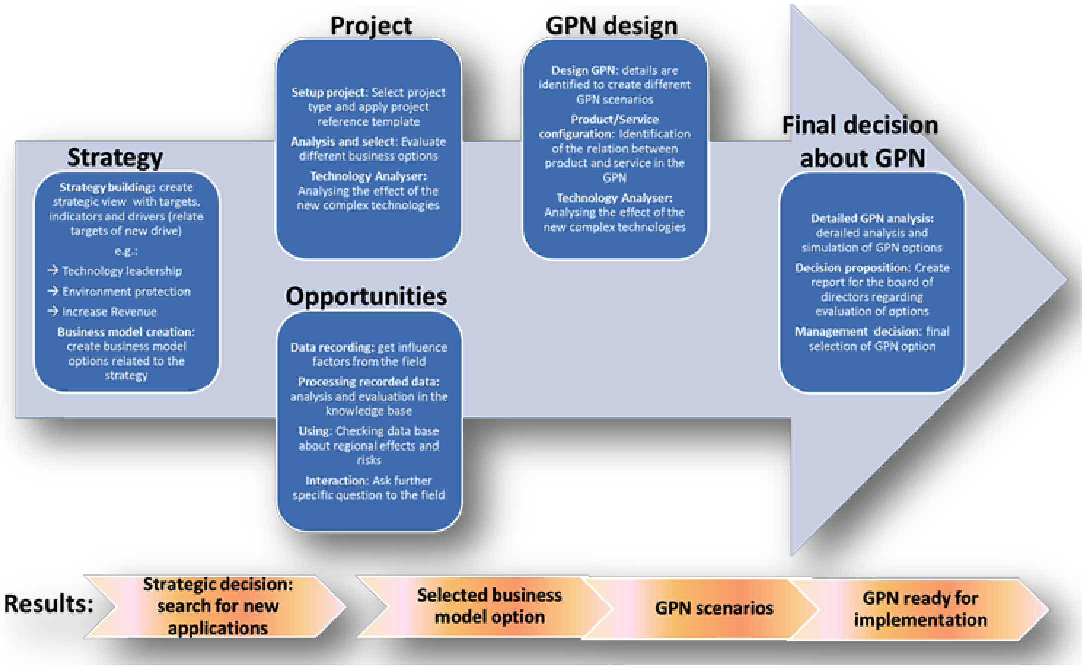


Figure 5-1: KSB scenario (from D1.3)

The KSB scenario (from D1.3) expresses the whole approach beginning with strategies, followed by projects related to new opportunities and ideas, then GPN alternatives and the finally the decision about the proposed GPNs. This process has several quality gates. The gates are related to feasibility of ideas, strategic conformance of ideas, business model forecasts, project establishment, definition of business model scenarios, release of business models, selection of GPN alternatives and final selection of the GPN. Back loops are not presented in the figure but are possible if decisions need to be revised (see Figure 5-1).

The Strategic Influence factors (from D1.3) of the KSB scenario are influenced by technical, political and market indicators (see Figure 5-2). This is reflected in the BSC analysis in figure 30.

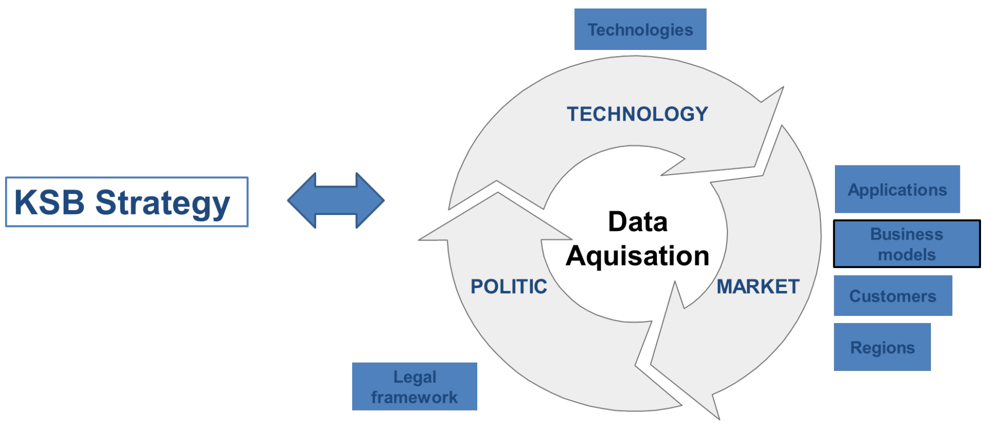


Figure 5-2: Strategic Influence factors (from D1.3)

The Initial GPN development process at KSB (derived from D6.2) which defines the process from idea to the GPN design decision stage illustrates the potential use of the FLEXINET components within KSB. It provides an idea in which processes the FLEXINET applications are used (see Figure 5-3).

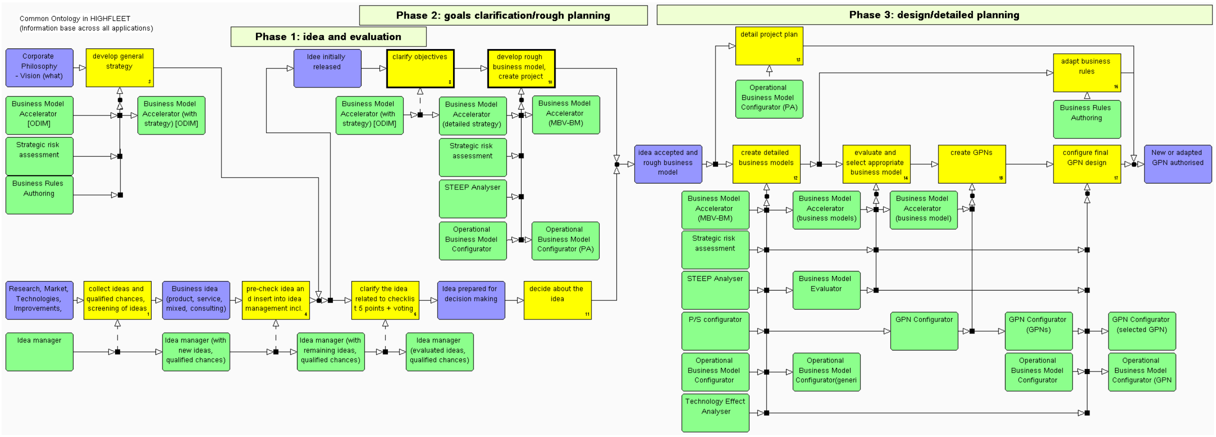


Figure 5-3: Initial GPN development process at KSB (derived from D6.2)

In fact the KSB scenarios cover several sub-scenarios for projects, business models and GPNs. They are described in the specific steps of the process from idea to the GPN design. The related information structures are part of the ontology which provides the definitions for business model and GPN scenarios.

The general KSB scenarios focus on the marketing of a new low energy consumption drive for pumps. The idea is to extend its application areas to create better revenues. Therefore the scenario is defined in a two step approach:

1. Business model and GPN for low energy consumption drive,
2. Identification of new application areas.

It is encompassed by the following two strategic questions:

3. How to ensure reduction of energy consumption thereby reducing CO emissions as required by new regulations,
4. How to ensure the economic success of new energy saving technologies.

The focus of the first scenario is on question 1 and considers the application of the low energy consumption drive to KSB pumps. The second scenario focuses on question 2 as well as on 1 and considers how to open the market for these drives to other applications such as air-conditioning systems.

5.1.2 Step 0: Preparation

The knowledge base is loaded with the KSB facilities and potential suppliers. The strategic objectives and related business rules are defined in terms of the general KSB strategy. In the scenario the objectives are provided as potential objectives by KSB. The most relevant **Strategic objectives** are

- Technology leadership,
- Environmental protection,

- Increase revenue.

