Analysis of the system
Motorways of the Sea

This report is part of Work Package D of the *MoS Strategic Demonstration Project – StratMoS* funded as part of the INTERREG IV B North Sea Programme.

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Preliminary Comments

This report will be developed in a modular way over the whole project. This structure gives consideration to the methodology of 'systems analysis' which is applied in an iterative way and which needs to reflect future conclusions on former findings. The sections which will be completed in later versions are marked in the text. The main changes of this version (compared to version 2) have been made in chapters 2, 3 and 5.

It is planned to publish a last and final version by the end of 2010.

Content

1 Introduction

This chapter presents the background and motivation for this study, clarifies the objective and target group and explains the methodological approach taken.

1.1 Background

Several networks and corridors for freight transport currently exist in the North Sea region (NSR), also extending into neighbouring regions such as the Baltic Sea and North West Europe. These corridors are not always precisely defined, and have also to some extent been developed independently of each other. They are further characterised by missing links, suboptimal interoperability and various administrative bottlenecks. There is therefore a need to develop functional concepts for connecting such networks and corridors in terms of requirements for infrastructure, facilities, organisational arrangements and mechanisms for cooperation. Such connecting concepts would contribute to a more coherent and efficient freight transport network in the NSR and beyond, thus improving the overall multimodal accessibility in this region.

The EU concept of Motorways of the Sea (MoS) is similar yet different from the existing short sea shipping lines operating in European waters[1]. This presents challenges in several respects. Firstly, it is still in some instances difficult to communicate to those, who might potentially foster, implement, operate or benefit from Motorways of the Sea what these differences actually are and why they are important. Secondly, it is not always easy for those involved with MoS to be definite themselves, what activities or elements are part of or connected to Motorways of the Sea and which are not. Therefore, it is not always easy to have a clear overview over the MoS system, what is needed to make it work and how this could best be achieved.

1.2 Objective and target group

The overall objective of the StratMoS WP D ‘Transport Networks and Corridors’ is to develop functional concepts for connecting transport networks, comprising hubs and transport corridors, by defining requirements for investments in infrastructure and facilities as well as for organisational arrangements and mechanisms for cooperation. The specific objectives for constructing a MoS systems model in WP D are to help clarify the definition, (necessary) activities and actors relevant to MoS to help make decision making on and planning and implementation of MoS projects more focused, efficient and effective.

The approach ‘systems analysis’ helps to identify all the relevant variables and the dynamics of their interactions, which together comprise system ‘MoS’ and its purpose in a transport network.

The main target groups for the results of the systems analysis are transport, logistics and port related public actors at all levels (regional, national, European). The aim is to sensitize these target groups to the significant variables they have to concentrate on to achieve a desired result. Private companies realising projects in the MoS-system can also benefit from this work.

The decision maker‘s benefit is to gain insight into and transparency of the whole system, not only the parts he or she is involved in. Additionally the benefit is to learn which variable should be changed (and which not) and which effects would be caused by any changes as a basis for planning, regulating and controlling the system. The systems analysis will help to

[1] See this link for more information:
http://ec.europa.eu/transport/maritime/motorways_sea/motorways_sea_en.htm.

understand the interrelations in the system and enable the decision makers to effectively focus their activities.

1.3 Methodological approach

The *systems analysis* approach helps to identify all the relevant variables which have to be considered to represent the system. Apart from elaborating, which variables are important and in what way, it is necessary to describe and analyse how they interact with each other. If no other source is named, the following approach is based on the so called *'Sensitivitäts-modell'* and the '*Papiercomputer'* which were developed by Prof. Vester[2].

To develop a reliable systems model the following steps are required:

- defining the system boundaries,
- developing a set of significant variables,
- describing the impact of these variables upon each other and
- analysing the resulting interrelations.

The process is iterative, as one step can generate new findings for the preceding step. Therefore the results of one step always need to be reflected against the results of the other steps (see Figure 1).

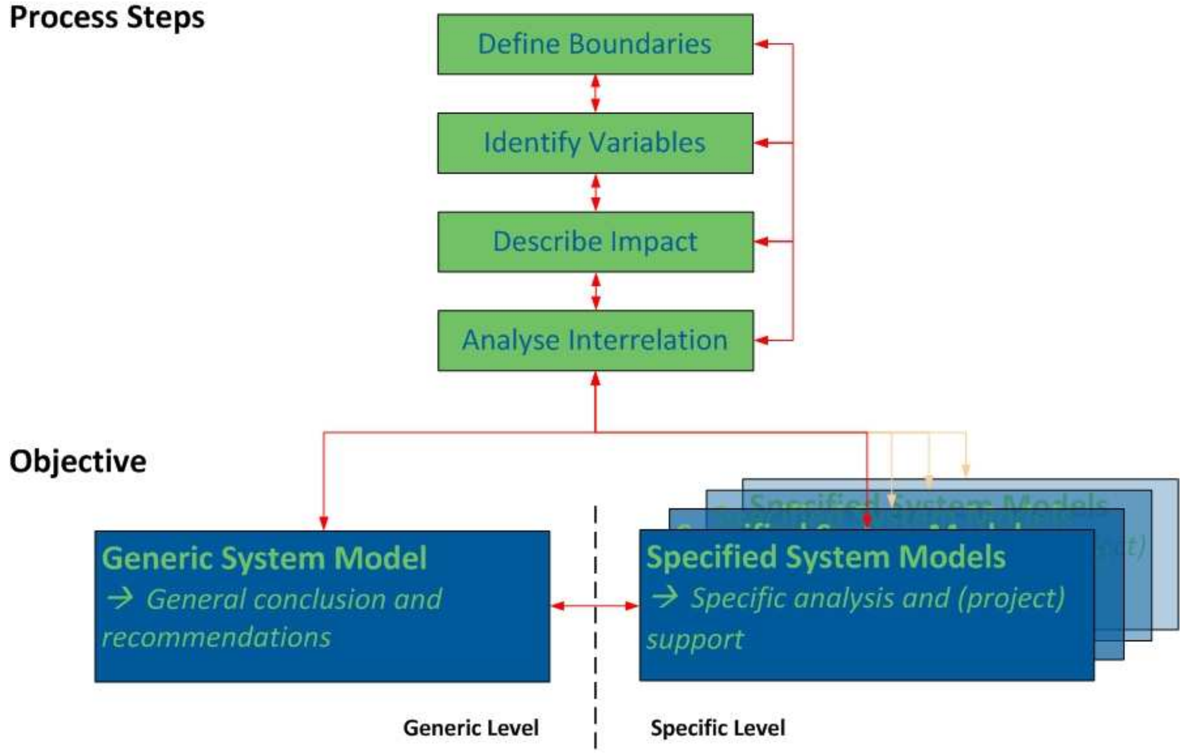


Figure 1: Systems analysis: iterative approach with two objective levels

Within the StratMoS project, there are two objective levels which are targeted by the approach. On the one hand there is a generic level, wherein a generic systems model will be developed to derive general conclusion and recommendations for the overall system MoS. On the other hand, specific systems models will be developed for some of the Demonstration

2 Sources:
Vester, Frederic: Ausfahrt Zukunft – Supplement zur Systemuntersuchung. München 1991
Vester, Frederic; Hesler, Alexander von: Sensitivitätsmodell. Forschungsbericht 80-101 040 34. Im Auftrag des Umweltbundesamtes, 1980

Projects (DPs), which are part of the StratMoS project. These specific models are intended to support the project in deriving measures and/or in evaluating future scenarios. In addition to this, these specific models will help to calibrate the generic model and make it more realistic.

In building the systems model, it was decided to mix deductive and inductive approaches. At first, all the steps were taken required to develop the generic model up to a certain extent. This provided the basis for working on the specific models for the different DPs. These specific models are then fed back to optimise the generic model via practical examples.

To illustrate the methodology, an example of a completed systems analysis is presented below. This will clarify possible achievements, conclusions which can be drawn from such an analysis and the benefits for the target group.

The following results are taken from the research project: 'Potential of urban development and traffic route infrastructure'[3]. The example in Figure 2 shows the variable 'road infrastructure' as a part of the whole system. It illustrates the role of different variables in the system and their dynamic interaction.

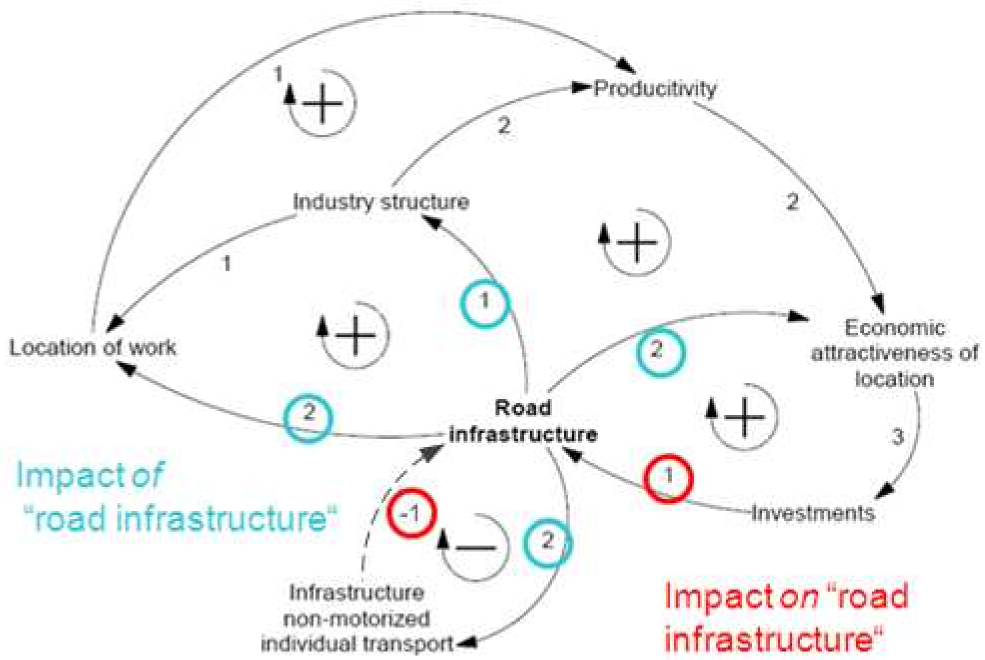


Figure 2: Example of a final result showing the impact from and on a variable

The direction of the variables' impact is visualized by the arrows, numbers 1, 2 and 3 represent the relative strength of the impact. By quantifying the strength of the direct impact, the role of the variables in the system can be analysed.

On the one hand, the impacts *on* one specific variable (marked red in the example: two on 'road infrastructure') are of interest, on the other hand the impact *of* one specific variable on the others (marked blue in the example: seven from 'road infrastructure') are considered.

[3] Source: Forschungs- und Entwicklungsvorhaben des Bundesministeriums für Verkehr-, Bau- und Wohnungswesen. Schlussbericht: 'Stadtentwicklungspotentiale und Verkehrswegeprojekte', Dezember 2001.

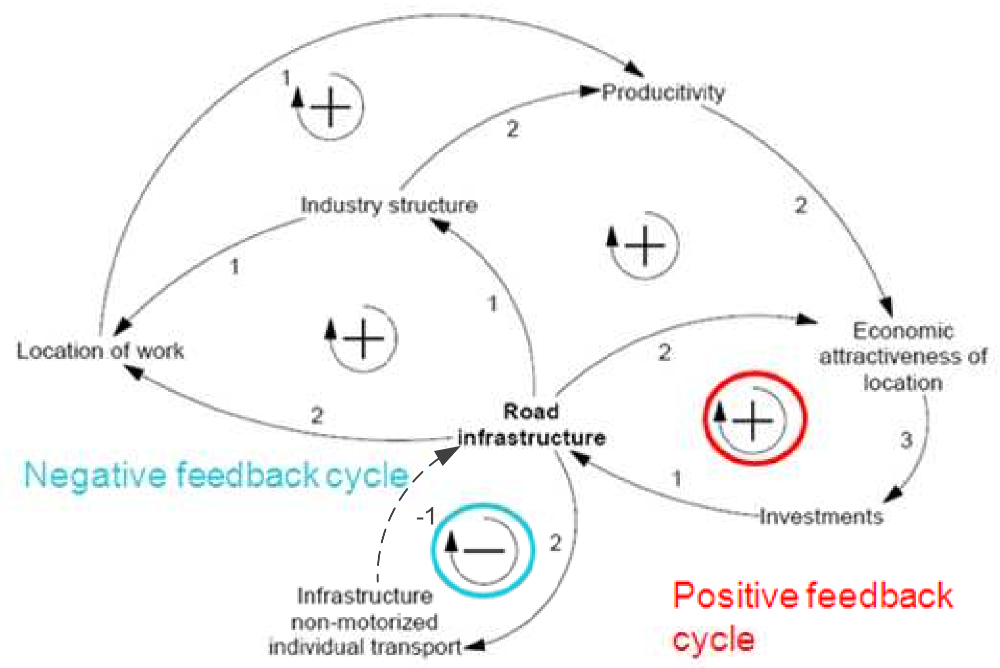


Figure 3: Example of a final result showing the feedback cycles involving one variable

The positive and negative loops in Figure 3 illustrate the feedback cycles within the system. Positive feedback causes a reinforcement of the impacts (more leads to more, less leads to less). Negative feedback cycles are a sign of balance, they have a self-regulating influence within the system.

The impact of 'road infrastructure' has an enforcing influence on the 'economic attractiveness of location', 'industry structure' and on 'location of work'. Following the impact loops, these variables again have an enforcing impact on other variables, which feed an enforcing impact back to 'road infrastructure'. Thus better/more road infrastructure will generally lead to better/more road infrastructure, an impairment of infrastructure leads to impairment. This is due to the domination of positive feedback cycles.

The different process steps required for systems analysis are described in the following sections.

1.3.1 Defining the system boundaries

Before starting the analysis of a system it is of great importance to delineate the system boundaries. Therefore the objective of the systems analysis has to be clearly defined. Based on these, the system boundaries can then be formulated, i.e. which aspects will be considered and which will be considered to be beyond the limits of the investigation. Thus, first of all the object of the analysis (what?) is of interest. In addition to this and depending on the context, it might also be useful to define the spatial expanse/location (where?) and the time of investigation (when?).

1.3.2 Developing a set of significant variables

The set of variables should comprise all the relevant elements which are needed to describe the system.

Rules for developing the set of variables:
The set of variables should be as precise as necessary but as broad as possible.

Variables are variable factors with the following properties

- They can be ‘hard’ (e.g. frequency) or ‘soft’ (e.g. image) variables.
- They have to be measurable via indicators (qualitative or quantitative).
- They have an impact on other variables, but they are also influenced by other variables.

It is recommended to define subsystems to structure the set.

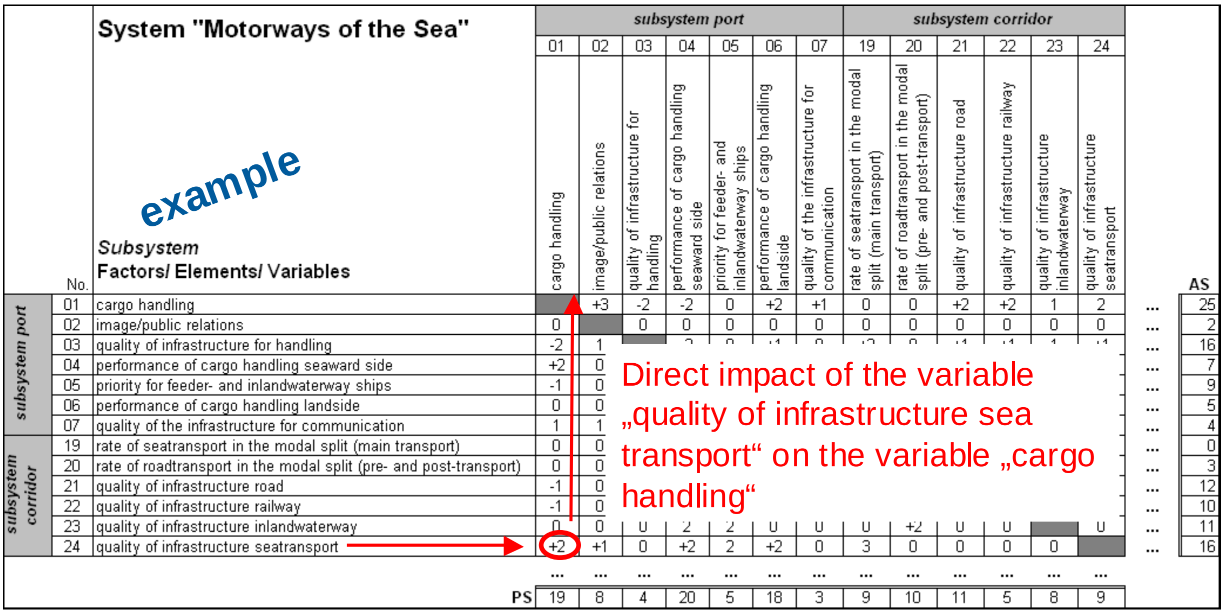
A *description* has to be formulated for each variable for a clearer understanding. It is advisable to formulate the definition including a (desired) direction of development to enable the evaluation of impacts: It is easier to evaluate „What is the impact of increased cargo handling on the improvement of the port‘s image?“, than evaluating „What is the impact of cargo handling on image?“.

Indicators have to be identified, which have to be kept in mind to describe the impact of/on the variables.

External impacts also have to be taken into consideration to bear in mind effects from outside the system.

1.3.3 Describing the impacts

For analysing the impacts within the system, every variable has to be considered against every other variable. For this, a cross-impact-matrix is used, in which the impact of one variable upon the others can be quantified (see example in Figure 4).



System "Motorways of the Sea"

Subsystem	No.	*Subsystem* Factors/ Elements/ Variables	01 cargo handling	02 image/public relations	03 quality of infrastructure for handling	04 performance of cargo handling seaward side	05 priority for feeder- and inlandwaterway ships	06 performance of cargo handling landside	07 quality of the infrastructure for communication	19 rate of seatransport in the modal split (main transport)	20 rate of roadtransport in the modal split (pre- and post-transport)	21 quality of infrastructure road	22 quality of infrastructure railway	23 quality of infrastructure inlandwaterway	24 quality of infrastructure seatransport		AS
			subsystem port							*subsystem corridor*							
subsystem port	01	cargo handling		+3	-2	-2	0	+2	+1	0	0	+2	+2	1	2	...	25
	02	image/public relations	0		0	0	0	0	0	0	0	0	0	0	0	...	2
	03	quality of infrastructure for handling	-2	1		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	...	16
	04	performance of cargo handling seaward side	+2	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	...	7
	05	priority for feeder- and inlandwaterway ships	-1	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	...	9
	06	performance of cargo handling landside	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	...	5
	07	quality of the infrastructure for communication	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	...	4
subsystem corridor	19	rate of seatransport in the modal split (main transport)	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	...	0
	20	rate of roadtransport in the modal split (pre- and post-transport)	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	...	3
	21	quality of infrastructure road	-1	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	...	12
	22	quality of infrastructure railway	-1	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	...	10
	23	quality of infrastructure inlandwaterway	0	0	0	2	2	0	0	0	+2	0	0		0	...	11
	24	quality of infrastructure seatransport	+2	+1	0	+2	2	+2	0	3	0	0	0	0		...	16
			...	...	...	...	...	...	...	...	...	...	...	...	...		
		PS	19	8	4	20	5	18	3	9	10	11	5	8	9		

Figure 4: Cross-impact matrix: quantification of the variables’ impact on each other

Rules for completing the cross-impact-matrix:

The crucial question is: *If variable A changes, how strongly does variable B change because of the direct impact of variable A on variable B?*

The *direction* of the impact can be expresses by the algebraic signs:

- mutually reinforcing impact → **+**
- opposing impact → **-**

The strength of the impact can be quantified as follows:

- no/very little impact → 0
- weak/ little impact → 1

- strong impact → 2
- very strong impact → 3

Only the direct impact of variable A upon B should be considered.

Consider the impact of ‚A on B‘ - not ‚B on A‘ or the ‚relationship between A and B‘.

Evaluate the impact line by line and finish one variable before starting the next one. Since the evaluation is relative, it is recommended to first identify the relations without impact (evaluation: 0) and the ones with very strong impact (evaluation: 3) in each line, others can then be fitted inbetween.

1.3.4 Analysing the interrelations

Role of the variables

The outputs from of the cross-impact matrix consist of some simple calculations (see Figure 5). For each of the variables, the active sum (AS) and the passive sum (PS) are calculated. The active sum (line sum using absolute values) expresses the overall level of impact of the variable in question upon the other variables of the system. The passive sum (column sum using absolute values) describes the overall impact all other variables have on the variable in question.

example

	No.	System "Motorways of the Sea" *Subsystem* Factors/ Elements/ Variables	01 cargo handling	02 image/public relations	03 quality of infrastructure for handling	04 performance of cargo handling seaward side	05 priority for feeder- and inlandwaterway ships	06 performance of cargo handling landside	07 quality of the infrastructure for communication	19 rate of seatransport in the modal split (main transport)	20 rate of roadtransport in the modal split (pre- and post-transport)	21 quality of infrastructure road	22 quality of infrastructure railway	23 quality of infrastructure inlandwaterway		AS
			subsystem port							*subsystem corridor*						
subsystem port	01	cargo handling		3	2	2	0	2	1	0	0	2	2	1	...	25
	02	image/public relations	0		0	0	0	0	0	0	0	0	0	0	...	2
	03	quality of infrastructure for handling	2	1		2	0	2	0	2	0	1	1	1	...	16
	04	performance of cargo handling seaward side	2	0	0		0	2	0	0	0	0	0	0	...	7
	05	priority for feeder- and inlandwaterway ships	1	0	0	1		1	0	0	0	0	0	2	...	9
	06	performance of cargo handling landside	0	0	0	2	0		0	0	0	0	0	0	...	5
	07	quality of the infrastructure for communication	1	1	0	1	0	0		0	0	0	0	0	...	4
subsystem corridor	19	rate of seatransport in the modal split (main transport)	0	0	0	0	0	0	0		0	0	0	0	...	0
	20	rate of roadtransport in the modal split (pre- and post-transport)	0	0	0	0	0	0	0	0		0	0	0	...	3
	21	quality of infrastructure road	1	0	0	1	0	2	0	1	2		0	1	...	12
	22	quality of infrastructure railway	1	0	0	1	0	2	0	0	2	0		0	...	10
	23	quality of infrastructure inlandwaterway	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		...	11
															...	16
			...	...	...	...	...	...	...	...	...	...	...	...	...	
		PS	19	8	4	20	5	18	3	9	10	11	5	8	9	

Figure 5: Cross-impact matrix: active and passive sum

The active and passive values are then used for further calculations. For each variable the product (P = AS x PS) and the quotient (Q = AS/PS) are calculated. From these, the role of the variables can be deduced as follows: The higher the product (P) of the active and passive sums, the more integrated the variable is. It has influence on the other variables and is also influenced by them. Such variables are called *critical*. The opposite, variables with a low level of integration, are called *buffering*. The quotient (Q) of active and passive sum describes a variable's influence within the system. The higher the quotient (i.e. the active sum is much higher than the passive sum) the more regulating a variable can be. Such variable have a lot of influence on other variables but are not much influenced by others, they are called *active*. The opposite are *reactive* variables, they are commonly used as indicators, as they have not much influence on other variables, but others have a strong effect on them.

Influence	**Q-values**	**Integration**	**P-values**
highly active	> 2,25	highly critical	> 2,5 $*(n-1)^2$
active	1,61 - 2,25	critical	1,71-2,5 $*(n-1)^2$
moderately active	1,31 - 1,60	moderately critical	1,21-1,70 $*(n-1)^2$
neutral	0,76 - 1,30	neutral	0,81-1,20 $*(n-1)^2$
moderately reactive	0,63 - 0,75	moderately buffering	0,51-0,80 $*(n-1)^2$
reactive	0,45 - 0,62	buffering	0,16-0,50 $*(n-1)^2$
highly reactive	< 0,45	strongly buffering	< 0,16 $*(n-1)^2$
(neutral line)	1,00	(neutral line)	$(n-1)^2$

n = number of variables

Table 1: Scales for interpreting levels of influence and integration

Table 1 presents value ranges for interpreting the Q- and P-values. The level of influence (left columns) is independent of the system, as it relies solely on the relation of active and passive sums. The level of integration (right columns) on the other hand also depends on the number of variables within the system.

In addition to the numerical analysis, it is important to use visualisation as illustrated in Figure 6 and Figure 7. The areas of influence and integration are illustrated in Figure 6.

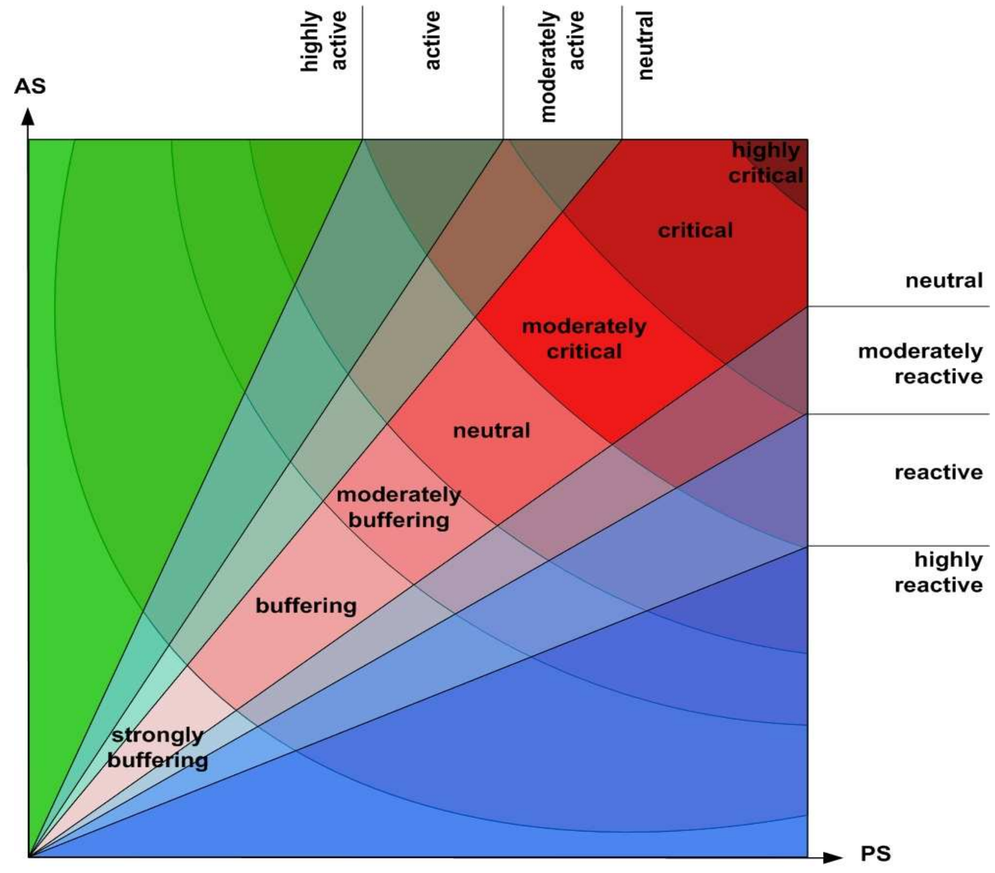


Figure 6: Areas of influence and integration

Depending on their active (AS) and passive sums (PS), all the variables can be arranged along two axes. According to the classification determined by the areas illustrated above, the variables' roles in the system can be derived as described in Figure 7.

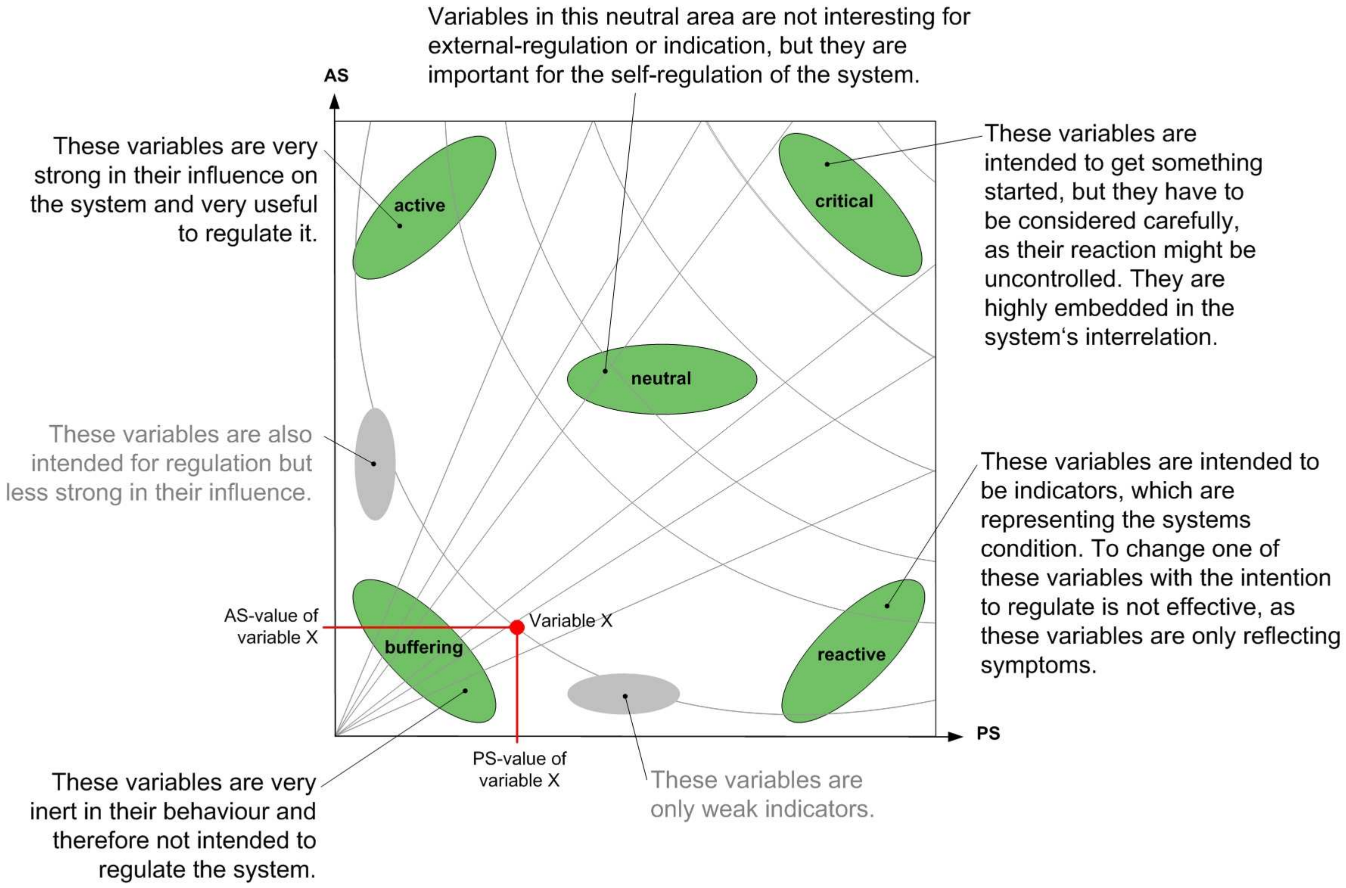


Figure 7: Role of the variables depending on their active and passive sum

Impact cycles

Concerning the dynamics between variables it is not only the strength but also the quality of the impact which is important for interpreting the interrelations. It is of great interest if the impact is mutually reinforcing (positive feedback cycle, i.e. more leads to more, less leads to less) or if they are regulating (negative feedback cycle, i.e. more leads to less, less leads to more). In Figure 8 and Figure 9 respective examples from the MoS system are shown.

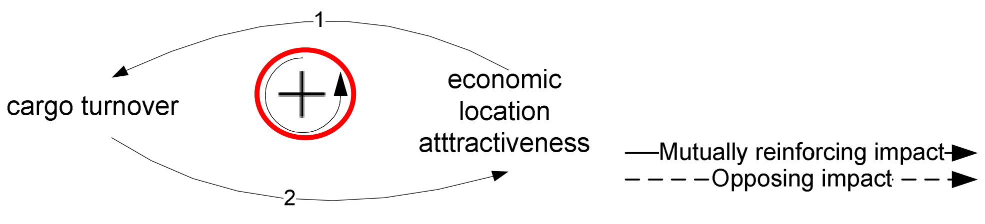


Figure 8: Positive feedback cycle

An example for a positive feedback cycle would be: The more cargo a port handles, the more attractive is this hub for economy. This increasing economic location attractiveness leads again to an increasing cargo turnover, since the more companies settle down or the more service is offered in the hub, the more cargo is available.

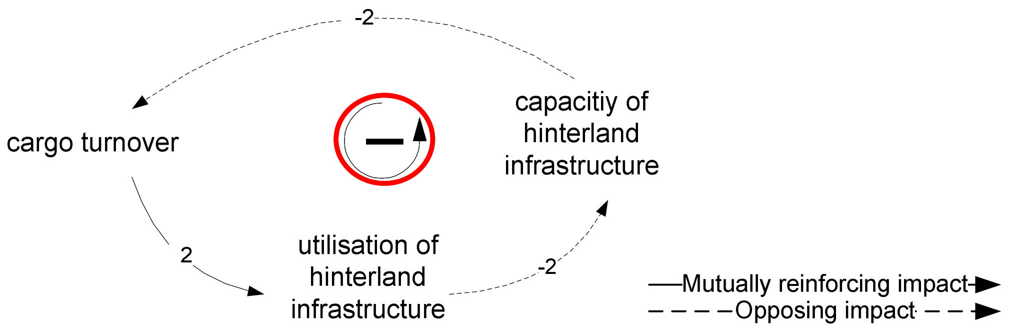


Figure 9: Negative feedback cycle

Figure 9 shows a negative feedback cycle: The more cargo a port handles, the more the hinterland infrastructure is utilised, which decreases the capacity of the hinterland infrastructure. Once the capacity of the hinterland infrastructure is exceeded, this effect leads to less cargo handling, as it cannot be transported efficiently on the hinterland infrastructure.

1.3.5 Working on the process steps in StratMoS

The development of the systems model was mainly divided into two types of work: workshops and deskwork. This approach relies heavily on group work, since for a realistic system analysis as many perspectives as possible have to be integrated. This group work was organised in workshops with participation of StratMoS project partners (minutes from these workshops can be found on the StratMoS homepage). To prepare propositions (variables, definitions, indicators) as a basis for these workshops and to structure the results, intensive deskwork was also important, which was carried out by the authors of this report.

2 The generic system *Motorways of the Sea*

This version of this chapter presents the current results of the process of building the generic systems model. As explained above, the chosen methodology is iterative and further work on the specific systems model for the StratMoS demonstration projects will be used to adjust the generic model in future versions of this report[4]. The final version will become available in the second half of 2010.

2.1 Boundaries of the MoS-system

The objectives of the EU MoS concept were taken as a baseline for defining the boundaries of the MoS-system. The main objective is to concentrate freight flows on reliable short sea shipping links considering the integration in door-to-door- logistic chains. Additionally, it is stressed, that the relevant activities shall support more sustainable mobility of freight. Following a discussion during the first workshop, the system boundaries were defined as follows:

The system *Motorways of the Sea* comprises all the factors which are needed to enhance the implementation and utilisation of MoS-corridors. This includes the relevant elements of the transport chain: the seaport, the (first) hinterland-hub, the corridor inbetween the two, the parameters which are significant for the MoS service and the factors which immediately influence these parameters (e.g. funding, environment, etc).

