POCACITO

european post-carbon cities of tomorrow

SYSTEMIC CHARACTERISTICS OF THE CASE STUDY CITIES

APPLYING THE SENSITIVITY MODEL

IVL, ECOLOGIC INSTITUTE, FEEM, POLITO, CEPS, AU, UNDP, CUNI

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LIST OF ABBREVIATIONS

DMC	Domestic Material Consumption
PCIA	POCACITO Critical Impact Matrix
POCACITO	Post-Carbon Cities of Tomorrow
TOE	Tonne of oil equivalent

I EXECUTIVE SUMMARY

The POCACITO project aims to facilitate the transition of European cities towards a post-carbon future by defining a Roadmap for the transition. The project includes urban areas of various sizes from towns, cities through to megacities. A series of participatory stakeholder workshops are central to the project and take place in the case study cities of Barcelona, Copenhagen/Malmö, Istanbul, Lisbon, Litoměřice, Milan/Turin, Rostock and Zagreb. The purpose of these workshops is to bring together local stakeholders to construct a common post-carbon vision for 2050 and to define a roadmap, or action plan, to reach the vision.

This report details the initial phase of Work Package 5 that focuses on modelling and quantifying the environmental and socio-economic impacts of the 2050 visions compared to business as usual. The first task involves the application of a participatory systems analysis tool with the aim of identifying significant factors that are important for the quantification. The report contains reports and analysis from 8 of the 10 case study cities of POCACITO. The main objectives of these workshops were to:

I. Understand the **influence that different factors/variables have on each other** in the cities development. This will not only increase the understanding of the participants but also help to:

II. **Identify specific important factors** for the individual case study city. These may include the POCACITO indicators (from WP1), or may not have been highlighted before. By viewing the city as a "system" rather than focussing only on what we think is needed for a post-carbon city, new important factors can be found.

The Sensitivity Model developed by Prof. Vestor was adapted for use in the case study workshops and analysis. The first 3 stages of the 9 stage process were utilised and adapted to form what the project called the POCACITO Critical Influences Assessment (PCIA).

The main difference in the adapted approach is that the information and findings from the previous POCACITO workshops were utilised to make an initial impact matrix and analysis before the workshop. That meant slightly more work upfront for the case study coordinators but removed some of the more laborious work from the workshop participants, and left more time for review, discussion and refinement.

I.I THE PCIA PROCESS

Overall, the PCIA process has helped identify the main variables (or factors) that are important for the modelling and quantification stage (the next stages of WP5) of each individual city.

The initial analysis stage by the case study leaders went well and seems to have been quite straight forward, as there were limited follow-up questions. The understanding of the PCIA process amongst the case study leaders appears to be generally good, although there does appear to be a difference in the approach to scoring the matrix. For instance, some scoring was very "generous" or high (in the case of Zagreb, Turin and Milan) whilst other (e.g. Litoměřice) was quite minimal. Although as long as the same consistency was applied to all scoring, this should not have significant impact on the overall findings. In addition, as the work was then presented to the stakeholders in the PCIA workshops,

there was an opportunity for review and further iterations. However, it does appear the high scoring has made the city systems quite "critically" balanced in that there are more variables with a high criticality score.

The adapted process is somewhat open to criticism in that the main identification of the variables and the scoring of the matrix are performed by the case study leaders. This is opposed to the Sensitivity Model process that generally constructs the variables and the matrix with a group of stakeholders.

However, the PCIA process is still an iterative process and the workshops were designed to verify and draw out the option of the stakeholders. In that sense it is fairly robust (relative to the Sensitivity Model), and has the option for further iterations if necessary, just as the SM also has.

On the whole, the PCIA workshops were viewed favourably by the participants, in that it helped them understand how different variables within their cities influenced one another. There was also general agreement on the findings of the initial analysis and the impact matrix.

In summary, the PCIA process has identified some unique factors that can be focussed on in the modelling and quantification stages of WP5. The most prominent common variables are as follows:

- improving energy efficiency,
- developing renewable energy,
- resource efficiency/circular economy,
- creating awareness amongst citizens,
- traffic/mobility.

These will generally be considered for all cities in the modelling. Typical reactive variables were found to be water body quality, quality of life, air quality, environmental quality (or corridors for biodiversity/natural green areas) and CO_2 emissions.

Individually for the cities, variables shown in Table 1 are uniquely important for a particular focus in the modelling exercise and the quantitative assessments, of WP5 to the corresponding cities. The table has divided the top active and critical variables into either social, environmental, economic or strategy/policy and plans. This helps highlight which areas are important for each city and appears to largely reflect what we may expect is important for the cities. Zagreb for instance, which has one of the lowest GDP's of the case study cities has a focus on social related issues such as population, employment and quality of life.

The next stage of modelling will also need to decide how to incorporate the fact that variables such policy variables were high on the list for some cities, and especially Milan/Turin (but also Malmö and Zagreb). However, in the case of Milan/Turin there appears to be an imbalance in the system, which will require further investigation. This is because the variables are very policy and strategy biased which are largely not quantifiable in terms of sustainability impact. This seems to reflect a bias from the case study leaders in the case study team, and may need further revision of the variables and iteration of the impact matrix.

Policies are important, but are not variables that can be quantified for BAU or 2050. However, they can be incorporated in the individual actions and milestones which will influence the probable 2050 scenarios.

Table 1: Individual important factors for consideration in the modelling and assessment

Type of variable	Barcelona	Copenhagen	Litoměřice	Malmö	Rostock	Zagreb	Milan/Turin
• Social	• Attractiveness • Quality of life (interaction) • Population	•	•	• Segregation of housing	• Demographic Trend (age > 65) •	• Population • Employment • Quality of life •	•
• Environmental	•	• Bike network • Balance between development and green spaces • Traffic pollution management •	• Natural disasters (floods) • Improving the energy performance of buildings •	• Land use • Public Transport and bike network	• Building Density • Sustainable Housing • Green Space and Corridors •	• Decentralized energy production •	•
• Economic	• Industrial areas • Tourism	•	• Industry in the city and its surrounding •	•	• Budget Deficit •	•	• Economic specialisation*
• Plans and strategies and policies	• Governance • National policies •	• Economic incentives to drive behaviour • Urban plans and strategies in energy, waste, transport • Compatibility of national policies with local plans and strategies •	•	•	•	• Development and transport plan •	• Post-carbon strategic planning • Policies for resource efficiency • Smart city policies
Passive/ reactive (indicators)	• Water body quality • Waste management • Heat islands	• Corridors for biodiversity • Water quality •	• Quality of life • Quality of environment •	• Quality of life • Attractiveness	• Air quality • CO2 emissions	• Environmental quality • Social inclusion/equality	• Air quality • Natural and green areas • Soil consumption

**This variable resulted from the Milan-Turin workshop*

I.II NEXT STEPS

The identified variables now needs to be considered alongside the findings from the initial assessments of WP3 and D4.2 (Report on Stakeholder Workshops) to see what should be modelled and focused upon in each individual case study.

The scoring of the PCIA matrices can make quite a difference as to which variables appear “on top”. Some of the currently highlighted variables are followed quite closely in the table by other variables, so there will have to be considered alongside the others in the modelling process. This will be determined not only by which variables appear at the top, but by considering other information on what might be important in 2050, what can be modelled and what data is available and whether some of the variables are, or can be, covered by other variables or indicators.

Hence the modelling task in WP5 will now need to translate these variables into a set of indicators in order to model each city individually.

II INTRODUCTION

II.I BACKGROUND

The POCACITO project aims to facilitate the transition of European cities towards a post-carbon future by defining a Roadmap for the transition. The focus of the project includes urban areas of various sizes from towns and cities, through to megacities. Central to the project is a series of participatory stakeholder workshops in the case study cities of Barcelona, Copenhagen/Malmö, Istanbul, Lisbon, Litoměřice, Milan/Turin, Rostock and Zagreb. The purpose of these workshops is to bring together local stakeholders to construct a common post-carbon vision for 2050 and to define a roadmap, or action plan, to reach the vision.

This report details the initial phase of Work Package 5 that focuses on modelling and quantifying the environmental and socio-economic impacts of the 2050 visions compared to business as usual, for each of the case study cities. This first part involves the identification of the "systemic characteristics" of each case study city. In other words, to identify the most important factors/variables in each city, understand how they relate to each other and understand which variables are important for more detailed impact assessment.

This is an important part of the process, as it not possible to map all possible variables within each city.

A methodology that stood out as an appropriate way to do this was the Sensitivity Model (SM) developed by Prof. Vester for two main reasons.

III. It is a systems dynamics approach and understanding the complex interaction of factors within a city requires a systems dynamics approach. Any city can be described as a system, and this will help to model the city and identify important variables. In addition, the SM is a fuzzy logic approach, essentially meaning that it does not require "precise/exact" data inputs, but rather works on modelling influences of variables on one another. It is therefore a semi-quantitative modelling tool.

IV. The POCACITO project is fundamentally participatory, in that it involves a series of workshops with stakeholders from the case study cities. Similarly, the Sensitivity Model is built on utilising a participatory approach

The SM began its development in the 1970's (Vester 2007) and was used early on in urban development (Vester 1976). In addition to urban development it has been utilised to model and assess various systems ranging from corporate strategic planning, technology assessment, developmental aid projects, examination of economic sectors, insurance and risk management, and traffic planning.

There are 3 main phases to the SM approach. The first phase involves describing the system in question and developing a set of variables that help to represent the system. In the second phase, the influence of the variables are assessed used an impact matrix which is then analysed to identify the most critical and important variables. Finally, in the last phase a selection of variables are described more in depth in a simulation model and cybernetic evaluation.

Unfortunately much of its earlier applications have only been published in German. Recently however, it has been applied to a number of cases in urban and land development. Chan et al. (2004) used the SM to help understand the effects of sustainable development in the community of Ping-Ding in Taiwan. They modelled two different scenarios of development showing that there was a need to both plan the development of agriculture and the tourism industry. Similarly, Huang et al. (2009) used the SM to analyse urban development in Taiwan, linking it to sustainability indictors. The SM helped to show that the natural environment is one of the critical factors in Taiwan's urban development, and helped to provide decision makers with relevant information to aid their decisions on urban development. The approach was however not viewed as sufficient on its own as a sustainability assessment.

The impact matrix (or influence matrix) is in itself a very useful tool, and a developing science. It can be used as part of a participatory process to aid a group of stakeholders in assessing a system and agree on what the most critical variables are influencing that system. For instance, it has been applied on its own in the Motuka Catchment of New Zealand to understand the governing dynamics of the catchment and to identify needs for research and resource management plans and policies (Cole 2006).

The influence matrix builds on earlier techniques such as the Delphi method that was developed to forecast the impact of technology on warfare. Traditional forecasting methods, such as quantitative models, theoretical approach or trend extrapolation were found to have several shortcomings when applied to areas where precise scientific relationships were not established. Cross impact analysis emerged to address this weakness in methods such as those developed by Gordon and Hayward (1968) that was a computer based approach. However, this was a fairly complex method that was later simplified by Frederic Vester (1976) and further improved in the Networked Thinking methodology of Vester and von Hesler (1982). This employed a simplified scoring method that quantified the influence of variables on a scale of 0, 1, 2 or 3. Later, Vester continued to develop and refine the approach and its application (Vester, 1988; Vester and Guntrum, 1993) and it became an initial phase in computer based system dynamic modelling (Vester, 2004).

Overall, the SM models strengths are that it can model and simulate systems without the need for extensive or accurate data. It is also an effect technique to facilitate participation, in particular for a diverse group of stakeholders to agree on effects of variables on one another. The technique of using a matrix allows for these effects to be mapped whilst removing prejudice over which variables are most important. It hence removes the bias that can occur in other methods where the most prominent voice may sway results so that their particular concerns emerge as the most important.

The largest weakness is that the process can be very time consuming, especially where the entire modelling process (all three phases of the SM) is required. This demands strong commitment of the participants to continually review the model and the effects of variables during the simulation process. In addition, some of the results of the overall modelling process do not often appear to offer any unique conclusions, other than those which are generally intuitive, although it can help to reinforce the problems or challenges of a system. In addition, the process can be quite complex. Even during the initial phases it requires an understanding of system dynamics to ensure the variables that represent the system are not skewed towards one type of variable (i.e. that they do not have a disproportionate amount of one variables type, such as physical flow variables), otherwise the system

will not be a true representation. However, to overcome this Vester (2007) proposes an additional technique, called a criteria matrix, to review the variables and ensure enough variables of a each type are present.

II.I.I APPLYING THE SENSITIVITY MODEL IN POCACITO

Despite these challenges, the impact matrix was foreseen to offer valuable and appropriate potential to help understand the case study cities systems and identify important variables that will be quantified in later stages of the project. Following all of the 9 stages of the SM was considered too time consuming and it was felt that this would not be possible for 10 case studies within the scope of the POCACITO project. Therefore, the initial stages, which result in an impact matrix that helps to understand the interactions of variables, their influences on each other and helps to identify the most critically important variables, was considered sufficient for the purposes of POCACITO.

This document outlines how the Sensitivity Model was adapted and utilised in the POCACITO project. The process was renamed the POCACITO Critical Influences Assessment (PCIA) in an attempt to better reflect the use of the model and make it more marketable to the city stakeholders.

Below we clarify why the process was used and how it feeds into WP5 and the POCACITO project. The main difference in the adapted approach is that we utilised the previous POCACITO workshops to make an initial impact matrix and analysis before the workshop. This meant slightly more work upfront for the case study coordinators but removed some of the more laborious work from the workshop participants, leaving more time for review, discussion and refinement. POCACITO adapted the process because some of the steps that are required in the application of the Sensitivity Model had already been performed in the previous two workshops. This includes the visioning of the city and description of the city as a system, as well as the development of variables that are important and represent the city (or help to describe it).

II.II PURPOSE

The purpose of utilising the PCIA tool is to:

I. Understand the **influence that different factors/variables have on each other** in the cities development. This will not only increase the understanding of the participants but also help to:

II. **Identify specific important factors** for the individual case study city. These may include the POCACITO indicators (from WP1), or may not have been highlighted before. By viewing the city as a "system" rather than focusing only on what we think is needed for a post-carbon city, new important factors can be found.

The process will develop an "impact matrix" that maps the influence each variable has on another. Subsequent analysis will identify the critical impacts to assess for the cities development.

This will feed directly into the quantitative assessment in WP5 (see Figure 1 and Figure 2):

- The most important factors/areas will be modelled for 2050 for two scenarios: business as usual (BAU) and Post Carbon (PC). This could include variables in addition to the indicator set developed in WP1

- This process will also help **identify further measures that are necessary to achieve PC** and the associated costs and benefits**.** For example, perhaps city image is important for the tourism industry, which is a major part of the economy. This is influenced by many factors such as industry, pollution, noise, congestion and aesthetics. Hence further policies or investment in eco-industrial parks or cleaner production may be needed.
- The WP5 quantification will also identify gaps between what is intended to be achieved and the projected outcome. In this way it will identify further measures that are required by the cities, e.g. the renewable energy target will not reduce emissions by the intended amount.
- This information will then form part of the evidence base to develop the EU Roadmap.

It is anticipated that some of the indicators identified in the PCIA process will not be covered by the POCACITO indicators developed in WP3. For example, in the Malmö case study, segregation of housing emerged as a key factor/variable but is not covered by the WP3 indicators.

The POCACITO indicators cover standard sustainability dimensions, but in the PCIA process we want to focus on what other factors may also be important leading up to 2050. It is important to view the city as a system to try to create a balanced system of variables (see section 0). The variables do not need to be indicators, and should not only be indicators. However, from the variables the most important areas of concern for the case study city can be identified and indicators developed to represent these areas.

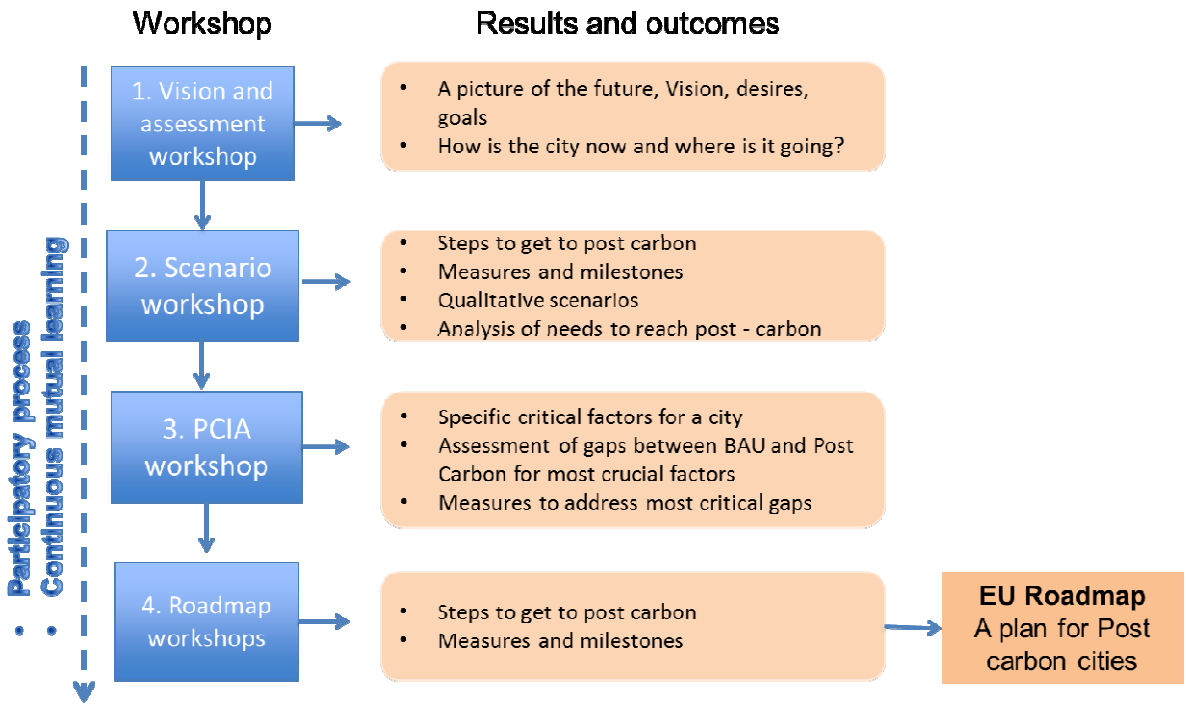


Figure 1: How the PCIA (Sensitivity Model) workshops contribute to the POCACITO project

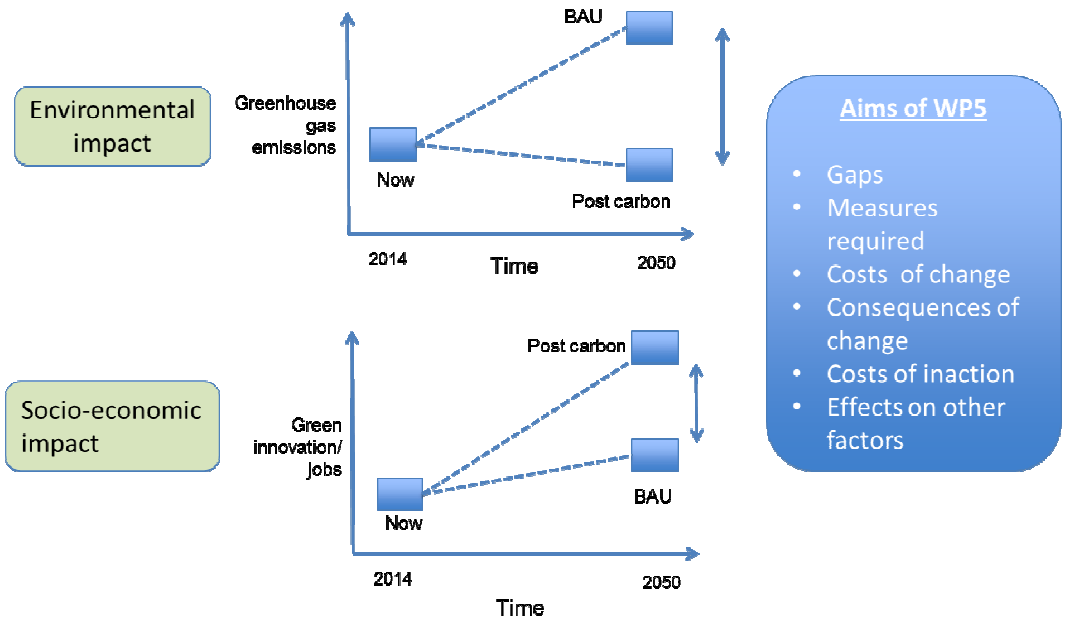


Figure 2: Aims of WP5 – modelling and quantification of BAU and PC scenarios

II.III PCIA PROCEDURE

The approach of Prof Vester's Sensitivity Model was simplified for the PCIA process, to remove onerous and repetitive work for the workshop participants. The normal procedure consists of three steps that include system description, defining a set of variables and developing an impact matrix. Following a POCACITO PCIA training workshop in Lisbon an adapted process was designed to utilise information gathered in the vision and scenario workshops of the city case study. The process consisted of 3 main steps:

1. **Initial work (pre-workshop) for the city case study coordinators (see section II.V)**
    a. Utilise developed vision and scenarios to
        i. construct a city picture (if not already performed) and
        ii. a preliminary variable set (primarily based on the topics and actions from the Backcasting workshop)
    b. Make sure that there is at least one variable from each of the categories
    c. Define variables (suggest 20-25)
    d. Use Excel sheet provided to develop initial Impact Matrix
    e. Use Excel sheet to develop a "systemic role" figure for the variables
    f. Perform initial analysis
        i. Please consult with IVL
2. **Workshop overview (see section** Fehler! Verweisquelle konnte nicht gefunden werden.**)**
    a. Present methodology, system diagram, variable set and impact matrix
    b. Present initial assessment – what it currently means for the city, types of measures that might be required.
        i. short group discussion on results
        ii. Present POCACITO indicator set – comparing results and what is covered

c. Break into groups to discuss variables
d. Adjust variable set accordingly and revise definitions where necessary
e. Impact matrix – trial a small selection of the impact matrix e.g. 5 variables. This will both compare the scoring of the participants with the coordinators, and increase the understanding of the participants of the process.
f. Present a new assessment at the end of the workshop

3. **Report to IVL**
   a. Develop a short report on the findings and the impacts matrix. The report includes any important comments and an overview of the discussion that took place.