Internal general performance indicators are prepared such as

- Maturity level of the technology,
- Requested / targeted delivery time,
- Requested / targeted delivery cost,
- Requested / targeted delivery quality,
- Requested / targeted delivery capability
- Time to market including time for training and marketing
- Machinery adaptation costs
- Required capacity
- Organisational refitting in terms of required changes
- Required service network in terms of company extensions

External general performance indicators are prepared such as

- Political stability (cooperation, stable, high tax, embargo, war) see also D2.2
- Environmental / sustainability awareness,
- Required knowledge related to new opportunities
- Market share
- Innovation level compared to competitors

It is usual that companies such as KSB have lots of **business rules**. The following selection is related to the GPN:

- A suitable supplier has the required production knowledge. The possession of this knowledge is evaluated by via audits of the delivered products and, in specific case, audits and accreditations of the suppliers by KSB. This is summarised in the following statements:
  - A suitable supplier has the required certification.
  - A Preferred supplier has the related quality accreditation.
- In terms of the GPN configuration a classification and ordering of the suppliers is requested. This is specified as a threshold which reflects how fast a supplier can react on orders. A good supplier can supply the parts faster than this threshold. This threshold can depend on the specific needs of the GPN because the required speed of supply needs to take into account logistic and other factors.
- A preferred supplier can provide an adequate delivery strategy, as the ability of a supplier to deliver in time or in sequence can be important. This again depends on needs within the GPN and related thresholds are adapted accordingly.
- A better supplier can provide the parts for a better price. In this case a threshold will provide the maximum price which can be accepted. However if the other rules are fulfilled, a selection between two suppliers would be based on the cheaper of the two.
- Logistic time in a specific GPN is an important performance indicator. Therefore rules for logistic time related to a specific supplier are of interest. The threshold might be, for example, logistic time should be lower than 14 days.
- The logistic time and also the reaction time regarding an order relates to the supplier stock levels, as well as where the warehouses are located. Therefore a rule which specifies the

minimum for this stock level is interesting. The rule provides a threshold which states a minimum for the potential delivery time in relation to the required parts.

- A further very important external indicator is political stability, for example how probable an embargo is. This relates also to the risk factors.
- A similar aspect is the stability of the currency exchange rate. A threshold might be no more than 5% variation per year. Again this also relates to risk aspects.

Once the potential network nodes (such as suppliers), the indicators, the business rules and the risk aspects have been identified and are available within the knowledge base, then the development of the GPN definition process from the idea to the GPN design decision stage can start. The further uses of the FLEXINET methods (with specific focus on the strategic/tactical aspects) are described in the following chapters.

5.1.3 Step 1/2: Ideas & Challenges

Idea: New available technology which allows 40% less energy consumption should be realised within a new low energy consumption drive.

The idea has passed the pre-analysis phase which checks the initial feasibility to avoid a "general problem solver idea". It also has been put into a discussion related to further ideas concerning impact on the technology roadmap of the new idea. The evaluation is informal and done during the initial checking of the idea. However, a decision is required if the idea is to be further developed. A check list could be used in this step to get a better understanding of the new idea, such as the 5 point approach at KSB (see KSB model for D1.1 and D1.2). These checklists might also consider the idea in terms of the driver and the objectives as well as indicators. This is covered in the following 5 points:

- Technological clarification and check of patents
- Check potential customers for the business idea
- Analyse regional characteristics
- Check potential applications
- Examine existing business models

The potential contributions to the company strategy are checked and further analysed. In the KSB scenario the idea of the new technology for energy saving drives belongs to both the environmental protection target (through the CO_2 reduction) as well as to the technology leadership target (via technology innovation aspects). The driver is the technology to reduce the energy consumption by 40%. So far the analysis only targets the initial feasibility and alignment with the company strategy. Currently an effect on the revenue is not directly expected (see Figure 5-4). However, this only applies to the direct contribution to the objectives. It is of course expected that the marketing of such a new drive will also affect the revenue in terms of better sales figures.

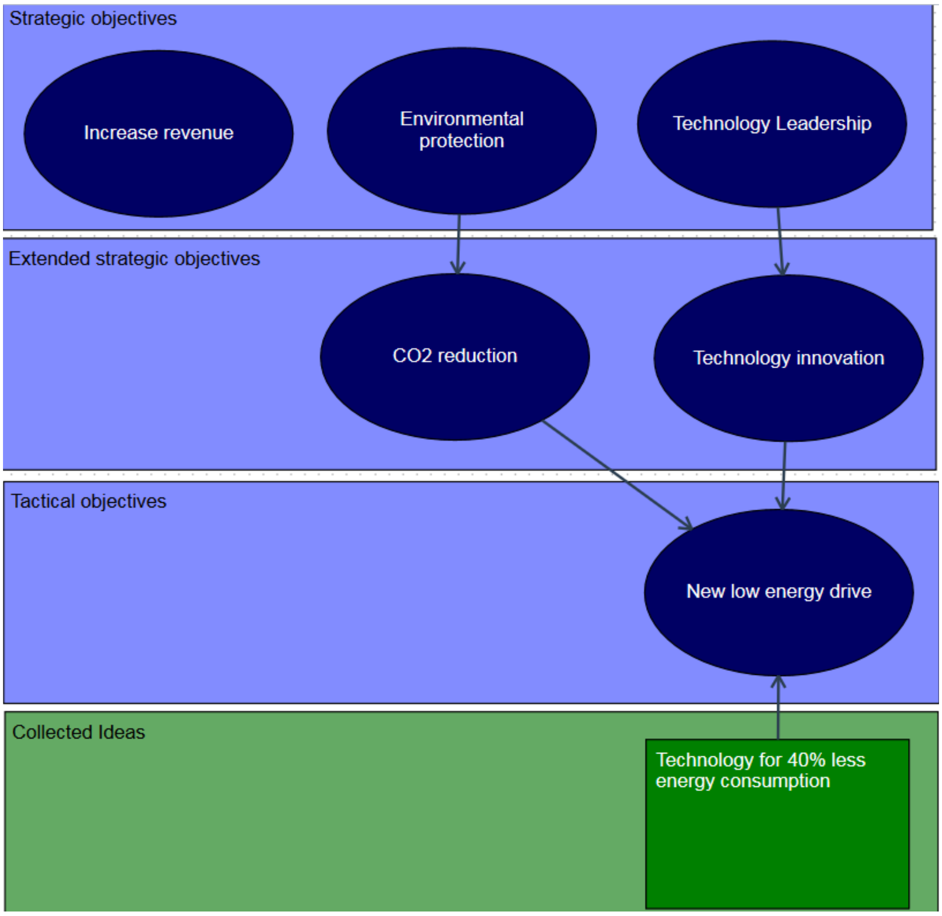


Figure 5-4: Objectives and Driver

The final decision will be made on this base in terms of go, no-go or further information required. We considered a "go" for the low energy consumption drive.

5.1.4 Step 3: Initial business model

After the idea passes the previous check it is further evaluated in terms of objectives and business modelling. This step requests a selection of business model components. In terms of the current KSB process these are the business model CANVAS components. However an adapted set of components related to specific needs of the business model analysis can be created, , e.g. risk can be added as a specific business model component.

The business model scenarios in Figure 5-5 are used for the analysis across different business models. This differs from the morphologic box approach in that elements may be duplicated within a row. In Figure 5-5 each column represents an alternative business model. This has been done to evaluate these business models separately. However, this view still allows different cells within one row to be selected. Afterwards, a normalised CANVAS view is created to enable specific selection of business model components.

The creation of a business model scenario starts with the value propositions. They are derived from a new business idea, specific business drivers or from potential values identified during the discussion of the idea (see Figure 5-4). Additional values could also appear during the discussion of other business model components and extend the value proposition. In FLEXINET the ideas and related discussions are managed by the idea manager application.. This is not described here but use of this application is assumed to have occurred. The ideas are added to the value proposition component of the business model CANVAS. Within the scenario different potential business models are defined regarding the place of final assembly, For example, if a drive is sold in India it can be assembled in Germany, or the final assembly can done in India to ensure that local regulations are adhered to and to potentially benefit from lower labour costs in India. The value proposition differs between the business models with the exception of the core ideas:

- Technology for 40% less energy consumption,
- Low energy consumption drive.