2.2 Variables and subsystems of the system MoS

To identify the variables of the MoS-system, a draft set was presented, discussed and amended as part of the first workshop on the systems model.

The feedback from the specification process, see chapter 3, confirmed this choice of variables. Apart from some changes of names and descriptions, the set of variables became the final one.

The resulting MoS-system finally comprises 27 variables.

The subsystem *hubs* and *corridors* comprise all the relevant variables of the MoS transport chain. The subsystem *service* contains all the variables relevant to the haulage market. The subsystem *sustainability* contains the wider economic, social and environmental dimensions relevant in the system. Within the subsystem *funding*, important financing mechanisms are brought together, as MoS is not a concept, which is initially meant to be solely reliant on market forces but receives targeted start-up subsidies from the EU level (albeit with the goal of such services becoming economically self-sustaining in the medium term).

The full set of variables including indicators and outside influences can be found in Annex A.

No.	Name	Description
01	cargo turnover seaport	increasing cargo turnover in a seaport
02	consideration of SSS/ feeder vessels in the seaport	strengthening priority for short sea shipping and feeder vessels in the seaport
03	cargo turnover hinterland-hub	increasing cargo turnover at the hinterland-hub

[4] See also procedural explanations on the modular structure of this report in the *Preliminary Comments* on the front page.

04	demand for MoS at a sea port[5]	increasing the demand for MoS at a sea port
05	quality of hub organisation and operation	improving the quality of hub organisation and operation
06	quality of hub facilities	improving the quality of hub facilities
07	accessibility of hubs	improving the hinterland infrastructure
08	shift to sea-based transport	increasing the share of sea-based transport in the modal split (long haulage)
09	quality of road infrastructure	improving the quality of road infrastructure (long haulage competing corridor to the sea corridor)
10	quality of railway infrastructure	improving the quality of railway infrastructure (long haulage competing corridor to the sea corridor)
11	quality of seaward infrastructure	improving the quality of seaward infrastructure
12	availability of MoS-connections at the port/hinterland hub	increasing the availability of MoS-connections
13	regularity	increasing the regularity
14	frequency of services	increasing the frequency of services
15	security of goods transported	improving security of goods transported
16	speed of the MoS-service	increasing the speed
17	price of the MoS-service	decreasing the price relative to other transport chains
18	simplicity of MoS-service	increasing the simplicity of MoS-service
19	awareness of MoS-services	increasing the awareness of MoS among relevant actors
20	local emissions	decreasing local emissions
21	global climate change emissions	decreasing global climate change emissions
22	residential quality	increasing the social location attractiveness
23	economic location attractiveness at the port/hinterland hub	increasing the economic location attractiveness
24	MoS-funding	increasing the attractiveness of MoS-funding
25	Marco Polo-funding	increasing the attractiveness of Marco Polo-funding
26	other EU budget for investment/funding/subsidies	increasing the EU-budget for investment/funding/subsidies (including funding of potentially competing systems)
27	overall national /regional budget for investment/ funding/ subsidies	increasing the national/ regional budget for investment/ funding/ subsidies (including funding of potentially competing systems, including private investments)

Table 2: Set of variables of the generic MoS systems model

To cluster these variables, five subsystems were defined as shown in Figure 10.

[5] The factor's name will be changed to 'demand for MoS-connections at a sea port' while developing the specific models.

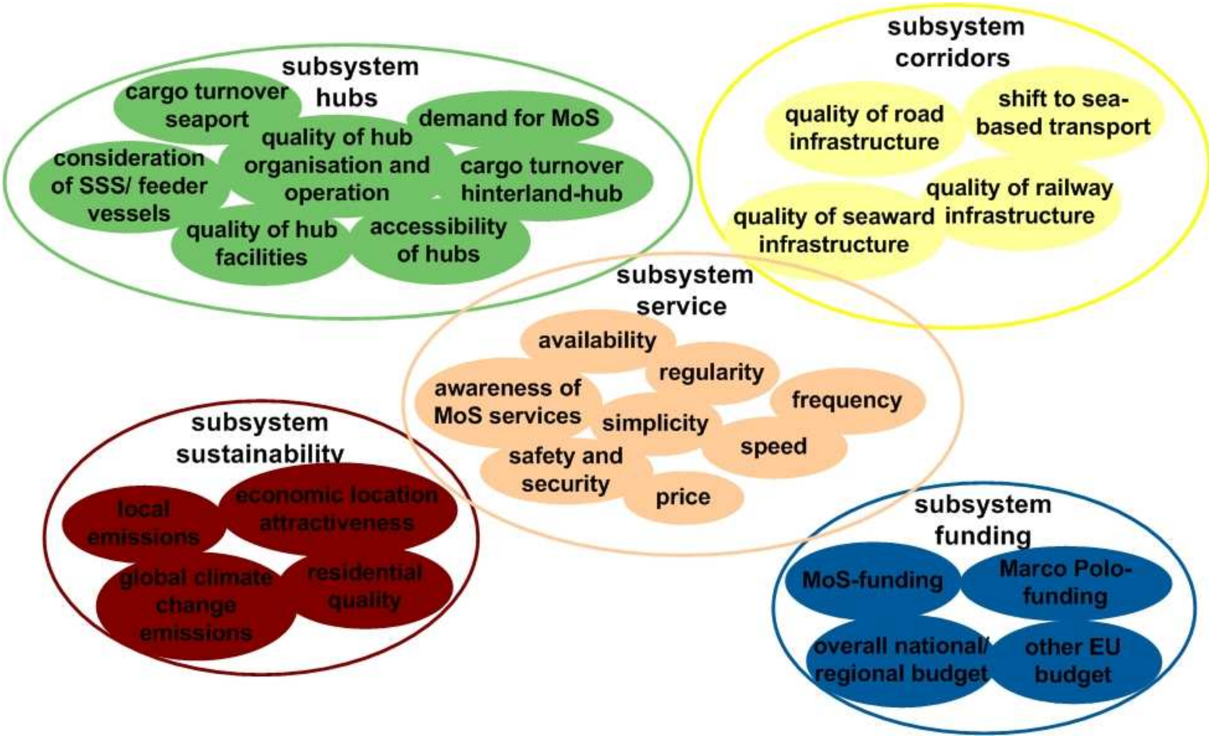


Figure 10: Variables clustered into subsystems

2.3 Cross-impact matrix

A first draft of the cross-impact matrix was also completed during the first workshop. Any inconsistencies in the evaluation of the impacts were later amended by the authors.

During the specification process, see chapter 3, the matrix was adapted. The changes made are documented in detail in chapter 3.3.3. The draft matrix from the first workshop can be found in Annex B.

The completed final matrix is shown in Figure 11 (see section 1.3.3 for the methodological background). Every variable is assessed against all other variables regarding the strength and quality of the impact it has on them. The strength of the impact is quantified by 0 for no impact, 1 for weak impact, 2 for strong impact and 3 for very strong impact. The quality is expressed by algebraic signs: positive impacts (marked in green) are enhancing, while negative impacts (marked in red) have a reducing effect. The last two columns on the right comprise the calculated active sums (AS) and passive sums (PS) for every variable.

Overall, 702[6] possible impact combinations were evaluated. Of these, 163 did not equal 0, i.e. in these combinations an impact was diagnosed. A weak impact was identified 77 times, a strong impact 65 times and a very strong impact 21 times.

The completed matrix is the basis for the analysis of the interrelations described in the following chapter.

[6] Since one variable has no impact on itself, 27 x 26 = 702 combinations are possible.

System *Motorways of the Sea*: IMPACT of → on ↑		No.	subsystem hub	1 cargo turnover sea port	2 consideration of SSS/ feeder vessels in the seaport	3 cargo turnover hinterland-hub	4 demand for MoS-connections at a sea port	5 quality of hub organisation and operation	6 quality of hub facilities	7 accessibility of hubs	subsystem corridor	8 shift to sea-based transport	9 quality of road infrastructure	10 quality of railway infrastructure	11 quality of seaward infrastructure	subsystem MoS service	12 availability of MoS-connections at the port/hinterland hub	13 regularity of MoS-service	14 frequency of services	15 security of goods transported	16 speed of the MoS-service	17 price of the MoS-service	18 simplicity of MoS-service	19 awareness of MoS-services	subsystem sustainability	20 local emissions	21 global climate change emissions	22 residential quality	23 economic location attractiveness at the	subsystem funding, subsidy, investment	24 MoS-funding	25 Marco Polo-funding	26 other EU budget for investment/funding/subsidies	27 overall national/regional budget for investment/funding/subsidies	AS	PS
subsystem hub			0,74								0,21					0,79									0,64					0,32						
	cargo turnover sea port	1			0	3	2	0	0	-3		1	0	0	-1		0	0	0	0	0	0	0	0		-2	-1	-1	2		0	0	0	3	19	12
	consideration of SSS/ feeder vessels in the seaport	2		0		0	1	0	0	0		1	0	0	0		2	3	0	0	1	0	0	1		0	0	0	0		0	0	0	0	9	4
	cargo turnover hinterland-hub	3		1	0		1	0	0	-3		0	0	0	0		0	0	0	0	0	0	0	0		-1	-1	-1	2		0	0	0	2	12	13
	demand for MoS-connections at a sea port	4		0	2	0		0	0	0		0	0	0	0		3	-1	3	0	0	-1	1	0		0	0	0	1		1	1	0	2	16	27
	quality of hub organisation and operation	5		2	0	1	0		0	0		0	0	0	2		1	3	0	3	2	1	2	2		2	0	0	1		0	0	0	0	22	8
	quality of hub facilities	6		2	0	2	0	2		0		0	0	0	1		1	2	0	2	1	2	0	1		0	0	0	1		0	0	0	0	17	6
	accessibility of hubs	7		3	0	3	0	0	0			0	0	0	0		1	3	0	0	1	0	0	0		0	0	0	2		0	0	0	0	13	14
subsystem corridor			0,21								0,50					0,19									0,63					0,00						
	shift to sea-based transport	8		0	0	0	0	0	0	0			1	1	-1		0	0	0	0	0	0	1	0		-1	1	0	0		0	0	0	0	6	10
	quality of road infrastructure	9		0	0	0	-2	0	0	0		-1		0	0		0	0	0	0	0	0	0	0		0	-3	0	2		0	0	0	0	8	4
	quality of railway infrastructure	10		0	0	1	-1	0	0	0		0	0		0		0	0	0	0	0	0	0	0		0	0	0	1		0	0	0	0	3	5
	quality of seaward infrastructure	11		0	0	0	2	0	0	0		2	0	0			1	2	0	0	2	0	0	0		0	0	0	2		0	0	0	0	11	14
subsystem MoS service			0,46								0,16					0,52									0,06					0,06						
	availability of MoS-connections at the port/hinterland hub	12		3	1	2	2	0	0	0		2	0	0	-1			0	1	0	0	2	2	2		0	0	0	1		0	0	0	0	19	17
	regularity of MoS-service	13		0	0	0	2	0	0	0		0	0	0	0		0		0	2	0	0	1	0		0	0	0	0		0	0	0	0	5	18
	frequency of services	14		0	0	0	2	0	0	-1		0	0	0	-1		0	0		0	0	0	0	0		-1	0	0	0		0	0	0	0	5	9
	security of goods transported	15		0	0	0	2	0	0	0		0	0	0	0		0	1	0		0	-1	0	0		0	0	0	0		0	0	0	0	4	14
	speed of the MoS-service	16		0	0	0	2	0	0	0		0	0	0	0		2	0	2	0		-1	1	0		0	0	0	0		0	0	0	0	8	8
	price of the MoS-service	17		0	0	0	3	0	0	0		0	0	0	0		1	0	0	0	0		0	0		0	0	0	0		0	0	0	0	4	8
	simplicity of MoS-service	18		0	0	0	3	0	0	0		1	0	0	0		0	0	0	0	0	0		0		0	0	0	0		2	0	0	0	6	13
	awareness of MoS-services	19		0	1	0	2	0	0	0		0	0	0	0		2	3	0	2	1	0	2			0	0	0	0		0	0	0	0	13	6
subsystem sustainability			0,07								0,13					0,00									0,33					0,31						
	local emissions	20		0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0	0	0			0	2	0		0	0	0	-1	3	7
	global climate change emissions	21		0	0	0	0	0	0	0		2	0	0	0		0	0	0	0	0	0	0	0		0		1	0		0	0	-1	-1	5	6
	residential quality	22		0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0	0	0		0	0		1		0	0	0	0	1	6
	economic location attractiveness at the port/hinterland hub	23		1	0	1	0	0	0	0		0	0	0	0		0	0	0	0	0	0	0	0		0	0	0			0	0	0	2	4	18
subsystem funding, subsidy, investment			0,68								0,88					0,44									0,19					0,58						
	MoS-funding	24		0	0	0	0	2	3	3		0	0	0	2		0	0	1	1	0	0	1	0		0	0	0	0			0	0	0	13	3
	Marco Polo-funding	25		0	0	0	0	2	1	0		0	0	1	2		2	0	2	1	0	0	2	0		0	0	0	0		0		0	3	16	1
	other EU budget for investment/funding/subsidies	26		0	0	0	0	0	0	1		0	1	1	1		0	0	0	1	0	0	0	0		0	0	0	0		0	0		2	7	3
	overall national/regional budget for investment/funding/subsidies	27		0	0	0	0	2	2	3		0	2	2	2		1	0	0	2	0	0	0	0		0	0	1	2		0	0	2		21	16

Figure 11: Cross-impact matrix of generic MoS systems model

2.4 Interrelations analysed

Based on the results of the completed cross-impact matrix, the interrelations within the subsystems can be analysed. Once again it should be mentioned, that the results presented hereinafter are a first version and an adaptation after iterative steps of the process is possible.

2.4.1 Role of the variables

The active and passive sums (see section 1.3.4 for methodological background) of every variable are illustrated in Figure 12. On the one hand the actual values of the active and passive sums are of interest, but on the other hand also the relation of both.

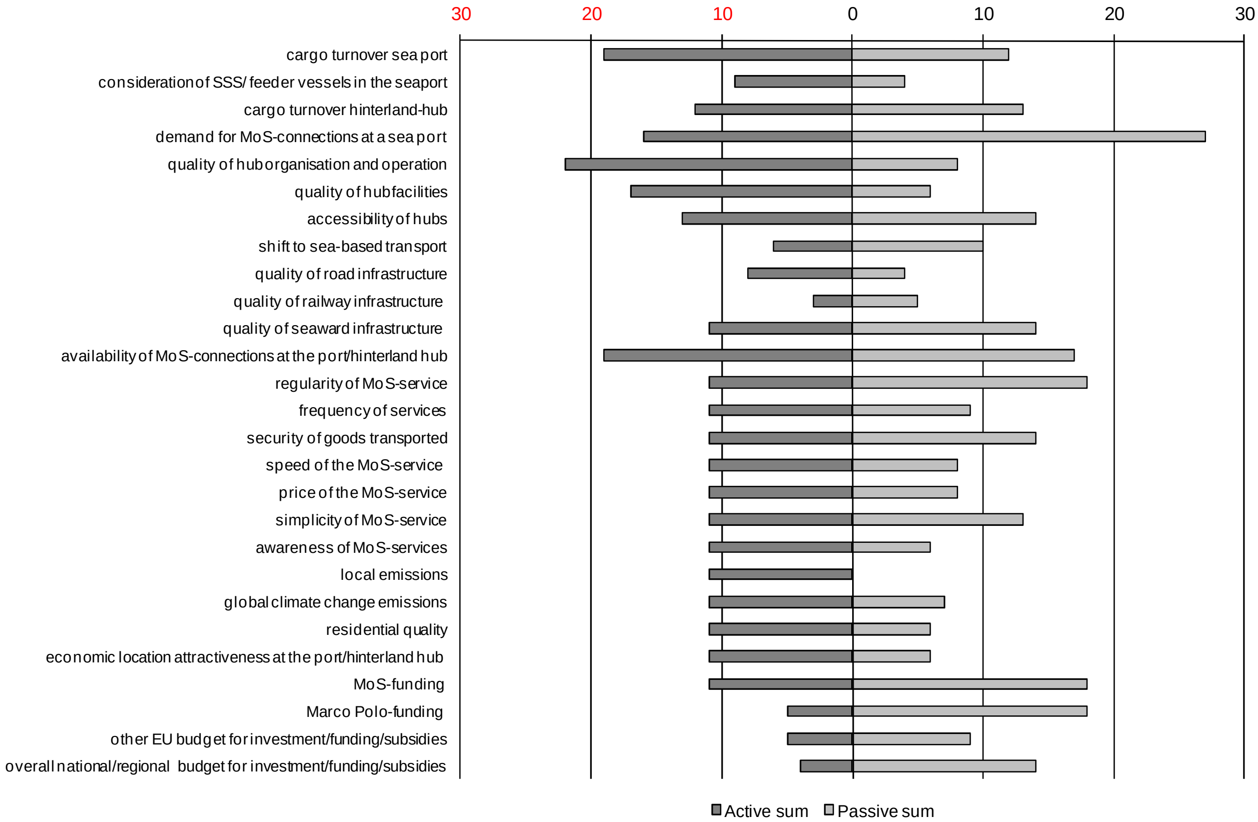


Figure 12: Active and passive sums of each variable

Table 3 shows the value ranges for interpreting the generic systems model, which are the basis for classifying the variables. In Annex A the quantitative results of the cross-impact matrix are shown for each variable.

Influence	**Q-values**	**Integration**	**P-values**
highly active	> 2,25	highly critical	> 1690
active	1,61 – 2,25	critical	1155,96 – 1690
moderately active	1,31 – 1,60	moderately critical	817,96 – 1149,2
neutral	0,76 – 1,30	neutral	547,56 – 811,2
moderately reactive	0,63 – 0,75	moderately buffering	344,76 – 540,8

reactive	0,45 – 0,62	buffering	108,16 – 338
highly reactive	< 0,45	strongly buffering	< 108,16
(neutral line)	1,00	(neutral line)	676

(n = 27)

Table 3: Scales of influence and integration for the generic systems model

The results of this classification are shown in Table 4. Note, that this has been used in addition to the diagrams and their interpretation described below.

Sub-system	No.	Variable	Integration	Influence
hub	1	cargo turnover sea port	buffering	moderately active
	2	consideration of SSS/ feeder vessels in the seaport	moderately buffering	active
	3	cargo turnover hinterland-hub	buffering	neutral
	4	demand for MoS at a sea port	lightly buffering	reactive
	5	quality of hub organisation and operation	buffering	highly active
	6	quality of hub facilities	moderately buffering	highly active
	7	accessibility of hubs	buffering	neutral
corridor	8	shift to sea-based transport	moderately buffering	reactive
	9	quality of road infrastructure	moderately buffering	active
	10	quality of railway infrastructure	moderately buffering	reactive
	11	quality of seaward infrastructure	buffering	neutral
MoS service	12	availability of MoS-connections at the port/ hinterland hub	buffering	neutral
	13	regularity	moderately buffering	highly reactive
	14	frequency of services	moderately buffering	reactive
	15	security of goods transported	moderately buffering	highly reactive
	16	speed of the MoS connection	moderately buffering	neutral
	17	price of the MoS connection	moderately buffering	reactive
	18	awareness of MoS services	moderately buffering	reactive
	19	simplicity of MoS services	moderately buffering	active
sustainability	20	local emissions	moderately buffering	highly reactive
	21	global climate change emissions	moderately buffering	neutral
	22	residential quality	moderately buffering	highly reactive
	23	economic location attractiveness at the port/ hinterland hub	moderately buffering	highly reactive

funding, subsidy, investment	24	MoS-funding	moderately buffering	highly active
	25	Marco Polo-funding	moderately buffering	highly active
	26	other EU budget for investment/ funding/ subsidies	moderately buffering	highly active
	27	overall national/regional budget for investment/ funding/ subsidies	buffering	moderately active

Table 4: Amount of influence and integration for every variable

It is necessary to combine this step in the interpretation with the interpretation through a diagram, as described hereafter. Depending on their active and passive sums, all variables are arranged along X and Y axes, which allows drawing general conclusions about the system and the cybernetic role of every variable can be portrayed. In Figure 13, the variables are arranged to illustrate the system's overall constitution – thus the variables are not labelled individually, each one is simply represented by a black box.

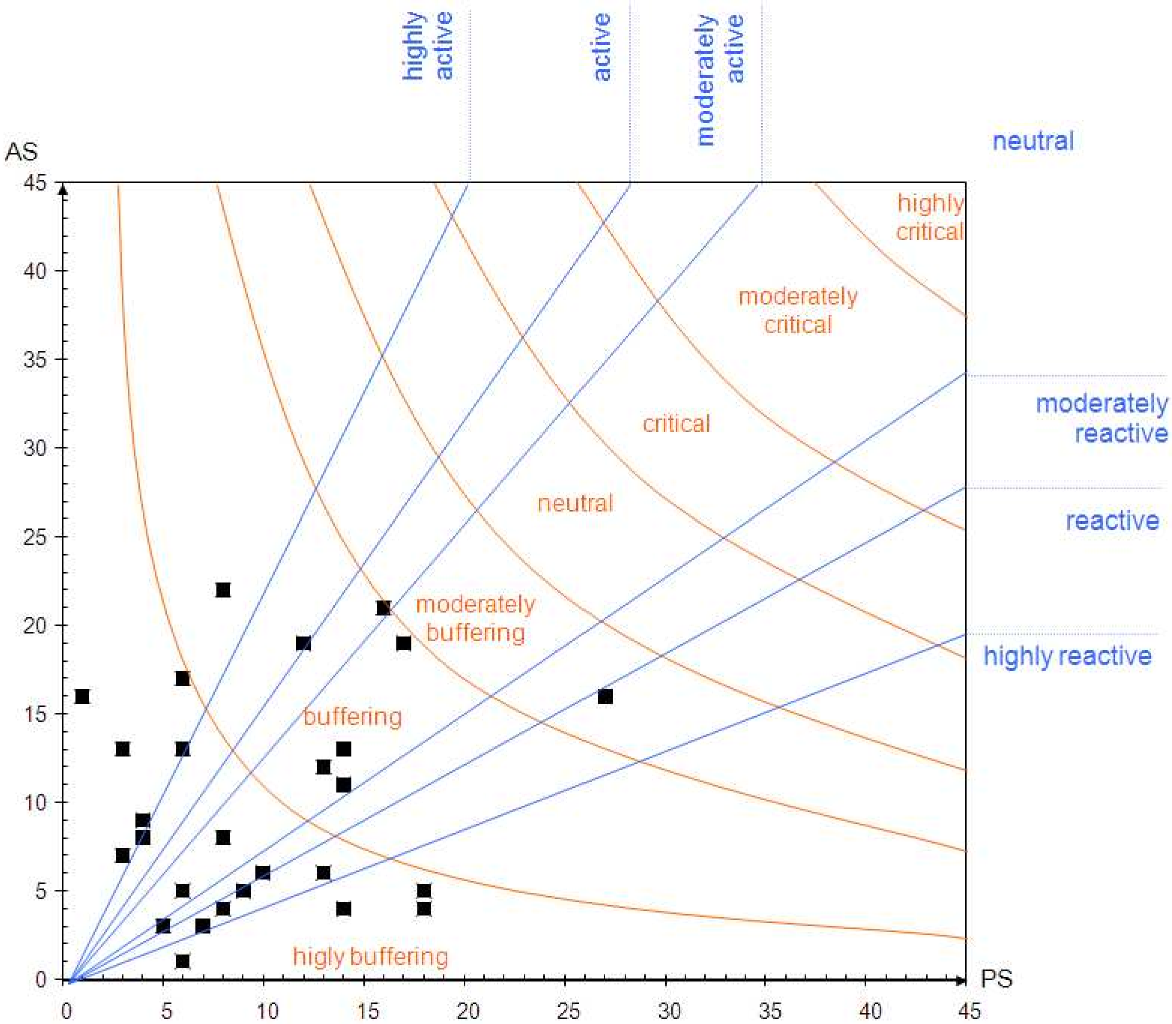


Figure 13: Role of the variables: overall cybernetic allocation of the variables

It is obvious, that the cybernetic roles of the variables are diverse but not very extreme.

There are some variables, which are located in the highly active area, but as none of them is very outstanding, the regulation of the system cannot be significantly influenced by changing just one variable, a mix of measures affecting several variables would be needed to have an effect. There are also some variables in the highly passive area, but again none of them is outstanding i.e. various variables have to be observed as indicators for the system's constitution. As there are no variables in the neutral area, it can be concluded that the system's self-regulation is not well developed. In addition to this, there are no critical variables, thus, it can be derived that the integration is not well developed. Integration means the interconnectedness of the variables. Several, relatively inert variables are located in the buffering area.

Overall, the generic MoS system predominantly consists of individual variables with relatively moderate cybernetic function, which in general makes it quite resilient to change from within – both intended and unintended. Outside variables, such as for example the overall state of the economy, oil prices or the social and political prioritisation of environmental issues can on the other hand have quite a notable impact on the system.

Within the system, some variables are cybernetically more relevant than others and should be noted for this. All variables are illustrated in Figure 14.

With regard to the purpose of this systems analysis especially the regulating variables are of interest. Therefore in Table 5 all variables are shown ordered by their Q-value in addition to the illustration in Figure 14. This Q-value, which is the quotient of active and passive sum, represents the suitability for regulation of each variable (see chapter 1.3.3 for methodological background).

No.	Variable	Q-value	Interpretation of Q-value
25	Marco Polo-funding	16,00	highly active
24	MoS-funding	4,33	highly active
6	quality of hub facilities	2,83	highly active
5	quality of hub organisation and operation	2,75	highly active
26	other EU budget for investment/funding/subsidies	2,33	highly active
2	consideration of SSS/ feeder vessels in the seaport	2,25	active
19	awareness of MoS-services	2,17	active
9	quality of road infrastructure	2,00	active
1	cargo turnover sea port	1,58	moderately active
27	overall national/regional budget for investment/funding/subsidies	1,31	moderately active
12	availability of MoS-connections at the port/hinterland hub	1,12	neutral
16	speed of the MoS-service	1,00	neutral
7	accessibility of hubs	0,93	neutral
3	cargo turnover hinterland-hub	0,92	neutral
21	global climate change emissions	0,83	neutral
11	quality of seaward infrastructure	0,79	neutral
8	shift to sea-based transport	0,60	reactive
10	quality of railway infrastructure	0,60	reactive
4	demand for MoS-connections at a sea port	0,59	reactive
14	frequency of services	0,56	reactive
17	price of the MoS-service	0,50	reactive
18	simplicity of MoS-service	0,46	reactive
20	local emissions	0,43	highly reactive
15	security of goods transported	0,29	highly reactive
13	regularity of MoS-service	0,28	highly reactive
23	economic location attractiveness at the port/hinterland hub	0,22	highly reactive
22	residential quality	0,17	highly reactive

Table 5: Variables of the generic systems model ordered by their suitability for regulation

Among the highly active variables there are three variables of the subsystem funding: '*Marco Polo-funding*', '*MoS-funding*' and '*other EU budget for investment/funding/subsidies*'. Thereof the '*Marco Polo-funding*' is really outstanding in comparison to the other funding sources. It can be concluded that its impact on the MoS-system can be much stronger than the (TEN-T) MoS funding or funding from other European programmes. Nevertheless, the other funding variables are suitable for regulation as well.

There are two potential objects of funding among the highly active variables: '*quality of hub facilities*' and '*quality of hub organisation and operation*'. Thus they can be seen as very promising funding objects. Furthermore there are the variables '*consideration of SSS/ feeder vessels in the seaport*', '*awareness of MoS-services*' and '*quality of road infrastructure*' which are still in the active area and therefore also suitable for regulation.

Apart from the active variables, there are other cybernetic functions within the system, which are investigated in the following (see Figure 14 for illustration).

There are two variables which should be considered as indicators for the system's constitution: '*regularity of the MoS-service*' and '*economic location attractiveness'*, as they have the highest passive sums. Accepting these two variables as indicators for the system's constitution leads to the conclusion, that the degree of success of MoS-services is indicated by the regularity of the service as well as by the economic location attractiveness of the hub.

Concerning the integration of the system, three variables stand out: '*demand for SSS', 'overall national/regional budget for investment, funding or subsidies'* and '*availability of MoS-connections*'. They are, relatively speaking, the most integrated variables in the system, but regarding their location within the diagram, they quite far from being really critical variables. Their location is much closer to the neutral area, where variables important for the system's self regulation would be found. It can be concluded, that the system has no critical variables, which by themselves could be used to initiate a strong effect.

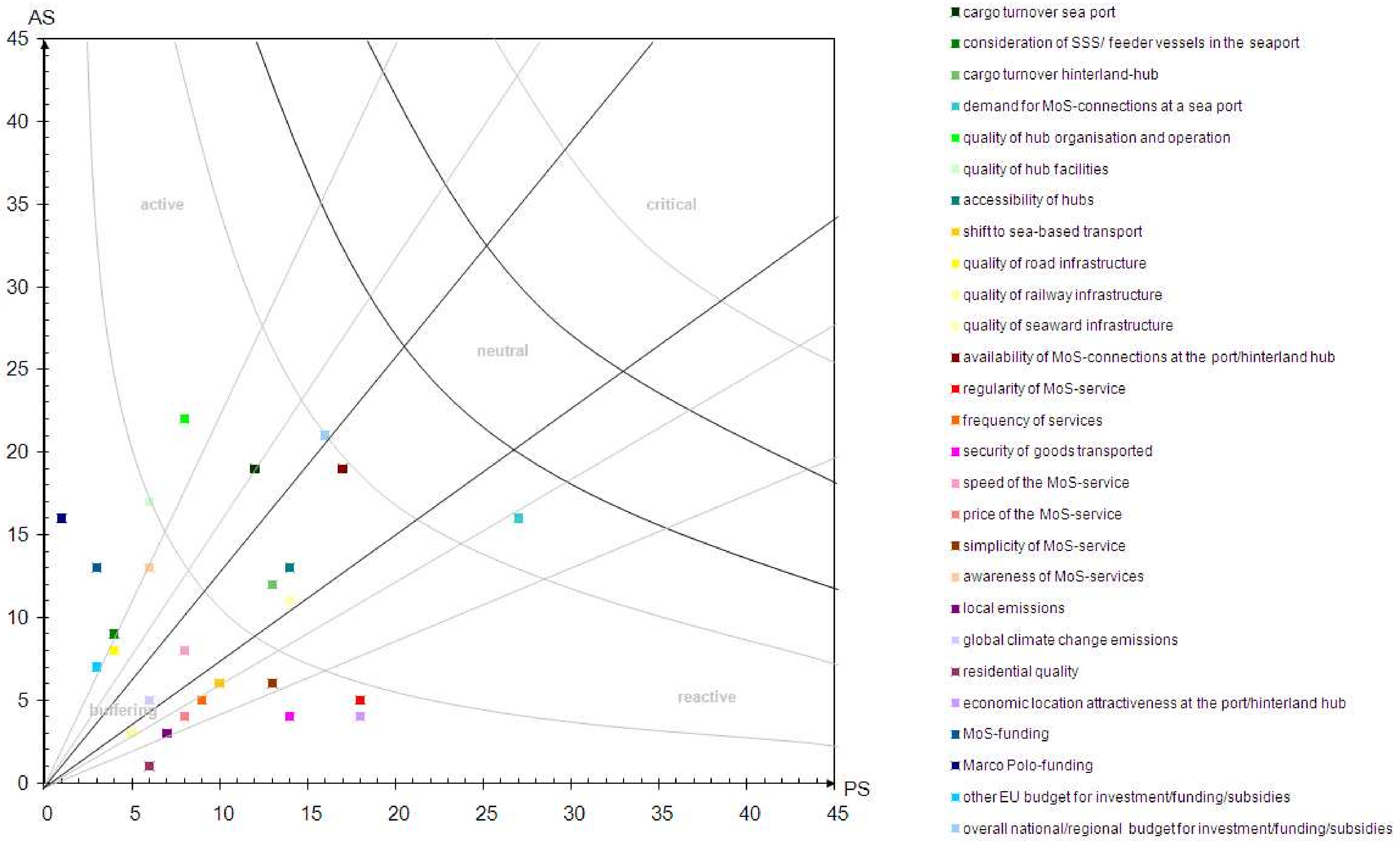


Figure 14: Role of the variables: key cybernetic variables

2.4.2 Role of the subsystems

Figure 15 shows the variables coded according to the subsystems to show the role of these within the system. The subsystem *hub* comprises many of the active variables, which leads to the conclusion, that this subsystem is quite important for regulation. Another interesting subsystem is *service*, which contains a mix of active, reactive and integrated variables. The subsystems *corridor* and *sustainability* are mainly dominated by inert and reactive variables, therefore they are not important for regulation. The last subsystem *funding* is very interesting: it consists only of active variables, and is thus important for regulation.

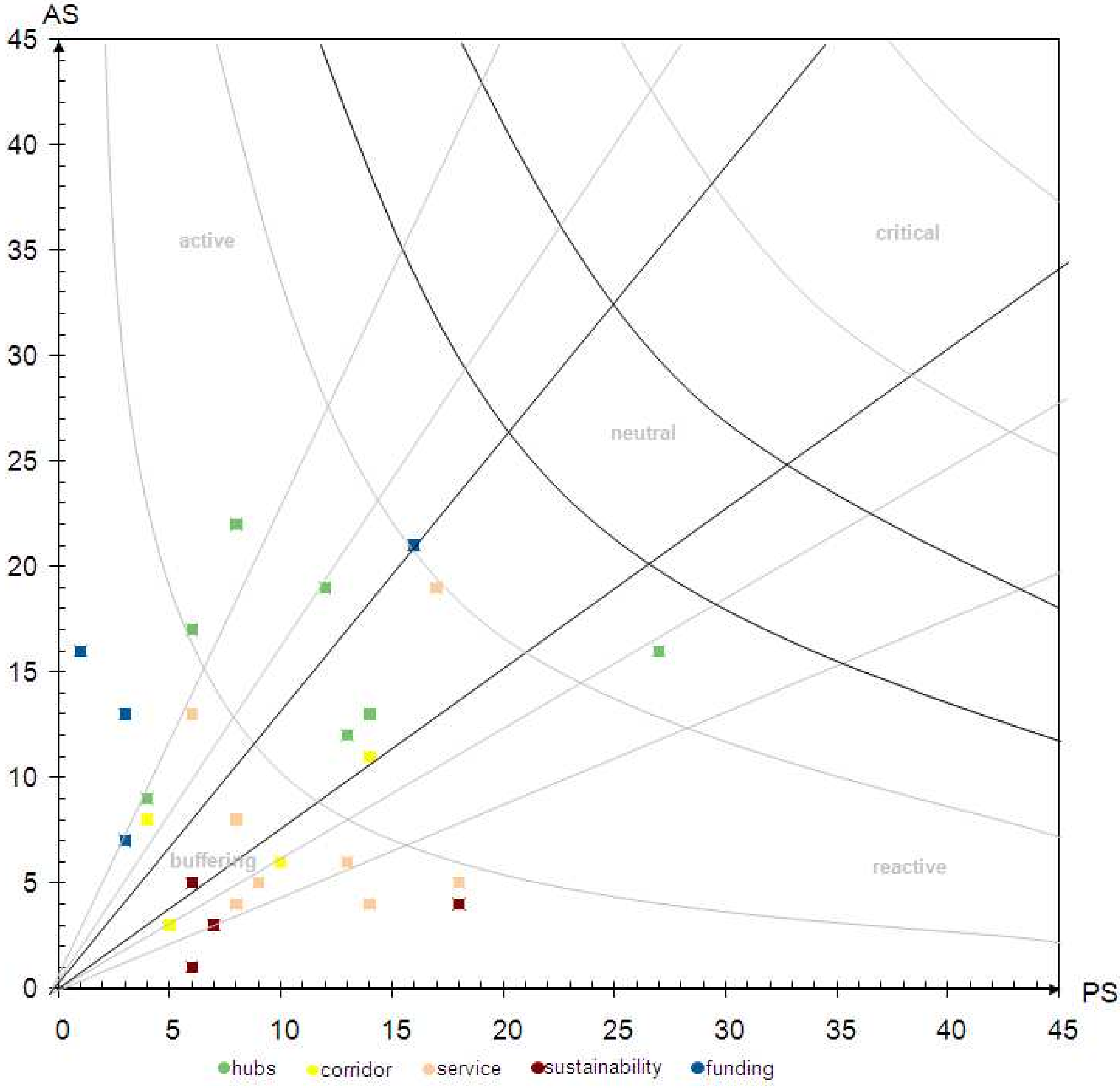


Figure 15: Role of the variables: variables coded according to subsystems

Figure 16 underlines the conclusions made above. As the subsystems contain different numbers of variables, the diagram is adjusted according to the average impact per variable.