Each case study city leader was supplied with training on the use of the PCIA process, guidelines on how to perform the PCIA process and workshops, and an Excel based tool to help construct the impact matrix and perform the analysis.

II.IV FRAMING AND SELLING OF THE PCIA WORKSHOPS

The PCIA tool is used to understand how the different elements/factors within the system affect one another and which ones are most important for detailed quantitative analysis (within WP5). The two previous workshops have developed a vision, and then a scenario with backcasting steps required. The PCIA workshops now help understand the influence of important variables in the system and which ones to assess.

It was proposed that the participants of the workshops would benefit from the PCIA workshops by:

- Understanding better the influences that different factors (variables) in the city have on one another.
- Helping to identify which factors will have large effects on others and what measures can be put in place to counteract if necessary (e.g. renewable energy effects of land use). WP5 will assess whether an improvement in one facet of the city will mean a decline in another component. What policies or other factors are required to achieve a favourable PC 2050?
- Having a say in what factors are included in the project analysis and the Roadmap.
- Cross-learnings – comparing and sharing lessons from this and the previous workshops between cities.

II.V PCIA METHODOLOGY

There are 3 steps in the initial step of using the PCIA tool that are described below:

1. System description and variable Set
2. Constructing the Impact Matrix
3. Analysis of the variables from the Impact Matrix and other tools

II.V.I STAGE 1: SYSTEM DESCRIPTION AND VARIABLE SET

The system description should give a brief description of the city that the stakeholders (i.e. the participants of the previous workshops) can agree gives a good overview of the city. It is useful to also describe what the boundaries of the city are. This is essentially using the information and descriptions of the cities so far gathered.

Variables should be identified from a combination of information and outcomes from the previous workshops, and other information and literature on the city. The focus is on identifying a set of variables that represent the city as a system. It is important to get a good selection of variables that help describe the city and cover each of the areas described in section 0. The analysis is only as good as the variable set.

WHAT ARE VARIABLES?

Variables can be described by a number of attributes (Vester, 2007). Variables:

- are factors that change,
- can be soft or hard (e.g. soft: image of a region;, hard: number of jobs),
- are measurable (scalable or countable),
- have an effect with the system, on other variables,
- but can also be influenced by other variables,

When reviewing how variables represent the system, some may need to be merged, depending on the analysis, e.g. gardens, structure and roads, could be represented by the built environment. Whilst others may need to be subdivided, e.g. population into size and structure.

Case study leaders were provided with the following list of questions to promote identification of potential system variables:

1. What are the crucial elements of the city as it functions
    a. buildings
    b. transport
    c. recreation
2. What are the key issues?
    a. e.g. social issues, segregation of housing¨
    b. consumption
    c. travel times
    d. urban sprawl
        i. high density housing
3. What is likely to be affected by future development – e.g. land use, encroachment of nature parks, water quality?
4. What are the specific risks of climate change for the city?
    a. flooding
    b. heatwaves – heat island effect,

5. What mitigation may be needed
    a. Heating and cooling
        i. heat island effect – reduce need for air conditioning through urban greening.
    b. transport
    c. reduce consumption
6. Adaption
    a. defences
    b. green roofs – absorbing
7. Control mechanisms – i.e. policies
    a. funding
    b. planning policy e.g. encouraging green roofs, solar panels,
    c. waste systems

CHECKING THE VARIABLE SET

According to Vester (2007), research and experience in the application of the Sensitivity Model has shown that it is necessary to include variables from a certain group of categories. This is to ensure the system is balanced and is not skewed to a certain type of variable type (e.g. focussing on policy and not considering physical flows). Hence Vester (2007) identified 13 groups of variables that are necessary to represent any system, whether it is a city, an ecosystem or business. These are discussed below. Whilst some research has not followed this when only using the impact matrix (e.g. Waltz *et al*. 2007; Cole, 2006), this has resulted in weaknesses in the assessment. It was also discussed within the POCACITO project whether to focus on the indicators developed in work package 3 in the impact matrix. However, this would not help to identify areas of particular importance for individual cities, such as those not covered by the indicators. It was therefore considered prudent to follow the structure and framework developed by Vester (2007). This would create a balanced system to enable the identification of important variables. An imbalanced system, for example focusing on physical flows or the built environment, would be biased to identifying these variables as important, and would likely miss other important types of variables (e.g. renewable energy or segregation).

To check that the system is reasonably balanced and covers most of the essential elements that are considered necessary to describe a system the initial set of variables was reviewed to ensure that there is at least one variable from each of the following categories.

Seven areas of life

- **Economy: level of activities**
    - Variables that influence and tell us about what is produced, constructed, exchanged, bought and sold in this system: Examples: Production, services, capital, investments, procurement and sales, import, export, turnover, company targets, shareholder value etc.
- **Participants: level of participants**
    - Variables which supply information about the "in-habitants" of the system. *Examples:* population, residents, colleagues, customers, state and density of population, migration, commuters and voyagers, birth and death rate but also age structure and diversity of manpower.

- **Space utilisation: level of space**
  - Variables that concern how space is used and where. Examples: land use, industrial real estate, office space, forest areas, airports, harbours, parking spaces, recreation centers, etc.
- **Human ecology: level of wellbeing**
  - Variables that give information about the well-being of people. Examples: Health, standard of living, satisfaction, education, awareness, behaviour, self-fulfillment, demands, social interaction, etc.
- **Natural balance: level of relation to the ecological surrounding**
  - Variables concerning how resources are functioning. Examples: Climate, weather, air, soil, water, flora and fauna, cycles, changes, burdens, destruction, integrity of ecosystems, etc.
- **Infrastructure: level of internal processes**
  - Variables concerning structures and system communication. includes everything which makes activities between the system components possible. Examples: Traffic networks, logistics, maintenance, media, telecommunications, computer systems, etc**.**
- **Rules and laws: level of internal order**
  - Variables that determine the internal regulation of the system. Examples: Taxes, governments, insurances, claim settlement, customs, legislation, regulations, borders, etc.

Physical categories

- **Matter**: Variables having a primarily material character
  Examples: buildings, raw materials, production means, people etc.

- **Energy**: Variables having a primarily energy-related character *Examples*: electricity consumption, financial power, decision-making authority etc.
- **Information**: Variables having a primarily information related character
  Examples: media, decisions, information exchange, regulations, awareness, perception, money

Definition of variable's dynamic base criteria

- **Flow size**: variables expressing primarily flows of matter, energy or information within the system. Examples: power consumption, traffic, commuters, instructions, attractiveness)
- **Structure size:** Variables serving to determine structure rather than flow. (e.g. green spaces, population densities, traffic network, accessibility, vocational diversity, centralised or decentralised division, hierarchy)
- **Temporal dynamics:** Variables that at the same location change at a given time or that possess a temporal dynamics. (e.g. seasonal activity, election meetings, climatic factors, transport timetables, tax checking)

II.V.II STAGE 2: THE IMPACT MATRIX

The impact matrix is where the influence of the variables over each other is mapped. The normal procedure is for stakeholders to break into a few groups of 3-5 people and score each box. However, for the POCACITO case studies we recommended that this was performed initially by the case study coordination team. This was to utilise the previous workshops that covered visioning and scenarios, and to reduce repetitive work for the stakeholder participants (the idea to have them review and verify the matrix in the PCIA workshops).

STRENGTH OF INTERCONNECTIONS BETWEEN VARIABLES

The scoring was entered into the impact matrix in an Excel based tool that was supplied to the case study teams. Starting with the first variable in the column, the scoring is performed by working across the row. The idea is to score how much influence the variable in column B has on each of the other variables in the columns. It is crucial to realise that only the strength of the relationship is scored and not the direction of the change. The question is always: If variable X changes, how much does variable Y change? The procedure is as follows:

A. Assess relations with 0, 1, 2 or 3 according to:

0	No relation
1	Weak relation
2	Proportional relation
4	Intensive relation

B. Only direct relations should be scored. That is to say if a change in variable X causes a change in variable Y, which in turn causes a change in variable Z (but if y is absent, or not considered no change takes place) then the effect of a change in x is not directly on z. This should then not be scored. For example, does “segregation of housing” directly affect “water quality”? It may cause some social problems which lead to actions (e.g. dumping) which could in turn affect water quality. But it is not possible to say that an increase in segregation will directly lead to poorer water quality. It is possible to say though that national policies (e.g. subsidies) can have a direct effect on renewable energy. However, directness can often be somewhat contentious, and it is therefore important to have well defined and understood variables to reduce this.

C. There is a need to be careful: and only assess relation “A to B”, not relation “between A and B”.

D. Work row after row.

II.V.III STAGE 3: ANALYSIS OF THE VARIABLES FROM THE IMPACT MATRIX AND OTHER TOOLS

Once the matrix is complete the analysis could be performed using the Excel based tool. Figure 3 shows an example of a completed impact matrix. The tool sums up each row and column to produce an "active" and "passive" score for each variable.

	Påverkar:	Population	Robust economy - busines	Environmental Awareness	Circular economy and shar	Activities and culture	Land use	Green space and corridors	Qual ty of life (interaction	Social inclusion /equality	Water body quality	Local food production	Resource efficiency	Public Transport and bike	Smart logisitics	Resource/environment tax	Development and transpo	Buildings	Renewable energy	Attractiveness	National pol cies	Traff c volumes	Industrial areas	Segregation of housing are	AS
1	Population	X	1	0	0	1	2	1	1	1	1	2	0	2	0	0	1	2	2	1	0	2	0	1	21
2	Robust economy - business/financial servic	3	X	0	2	2	1	0	3	2	0	2	2	3	2	0	0	2	2	3	0	2	0	0	31
3	Environmental Awareness	0	0	X	3	0	2	2	0	0	1	2	2	2	0	0	0	0	2	0	0	2	0	0	18
4	Circular economy and sharing	0	2	2	X	0	1	1	2	1	2	3	3	2	2	1	2	1	2	2	1	1	2	0	33
5	Activities and culture	1	0	0	0	X	2	2	3	2	0	0	0	0	0	0	0	1	0	3	0	1	0	0	15
6	Land use	0	0	1	0	2	X	2	3	0	1	2	0	1	0	0	2	0	2	3	0	0	2	0	21
7	Green space and corridors	0	0	0	0	3	3	X	3	1	1	2	0	1	0	0	0	0	1	3	0	0	2	0	20
8	Quality of life (interaction)	1	1	1	1	0	0	0	X	0	0	0	0	0	0	0	2	0	0	3	1	1	0	0	11
9	Social inclusion /equality	1	1	0	0	2	0	0	2	X	1	0	0	0	0	0	0	0	0	2	1	0	0	2	12
10	Water body quality	1	0	1	0	2	0	0	2	0	X	3	0	0	0	0	1	0	0	3	1	0	0	0	14
11	Local food production	0	1	1	3	0	2	2	0	0	1	X	2	0	2	1	1	1	1	1	0	0	2	0	21
12	Resource efficiency	0	2	1	2	0	0	0	2	0	1	0	X	0	0	2	1	1	1	1	1	0	0	0	15
13	Public Transport and bike network	1	1	1	3	2	3	2	2	3	1	0	3	X	2	0	3	0	0	3	0	3	0	0	33
14	Smart logisitics	0	0	0	2	0	1	0	0	0	1	0	3	0	X	0	0	0	0	1	0	3	0	0	11
15	Resource/environment tax and charges	0	2	0	3	0	0	0	1	0	1	0	2	2	2	X	0	0	2	1	0	2	1	0	19
16	Development and transport plan	0	0	0	1	1	3	3	1	0	1	1	2	3	1	2	X	3	3	2	0	3	2	0	32
17	Buildings	1	1	0	0	0	2	2	1	0	1	2	3	2	0	0	1	X	0	3	0	0	1	3	23
18	Renewable energy	0	1	2	1	0	3	0	1	0	1	0	1	0	0	1	0	0	X	2	0	0	0	0	13
19	Attractiveness	0	1	0	0	2	0	0	2	2	0	0	0	0	0	1	0	1	0	X	0	0	0	1	13
20	National policies	1	2	1	2	0	1	1	1	1	1	0	3	1	1	3	3	1	3	0	X	2	1	1	30
21	Traffic volumes	1	0	1	0	0	3	2	3	0	2	0	3	2	1	0	3	0	0	3	0	X	0	0	24
22	Industrial areas	0	0	0	0	0	3	2	2	0	2	2	0	0	0	0	1	2	0	3	0	0	X	0	17
23	Segregation of housing areas	2	0	0	1	1	1	0	2	3	0	0	0	0	0	0	1	2	0	3	0	2	0	X	18
24																									X
25	PS	16	16	12	24	18	33	22	37	16	20	21	29	21	13	11	22	17	21	46	5	24	13	8	######

Figure 3: Example of an Impact Matrix

1. Active scores are in the second to last column marked "AS". A high value of these means the variable has a lot of influence over the other variables.
2. Passive scores are the second to last row marked PS . A high value of this means that the variables are highly influenced by other variables.

For the POCACITO project, the main objective is to identify specific areas of concern for the individual city and present and discuss these with stakeholders in a workshop. Below is some more information on the other tools that were used to assess what the results mean.

The analysis can now begin to examine deeper questions (Vester, 2007) such as: Which variables could function as potential control levers – that may allow the development of the city to be steered in a preferential direction? Which components may endanger the system? For which indicators would it be analogous to only treating symptoms if trying to improve?

Knowledge of only the active and passive scores does not help to answer these questions (Vester, 2007). For example, if an active component such as "circular economy" from Figure 4 also has a high passive score, it would not make a appropriate control lever. However, the active total of 30 for "national polices" means it has a very prominent role, whereas this is not true for "traffic volumes", which also has a high passive score.

Therefore, the relationship between active and passive totals (specifically the AS/PS quotient, referred also as the Q-value) is actually what determines whether a variable is active or reactive in character. A second index given by the product of the active and passive totals for each variable (also referred to as the P-value) illustrates how strong a role a variable plays in the system and how much it affects events overall.

The larger the P-value the greater role the variable plays in determining the behaviour of the system, meaning it is a critical variable. Similarly, a smaller value means it has a smaller role and is referred to as a buffering variable.

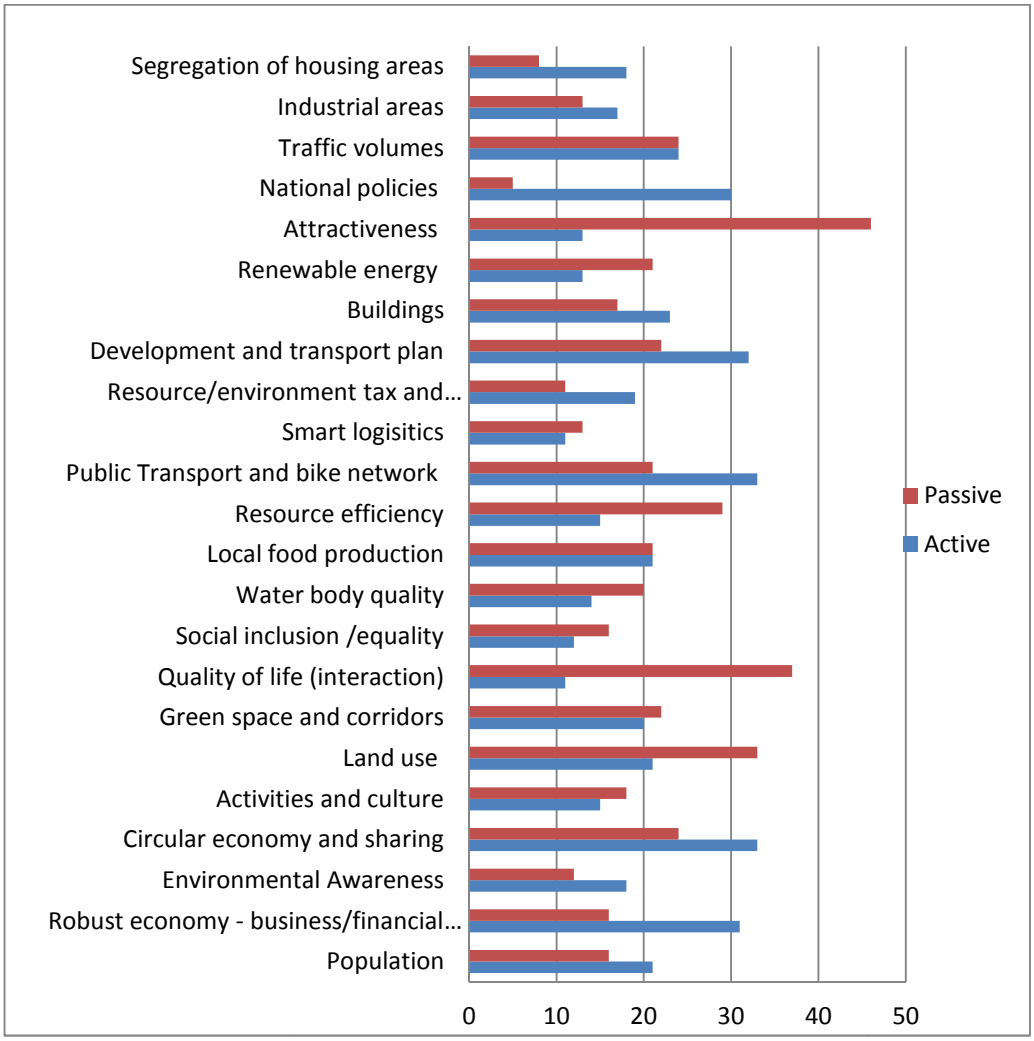


Figure 4: Influence strengths

Variables are thus classified as either active, passive, or reactive, and either critical or buffering. Analyse of these two types of behaviour can help determine whether a variable can be manipulated to produce a certain influence within the system. They can then be interpreted as a lever (active), a risk factor (critical), an indicator (reactive), an inert factor (buffering) or a combination of either (Vester, 2007).

The Sensitivity Model also has a graph called the “systemic role” used to provide further analysis. This was incorporated into the Excel based tool and an example result is shown in Figure 5. The Excel tool developed for the case study leaders also automatically sorts the variables into two tables that show to which degree the variables are active-passive and critical-buffering.

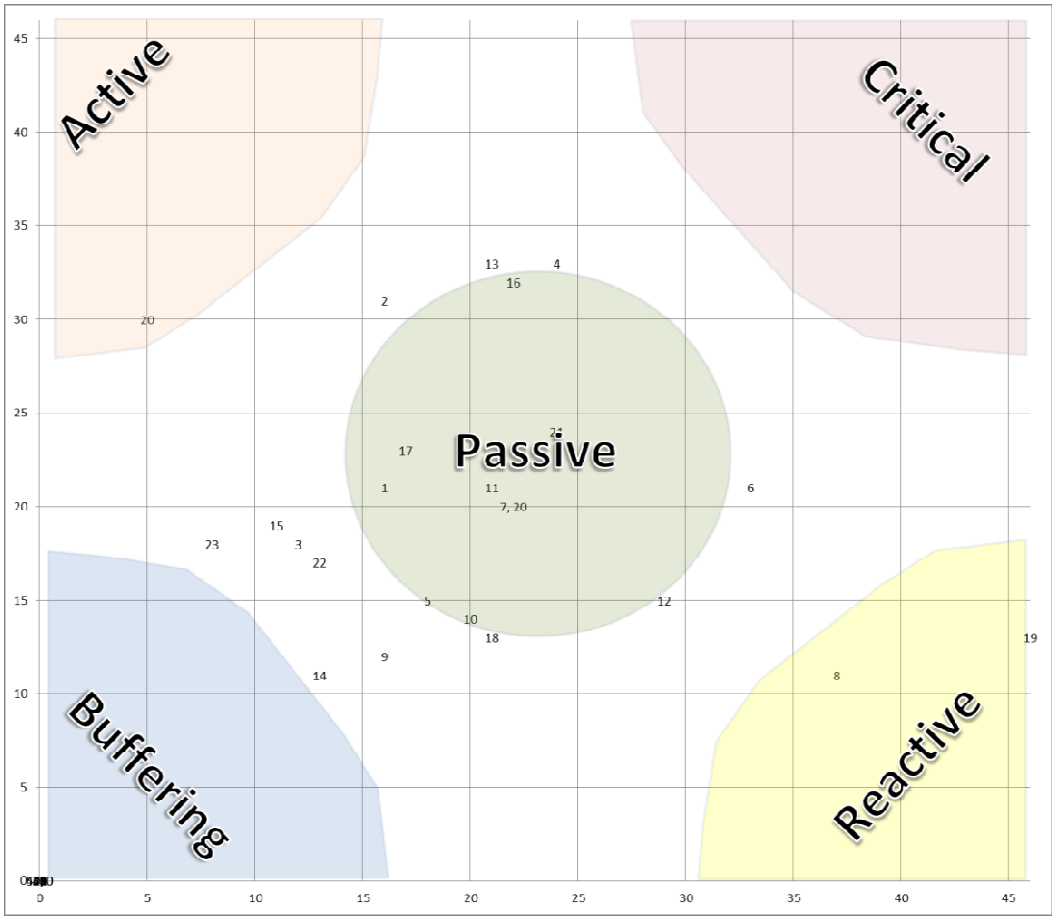
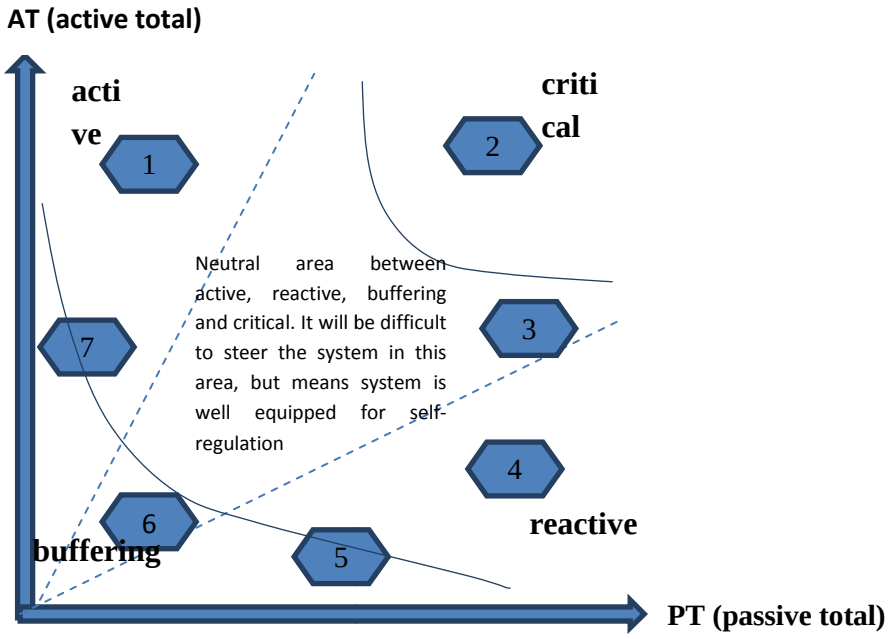


Figure 5: Systemic role of variables

Vester (2007) provides further explanation of the meaning of the areas of where variables can appear (referring to Figure 6):

1. Control –levers – that will re-stabilise a system once a change has occurred.
2. Accelerators and catalysts – suitable for firing up in order to get things going. Caution is required though
3. It is dangerous if associated clusters of variables lie in the critical/reactive area (in terms of stability)
4. Reactive - Intervening here to steer things will produce only cosmetic corrections (treating symptoms). However, these components make excellent indicators.
5. Somewhat sluggish indicators, but they can be experimented with.
6. Area where interventions and controls serve no purpose.
7. Here are weak control levers with few side effects.