It can be seen that the value proposition focuses on the value for the customer or market. Therefore the energy reduction but also indirect effects such as environmental effects e.g. CO reduction are relevant. This is expressed here by the "low energy consumption drive" as a new product. Once the initial value proposition is in place the required key activities are defined. These activities can be selected from a list of templates or model fragments and any new activities needed can also be created. In the course of trialling the scenario it was discovered that a more specific definition of key activities was required in order to distinguish between activities in different regions or partners. Therefore the business model elements are enhanced by country and/ or partner relationships, such as <key activity name>_<location name>_<partner name>. This allows specific properties for key activities in different environments. An example is the key activity "marketing" which has been renamed to "marketing_germany". This allows a specific set of attributes and indicators which differ from a general marketing activity. When the name of the partner already incorporates the location, only the partner name is added e.g., "KSB Halle". In terms of the ontology this represents two different facts i.e., supplier organisation (KSB) and facility (Halle).

The choice of key partner partially depends on the key activities. Therefore the key partners are defined in the next step. The key partners should be also defined as specifically as possible to enable a specific set of properties and indicators to be populated. The potential business models have different sets of key partners depending on the final assembly step in addition to the specific set of elements in the value proposition.

In terms of the KSB scenario the customer relationship is the same in the three potential business models. These customer relationships can be selected from a predefined set of definitions. The sequence of the elements is not relevant because they are members of a set which represents the elements within a business model component.

The channels depend on the potential customers and clients to be encountered. In the KSB case the pump configurator can be used by customers directly or by distributors. Only the level of detail differs between both types of users. The pump configurator is accessible from a KSB web portal, It can be easily used to configure a pump, to provide a configuration offer or to order a specific configuration. The pump configurator incorporates the "customer relationship" which is an important channel in all potential business models. Other channels may be predefined, e.g. exhibitions. However these additional channels should be as specific as possible, as in the India case "Aquatech".

The "customer segments" differ in the India case because this business model covers the service aspects for the end users. Consequently the concept "end users" has been added. The specific type of end user is not specified at the moment so the concept covers all potential end users including equipment manufacturer, operators and retailers..

Key resources are related to the key partners, the key activities and to specific locations. Therefore the following naming convention is proposed:<resource name>_<key partner>_<location>. The Key partner and location are optional if the resource is uniquely defined. However, during trialling the scenario it was found that identifying the location and key partners facilitated understanding, An example from one of the potential business models is "production facility Halle". Here name and location is evident and can be used as equivalent identifiers. But "SW program" appears without partner or location because these are not specified at the moment. Hence the values given to properties of this resource are just approximations. Later this resource can be made more specific by changing the name or adding further details.

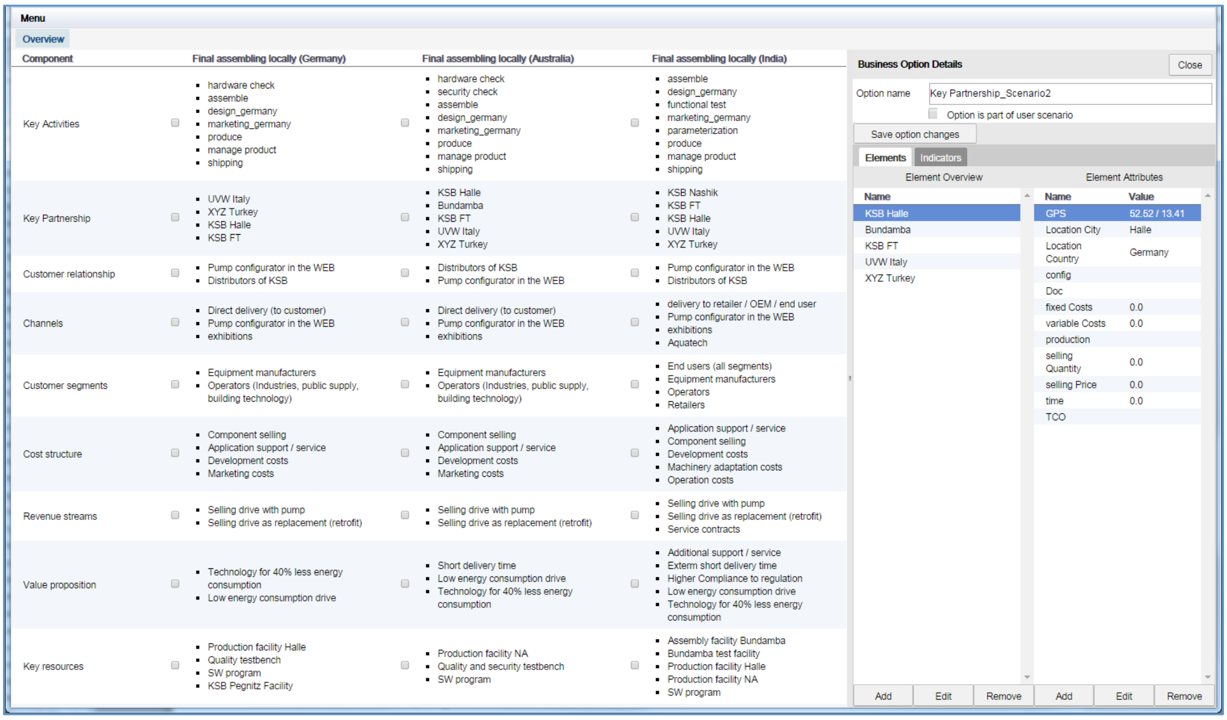


Figure 5-5: CANVAS related business models (Business Model Accelerate - BMA)

The "cost structure" considers the selling of the electric drive as a pump component. The selling of applications and services are taken into account only in the India case. The costs are calculated by considering the cost properties of the key activities, key partners, key resources and other potential components. The cost calculation also considers development costs, operation costs, marketing costs and machinery adaptation costs. These costs mostly consist of aggregations as they will be calculated from other business model elements. Each element can be composed of fixed costs, variable costs and investment costs as well as end of life costs. However, additional costs such as interest rates can be defined under the cost structure.

To cover the costs, revenues are required. In the scenario these revenues can be achieved by selling the "new drive" or, in the India case, by selling services. The revenues are defined by the number of drives sold, price and service contract prices. When different prices occur in different countries or for different clients they are added to the name of the revenue stream element e.g.,"service_contract_india".

An important step is the final configuration of the business model. This is supported by

- Consistency checks related to business rules,
- Evaluation of costs versus revenues,
- Evaluation of time aspects.

The business rules rely on information contained in the knowledge base. For example, the potential key partners are defined in the knowledge base and a check can be applied if they fulfil the current business rule thresholds when compared against country equivalent values supplied by the STEEP application. Information about the countries where the key partners are located is supplied with each facility definition. It can be seen that several data sources are utilised.

5.1.5 Step 4: Initial business model evaluation and selection

5.1.5.1 Complaints to business rules

The next step is the check for compliance against the business rules of the different business model elements. As an example we use the key partners added to the business model. Three ways of checking are possible

1. Checking during the insertion of a key partner,
2. Checking of the key partner after the configuration,
3. Checking of time aspects by semi-automated generation of an initial business process model (BPM).

The second way has been used. The key partners derived in terms of potential GPN nodes from the knowledge base (e.g. suppliers) are added to the business model. Now they are checked against the business rules such as:

- Political compliance e.g. potential embargos, wars, increase of boarder control,
- Stability of exchange rates,
- Delivery of a certain quality e.g. by experience gained from past deliveries,
- Has the required accreditation,
- Reliability of the supplier.

These rules are predefined in the knowledge base and do not need to be directly correlated with the suppliers. It is expected that the required external data is retrieved e.g. by the STEEP application. The internal data such as the "reliability in the supplier" or "has the required accreditations" can be retrieved from an ERP system or approximated if not available, e.g. if a new supplier is being evaluated. The scenario has considered a small set of rules to illustrate the concept but later it will be easy to have an incremental enrichment of the rules. In the case that a rule does fail, the business model designer has three options::

- Adaptation of the rule,
- Change the key partner,
- Ignore the evaluation.

However, it is important to analyse relations with other aspects and rules, for example with the risk application. The BSC analysis can provide further ideas of interdependency between two partners in the business model because it takes into account the set of performance indicators, external factors and risks to generate a kind of attractiveness. This can be used to see which key partner of two alternatives is more attractive. However, the final decision needs to be done by the expert.