The subsystem *hub* has the biggest share of active impacts, followed by the subsystem *funding*. Their passive impacts are quite smaller. The subsystems *service* and *corridor* are more balanced in that way, as both, the active and passive impact are nearly of the same amount. The subsystem *sustainability* is unbalanced in that way, as here the passive impact is quite higher than the active one.

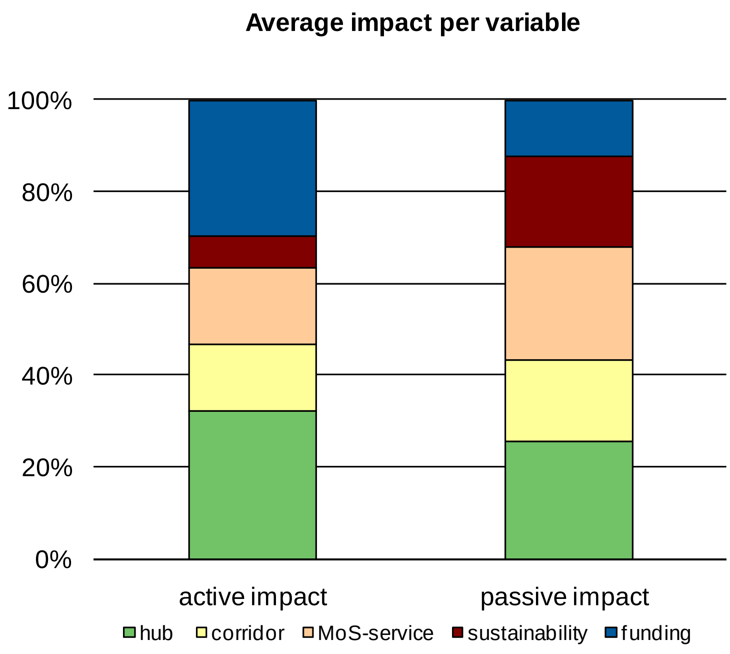


Figure 16: Share of active and passive impact by subsystems

As part of the systems analysis methodology the impact of the subsystems on each other should also be considered (see Figure 17), to investigate interrelations on an aggregated level. The classification follows the average impact per variable of one subsystem on the variables of the other subsystem and adheres to the following classification: more than 0.6: strong impact; between 0.3 and 0.6: medium impact; less than 0.3: low impact.

The subsystem *funding* has a strong impact on the subsystems *hub* and *corridor*. These subsystems in turn also have strong impacts: *hub* on *service* and *corridor* on *sustainability*. It can be conclude, the subsystem *funding* is the most important for regulation. Additionally, the variables comprised in *hub* strongly influence the variables of *service* and *sustainability*, while *corridor* affects *sustainability* the most. Looking at the medium impacts, first of all there are the subsystems *service* and *hub*, which affect each other (*service* having a medium impact on *hub*) these two are most strongly interrelated. *Hub* also has a medium impact on *funding*, which underlines the conclusions made above, that *hub* is the most important subsystem. Furthermore there are medium impacts from *sustainability* on *funding*, which indicates an adjustment of investment policies according to sustainability aspects.

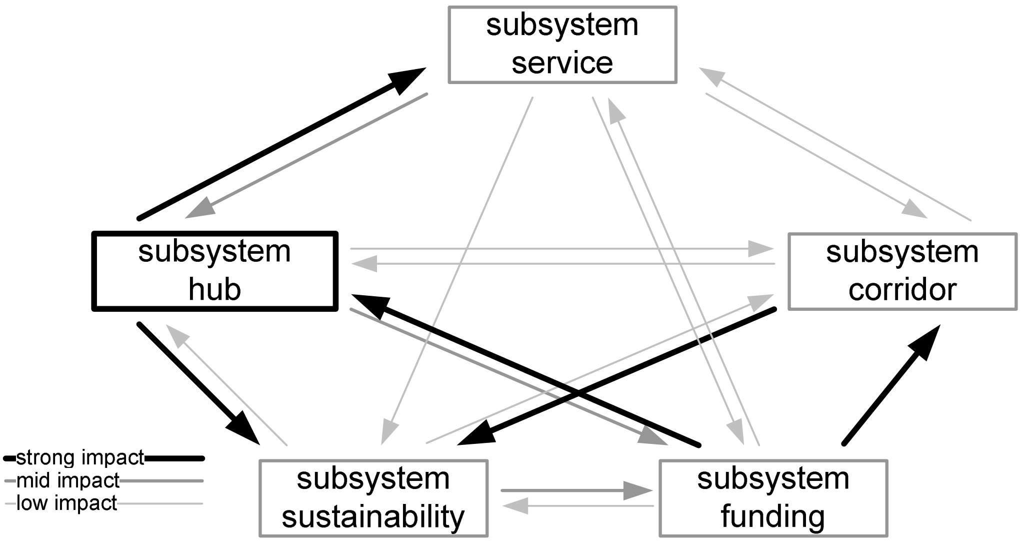


Figure 17: Impact of the subsystems on each other

2.4.3 Impact cycles

The variables portrayed in the impact cycles were chosen by the amount of active and passive sums: all with an active resp. passive sum greater or equal 14. Additionally all variables affected by a strong/very strong impact of MoS- or Marco Polo-funding were included as well. Due to the convenience, only strong (impact of 2) or very strong impact (impact of 3) relations are portrayed.

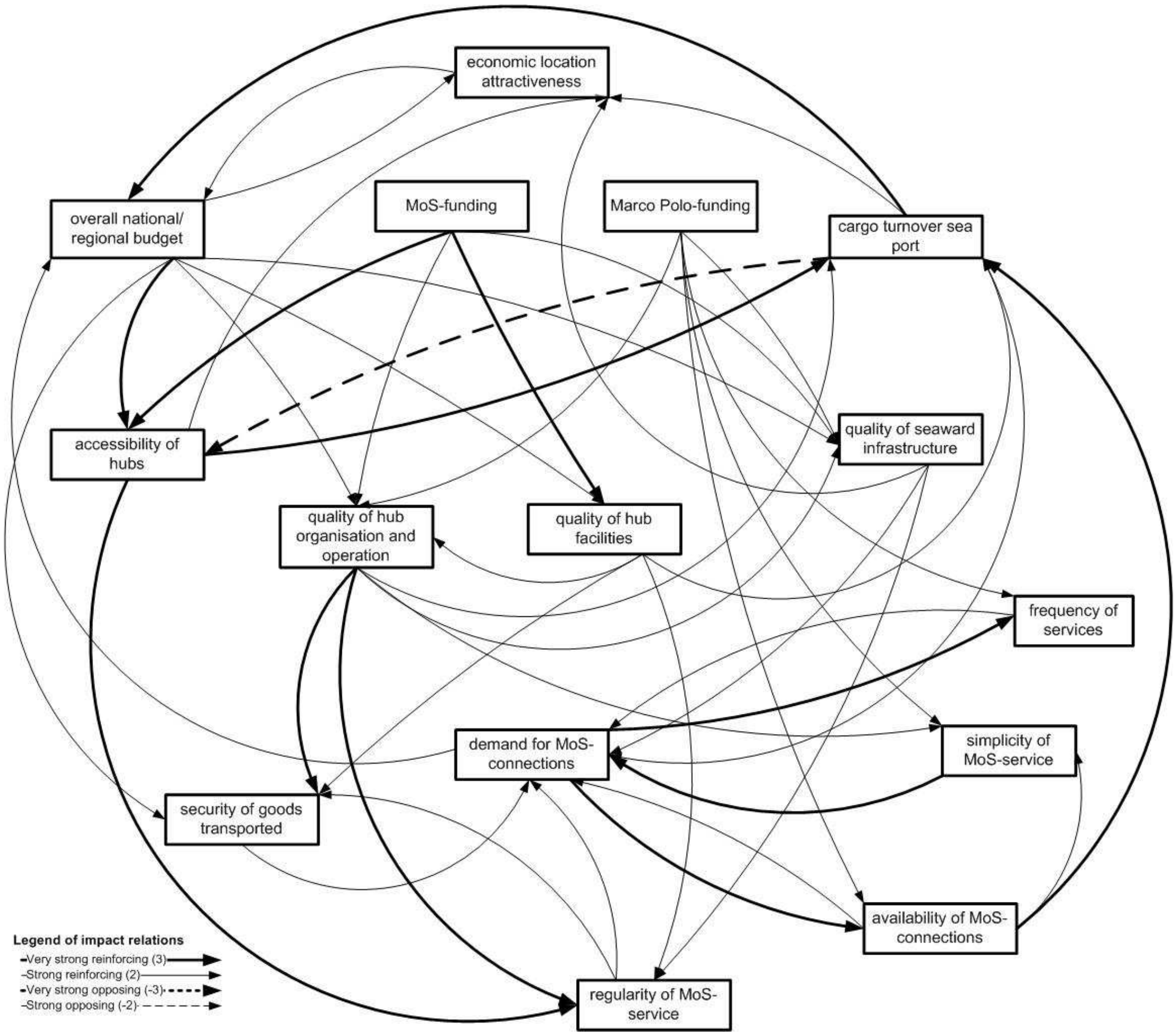


Figure 18: Neutral Impact cycle for the generic system model

In the following there are two base scenarios displayed for the most interesting funding sources in this context: MoS funding of the TEN-T programme and the Marco Polo funding programme. In contrast to the funding scenarios presented below, these two base scenarios display the potential of the particular funding programme in the system.

To illustrate the impact of funding, colour-based symbolism has been used. The more directly the system variables are affected by funding, the darker is the blue of their boxes and of the impact connections (represented by arrows).

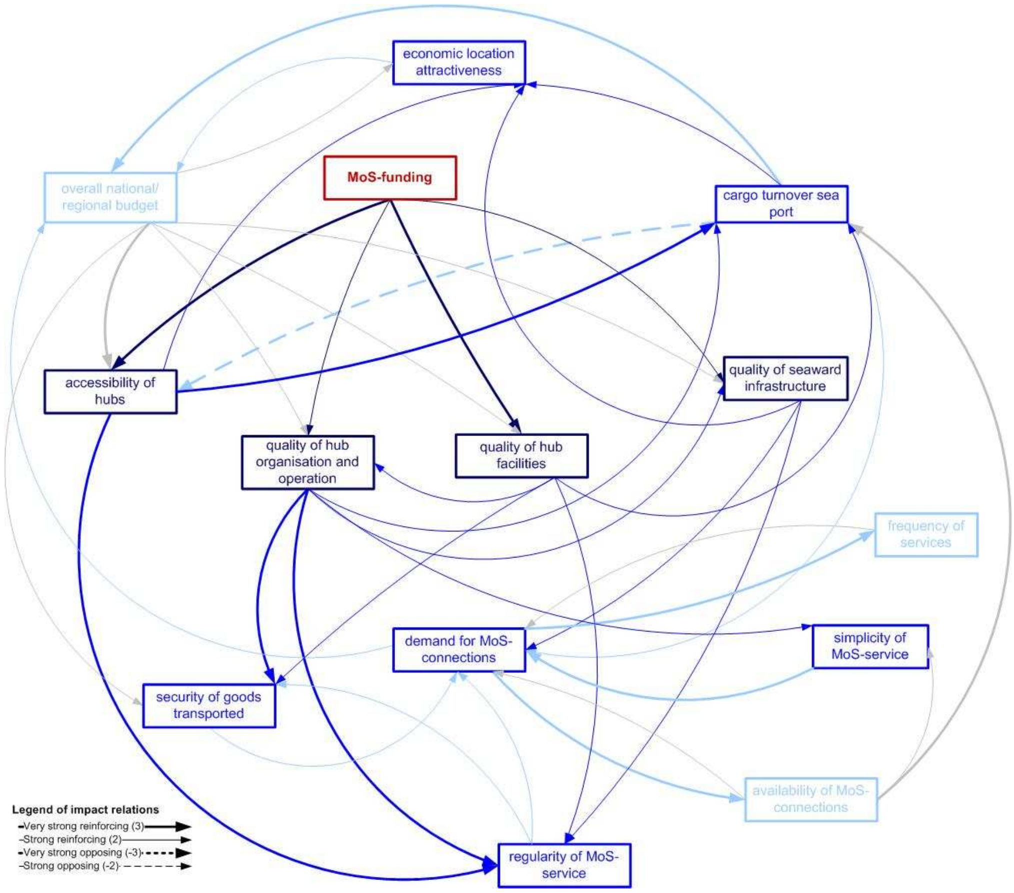


Figure 19: Base Scenario: (TEN-T) MoS-funding and related funding objects

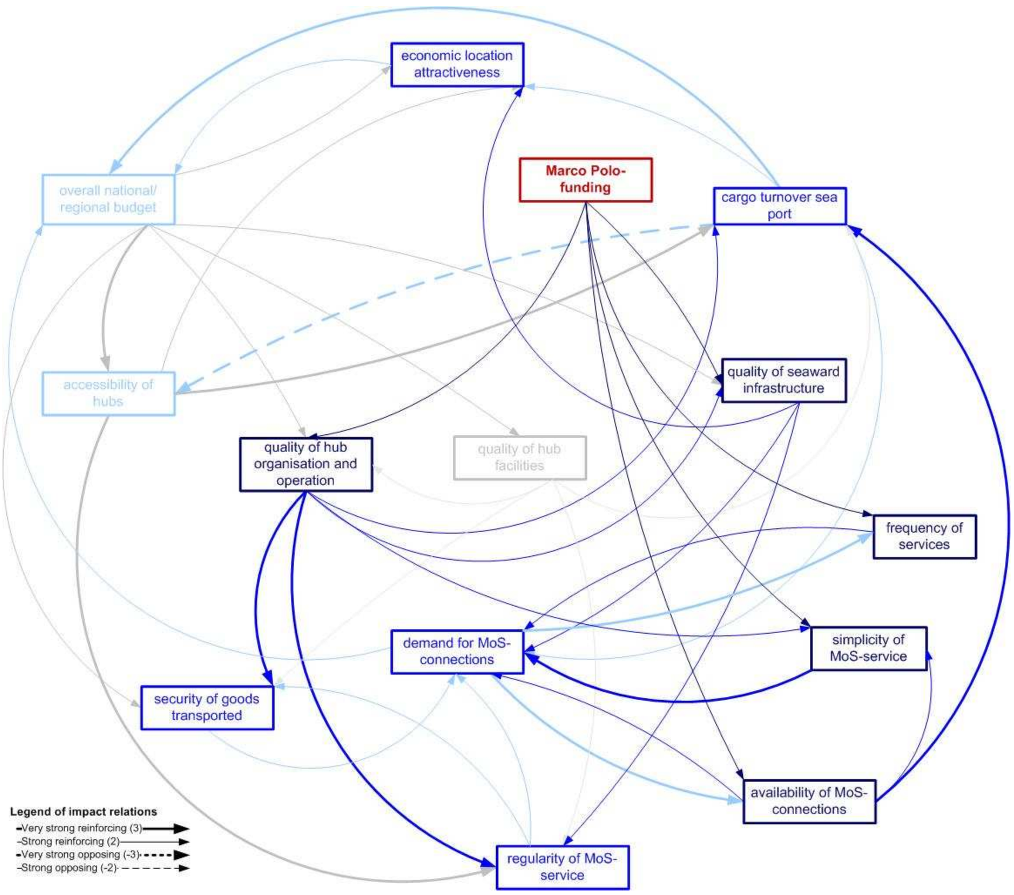


Figure 20: Base Scenario: Marco Polo funding and related funding objects

In Table 6 an overview of possible funding scenarios within the MoS programmes is provided. Each scenario is linked to one funding source and one object of funding.

Funding scenario No.	**Funding source**	**Object of funding**
1	TEN-T funding for MoS	Quality of hub organisation and operation
2		Quality of hub facilities
3		Accessibility of hubs
4		Quality of seaward infrastructure
5	Marco Polo funding for MoS	Quality of hub organisation and operation
6		Quality of seaward infrastructure
7		Availability of MoS-connections in the seaport
8		Frequency of MoS-service
9		Simplicity of MoS-service

Table 6: Generic model - funding scenarios

There are nine different funding scenarios which will be investigated further.

In the following figures, each one of these funding scenarios is illustrated through one impact cycle diagram (see Figure 21 to Figure 29), which should be read like the two base scenarios: to illustrate the impact of funding one (or more) object(s), colour-based symbolism has been used. The more directly the system variables are affected by funding, the darker is the blue of their boxes and of the impact connections (represented by arrows). The funding source and the object(s) of funding are marked in red.

Thus, different funding scenarios can be assessed visually by comparing the strength of their colouring. The more dark blue system variables and impact connections between them are shown, the stronger is the impact of a particular funding scenario on the system.