(source. Vester, 2007)

Figure 6: Allocation of roles

II.VI THE CASE STUDY CITIES PCIA ASSESSMENTS

The following sections outline the application of the PCIA process for 8 of the 10 case study cities. At the time of writing, analysis or workshops had not been performed for the Lisbon or Istanbul case studies. In addition, the workshop has not been performed for Barcelona and only initial analysis and interpretation is provided from the case study team. Copenhagen has utilised an adapted process where interviews were used to discuss and verify the initial analysis of the case study team.

Each section is divided into two parts. The first part outlines the initial work of the case study team to utilise the work from the previous two POCACITO workshops to develop a system description, set of variables and an impact matrix for their city. It also contains the analysis from this process on the influence of the variables with the system and which are the most active, passive, critical and buffering. The second part then describes the workshop process, the outcomes and the discussions and thoughts of the participants on the PCIA process.

III BARCELONA

III.I PRE WORKSHOP ACTIVITIES

III.I.I SYSTEM DESCRIPTION

Barcelona is located in the North-Eastern area of Spain and is surrounded by the sea and a mountainous region which has influenced the development of the city considerably, making it one of the most densely populated centres in Europe, as well as one of the most populated. Barcelona is an historically important economic centre and port and this has influenced the economic structure of the city, its important trade and touristic position in Europe. The Barcelona authorities have consciously focused on making the city an innovation and trade hub in Europe and the city is ranked as one of the most advanced cities in the world and at the forefront on of the smart city development. In 2014 it received the award of European Capital of Innovation in a competition with 58 other European cities.

The growth of the city has resulted in the merging of 36 municipalities surrounding the city, together they form a single urban area. Recognising this, Barcelona founded the Barcelona Metropolitan Area (AMB) which allows for a more integrated development approach.

Many municipal services are being integrated to reflect this urban reality. The municipality of Barcelona with 1.6 million inhabitants and 101.4 km^2 is only one of the 36 municipalities that make up the metropolitan. There are three levels of population of Barcelona, NUTs III district, the metropolitan area AMB and the municipality. The province has 5.5 million inhabitants, of this the metropolitan area covers 3.24 million inhabitants and the municipality 1.6 million.

The city system is primarily described by the municipal boundaries but the variables recognise the interconnectedness with the surrounding region.

III.I.II VARIABLE SET

The variable set was partially influenced by the areas of importance developed in the visioning and backcasting workshops, in particular the mind map.

Table 2: List of variables and descriptions for Barcelona

TYPE OF VARIABLE	VARIABLE	DEFINITION
Participants	Population	The people who live in the city
Activities	Robust economy - business/financial service /IT	A service and knowledge based economy, circular and sharing
	Environmental Awareness	The level of environmental awareness through appropriate information and education
	Activities and culture	The vibrancy of the city and the number of things to do

TYPE OF VARIABLE	VARIABLE	DEFINITION
Space	Green space and corridors	Green space and corridors for biodiversity
	Industrial areas	Industrial area size
Mood	Quality of life (interaction)	Activities, security, Flexibility at work, Health
	Social inclusion /equality	The degree that the diverse people are well integrated into the general population
Natural balance	Water body quality	Quality of the surrounding water body
	Waste management	Waste reuse and recycling.
	Heat islands	Areas with risk of heat shocks/heat island
Internal processes	Green transport	Green public transport and bike network
	Smart logistics	Freight transport and inter-city provision of goods to consumers
Internal order	Public services	Services too citizens, environmental, administrative, social
	Governance	Rule of law, quality of administration
Matter	Real estate market	Developments in the housing market, impact on construction and value
Energy	Energy efficiency and RES	Energy efficiency in buildings. Wind, solar and power production. Self-power production and grid feed.
Economy	Trade – internal and external	Value of trade flows
Information	Education, including civic education	Quality and level of education, including civic education
	Attractiveness	For living, work and tourism
Policy	National policies	The level of compatibility and support of national policies with local plans and strategies.

III.I.III IMPACT MATRIX

The initial impact matrix for Barcelona is shown in Figure 7.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Population	Robust economy - busines	Environmental Awareness	Green transport	Tourism	Culture	Green space and corridors	Quality of life (interaction	Social inclusion /equality	Water body quality	waste management	public services	Education/ including civic	Energy efficiency and RES	trade - internal and extern	Governance	Public space	Industrial areas	Attractiveness	National policies	Real estate market	Heat islands
1	Population	X	2	0	2	1	2	2	1	2	1	2	1	2	1	2	1	2	2	1	0	2	0
2	Robust economy - business/financial	3	X	1	2	2	2	0	2	2	1	2	2	3	2	2	1	0	2	3	0	2	0
3	Environmental Awareness	0	0	X	2	0	2	2	1	1	2	2	2	2	2	0	2	1	1	1	0	1	1
4	Green transport	0	1	2	X	0	0	1	3	1	1	1	1	1	2	0	1	0	1	2	1	1	0
5	Tourism	1	2	0	1	X	1	2	3	1	2	2	0	0	0	1	2	1	0	3	0	1	0
6	Culture	0	0	1	0	2	X	2	3	1	1	1	0	2	0	0	2	0	0	3	0	0	0
7	Green space and corridors	0	0	2	2	1	0	X	2	1	1	2	0	1	0	0	0	0	1	3	0	0	3
8	Quality of life (interaction)	1	1	1	1	1	0	0	X	0	0	0	1	0	0	0	1	1	0	3	1	1	0
9	Social inclusion /equality	1	1	0	0	1	0	0	2	X	0	0	2	1	0	0	1	1	0	2	1	0	0
10	Water body quality	0	0	0	0	0	0	1	1	0	X	0	0	0	0	0	1	0	0	3	1	0	0
11	waste management	0	1	1	0	0	0	1	1	0	2	X	0	0	1	0	0	0	0	1	1	0	0
12	public services	0	2	1	2	1	2	0	2	2	1	1	X	1	0	0	2	1	1	1	1	0	0
13	Education/ including civic values	0	3	2	1	1	3	0	2	1	0	0	1	X	0	2	0	1	1	1	0	0	0
14	Energy efficiency and RES fostered in	0	0	1	2	0	0	1	1	0	1	1	0	1	X	0	0	0	0	1	0	1	0
15	trade - internal and external demand	0	2	0	3	1	0	0	1	0	1	0	1	1	0	X	0	0	2	1	0	1	0
16	Governance	0	2	1	1	1	0	1	1	1	1	1	2	2	1	2	X	3	3	2	0	1	0
17	Public space	0	1	0	0	0	2	0	1	1	0	0	1	2	0	0	1	X	0	1	0	0	0
18	Industrial areas	2	2	2	1	0	0	1	1	1	3	3	0	0	0	2	0	0	X	2	0	2	1
19	Attractiveness	3	1	1	0	2	1	0	2	1	0	0	0	0	0	0	0	0	0	X	0	2	0
20	National policies	1	2	1	2	1	1	1	1	2	1	1	3	1	1	3	2	1	2	0	X	2	0
21	Real estate market	1	1	1	0	1	0	1	1	1	1	1	1	0	1	0	0	0	0	2	0	X	2
22	Heat islands	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	1	0	0	X

Figure 7: Impact matrix for Barcelona

III.I.IV ANALYSIS OF VARIABLES FROM EXCEL TOOL

The initial analysis of the impact matrix is shown provided by Figure 8 and Figure 9. The city system as represented by these variables and impact matrix appears to be fairly well balanced from Figure 9. This is because there is a fairly good distribution of variables around the central passive area, with few critical variables.

The bar chart (Figure 8) showing the influence strengths illustrates the balance between how active and passive a variables is.

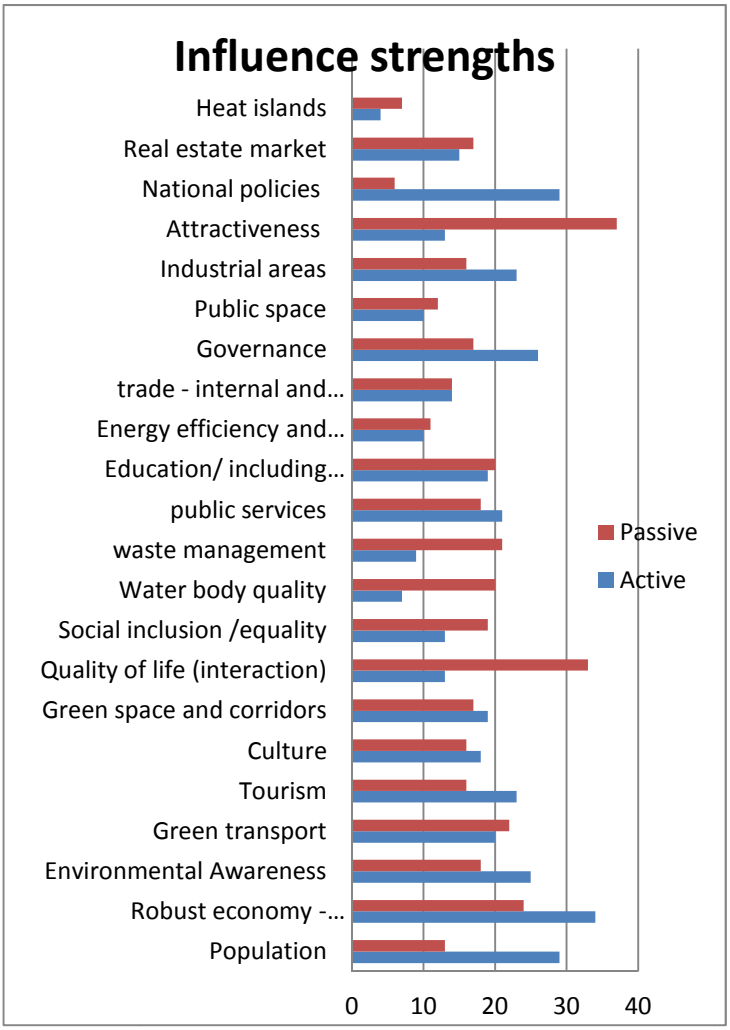


Figure 8: Influence strengths bar chart for Barcelona

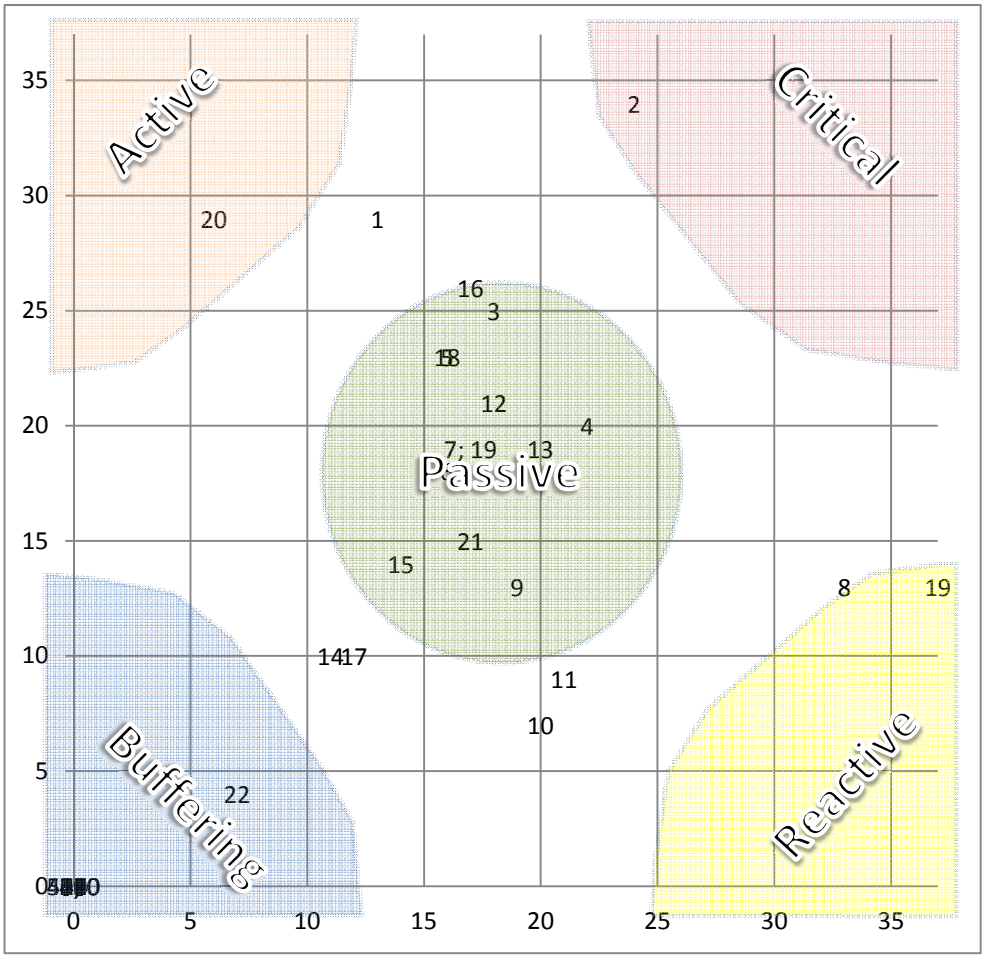


Figure 9: Systemic role figure for Barcelona.

Further in-depth analysis is shown in provided by Table 3 and Table 4, which outline the degree of activeness and criticality respectively. “National policies” are the most active and along with the variable “population” influences the system most actively. Several variables in Table 3 are slightly active that include governance, economic related variables and environmental awareness. “Water body quality”, “attractiveness” and “quality of life” are highly passive meaning that they are affected by many variables in the system.

The most highly critical variable is “robust economy” meaning it has most bearing and influence within the system. Buffering variables include “heat islands”, “energy efficiency”, “public space” and “water body quality”, meaning that these are difficult variables to control or influence.

Table 3: Ranking of active-passive influence for Barcelona

ACTIVE-PASSIVE RANKING	VARIABLE NO.	VARIABLE NAME	Q-VALUE
Highly active	20	National policies	4.83
Active	1	Population	2.23
Slightly active	16	Governance	1.53
Slightly active	18	Industrial areas	1.44
Slightly active	5	Tourism	1.44
Slightly active	2	Robust economy - business/financial service /IT	1.42
Slightly active	3	Environmental Awareness	1.39
Neutral	12	public services	1.17
Neutral	6	Culture	1.13
Neutral	7	Green space and corridors	1.12
Neutral	15	trade - internal and external demand	1.00
Neutral	13	Education/ including civic values	0.95
Neutral	14	Energy efficiency and RES fostered independence	0.91
Neutral	4	Green transport	0.91
Neutral	21	Real estate market	0.88
Neutral	17	Public space	0.83
Slightly passive	9	Social inclusion /equality	0.68
Passive	22	Heat islands	0.57
Passive	11	waste management	0.43
Highly passive	8	Quality of life (interaction)	0.39
Highly passive	19	Attractiveness	0.35
Highly passive	10	Water body quality	0.35

Table 4: Ranking of critical-buffering influence for Barcelona

CRITICAL – BUFFERING RANKING	VARIABLE NO.	VARIABLE NAME	P-VALUE
Highly critical	2	Robust economy - business/financial service /IT	816
Slightly critical	19	Attractiveness	481
Slightly critical	3	Environmental Awareness	450
Slightly critical	16	Governance	442
Slightly critical	4	Green transport	440
Slightly critical	8	Quality of life (interaction)	429
Slightly critical	13	Education/ including civic values	380
Slightly critical	12	public services	378
Slightly critical	1	Population	377
Neutral	18	Industrial areas	368
Neutral	5	Tourism	368
Neutral	7	Green space and corridors	323
Neutral	6	Culture	288
Neutral	21	Real estate market	255
Slightly buffering	9	Social inclusion /equality	247
Slightly buffering	15	trade - internal and external demand	196
Slightly buffering	11	waste management	189
Slightly buffering	20	National policies	174
Buffering	10	Water body quality	140
Buffering	17	Public space	120
Buffering	14	Energy efficiency and RES fostered independence	110
Highly buffering	22	Heat islands	28

III.II PCIA WORKSHOP REPORTING

Unfortunately due to political changes that affect the Barcelona stakeholders, the PCIA workshop was postponed. Therefore, at the time of writing the above analysis has not yet been presented, discussed or verified with stakeholders from the city of Barcelona.

IV COPENHAGEN

IV.I PRE WORKSHOP ACTIVITIES

IV.I.I SYSTEM DESCRIPTION

The city system is primarily described by the municipal boundaries but the variables recognise the interconnectedness with the surrounding region.

IV.I.II VARIABLE SET

The variables were derived by utilising the POCACITO case study reports developed for D4.1 and D3.1, i.e. specifying indicators for Copenhagen and identifying the urban visions of the city. Moreover, the policy documents published by Copenhagen which address urban visions were consulted to determine the set of variables. It should be noted that these variables represent the researcher's interpretation of which variables can be used to represent the city system, based on this information. There is therefore a degree of uncertainty as to their true representativeness, but this was later verified with interviews (see section IV.II). The variables addressed for the city visions are compiled in Table 5.

Table 5: List of variables and descriptions for the Copenhagen

TYPE OF VARIABLE	VARIABLE	DEFINITION
Participants	1. Population	The people who live in the city
Activities	2. Robust economy - business/financial service /IT	A service and knowledge based economy, circular and sharing
	3. Awareness	The level of environmental awareness through appropriate information and education
	4. Circular economy and sharing	Circular consumption and sharing, synergies with agriculture
	5. Activities and culture	The vibrancy of the city and the number of things to do
Space	6. Land use	The balance with development, green space and agriculture
	7. Green space and corridors	Green space and corridors for biodiversity
Mood	8. Quality of life (interaction)	Activities, security, Flexibility at work, Health
	9. Social inclusion /equality	The degree that the diverse people are well integrated into the general population

TYPE OF VARIABLE	VARIABLE	DEFINITION
Natural balance	10. Water body quality 11. Local food production 12. Resource efficiency	Quality of the surrounding Local and organic Use of raw materials, energy and water. More with less. Reuse of building and infrastructure materials. Waste reuse and recycling.
Internal processes	13. Public Transport and bike network 14. Smart logistics	Public transport and bike network Freight transport and inter-city provision of goods to consumers
Internal order	15. Resource/environment tax and charges 16. Development and transport plan	Economic incentives to drive behaviour towards resource efficiency, public transport, less consumption, the circular economy. City level plans and strategies, such as energy and waste etc
Matter	17. Buildings	Resource efficient buildings, high-density housing that are aesthetically pleasing and functional
Energy	18. Renewable energy	Wind, solar and geothermal. Self-power production and grid feed,
Information	19. Attractiveness	For work and tourism
	20. National policies	The level of compatibility and support of national policies with local plans and strategies.
Flow size	21. Traffic volumes	Management of traffic congestion and pollution
Structure size	22. Industrial areas	The integration and proximity of industrial areas
Structural dynamics	23. Segregation of housing areas	The division of low and high income population into different areas

Some variables are not relevant for Copenhagen and were left out. These concern specifically 1) agriculture as this is not an issue for a city with 1.7 million inhabitants, and 2) economic incentives since Danish local governments are not allowed to make taxes.