Adapting the rule could be a long process however, it is one potential option. The usual option would be taking the risk and adding a certain amount of money to enrich the compliance to the business rules of the supplier or substituting the key partner by another. Specific rules can have direct risk aspects which need to be considered and can also quickly change, such as the "political stability".

The selection of a preferred business model is required based on the business rules and specific risks. This selection of a preferred business model is supported by the evaluation of properties of the business model elements such as costs, amount, price and time.

5.1.5.2 Cost and time calculation

The evaluation is derived from a break even analysis (described in the forthcoming deliverable D4.3). It takes into account fixed costs and variable costs as well as investment and other costs. It compares these costs with the revenue values and provides a breakeven point (see also D4.2) in quantitative value or in time. In fact the usual way is to use the quantitative value to achieve the breakeven but if a value is given by amount per month also an approximation in terms of time can be provided. The required data and specific relations are given blow:

s_p	Potential selling quantity per time period
Q	Non-recurring costs e.g. cost of development and innovation cost
k_{fix_i}	Fixed costs of different cost components
$K_{fix} = \sum_i k_{fix_i}$	Total fixed costs per time period
$k_{var\,j}$	Variable costs of different cost components
$x_{p\,j}$	Potential production quantity per time period of different cost components
$K_{var} = \sum_j k_{var\,j} * x_{p\,j}$	Total variable cost per time period
p	Unit selling price
$r_p = p * s_p$	Revenue per period

The Definition and equation of the time dependent cost and revenue function leads to the required point in time of the Break Even:

$(I) \qquad K(t) = Q + K_{fix} + t * K_{var}$	Cost function

$(II) \qquad R(t) = t * r_p$	Revenue function
$(I) = (II) \qquad t = \frac{Q+K_{fix}}{r_p - K_{var}}$	Break even time point
$x = x_p * t.$	The breakeven output quantity

Table 5-1 below gives an overview of where the relevant parameters for breakeven calculation are located at the different CANVAS components:

Table 5-1: List of indicators assigned to GPN node types

CANVAS Component	Parameter
Cost Structure	• Q – non-recurring costs • k_{fix_i} – fixed costs of a CANVAS Model Element • k_{var_j} – variable costs per unit • x_{p_j} – Potential production quantity per time period
Key Activities	• Q – non-recurring costs • k_{fix_i} – fixed costs of a CANVAS Model Element • k_{var_j} – variable costs per unit • x_{p_j} – Potential production quantity per time period
Key Resources	• Q – non-recurring costs • k_{fix_i} – fixed costs of a CANVAS Model Element • k_{var_j} – variable costs per unit • x_{p_j} – Potential production quantity per time period
Channels	• Q – non-recurring costs • k_{fix_i} – fixed costs of a CANVAS Model Element • k_{var_j} – variable costs per unit • x_{p_j} – Potential production quantity per time period
Revenue Streams	• p – unit selling price • s_p– potential selling quantity per period

The different Canvas Model Components are cost drivers or revenue drivers (see D 4.2). Therefore the different parameters are targeted to a relevant Canvas Component. Since the components of Customer relationship, Channels, Customer segments and Value proposition directly affect the revenues but do not generate income by themselves, only the revenue stream can supply the parameters such as selling price p and selling quantity per period s_p. In contrast to the revenues, there is no need for the Canvas component Cost Structure to provide cost parameters due to the fact that the cost structure is calculated via cost properties of key activities, key partners, key resources and channels. These Components (key Partners, key Activities, key Resources and channels) contain fixed costs k_{fix_i}, variable costs k_{var_j} and non-recurring costs Q. However in terms of the method, the cost structure elements can also contain the cost calculation measures for specific costs.

The following example illustrates its usage: The company of KSB produces per month 100 revised pumps which are sold at a profit of 300€ per unit. The corresponding cost results from production costs of 120€ per unit, marketing costs of 5.500€ and non-recurring development costs of 7.000€ . Further fixed costs in amount of 6.000€ arise from contract conditions with the Key Partners of the company. The breakeven time point follows from:

$$s_p = 100\ pumps\ per\ month$$

$$K_{fix} = 5.500€ + 6.000€ = 11.500€$$

with $k_{fix_1} = 5.500€\ and\ k_{fix_2} = 6.000€$

$$Q = 7.000€$$

$$K_{var} = 100 * 120€ = 12.000€$$

with $k_{var_1} = 120€\ and\ x_{p_1} = 100$

$$r_p = 100 * 300€ = 30.000€$$

$$t = \frac{Q + K_{fix}}{r_p - K_{var}} = \frac{7000€ + 11.500€}{30.000€ - 12.000€} = 1{,}03\ month$$

The result shows that after 1,03 months the whole costs are covered by the revenues of 100 pumps per month.

Menu

Overview

Component		Final assembling locally (Germany)		Final assembling locally (Australia)		Final assembling locally (India)
Key Activities	☑	• hardware check • assemble • design_germany • marketing_germany • produce • manage product • shipping	☐	• hardware check • security check • assemble • design_germany • marketing_germany • produce • manage product • shipping	☐	• assemble • design_germany • functional test • marketing_germany • parameterization • produce • manage product • shipping
Key Partnership	☐	• UVW Italy • XYZ Turkey • KSB Halle • KSB FT	☑	• KSB Halle • Bundamba • KSB FT • UVW Italy • XYZ Turkey	☐	• KSB Nashik • KSB FT • KSB Halle • UVW Italy • XYZ Turkey
Customer relationship	☐	• Pump configurator in the WEB • Distributors of KSB	☐	• Distributors of KSB • Pump configurator in the WEB	☑	• Pump configurator in the WEB • Distributors of KSB
Channels	☐	• Direct delivery (to customer) • Pump configurator in the WEB • exhibitions	☑	• Direct delivery (to customer) • Pump configurator in the WEB • exhibitions	☐	• delivery to retailer / OEM / end user • Pump configurator in the WEB • exhibitions • Aquatech
Customer segments	☑	• Equipment manufacturers • Operators (Industries, public supply, building technology)	☐	• Equipment manufacturers • Operators (Industries, public supply, building technology)	☑	• End users (all segments) • Equipment manufacturers • Operators • Retailers
Cost structure	☐	• Component selling	☑	• Component selling	☑	• Application support / service • Component selling
Revenue streams	☐	• Selling drive with pump • Selling drive as replacement (retrofit)	☑	• Selling drive with pump • Selling drive as replacement (retrofit)	☑	• Selling drive with pump • Selling drive as replacement (retrofit) • Service contracts
Value proposition	☑	• Technology for 40% less energy consumption • Low energy consumption drive	☐	• Short delivery time • Low energy consumption drive • Technology for 40% less energy consumption	☐	• Additional support / service • Exterm short delivery time • Higher Compliance to regulation • Low energy consumption drive • Technology for 40% less energy consumption
Key resources	☐	• Production facility Halle • Quality testbench • SW program • KSB Pegnitz Facility	☑	• Production facility NA • Quality and security testbench • SW program	☐	• Assembly facility Bundamba • Bundamba test facility • Production facility Halle • Production facility NA • SW program
Pricing models	☐	• Fixed price	☑	• Fixed price	☐	• Fixed price

Figure 5-6: Selecting a business model

The required data contains approximations, data from previous information, offers or data available in IT systems, such as the supplier relationship management (SRM). In fact the data can become more accurate during the evolution of the business model.

Not only can the three potential business models be analysed but also a user defined selection across the alternative models is possible. It is the responsibility of the user to keep the selections consistent. To support consistency and further development a business model CANVAS can be automatically derived. So from the business model MBV in Figure 5-6 the business model CANVAS in Figure 5-7 is generated.