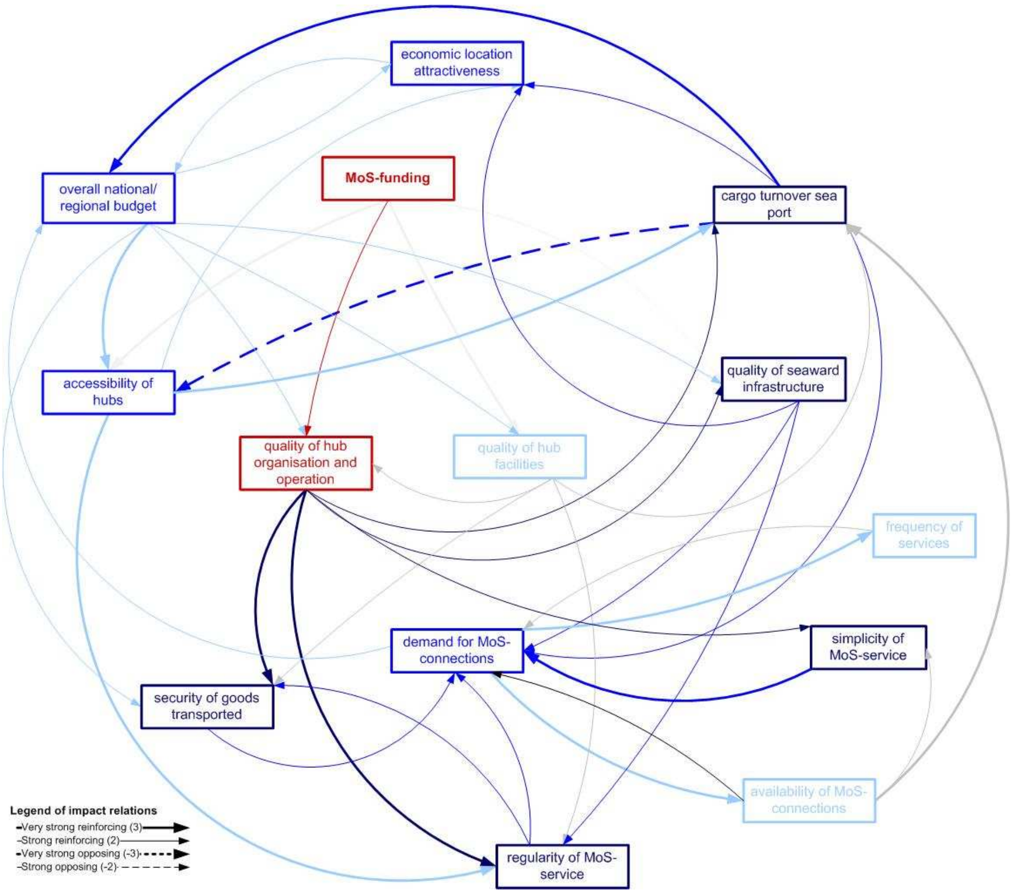


Figure 21: (TEN-T) MoS-funding Scenario 1

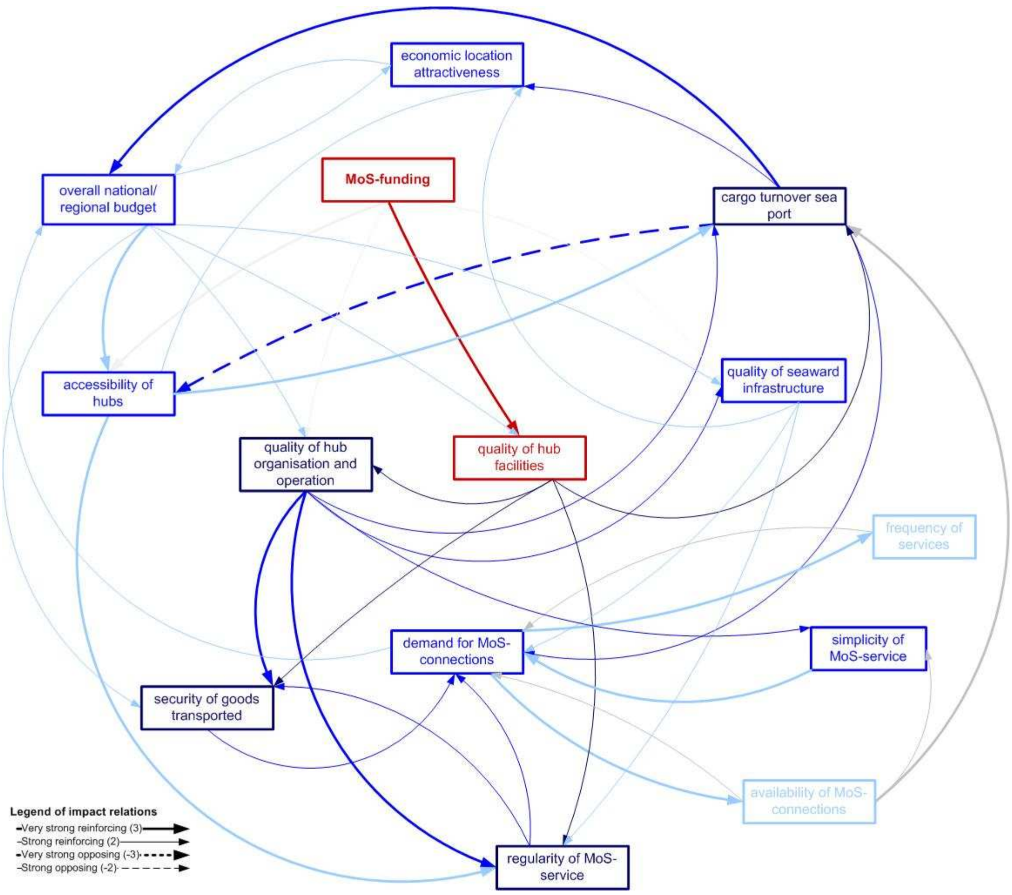


Figure 22: (TEN-T) MoS-funding Scenario 2

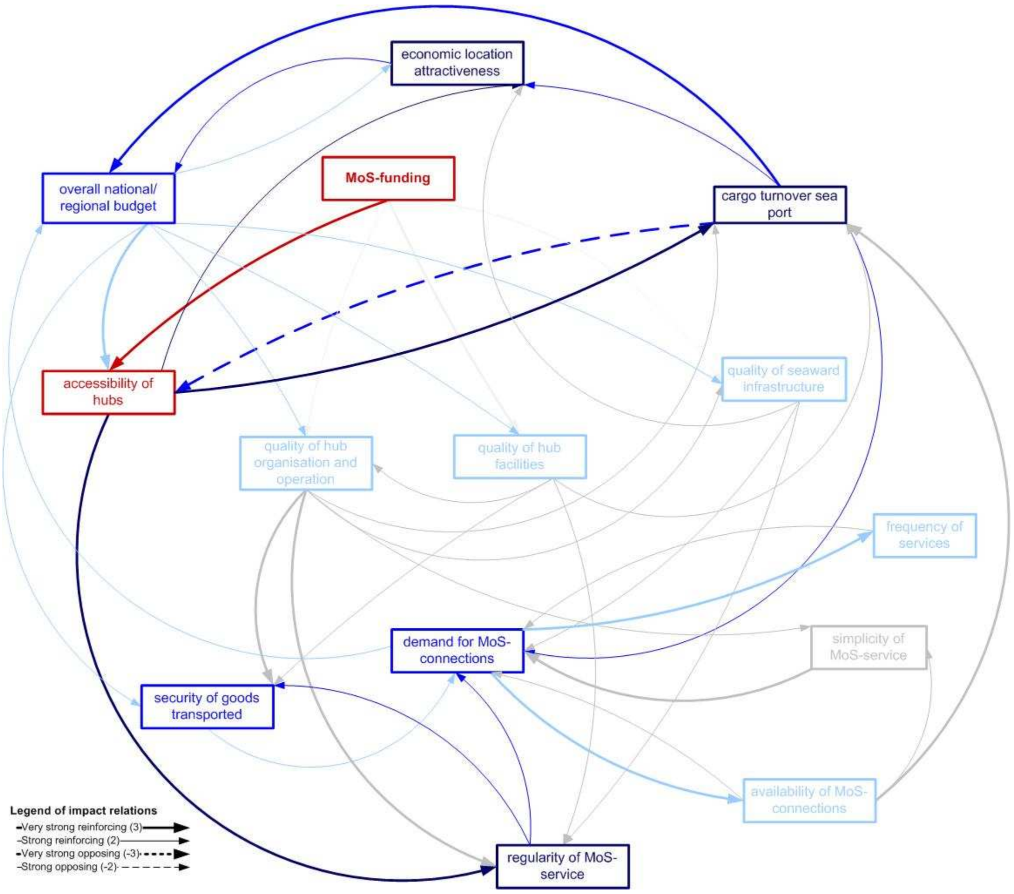


Figure 23: (TEN-T) MoS-funding Scenario 3

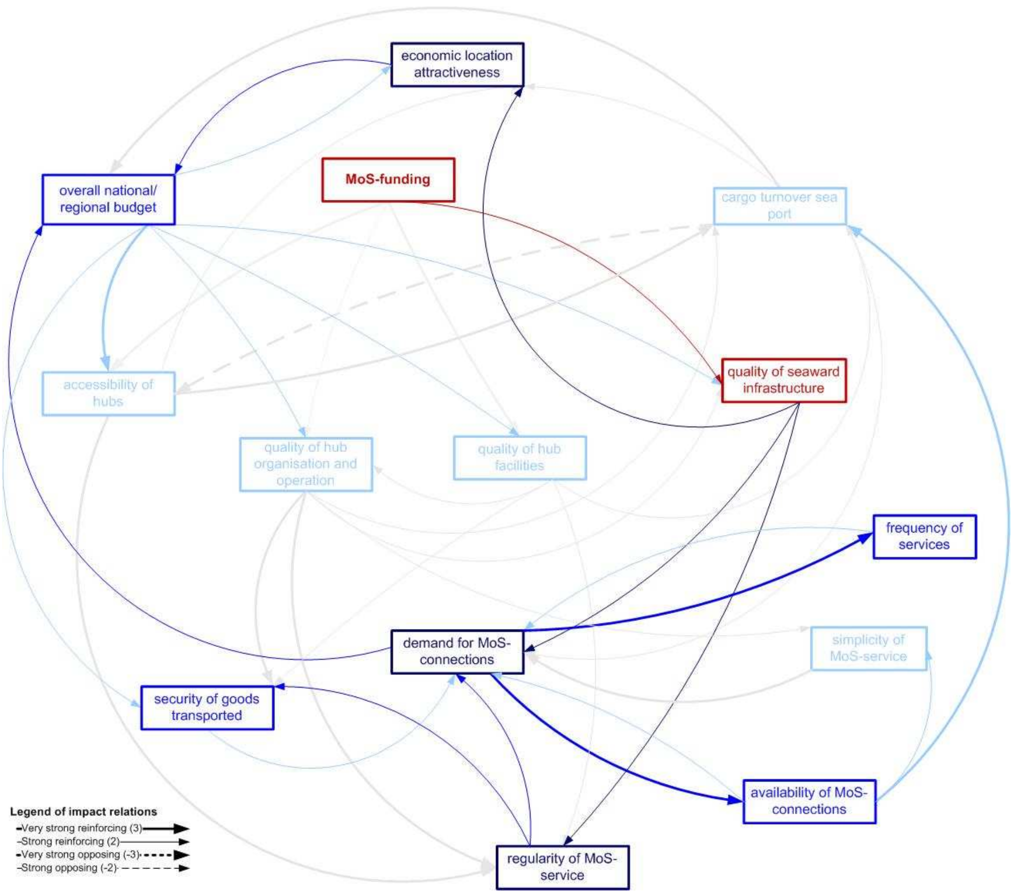


Figure 24: (TEN-T) MoS-funding Scenario 4

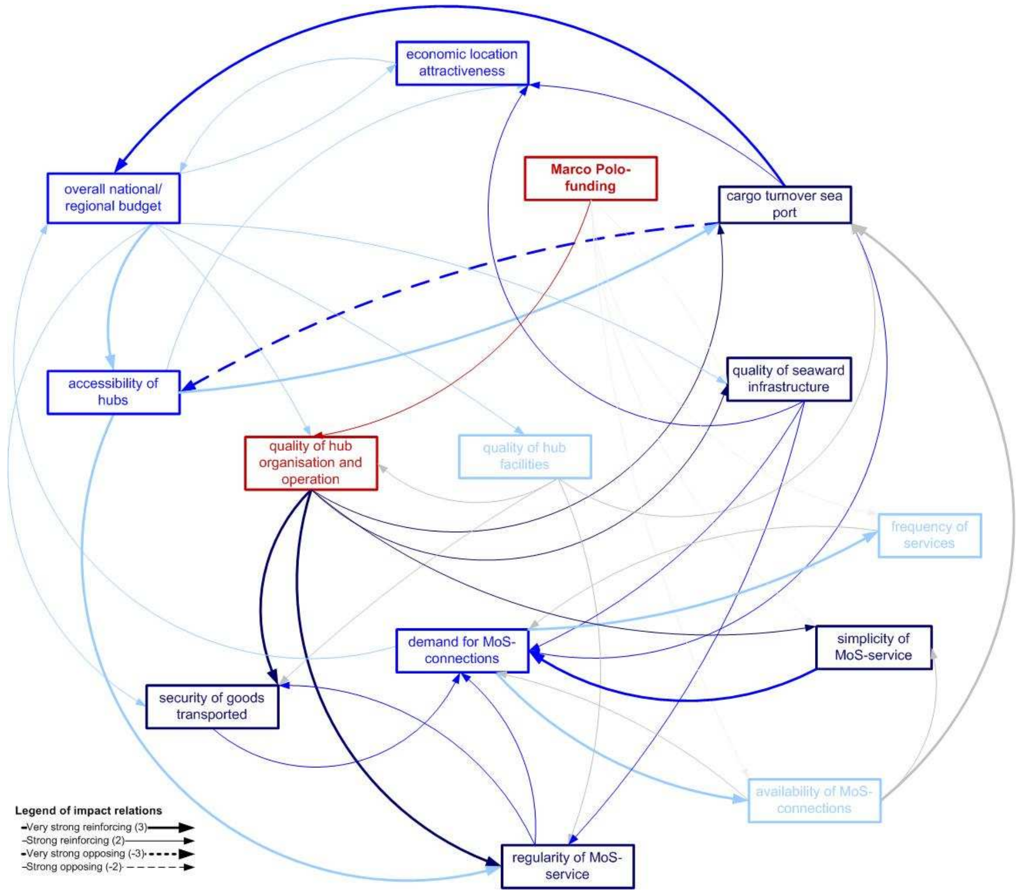


Figure 25: Marco-Polo funding Scenario 5

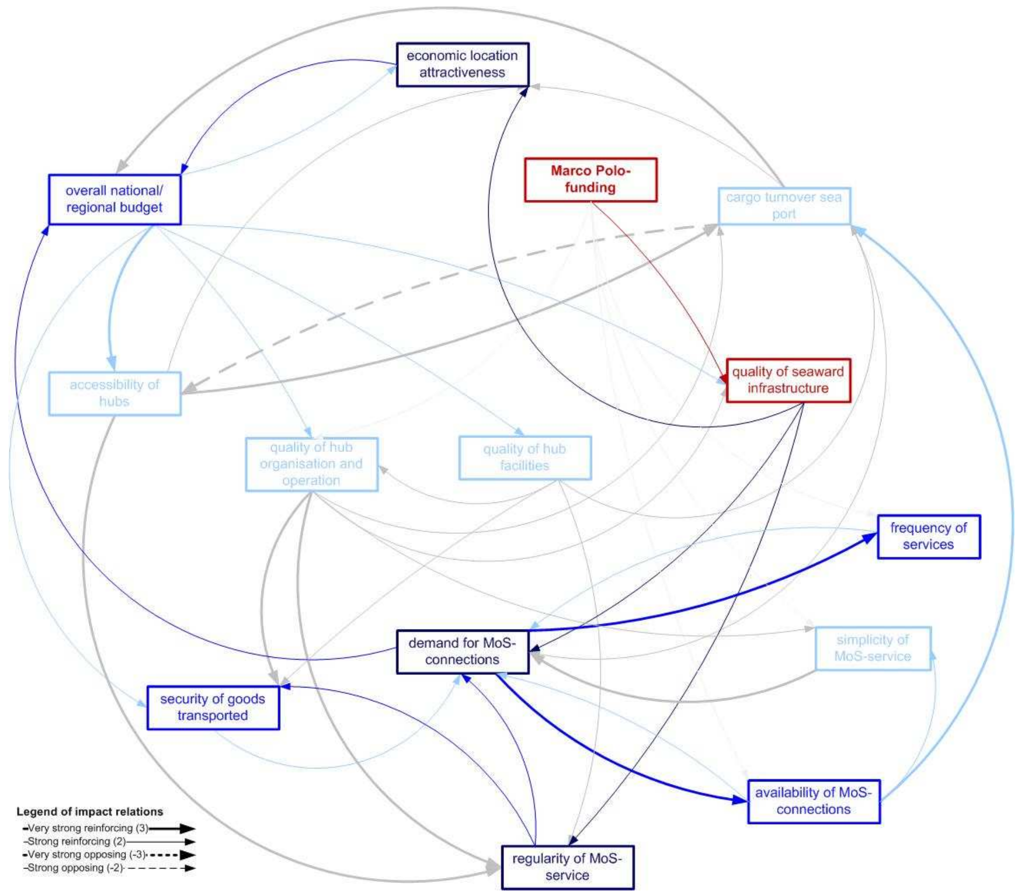


Figure 26: Marco-Polo funding Scenario 6

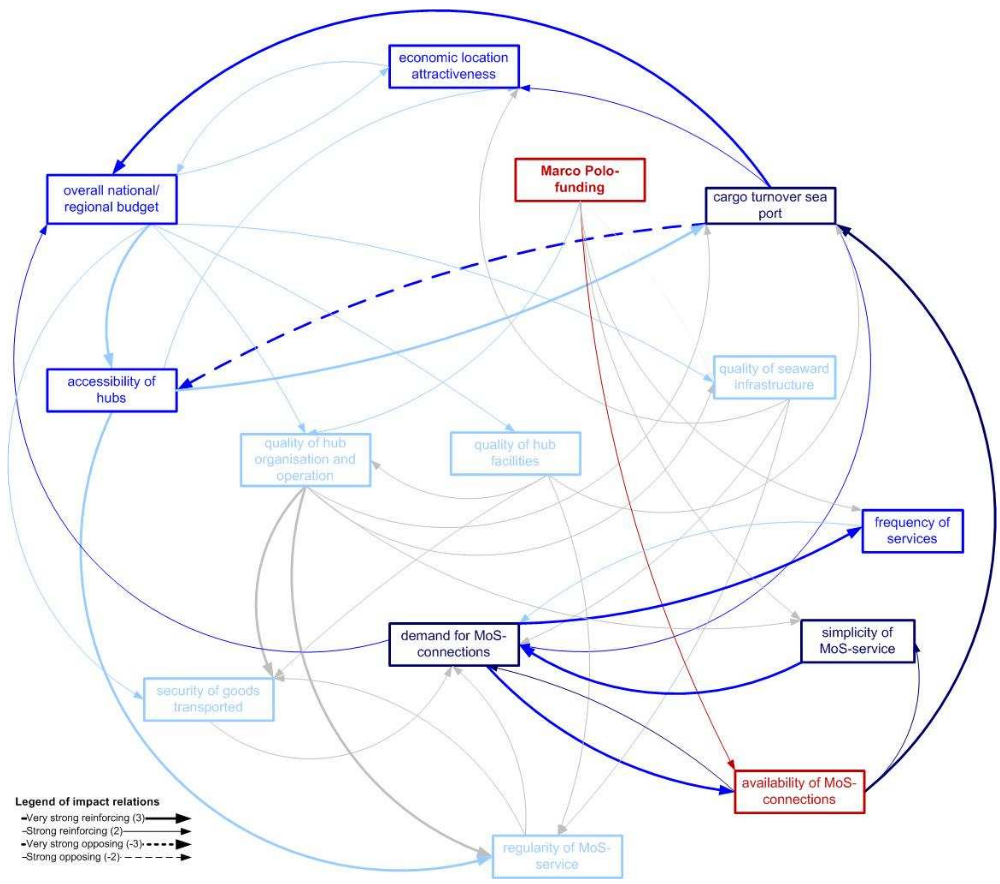


Figure 27: Marco-Polo funding Scenario 7

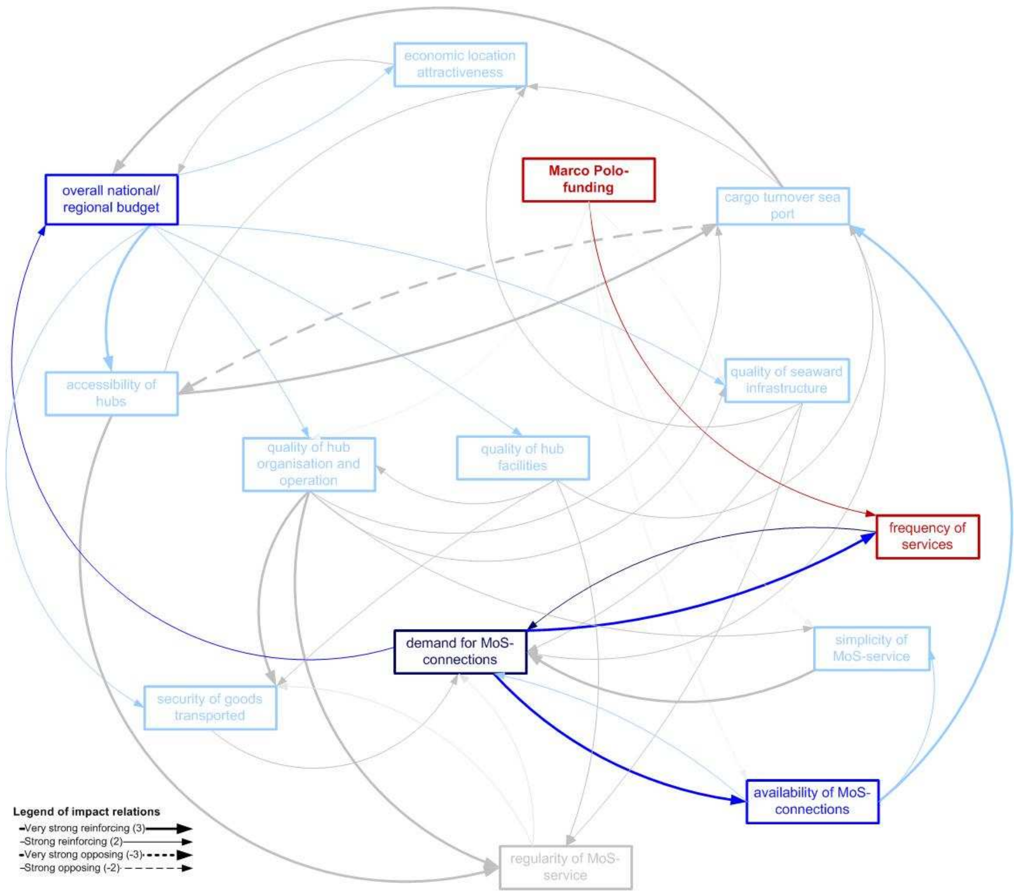


Figure 28: Marco-Polo funding Scenario 8

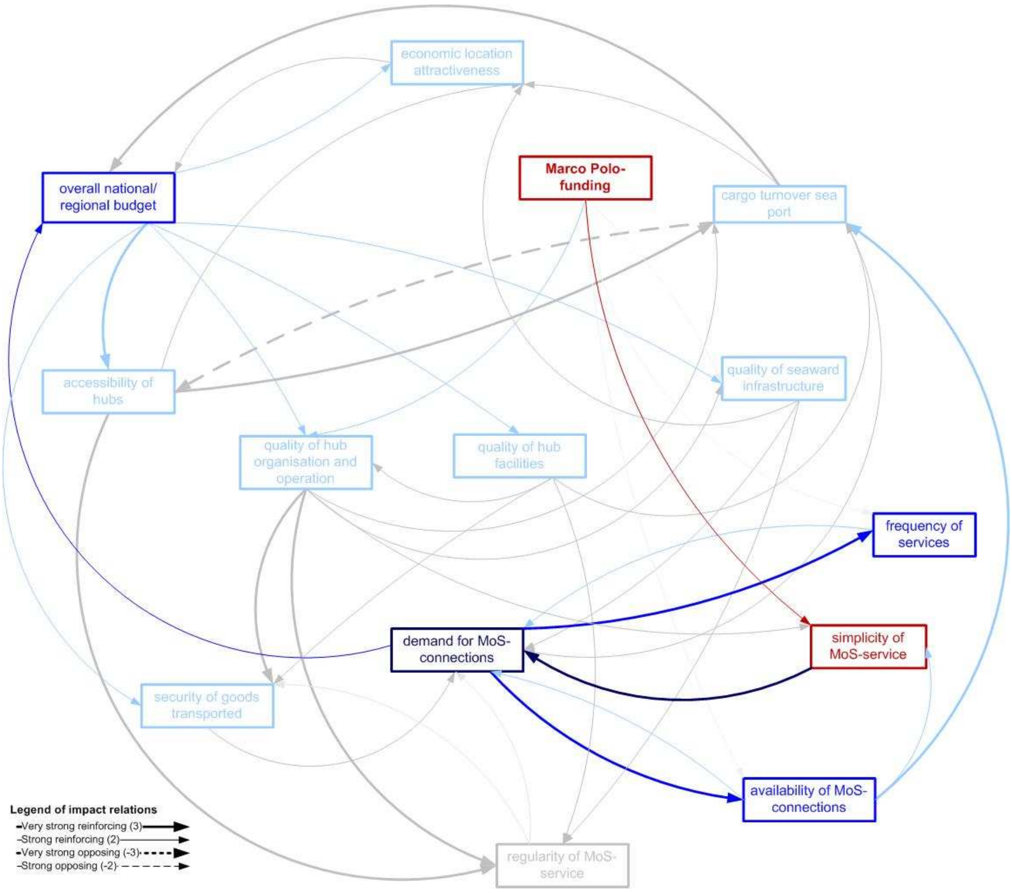


Figure 29: Marco-Polo funding Scenario 9

In addition to the visualisation the amount of impact can be also quantified, by counting the number of variables

- which are affected directly by the object(s) of funding,
- which are affected indirectly by the object of funding and
- which remain.

Therefore the following table has been used. The scenarios of great interest are no. 1, 2, and 5, a funded measure here leads to high amount of affected variables in the system (directly and indirectly). The scenarios which might be interesting as well (no. 3, 4, 6 and 7) are marked in light grey and the ones which seem to be of low interest (8 and 9) are marked in dark grey.

Scenario	**Amount of variables which are directly affected by the object(s) of funding**	**Amount of variables which are indirectly affected by the object(s) of funding**	**Remaining variables**
1	5	4	3
2	4	6	2
3	3	3	6
4	3	4	5
5	5	4	3
6	3	4	5
7	3	4	5
8	1	2	9
9	1	3	8

Table 7: Comparison of scenarios for the generic model

2.4.4 Conclusion for the generic system model

<<This chapter will be amended in version 4.>>

According to the results of investigating the impact cycles, the most promising funding scenarios are the ones affecting the variables '*quality of hub organisation and operation'* and '*quality of hub facilities'.*

It is planned to develop rough project ideas and transfer them to funding scenarios, which can be displayed by the systems model. These scenarios – in contrast to the ones investigated above – could also affect several variables.

The results will be the basis for the recommendations for investment, which are the main purpose of this systems analysis.

3 The specific cases within the system MoS

The investigation of specific cases within the MoS system has two objective levels. On the one hand, the specific cases are analysed to validate the generic systems model against real scenarios. On the other hand, the applying the approach in a specific context can be useful for the Demonstration Project itself in terms of identifying important variables in the system and in deriving or evaluating measures.

Within the StratMoS project, it is planned to analyse at least two Demonstration Projects in detail. It was decided to analyse DP 1 ‘Northern Maritime Corridor - Barents sea intermodal service (BASIS)’ and DP 3b: ‘Optimising feeder and short sea in ports’ as with these two DPs, a corridor-focusing (DP 1) and a hub-focusing (DP 3b) project will be represented. These analyses will also provide an additional feedback loop for the generic model. The other DPs will not be analysed, as other partners were not involved in this workpackage or not motivated to support the analysis.

The work on the specific models is based on the intermediate results of the generic model. Therefore, the following tasks have been carried out for DP 1 and DP 3b:

- adapting the generic set of variables to the specific context
- describing the impact relations between these variables
- analysing the interrelations within the system

The results are described in the following subchapters.

3.1 Demonstration Project 1 ‘Northern Maritime Corridor - Barents sea intermodal service (BASIS)’

3.1.1 General Information on the demonstration project

The increasing cargo flow between Europe and Russia represents positive economic development but also increasing challenges related to congestion, both along roads and in important ports. The suggestion is an alternative maritime corridor for cargo between UK/continental Europe and Russia. The upcoming development in offshore oil and gas extraction in the Barents Sea will be facilitating infrastructure development in the Barents region. Recent developments related to Russian offshore activities in the Barents Sea suggest such activities will start within 2010-2011. Modern infrastructure related to ports and road systems and a growing demand for supplies and cargo going north are facilitating the possibility of a cost efficient transport corridor via the Barents region. This corridor (the Northern Maritime Corridor) could result in shifting cargo from congested European roads to ships. This is not yet part of the EU strategy for enhancing maritime transport (Motorways of the Seas), although Russia is included in the EU’s Northern Dimension Strategy.

A long term goal for the Northern Maritime Corridor project (NMC) is to seek cooperation and integrating the North Sea and Barents Sea Basins by developing a transport corridor from UK and continental Ports to the ports of Northwest Russia - Murmansk, Archangelsk and Naryan-Mar - in parallel with the upcoming offshore developments in the Barents Sea. To realize the Northern Maritime Corridor there a maritime service between major continental/UK ports and arctic ports in Norway and North-West Russia was proposed. This new service would necessitate additional terminal capacity where needed to serve the rapidly expanding containerized market in Russia and to provide an alternative to congested port facilities in St. Petersburg and in the Baltic states. In addition, it would offer a more direct route for trade arising locally, including products from the petroleum and seafood industries. The Barents Sea intermodal services (BASIS), as an initiative within the NMC, has resulted in close cooperation between public bodies (authorities/regional administrations) and the private sector (oil companies/service companies/logistics service providers). The goal is to create innovative, cost effective and sustainable transport solutions. BASIS has resulted in a working group which has produced market/infrastructure reports, networking and business meetings between Western European and Russian businesses and authorities. Obstacles and challenges related to establishing maritime services via the Barents region have been identified, but also opportunities for cost-efficient intermodal transport. The private sector in both Russia and EU/Norway wants to utilise these opportunities, but there are challenges related to cooperation, boarder-crossings, infrastructure, port handling capacity, uncertainty about cargo volumes and types and about petroleum extraction developments in the Barents Sea. Therefore, cooperation between public and private bodies is crucial for success.

The StratMoS demonstration project 'Northern maritime corridor – Barents Sea intermodal service' (NMC-BASIS) will focus on establishing and supporting the operation of a maritime service between major continental/UK ports and arctic ports in Norway and North-West Russia. Two important issues must be addressed in this context:

- improving the connections to the Russian hinterland to increase the amount and types of cargo that can be handled and
- identifying co-funding opportunities within the structures of 'The Northern Dimension' and/or Marco Polo programme.

Some crucial challenges must furthermore be met to develop cost efficient solutions:

- providing the information and organisational structures necessary to meet the logistics demands of the petroleum industry in the Barents region,
- establishing cross-boarder port cooperation, solving challenges related to intermodal solutions, cargo handling-capacity, infrastructure development, exchange of knowledge and information provision and
- establishing a working group dedicated to border-crossing obstacles: customs, different fee-regimes and connection to hinterland markets.

3.1.2 Developing the specific set of variables

Within a half-day workshop the variables of the generic system were adapted to the context of DP 1. The results are presented in Figure 30, the variables coloured grey are those considered as not relevant for the DP. The arguments for defining a variable as relevant or not are outlined below.

Subsystem hubs

The aim of the DP is to increase cargo flows in the Barents Sea, therefore '*cargo turnover sea port*' is relevant. No actual hinterland-hubs exist currently, so that 'c*argo turnover hinterland-hub'* was also excluded. It is intended, though, to elaborate if there is a need for a hinterland hub or hubs as a requirement for increasing demand. Thus the '*demand for SSS at a sea port'* was also identified as a relevant variable. Furthermore the '*quality of hub organisation and operation*' is considered a crucial variable. The DP is intended as a platform for information exchange on related issues, considering challenges of and solutions for customs procedures, complexity, rules and regulations, cultural 'habits', etc. The other variables of the generic subsystem hubs - '*consideration of SSS/feeder vessels in the seaport'*, '*quality of hub facilities*' and '*accessibility of hubs*' were identified as being not relevant, as the DP does not directly deal with them.

Subsystem corridors

In trying to achieve a shift from road to sea based transport by contracting forwarders the '*shift to sea-based transport*' is an evidently relevant. The '*quality of seaward infrastructure*' was also considered to be relevant, as there are some ports in the corridor considered, whose accessibility can be affected by weather conditions (resp. ice and storm). As a competitor to the sea corridor only road corridors play a role, since no competing railway corridor exists. Thus '*quality of road infrastructure*' was identified as relevant.

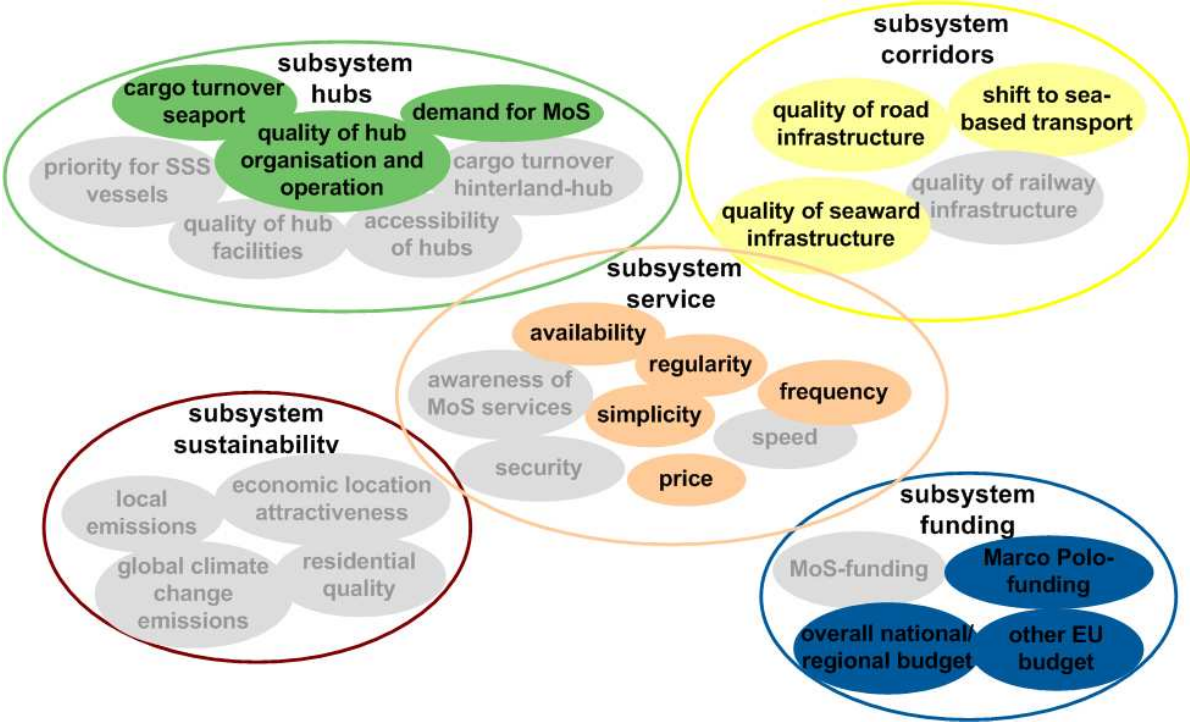


Figure 30: DP 1 - adapted set of variables

Subsystem service of MoS

'*Availability of MoS-connections at the port/hinterland hub*' was identified as relevant since it is one of the project's explicit objectives to strengthen this. Trying to avoid delays through improving customs procedures (see above) also makes '*regularity*' an important variable. The '*frequency of services*' in being important for shippers was also considered relevant. Furthermore '*price of the MoS-service*' was evaluated as being important in terms of competitiveness for implementing a new service in the Barents Sea. For the DP, standardisation of IT-systems, esp. with authorities in Russia, plays an important role, which affects the variable '*simplicity of MoS-service'*. The other variables within the subsystem were identified as being not relevant for the DP.

Subsystem sustainability

In this subsystem, none of the variables were identified as being relevant.

Subsystem funding

In the context of this DP, it is planned to submit a Marco Polo application, thus '*Marco Polo funding*' is a relevant variable. '*Other EU budget for investment/ funding/ subsidies*' is relevant because of the EU's Northern Dimension policy (EU-Russia-Norway-Iceland), which might play a role in the DP. Also the '*overall national/regional budget for investment/ funding/ subsidies*' was said to be relevant for the DP relating to investments in port facilities. Only '*MoS-funding*' was not identified as being relevant for the DP.

3.1.3 Specifying the impact within the systems model

The cross-impact matrix was completed during a workshop and is shown in Figure 31 (see section 1.3.3 for the methodological background). Every variable is assessed against all other variables regarding the strength and quality of the impact it has on them. The strength of the impact is quantified by 0 for no impact, 1 for weak impact, 2 for strong impact and 3 for very strong impact. The quality is expressed by algebraic signs: positive impacts (marked in green) are enhancing, while negative impacts (marked in red) have a reducing effect. The last two columns on the right comprise the calculated active sums (AS) and passive sums (PS) for every variable.

Overall, 184[7] possible impact combinations were evaluated. Of these, 78 did not equal 0, i.e. in these combinations an impact was diagnosed. A weak impact was identified 44 times, a strong impact 28 times and a very strong impact 6 times.

The completed matrix is the basis for the analysis of the interrelations described in the following chapter.

[7] Since one variable has no impact on itself, 14 x 13 + 2 = 184 combinations are possible.

Specific System 'Northern Maritime Corridor - Barents sea intermodal service' (DP1) as part of Motorways of the Sea			*subsystem hub*			*subsystem corridor*			*subsystem service*					*subsystem funding, subsidy, investment*			Analysis	
			cargo turnover sea port	demand for MoS-connections at a sea port	quality of hub organisation and operation	shift to sea-based transport	quality of road infrastructure	quality of seaward infrastructure	availability of MoS-connections at the port/ hinterland hub	regularity	frequency of services	price of the MoS-connection	simplicity of MoS services	Marco Polo-funding	other EU budget for investement/funding/subsidies	overall national/ regional budget for investment/ funding/ subsidies		
		Nr.	**1**	**4**	**5**	**8**	**9**	**11**	**12**	**13**	**14**	**17**	**18**	**25**	**26**	**27**	**AS**	**PS**
subsystem hub	cargo turnover sea port	**1**		1	-1	0	0	-1	0	-1	0	0	0	0	1	2	7	5
	demand for MoS-connections at a sea port	**4**	0		0	0	0	0	2	0	3	-2	0	1	1	1	10	16
	quality of hub organisation and operation	**5**	0	2		2	0	0	1	2	0	0	0	0	0	1	8	7
subsystem corridor	shift to sea-based transport	**8**	3	1	0		3	0	0	0	0	0	2	0	0	0	9	12
	quality of road infrastructure	**9**	0	-2	0	0		0	0	0	0	0	0	0	0	0	2	4
	quality of seaward infrastructure	**11**	0	1	0	2	0		0	3	0	-1	0	0	0	2	9	10
subsystem service	availability of MoS-connections at the port/ hinterland hub	**12**	2	1	0	0	0	-1		-1	0	1	1	1	1	1	10	8
	regularity	**13**	0	1	1	1	0	1	1		0	0	2	0	0	0	7	7
	frequency of services	**14**	0	1	1	2	0	-1	0	0		0	1	0	0	0	6	7
	price of the MoS-connection	**17**	0	2	0	2	0	0	0	0	0		0	0	0	0	4	6
	simplicity of MoS services	**18**	0	2	0	2	0	0	0	0	0	0		1	1	1	7	10
subsystem funding, subsidy, investment	Marco Polo-funding	**25**	0	1	2	1	0	2	2	0	2	1	2		0	3	16	4
	other EU budget for investement/funding/subsidies	**26**	0	0	0	0	1	1	0	0	0	0	1	0		2	5	6
	overall national/ regional budget for investment/ funding/ subsidies	**27**	0	1	2	0	0	3	2	0	2	-1	1	1	2		15	13

Figure 31: Cross-impact matrix of the DP 1 systems model

3.1.4 Analysing the specific interrelations

Based on the results of the completed cross-impact matrix, the interrelations within the subsystems can be analysed.

Role of the variables

The active and passive sums (see section 1.3.4 for methodological background) of every variable are illustrated in Figure 32. On the one hand the actual values of the active and passive sums are of interest, but on the other hand also the relation of both.

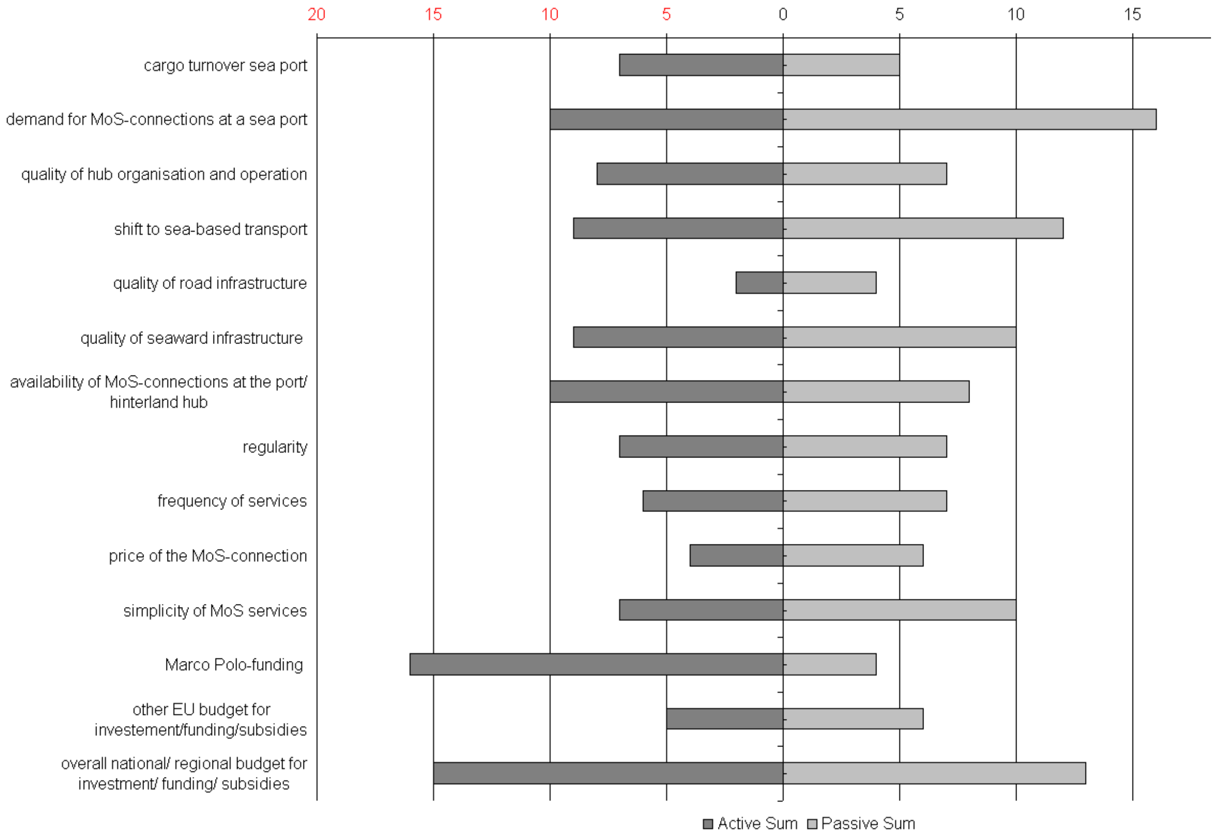


Figure 32: Active and passive sums of each variable

The variables are classified according to the scheme pointed out in Table 1 for interpreting the systems model regarding to the scale of influence and integration. The specification for this systems model is shown in 0 which is the basis for classifying the variables. In Annex F the quantitative results of the cross-impact matrix are shown for each variable.

The results of the classification are shown in Table 17. Note, that this has been used in addition to the diagrams and their interpretation described below.

Sub-system	No.	Variable	Integration	Influence
hub	1	cargo turnover sea port	buffering	moderately active
	4	demand for MoS at a sea port	neutral	reactive
	5	quality of hub organisation and operation	buffering	neutral

corridor	8	shift to sea-based transport	buffering	reactive
	9	quality of road infrastructure	strongly buffering	reactive
	11	quality of seaward infrastructure	buffering	neutral
MoS service	12	availability of MoS-connections at the port/ hinterland hub	buffering	neutral
	13	regularity of MoS-service	buffering	neutral
	14	frequency of MoS-services	buffering	neutral
	17	price of the MoS connection	strongly buffering	reactive
	18	simplicity of MoS services	buffering	reactive
funding, subsidy, investment	25	Marco Polo-funding	buffering	highly active
	26	other EU budget for investment/ funding/ subsidies	strongly buffering	neutral
	27	overall national/regional budget for investment/ funding/ subsidies	neutral	neutral

Table 8: Amount of influence and integration for every variable

Comparable to the generic systems model, it is necessary to amend this step with the interpretation through a diagram. All variables are arranged along X and Y axes, depending on their active and passive sums. By this diagram, general conclusions can be drawn about the system and the cybernetic role of every variable can be portrayed. In Figure 33, the variables are arranged to illustrate the system's overall constitution – thus the variables are not labelled individually, each one is simply represented by a black box.

Considering the overall allocation of the system's variable it must be stated that the cybernetic roles are not very divers.

Though, there is one exclusion, one variable is located in the highly active area. Thus the regulation of the system can be significantly influenced by changing just this variable. There are several variables in the (moderately) reactive area, therefore various variables have to be observed to indicate the system's constitution. The amount of variables in the neutral area is determined to one and therefore it can be concluded that the system's self-regulation is less developed. In addition to this, there are no critical variables, thus, it can be derived that the integration is not well developed, i.e. variables are not very interconnected. Finally, the half of the variables is located in the buffering area what classifies them as relatively inert.

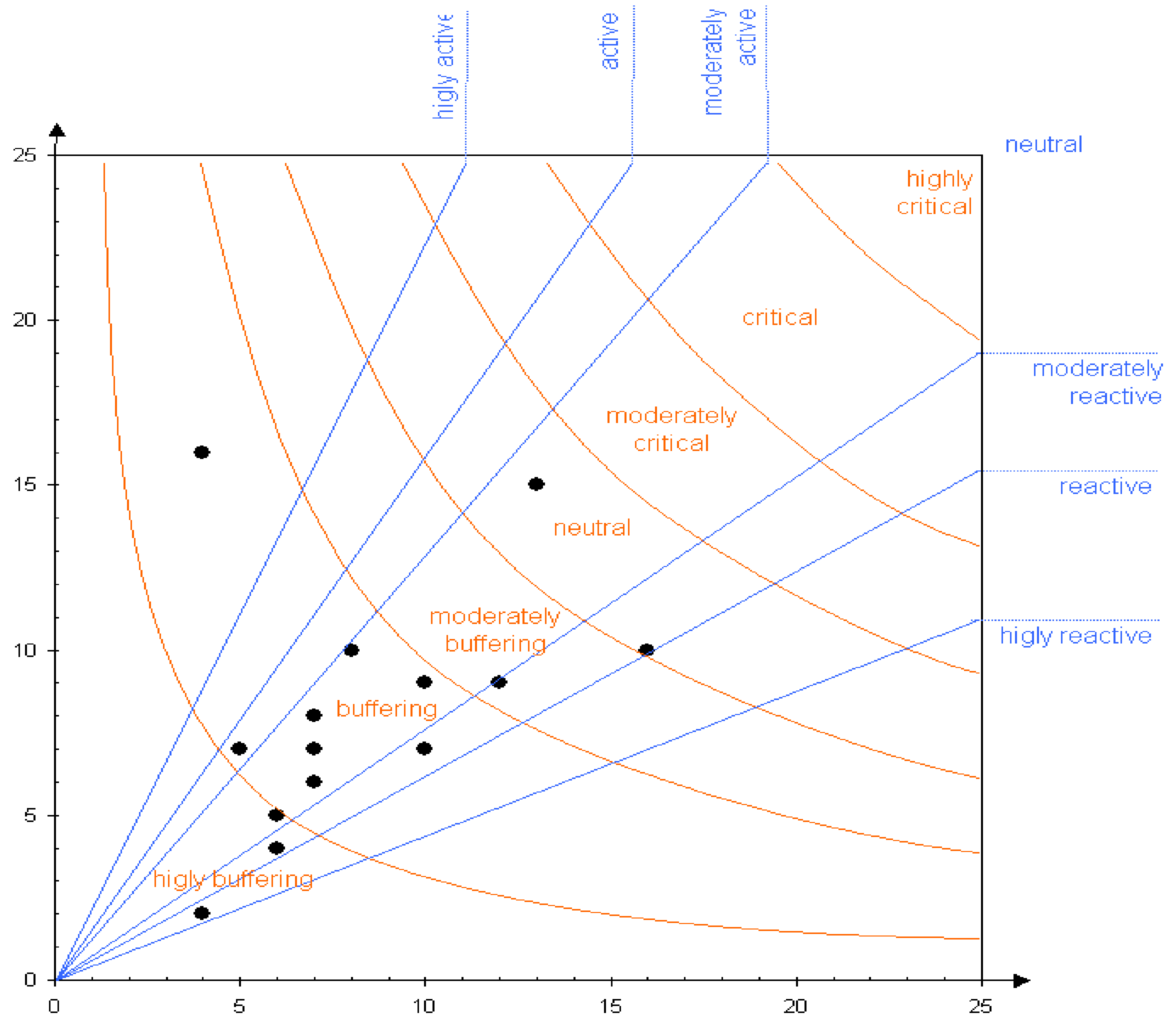


Figure 33: Role of the variables: overall cybernetic allocation of the variables

Up to regulation, there is one variable which stands out: '*Marco Polo-funding'* is located in the highly active and therefore intended to be the best (internal) regulator. Additionally there is one other variable, '*cargo turnover sea port*', which is located in the moderately active area and could also conduce for regulation.

There are several variables located in the (moderately) reactive area whereof the following could be considered for indicating the system's constitution: there are the '*demand for MoS-connections in the sea port*', the '*shift to sea-based transport*' and '*simplicity of MoS-service'*. But it must be said, that the system lacks variables which are located in the highly reactive area and therefore really intended to be good indicators. However, accepting this variable as indicator for the system's constitution leads to the conclusion, that the degree of success of MoS-services is best indicated by the '*shift to sea-based transport'* and the '*demand for MoS-connections'*.

Although there is one variable in the neutral area, the '*overall national and regional budget for investment, funding and subsidy'*, it cannot be concluded that the system's self-regulation is well developed.