IV.I.III IMPACT MATRIX

The variables and their individual and relative influence on other variables were recorded in the matrix and discussed in an interview with an experienced Copenhagen planner who has worked in different departments, including transport, housing, regeneration, strategic planning, and has extensive experience from both the Technical and Environmental Administration and Financial Administration. Figure 10 presents the impact matrix for Copenhagen and the main characteristics are discussed below.

variable influenced	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	28	29
Variable influencing	population	population growth	robust economy based	environmental awarer	circular concusmption	synergies with agricult	vibrancy of the city	recreational activities	balance bt developme	green spaces	corridors for biodiversi	activities security flexi	integration of multiple	quality of the water in	local organic food proc	reuse of raw materials	waste recycling	public transport	bike network	freight transport and ir	economic incentives tc	urban plans and strate	ressource efficient buil	functional, aesthetic hi	renewable energy	attractiveness for worl	compatibility of natior	traffic congestion man	traffic pollution manag
1 population	X	0	3	3	1	0	3	3	3	0	0	0	2	1	0	2	3	3	3	2	0	1	1	1	0	3	0	3	3
2 population growth	3	X	2	1	0	0	3	2	0	2	0	2	3	0	0	0	0	3	3	3	0	2	3	3	0	3	0	3	3
3 robust economy based on servi	0	2	X	0	2	0	3	2	3	1	0	2	2	1	0	3	2	3	1	3	0	3	1	2	3	3	0	3	3
4 environmental awareness	0	0	1	X	3	2	1	1	2	2	2	0	0	1	3	1	3	1	1	0	0	0	0	0	1	0	0	0	2
5 circular concusmption	0	0	3	3	X	2	0	0	2	0	0	0	0	0	1	3	3	0	0	3	0	0	2	2	1	0	0	0	0
6 synergies with agriculture	0	0	2	2	3	X	0	0	2	1	3	0	0	3	3	0	1	0	0	2	0	0	0	0	0	0	0	0	0
7 vibrancy of the city	3	3	3	1	0	0	X	3	3	3	0	3	3	0	1	0	1	3	3	0	0	3	2	3	0	3	0	2	2
8 recreational activities and cultu	3	3	2	2	0	0	3	X	3	3	0	3	3	0	3	0	2	3	3	2	0	2	2	3	1	3	0	3	3
9 balance bt development and gr	3	3	3	3	0	1	2	3	X	3	3	3	1	1	0	2	2	2	2	2	0	3	2	3	3	3	1	3	3
10 green spaces	3	3	0	3	0	2	3	3	3	X	3	2	2	0	3	0	0	0	3	0	0	2	0	3	1	3	0	0	2
11 corridors for biodiversity	0	0	0	2	0	2	0	0	0	1	X	0	0	0	3	0	0	0	0	0	0	2	0	1	0	1	0	0	0
12 activities security flexibility at	3	3	2	1	0	0	3	3	1	1	0	X	3	0	0	0	0	2	2	0	0	2	0	0	0	3	0	2	20
13 integration of multiple groups c	3	1	1	2	2	0	3	2	1	1	0	3	X	0	1	0	2	2	2	0	0	2	0	2	0	3	0	0	0
14 quality of the water in the surro	0	0	2	1	0	0	0	0	0	1	3	0	0	X	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 local organic food production	0	0	2	3	3	3	0	1	2	1	3	1	1	1	X	0	0	0	0	2	0	1	0	0	0	1	0	0	0
16 reuse of raw materials, water,	0	0	2	1	3	0	0	0	2	1	0	0	0	0	0	X	3	0	0	2	0	1	0	0	0	0	0	0	0
17 waste recycling	0	0	1	3	3	0	0	1	1	0	0	0	0	0	0	2	X	0	0	2	0	3	1	0	0	1	0	0	0
18 public transport	3	3	3	1	0	0	3	3	1	0	0	3	3	0	0	0	0	X	2	0	0	3	0	0	3	3	3	3	3
19 bike network	3	3	3	3	0	0	3	3	2	2	1	3	3	0	0	0	0	2	X	0	0	3	1	3	3	3	3	3	3
20 freight transport and intercity p	0	0	3	0	3	3	0	1	2	0	3	1	0	0	0	0	2	0	0	X	0	2	0	0	0	0	0	3	3
21 economic incentives to drive be	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	2	2	3	3	3	X	0	3	0	3	0	0	3	3
22 urban plans and strategies in er	3	3	3	0	3	3	2	3	3	3	3	3	3	3	1	2	3	3	3	2	0	X	3	3	3	3	0	3	3
23 ressource efficient buildings	2	2	0	3	3	0	0	0	0	0	3	1	0	2	0	1	2	0	3	0	2	0	X	3	3	1	0	3	3
24 functional, aesthetic high densit	3	3	0	1	3	0	3	3	2	2	3	1	2	0	0	0	2	3	3	1	0	0	3	X	3	3	0	3	3
25 renewable energy	1	1	1	2	3	0	0	0	1	0	3	0	0	0	0	1	2	2	2	0	0	2	2	1	X	1	0	0	2
26 attractiveness for work and tou	3	3	3	0	3	0	3	3	1	3	0	3	3	0	0	0	0	3	3	0	0	3	1	3	0	X	0	3	3
27 compatibility of national policie	2	0	3	0	3	0	2	0	2	2	3	0	2	3	0	2	2	3	3	3	3	2	3	1	3	0	X	3	3
28 traffic congestion management	3	2	3	0	0	0	3	3	0	0	0	3	0	2	0	0	0	3	3	3	0	3	0	2	1	3	0	X	3
29 traffic pollution management	3	1	2	2	0	0	3	3	1	2	3	3	0	3	0	0	0	3	3	2	0	2	1	2	1	3	0	3	X

Figure 10: Impact matrix for Copenhagen

IV.I.IV BACKGROUND FOR STRONG AND WEAK VARIABLES

The matrix reflects that Copenhagen is growing and that population in the city has changed over the past 10-15 years. This is strongly reflected in strategies and plans and has for example prompted policies on housing and developing new urban neighbourhoods, as well as on providing an efficient urban transport and energy system. In plans and strategies and among the city council planners, attention to foster, maintain and improve an attractive city environment is evident and it has a strong presence in the city's approach to future development.

On an annual or biannual basis, the City of Copenhagen conducts surveys to determine the needs, preferences and attitudes of Copenhageners for a set of key areas. These surveys consistently show that the green and recreational dimension of urban spaces is important to maintain the city as an attractive place of residence. Likewise, green spaces are significant for making cycle mobility the chosen means of daily transport, while the attention among urban residents to urban green spaces is not reflected in environmental awareness or in concern for e.g. biodiversity or a preference for urban farming and locally produced food. Rather, green spaces in line with neighbourhoods with people friendly urban design and public spaces represent spaces of experience for the residents and spaces for activities that are framed by amiable urban structures. This is reflected in the weak variable of environmental awareness. The same lack of strong connection can be found between public awareness and renewable energy. Urban residents want the energy but do not place many efforts in determining which type of energy.

In developing new housing areas, the City of Copenhagen has taken this into account. In urban development projects, multiple objectives come together as reflected in the strong variables of

energy efficient housing, bike infrastructure, public transport. In some of the major urban development projects the creation of liveable spaces and multi-functional, attractive urban area are mixed with green and blue spaces, low-carbon, energy efficient buildings and recycling of water and waste. A main example of how this structures urban development is the new 40,000 people neighbourhood, Nordhavn, which is under construction in the northern old industrial port area and on artificial islands created with soil from the construction of the underground metro. Sustainable urban transport infrastructure in combination with activity spaces, waste recycling infrastructure, zero-energy housing and office buildings is a basic requirement for public and private developers engaged in developing Nordhavn.

Other major neighbourhoods have been or are being renovated to ensure energy efficient housing and integration of cycle infrastructure and public transport is implemented. The development of some of these areas, e.g. Norhavn and Carlsberg, is guided by regulations according to sustainable urban development and low-carbon development.

The matrix furthermore shows that urban plans and strategies is a strong variable, which in Copenhagen influences most other variables. Some urban initiatives have been blocked by national regulations and national laws which the state actors have been unwilling to change. Examples of these are the establishment of a payment ring for road traffic to improve air quality, reduce congestion and control transport related CO2 emissions; initiatives to regulate socially deprived housing areas through mixed housing and priority lists for allocating apartments; and actions to finance urban and community level climate adaptation initiatives through household level recycling of water

Variables difficult to assess

As noted above, agriculture is not an issue in Copenhagen. Urban gardening – including with occasional growth of vegetables – is supported by the city council and is to a very minor extent present in the form of gardens for town houses, garden lots in association ('kolonihaveforeninger') and in one urban park, users have established – and been permitted to establish – vegetable plots in a small area.

Moreover, the economic instruments are limited since Danish local governments are not allowed to make taxes and the city does not have a subsidy scheme for specific industries of types of activities, and use other motivational instruments to change e.g. transport behaviour or motivate waste recycling practices. One exception is that the city in collaboration with water companies has been pushing for a change of national regulations such that the funding of climate adaptation

IV.I.V ANALYSIS OF VARIABLES FROM EXCEL TOOL

The systemic role of the Copenhagen variables given by the impact matrix is shown in Figure 11. This shows that many variables of fairly critical, which suggests quite a volatile system. Hence there are many variables which could have a strong and significant influence on the city system.

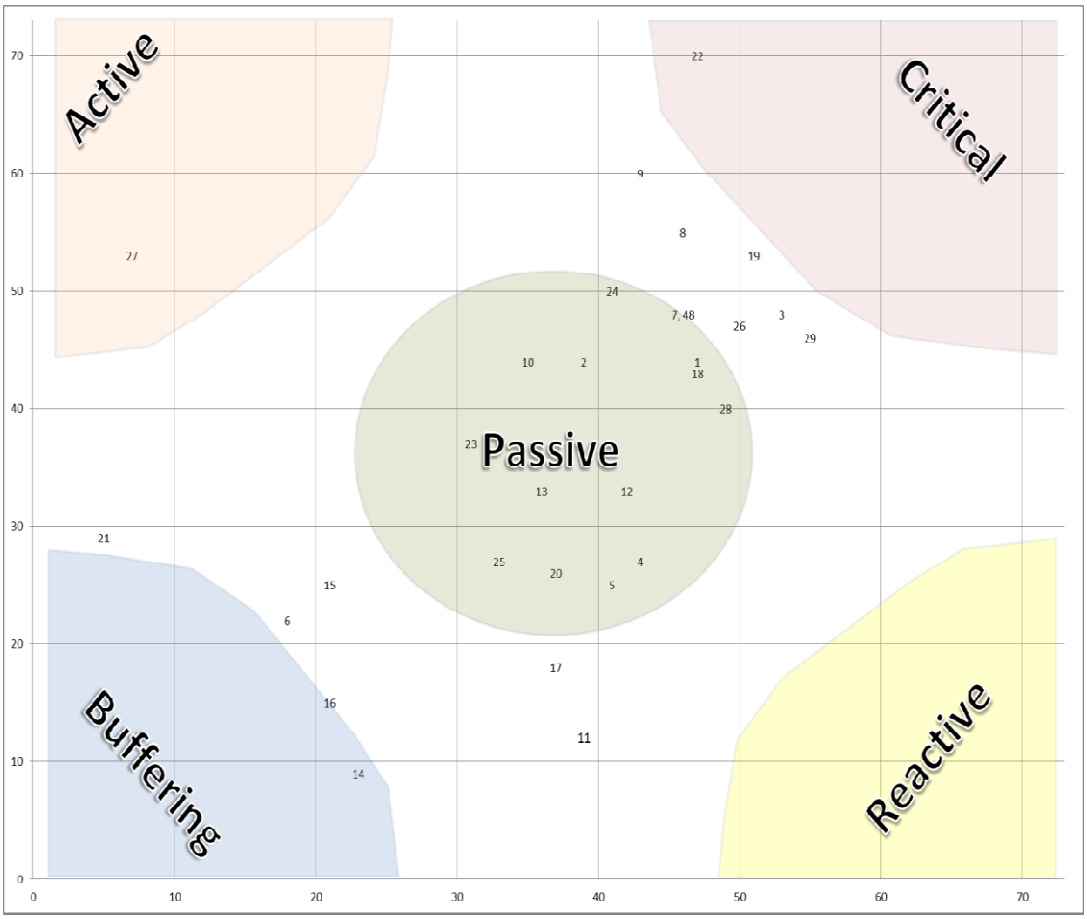


Figure 11: Systemic role figure for Copenhagen

Further assessment of the variables is provided in Table 13 and Table 14. The most critical variable is "urban plans and strategies in energy, waste and transport", with several others also quite critical including: bike network, balance between development and green spaces, robust economy based on service and knowledge, traffic pollution management and recreational activities and culture. These variables are quite volatile and could pull the system in certain directions and (from a systems viewpoint) require careful management. "Economic incentives to drive behaviour" are highly buffering, meaning they are not easily influenced, and interventions and controls will not easily influence.

The "compatibility of national policies with local plans if a highly active" variable, and as described above has influenced many development factors within Copenhagen. "Economic incentives to drive behaviour" is also highly active which, taken together with its highly buffering status, means it influences many factors but cannot be easily changed. Other active variables include "urban plans and strategies in energy, waste and transport" and "balance between development and green spaces". "Corridors for biodiversity" and "water quality" are the most passive variables, meaning they are influenced by many factors but do not greatly influence other variables.

Table 6: Ranking of active-passive influence for Copenhagen

ACTIVE-PASSIVE RANKING	VARIABLE NO.	VARIABLE NAME	Q-VALUE
Highly active	27	compatibility of national policies with local plans and strategies	7.57
Highly active	21	economic incentives to drive behaviour	5.80
Slightly active	22	urban plans and strategies in energy, waste, transport	1.49
Slightly active	9	balance bt development and green spaces	1.40
Neutral	10	green spaces	1.26
Neutral	6	synergies with agriculture	1.22
Neutral	24	functional, aesthetic high density housing	1.22
Neutral	8	recreational activities and culture	1.20
Neutral	23	resource efficient buildings	1.19
Neutral	15	local organic food production	1.19
Neutral	2	population growth	1.13
Neutral	7	vibrancy of the city	1.04
Neutral	19	bike network	1.04
Neutral	26	attractiveness for work and tourism	0.94
Neutral	1	population	0.94
Neutral	13	integration of multiple groups of people	0.92
Neutral	18	public transport	0.91
Neutral	3	robust economy based on service and knowledge industries	0.91
Neutral	29	traffic pollution management	0.84
Neutral	25	renewable energy	0.82
Neutral	28	traffic congestion management	0.82
Neutral	12	activities security flexibility at work health	0.79
Slightly passive	16	reuse of raw materials, water, building and construction materials	0.71
Slightly passive	20	freight transport and intercity provision of goods	0.70
Slightly passive	4	environmental awareness	0.63
Slightly passive	5	circular consumption	0.61
Passive	17	waste recycling	0.49
Highly passive	14	quality of the water in the surroundings	0.39
Highly passive	11	corridors for biodiversity	0.31

Table 7: Ranking of critical-buffering influence for Copenhagen

CRITICAL – BUFFERING RANKING	VARIABLE NO.	VARIABLE NAME	P-VALUE
Highly critical	22	urban plans and strategies in energy, waste, transport	3290
Critical	19	bike network	2703
Critical	9	balance bt development and green spaces	2580
Critical	3	robust economy based on service and knowledge industries	2544
Critical	29	traffic pollution management	2530
Critical	8	recreational activities and culture	2530
Critical	26	attractiveness for work and tourism	2350
Critical	7	vibrancy of the city	2208
Critical	1	population	2068
Critical	24	functional, aesthetic high density housing	2050
Critical	18	public transport	2021
Critical	28	traffic congestion management	1960
Slightly critical	2	population growth	1716
Slightly critical	10	green spaces	1540
Slightly critical	12	activities security flexibility at work health	1386
Neutral	13	integration of multiple groups of people	1188
Neutral	4	environmental awareness	1161
Neutral	23	resource efficient buildings	1147
Neutral	5	circular consumption	1025
Neutral	20	freight transport and intercity provision of goods	962
Slightly buffering	25	renewable energy	891
Slightly buffering	17	waste recycling	666
Buffering	15	local organic food production	525
Buffering	11	corridors for biodiversity	468
Buffering	6	synergies with agriculture	396

CRITICAL – BUFFERING RANKING	VARIABLE NO.	VARIABLE NAME	P-VALUE
Buffering	27	compatibility of national policies with local plans and strategies	371
Buffering	16	reuse of raw materials, water, building and construction materials	315
Buffering	14	quality of the water in the surroundings	207
Highly buffering	21	economic incentives to drive behaviour	145

IV.II PCIA WORKSHOP REPORTING

IV.II.I GENERAL INFORMATION

The workshop was substituted by interviews. Unfortunately Copenhagen could not be engaged in an actual workshop, because it had performed extensive similar work with visons and scenarios. In addition, they have developed their own methods for this kind of work. Hence instead of verifying the matrix through a workshop interviews were conducted with a selection of city stakeholders.

WORKSHOP DATES AND LOCATIONS

The interviews were held in spring 2015.

PARTICIPANTS

The interviewees were selected among urban planners and policy makers from City of Copenhagen who were or have been working with urban development and issues included in the variables. The interviewees are balanced with respect to gender but do not reflect social or ethnic diversity and the majority are middle-aged with academic educations.

FORMAT AND METHODOLOGY

The format of the interview was composed of semi-structured, in-depth interviews, some with follow-up interviews. Interview guides were based on the framework outlined in WP4 and WP5 and the interviews were recorded and summaries were composed. Some interviewees wished to remain anonymous to enable a more critical discussion of urban affairs.

The matrix input was derived from policy documents and the interviews. The matrix results were discussed with a very experienced planner and adjusted accordingly.

V LITOMĚŘICE

V.I PRE WORKSHOP ACTIVITIES

V.I.I SYSTEM DESCRIPTION

In order to help describe the city system for Litoměřice information was utilised from previous POCACITO workshops that developed a post-carbon vision and performed a backcasting exercise.

The system encompasses primarily the municipality area. However, influences of the city on the region were also represented by the variables “economic development of the region” and “industry in the city and its surrounding”.

V.I.II VARIABLE SET

The process of selecting the variables for Litoměřice consisted of two stages. Firstly, variables were selected from the post-carbon city vision and its backcasting scenarios developed during the initial workshops. The strategic goals of the city from the city’s Strategy Development Plan were also utilised to develop the set of variables. Secondly, indicators relevant for quantification in WP5 were included such as CO_2 emissions, quality of life, environmental quality, economic development, social inequality, energy consumption and land use.

The variables were subsequently discussed with the prospective participants of the PCIA workshop and some were modified and refined. Table 8 presents the final list of variables assessed during the workshop.

Table 8: List of variables and definitions for Litoměřice

NO	VARIABLE	DEFINITION
1	Transport infrastructure	Transport infrastructure, including infrastructure for cycling, public transport, local road network, parking capacity, filling and recharging stations for alternative fuels.
2	Ecological transport modes	Cycling, walking and motorized transport modes, individual as well as public, using ecological fuels
3	Economic development of the city	Economic development of the city
4	Economic development of the region	Economic development of the region
5	CO2 emissions	CO2 emissions of the city
6	Energy self-sufficiency	Energy self-sufficiency of the city with no energy imports
7	Energy recovery of waste	Energy recovery of waste in the city
8	Information and communication technologies in transport	Information and communication technologies in transport
9	Culture and sights	Cultural events, social life, meeting and networking of citizens; city monuments, historic centre and value of the city
10	Air quality	Air quality in the city and its surrounding
11	Quality of life	Citizens quality of life

NO	VARIABLE	DEFINITION
12	Quality of environment	Quality of the environment in the city and its surrounding
13	Urban greenery	Urban greenery - parks, other green areas and corridors in the city
14	Traffic volumes	Traffic volumes in the city
15	Civic society and participation	Various forms of civic society (NGOs, communities etc., participation and engagement of citizens in public matters
16	Energy flows optimisation	Optimisation of energy flows, production and consumption
17	Population	Population of the city
18	Waste production	Production of municipal waste
19	Industry in the city and its surrounding	Industrial sites in the city and its surrounding
20	Natural disasters (floods)	Extreme natural events having negative impacts on the city, i.e. floods, possibly as impacts of climate change
21	Financial resources of the city	Financial resources of the city, including external sources as grants and subsidies
22	Social equality	Equal social status of citizens
23	Energy consumption	Energy consumption in the city
24	Tourism	Tourism in the city
25	Use of non-renewable energy	Use of energy from non-renewable sources of energy, primarily fossil and nuclear energy sources
26	Use of renewable energy	Use of energy from renewable sources, namely solar, wind, geothermal, biomass and energy of the environment
27	Education and awareness	The level of education and general awareness of citizens
28	Employment	Share of employed citizens
29	Improving the energy performance of buildings	Improving the energy performance of buildings in the city by insulation, energy management and other measures
30	Soil sealing of land	Soil sealing of agricultural and forest land in the city surrounding and in undeveloped areas in the city

V.I.III IMPACT MATRIX

The initial assessment was made by two members of the case study team in advance and only the associations were identified, not the strengths. The strengths of the individual associations were defined during the PCIA workshop. The results from the workshop differ only slightly. Figure 12. shows the influence strength of the individual variables.

Figure 12: Influence strength of individual variables for Litoměřice

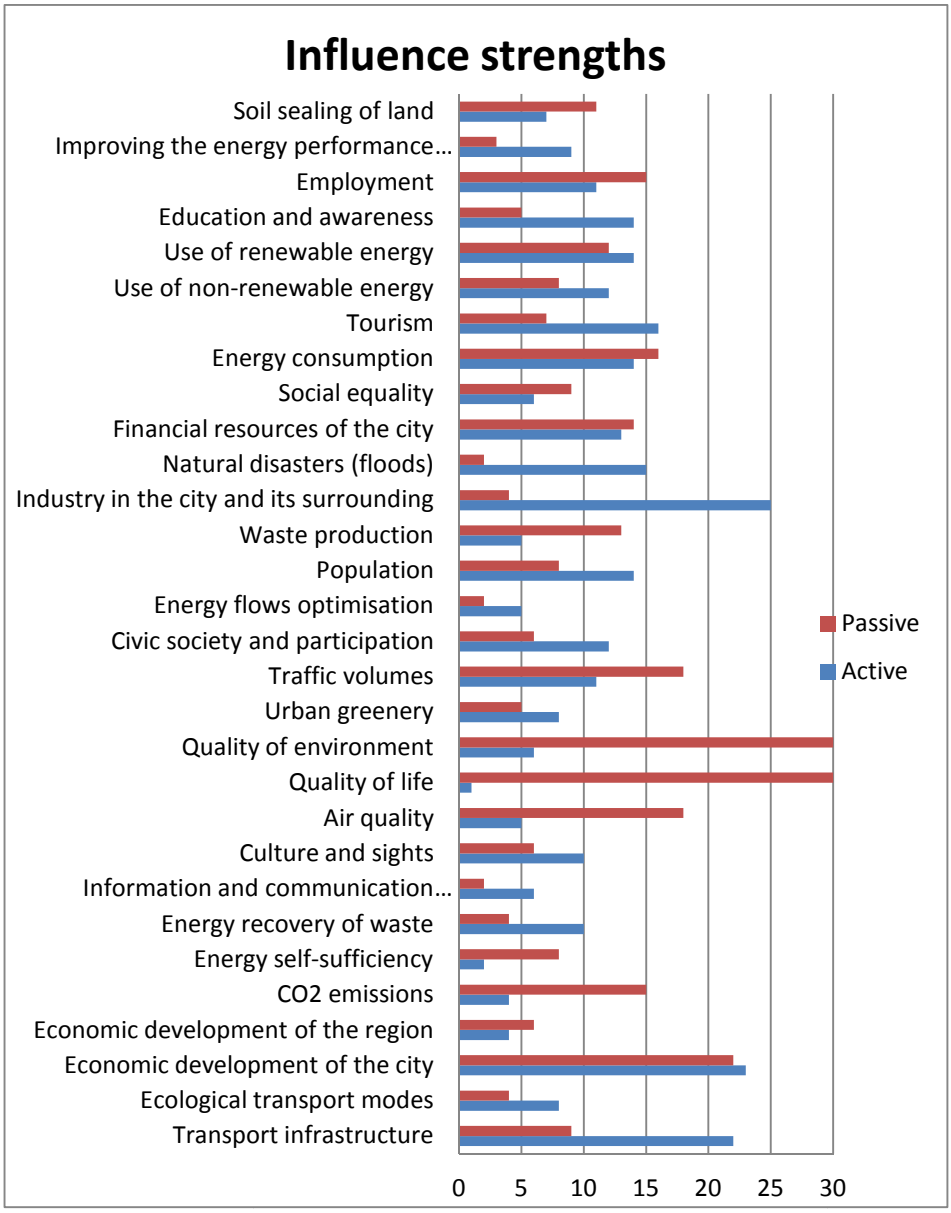
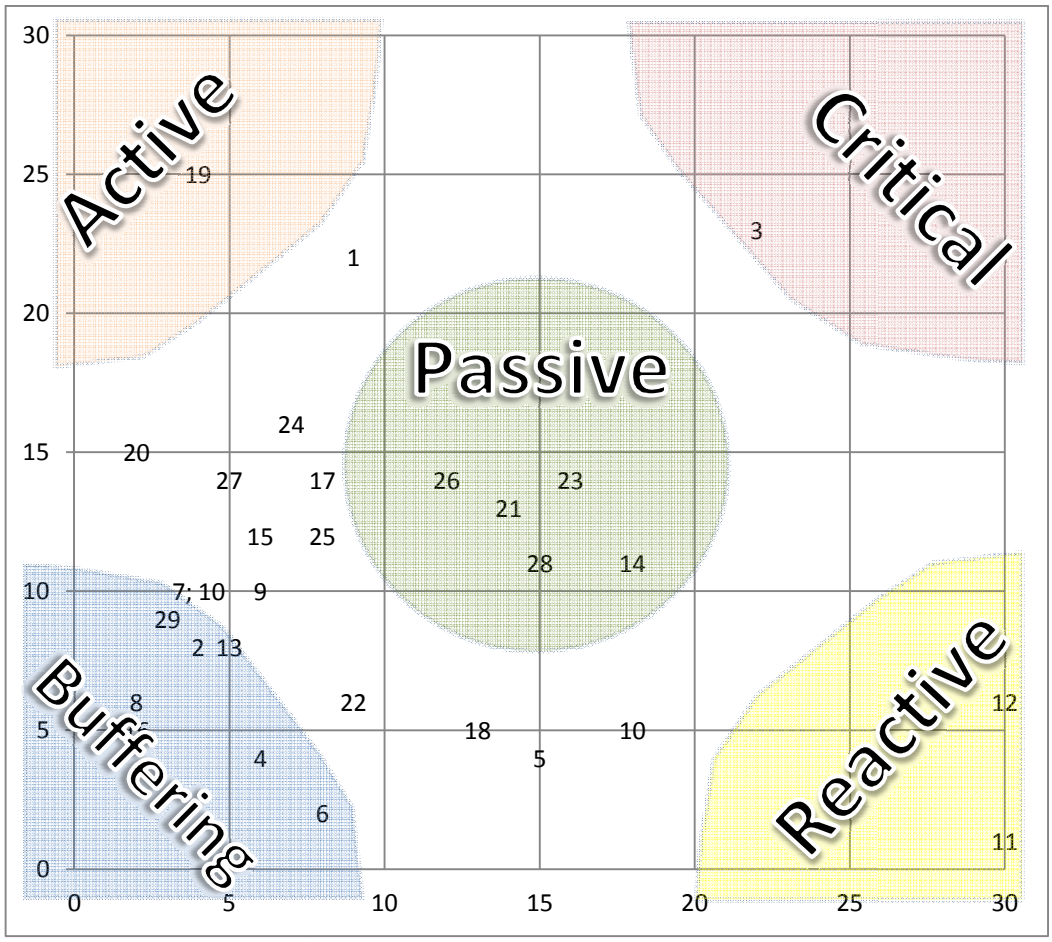