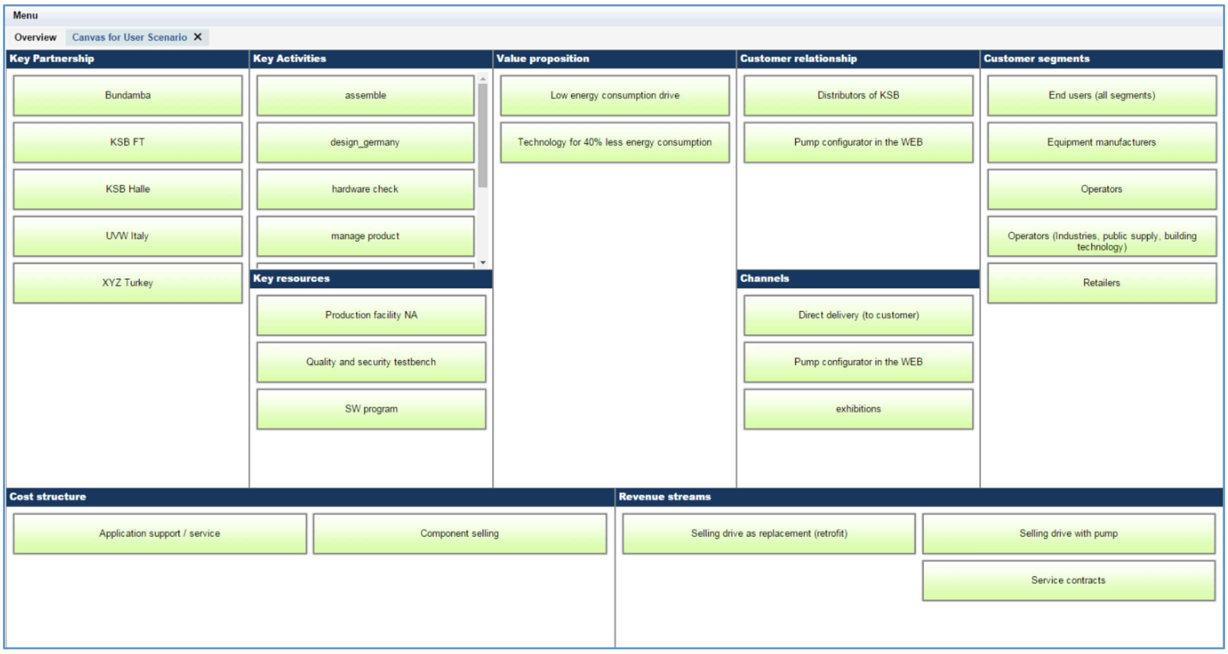


Figure 5-7: Selected business model

This model can now be analysed in more detail. An initial process view of the business model can be generated now all elements are present within an integrated enterprise model. The key activities, key resources and key partners are directly available and need only to be arranged into the right sequence. After this stage an analysis can be performed to create an initial approximation about the time aspects of the business model. This can be done with a simple calculation procedure or, more accurately, with a rough simulation, e.g. via Petri-net or place/transition net analysis (see D4.3). This forms an early analysis to improve the quality of the business model evaluation. A detailed simulation would require simulation tools such as the ARENA approach in D4.3 and hence require more details and development time. Therefore it is more appropriate at a later stage of the business model development when the proposed GPN is evaluated.

5.1.6 Step 5/6: Business Model and GPN

The business model CANVAS already covers parts of the GPN, especially the key nodes of the GPN in terms of key partners, key resources and key activities. This determines the country as well as the degree of partnership. Furthermore, the business process structure provides the specific order of the key activities. Different GPN scenarios can now be created in three ways:

- Changing the sourcing / supplying relationship between partners such as giving more or less importance to a partner,
- Changing the logistic between partners, e.g. alternatives such as ship, plane, car or different methods of transport in different countries. This can avoid costs.
- Substituting partners by creating an alternative business model.

The information can now be used to sharpen the FLEXINET BSC and especially to create the FLEXINET BSC 2.0 which also provides a comparison of attractiveness between different GPNs. These details are specified in chapter 3. From a given list of indicators the relevant external factors and key performance indicators are selected (see Figure 5-8). The selection of indicators also includes a check which ensures the indicators are relevant to the business model. Each of the elements in the business model components has associated performance indicators, external factors, objectives and risks. For example, the "CO2 emissions" is an indicator which indicates regions with a strong need to focus on CO2 reduction. This can indicate a good market for a low energy consumption drive under the following conditions:

- The awareness of this issue arises within the market,
- The creation of energy produces CO2 emissions.

On the other hand, a region with a high economy and strong environmental awareness could be also a very good market. The indicators suggest potential valuable markets. However, they do need to be configured and precisely related to specific questions. If the question is not marketing but production the CO2 emission is less of interest but the costs related to regulations to reduce the CO2 emissions are relevant. A mix of indicators is used from external sources like the World Bank or Eurostat, internal sources from different information systems (such as ERP, SRM) or just approximated. The important aspect is to ensure an evolution of the values and to update the evaluations and models accordingly. This is one of the requirements for developing a seamless interoperability between strategic decisions and the tactical planning, and the decisions to realise the strategy. It also requires a common knowledge base across all methods and applications be used which is given by the FLEXINET KB.

The indicators described in Step 0 are quite general. The BSC network analysis uses the following indicators:

- Labour expense
- Operating resource productivity
- personnel training expenses versus the total amount of expenses
- Labour productivity
- Ratio of timely completed orders
- CO2 emissions
- Supplier on-time delivery performance (incl. Logistics)
- Overall customer satisfaction
- Market share (local market)
- Number of advertising campaigns (number of potential customers)
- Marketing expenses per customer

The evaluation now provides an attractiveness score for each of the regions in the network. Figure 5-8 illustrates an example of a result. On average Germany is more attractive, but taking the highest potential values India is more attractive. An interpretation of this result is that Germany is a good place but the opportunities are higher in India. It also illustrates that the India case is lower risk (by 100 points) than the German case. Hence the evaluation considers economic analysis opportunities and risk approximations.

However, the next step covers the risk in more detail because it has been not taken into account in the first attempt. Due to the economic disasters in the last decades business analysis is increasingly required to take account of potential risks. For the KSB case the following risk factors has been identified:

- Inoperability of Scenario 1: Supplier Insolvency
- Inoperability of Scenario 2: Unreliability of Supplier
- Inoperability of Scenario 3: Machine Failure
- Inoperability of Scenario 4: Technological Challenge
- Inoperability of Scenario 5: Political Issues
- Inoperability of Scenario 6: High Inflation / Currency exchange rates
-