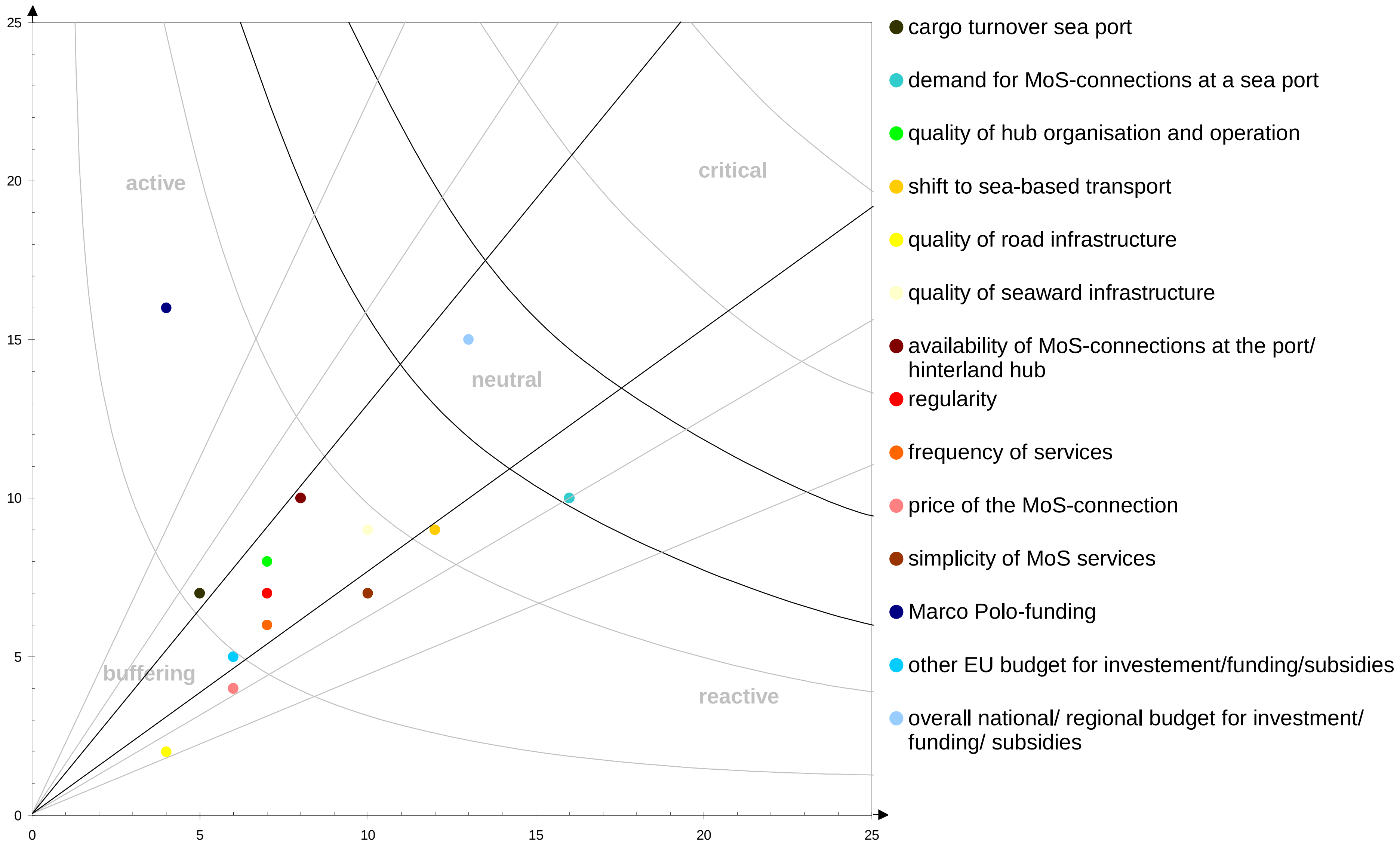


Figure 34: Role of the variables: key cybernetic variables

Furthermore, no variable could be located in the critical area, thus the system's integration is less developed as well.

Finally it can be summarised, that the specific system 'Northern Maritime Corridor - BASES' predominantly consists of variables with relatively little cybernetic function, with one exclusion: '*Marco Polo-funding'*. Changing this variable might be successful for pursuing the system's objective to initiate transport flows on this corridor. Variables outside the system's boundaries, such as the overall state of economy, the oil price or regulative prioritisation of environmental issues can have quite a significant impact on the system, as well.

Role of the subsystems

Figure 35 shows the variables coded according to the subsystems to show the role of these within the system. The subsystem *funding, subsidy, investment* comprises many of the active variables, which leads to the conclusion, that this subsystem is quite important for regulation. Another interesting subsystem is *hub*, which contains a mix of active, reactive and integrated variables. The subsystems *corridor* and *service* are mainly dominated by inert and reactive variables, therefore they are not important for regulation.

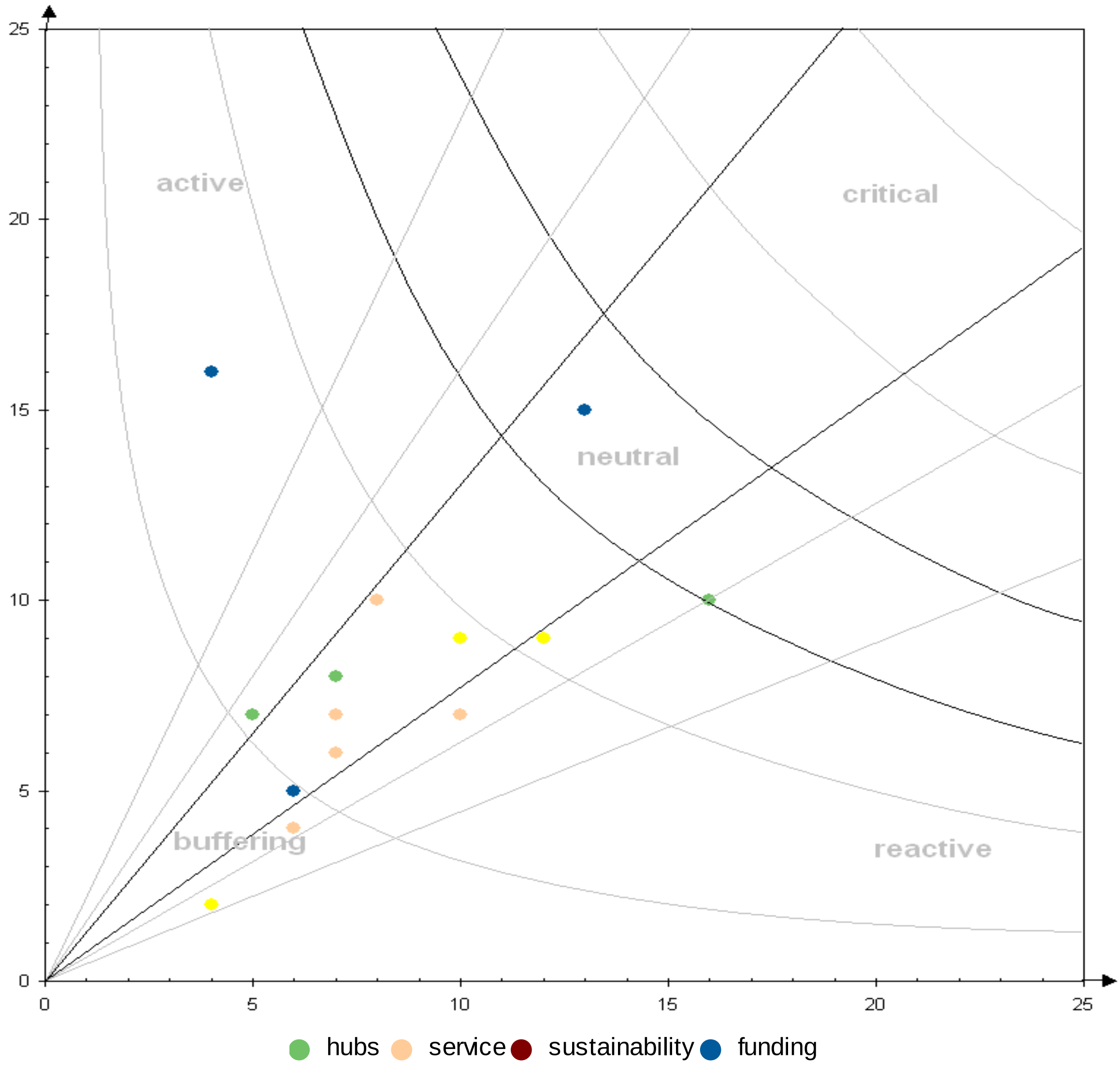


Figure 35: Role of the variables: variables coded according to subsystems

Impact cycles

The result of the analysis of the variables' roles leads clearly to the point, that it is the 'Marco-Polo-funding' which may serve for regulating the system to the objective to initiate cargo flows on the NMC. Therefore the following analysis adopts this hypothesis and it will be investigated, which objects of funding may have a greater positive impact on the system.

There are five variables which were identified as possible objects of Marco-Polo-funding: '*quality of hub organisation and operation*', '*quality of seaward infrastructure'*, '*availability of MoS-connections at the port*', '*frequency of services'* and '*simplicity of MoS services'*.

The following impact cycle (see Figure 36) shows this relation. There are all variables included, but ‚*quality of road infrastructure*' as it was classified as a weak indicator as well as '*other EU budget for investment/ funding/ subsidies*' and '*frequency of MoS-services*' as they were evaluated as being inert and buffering variables with only little cybernetic function. In the diagram the variables are illustrated, as well as the strong (quantified by 2) and very strong (quantified by 3) impacts.

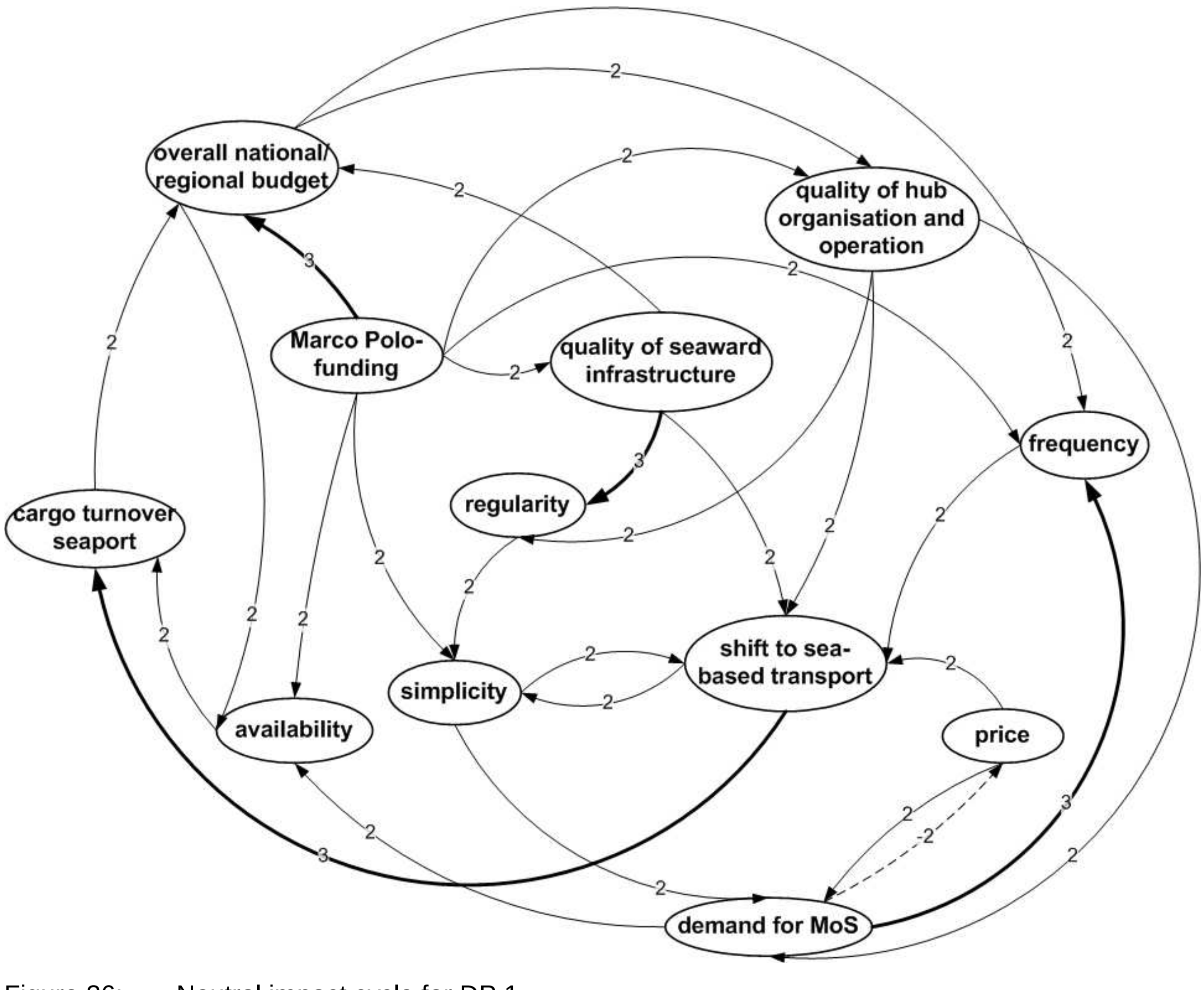


Figure 36: Neutral impact cycle for DP 1

The further analysis is closely linked to the derivation of measures. Therefore in Table 9 an overview of possible measures is provided, which are linked to one object of funding. As possible measures might also be linked to two objects of funding at the same time, these combinations are also taken into consideration.

Funding scenario No.	**Object of funding**	**Example measure**
1	Quality of hub organisation and operation	Improvement of the hub's organisation and operation regarding to MoS-vessels
2	Quality of hub organisation and operation & Frequency of MoS-service	Improvement of the hub's organisation and operation to realise a higher frequency on a certain connection
3	Quality of hub organisation and operation & Quality of seaward infrastructure	Improvement of the hub's organisation and operation to realise a higher seaward accessibility *or* Improvement of seaward accessibility (e.g. fairways) to improve the hub's organisation and operation
4	Quality of hub organisation and operation & Simplicity of MoS-service	Improvement of customs procedures in the hub
5	Quality of seaward infrastructure	Funding of icebreaker, vessels
6	Quality of seaward infrastructure & Frequency of MoS-service	Funding of vessels to realize more departures/ arrivals on a connection
7	Quality of seaward infrastructure & Availability of MoS-connections in the seaport	Funding of icebreaker or vessels to realize more connections
8	Simplicity of MoS-service	MoS-database (e.g. for available cargo)
9	Availability of MoS-connections in the seaport	Funding of new services

Table 9: DP 1: Funding scenarios to derive measures

There are nine different funding scenarios which will be investigated further.

In the following figures, each one of these funding scenarios is illustrated through one impact cycle diagram (see Figure 37 to Figure 45), which should be read as follows: to illustrate the impact of funding one (or more) object(s), colour-based symbolism has been used. The more directly the system variables are affected by funding, the darker is the blue of their boxes and of the impact connections (represented by arrows). Thus, different funding scenarios can be assessed visually by comparing the strength of their colouring. The more dark blue system variables and impact connections between them are shown, the stronger is the impact of a particular funding scenario on the system.

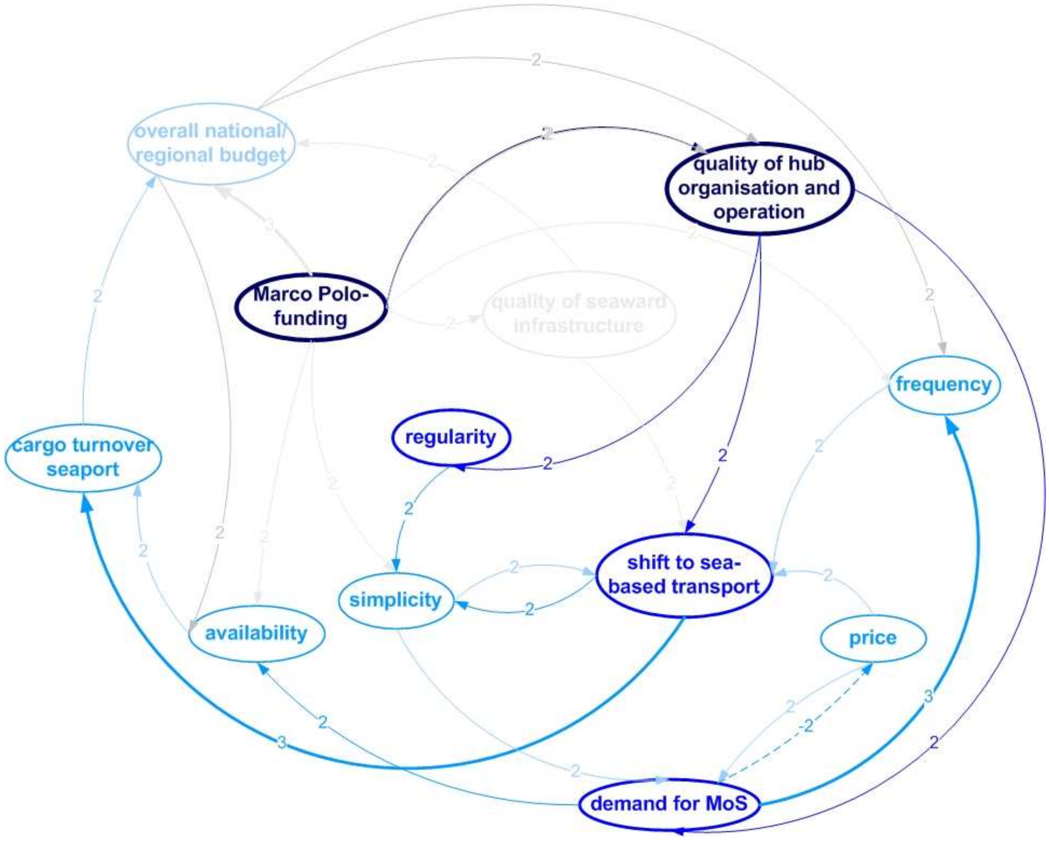


Figure 37: DP 1 Scenario 1

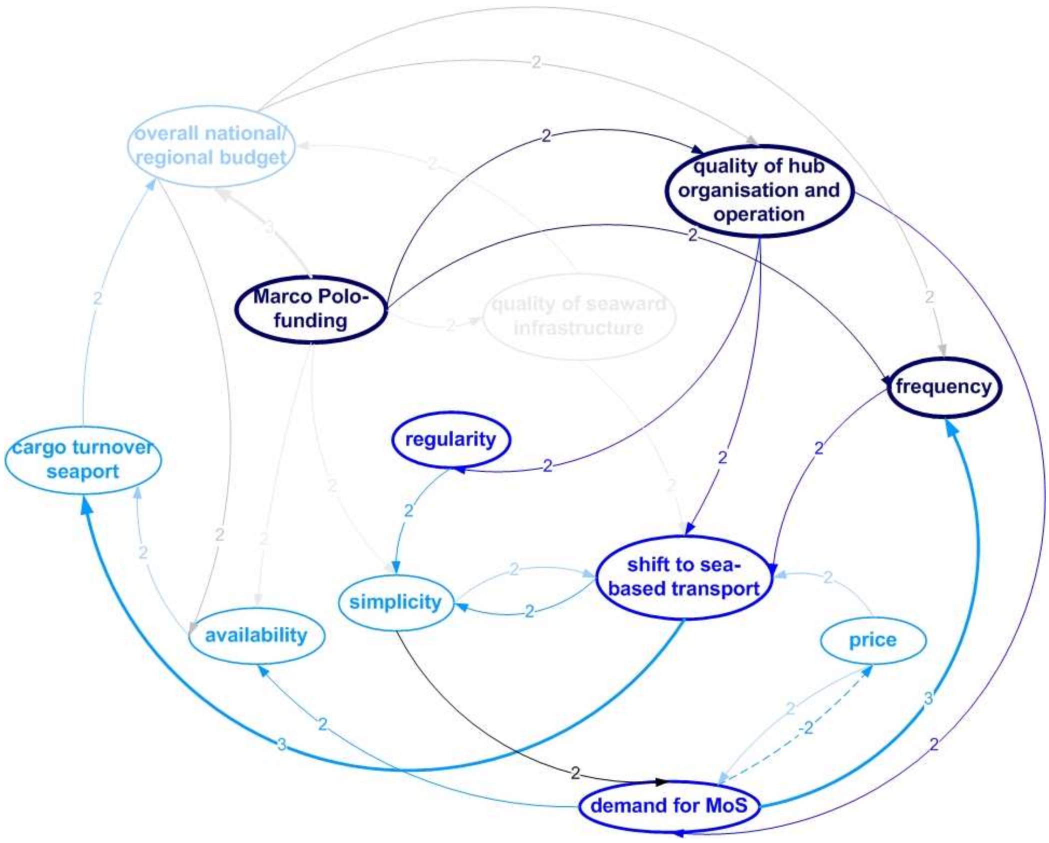


Figure 38: DP 1 Scenario 2

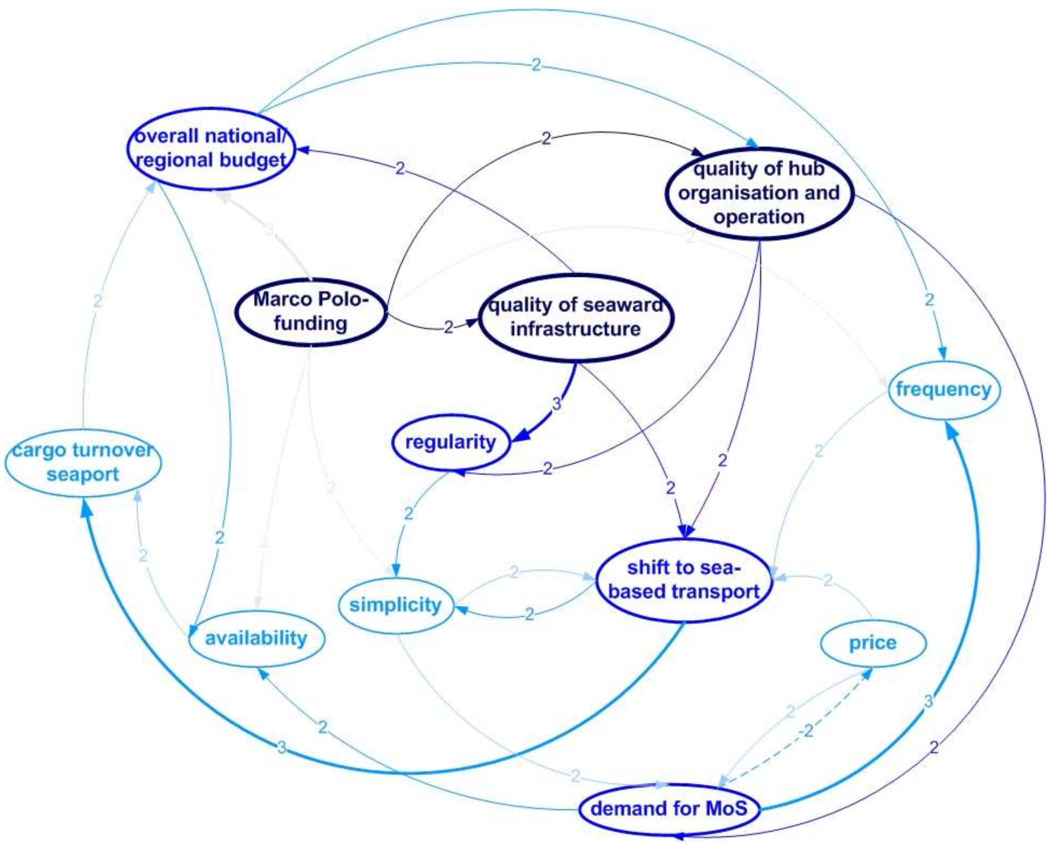


Figure 39: DP 1 Scenario 3

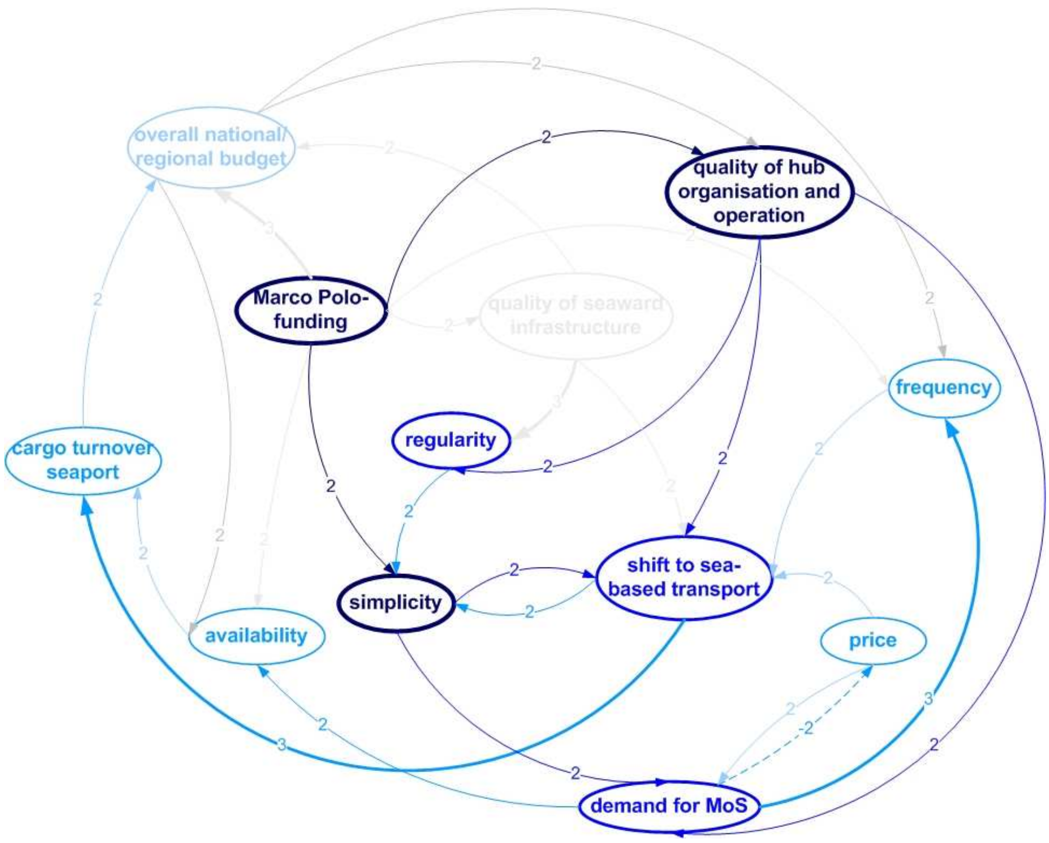


Figure 40: DP 1 Scenario 4

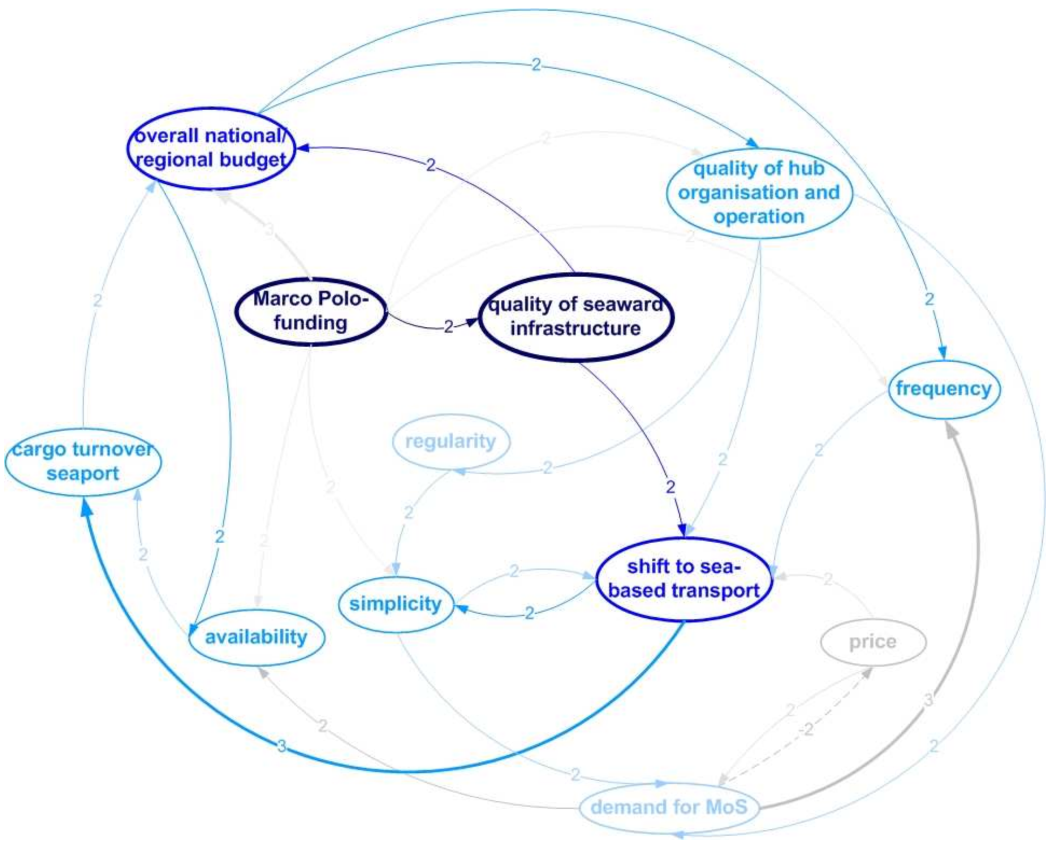


Figure 41: DP 1 Scenario 5

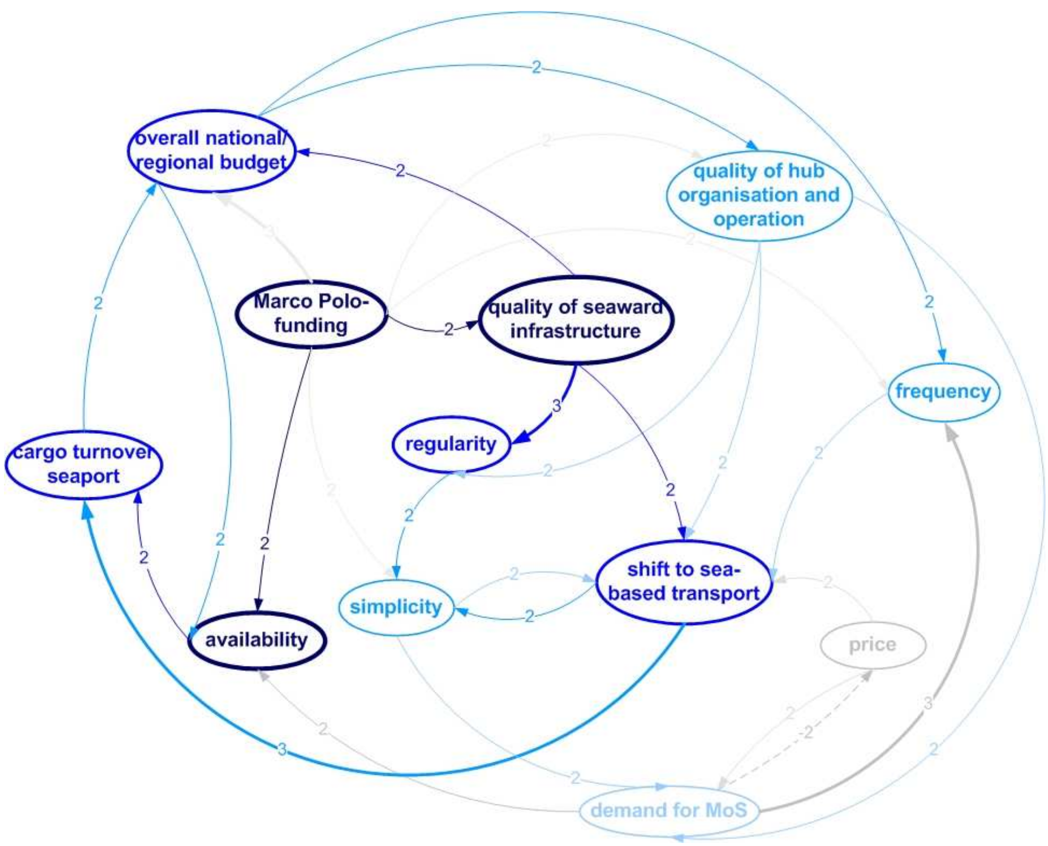


Figure 42: DP 1 Scenario 6

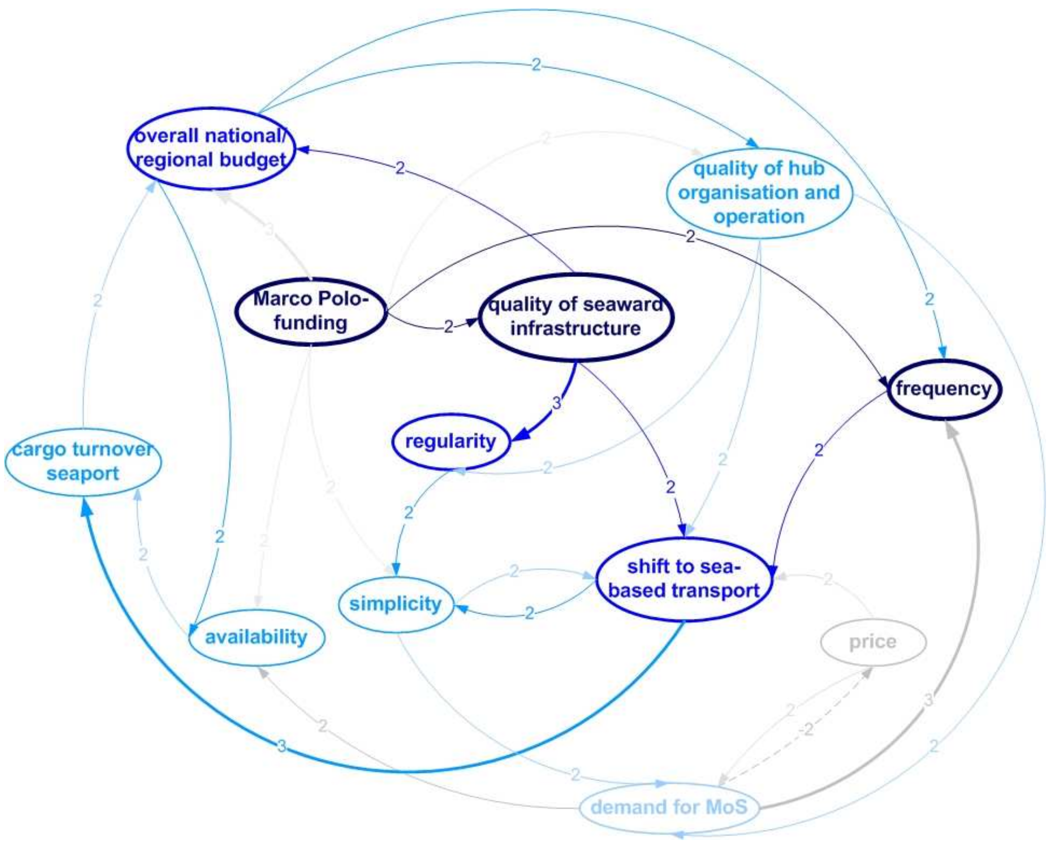


Figure 43: DP 1 Scenario 7

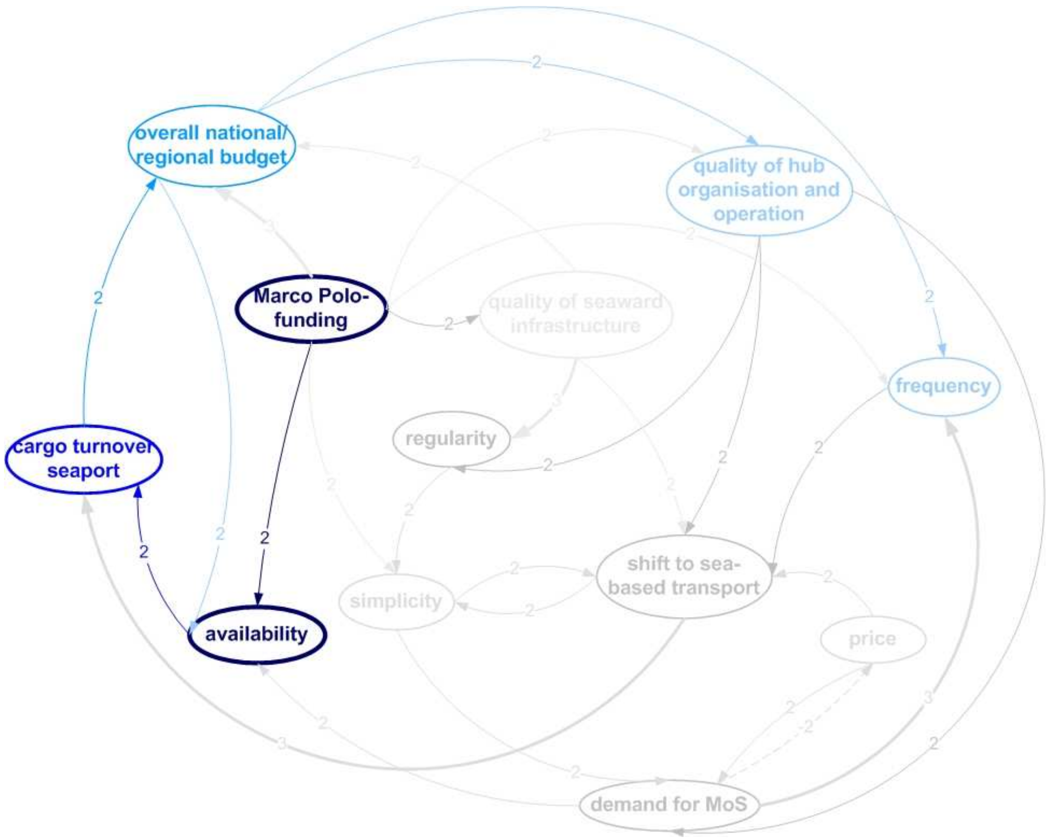


Figure 44: DP 1 Scenario 8

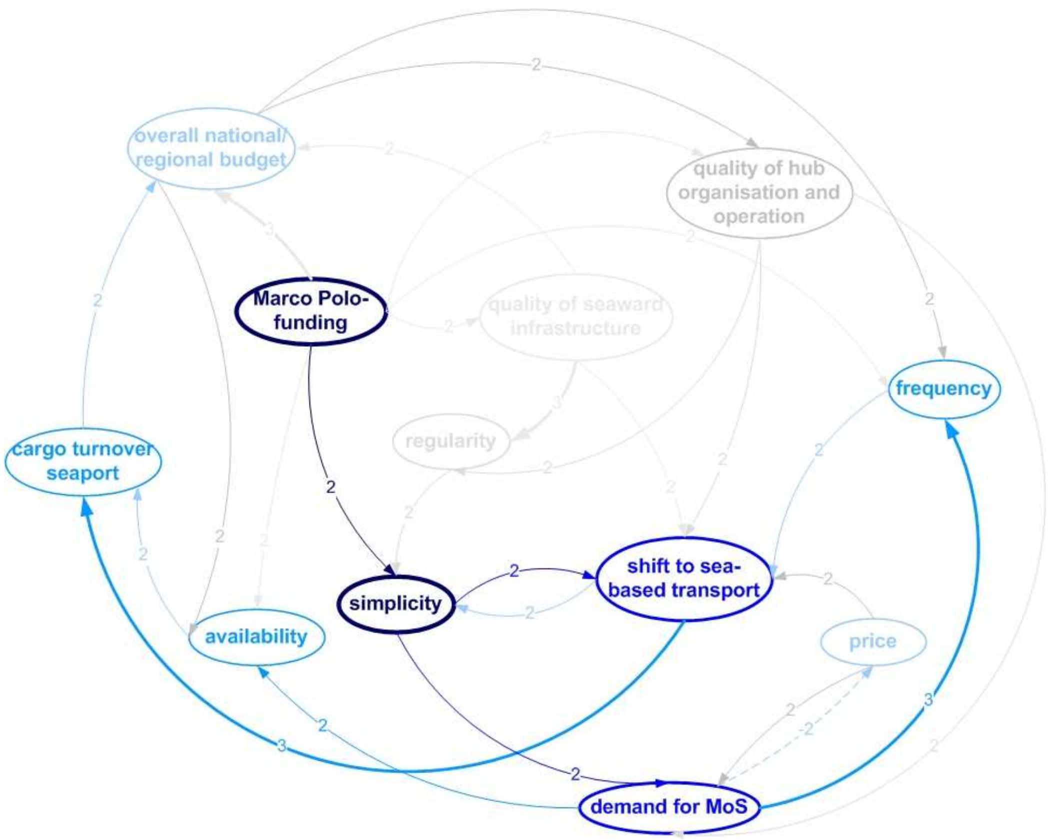


Figure 45: DP 1 Scenario 9

In addition to the visualisation the amount of impact can be also quantified, by counting the number of variables

- which are affected directly by the object(s) of funding,
- which are affected indirectly by the object of funding and
- which remain.