Figure 13 shows the role of the variables in the system (refer to Table 8 for the numbers associated with the variables). This figure suggests that the balance of the variables within the city system are focussed towards being both active and buffering.

Figure 13: Systemic role figure for Litoměřice



V.I.IV ANALYSIS OF VARIABLES FROM EXCEL TOOL

Table 9 and Table 10 respectively show the active-passive and the critical-buffering scores of the variables. The most passive variables are clearly “quality of life” and “quality of the environment”. Further highly passive variables are “energy self-sufficiency”, “CO2 emissions”, “air quality” and “waste production”. The most active variables on the other hand were “natural disasters (floods)”, “industry in the city and its´ surrounding”, “improving the energy performance of buildings”, “ICT in transport and education” and “awareness”.

Table 9: PCIA matrix results – highly active to highly passive variables for Litoměřice

ACTIVE-PASSIVE RANKING	NO.	VARIABLE	Q-VALUE
Highly active	20	Natural disasters (floods)	7,50
Highly active	19	Industry in the city and its surrounding	6,25
Highly active	29	Improving the energy performance of buildings	3,00
Highly active	8	Information and communication technologies in transport	3,00
Highly active	27	Education and awareness	2,80
Active	16	Energy flows optimisation	2,50
Active	7	Energy recovery of waste	2,50
Active	1	Transport infrastructure	2,44
Active	24	Tourism	2,29
Active	15	Civic society and participation	2,00
Active	2	Ecological transport modes	2,00
Active	17	Population	1,75
Slightly active	9	Culture and sights	1,67
Slightly active	13	Urban greenery	1,60
Slightly active	;25	Use of non-renewable energy	1,50
Neutral	26	Use of renewable energy	1,17
Neutral	3	Economic development of the city	1,05
Neutral	21	Financial resources of the city	0,93
Neutral	23	Energy consumption	0,88
Slightly passive	28	Employment	0,73
Slightly passive	22	Social equality	0,67
Slightly passive	4	Economic development of the region	0,67
Slightly passive	30	Soil sealing of land	0,64
Slightly passive	14	Traffic volumes	0,61
Highly passive	18	Waste production	0,38
Highly passive	10	Air quality	0,28
Highly passive	5	CO2 emissions	0,27
Highly passive	6	Energy self-sufficiency	0,25
Highly passive	12	Quality of environment	0,20
Highly passive	11	Quality of life	0,03

Table 10: PCIA matrix results – highly critical to highly buffering variables for Litoměřice

CRITICAL-BUFFERING RANKING	NO.	VARIABLE	P-VALUE
Critical	3	Economic development of the city	506
Neutral	23	Energy consumption	224
Neutral	14	Traffic volumes	198
Neutral	1	Transport infrastructure	198
Neutral	21	Financial resources of the city	182
Neutral	12	Quality of environment	180
Neutral	26	Use of renewable energy	168
Slightly buffering	28	Employment	165
Slightly buffering	24	Tourism	112
Slightly buffering	17	Population	112
Buffering	19	Industry in the city and its surrounding	100
Buffering	25	Use of non-renewable energy	96
Buffering	10	Air quality	90
Buffering	30	Soil sealing of land	77
Buffering	15	Civic society and participation	72
Buffering	27	Education and awareness	70
Buffering	18	Waste production	65
Buffering	9	Culture and sights	60
Buffering	5	CO2 emissions	60
Buffering	22	Social equality	54
Buffering	13	Urban greenery	40
Buffering	7	Energy recovery of waste	40
Highly buffering	2	Ecological transport modes	32
Highly buffering	20	Natural disasters (floods)	30
Highly buffering	11	Quality of life	30
Highly buffering	29	Improving the energy performance of buildings	27
Highly buffering	4	Economic development of the region	24

CRITICAL-BUFFERING RANKING	NO.	VARIABLE	P-VALUE
Highly buffering	6	Energy self-sufficiency	16
Highly buffering	8	Information and communication technologies in transport	12
Highly buffering	16	Energy flows optimisation	10

The city system of Litoměřice is extremely buffering on the whole, and no highly critical variables were identified. The only critical variable of the system is “economic development of the city”. On the other hand eight variables scored to be highly buffering in the system: ecological transport modes, natural disasters (floods), quality of life, improving the energy performance of buildings, economic development of the region, energy self-sufficiency, ICT in transport and energy flows optimisation.

Since the emphasis of the city, reflected both in the POCACITO vision building and backcasting process as well as in the Strategy Development Plan of the city, is on energy policy, some of the energy variables, i.e. improving the energy performance of buildings appear among the highly active ones.

Industry in Litoměřice and its surrounding influences many aspects of systems. A large chemicals factory close to the city is an important employer in the region, but also causes in significant traffic and resultant air pollution. Transport infrastructure will play an important role in the city´s plans for emission free and more alternative transport options (cycling, walking, public transport). However, development of the city and its quality of life is dependent on the economic development of the city.

V.II PCIA WORKSHOP REPORTING

V.II.I GENERAL INFORMATION

WORKSHOP DATES AND LOCATIONS

The workshop took place in Litoměřice on 28th May 2015 in the premises of the city office.

PARTICIPANTS

In total seven participants were present at the workshop, of which five 5 participated in the previous POCACITO workshops. Two members of the POCACITO case study team were facilitated the workshop. The type of occupation that each participant has is shown in Table 11.

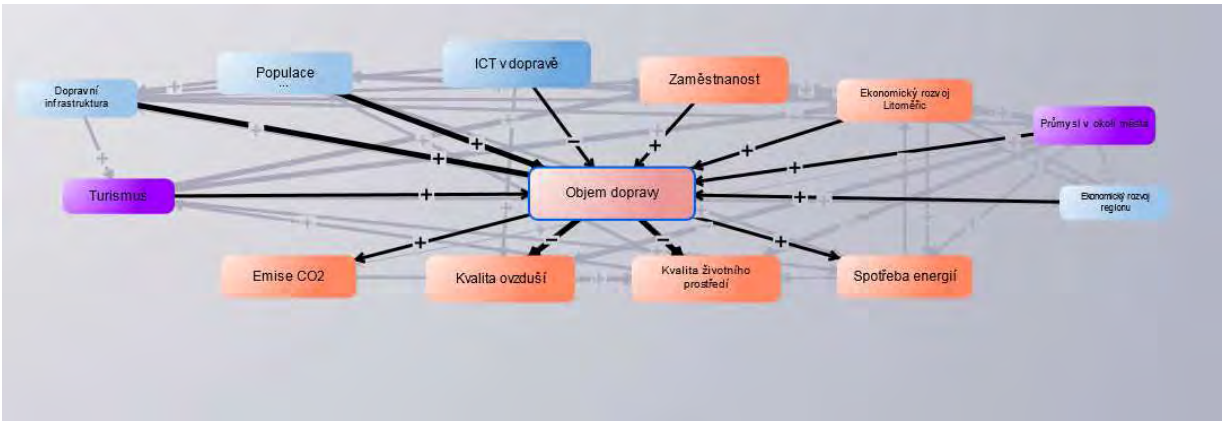
Table 11: Participants in PCIA workshop for Litoměřice

	ROLE OF PARTICIPANT	PRESENT AT VISION BUILDING WORKSHOP	PRESENT AT BACKCASTING WORKSHOP
1	Head of Environment department, city office	Y	Y
2	Representative of Urban development department	N	N
3	Head of Projects and strategies department	N	N
4	Energy manager of the city	Y	Y
5	Coordinator of geothermal power plant project	Y	Y
6	Healthy city coordinator	Y	Y
8	Representative of urban planning NGO	Y	Y

FORMAT AND METHODOLOGY

The format as outlined in PCIA guidelines was primarily followed but iModeler[1] software was also utilised to aid the visualisation of the relationships between the variables. The relationships of the variables and the strength of influence was discussed with the participants and entered into both the iModeler software and PCIA matrix. The iModeler software allowed the identification and mapping of whether the relationships are positive or negative. An example of the iModeler working environment is shown in Figure 14.

Figure 14: iModeler working environment – example of transport



[1] See more on iModeler software at http://www.consideo.com/.

PRESENTATION

In general, stakeholders perceived the initial results as interesting, but had difficulty relating the results and process to their roles with the cities. Due to time constraint the results could not be discussed in detail.

V.II.II GENERAL REMARKS

Because this was already a third workshop in a row, the interest of the participants appears to have declined slightly. In addition, the participants had trouble identifying with the PCIA process. However, the participants were in general satisfied with the workshop and they also expressed interest in the subsequent quantification work within WP5.

Results from the visioning workshops from other cities in the POCACITO project were shown and was received positively by the participant. Consequently, they would like WP5 to enable a comparison or benchmarking with the other POCACITO cities.

VI MALMÖ

VI.I PRE WORKSHOP ACTIVITIES

VI.I.I SYSTEM DESCRIPTION

The city system is that of the Malmö municipality and its boundaries. Utilising the results of the backcasting workshop the main elements of that help to describe the city system are:

- Energy
- Transport and logistics
- Agriculture/food production
- Policy measures
- Carbon footprint
- Communication /marketing
- Education and lifestyle
- Housing
- Waste and recycling

VI.I.II VARIABLE SET

Knowledge and information from several sources were utilised to make the initial variable set. This included the vision- and backcasting workshops and the discussions held, the initial assessment of Malmö and other literature and reports on Malmö. IVL then used the structure provided in the PCIA guidelines to check that variables were included from each type of variables required (i.e. the seven areas of life, physical categories etc) and that there were not too many of one type, creating an imbalance. Some variables were merged whilst other new ones were then included. The variable set defined for Malmö is listed in Table 10.

Table 12: List of variables and descriptions for Malmö

TYPE OF VARIABLE	VARIABLE	DEFINITION
Participants	1. Population	The people who live in the city
Activities	2. Robust economy - business/financial service /IT	A service and knowledge based economy, circular and sharing

TYPE OF VARIABLE	VARIABLE	DEFINITION
	3. Awareness	The level of environmental awareness through appropriate information and education
	4. Circular economy and sharing	Circular consumption and sharing, synergies with agriculture
	5. Activities and culture	The vibrancy of the city and the number of things to do
Space	6. Land use 7. Green space and corridors	The balance with development, green space and agriculture Green space and corridors for biodiversity
Mood	8. Quality of life (interaction) 9. Social inclusion /equality	Activities, security, Flexibility at work, Health The degree that the diverse people are well integrated into the general population
Natural balance	10. Water body quality 11. Local food production 12. Resource efficiency	Quality of the surrounding Local and organic Use of raw materials, energy and water. More with less. Reuse of building and infrastructure materials. Waste reuse and recycling.
Internal processes	13. Public Transport and bike network 14. Smart logistics	Public transport and bike network Freight transport and inter-city provision of goods to consumers
Internal order	15. Resource/environment tax and charges 16. Development and transport plan	Economic incentives to drive behaviour towards resource efficiency, public transport, less consumption, the circular economy. City level plans and strategies, such as energy and waste etc
Matter	17. Buildings	Resource efficient buildings, high-density housing that are aesthetically pleasing and functional
Energy	18. Renewable energy	Wind, solar and geothermal. Self-power production and grid feed,
Information	19. Attractiveness	For work and tourism
	20. National policies	The level of compatibility and support of national policies with local plans and strategies.
Flow size	21. Traffic volumes	Management of traffic congestion and pollution
Structure size	22. Industrial areas	The integration and proximity of industrial areas
Structural dynamics	23. Segregation of housing areas	The division of low and high income population into different areas

VI.I.III IMPACT MATRIX

Figure 15 shows the initial impact matrix for Malmö, constructed by the IVL team. Most of the variables are relatively passive or buffering, and a few are reactive. It is surprising that there were not any critical variables. On reflection, a sufficient number of variable types were included to represent the city for analysis. However, there is a trade-off between level of detail (i.e. number of variables) and the time necessary (and hence the feasibility) to fill out the matrix.

	Påverkar:	Population	Robust economy - busines	Environmental Awareness	Circular economy and shar	Activities and culture	Land use	Green space and corridors	Quality of life (interaction	Social inclusion /equality	Water body quality	Local food production	Resource efficiency	Public Transport and bike	Smart logisitics	Resource/environment ta	Development and transpo	Buildings	Renewable energy	Attractiveness	National policies	Traffic volumes	Industrial areas	Segregation of housing are	AS
1	Population	X	1	0	0	1	2	1	1	1	1	2	0	2	0	0	1	2	2	1	0	2	0	1	21
2	Robust economy - business/financial servic	3	X	0	2	2	1	0	3	2	0	2	2	3	2	0	0	2	2	3	0	2	0	0	31
3	Environmental Awareness	0	0	X	3	0	2	2	0	0	1	2	2	2	0	0	0	0	2	0	0	2	0	0	18
4	Circular economy and sharing	0	2	2	X	0	1	1	2	1	2	3	3	2	2	1	2	1	2	2	1	1	2	0	33
5	Activities and culture	1	0	0	0	X	2	2	3	2	0	0	0	0	0	0	0	1	0	3	0	1	0	0	15
6	Land use	0	0	1	0	2	X	2	3	0	1	2	0	1	0	0	2	0	2	3	0	0	2	0	21
7	Green space and corridors	0	0	0	0	3	3	X	3	1	1	2	0	1	0	0	0	0	1	3	0	0	2	0	20
8	Quality of life (interaction)	1	1	1	1	0	0	0	X	0	0	0	0	0	0	0	2	0	0	3	1	1	0	0	11
9	Social inclusion /equality	1	1	0	0	2	0	0	2	X	1	0	0	0	0	0	0	0	0	2	1	0	0	2	12
10	Water body quality	1	0	1	0	2	0	0	2	0	X	3	0	0	0	0	1	0	0	3	1	0	0	0	14
11	Local food production	0	1	1	3	0	2	2	0	0	1	X	2	0	2	1	1	1	1	1	0	0	2	0	21
12	Resource efficiency	0	2	1	2	0	0	0	2	0	1	0	X	0	0	2	1	1	1	1	1	0	0	0	15
13	Public Transport and bike network	1	1	1	3	2	3	2	2	3	1	0	3	X	2	0	3	0	0	3	0	3	0	0	33
14	Smart logisitics	0	0	0	2	0	1	0	0	0	1	0	3	0	X	0	0	0	0	1	0	3	0	0	11
15	Resource/environment tax and charges	0	2	0	3	0	0	0	1	0	1	0	2	2	2	X	0	0	2	1	0	2	1	0	19
16	Development and transport plan	0	0	0	1	1	3	3	1	0	1	1	2	3	1	2	X	3	3	2	0	3	2	0	32
17	Buildings	1	1	0	0	0	2	2	1	0	1	2	3	2	0	0	1	X	0	3	0	0	1	3	23
18	Renewable energy	0	1	2	1	0	3	0	1	0	1	0	1	0	0	1	0	0	X	2	0	0	0	0	13
19	Attractiveness	3	1	0	0	2	0	0	2	2	0	0	0	0	0	1	0	1	0	X	0	0	0	1	13
20	National policies	1	2	1	2	0	1	1	1	1	1	0	3	1	1	3	3	1	3	0	X	2	1	1	30
21	Traffic volumes	1	0	1	0	0	3	2	3	0	2	0	3	2	1	0	3	0	0	3	0	X	0	0	24
22	Industrial areas	0	0	0	0	0	3	2	2	0	2	2	0	0	0	0	1	2	0	3	0	0	X	0	17
23	Segregation of housing areas	2	0	0	1	1	1	0	2	3	0	0	0	0	0	0	1	2	0	3	0	2	0	X	18
24																									X
25	PS	16	16	12	24	18	33	22	37	16	20	21	29	21	13	11	22	17	21	46	5	24	13	8	#####

Figure 15: Impact matrix for the Malmö municipality system.

VI.I.IV ANALYSIS OF VARIABLES FROM EXCEL TOOL

The bar chart for influence strength of the variables is presented in Figure 16 below. It is clear that variables such as Quality of life and Attractiveness are very passive. This is natural, since the attractiveness of a city depends on many other variables, like green spaces, culture, work opportunities, housing etc. Figure 17 shows the systemic roles of the variables.

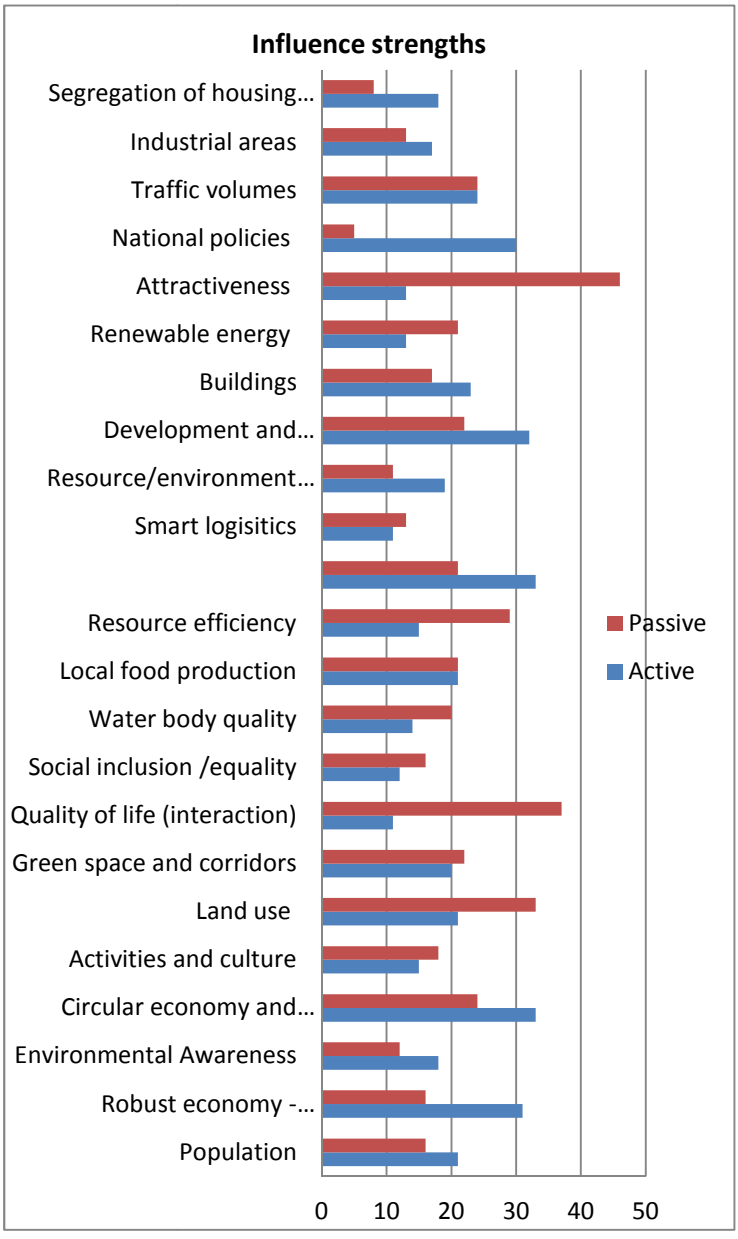


Figure 16: Bar chart for influence strength of the Malmö matrix variables.