			LEVEL 0																
			Economic and risk feasibility maximum score	1000															
		LEVEL 1																	
share of this view:		0,15	BSC view: financial																
			KPI	min (worst) value	max (best) value	max points	Germany						India						notes
share		share					absolute value			points			absolute value			points			
LEVEL 2		LEVEL 3					Lowest	Likely	Highest	Lowest	Likely	Highest	Lowest	Likely	Highest	Lowest	Likely	Highest	
0,34	costs	0,3	Industrial electricity prices	0,186	0,042	15,3	0,11	0,1185	0,12	7,013	7,172	8,075	0,06	0,0777	0,08	11,263	11,507	13,388	€/kWh, 2014
		0,3	Industrial gas prices	14,327	5,918	15,3	10,23	10,23	10,23	7,454	7,454	7,454	10,296	10,296	10,296	7,334	7,334	7,334	€/Gigajoule, 2014
		0,4	Labour expense	44,8	3	20,4	20,23	22,23	25,23	9,551	11,015	11,991	6,8	6,8	6,8	18,545	18,545	18,545	€
0,33	revenue	0,3	Revenue per employee	200	500	14,85	228,26	228,26	228,26	1,399	1,399	1,399	304,66	304,66	304,66	5,181	5,181	5,181	€, assumption
		0,3	Capital productivity ratio	0	1	14,85	0,3	0,3	0,3	4,455	4,455	4,455	0,5	0,5	0,5	7,425	7,425	7,425	assumption
		0,4	operating resource productivity	0	500	19,8	277,12	277,12	277,12	10,974	10,974	10,974	350,25	350,25	350,25	13,870	13,870	13,870	€/h, assumption
0,33	growth	0	Specific weight of expenses on research and innovation in the total amount of expenses	0	100	0	10	20	30	0,000	0,000	0,000	20	20	20	0,000	0,000	0,000	%, assumption
		1	Expenses in training of personnel in the total amount of expenses	0	100	49,5	10	10	10	4,950	4,950	4,950	10	15	30	4,950	7,425	14,850	%, assumption
		0	Expenses related to preparations and study of new products in the total amount of expenses	0	100	0	4	4	4	0,000	0,000	0,000	4	4	4	0,000	0,000	0,000	%, assumption
			Structural Uncertainty			150	2,00%		3,00%	-3,000		4,500	2,00%		3,00%	-3,000		4,500	
					Total	150				42,796	47,419	53,798				65,568	71,287	85,093	
		LEVEL 1																	
share of this view:		0,35	BSC view: internal																
			KPI	min (worst) value	max (best) value	max points	Germany						India						notes
share		share					absolute value			points			absolute value			points			
LEVEL 2		LEVEL 3					Lowest	Likely	Highest	Lowest	Likely	Highest	Lowest	Likely	Highest	Lowest	Likely	Highest	
0,25	productivity	1	Labor productivity	0	400	87,5	250	300	320	54,688	65,625	70,000	100	150	300	21,875	32,813	65,625	#/h, assumption
		0	Efficiency of information systems	0	100	0	85	90	95	0,000	0,000	0,000	80	85	90	0,000	0,000	0,000	%, assumption
		0	Cycle time of production	70	10	0	40	40	40	0,000	0,000	0,000	40	40	40	0,000	0,000	0,000	min/pump, assumption
0,35	quality	0,5	Ratio of timely completed orders	0	100	61,25	98	99	100	60,025	60,638	61,250	80	85	90	49,000	52,063	55,125	%, assumption
		0,5	CO2 emissions (plus awarness)	30	4	61,25	12,69	12,69	12,69	40,778	40,778	40,778	12,69	13,69	14,69	36,067	38,423	40,778	ton CO2/1mio.€ sales, assumption
0,4	lead time	1	supplier on-time delivery performance (incl. Logistic)	0	100	140	98	99	100	137,200	138,600	140,000	80	85	90	112,000	119,000	126,000	%, assumption
		0	Order fulfilment lead time (for customized pumps)	120	60	0	90	95	98	0,000	0,000	0,000	100	102	108	0,000	0,000	0,000	min/order, assumption
		0	Order fulfilment lead time (for standardized pumps)	70	50	0	60	60	60	0,000	0,000	0,000	60	60	60	0,000	0,000	0,000	min/order, assumption
			Structural Uncertainty			350	1,00%		1,00%	-3,500		3,500	1,00%		1,00%	-3,500		3,500	
					Total	350				289,191	305,641	315,528				215,442	242,298	291,028	
		LEVEL 1																	
share of this view:		0,4	BSC view: customer																
			KPI	min (worst) value	max (best) value	max points	Germany						India						notes
share		share					absolute value			points			absolute value			points			
LEVEL 2		LEVEL 3					Lowest	Likely	Highest	Lowest	Likely	Highest	Lowest	Likely	Highest	Lowest	Likely	Highest	
0,3	satisfaction	1	Overall customer satisfaction	0	10	120	6	7	8	72,000	84,000	96,000	7	8	9	84,000	96,000	108,000	scale 1-10, assumption
		0	Number of lost customers	200	0	0	10	10	10	0,000	0,000	0,000	10	10	10	0,000	0,000	0,000	#/a, assumption
		0	Trademark index	0	10	0	8	8	8	0,000	0,000	0,000	5	5	5	0,000	0,000	0,000	scale 1-10, assumption
0,7	market shares	0,5	Market share (local market)	0	100	140	10	20	40	14,000	28,000	56,000	5	20	50	7,000	28,000	70,000	%, assumption
		0,5	Number of advertising campaigns (number of potential customers)	0	50	140	5	5	5	14,000	14,000	14,000	1	1	1	2,800	2,800	2,800	#/a, assumption
		0	Average time between first contact with the customer and signing of agreement	180	2	0	31	31	31	0,000	0,000	0,000	40	40	40	0,000	0,000	0,000	d, assumption
		0	Marketing expenses ratio of sales	0	100	0	1	1	1	0,000	0,000	0,000	5	5	5	0,000	0,000	0,000	%, assumption
0	product range	0,34	Average amount of products shipped to one customer (local market)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		0,33	Expenses per customer	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		0,33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
			Structural Uncertainty			400	1,00%		2,00%	-4,000		8,000	1,00%		2,00%	-4,000		8,000	
					Total	400				96,000	126,000	174,000				89,800	126,800	188,800	
		LEVEL 1																	
share of this view:		0,1	BSC view: innovation																
			KPI	min (worst) value	max (best) value	max points	Germany						India						notes
share		share					absolute value			points			absolute value			points			
LEVEL 2		LEVEL 3					Lowest	Likely	Highest	Lowest	Likely	Highest	Lowest	Likely	Highest	Lowest	Likely	Highest	
0	product launch	0	Length of research and innovation projects	30	3000	0	512	512	512	0,000	0,000	0,000	512	512	512	0,000	0,000	0,000	d/project, assumption
		0	Expenses for research and innovation	2	0,1	0	1,3	1,3	1,3	0,000	0,000	0,000	0,9	0,9	0,9	0,000	0,000	0,000	%/GDP (GDP=BIP)
1	market penetration	0	Number of registered patents	0	500	0	50	50	50	0,000	0,000	0,000	15	15	15	0,000	0,000	0,000	#, assumption
		1	Marketing expenses per customer (Case 1 lower, Case 2 higher)	1000	50	100	450	700	900	10,526	31,579	57,895	200	500	800	21,053	52,632	84,211	€/customer, assumption
0,5	growth	0,5	Specific weight of expenses on improvements in total amount of expenses related to pump technologies	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20	5,000	5,000	5,000	%, assumption
		0,5	Number of rational and creative ideas per employee	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0,05	0,250	0,250	0,250	#, assumption
			Structural Uncertainty			150	2,00%		4,00%	-3,000		6,000	2,00%		4,00%	-3,000		6,000	
					Total	150				13,026	37,079	69,395				23,303	57,882	95,461	
		LEVEL 1																	
share of this view:		0	BSC view: risk																
			KPI	min (worst) value	max (best) value	max points	Germany						India						notes
share		share					absolute value			points			absolute value			points			
LEVEL 2		LEVEL 3					Lowest	Likely	Highest	Lowest	Likely	Highest	Lowest	Likely	Highest	Lowest	Likely	Highest	
0,3	Supply	0,5	Inoperability of Scenario 1: Supplier Insolvency	1	0	0	0	0,01	0,015	0,000	0,000	0,000	0	0,02	0,03	0,000	0,000	0,000	percent, calculated
		0,5	Inoperability of Scenario 2: Unreliability of Supplier	1	0	0	0	0,001	0,002	0,000	0,000	0,000	0	0,01	0,02	0,000	0,000	0,000	percent, calculated
0,1	Production	0,5	Inoperability of Scenario 3: Machine Failure	1	0	0	0	0,01	0,015	0,000	0,000	0,000	0	0,02	0,03	0,000	0,000	0,000	percent, calculated
		0,5	Inoperability of Scenario 4: Technological Challenge	1	0	0	0,22	0,25	0,27	0,000	0,000	0,000	0,22	0,25	0,27	0,000	0,000	0,000	percent, calculated
0,6	External	0,5	Inoperability of Scenario 5: Political Issues	1	0	0	0	0	0,0002	0,000	0,000	0,000	0	0,1	0,3	0,000	0,000	0,000	percent, calculated
		0,5	Inoperability of Scenario 6: High Inflation / Currency exchange rates	1	0	0	0	0,05	0,1	0,000	0,000	0,000	0,1	0,2	0,3	0,000	0,000	0,000	percent, calculated
			Structural Uncertainty			0	1,00%		1,00%	0,000		0,000	1,00%		1,00%	0,000		0,000	
					Total	0				0,000	0,000	0,000				0,000	0,000	0,000	
	Equals 1?	1																	

max points		overall score					
		Germany			India		
		Lowest	Likely	Highest	Lowest	Likely	Highest
1050		441,013	516,139	612,721	394,112	498,266	660,382

Figure 5-8: BSC evaluation sheet

If a high political challenge and a potential risk of high inflation is presumed the score of attractiveness in India decreases. However, the values depend on the risk scenarios defined because the risk of political stability could be described by a set of indicators depending on social, economic, environmental aspects. The risks are identified such as the following:

- Risk of production failure (supply of non-compliant parts)
  - India = high
  - Australia = middle
  - Germany = low
- Strikes → social political stability
  - India = low
  - Australia = middle
  - Germany = middle
- Environment event (e.g. earthquake) –
  - India = high
  - Australia = middle
  - Germany = low
- Economic risk of "interest rates" and "exchange rates"
  - India = middle
  - Australia = middle
  - Germany = low
- Lobby risks such as TTIP
  - India = low
  - Australia = middle
  - Germany = high
- Risk of economic development of a country/market - related to the selling of product
  - India = high development (lower risk)
  - Australia = stable
  - Germany = stable

These are the factors that the risk analysis is based on but the final risk analysis also depends on the GPN and considers interdependencies of the different nodes within the GPN. This has been already described in the previous deliverables and updated in chapter 4.