Therefore the following table has been used. The scenarios of great interest are no. 1, 2, and 6, a funded measure here leads to high amount of affected variables in the system (directly and indirectly). The scenarios which might be interesting as well (no. 3, 4, 5 and 7) are marked in light grey and the ones which seem to be of low interest (8 and 9) are marked in dark grey.

Scenario	**Amount of variables which are directly affected by the object(s) of funding**	**Amount of variables which are indirectly affected by the object(s) of funding**	**Remaining variables**
1	3	5	2
2	4	5	0
3	3	4	2
4	3	4	2
5	2	5	3
6	4	3	2
7	3	4	2
8	1	1	8
9	2	3	5

Table 10: Comparison of scenarios for DP 1

3.1.5 Conclusion for Demonstration Project 1

Based on this systems analysis, it can be summarised, that the following Marco Polo-funding scenarios seems to be the more successful to initiate cargo flows on the NMC:

Funding of

- Quality of hub organisation and operation (e.g. improvement of the hub's organisation and operation regarding to the handling of MoS-vessels)
- Quality of hub organisation and operation & Frequency of MoS-service (e.g. improvement of the hub's organisation and operation to realise a higher frequency on a certain connection)or
- Quality of seaward infrastructure & Frequency of MoS-service (e.g. funding of vessels to realize more departures/ arrivals on a connection).

To finalise the systems analysis for the specific model for DP 1 these results were presented and discussed in context of another workshop.

Overall the results were regarded as plausible and it was stated by the workshop participants, that no relevant funding scenario was missed.

During the workshop also the recent development of the DP was discussed. The main changes in the DP's intention which is relevant to this systems analysis were presented by the DP coordinator. Currently the decision to apply for Marco Polo funding is still under discussion, as it is not

It was discussed which other funding sources would be relevant to the DP. Anyway it was concluded that although the results of the systems analysis of DP 1 were focusing on Marco Polo funding, the investigated funding scenarios can be transferred to other funding sources.

3.2 Demonstration Project 3b ‘Optimising feeder and short sea shipping in ports’

3.2.1 General Information on the project

For several years, major ports such as the Port of Hamburg, have been experiencing a significant growth in volume and change in composition of seaborne cargo. Furthermore, new logistics concepts are leading to modifications in transport organisation and handling. However, port infrastructure such as quayside gantry cranes are in general still set up according to the needs of one end user only: overseas maritime traffic. Therefore, all other vessels calling, e.g. feeder vessels or barges are obliged to use this infrastructure as well. For the terminals, this makes it a very expensive option to handle the smaller vessels, as they generally need longer handling time. As a result of that, container terminals in the Port of Hamburg were thinking of asking shipping lines for extra handling charges, if they do not load and unload a minimum number of containers per call. This presents a threat for short sea, feeder and inland shipping via the Port of Hamburg. For the future, a closer look on feeder traffic organisation is therefore inevitable for the port’s performance. After all, combining different modes of transport in an ideal way is vital for a logistics hub.

The main objectives of the demonstration project are:

- increasing efficiency of terminal operations
- strengthening the European short sea transport network
- contributing to modal shift on potential short sea routes
- ensuring reliable operations in the Port of Hamburg in spite of growing cargo volumes

3.2.2 Developing the specific set of variables

The adaptation of the generic set of variables for DP 3b has been completed and is described hereafter. The variables of the generic system were adapted to the context of DP 3b within a half-day workshop. Figure 46 presents the results, variables coloured grey are those identified as not relevant for the DP. The arguments for defining a variable as relevant or not are outlined below.

Subsystem hubs

The ‘*cargo turnover sea port*’ was identified as relevant as the increasing turnover is the reason for the need of an improved SSS and feeder traffic. The Port of Hamburg focuses on the handling of overseas container traffic, thus the handling of smaller container vessels, which is less efficient from the perspective of terminal operators, is threatened (see above). Improving the ‘*consideration of SSS/feeder vessels in the seaport*’ is the main goal of the DP and therefore crucial. The consequence of an ineffective handling of feeder transport resp. customers and operators being affected by congestion could be a shift of business to competing ports, e.g. Rotterdam (assuming their operations run more smoothly). The focus of the DP is mainly on the requirements for SSS and feeder traffic at the seaport itself. This is why ‘*cargo turnover hinterland-hub*’ was said to be not relevant. Whereas the two variables ‘*quality of hub organisation and operation*’ as well as ‘*quality of hub facilities*’ are highly relevant because these two variables affect the processes in the seaport. The first one has a particular impact on the port cycle and berthing times and thus the utilisation of waterside and landside infrastructure. The second one also has an influence on the processes, e.g. the depths and availability of the dolphins (draught). The ‘*demand for SSS at a sea port*’ was also identified as a relevant. Improving the quality of operation and organisation of the hub is deemed to increase the demand: e.g. by offering shorter cycle times, more overseas cargo for Russia will be transhipped in HH. The '*accessibility of hubs*' was evaluated as not being relevant for feeder traffic, as the DP activities do not focus on this part of the transport chain.

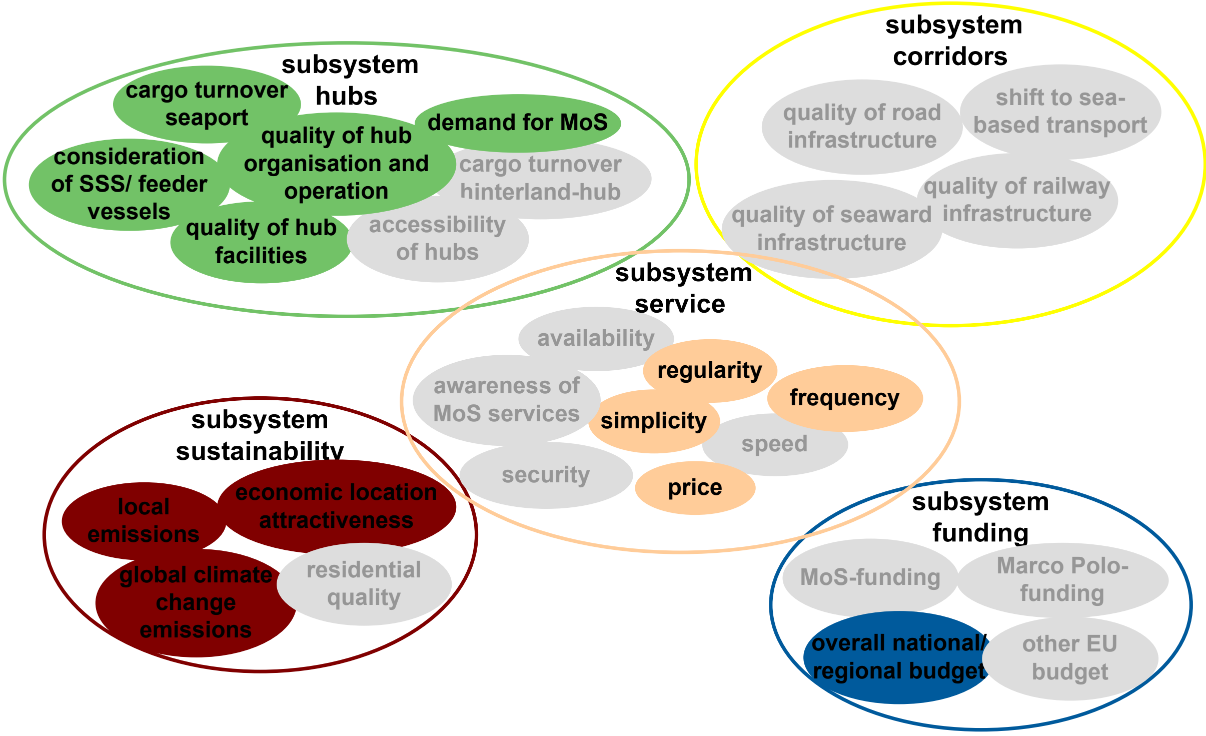


Figure 46: DP 3b - adapted set of variables

Subsystem corridors

None of the variables of the subsystem corridor were identified as relevant. As has already been mentioned above, the DP mainly focuses on the seaport and the variables influencing the processes there. Therefore, neither the seaward nor the competing corridors are of immediate interest. But some points of indirect relevance were noted. The '*shift to sea-based transport*' was mentioned as a side effect, as the quality of feeder connections affects the willingness to shift cargo from road to sea. Furthermore, it was mentioned, that there is an indirect relevance of '*quality of seaward infrastructure'*, since due to tidal depth restrictions (in Hamburg), certain tidal windows are reserved for larger ship. Thus feeder ships also depend on these windows resp. the time in-between.

Subsystem service of MoS

Several variables of the service of MoS were identified as being relevant for the DP. The '*regularity of the MoS-service*' is a relevant variable, as the DP aims to improve regularity of timetables, berth planning etc. This is very important for feeder transport operators as well as for terminal operators. The '*frequency of services*' was evaluated as relevant as it affects the utilisation of port-infrastructure. The '*price of the MoS-service*' is one of the driving factors for competition and thus very important for the DP. Furthermore, the '*simplicity of MoS-service*' was identified as being relevant, as it is important for the competitiveness in relation to land-based-transports, especially if going out of the EU. The other variables of the subsystem MoS-service were identified as being not relevant for several reasons. The '*availability of MoS-connections at the port/hinterland hub*' was declared as an issue for Baltic Sea ports e.g. Lübeck. The '*speed of the MoS-service*' was excluded, as the feeder traffic is said to be the shortest part of the transport chain with low impact on the overall time for transportation.

Subsystem sustainability

Both environmental issues were identified as relevant, since decreasing '*local emissions'* (as road emissions within the port) and decreasing '*global climate change emissions*' can be used as an argument in communications with both the forwarders and/or the general public. The social dimension, described here through '*residential quality*', was not considered to matter directly for the DP. Lastly, there is the economic dimension, '*economic location attractiveness at the port/hinterland hub*', which was identified as relevant since one of the DP's objectives is to optimise operational handling in the port. If this is achieved, the port/ region should attract more industry and transport operators.

Subsystem funding

Within the DP only the '*overall national/regional budget for investment/funding/subsidies'* was evaluated as relevant. In the context of the project, a centralised 'Logistikleitstand' (platform for information exchange on and organisation of logistic processes) has been installed, financed by shipping lines to optimise feeder transport. MoS, Marco Polo or other EU-funding is of no importance or not addressed by the DP, even though some positive side effects in terms of disseminating information about MoS-funding more widely, are expected.

3.2.3 Specifying the impact within the systems model

The cross-impact matrix was completed during a second workshop. The completed matrix is shown in Figure 47 (see section 1.3.3 for the methodological background). Every variable is assessed against all other variables regarding the strength and quality of the impact it has on them. The strength of the impact is quantified by 0 for no impact, 1 for weak impact, 2 for strong impact and 3 for very strong impact. The quality is expressed by algebraic signs: positive impacts (marked in green) are enhancing, while negative impacts (marked in red) have a reducing effect. The last two columns on the right comprise the calculated active sums (AS) and passive sums (PS) for every variable.

Overall, 156[8] possible impact combinations were evaluated. Of these, 61 did not equal 0, i.e. in these combinations an impact was diagnosed. A weak impact was identified 28 times, a strong impact 17 times and a very strong impact 16 times.

The completed matrix is the basis for the analysis of the interrelations described in the following chapter.

[8] Since one variable has no impact on itself, 13 x 12 = 156 combinations are possible.

Specific System 'Optimising feeder and short sea shipping in ports' (DP§B) as part of Motorways of the Sea			*subsystem hub*					*subsystem MoS service*				*subsystem sustainability*			*sub-system funding*	Analysis	
			cargo turnover sea port	consideration of SSS/ feeder vessels in the seaport	demand for MoS-connections at a sea port	quality of hub organisation and operation	quality of hub facilities	regularity of MoS-service	frequency of services	price of the MoS-connection	simplicity of MoS-service	local emissions	global climate change emissions	economic location attractiveness at the port/hinterland hub	overall national/regional budget for investment/ funding/ subsidies		
		Nr.	**1**	**2**	**4**	**5**	**6**	**13**	**14**	**17**	**18**	**20**	**21**	**23**	**27**	**AS**	**PS**
subsystem hub	cargo turnover sea port	1		-3	2	-1	0	0	1	1	0	-2	2	2	3	17	8
	consideration of SSS/ feeder vessels in the seaport	2	-1		1	2	0	3	1	0	1	0	0	0	3	12	9
	demand for MoS-connections at a sea port	4	2	3		0	0	0	3	-2	0	0	0	0	3	13	13
	quality of hub organisation and operation	5	3	3	0		0	3	0	2	3	2	1	2	0	19	10
	quality of hub facilities	6	0	0	0	2		1	0	2	0	0	1	1	0	7	3
subsystem MoS service	regularity of MoS-service	13	0	0	2	1	0		0	0	1	0	0	0	0	4	11
	frequency of services	14	0	0	1	0	0	-1		1	0	-1	-1	1	0	6	5
	price of the MoS-connection	17	0	0	3	0	0	0	0		0	0	0	1	0	4	9
	simplicity of MoS-service	18	0	0	3	2	0	3	0	1		0	0	1	0	10	6
subsystem sustainability	local emissions	20	0	0	0	0	0	0	0	0	0		0	1	-1	2	6
	global climate change emissions	21	0	0	0	0	0	0	0	0	0	0		0	-1	1	5
	economic location attractiveness at the port/hinterland hub	23	2	0	1	0	0	0	0	0	0	1	0		3	7	11
subsystem funding, subsidy, investment	overall national/regional budget for investment/funding/subsidies	27	0	0	0	2	3	0	0	0	1	0	0	2		8	14

Figure 47: Cross-impact matrix of the DP 3b systems model

3.2.4 Analysing the specific interrelations

Based on the results of the completed cross-impact matrix, the interrelations within the subsystems can be analysed.

Role of the variables

The active and passive sums (see section 1.3.4 for methodological background) of every variable are illustrated in Figure 48. On the one hand the actual values of the active and passive sums are of interest, but on the other hand also the relation of both.

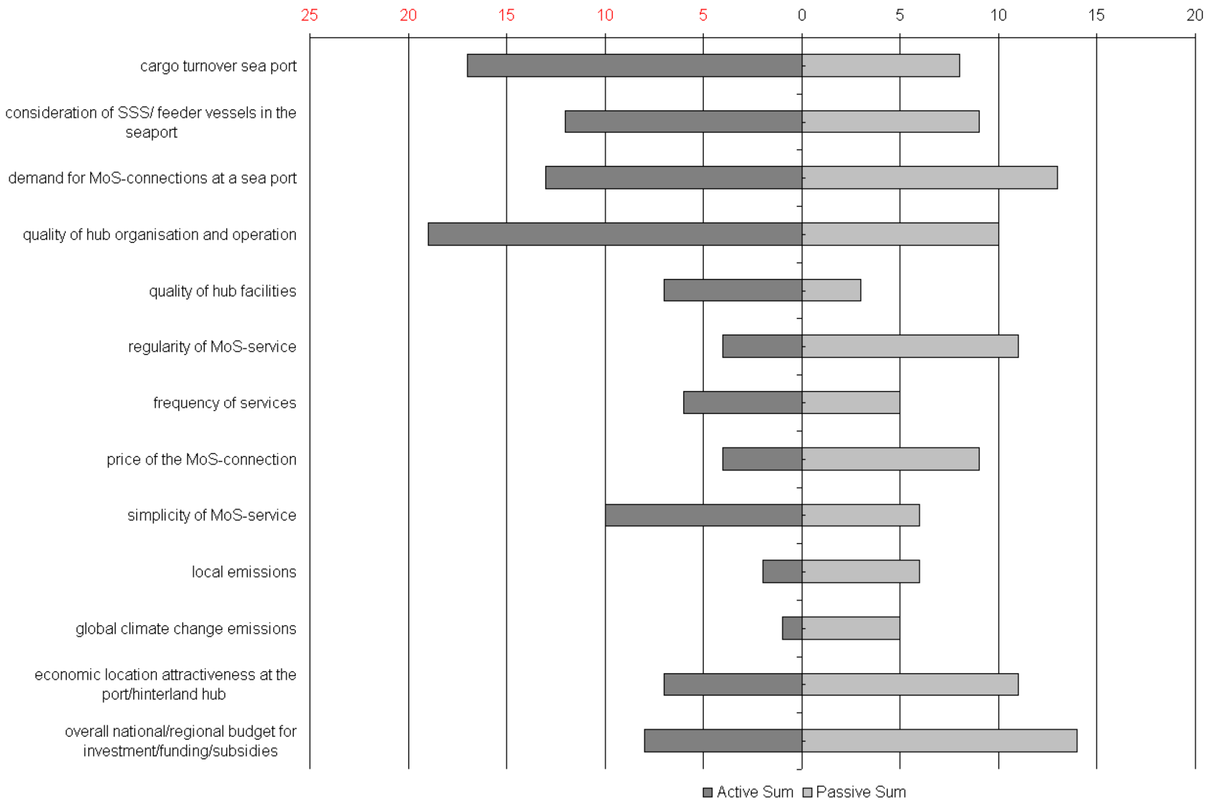


Figure 48: DP 3b: Active and passive sums of each variable

For interpreting the systems model, the variables are classified according to the scheme pointed out in Table 1. The specification for this systems model is shown in Annex G. In Annex H the quantitative results of the cross-impact matrix are shown for each variable.

The results of this classification are shown in Table 11. Note, that this has been used in addition to the diagrams and their interpretation described below.

Sub-system	No.	Variable	Integration	Influence
hub	1	cargo turnover sea port	neutral	active
	2	consideration of SSS/ feeder vessels in the seaport	moderately buffering	moderately active
	4	demand for MoS at a sea port	neutral	neutral
	5	quality of hub organisation and operation	moderately critical	active
	6	quality of hub facilities	strongly buffering	highly active

MoS-service	13	regularity of MoS-service	buffering	highly reactive
	14	frequency of services	buffering	neutral
	17	price of the MoS-connection	buffering	highly reactive
	18	simplicity of MoS services	buffering	active
sustainability	20	local emissions	strongly buffering	highly reactive
	21	global climate change emissions	strongly buffering	highly reactive
	23	economic location attractiveness at the port/hinterland hub	moderately buffering	moderately reactive
funding, subsidy, investment	27	overall national/regional budget for investment/funding/subsidies	moderately buffering	reactive

Table 11: Amount of influence and integration for every variable

The interpretation of the amount of influence and integration for every variable has to be combined with the interpretation through a diagram. In Figure 49, the variables are arranged to illustrate the system's overall constitution, depending on their active and passive sums, they are arranged along X and Y axes, which allows drawing general conclusions about the system and possible cybernetic roles (therefore the variables are not labelled individually, each one is simply represented by a black box).

It can be derived from the overall allocation of the variables that the cybernetic roles are moderately diverse and distinctive, more than e.g. within the generic model. There are several variables located in the active area, which are therefore intended to conduce for regulating the system. Also in the passive area, some variables can be found, thus they might be indicators for the systems' constitution. It has to be mentioned, although there are variables intended for regulating and indicating, that no variables are located in the 'extreme area' what means being located in the corners of both areas. That leads to the point, that the regulation as well as the choice of indicators has to affect several variables than only one variable. The self-regulation of the system seems to be less developed, since only one variable can be located in the neutral area. As there is only one variable in the (moderately) critical area, it can be concluded that the interconnectedness of the variables resp. the system's integration is less developed.

Overall, there are three variables which are intended to be good regulators: '*quality of hub organisation and operation*', '*cargo turnover sea port*' and *'quality of hub facilities'*. The latter is located in the highly active area, although the impact on the system is determined because of its relative low active sum, but nevertheless on the same time the impact is well predictable. The variable '*quality of hub organisation and operation'*, being located in the active area, is at the same time evaluated as moderately critical, thus changing this variable should be handled a little bit with care, because of its amount of integration. There are two other variables which could also be interesting for regulation: '*consideration of SSS/ feeder vessels in the sea port*' and '*simplicity of MoS-service'*. The first one was evaluated as moderately active, the latter as active.

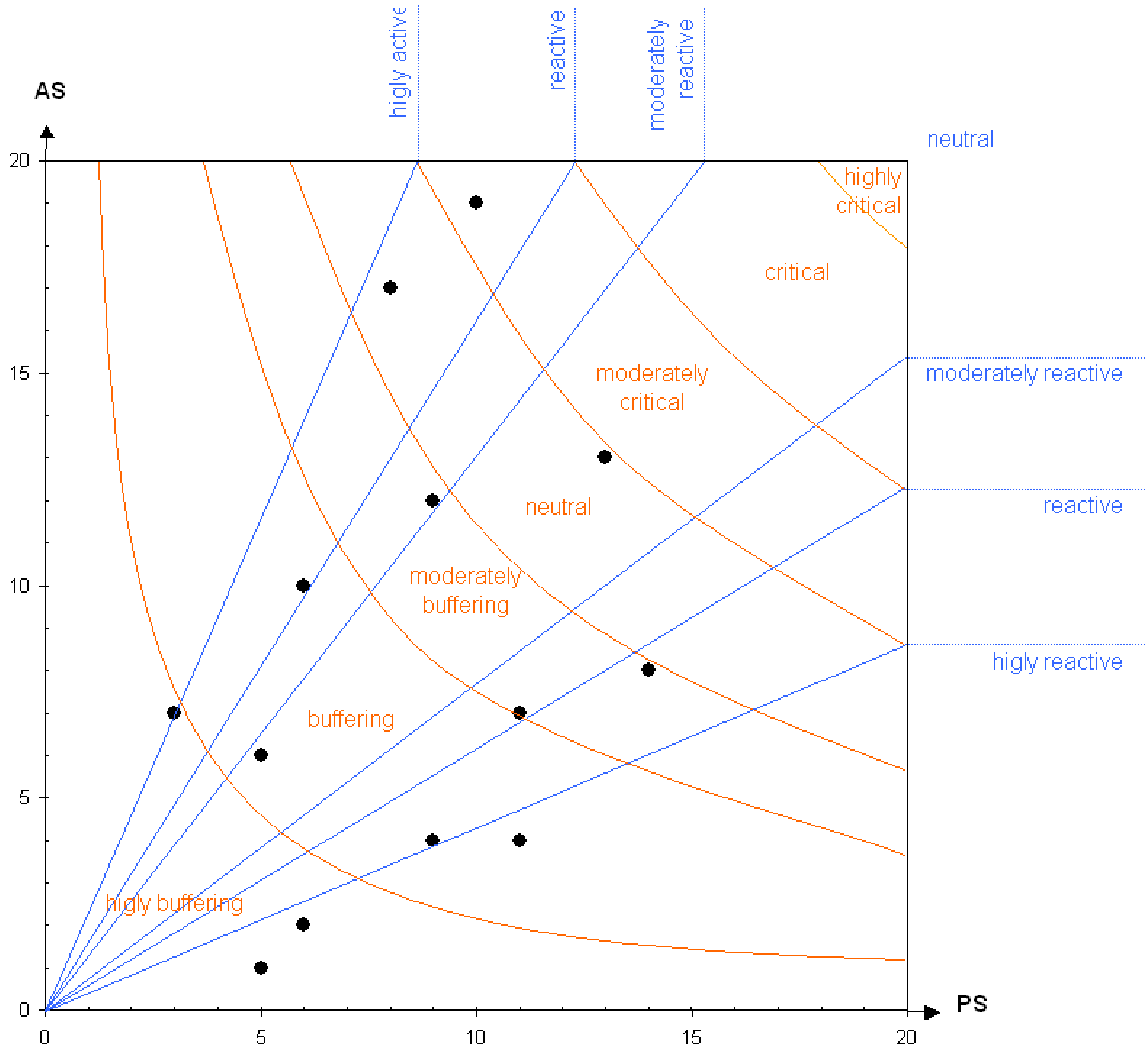


Figure 49: Role of the variables: overall cybernetic allocation of the variables

For the choice of variables indicating the system's constitution regarding to the objective to optimise feeder transport in the sea port there are first of all three variables: '*local emissions'*, '*global climate change emissions*' and '*regularity of MoS-service'*. They are all located in the highly reactive area. However the first two have relatively low passive sums and are therefore less qualified for being indicators. Hence regularity could be a system's indicator. Furthermore there are two other variables, both located in the reactive area, which also could be considered for this cybernetic role: '*price of MoS-connection'* as well as the '*overall national and regional budget for investment, funding and subsidy*'.

Up to the integration (critical area) of the system, no variable stands out. Thus the interconnectedness of the variables is not well marked (see above).

Concerning the self-regulation (neutral area) of the system, there is only one variable which can be found in this area: '*demand for MoS-connections in the sea port*'. This leads to the point (like already mentioned above) that the system needs outer regulation.

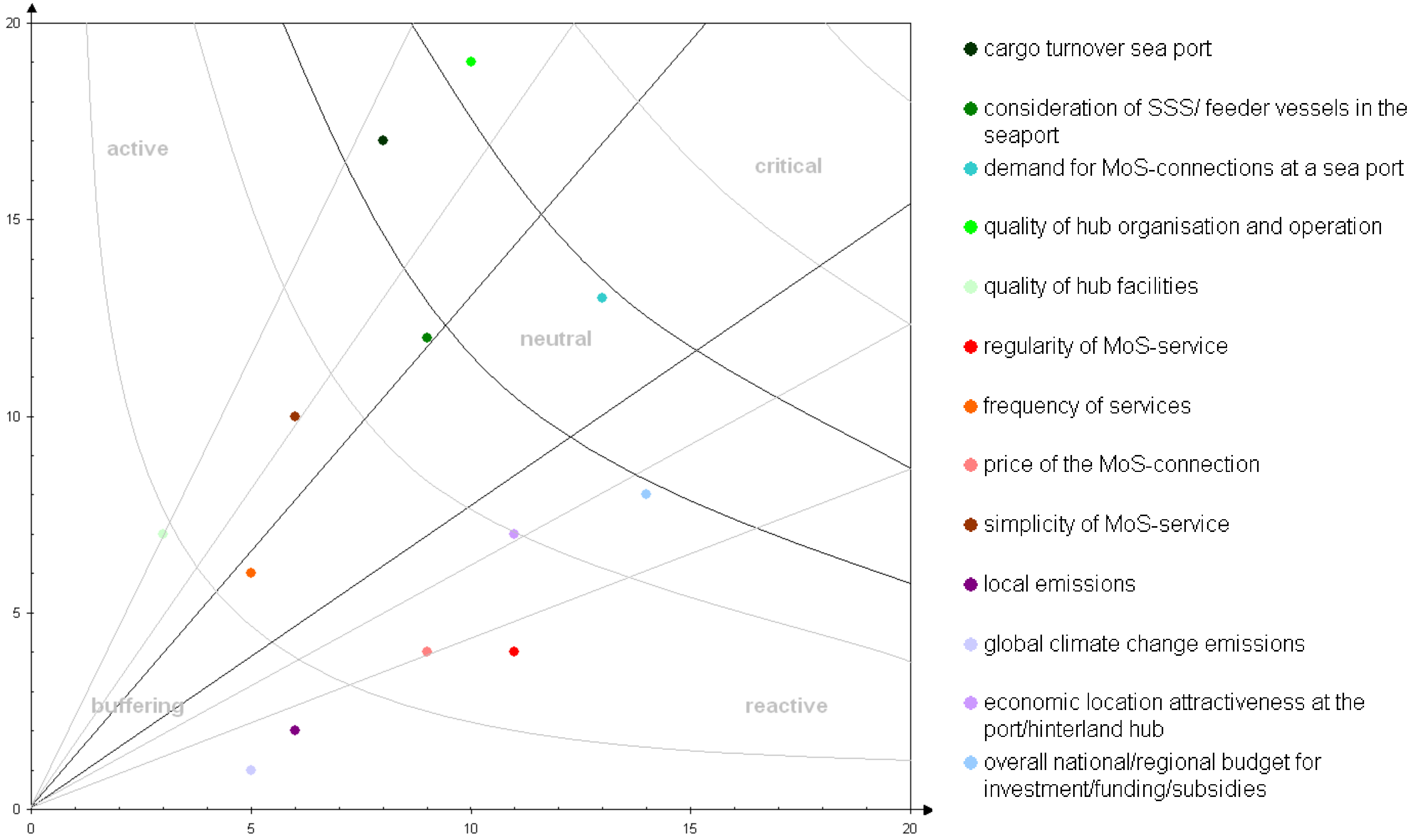


Figure 50: Role of the variables: key cybernetic variables

Summarising it can be stated, that the specific system on feeder and short sea shipping in ports (case Hamburg) offers possibilities to be regulated, what means that there are options to pursue the objective to optimise feeder and short sea shipping within the port by taking impact on one of the active variables within the system. Nevertheless, there are factors outside the system's boundaries which might also have a significant impact like the economic and trading conditions or the oil price.

Role of the subsystems

Figure 51 shows the variables coded according to the subsystems to show the role of these within the system. The subsystem *hub* comprises many of the active variables, which leads to the conclusion, that this subsystem is quite crucial for regulation. Another interesting subsystem is *service*, which contains a mix of active and reactive variables. Whereas the subsystem *sustainability* consists of reactive variables. The subsystem *funding, subsidy, investment* and is only represented with one reactive variable.