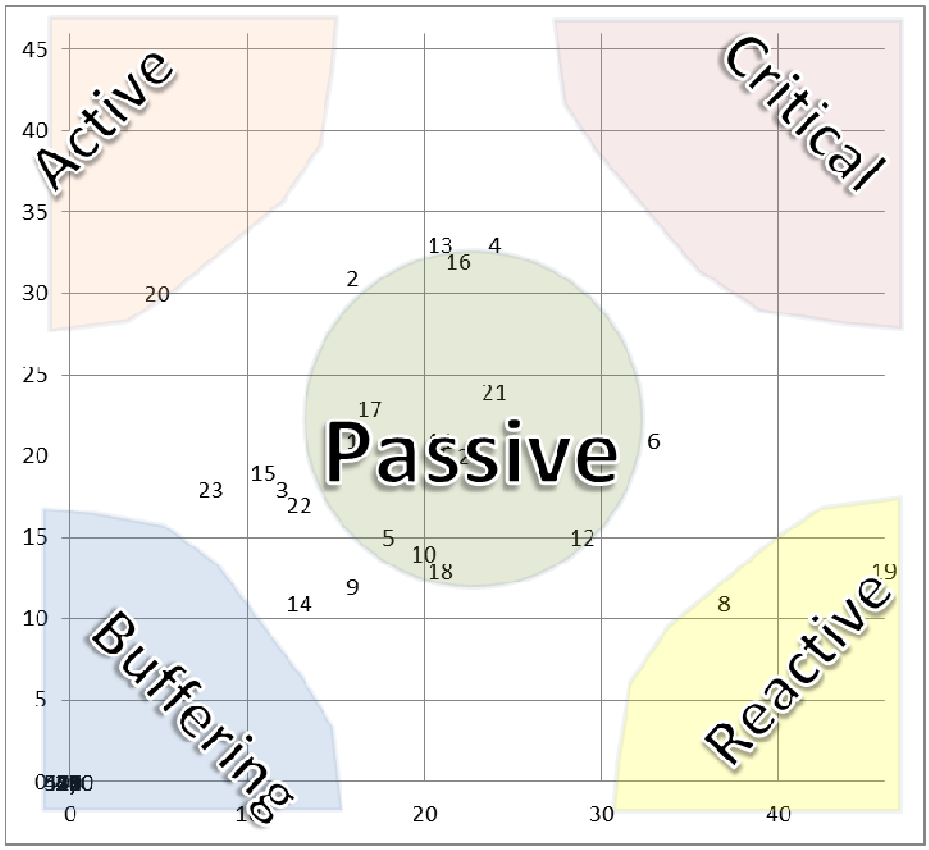


Figure 17: Systemic role figure for Malmö.

The main results from the systemic role figure are:

- The most active variable (or variable that affects others) is “national policies” (20).
- Active variables include: segregation of housing areas, robust economy, and resource /environmental tax
- Attractiveness (19) and quality of life (8) are highly passive meaning they do not effect much, but are effected by many factors. Variables in this area are supposed to make good indicators, which is what these variables are.
- There are no highly critical or critical variables which is illustrative of a fairly balanced system Hence there are no variables that are volatile or may cause imbalance in the system.
- Buffering variables (where interventions and controls serve little purpose) include: population, water body quality, renewable energy, and activities and culture.

One of the main surprises is how highly active “segregation of housing” is – meaning it seems to affect a lot in the city and is therefore very important for future consideration. In terms of measures for a Post-Carbon Malmö this should be addressed and be considered for further analysis.

Circular economy is fairly critical which means that it might be suitable as a catalyst for changing or manipulating the system.

Other slightly critical variables include the development and transport plan, public transport and bike network, land use and attractiveness. These are variables which should be selected for further analysis in the WP5.

VI.II PCIA WORKSHOP REPORTING

VI.II.I GENERAL INFORMATION

Below is the general information regarding the Malmö PCIA workshop.

WORKSHOP DATES AND LOCATIONS

The Workshop was carried out in the Brasserie KP, Malmö, on April 29th 2015.

PARTICIPANTS

The following participants joined the workshop:

NAME	ORGANISATION AND ROLE	1ST WS	2ND WS	3RD WS
Jenny Holmquist	MKB real estate, Environmental strategy	no	no	yes
Sara Pettersson	Thesis worker, IVL (food banks)	no	no	yes
Tor Fossum	Malmö city, Energy strategy	yes	yes	yes
Jan Rosenlöf	City building council, city planning	yes	no	yes
Annika Hansson	NCC Construction Sverige AB, Project leader	yes	no	yes
Jeanette Green	IVL, Coordinator Malmö office	yes	yes	yes
Hanna Ljungkvist	IVL, Workshop leader	yes	yes	yes

Due to the low number of participants not all sectors were represented. Energy and physical planning were the best represented sectors at the workshop. Social and economic sectors were less represented, except a thesis student who partly represented both of these sectors. Her work is about collecting, selling and/or distributing left over food from supermarkets to organisations helping people in need.

FORMAT AND METHODOLOGY

The workshop format outlined in the PCIA guidelines was followed to a large extent. An “inspirational presentation” formed part of the introduction, where a thesis student presented her work on food banks. This promoted some good discussion among the participants. The results from previous the workshops from the other POCACITO case study cities were also briefly presented and were well received.

IVL then presented the pre-workshop analysis that had been performed before the workshop. This included the variables, the impact matrix, the bar diagram and the variables character chart. A breakout session followed where the participants worked in pairs to provide feedback on the set of variables that IVL had produced.

PRESENTATION

The participants mostly agreed to the initial analysis made by IVL, but thought that the social KPI’s could be improved. The following statements were made:

- Age is more important than gender in Malmö, since it is a very young city.
- Education in lower levels is also important; it´s the basis/potential for the future!
- Consumption is crucial to how carbon emissions are measured and how goals are set; it should be included!
- Malmö is working on setting up a number of KPI’s. The POCACITO KPI’s (from WP1) are not specific to Malmö and therefor of less importance to the city.

In some cases the participants did not entirely agree with the level of importance of some variables. For instance, the importance of the built environment (or buildings) was thought to be higher (it was shown to be “slightly active”). But this may be due to a difference in understanding/perception of the variables but also that some of the stakeholders were related to this area.

In conclusion, the participants viewed the following five variables as the most important for Malmö:

1. School and education
2. Renewable/recycled energy
3. Equality and inclusion
4. Innovation
5. Robust economy

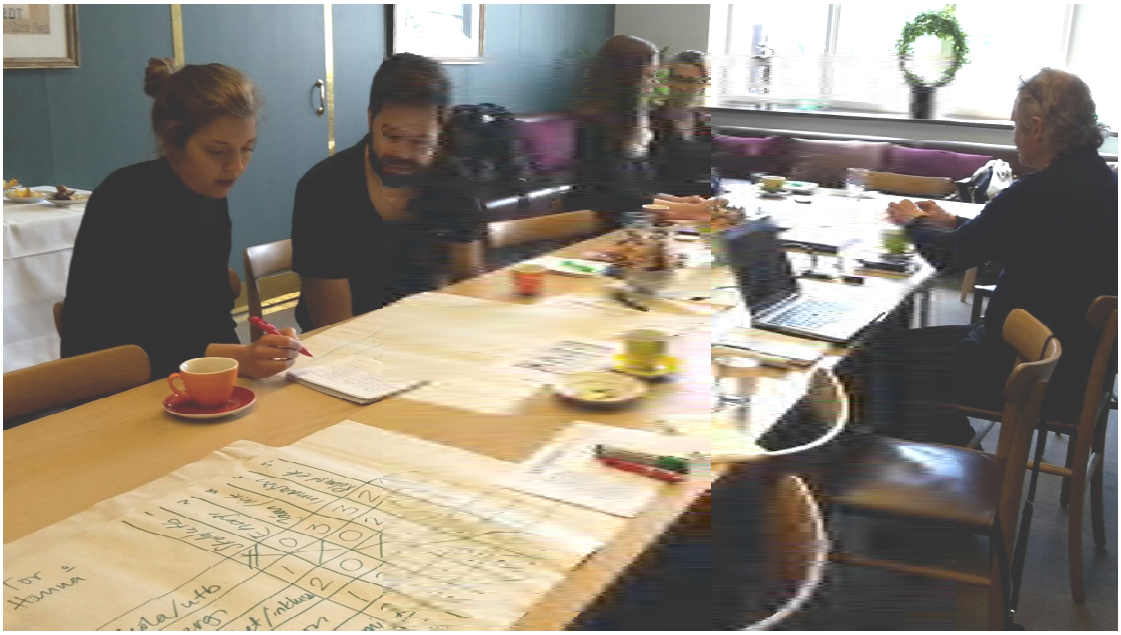
The following feedback on the methodology was given by the participants:

- It is sometimes difficult to decide between what is direct/indirect impact.
- Depending on how well you define the variables, you can get different interpretations of them: important with good definitions.
- It is easier to make the matrix with variables that you selected yourself, because you have built an understanding of what they mean.

- You have to be open to the fact that the result is somewhat subjective and depends on the participants represented in the workshop.
- The variable of local food production is maybe not so important from an efficiency/food supply standpoint, but may have positive social effects and could also create jobs.
- Self-sufficiency in energy and food; is this really desirable or not? Why is it important?

VI.II.II GENERAL REMARKS

The participants were satisfied with the workshop, and found the methodology interesting. They were also keen on seeing the outcome from other cities, and to be informed about the work with the final roadmap. They suggested that the roadmap should be differentiated depending on characteristics of the cities assessed, since there is no "silver bullet" or "one size fits all"-solution to post-carbon cities.



VI.II.III FINAL MALMÖ ASSESSMENT

The five variables were considered for inclusion into a refined impact matrix, but after review it was concluded that most of them were already covered by other variables. Equality/inclusion and renewable energy are already covered, whereas consumption can be considered to be covered by the variables "resource efficiency" and "circular economy and sharing". Innovation is too generic a term and difficult to utilise as a variable, so it was decided not to include this. Therefore the only new addition to a final analysis is that of "schools and education". The new results are shown in Table 13 and Table 14. The inclusion of just one more variable does not make any major difference on the overall findings. The new variable is shown to be quite "active", but also fairly neutral in terms of critical –buffering ranking.

Table 13: Ranking of active-passive influence for Malmö

ACTIVE-PASSIVE RANKING	VARIABLE NO.	VARIABLE NAME	Q-VALUE
Highly active	20	National policies	5.5
Active	23	Segregation of housing areas	2.375
Active	2	Robust economy - business/financial service /IT	1.789
Active	15	Resource/environment tax and charges	1.727
Slightly active	13	Public Transport and bike network	1.571
Slightly active	16	Development and transport plan	1.5
Slightly active	24	Schools and education standard	1.462
Slightly active	17	Buildings	1.353
Neutral	22	Industrial areas	1.308
Neutral	4	Circular economy and sharing	1.308
Neutral	1	Population	1.294
Neutral	3	Environmental Awareness	1.286
Neutral	21	Traffic volumes	1
Neutral	11	Local food production	1
Neutral	7	Green space and corridors	0.909
Neutral	14	Smart logistics	0.846
Neutral	5	Activities and culture	0.789
Slightly passive	9	Social inclusion /equality	0.722
Slightly passive	10	Water body quality	0.667
Slightly passive	6	Land use	0.667
Slightly passive	18	Renewable energy	0.619
Passive	12	Resource efficiency	0.5
Highly passive	8	Quality of life (interaction)	0.3
Highly passive	19	Attractiveness	0.271

Table 14: Ranking of critical-buffering influence for Malmö

CRITICAL – BUFFERING RANKING	VARIABLE NO.	VARIABLE NAME	P-VALUE
Slightly critical	4	Circular economy and sharing	884
Slightly critical	16	Development and transport plan	726
Slightly critical	6	Land use	726
Slightly critical	13	Public Transport and bike network	693
Slightly critical	2	Robust economy - business/financial service /IT	646
Neutral	19	Attractiveness	624
Neutral	21	Traffic volumes	576
Neutral	8	Quality of life (interaction)	480
Neutral	12	Resource efficiency	450
Neutral	11	Local food production	441
Neutral	7	Green space and corridors	440
Slightly buffering	17	Buildings	391
Slightly buffering	1	Population	374
Slightly buffering	10	Water body quality	294
Slightly buffering	5	Activities and culture	285
Slightly buffering	18	Renewable energy	273
Buffering	3	Environmental Awareness	252
Buffering	24	Schools and education standard	247
Buffering	9	Social inclusion /equality	234
Buffering	22	Industrial areas	221
Buffering	15	Resource/environment tax and charges	209
Buffering	20	National policies	198
Buffering	23	Segregation of housing areas	152
Buffering	14	Smart logistics	143

VII MILAN/TURIN

VII.I PRE WORKSHOP ACTIVITIES

VII.I.I SYSTEM DESCRIPTION

In the POCACITO project Turin and Milan are originally conceived an integrated case study. Thus, ideally the system description should include flows between the two cities, e.g. in terms of commuters, students, tourists, investments and so on. However, one of the main outcomes from the first two workshops was that this integration does not appear to be so relevant for the local stakeholders and the evolution to becoming post-carbon. Therefore, although this third workshop was an integrated one (involving stakeholders from both Turin and Milan), the aim was not to develop a “system description” of the two cities as one whole system. Rather, it was to have a "mutual learning process" between stakeholders from Milan and Turin in defining the sensitivity matrix.

The system of the two cities is therefore defined by each of the city’s municipal boundaries. The following elements derived from the initial visions and backcasting workshops help to understand the challenges, strengths and weaknesses of the each city and its metropolitan area. As regards Turin:

- Demography: the population of Turin is quickly ageing.
- Economy: the economic base is being increasingly differentiated in the last decades, but new sectors still need to be enhanced.
- R&D: the area of Turin is one of the most important in Italy for investments in innovation.
- Human capital: the unemployment rate has seriously increased since 2008, and the tertiary education rate is still low. Social inclusion is good, but is threatened by the impacts of the continuing economic challenges.
- Environment: the metropolitan area benefits from large green areas, but air quality is very poor because of traffic pollution.
- Transport: modal split must be re-balanced in order to reduce the excessive weight of private motorized mobility.
- Planning: strategic planning for the metropolitan area is well established, but environmental problems are not receiving appropriate attention.

As regards Milan:

- Demography: the population dynamics of Milan are similar to Turin.
- Economy: The Milanese economy is traditionally one of the strongest in Italy and in the EU, and it has withstood the impacts of the recent crisis better than the rest of Italy. The province of Milan (and future Metropolitan area) is among the richest, in Italy and in the EU. The main

contributor to GDP, as well as the main employer, is the service sector for both core city and Province.

- R&D: Research activities are significant in the region; although only slightly more than 1% of GDP is invested in R&D. The largest number of innovations occur in the Lombardy region.
- Human capital: Access to tertiary education is similar to the one in Turin, with a slightly higher share and more uniformity between male and female residents. Unemployment, was rose until 2010 and hence since plateaued, and is at least 4 percentage points less than in Turin.
- Environment: Air quality is a critical issue in Milan, with pollution indicators showing a situation comparable to the one in Turin. Partial traffic closures occur because pollution levels exceed critical (legal) thresholds. Milan has about half the green area compared to Turin.
- Transport: Public transport gets is the main transportation mode in Milan, and its share is increasing, whilst private car use in particular is decreasing. Biking is however still a minor transportation option.
- Planning: Planning activities are well established and forward looking, with a particular focus on energy and mobility.

VII.I.II VARIABLE SET

The set of variables was defined through a coordinated procedure involving the two case study teams. Researchers from FEEM built a list of 21 variables based on the results of the initial assessment and the first two Milan workshops. Whilst independently, researchers from the Politecnico di Torino team developed a list of 20 variables for "their" city. The two lists were compared and combined to form a list of 18 variables to cover both cities. In terms of variable type, these variables cover all the seven "areas of life" and the three "physical categories" stated necessary in the PCIA guidelines. However, none of the variables were classified according to the dynamic base criteria (flow size, structure size, temporal dynamics), as these types of variables were considered by the researchers redundant if compared to the previous types.

Table 15: List of variables for Milan-Turin

TYPE OF VARIABLE	NO.	VARIABLE	DEFINITION
Participants	1	Demographic structure of the population	This variable includes aspects connected to ageing of the society, immigration
Activities	2	Economic specialization	As Turin comes from a history with a strong focus on one industrial sector (car manufacturing) the specialization is seen as a problematic issue in a dichotomy between offering highly specialized services for targeted sectors (promoting specialization) and a greater "robustness" of a local economy based on a variety of different sectors

TYPE OF VARIABLE	NO.	VARIABLE	DEFINITION
	3	Circular economy and sharing	Increase economic activities which are able to re-use objects discarded by other sectors, and increase economic/social activities based on sharing of objects
	4	Human capital valorization	Promoting specific qualification/human resources present in the cities
	5	R&D, funding and policies for innovation	Specific policies aiming at increasing R&D activities among existing or new firms
Space utilisation	6	Soil consumption	Aiming mainly at reducing further urban expansion and reducing further transformation of rural into urbanized areas
	7	Natural and green areas, ecologic corridors	Maintenance / enhancing green areas /networks of green areas within the urbanized areas
	8	Enhancement of cultural heritage and landscape, rehabilitation of derelict areas	Maintain/restore and enhance cultural heritage (which in the Italian concept of culture included also landscape) as a resource for increasing the touristic attractiveness of the city and the quality of urban spaces, reuse of derelict areas and buildings for new urban functions
Human ecology	9	Sustainability awareness	Increase the public awareness about issues connected to urban sustainability
	10	Social inclusion	Reduce/avoid the exclusion of social groups from the urban life, starting from the reduction of segregated residential areas.
Natural balance	11	Policies and incentives for resource efficiency	Increase public incentives promoting sustainable behaviour and resource efficiency
	12	Air quality	As a first step, reduce the PM10 concentration, further improvements to follow
Infrastructure	13	Policies and infrastructures for no-fossil fuel mobility	Infrastructures for bicycles, charging points for electric cars
	14	Smart logistics	Organizational measures for provisioning of commercial activities in the city
Rules and laws	15	Post-carbon strategic planning	Establish local strategies for low carbon policies.
Matter	16	Resource efficient buildings	Aim at low energy or zero energy buildings
Energy	17	Renewable energy production	Improve the generation of renewable energy in the city (solar panels, etc.)
Information	18	Smart city policies	Improve the functioning of urban infrastructures and services by using intelligent solutions.

VII.I.III IMPACT MATRIX

The initial 18x18 Impact Matrix was constructed using an iterative process. Four members of FEEM (divided in two groups) and two of Politecnico di Torino filled in the matrix. The values were compared and found to be similar. An average matrix was then produced shown in Figure 18.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Active
1	X	2	2	3	2	1	1	1	3	3	1	1	0	1	0	0	0	1	22
2	3	X	2	3	3	1	1	1	1	2	1	1	2	2	2	0	1	2	28
3	1	2	X	2	1	2	2	3	3	2	3	2	2	3	2	3	3	2	38
4	3	2	3	X	2	0	0	1	2	3	1	0	0	0	1	0	0	1	19
5	1	3	2	3	X	1	1	1	1	1	3	1	3	3	2	3	3	3	35
6	1	0	1	0	0	X	3	3	1	0	3	2	2	2	1	0	1	1	21
7	1	0	1	0	0	3	X	3	2	1	2	3	1	0	1	0	1	0	19
8	1	1	3	2	2	3	3	X	3	2	3	1	2	1	1	2	2	1	33
9	1	1	3	2	2	3	3	3	X	2	3	3	3	3	3	3	3	3	44
10	2	1	2	3	1	1	1	1	1	X	1	0	1	1	1	1	1	1	20
11	0	1	3	1	3	3	3	3	3	1	X	2	2	3	3	3	3	2	39
12	1	1	1	0	1	1	3	1	2	0	1	X	1	1	2	1	1	2	20
13	1	1	3	1	2	2	2	2	3	1	3	3	X	3	2	1	3	2	35
14	0	1	3	1	2	3	1	2	2	0	3	3	3	X	1	1	1	3	30
15	0	3	3	1	3	3	3	3	3	2	3	3	3	3	X	3	3	3	45
16	0	1	3	0	1	2	0	3	3	0	3	3	1	0	1	X	3	2	26
17	0	1	2	0	2	2	2	2	2	0	3	3	2	2	1	3	X	2	29
18	1	3	3	2	3	1	0	2	2	2	3	2	2	3	1	2	2	X	34
Passive	17	24	40	24	30	32	29	35	37	22	40	33	30	31	25	26	31	31	

Figure 18: The Impact Matrix for Milan-Turin made by the case study teams

Unsurprisingly, the most active variables were linked to strategic planning and policies (for resource efficiency, innovation, sustainable mobility, smart city), awareness, economic structure. In decreasing order of the activity score in Figure 18, they are:

- 15. Post-carbon strategic planning
- 9. Sustainability awareness
- 11. Policies and incentives for resource efficiency
- 3. Circular economy and sharing
- 5. R&D, funding and policies for innovation
- 13. Policies and infrastructures for no-fossil fuel mobility
- 18. Smart city policies

Conversely, there were unexpected results in the most "passive" variables, that is, the variables which are expected to be influenced the most by the other variables in this set according to the compilers of this matrix. In particular "Policies and incentives for resource efficiency", "Circular economy and sharing" and "Sustainability awareness", which are also very active but probably are significantly

impacted by a lot of other variables. Soil consumption, which is often considered a strategic element in environmental policies, turned out to be prevalently passive. In decreasing order of the passivity score in Figure 18, they are:

- 11. Policies and incentives for resource efficiency
- 3. Circular economy and sharing
- 9. Sustainability awareness
- 8. Enhancement of cultural heritage and landscape, rehabilitation of derelict areas
- 12. Air quality
- 6. Soil consumption

Figure 19 illustrates the active-passive relationship of the variables.