The definition of the GPN scenarios is now the next step. The GPN analysis in terms of simulation and technical effects is part of D4.3. This covers two main steps

1. Create different GPN scenario alternatives based on logistic, political, economic and environmental aspects.
2. Select a subset of attractive scenarios and simulate them against risk events and economic properties.

Finally a prioritized GPN is selected and a report is provided to the company board for final release. The subsequent operation of the GPN is out of scope for FLEXINET but the knowledge generated during the design can now be used to support this operation e.g., in terms of indicators and risk properties which can now be updated and analysed continually.

5.2 Identification of new application areas

After the low energy consumption drive has been invented the focus shifts to the increase in the revenues which forms the second scenario. Instead of a new product or service, this scenario targets new business opportunities. The Step 0 is similar to the Step 0 of the previous scenario therefore it is not described here and the other steps are also very similar in terms of the method. However, it illustrates another idea that this process can encompass. This process can consider the following ideas::

- New product idea
- New service idea
- New product / service idea
- New idea of business opportunity.

To avoid duplication of the previous scenario the description is less detailed..

5.2.1 Step 1/2: Ideas and Challenges

The idea is that the low energy consumption drive has the capacity to be introduced in several application areas and not only for pumps. The new idea has been discussed and potential areas are identified such as

- Air-conditioning systems
- Heating systems such as for the use of ground heat
- Drives for production machines
- Wind tunnels.

The heating system idea is closely related to a pump and will be implemented anyway. The wind tunnel idea was rejected because of the small market. The "air-conditioning system" was selected as the first option to consider with the "drives for production machines" as a second option.

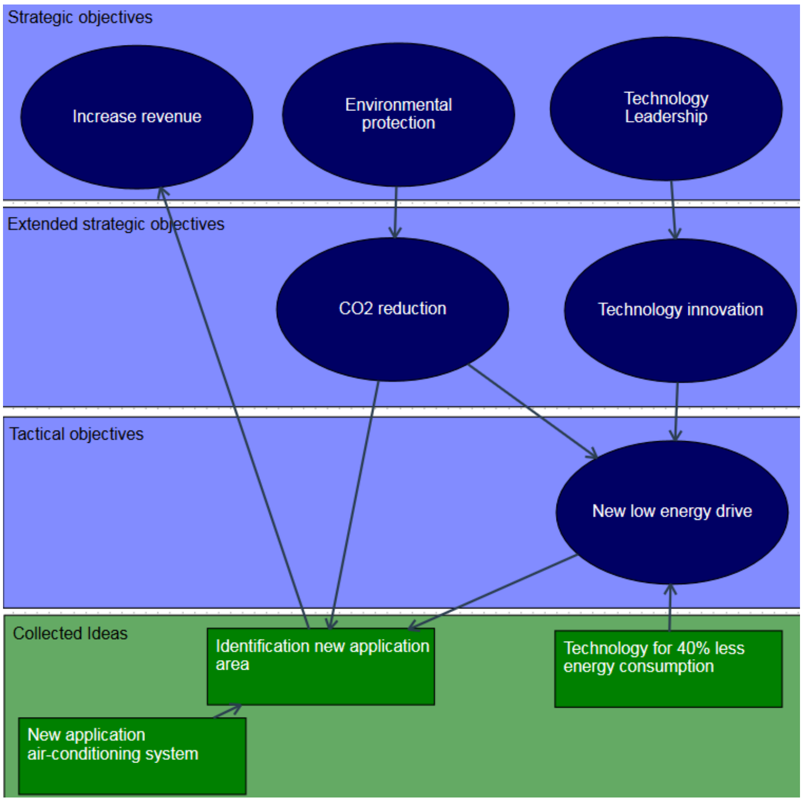


Figure 5-9: Objectives and Driver for new application areas

For this "business opportunity idea" the following 5 points are interesting:

- Technological clarification
- Check potential clients for the business idea
- Analyse regional characteristics
- Check potential applications
- Examine related to existing business models

The market analysis does not address the final customers but considers potential business partners or industrial customers. This needs to be taken into account to find specific partners and customers. In the next step the strategy needs to be defined similar to the first scenario (see Figure 5-9).

The identification of a new application area can increase the revenue and is enabled by the development of the low energy consumption drive. The low energy consumption will also aid an expected CO_2 reduction.. One potential new application area is the air-conditioning system industry. A description of how this is depicted by the business model is given in the next section.

5.2.2 Step 3: Initial business model

The potential business model alternatives are defined in terms of utilization of the low energy consumption drive for alternative applications and business scenarios:

1. Producing the drive for air-conditioning systems **in-house** even though it is not the usual business of KSB which focuses on pumps.
2. **Outsourcing** the drives for air-conditioning system,keeping the final assembly **in-house** to secure the innovation of the drive and selling the drive to OEMs.

3. **Selling licences** to OEMs for producing the drive for their applications. Retaining the marketing rights assuming a single licence fee applies.. Retaining the design and prototype development, maintaining the customer relationship.

An additional aspect is to find collaboration partners.. This can be described in the business model. However, an important aspect is to locate a suitable solution concerning the new application as this requires an interactive and brainstorming process . A recommendation is the use of ODIM together with the business model MBV and the CANVAS view to support this process.

Menu

Overview

Component	In-house production	Out-sourcing	Selling licence
Key Activities	▪ hardware check ▪ assemble ▪ design_germany ▪ marketing_germany ▪ produce ▪ manage product ▪ shipping	▪ assemble ▪ design_germany ▪ marketing_germany ▪ Partner management	▪ design_germany ▪ marketing_germany ▪ Licence management
Key Partnership	▪ KSB Halle ▪ KSB FT ▪ KSB Nashik ▪ UVW Italy ▪ XYZ Turkey ▪ Bundamba	▪ Supplier 1 ▪ Supplier 2 ▪ Local service provider	▪ OEM
Customer relationship	▪ Pump configurator in the WEB ▪ Distributors of KSB	▪ Distributors of KSB ▪ Pump configurator in the WEB	▪ Low energy drive licence
Channels	▪ Pump configurator in the WEB ▪ exhibitions ▪ OEM	▪ Pump configurator in the WEB ▪ exhibitions ▪ OEM	▪ exhibitions
Customer segments	▪ Equipment manufacturers ▪ Operators (Industries, public supply, building technology)	▪ Equipment manufacturers ▪ Operators (Industries, public supply, building technology)	▪ OEM
Cost structure	▪ Component selling ▪ Application support / service ▪ Development costs ▪ Marketing costs ▪ Assembly costs ▪ Production costs	▪ Development costs ▪ Marketing costs ▪ Assembly costs ▪ Component costs	▪ Development costs ▪ Marketing costs ▪ Lawyer costs
Revenue streams	▪ Service contracts ▪ Selling drive	▪ Selling drive ▪ Service contracts	▪ Licence fee
Value proposition	▪ New application air-conditioning system ▪ Technology for 40% less energy consumption ▪ Low energy consumption drive	▪ New application air-conditioning system ▪ Technology for 40% less energy consumption ▪ Low energy consumption drive	▪ New application air-conditioning system ▪ Technology for 40% less energy consumption ▪ Low energy drive licence
Key resources	▪ Quality testbench ▪ SW program ▪ Production facility Halle ▪ Production facility NA ▪ Bundamba test facility ▪ Assembly facility Bundamba ▪ KSB Pegnitz Facility	▪ Quality and security testbench	▪ lawyer

Figure 5-10: Business model scenarios for new application areas

The business scenarios are set up and potential partners, resources and activities are identified. Further evaluation follows the same way as in the first KSB scenario: it consists of evaluation, selection of the most attractive business model, creation of the GPN scenarios and selection of the most attractive scenario. However, the real process this scenario depends upon is the selected business model scenario (see Figure 5-10) because when outsourcing is considered the partners should be involved in this process. When selling licences is envisioned the process is shorter because the GPN is mostly the responsibility of the partner.