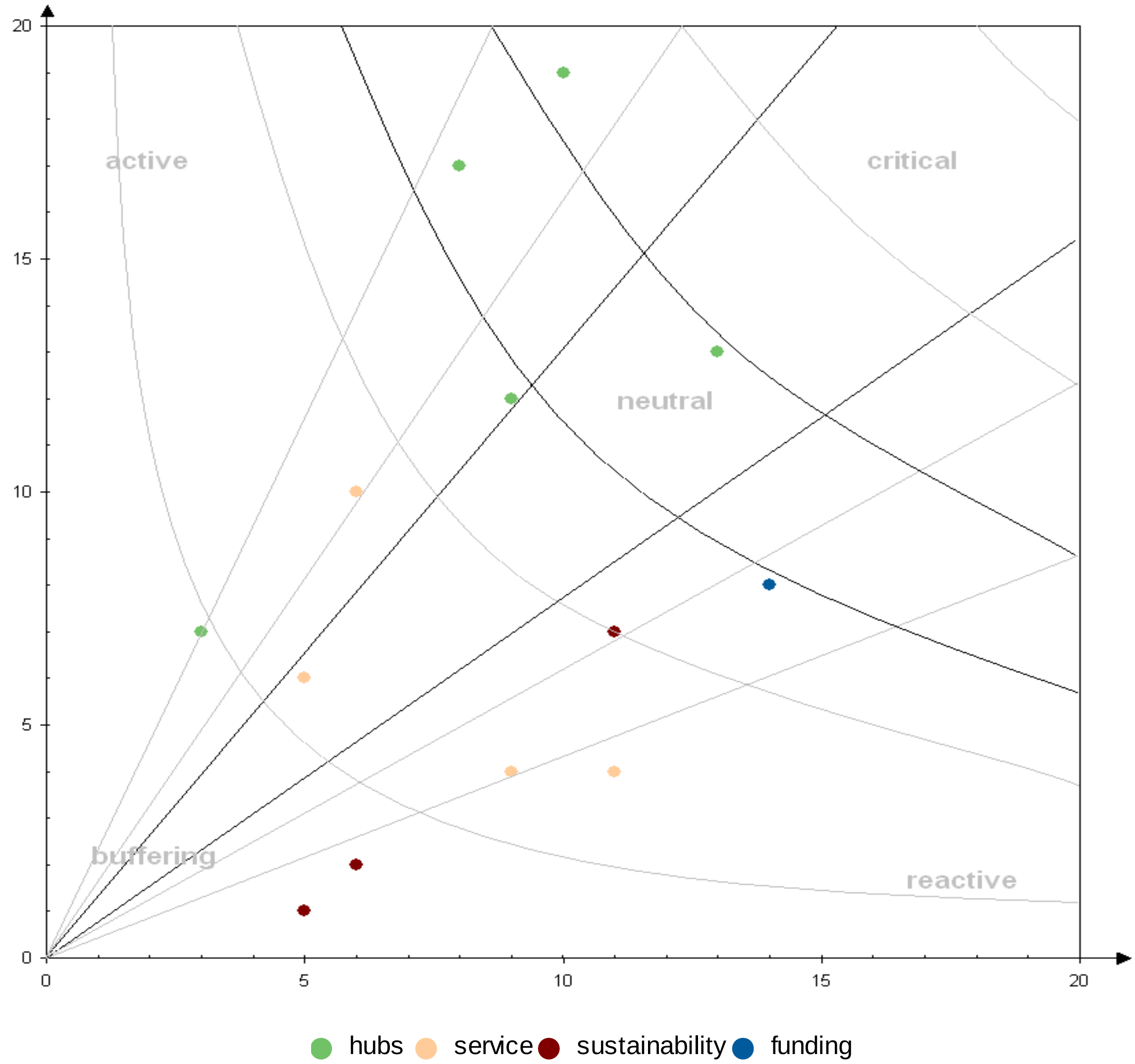


Figure 51: Role of the variables: variables coded according to subsystems

Facing the objective of this specific system model to find and evaluate measures to optimise feeder and SSS transport in the sea port, it can be conclude, that the main approach for regulation should be realised via the hub itself.

Impact cycles

The demonstration project's objective is to optimise feeder and short sea-shipping transport (see above). Within the project work certain measures have already been defined to reach this objective. Thus the specific systems model will be used here for evaluating these measures. Additionally it will be cross-checked, if these measures affect those variables which have been identified as good regulators for the specific system.

Taking a look on the role of the variables there have been the following variables identified as being good regulators: '*quality of hub organisation and operation*', '*cargo turnover sea port*', *'quality of hub facilities'*, '*consideration of SSS/ feeder vessels in the sea port*' and '*simplicity of MoS-service'*. Apart from the second one, these are exactly the variables which are affected by the defined measures.

The following impact cycle (see Figure 52) shows the impact relation of DP 3b. There are all variables included, but ‚*local emissions*' and '*global climate change emissions*' as they were classified as weak indicators as well as '*frequency of MoS-services*' as it was evaluated as being an inert and buffering variable with only little cybernetic function. In the diagram the variables are illustrated, as well as the strong (quantified by 2) and very strong (quantified by 3) impacts.

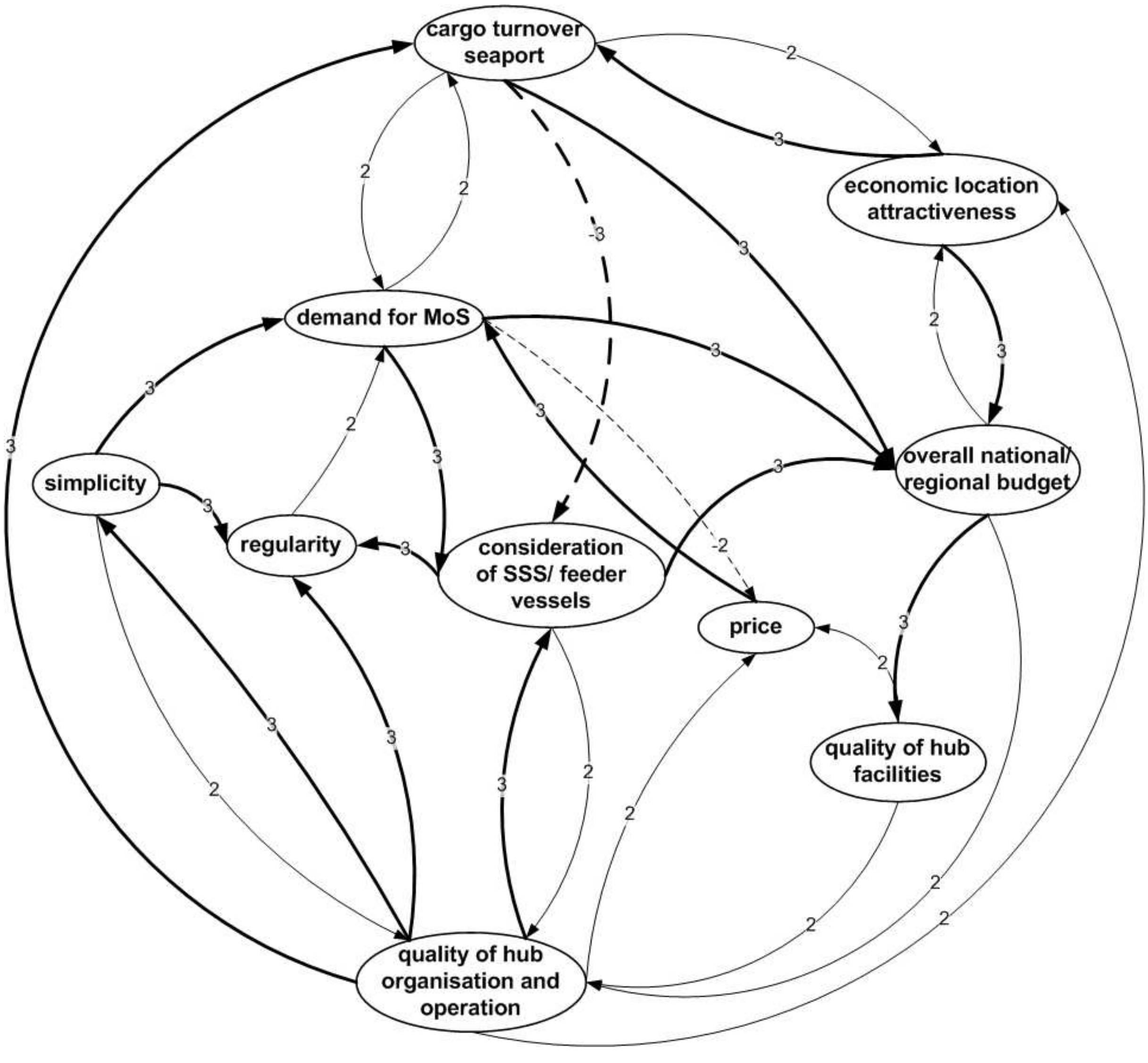


Figure 52: Neutral Impact cycle for DP 3b

To investigate the impact of the already defined measures on the system, the relation of the measures to one or several variables of the system has been identified (see Table 12). The level of detail of the concrete measures cannot be illustrated by the systems model and not for every measure a scenario can be built. But the measures can be clustered according to the variables they are affecting. Hence there are six different scenarios:

Scen. No.	**Variables affected by measure**	**Measure**
1	’consideration of SSS/ feeder vessels in the seaport’ & ’quality of hub organisation and operation’	Increase ship’s turnover per terminal call. Increase of transhipments by barge.
2	’consideration of SSS/ feeder vessels in the seaport’ & ’quality of hub facilities’	Special feeder berths. Dedicated feeder terminal.
3	’quality of hub organisation and operation’	Working hours’ adjustment. Increase of cell guides. Binding schedules/ list of sailings. Feeder consortia. Increase disposability of pilots. Port dues adjustment. Terminal comprehensive preplanning. Alteration port of calls. Increase disposability of tugs.
4	’quality of hub organisation and operation’ & ’quality of hub facilities’	Increase of gantry cranes availability
5	’quality of hub organisation and operation’ & ’simplicity of MoS-service’	Previous transfer of container information. Accelerate customs clearance.
6	’quality of hub facilities’	Increase of dolphins and other waiting berths. Faster lashing/ unlashing Faster mooring/ unmooring

Table 12: DP 3b: Scenarios to evaluate measures

Three of the measures defined in the DP are affecting the variable ’quality of seaward infrastructure’, which is not part of the specific system (but of the generic one): ‘Ships without hatch covers’, ‘Larger feeder vessels’ and ‘Faster hatch covers’. One measure takes influence on the quality of equipment (‘Upgrade container quality’) which is not part of the systems model at all.

For every scenario an impact cycle diagram can be found to illustrate the impact of the measures (see Figure 53 to Figure 58). Comparable to DP 1, the same colour-based symbolism has been used. The more directly the system variables are affected by funding, the darker is the blue of their boxes and of the impact connections (represented by arrows). Thus, different scenarios can – in a first step – be visually by comparing the strength of their colouring. The more dark blue system variables and impact connections between them are shown, the stronger is the impact of a particular scenario on the system.

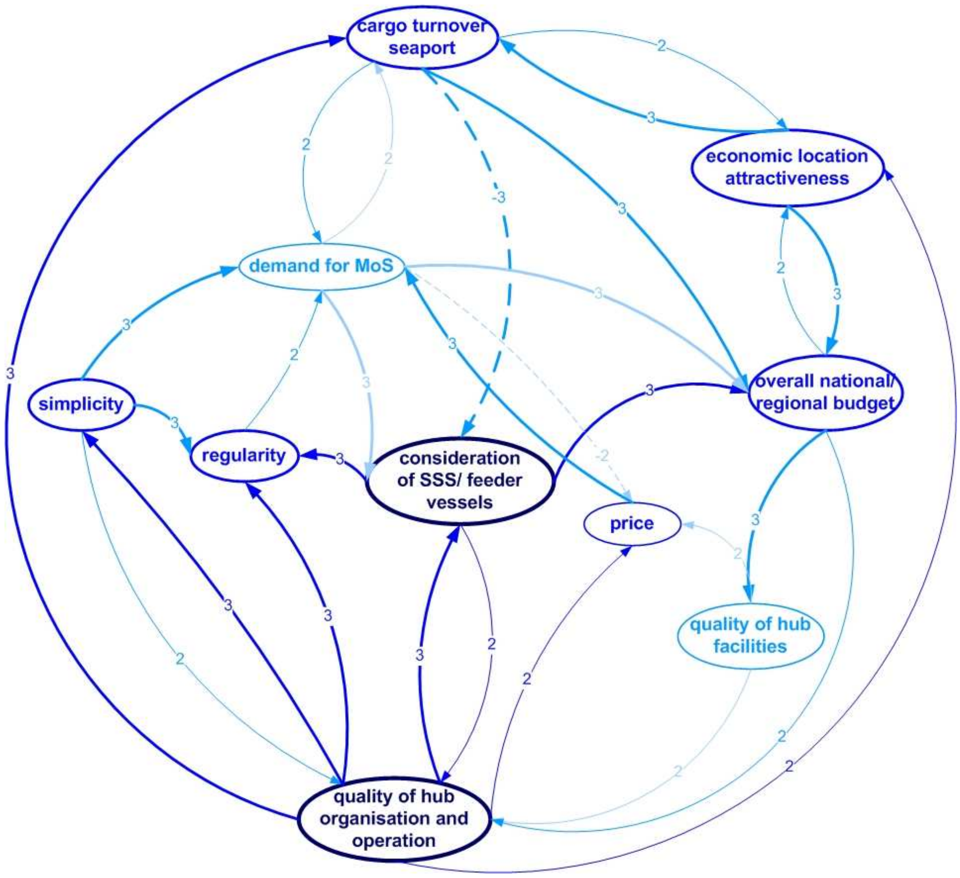


Figure 53: DP 3b Scenario 1

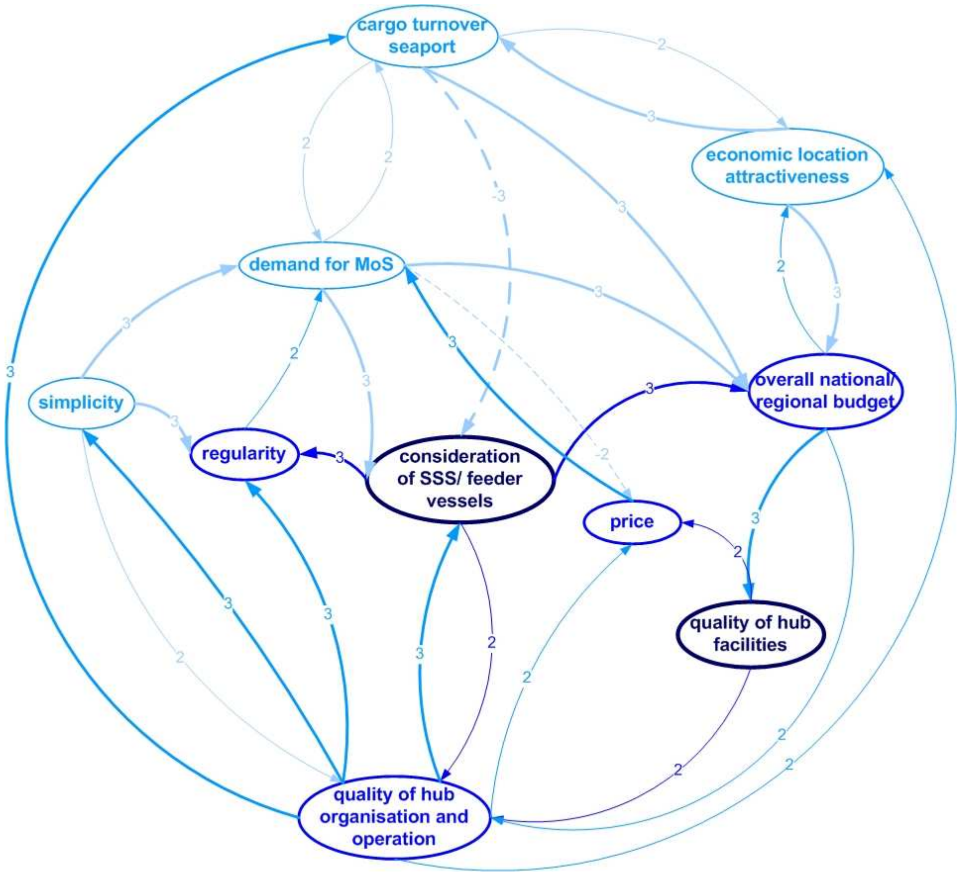


Figure 54: DP 3b Scenario 2

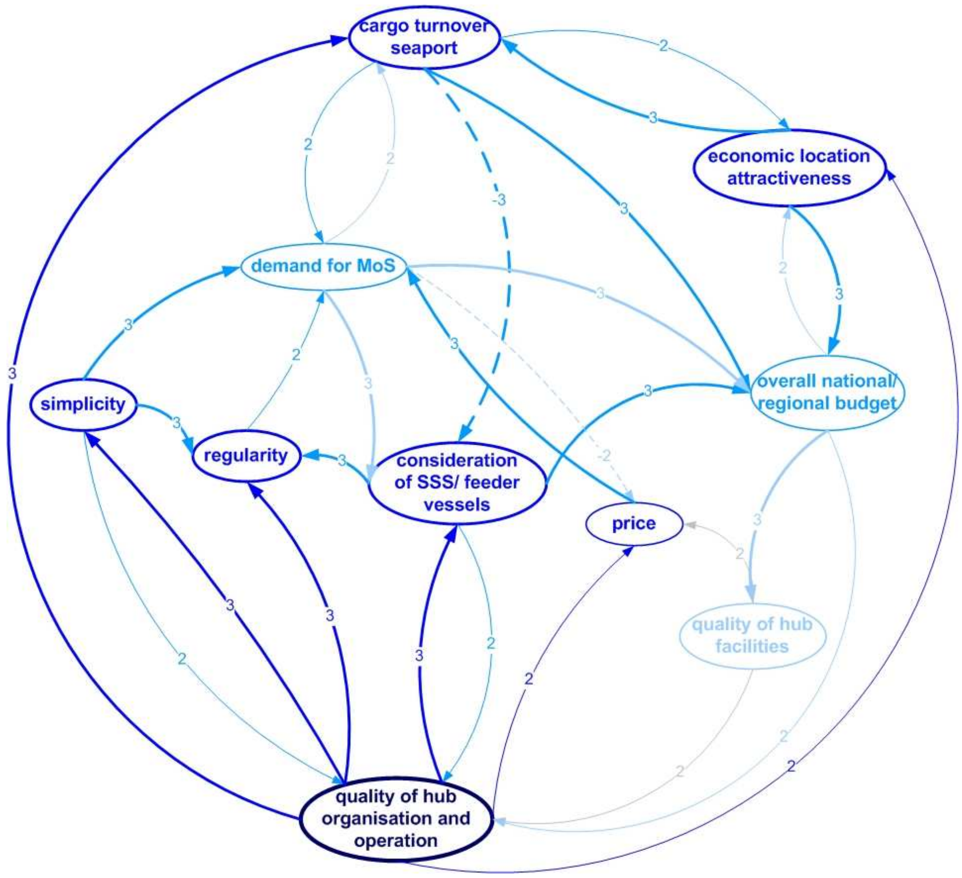


Figure 55: DP 3b Scenario 3

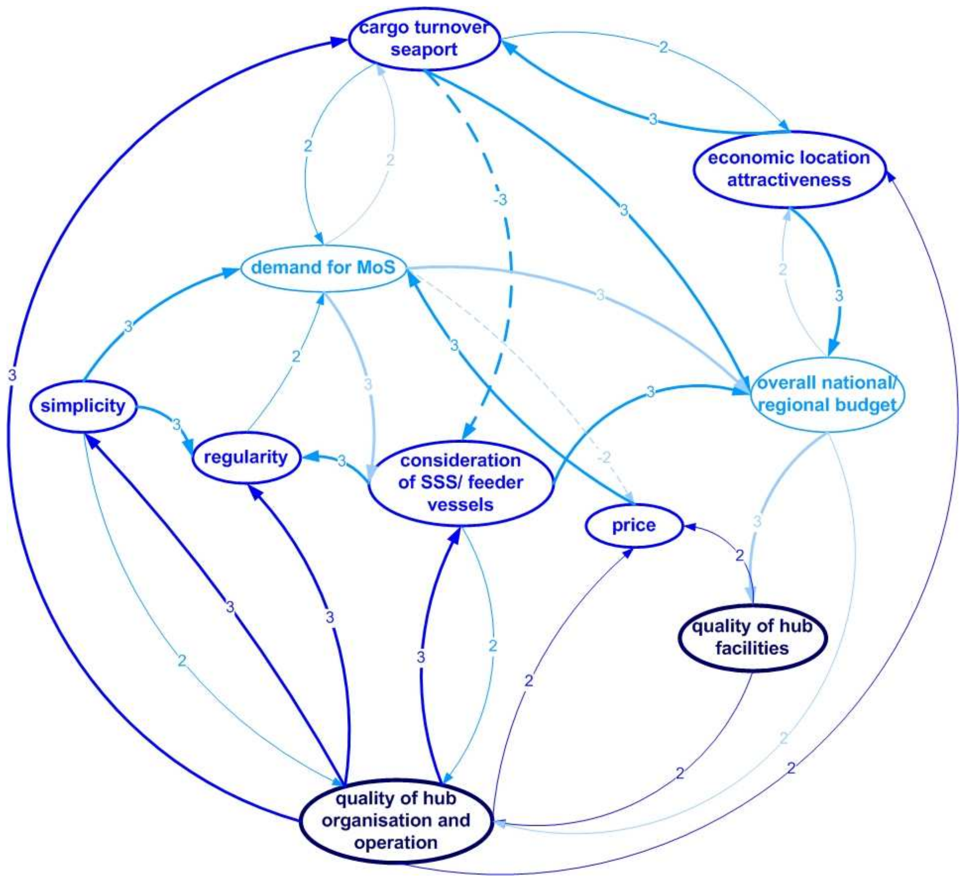


Figure 56: DP 3b Scenario 4

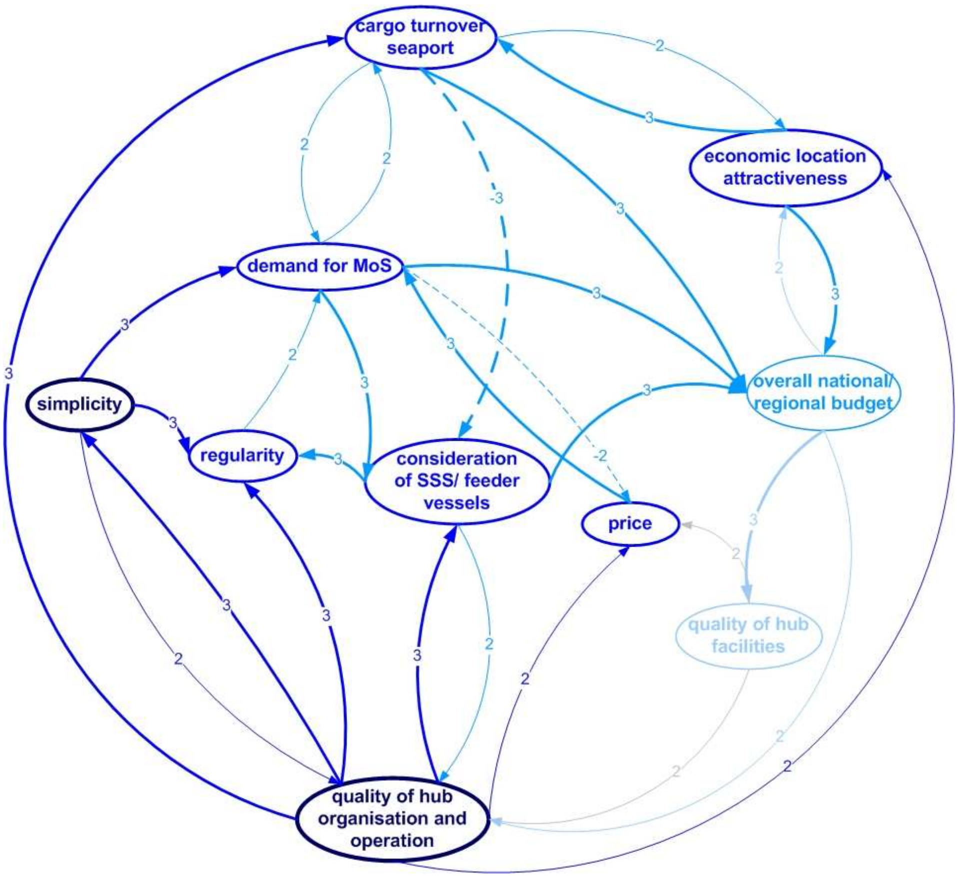


Figure 57: DP 3b Scenario 5

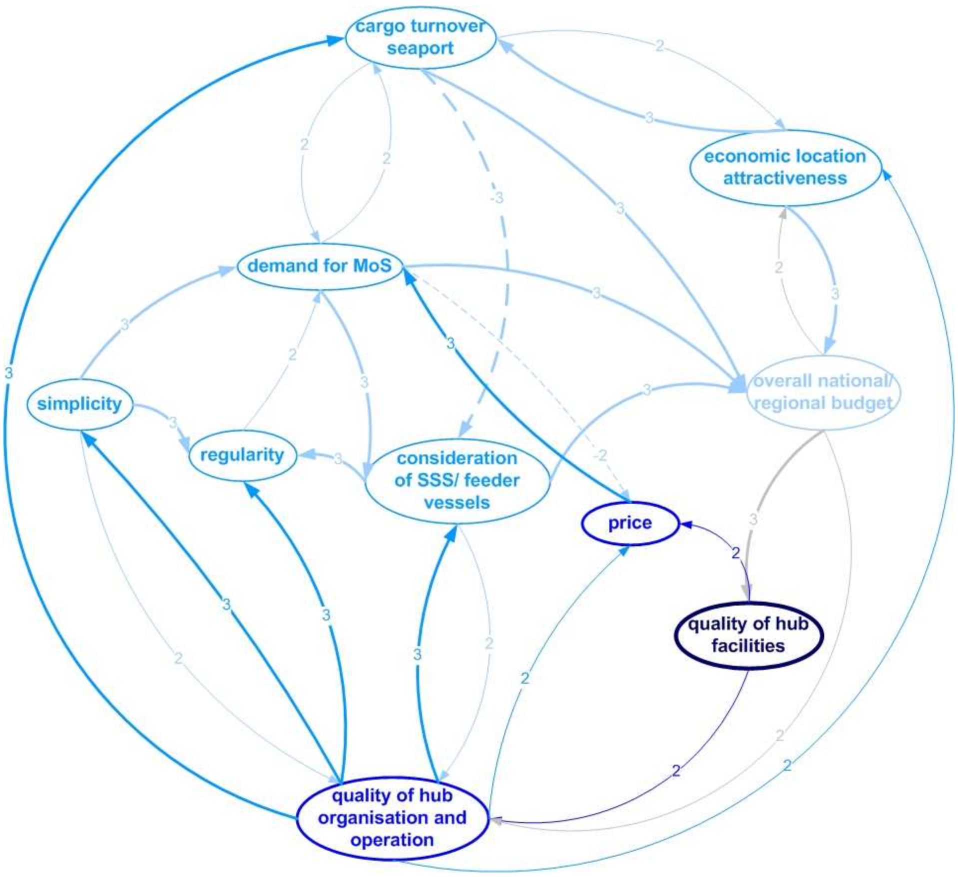


Figure 58: DP 3b Scenario 6

In addition to the visualisation the amount of impact can be also quantified, by counting the number of variables

- which are affected directly by the object(s) of funding,
- which are affected indirectly by the object of funding and
- which remain.

Therefore Table 13 has been used. The scenarios of great interest are scenarios no. 1, 3, 4 and 5, as they lead to a high amount of affected variables in the system (directly and indirectly). The scenarios which might be interesting as well are no. 2 and 6 (marked in grey).

Scenario	Amount of variables which are directly affected by the regulating variables	Amount of variables which are indirectly affected by the regulating variables	Remaining variables
1	6	3	0
2	4	4	0
3	6	2	1
4	6	2	0
5	6	1	1
6	2	6	1

Table 13: Comparison of measures for DP 3b

3.2.5 Conclusion for Demonstration Project 3b

It can be concluded, that measures affecting the variable *'quality of hub organisation and operation*' (alone or in combination with others) are the most promising ones. Unfortunately the specific system like it is built up at the moment, lacks the level of detail to compare the measures more precisely.

The following measures are thus recommendable according to the results of the systems analysis; among them the first two are evaluated as the most effective:

- **Increase ship's turnover per terminal call.**
- **Increase of transhipments by barge.**
- Working hours' adjustment.
- Increase of cell guides.
- Binding schedules/ list of sailings.
- Feeder consortia.
- Increase disposability of pilots.
- Port dues adjustment.
- Terminal comprehensive preplanning.
- Alteration port of calls.
- Increase disposability of tugs.
- Increase of gantry cranes availability
- Previous transfer of container information.
- Accelerate customs clearance.

To finalise the systems analysis for the specific model for DP 3b the results were presented and discussed in context of another workshop. In general the results of the evaluation of the measures were regarded as plausible and helpful by the workshop participants.

3.3 Feedback to the generic model

Two specific demonstration projects have been investigated to deepen the systems analysis of MoS. One reason to choose these DPs was because of their different characteristics: the DP 1 covers a whole corridor whereas the DP 3b focuses on a hub. By this it was intended to get a broad picture of potential MoS projects and reflect the complex structures within the system. To precise the feedback to the generic model, firstly some intermediate results from the process of the specific analysis are presented. Then the specific results and their similarities and differences facing the generic model will be pointed out. In a last step the specific analysis and the results will be reflected on the generic level.

3.3.1 Results of the process of specification

Some of the variables of the generic systems model maintained some imprecision in the way they were described and important comments on and amendments of the description of these variables were made during the workshops for the specific models.

It became clear, that it is necessary to clarify or adapt the terms 'MoS' and 'short sea shipping' in the context of the systems model. This especially concerns the variables 'demand for SSS at the seaport' and 'availability of MoS-connections at the port/hinterland hub'. Originally, this difference was made to underline that, from the customers' point of view, it is important to have a door-to-door solution available, i.e. a MoS-connection. However, from the transport operator's point of view it is more interesting to have a demand for the sea-based part of the transport chain: thus short sea shipping. It was proposed, though, to stick to one expression to avoid confusing future 'users' of the systems model. Since one main objective of the EU's MoS programme is to strengthen door-to-door logistics chains, it was decided to focus on the MoS-connection in every relevant variable and not only on the SSS-part.

Furthermore the name of the variable '*priority for short sea shipping vessels in the seaport'* was replaced by *'consideration of SSS/ feeder vessels in the seaport'* as in sea ports where mainly over sea vessels are served, it is not very realistic to give real priority to the SSS/feeder vessels but consideration.

'*Safety and security of goods transported*' were seen to be as problematic in being considered together, thus the variable should either be split into two or one should concentrate on the security aspect, which was considered to be more important for e.g. customs matters. Thus it was decided to rename the variable as '*security of goods transported*'.

Another suggestion developed within the workshops was to adjust the points of reference of some variables: some variables, esp. within the subsystem service, were originally described relatively to competing transport modes while others were not. It was decided to provide the following variables of the subsystem *MoS service* with the relative descriptions shown in Table 14:

Variable	Description
regularity	increasing the regularity relative to other transport chains
frequency of services	increasing the frequency of services relative to other transport chains
speed of the MoS-service	increasing the speed of MoS-service relative to other transport chains
price of the MoS-service	decreasing the price of MoS-service relative to other transport chains
simplicity of MoS-service	increase of the simplicity of MoS-service relative to other transport chains

Table 14: Variables of subsystem *MoS service* adjusted to include relative descriptions

3.3.2 Similarities and differences

In the following similarities and differences are pointed out for the choice of variables as well as for evaluation of impact.

Choice of variables

Concerning the comparison of the models of the demonstration projects (DPs) to the generic model (GM) the first look should be on the choice of variables. Along with the focus of each DP, the choice of variables can be explained (see chapters 3.1.2. and 3.2.2 for details).

In Figure 59, it becomes evident, that the DPs' choice of variables was very divergent. Concerning the subsystems, three of them (the subsystems *hubs*, *service* and *funding*) were partly covered by both DPs, whereas the subsystem *corridor* were only covered by DP 1 and the subsystem *sustainability* only by DP 3b. A closer look on the variables chosen, leads to the following results: only around a third of the variables (8 of 27) was chosen by both DPs (coloured in violet), again a little bit less than a third (8 of 27) were chosen by none of the DPs (coloured in grey). The remaining variables (11 of 27) were chosen only by one DP (coloured in orange when chosen by DP 3b only, in turquoise when chosen by DP 1 only).

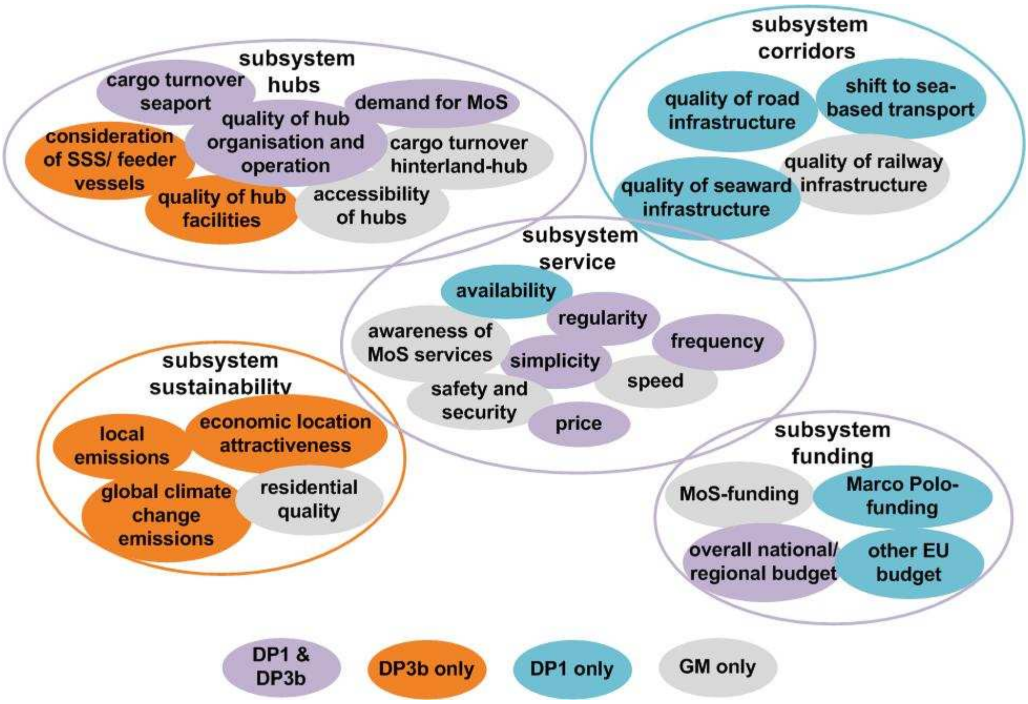


Figure 59: Comparison of the choice of variables

It is worth to mention, that no variable was missed while developing the specific sets. Thus the divergent choices of each DP should not lead to the result, that the variables of the GM do not cover the system sufficiently. The main conclusion is rather, that the characteristics of projects within the system MoS may differ and the generic model provides the opportunity to cover all of them.

On the other hand, these circumstances indicate that the generic model is difficult to apply on an operational (project-related) level without an adaption. Nevertheless, it should be mentioned, that the main goal of the systems analysis - to derive recommendations for investments within the system MoS - is not touched by this.

Overall it can be stated, that the specific results of the DPs' systems analysis concerning the choice of variables is not contradictory to the GM, and thus no additional adaption is needed

Evaluation of impact

When it comes to the comparison of the impact within the different models, a closer look is needed. In the following, the comparisons are made for each of the DPs with the GM and then the conclusions are drawn for both together. The comparison can only be made for those variables which were parts of the particular DP and the GM. For DP 1 overall the evaluation of 14x14 relations has been compared, for DP 3b there were 13x13 relations.

As it is portrayed in Figure 60 the evaluation of the impact is in both models for more than a half relations congruent with the GM: 56% for DP 1 and 64.4% for DP 3b. Therefore it was counted those relations where no impact and those where the same impact was identified. The share of impact relations where no impact was identified for the GM but for the particular DP is quite interesting (23.1% for DP 1 and 20.5% for DP 3b), as it is much bigger than the opposite case: no impact identified in the DP but in the GM (7.7% for DP 1 and 3.2% for DP 3b). It can be concluded that the evaluation of impacts in context of a realistic and concrete project as part of the system MoS is easier and leads to more concrete results than the rather abstract evaluation of the impacts in the generic model. The remaining share represents those impact relations where in both models – DP and GM – an impact, but a different one was identified.