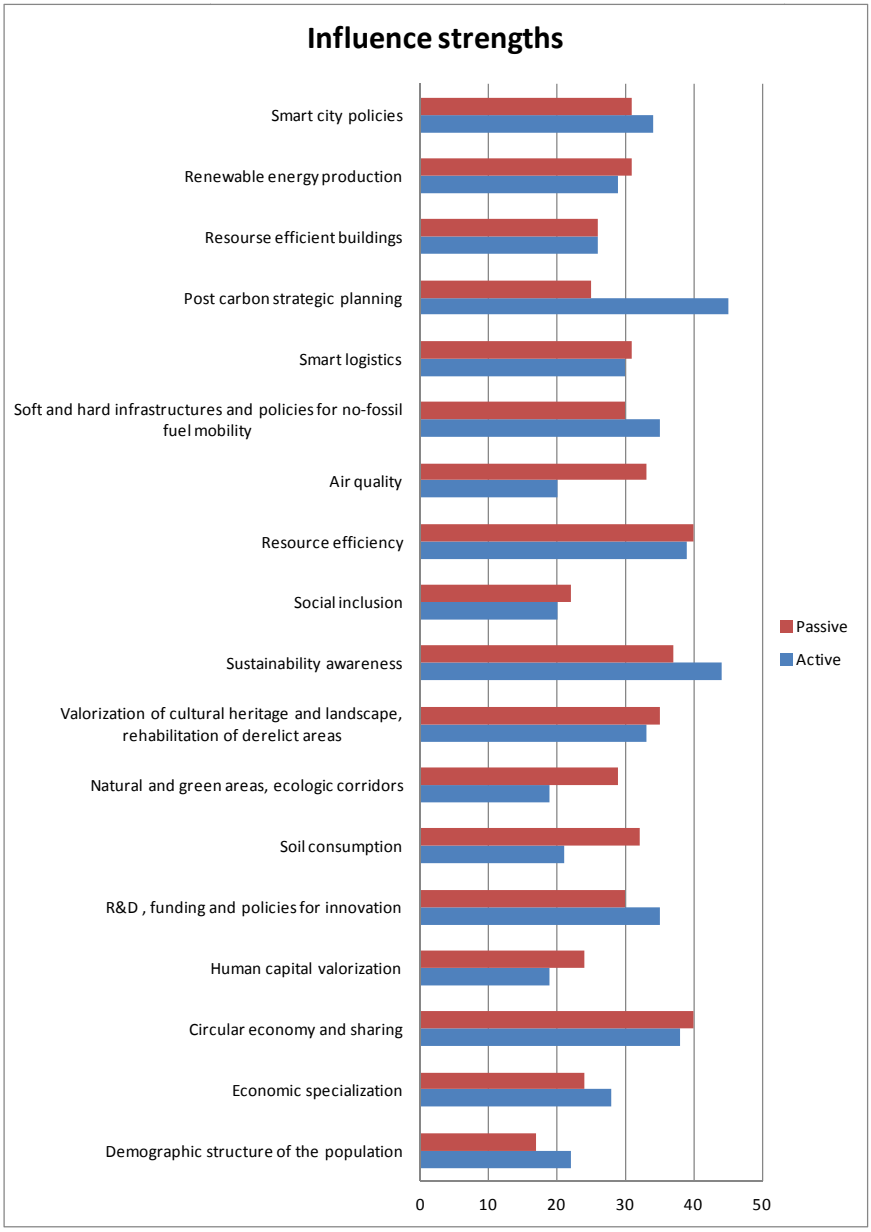


Figure 19: The bar chart of influence strengths for Milan-Turin

VII.I.IV ANALYSIS OF VARIABLES FROM EXCEL TOOL

The analysis of the Q-value (AS/PS) shows that – "post-carbon strategic planning" is highly active. "Demographic structure of the population" and "economic specialization" are not as active in absolute terms, but once the Q-value is assessed. "Smart city policies" and "resource efficiency" seem quite neutral. The social variables "Human capital valorisation" and "social inclusion" are quite reactive. Environmental variables such as "soil consumption", "natural and green areas, ecologic corridors" and "air quality" are highly reactive.

Table 16: Ranking of active-passive influence for Milan-Turin (Q-values: AS/PS)

ACTIVE-PASSIVE RANKING	VARIABLE NO.	VARIABLE NAME	Q-VALUE
Active	15	Post-carbon strategic planning	1.80
Neutral	1	Demographic structure of the population	1.29
Neutral	9	Sustainability awareness	1.19
Neutral	13	Soft and hard infrastructures and policies for no-fossil fuel mobility	1.17
Neutral	5	R&D , funding and policies for innovation	1.17
Neutral	2	Economic specialization	1.17
Neutral	18	Smart city policies	1.10
Neutral	16	Resource efficient buildings	1.00
Neutral	11	Resource efficiency	0.98
Neutral	14	Smart logistics	0.97
Neutral	3	Circular economy and sharing	0.95
Neutral	8	Enhancement of cultural heritage and landscape, rehabilitation of derelict areas	0.94
Neutral	17	Renewable energy production	0.94
Neutral	10	Social inclusion	0.91
Neutral	4	Human capital enhancement	0.79
Slightly passive	6	Soil consumption	0.66
Slightly passive	7	Natural and green areas, ecologic corridors	0.66
Slightly passive	12	Air quality	0.61

Table 17: Ranking of critical - buffering influence for Milan-Turin (P-values)

CRITICAL – BUFFERING RANKING	VARIABLE NO.	VARIABLE NAME	P-VALUE
Highly critical	9	Sustainability awareness	1628
Highly critical	11	Resource efficiency	1560
Highly critical	3	Circular economy and sharing	1520
Critical	15	Post-carbon strategic planning	1125
Critical	18	Smart city policies	1054
Critical	13	Soft and hard infrastructures and policies for no-fossil fuel mobility	1050
Critical	5	R&D , funding and policies for innovation	1050
Critical	14	Smart logistics	930
Critical	17	Renewable energy production	899
Slightly critical	16	Resource efficient buildings	676
Slightly critical	6	Soil consumption	672
Slightly critical	2	Economic specialization	672
Slightly critical	12	Air quality	660
Neutral	7	Natural and green areas, ecologic corridors	551
Neutral	4	Human capital enhancement	456
Neutral	10	Social inclusion	440
Neutral	1	Demographic structure of the population	374

In terms of critical/ buffering variables, the P-values[2] show that “Sustainability awareness”, “Resource efficiency” and “Circular economy and sharing” are the most critical variables, whilst environmental and social variables are the most buffering ones.

Finally, the systemic role figure shown in Figure 20 illustrates how the variables are placed, with a cluster of critical variables, and another cluster of mostly passive variables.

[2] Buffering values relate to those variables which are not strongly or easily affected by regulation or control.

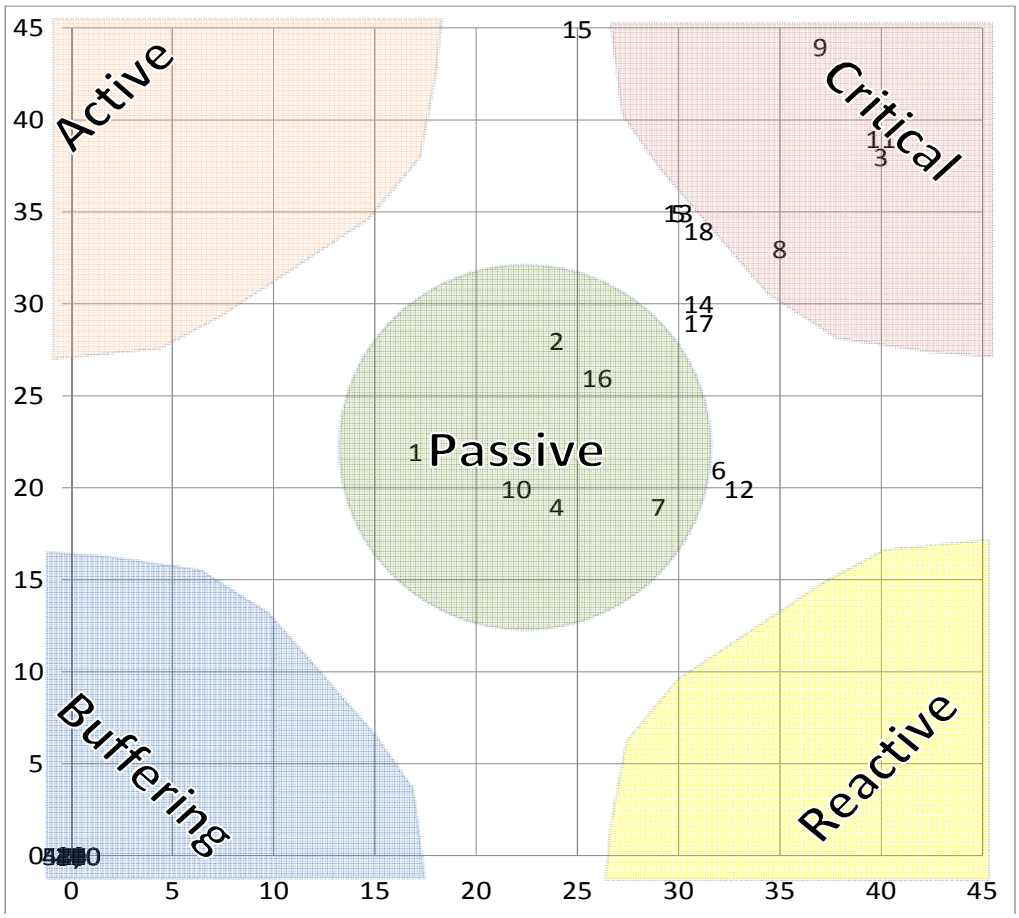


Figure 20: Systemic role figure for Milan-Turin.

VII.IIPCIA WORKSHOP REPORTING

VII.II.I GENERAL INFORMATION

WORKSHOP DATES AND LOCATIONS

The workshop was held on 4th May 2015, at Castello del Valentino, the same location of the first two workshops for the case study of Turin.

PARTICIPANTS

The PCIA workshop was organized as an integrated one: stakeholders were invited from both Turin and Milan, so to have a "mutual learning process" in defining the Impact Matrix.

Over thirty people were invited to attend the workshop; eighteen of them accepted the invitation, **fifteen** were actually present at the workshop: ten from Turin, five from Milan. Most of them attended at least one of the first two POCACITO workshops in their respective city.

Different institutions were represented, so to cover most sectors:

- The Municipality of Turin by a member of the Transport Department, a member of the Urban planning Department and two members of the Environment Department.
- Torino Strategica (the association which promotes strategic planning in Turin metropolitan area).
- Unione industriale di Torino and Collegio Costruttori Edili (the associations of the industrial and building entrepreneurs of the city of Turin).
- Dislivelli (an association for regional planning in mountain areas).
- Agenzia per la Mobilità Metropolitana (which is responsible for public transport planning at the metropolitan level in Turin).
- Two academic bodies (Politecnico di Torino and Università Bocconi in Milan).
- INU Lombardia (the regional association of urban and regional planning in Lombardy).
- Fondazione Lombardia per l'Ambiente (a regional environmental association in Lombardy).
- Finlombarda (a public society of Regione Lombardia that provides financial support to regional policies).
- A2A (one of the main multi-utility in the environmental sector in Italy).

The group of stakeholders were quite balanced in terms of sectors (five participants for the environment, four for economy, three for urban and regional planning, two for transport, one for energy) and institution (municipalities, public and private associations and multi-utilities were represented). Two members of FEEM and three members of Politecnico di Torino coordinated the activities during the workshop and took part in the discussion.

The full list of names and institution of the workshops participants is provided in Table 18.

Table 18: List of participants for the Milan-Turin workshop

INSTITUTION	NAME AND SURNAME	PRESENCE AT THE PREVIOUS WORKSHOPS	
		Workshop 1	Workshop 2
Turin Municipality – Transport Department	Giuseppe Estivo	Yes	No
Turin Municipality – Urban planning Department	Liliana Mazza	No	Yes
Turin Municipality – Environment Department	Enrico Bayma	No	No
Turin Municipality – Environment Department	Mirella Iacono	No	No
Torino Strategica	Riccardo Saraco	Yes	Yes
Unione industriale di Torino	Elisa Merlo	No	No

INSTITUTION	NAME AND SURNAME	PRESENCE AT THE PREVIOUS WORKSHOPS	
Collegio Costruttori Edili	Paolo Peris	Yes	No
Dislivelli	Federica Corrado	No	Yes
Agenzia per la Mobilità Metropolitana	Andrea Stanghellini	Yes	Yes
Politecnico di Torino	Luigi Buzzacchi	No	Yes
Università Bocconi	Tania Molteni		
INU Lombardia	Luca Imberti		
Fondazione Lombardia per l'Ambiente	Mita Lapi		
Finlombarda	Dino De Simone		
A2A	Riccardo Fornaro		
FEEM	Margaretha Breil		
FEEM	Cristina Cattaneo		
Politecnico di Torino	Patrizia Lombardi	Yes	Yes
Politecnico di Torino	Stefania Guarini	Yes	Yes
Politecnico di Torino	Luca Staricco	Yes	Yes

FORMAT AND METHODOLOGY

The workshop was structured according to the format outlined in the PCIA guidelines, with some minor changes in order to facilitate the integration between the two case study cities.

First of all, the agenda of the day and the objectives of the workshop were presented to the participants. The results of the first two workshops were illustrated, so that stakeholders from Turin could familiarize with the vision and the back-casting workshop outcomes for Milan, and vice versa.

The whole PCIA methodology was described to the participants. Then the preliminary variable set (with some renamed variables and two more variables, “Accessibility of urban services” and “Redesign of public transport network”) built by the city case study coordinators in the pre-workshop phase was illustrated; participants were randomly split in three groups and asked to discuss this set and to select ten variables that they considered most important to describe the integrated case study. One member of each group presented the ten selected variables and then the ten most quoted variables by the three groups were introduced in a new Impact Matrix.

Participants were then divided into three group; at this time, the division was organized so to have one group composed only by stakeholders from Milan, one only from Turin, and one mixed of stakeholders from both Milan and Turin. This approach was meant to compare different views for the two cities. Each group filled in the Impact matrix, performed the analysis of the systemic role of the variables and then showed the results to the other groups.

Finally, the PCIA tool and methodology, the output of the exercise and the implications for the two cities were discussed in a plenary session.

PRESENTATION

In general terms, participants considered the variable set pre-defined by the coordinators as appropriate to describe the joint case study. Only one new variable was proposed by one group: the power of attracting students, tourists and company; but it was not considered as relevant by the other two groups.

Eleven variables were quoted by at least two groups as relevant; they covered all the seven “areas of life” and one of the “physical categories”. These eleven variables were selected to structure the new Impact Matrix.

Table 19: Variables selected as "Ten most relevant" by the three groups

	VARIABLES	GROUP 1	GROUP 2	GROUP 3
1	Demographic structure of the population		X	X
2	Economic specialization		X	X
3	Circular economy and sharing	X		
4	Human capital enhancement	X		
5	R&D , funding and policies for innovation	X		X
6	Soil consumption		X	X
7	Natural and green areas, ecologic corridors	X		X
8	Enhancement of cultural heritage and landscape, rehabilitation of derelict areas	X	X	
9	Sustainability awareness			X
10	Social inclusion			
11	Accessibility of urban services	X	X	X
12	Policies and incentives for resource efficiency	X		X
13	Air quality			
14	Policies and infrastructures for no-fossil fuel mobility	X	X	X
15	Smart logistics		X	
16	Redesign of public transport network			
17	Strategic planning and measures for energy efficiency	X	X	X
18	Resource efficient buildings			
19	Renewable energy production	X	X	
20	Smart city policies			
	Proposed new variables:			
21	Students, tourist, company attraction		X	

The full list of the eleven variables selected by the participants is provided in Table 20.

Table 20: Variables selected for the Impact matrix

	TYPE OF VARIABLE	VARIABLES SELECTED
1	Participants	Demographic structure of the population
2	Economy	Economic specialization
3	Economy	R&D, funding and policies for innovation
4	Space utilization	Soil consumption
5	Space utilization	Natural and green areas, ecologic corridors
6	Space utilization	Enhancement of cultural heritage and landscape, rehabilitation of derelict areas
7	Human ecology	Accessibility of urban services
8	Natural balance	Policies and incentives for resource efficiency
9	Infrastructure	Policies and infrastructures for no-fossil fuel mobility
10	Rules and laws	Strategic planning and measures for energy efficiency
11	Energy	Renewable energy production

The analysis of the influence strength of the variables from the Impact Matrix filled in by each group is shown in Figure 21.

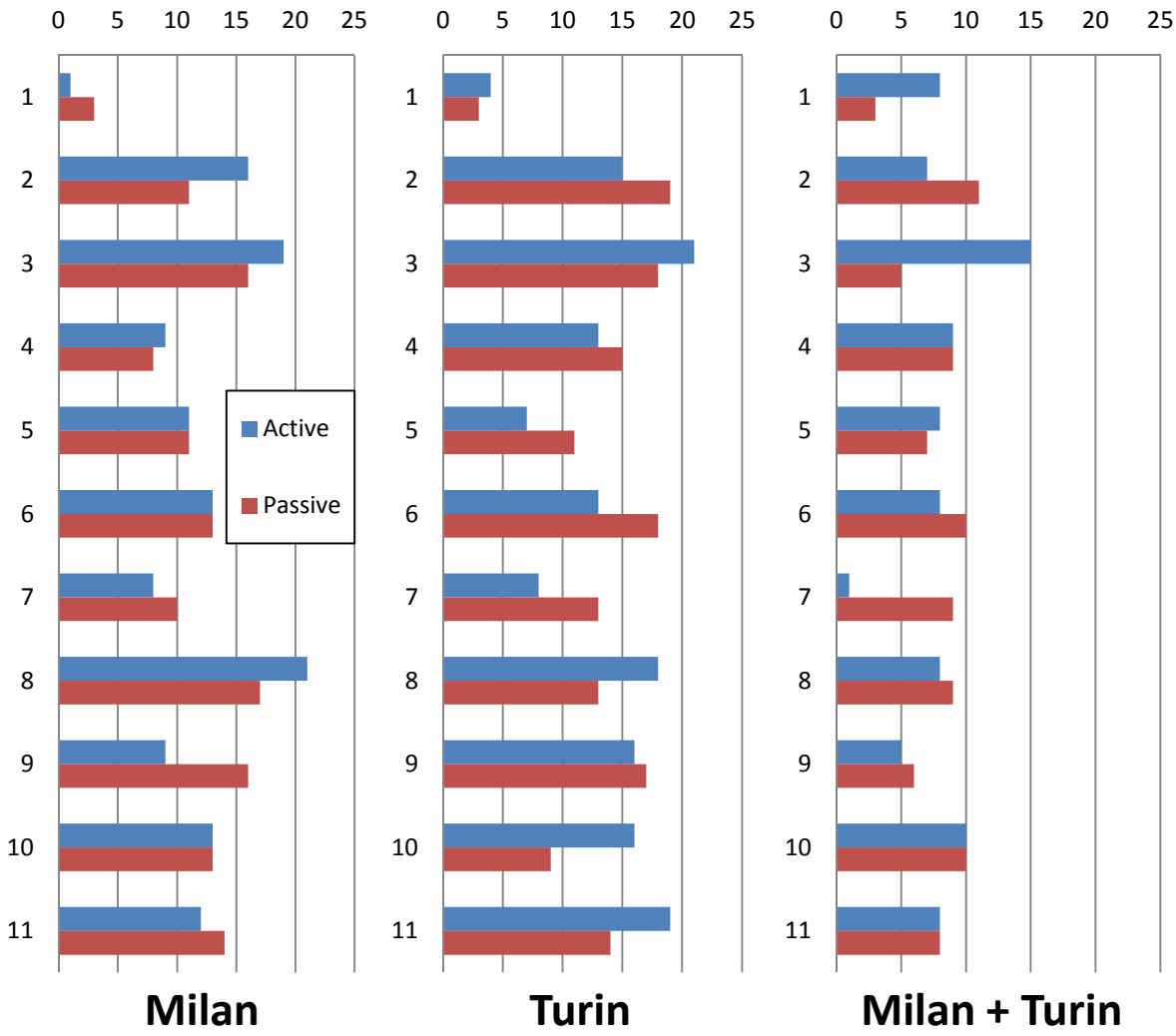


Figure 21: The bar charts for influence strengths

Table 21 and Table 22 shows the active and critical ranking for the variables from a combined matrix for the three groups. It can be seen that there are many critical values in Table 22. This generally indicates a very imbalanced system that is prone to sudden change. However, in this case it is the result of an imbalance in the system variables, as there are not enough to represent a complete system. Hence, also it highlights the importance of certain active and critical variables, the results will need careful consideration and comparison with the pre-workshop assessment.

Table 21: Active-passive ranking of variables for combined groups matrix

ACTIVE-PASSIVE RANKING	VARIABLE NO.	VARIABLE NAME	Q-VALUE
Slightly active	3	R & D funding and policies for innovation	1.462
Slightly active	1	Demographic structure of the population	1.333
Neutral	8	Policies and incentives for resource efficiency	1.308
Neutral	10	Strategic planning and measures for energy efficiency	1.182
Neutral	4	Soil consumption	1
Neutral	11	Production of renewable energy	0.923
Neutral	6	Enhancement of cultural heritage and landscape rehabilitation brownfields	0.923
Neutral	5	Natural areas and green, ecological corridors	0.9
Neutral	2	Economic specialization	0.867
Neutral	9	Policies and infrastructure for no carbon mobility	0.846
Highly passive	7	Accessibility of urban services	0.4

Table 22: Critical-buffering ranking of variables for combined groups matrix

CRITICAL-BUFFERING RANKING	VARIABLE NO.	VARIABLE NAME	Q-VALUE
Highly critical	3	R & D funding and policies for innovation	247
Highly critical	8	Policies and incentives for resource efficiency	221
Critical	2	Economic specialization	195
Critical	11	Production of renewable energy	156
Critical	6	Enhancement of cultural heritage and landscape rehabilitation brownfields	156
Critical	10	Strategic planning and measures for energy efficiency	143
Critical	9	Policies and infrastructure for no carbon mobility	143
Slightly critical	4	Soil consumption	100
Neutral	5	Natural areas and green, ecological corridors	90
Buffering	7	Accessibility of urban services	40
Highly buffering	1	Demographic structure of the population	12

VII.II.II GENERAL REMARKS

In the final discussion, participants commented the output of the workshop. As regards the methodology they pointed out two main difficulties. The first problem concerned how variables were to be interpreted: have they to be considered “status variables”, which describe a certain state of the system, or normative variables, which represent a desired state of the system? On this regard, participants expressed some doubts about the lack of precision in the variables included in the matrix: for instance urban green areas are to be regarded as policy target to work towards to, or are only a city feature that will be impacted by the policies? Some stakeholders found an excessive unevenness in the level of generalization: some variable were quite general (for instance, strategies for energy efficiency), other seemed to be quite specific in comparison.

The second problem regarded the difficulties in identifying only “direct” relations between variables: how should a “direct” impact be defined?

At the end of the simulation, some stakeholders redefined their priority about the variables: they stated that new variables could be introduced, like green economy, climate change policies, raising awareness measures.