5.3 Lessons learnt from and about scenarios

The scenarios illustrate the application of the methods to the GPN definition process stage which consists of strategic business development to the tactical business design of a new idea. Alternative general business scenarios have been identified:

1. New technologies in terms of products
2. New technologies in terms of services such as new apps, click and buy, …

3. New technologies in terms of product/service
4. New business opportunities in terms of open the business to new markets

Two scenarios are drafted related to 1 and to 4. Case studies for all three end users have been created but KSB has been selected for the detailed illustration of the application of the methodology in D2.4.

Each scenario consists of several sub-scenarios:

- Collection of ideas to be followed in FLEXINET terms "concepts",
- Alternative business model scenarios modelled within a morphologic box approach,
- Alternative GPN scenarios,
- Different risk scenarios (earthquake, loss of supplier, etc.),
- Different BSC configurations
- Different simulation scenarios.

These scenarios are modelled within the knowledge base. The business scenarios and the GPN scenarios are described in detail. The scenarios contain relationships to other concepts within of the knowledge base, such as the business rules.

The approach illustrates the potential of the different methods to support the evolution of an idea from design to realisation within a GPN. The scenarios also illustrate the need for interaction with the methods provided by the knowledge base. Business rules within the business model development need to consider the value proposition defined within the idea management application in terms of a "concept". The components for business process models and later for the GPN are captured within the business model, for example key partners, key activities, key resources. The risks and the indicators which are used for different evaluations (such as for the BSC and BSC 2.0) are required in all of the steps.

6 Conclusion

The deliverable provides an assessment and quantification of the impact of the business model in terms of procedures and methods for a potential reference process (chapter 2), analysis of attractiveness of different GPNs as an extension of the FLEXINET BSC approach (chapter 3) and a detailed risk analysis (chapter 4). The deliverable also provides two example scenarios based on one end user which demonstrate the reference process methods (chapter 5).

The work focuses on WP2 "Business models for global product-service production networks" and does not take into account all the FLEXINET applications because they are described in the WP5 deliverables e.g., the product/service configurator. These components are described in the demonstration scenarios used in the IT platform work packages (WP5). However, a general aim is to fill the gap between strategy and tactical planning and design. This deliverable is closely related to the work in WP4 "Methodology to Design Flexible Business Models for Production Network Configuration". This is reflected in the scenarios described in chapter 5.

Annex A: References

Hauksson, H. and Johannesson, P. (2014). Metamodeling for business model design. Facilitating development and communication of business model canvas (bmc) models with an omg standards-based metamodel. In The 8th International Workshop on Value Modeling and Business Ontology (VMBO 2014), Berlin and Germany.

Delgado, Miguel, María A Vila, and W Voxman. 1998a. "A Fuzziness Measure for Fuzzy Numbers: Applications." Fuzzy Sets and Systems 94 (2): 205–16. doi:10.1016/S0165-0114(96)00247-3.

———. 1998b. "On a Canonical Representation of Fuzzy Numbers." Fuzzy Sets and Systems 93 (1): 125–35. doi:10.1016/S0165-0114(96)00144-3.

Kiureghian, Armen Der, and Ove Ditlevsen. 2009. "Aleatory or Epistemic? Does It Matter?" Structural Safety 31 (2). Elsevier Ltd: 105–12. doi:10.1016/j.strusafe.2008.06.020.

Leetaru, Kalev, and Philip A Schrodt. 2013. "GDELT: Global Data on Events, Location, and Tone, 1979–2012." In ISA Annual Convention, 2:4.

Pedrycz, Witold, and Fernando Gomide. 1998. An Introduction to Fuzzy Sets: Analysis and Design. the MIT Press.

Yager, Ronald R. 2008. "Measures of Specificity over Continuous Spaces under Similarity Relations." Fuzzy Sets and Systems 159 (17): 2193–2210. doi:10.1016/j.fss.2007.12.026.

FLEXINET Deliverables D1.3, D2.1, D2.2, D2.3, D4.1, D4.2.

Annex B: Glossary

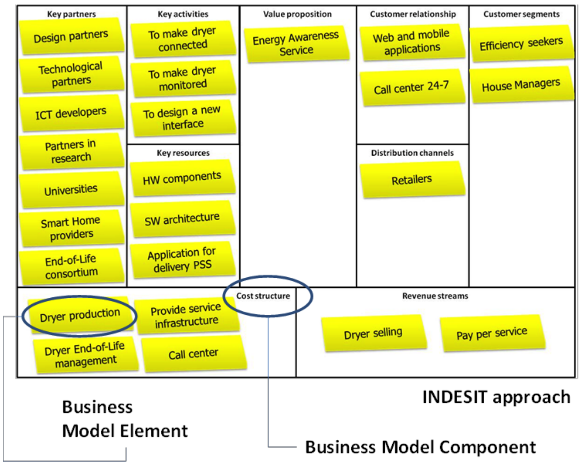
Indicator	According to D4.1 indicators are defined in the following way: PIs are grouped to KPIs. The **key performance indicators (KPI) are also called indicators** in the document. They can be a standard set or company specific. If a standard set is used then they can be predefined in terms of parameterisation 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 an indicator are derived from ECOGRAI as follows: • 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 consider how to react depending on the value of the indicator such corrective actions. • Aweight indicating its importance e.g. related to an objective. This defines a form for the minimum description of each indicator. The form will support the creation of 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 the indicator description is the definition of evaluation functionality for each indicator. This needs to be related to the environment the indicator is used in 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. The values specified enable 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. The indicators and external factors (see next section) are grouped bythe key performance indicator (KPI) at level 2.
External factor	According to D2.1 and the additions in D2.2 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 is also known asexternal 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 Bankopen 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 BSC framework (see section 3) has different KPI blocks which consist of indicators and factors. The description of an external factors is specified in similar way to an indicator and consists of:: • 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 limitof the external factor set, e.g. 0,186 could be the most expensive country for industrial electricity prices Max (best) value is the upper limitof the external factor data set, e.g. 0,042 for the cheapest country in terms of industrial electricity prices Note: the lowest limitcan 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 how up to date the data is, e.g. 2013 or 2014. To enable an evaluation based on different external factors with different units, the

	values have to be normalised within the 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. 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. Taking “key partner” as an example for a business model component then 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. The motivation for business rule is always an entrepreneurial goal. 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 falls bellows it's the minimum stock specified, the item should be ordered at the supplier.

	All these rules are dealing with the business and regulating aspects of the business and thus can be generalised. Business rules are commonly classified in three different categories as follows: • 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 are always 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 launch, prevent or allow actions, e.g. "If a new customer places an order, the creditworthiness has to be checked." This examples demonstrate one thing: Every enterprise has business rules, even if they are sometimes not documented and every IT system contains some business rules. 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 require 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 influenceboth the global production network configuration and guidelines on the implementation of projects. It is also important that the guidelines are known and applied. However, management systems need a mechanism to adapt these guidelines if the environment changes. WP2 proposes coding the business rules in a standard XML format. This will provide the capability to use and update the business rules across different levels and applications.

<table>
<tr><td>Business model element

Business model component</td><td>
</td></tr>
<tr><td>Revenue driver</td><td>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).</td></tr>
<tr><td>Cost driver</td><td>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.</td></tr>
</table>