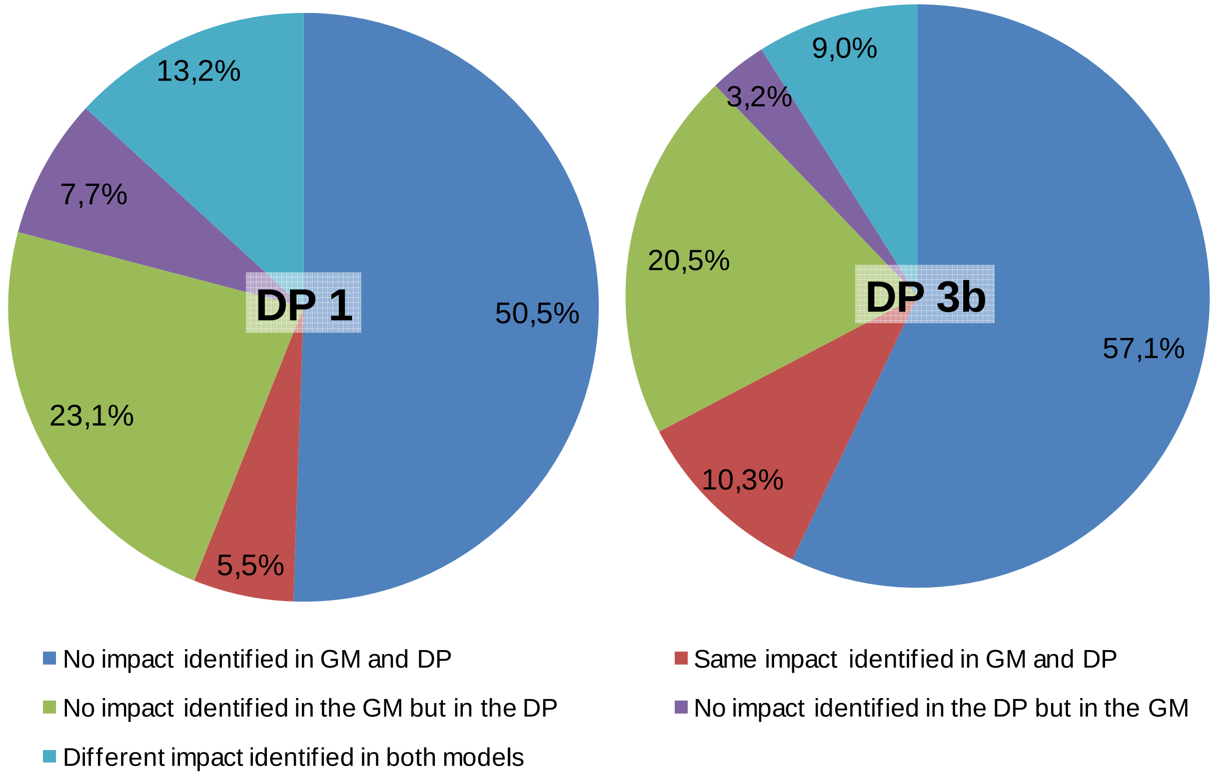


Figure 60: Comparison of impacts from the DP 1 and DP 3b models to the generic model (GM)

Having a closer look on the differences of evaluation (see

Figure 61), it becomes evident, that there was no or a small difference (of 1) between the particular DP and the GM (87.3% for DP 1 and 89.1% for DP 3b). As the evaluation of impact is qualitative a difference of 1 in evaluating the strength of impact is seen as insignificant. Thus a closer look is worth to take on the differences which are higher (difference of 2 or 3).

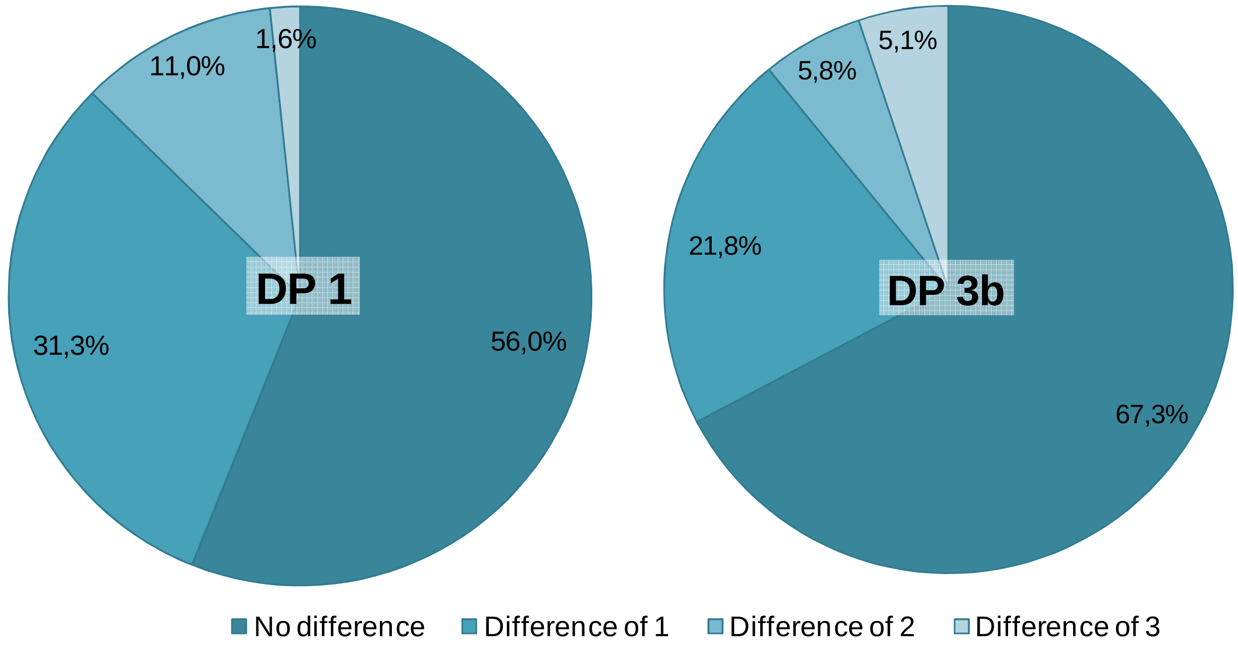


Figure 61: Differences of the quantified impact from the DP models to the generic model (GM)

3.3.3 Specific results to develop the generic model

Concerning the choice of variables no adaptations were needed for the generic model, apart from the above mentioned changes of their names and description.

Concerning the impact relations, a deeper investigation was performed, to benefit from the real project experience out of the specific models for DP 1 and DP 3b.

In the generic model there are overall 702 impact relations which were evaluated. The direct comparison of the DPs with the GM reflects 342 of these relations (as not all the variables were chosen by the particular models).

Taking the results of the particular comparisons into account (and neglecting the insignificant differences), there are 37 impact relations which should be re-evaluated facing the results described above. Thereof 10 relations differ by 3 and 27 relations differ by 2.

Additionally it should be considered with special attention that overall 2 impact relations do not only differ by the strength of impact but also by the direction.

In the following table, all these relations are listed and the argumentation for changing the impact or not within the GM is given. For easier reading the relations where changes were made are marked in grey.

The changes are integrated in the description of the generic systems model in chapter 2.

Impact (of/on)	**GM*old***	**DP 1**	**DP 3b**	**GM*new***	**Argumentation**
availability of MoS-connections at the port or hinterland hub/ shift to sea-based transport	2	0	-	2	No adaption for GM, as this relation is a specific case in DP 1.
availability of MoS-connections at the port/hinterland hub/ demand for MoS-connections at a sea port	3	1	-	2	Slight adaption to specific case in DP 1, as the interrelation is plausible, that availability only cannot have a very strong impact on the demand (cargo volumes are needed, too).
consideration of SSS and feeder vessels in the seaport/ quality of hub organization and operation	0	-	2	0	No adaption for GM, as this relation is a specific case in DP 3b (in an over sea port).
demand for MoS-connections at a sea port/ cargo turnover sea port	0	2	2	0	No adaption for GM. This impact relation is covered via the variable availability, which has to serve the demand before cargo turnover increases.
frequency of services/ demand for MoS-connections at a sea port	3	1	1	2	Slight adaption to specific cases in DP 1 and DP 3b, as both gave the same evaluation.
frequency of services/ shift to sea-based transport	0	2	-	0	No adaption for GM. This impact relation is covered via the variables demand and availability.
Marco-Polo funding/ frequency of MoS-service	0	2	-	2	Adaption to specific case in DP 1, as the evaluation seems to be plausible.
Marco-Polo funding/ simplicity of MoS-service	0	2	-	2	Adaption to specific case in DP 1, as the evaluation seems to be plausible.
other EU budget for investment, funding or subsidies/ overall national or regional budget for investment, funding or subsidies	0	2	-	2	Adaption to specific case in DP 1, as the evaluation seems to be plausible.

overall national or regional budget for investment, funding or subsidies/ quality of road infrastructure	2	0	-	2	No adaption for GM, as this relation is a specific case in DP 1.
overall national or regional budget for investment, funding or subsidies/ frequency of MoS-service	2	2	0	2	No adaption for GM, as this relation is a specific case in DP 3b.
overall national or regional budget for investment, funding or subsidies/ economic location attractiveness at the port or hinterland hub	0	-	2	2	Adaption to specific case in DP 3b, as the evaluation seems to be plausible.
overall national or regional budget for investment, funding or subsidies/ other EU budget for investment, funding or subsidies	0	2	-	2	Adaption to specific case in DP 1, as the evaluation seems to be plausible.
price of the MoS- services/ shift to sea-based transport	0	2	-	0	No adaption for GM. This impact relation is covered via the variables demand and availability.
price of the MoS- services/ simplicity of MoS-service	2	0	0	0	Adaption to specific cases in DP 1 and DP 3b, as the evaluation seems to be plausible.
quality of hub facilities/ cargo turnover sea port	2	-	0	2	No adaption for GM, as this relation is a specific case in DP 1.
quality of hub facilities/ quality of hub organization and operation	0	-	2	2	Adaption to specific case in DP 3b, as the evaluation seems to be plausible.
quality of hub organization and operation/ cargo turnover sea port	2	0	3	2	No adaption for GM, as this relation is a specific case in DP 1 and the difference to the evaluation in DP 3b is insignificant.

quality of hub organization and operation/ demand for MoS-connections at a sea port	0	2	0	0	No adaption for GM, as this relation is a specific case in DP 1.
quality of hub organization and operation/ quality of seaward infrastructure	2	0	-	2	No adaption for GM, as this relation is a specific case in DP 1.
quality of hub organization and operation/ local emissions	0	-	2	2	Adaption to specific case in DP 3b, as the evaluation seems to be plausible.
quality of hub organization and operation/ shift to sea-based transport	0	2	-	0	No adaption for GM. This impact relation is covered via the variables demand and availability.
quality of seaward infrastructure/ overall national or regional budget for investment, funding or subsidies	0	2	-	0	No adaption for GM, as this relation is a specific case in DP 1.
quality of seaward infrastructure/ shift to sea-based transport	0	2	-	2	Adaption to specific case in DP 1, as the evaluation seems to be plausible.
regularity of MoS-service/ demand for MoS-connections at a sea port	3	1	2	2	Slight adaption to specific cases in DP 1 and DP 3b, as the evaluation seems to be plausible.
shift to sea-based transport/ quality of road infrastructure	1	3	-	1	No adaption for GM, as this relation is a specific case in DP 1.
simplicity of MoS-service/ quality of hub organization and operation	0	0	2	0	No adaption for GM, as this relation is a specific case in DP 3b.
cargo turnover sea port/ consideration of SSS and feeder vessels in the seaport	0	-	-3	0	No adaption for GM, as this relation is a specific case in DP 3b.

cargo turnover sea port/ global climate change emissions	-1	-	2	-1	No adaption for GM, as this relation is a specific case in DP 3b.
consideration of SSS and feeder vessels in the seaport/ overall national or regional budget for investment, funding or subsidies	0	-	3	0	No adaption for GM, as this relation is a specific case in DP 3b.
demand for MoS-connections at a sea port/ frequency of MoS-service	0	3	3	3	Adaption to specific cases in DP 1 and DP 3b, as the evaluation seems to be plausible.
Marco-Polo funding/ overall national or regional budget for investment, funding or subsidies	0	3	-	3	Adaption to specific case in DP 1, as the evaluation seems to be plausible.
quality of hub facilities/ price of the MoS- services	-1	-	2	2	Adaption to specific case in DP 3b, as the evaluation seems to be plausible.
quality of hub organization and operation/ consideration of SSS and feeder vessels in the seaport	0	-	3	0	No adaption for GM, as this relation is a specific case in DP 3b.
quality of hub organization and operation/ simplicity of MoS-service	0	0	3	2	Slight adaption to specific case in DP 3b, as the evaluation seems to be plausible.
shift to sea-based transport/ cargo turnover sea port	0	3	-	0	No adaption for GM, as this relation is a specific case in DP 1.
simplicity of MoS-service/ regularity of MoS-service	0	0	3	0	No adaption for GM, as this relation is a specific case in DP 3b.

Table 15: Adaption of impact relations within the generic model

4 Recommendations derived out of the systems analysis

<<to be completed in Version 4>>

5 Summary and outlook

<<This chapter will be amended and adapted for every version of this report.>>

An initial version of the generic systems model has been developed in a first step. A set of variables has been defined and the impact between these variables has been examined in a cross-impact matrix.

In a second step, the results of this draft version of the generic model have been the framework for developing specific models out of the demonstration projects. One main result of specifying the generic model for the DPs is having reflected the variables against a real life scenario. So far, these reflections have been based on one demonstration project focussing on a corridor and one focusing on a hub. Additionally, a cross-impact matrix has been filled in for the specific systems of the two DPs examined in detail: DP 1 and DP 3b. In this way, a more reliable and more broadly applicable perspective of the interactions within the system can be gained. Furthermore, the analysis of these specific interrelations was taken to help the DPs to generate and/or evaluate scenarios or measures relevant to their objectives.

The third step was to feed back the results of the specific models to the generic model as a basis for the final analysis of its interrelations. Firstly, the choice of variables has been reflected. Furthermore, the specific impact relations of the DPs have been the basis for a re-evaluation of the generic impact matrix. Based up-on this, the generic interrelations have been updated and impact cycles have been developed and partly interpreted.

In a next step, project ideas will be developed in context of another workshop. These project ideas will be transferred to funding scenarios displayed by the help of the system models. The scenarios will be investigated and evaluated for the generic model comparable to the approach applied for the specific models.

The overall objective of WP D 'Transport Networks and Corridors' is to make the decision making on and planning and implementation of MoS projects more focused, efficient and effective by defining requirements for investments (e.g. in infrastructure and facilities as well as organisational arrangements and cooperation mechanisms). Thus, recommendations for targeting context specific investments to strengthen MoS transport will be the final StratMoS product of the systems analysis.

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List of Abbreviations

AS	Active sum
DP	Demonstration Projects
GM	Generic Systems Model
MoS	Motorways of the Sea
MP	Marco Polo
P	Product
PS	Passive sum
Q	Quotient
SSS	Short sea shipping
TEN-T	Trans European Network – Transport

Annexes

Annex A Generic model: Complete set of variables

27	*variables in total*			
No.	**System "Motorways of the Sea"** *Subsystem* **Factors/ Variables**	**Description**	**Indicator**	**Outside influences**
subsystem: hubs		***quantity of variables:***	7	
01	cargo turnover sea port	increasing cargo turnover in a sea port	cargo turnover [in t/TEU]; No. of departures	economic and trading conditions oil price
02	consideration of SSS/ feeder vessels in the seaport	strengthening consideration of SSS/ feeder vessels in the seaport	SSS/ feeder ratio of water-side cargo turnover	transport policy at EU/national/regional level
03	cargo turnover hinterland-hub	increasing cargo turnover at the hinterland-hub	cargo turnover [in t/TEU]	economic and trading conditions oil price
04	demand for MoS-connections at a sea port	increasing the demand for MoS-connections at a sea port	quantity of TEU/t/trailers per relation; available return cargo	economic and trading conditions oil price
05	quality of hub organisation and operation	improving of the quality of hub organisation and operation	quality in the customers/users eyes (quality criteria: IT systems, cooperation of actors, labour regime, customs regime & regulation, administrative regime & regulation, multimodal integration); time per port call; time per berth call; no. of berth call; time in waiting areas; no. of ship operations at the same time on the water; fuel requirement	-
06	quality of hub facilities	improving of the quality of hub facilities	quality and quantity of the infrastructure and suprastructure; no. of dolphins berths with 9.5m available for feeders	-
07	accessibility of hubs	improving of hinterland infrastructure	quality and quantity of hinterland infrastructure	transport policy at national/regional level

27	*variables in total*			
No.	**System "Motorways of the Sea"** *Subsystem* **Factors/ Variables**	**Description**	**Indicator**	**Outside influences**
subsystem: transport corridor		***quantity of variables:***	***4***	
08	shift to sea-based transport	increasing the share of sea-based transport in the modal split (long haulage)	quantity of TEU/t of sea-based transported goods share of sea-based transport in the modal split	transport policy at EU/national/regional level
09	quality of road infrastructure	improving of the quality of road infrastructure (long haulage competing corridor to the sea corridor)	quality (surface etc.) and quantity of streets, bridges, tunnels; network integration and connectivity;	planning and decision making processes; budgetary situation and economic condition; subsidization; ownership structures; lobbying by construction and automotive industry, environmental and transport organizations
10	quality of railway infrastructure	improving of the quality of railway infrastructure (long haulage competing corridor to the sea corridor)	quality (electrification, general condition) and quantity (lengths) of rail sidings; level of use of infrastructure; network integration and connectivity; accessible railway terminals; average user speeds	planning and decision making processes; budgetary situation and economic condition; subsidization; ownership structures; lobbying by railway companies, environmental and transport organizations
11	quality of seaward infrastructure	improving of the quality of seaward infrastructure	seaward accessibility (tidal influences, maximum vessel size, sluices, average speeds)	planning and decision making processes; budgetary situation and economic condition; subsidization; ownership structures; lobbying by shipping companies, ports, environmental and transport organizations

27	*variables in total*			
No.	**System "Motorways of the Sea"** ***Subsystem*** **Factors/ Variables**	**Description**	**Indicator**	**Outside influences**
subsystem: service of MoS		***quantity of variables:***	***8***	
12	availability of MoS-connections at the port/hinterland hub	increasing the availability of MoS-connections	number of origines and destinations directly accessible via MoS tonnage available	oil price economic and trading conditions
13	regularity of MoS-service	increasing the regularity relative to other transport chains	delays; flexibility to change in case of non-reliability	weather tides, currents strikes congestion
14	frequency of services	increasing the frequency of services relative to other transport chains	frequency of connections on particular routes	navigability network capacity operating costs
15	safety and security of goods transported	improvement of safety and security of goods transported	loss and damage rates number of accidents	weather piracy condition of vessels, infra- and suprastructures
16	speed of the MoS-service	increasing the speed of MoS-service relative to other transport chains	actual speed	weather congestion strikes
17	price of the MoS-service	decreasing the price of MoS-service relative to other transport chains	actual unit price cost of port calls	oil price economic and trading condition
18	simplicity of MoS-service	increase of the simplicity of MoS-service relative to other transport chains	availability & accessibility of standardised IT-systems/-interfaces; customs regulations and other relevant rules and regulations; having the same standards; delays	economic and trading conditions
19	awareness of MoS-services	increasing of the awareness	image and perception of the MoS-service; How often is named in the journal?	media

27	*variables in total*			
No.	**System "Motorways of the Sea"** *Subsystem* **Factors/ Variables**	**Description**	**Indicator**	**Outside influences**
subsystem: sustainability		*quantity of variables:*	*4*	
20	local emissions	decreasing local emissions	local air quality; noise emissions	environmental policy and regulations at EU/national/regional level;
21	global climate change emissions	decreasing global climate change emissions	fuel consumption per tkm	environmental policy and regulations at EU/national/regional level; climate change;
22	residential quality	increasing the social location attractiveness	residential property costs; residents' fluctuation at the location; average income	image media public relations
23	economic location attractiveness at the port/hinterland hub	increasing the economic location attractiveness	availability of land / commercial sites; commercial property costs; available work force; no. clients of port	economic & tax policy at EU/national/regional level political system/regime (local barriers or regulations)
subsystem: funding, subsidy, investment		*quantity of variables:*	*4*	
24	MoS-funding	increasing the attractiveness of MoS-funding	share of available funding allocated	transport policy at EU/national level
25	Marco Polo-funding	increasing the attractiveness of Marco Polo-funding	share of available funding allocated	transport policy at EU/national level
26	other EU budget for investment/funding/subsidies	increasing the EU-budget for investment/funding/subsidies (including funding of potentially competing systems)	total available budget; share of available funding allocated	spending policy at EU/national level
27	overall national/regional budget for investment/funding/subsidies	increasing the national/regional budget for investment/funding/subsidies (including funding of potentially competing systems, including private investments)	effectiveness / success-factor; amount of projects/ no of projects / initiatives	spending policy at regional/national level

Figure 62: Set of variables of the generic model

Annex B Generic model: Draft impact matrix

System *Motorways of the Sea* (IMPACT of → on)			*subsystem hub*								*subsystem corridor*					*subsystem MoS service*									*subsystem sustainability*					*subsystem funding, subsidy, investment*						
				cargo turnover sea port	consideration of SSS/ feeder vessels in the seaport	cargo turnover hinterland-hub	demand for MoS-connections at a sea port	quality of hub organisation and operation	quality of hub facilities	accessibility of hubs		shift to sea-based transport	quality of road infrastructure	quality of railway infrastructure	quality of seaward infrastructure		availability of MoS-connections at the port/hinterland hub	regularity of MoS-service	frequency of services	security of goods transported	speed of the MoS-service	price of the MoS-service	simplicity of MoS-service	awareness of MoS-services		local emissions	global climate change emissions	residential quality	economic location attractiveness at the port/hinterland hub		MoS-funding	Marco Polo-funding	other EU budget for investment/funding/subsidies	overall national/regional budget for investment/funding/subsidies		
		No.		1	2	3	4	5	6	7		8	9	10	11		12	13	14	15	16	17	18	19		20	21	22	23		24	25	26	27	AS	PS
subsystem hub			0,69								0,21					0,68									0,57					0,32						
	cargo turnover sea port	1			0	3	2	0	0	-3		1	0	0	-1		0	0	0	0	0	0	0	0		-2	-1	-1	2		0	0	0	3	19	12
	consideration of SSS/ feeder vessels in the seaport	2		0		0	1	0	0	0		1	0	0	0		2	3	0	0	1	0	0	1		0	0	0	0		0	0	0	0	9	4
	cargo turnover hinterland-hub	3		1	0		1	0	0	-3		0	0	0	0		0	0	0	0	0	0	0	0		-1	-1	-1	2		0	0	0	2	12	13
	demand for MoS-connections at a sea port	4		0	2	0		0	0	0		0	0	0	0		3	-1	0	0	0	-1	1	0		0	0	0	1		1	1	0	2	13	30
	quality of hub organisation and operation	5		2	0	1	0		0	0		0	0	0	2		1	3	0	3	2	1	0	2		0	0	0	1		0	0	0	0	18	5
	quality of hub facilities	6		2	0	2	0	0		0		0	0	0	1		1	2	0	2	1	-1	0	1		0	0	0	1		0	0	0	0	14	6
	accessibility of hubs	7		3	0	3	0	0	0			0	0	0	0		1	3	0	0	1	0	0	0		0	0	0	2		0	0	0	0	13	14
subsystem corridor			0,21								0,33					0,19									0,63					0,00					98	84
	shift to sea-based transport	8		0	0	0	0	0	0	0			1	1	-1		0	0	0	0	0	0	1	0		-1	1	0	0		0	0	0	0	6	8
	quality of road infrastructure	9		0	0	0	-2	0	0	0		-1		0	0		0	0	0	0	0	0	0	0		0	-3	0	2		0	0	0	0	8	4
	quality of railway infrastructure	10		0	0	1	-1	0	0	0		0	0		0		0	0	0	0	0	0	0	0		0	0	0	1		0	0	0	0	3	5
	quality of seaward infrastructure	11		0	0	0	2	0	0	0		0	0	0			1	2	0	0	2	0	0	0		0	0	0	2		0	0	0	0	9	14
subsystem MoS service			0,52								0,16					0,55									0,06					0,06					26	31
	availability of MoS-connections at the port/hinterland hub	12		3	1	2	3	0	0	0		2	0	0	-1			0	1	0	0	2	2	2		0	0	0	1		0	0	0	0	20	16
	regularity of MoS-service	13		0	0	0	3	0	0	0		0	0	0	0		0		0	2	0	0	1	0		0	0	0	0		0	0	0	0	6	18
	frequency of services	14		0	0	0	3	0	0	-1		0	0	0	-1		0	0		0	0	0	0	0		-1	0	0	0		0	0	0	0	6	3
	security of goods transported	15		0	0	0	2	0	0	0		0	0	0	0		0	1	0		0	-1	0	0		0	0	0	0		0	0	0	0	4	14
	speed of the MoS-service	16		0	0	0	2	0	0	0		0	0	0	0		2	0	2	0		-1	1	0		0	0	0	0		0	0	0	0	8	8
	price of the MoS-service	17		0	0	0	3	0	0	0		0	0	0	0		1	0	0	0	0		2	0		0	0	0	0		0	0	0	0	6	7
	simplicity of MoS-service	18		0	0	0	3	0	0	0		1	0	0	0		0	0	0	0	0	0		0		0	0	0	0		2	0	0	0	6	10
	awareness of MoS-services	19		0	1	0	2	0	0	0		0	0	0	0		2	3	0	2	1	0	2			0	0	0	0		0	0	0	0	13	6
subsystem sustainability			0,07								0,13					0,00									0,33					0,31					69	82
	local emissions	20		0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0	0	0			0	2	0		0	0	0	-1	3	5
	global climate change emissions	21		0	0	0	0	0	0	0		2	0	0	0		0	0	0	0	0	0	0	0		0		1	0		0	0	-1	-1	5	6
	residential quality	22		0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0	0	0		0	0		1		0	0	0	0	1	6
	economic location attractiveness at the port/hinterland hub	23		1	0	1	0	0	0	0		0	0	0	0		0	0	0	0	0	0	0	0		0	0	0			0	0	0	2	4	16
subsystem funding, subsidy, investment			0,64								0,88					0,22									0,06					0,00					13	33
	MoS-funding	24		0	0	0	0	2	3	3		0	0	0	2		0	0	0	1	0	0	0	0		0	0	0	0			0	0	0	11	3
	Marco Polo-funding	25		0	0	0	0	1	1	0		0	0	1	2		1	0	0	1	0	0	0	0		0	0	0	0		0		0	0	7	1
	other EU budget for investment/funding/subsidies	26		0	0	0	0	0	0	1		0	1	1	1		0	0	0	1	0	0	0	0		0	0	0	0		0	0		0	5	1
	overall national/regional budget for investment/funding/subsidies	27		0	0	0	0	2	2	3		0	2	2	2		1	0	0	2	0	0	0	0		0	0	1	0		0	0	0		17	11

Figure 63: Generic model – Draft impact matrix before specification process (final version see Figure 11)

Annex C Generic model: Quantitative results of the cross-impact matrix

No.	Variable	Active Sum	Passive Sum	P-value	Q-value
1	cargo turnover sea port	19	12	228	1,58
2	consideration of SSS/ feeder vessels in the seaport	9	4	36	2,25
3	cargo turnover hinterland-hub	12	13	156	0,92
4	demand for MoS-connections at a sea port	16	27	432	0,59
5	quality of hub organisation and operation	22	7	154	3,14
6	quality of hub facilities	17	6	102	2,83
7	accessibility of hubs	13	14	182	0,93
8	shift to sea-based transport	6	10	60	0,60
9	quality of road infrastructure	8	4	32	2,00
10	quality of railway infrastructure	3	5	15	0,60
11	quality of seaward infrastructure	11	14	154	0,79
12	availability of MoS-connections at the port/hinterland hub	19	16	304	1,19
13	regularity of MoS-service	5	18	90	0,28
14	frequency of services	5	7	35	0,71
15	security of goods transported	4	14	56	0,29
16	speed of the MoS-service	8	8	64	1,00
17	price of the MoS-service	4	8	32	0,50
18	simplicity of MoS-service	6	11	66	0,55
19	awareness of MoS-services	13	6	78	2,17
20	local emissions	3	7	21	0,43
21	global climate change emissions	5	6	30	0,83
22	residential quality	1	6	6	0,17
23	economic location attractiveness at the port/hinterland hub	4	18	72	0,22
24	MoS-funding	13	3	39	4,33
25	Marco Polo-funding	10	1	10	10,00
26	other EU budget for investment/funding/subsidies	7	3	21	2,33
27	overall national/regional budget for investment/funding/subsidies	21	16	336	1,31

Table 16: Generic model: Quantitative results of the cross-impact matrix

Annex D Development of generic model

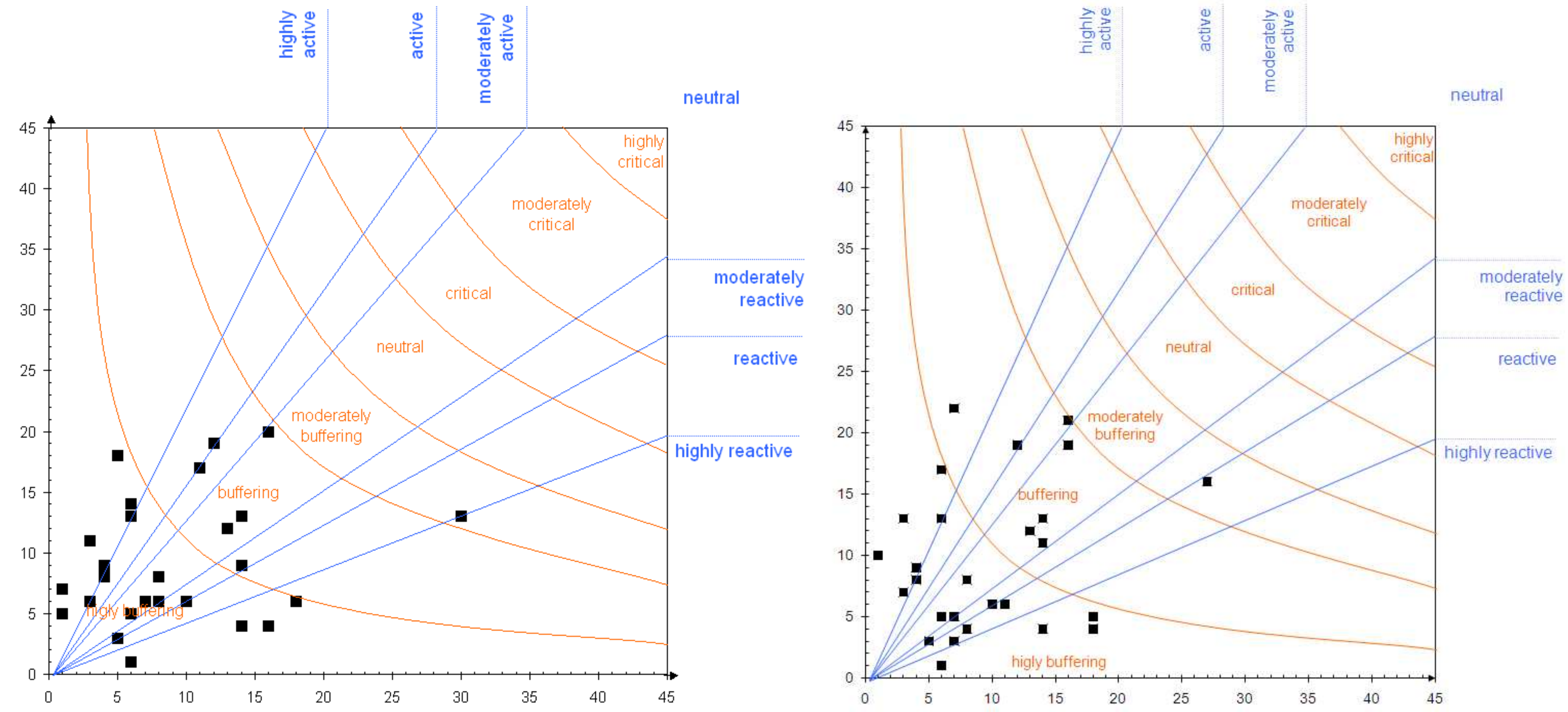

Figure 64: Comparison of the generic model – first draft (left) to final version (right)

Annex E Specific model DP 1: Scales of influence and integration

Influence	Q-values	Integration	P-values
highly active	> 2,25	highly critical	> 490
active	1,61 – 2,25	critical	335,16 - 490
moderately active	1,31 – 1,60	moderately critical	237,16 - 333,20
neutral	0,76 – 1,30	neutral	158,76 - 235,20
moderately reactive	0,63 – 0,75	moderately buffering	99,96 - 156,80
reactive	0,45 – 0,62	buffering	31,36 - 98
highly reactive	< 0,45	strongly buffering	< 31,36
(neutral line)	1	(neutral line)	196

(n = 15)

Table 17: Scales of influence and integration for the DP 1 systems model

Annex F Specific model DP 1: Quantitative results of the cross-impact matrix

No.	Variable	Active Sum	Passive Sum	P-value	Q-value
1	cargo turnover sea port	7	5	35	1,40
4	demand for MoS-connections at a sea port	10	16	160	0,63
5	quality of hub organisation and operation	8	7	56	1,14
8	shift to sea-based transport	9	12	108	0,75
9	quality of road infrastructure	2	4	8	0,50
11	quality of seaward infrastructure	9	10	90	0,90
12	availability of MoS-connections at the port/ hinterland hub	10	8	80	1,25
13	regularity	7	7	49	1,00
14	frequency of services	6	7	42	0,86
17	price of the MoS-connection	4	6	24	0,67
18	simplicity of MoS services	7	10	70	0,70
25	Marco Polo-funding	16	4	64	4,00
26	other EU budget for investment/funding/subsidies	5	6	30	0,83
27	overall national/ regional budget for investment/ funding/ subsidies	15	13	195	1,15

Table 18: Specific model for DP 1: Quantitative results of the cross-impact matrix

Annex G Specific model DP 3b: Scales of influence and integration

Influence	Q-values	Integration	P-values
highly active	> 2,25	highly critical	> 360
active	1,61 – 2,25	critical	246,24 - 360
moderately active	1,31 – 1,60	moderately critical	174,24 - 244,8
neutral	0,76 – 1,30	neutral	116,64 - 172,8
moderately reactive	0,63 – 0,75	moderately buffering	73,44 - 115,2
reactive	0,45 – 0,62	buffering	23,04 - 72
highly reactive	< 0,45	strongly buffering	< 23,04
(neutral line)	1	(neutral line)	144

(n = 13)

Table 19: Scales of influence and integration for the DP 3b systems model

Annex H Specific model DP 3b: Quantitative results of the cross-impact matrix

No.	Variable	Active Sum	Passive Sum	P-value	Q-value
1	cargo turnover sea port	17	8	136	2,13
2	consideration of SSS/ feeder vessels in the seaport	12	9	108	1,33
4	demand for MoS-connections at a sea port	13	13	169	1,00
5	quality of hub organisation and operation	19	10	190	1,90
6	quality of hub facilities	7	3	21	2,33
13	regularity of MoS-service	4	11	44	0,36
14	frequency of services	6	5	30	1,20
17	price of the MoS-connection	4	9	36	0,44
18	simplicity of MoS-service	10	6	60	1,67
20	local emissions	2	6	12	0,33
21	global climate change emissions	1	5	5	0,20
23	economic location attractiveness at the port/hinterland hub	7	11	77	0,64
27	overall national/regional budget for investment/funding/subsidies	8	14	112	0,57

Table 20: Specific model for DP 3b: Quantitative results of the cross-impact matrix