Besides, some stakeholders were puzzled about variables that a post-carbon strategy could poorly control, as social and demographic ones. Finally, the heterogeneity of factors to be assessed has made the work quite complex according to some participants.

Despite these doubts, the matrix was considered an useful tool to analyze the multiple relations between system variables and to put in evidence the most relevant as catalyst for changing toward a post-carbon society.

VIII ROSTOCK

VIII.I PRE WORKSHOP ACTIVITIES

VIII.I.I SYSTEM DESCRIPTION

The city of Rostock, Germany has already undergone a large economic, social and environmental transition due to the German Unification in 1990. As a city with a Baltic Sea harbour, climate change and adaption has been a concern for several years. In 2014, Rostock developed a 100% climate protection master plan, consisting of measures and indicators, to reduce the city's CO_2 emissions by 95 % by 2050, and improve energy efficiency by 50 %, compared to 1990 levels. Based on this master plan, Rostock has already implemented measures, established regional networks and has started to monitor their progress. Rostock is an important and dynamic city in the northeast of Germany.

VIII.I.II VARIABLE SET

The previous POCACITO workshops and reports helped to define a variable set for Rostock. A team from Ecologic Institute (Doris Knoblauch, Monica Ridgway and Michael Schock) extracted the set of variables based on the following process described below. Afterwards, Doris Knoblauch, Hans-Joachim Ziesing and Michael Schock from Ecologic Institute and Andrea Arnim and Kerry Zander, of the Environmental Agency of Rostock, checked the set of variables and filled in the Impact Matrix.

The variables were composed and based on the following aspects. The team tried to:

- cover the variables, which were mentioned as relevant during the first Workshop "Initial Assessment & Vision Building";
- use as much POCACITO key performance indicators as possible;
- cover the relevant questions of the guidelines on different aspects (crucial elements, key issues, affected by future development, risks of climate change, mitigation, and adaption);
- cover the "seven areas of life" (economy, participation, space utilisation, human ecology, natural balance, infrastructure, rules and laws); and
- keep the number of indicators small.

The following variables could not be included during the selection process and needed to be removed, due to the complexity and the need to keep the matrix manageable:

> Heterogeneity/Diversity, Environmental Awareness, Activities and Culture, Social Inclusion/Equality, Collective Action - Community/Coop/Association Building, Role Models/Business, Civil Society, Good Practices, Health, Green Economy/Social Entrepreneurship, Robust Economy - Business/Financial Service/IT, Circular Economy and Sharing, Local Food Production, National Policies, Eco-Design, Eco-Technology, Tourism, Innovative Communication/Information/Nudges, and the Harbour of Rostock.

The list of variables and descriptions for the city of Rostock are shown in Table 23.

Table 23: List of variables and descriptions for the city Rostock

TYPE OF VARIABLE	VARIABLE	DEFINITION
Environmental variables	Natural Balance (Air Quality)	Exceedance rate of air quality limit values)
	Resource Efficiency (DMC)	Resource efficiency based on total material consumption - Domestic Material Consumption (DMC)
	Renewable Energy (%)	Share of renewable energy production
	Energy Intensity (TOE/EUR)	Energy used to produce goods and services
	CO_2-Emissions (ton per capita)	Total CO_2-emissions per capita
	Consumption/Waste Generation	Amount of waste generated
	Waste Management	Share of waste recovery
	Public Transport and Bike Network	Share of people walking, cycling, or using public transport vs. using private motor vehicles (Modal Split)
	Coastal Protection	Expenditures for coastal protection (Flood Risk/Adaptation Defences)
	Flood Prone Areas	Size of flood prone areas (Flood Risk/Adaptation Defences)
	Water Indicator (Water Loss)	Amount of water loss in the water system
	Water Consumption (per capita)	Water consumption per capita in the city
	Sustainable Housing	Energy efficiency of buildings
Social variables	Building Density	Urban building density
	Green Space and Corridors	Availability of green space in the city
	Risk of Poverty	Insecurity for people becoming poor (Quality of Life)
	Equal Payment by Gender	Equality or inequality of payments by gender (Quality of Life)
	Affordable Housing	The (increase of) price levels for renting an apartment in the city (Rent Index)
	Demographic Trend (age > 65)	Development of the age structure, age > 65 years (%)
	Municipal Management	Municipal transition management: monitoring the progress of the 100 % climate protection master plan measures
	Regional Network	Involvement of the city in different regional (e.g. environmental) networks (qualitative indicator: low/middle/high)
Economic variables	Economy (GDP per capita)	Economic development of the city

TYPE OF VARIABLE	VARIABLE	DEFINITION
	Unemployment Rate	Percentage of unemployed people
	Budget Deficit	Financial resilience based on the public budget deficit
	Tertiary Education Level (%)	Percentage of people with tertiary education
	R&D Intensity	Spending on research and development

The list of variables covers different and detailed environmental, social and economic aspects of the city as a system. According to the guidelines for the Sensitivity Workshop, the necessary types of variables are covered in the set of variables to ensure that it is a robust system.

VIII.I.III IMPACT MATRIX

Members of the case study team at the Ecologic Institute each filled in an Impact Matrix individually. In addition, two members of the Environmental Agency of Rostock, filled in another Impact Matrix. There were no issues or difficulties reported and no second matrix was performed. A final Impact Matrix based on the average of each score was then produced and this is shown in Figure 22.

dependent variable:		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		
independent variable:		Natural Balance (Air Quality)	Resource Efficiency (DMC)	Renewable Energy (%)	Energy Intensity (TOE/EUR)	CO2-Emissions (ton per capita)	Consumption (Waste Generation)	Waste Management	Public Transport and Bike Network	Coastal Protection	Flood Prone Areas	Water Indicator (Water Loss)	Water Consumption (per capita)	Sustainable Housing	Building Density	Green Space and Corridors	Risk of Poverty	Equal Payment by Gender	Affordable Housing	Demographic Trend (age > 65)	Municipal Management	Regional Network	Economy (GDP per capita)	Unemployment Rate	Budget Deficit	Tertiary Education Level (%)	R&D Intensity	Active	P (AS*PS)
1	Natural Balance (Air Quality)	X	1	1	1	1	1	0	1	0	0	0	0	1	0	1	1	1	0	1	1	0	1	0	0	0	1	14	420
2	Resource Efficiency (DMC)	2	X	1	2	2	2	2	1	1	1	2	2	1	1	1	0	1	1	0	1	1	2	1	0	1	1	30	1050
3	Renewable Energy (%)	2	2	X	3	3	1	1	1	1	1	0	0	1	1	1	1	1	1	0	1	1	2	1	1	1	1	29	754
4	Energy Intensity (TOE/EUR)	2	3	2	X	3	2	1	1	0	0	0	1	1	1	1	0	0	1	0	1	1	2	1	1	1	1	27	945
5	CO2-Emissions (ton per capita)	2	1	1	1	X	1	1	1	1	1	0	0	0	0	1	0	0	1	0	1	1	1	1	0	1	1	18	702
6	Consumption (Waste Generation)	1	2	1	2	2	X	2	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0	1	1	18	522
7	Waste Management	1	2	1	1	2	1	X	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	1	14	224
8	Public Transport and Bike Network	3	2	1	2	3	1	0	X	1	1	0	0	0	0	1	0	0	0	1	1	1	1	1	0	1	1	22	462
9	Coastal Protection	0	1	1	1	1	1	0	0	X	1	1	1	0	1	1	1	0	0	0	1	1	2	1	2	0	1	19	285
10	Flood Prone Areas	0	1	1	1	1	1	0	0	1	X	1	1	0	1	2	1	0	0	0	1	1	1	1	1	0	1	18	288
11	Water Indicator (Water Loss)	1	1	0	1	1	1	0	0	0	1	X	2	1	0	1	1	0	1	0	1	1	1	1	1	1	1	19	323
12	Water Consumption (per capita)	1	2	0	1	1	1	0	0	1	1	2	X	1	0	1	1	0	0	0	1	1	1	1	0	1	0	18	342
13	Sustainable Housing	2	2	1	3	3	1	1	0	0	0	1	1	X	1	1	1	1	2	1	1	1	1	1	1	1	1	29	609
14	Building Density	2	1	1	2	1	1	0	2	1	1	1	1	2	X	2	1	1	2	1	1	1	1	0	0	0	0	26	416
15	Green Space and Corridors	3	1	1	1	1	1	1	1	1	1	1	1	0	1	X	1	1	2	1	1	1	0	0	0	1	0	23	598
16	Risk of Poverty	1	1	1	1	1	2	1	1	1	0	0	1	1	0	1	X	1	2	1	1	1	1	1	1	2	1	25	625
17	Equal Payment by Gender	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	X	1	1	1	1	1	1	0	1	1	16	256
18	Affordable Housing	0	1	1	1	1	1	0	1	0	0	0	0	1	1	1	2	1	X	0	1	1	1	1	1	1	0	18	396
19	Demographic Trend (age > 65)	0	1	1	1	1	1	0	1	0	0	0	0	0	1	1	2	1	1	X	1	1	1	1	1	1	1	19	247
20	Municipal Management	1	1	2	1	2	1	1	2	1	1	1	1	2	2	2	1	1	1	1	X	2	1	1	1	1	0	31	744
21	Regional Network	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	0	1	1	1	X	1	1	1	1	1	25	600
22	Economy (GDP per capita)	1	2	1	2	2	2	1	1	1	1	0	1	1	1	1	2	1	1	1	1	1	X	1	2	1	1	30	900
23	Unemployment Rate	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	2	2	2	1	1	1	2	X	1	1	1	28	616
24	Budget Deficit	1	1	1	1	1	1	1	2	1	2	1	0	2	1	1	2	1	1	1	1	1	1	1	X	1	1	28	476
25	Tertiary Education Level (%)	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	2	1	1	1	1	0	2	2	1	X	1	25	525
26	R&D Intensity	1	2	2	2	2	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	1	2	2	1	1	X	26	520
	Passive	30	35	26	35	39	29	16	21	15	16	17	19	21	16	26	25	16	22	13	24	24	30	22	17	21	20		
	Q (AS/PS)	0,5	0,9	1,1	0,8	0,5	0,6	0,9	1,0	1,3	1,1	1,1	0,9	1,4	1,6	0,9	1,0	1,0	0,8	1,5	1,3	1,0	1,0	1,3	1,6	1,2	1,3		

Figure 22: The initial Impact Matrix of Rostock.

Municipal Management has the highest active score (active: 31), followed by Resource Efficiency (active: 30) and Economy (active: 30). Renewable Energy (active: 29), Unemployment Rate (active: 28) and Budget Deficit (active: 28) have a nearly similar high score. Only Natural Balance and Waste Management have a very low active score (both: active: 14).

Passive variables are highly influenced by other variables. CO_2-Emissions (passive: 39) has the highest passive score. Resource Efficiency and Energy Intensity (both: passive: 35) are also strongly influenced by other variables of the set. Natural Balance (passive: 30), Economy (passive: 30), and Consumption (passive: 29) are also strongly influenced by the other variables. The variables Demographic Trend (passive: 13) and Coastal Protection (passive: 15) have the lowest passive score.

VIII.I.IV ANALYSIS OF THE VARIABLES SET

The systemic role figure shown in Figure 23 suggest that the system is both quite active and buffering, and also fairly critical.

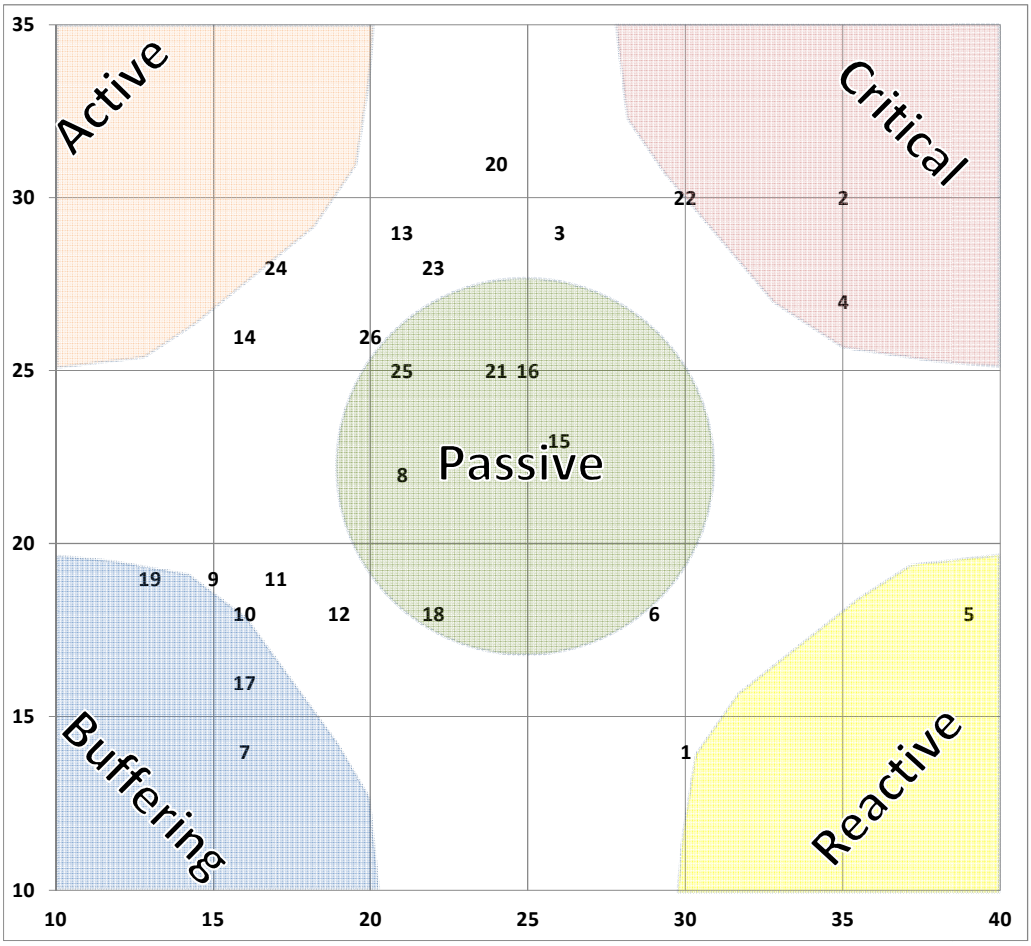


Figure 23: Systemic role figure for Rostock.

Figure 24 shows the sum of passive and active scores of the Impact Matrix of Rostock for each variable. The highly influenced variables with a relatively low passive score (CO_2-Emissions and

Natural Balance) can be noticed here, as well as all the variables with a high sore for both dimensions (e.g. Resource Efficiency, Energy Intensity).

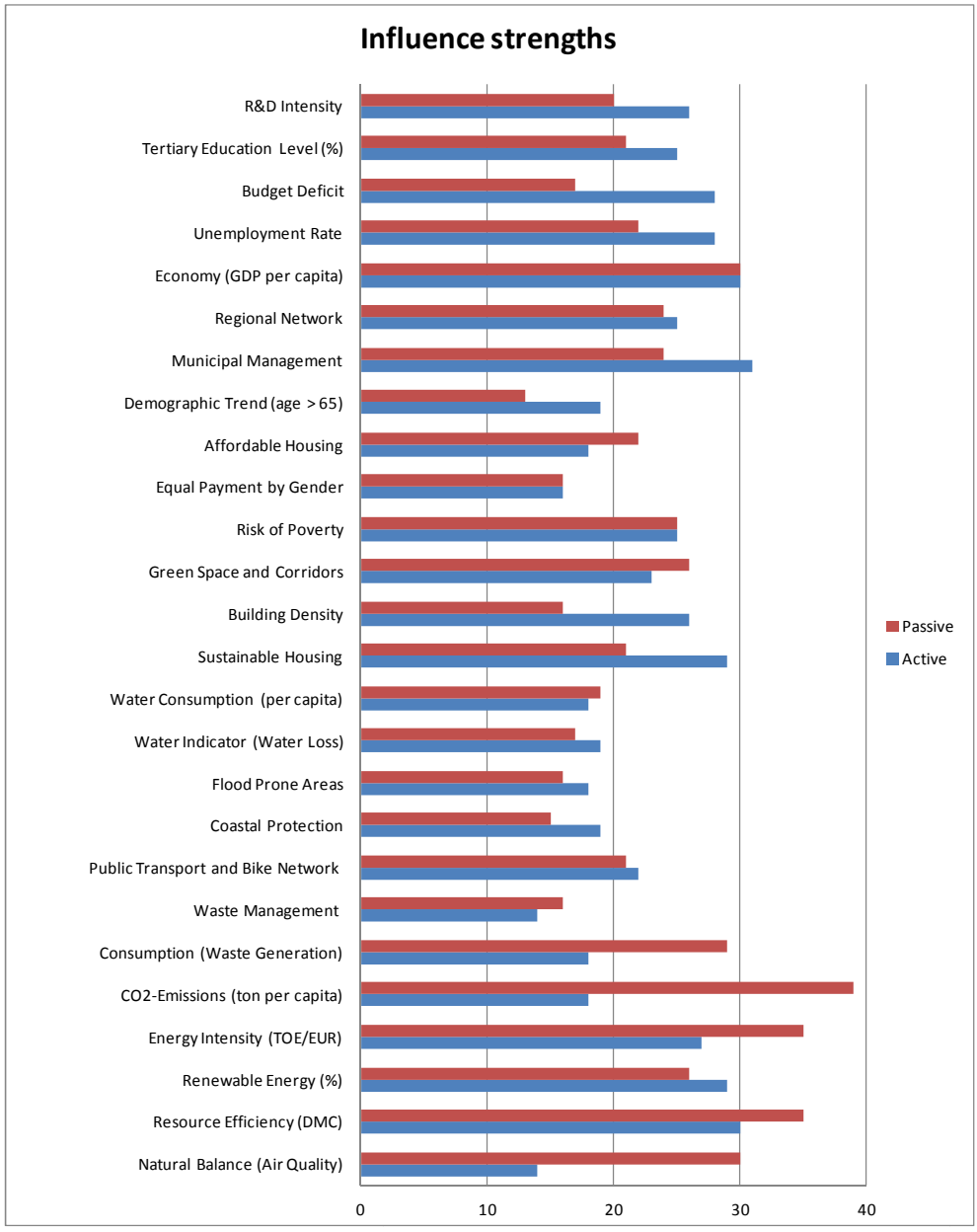


Figure 24: Influence strengths of the variables for Rostock.

The critical variables of Rostock are Resource Efficiency (no. 2), Energy Intensity (no. 4) and Economy (no. 22). The following active variables are only weakly passive: Budget Deficit (no. 24), Building Density (no. 14), Demographic Trend (no. 19) and Sustainable Housing (no. 13). R&D (no. 26), Municipal Management (no. 20), Unemployment Rate (no. 23) and Coastal Protection (no. 9) are also very active, but to a lesser extent.

Table 24 provides further details on the quotient values for each variable.

Table 24: Active-passive ranking of variables for combined groups matrix (Q-value) for Rostock

Active-Passive	no.	variable	AS/PS
Slightly active	24	Budget Deficit	1,65
Slightly active	14	Building Density	1,63
Slightly active	19	Demographic Trend (age > 65)	1,46
Slightly active	13	Sustainable Housing	1,38
Neutral	26	R&D Intensity	1,30
Neutral	20	Municipal Management	1,29
Neutral	23	Unemployment Rate	1,27
Neutral	9	Coastal Protection	1,27
Neutral	25	Tertiary Education Level (%)	1,19
Neutral	10	Flood Prone Areas	1,13
Neutral	11	Water Indicator (Water Loss)	1,12
Neutral	3	Renewable Energy (%)	1,12
Neutral	8	Public Transport and Bike Network	1,05
Neutral	21	Regional Network	1,04
Neutral	22	Economy (GDP per capita)	1,00
Neutral	17	Equal Payment by Gender	1,00
Neutral	16	Risk of Poverty	1,00
Neutral	12	Water Consumption (per capita)	0,95
Neutral	15	Green Space and Corridors	0,88
Neutral	7	Waste Management	0,88
Neutral	2	Resource Efficiency (DMC)	0,86
Neutral	18	Affordable Housing	0,82
Neutral	4	Energy Intensity (TOE/EUR)	0,77
Slightly passive	6	Consumption (Waste Generation)	0,62
Passive	1	Natural Balance (Air Quality)	0,47
Passive	5	CO2-Emissions (ton per capita)	0,46

Budget Deficit has the highest quotient value of the variable set and it is crucial for the city of Rostock. This variable influences the possibility of having financial capacity to invest in the future and into transition activities. Building Density and Sustainable Housing are also key variables of Rostock and have very high quotient (AS/PS) values. The district heating network of Rostock is one concrete example, underlining that these are aspects of relevance (see also the Factsheet Rostock on district heating network). Demographic Trend and Unemployment Rate are two important (more active than passive) social aspects of the Impact Matrix. Additionally, Municipal Management, which can directly be influenced by the city of Rostock, is as important as R&D and Tertiary Education.

The active-passive product of the variables is shown in Table 25. The product is calculated by the active score multiplied by the passive score of a variable.

Table 25: Critical-buffering ranking of variables for combined groups matrix (P-Value) for Rostock

Active-Passive	no.	variable	AS*PS
Highly critical	2	Resource Efficiency (DMC)	1050
Highly critical	4	Energy Intensity (TOE/EUR)	945
Highly critical	22	Economy (GDP per capita)	900
Critical	3	Renewable Energy (%)	754
Critical	20	Municipal Management	744
Critical	5	CO2-Emissions (ton per capita)	702
Critical	16	Risk of Poverty	625
Critical	23	Unemployment Rate	616
Critical	13	Sustainable Housing	609
Critical	21	Regional Network	600
Critical	15	Green Space and Corridors	598
Slightly critical	25	Tertiary Education Level (%)	525
Slightly critical	6	Consumption (Waste Generation)	522
Slightly critical	26	R&D Intensity	520
Slightly critical	24	Budget Deficit	476
Slightly critical	8	Public Transport and Bike Network	462
Slightly critical	1	Natural Balance (Air Quality)	420
Neutral	14	Building Density	416
Neutral	18	Affordable Housing	396
Neutral	12	Water Consumption (per capita)	342
Neutral	11	Water Indicator (Water Loss)	323
Neutral	10	Flood Prone Areas	288
Neutral	9	Coastal Protection	285
Slightly buffering	17	Equal Payment by Gender	256
Slightly buffering	19	Demographic Trend (age > 65)	247
Slightly buffering	7	Waste Management	224

The two most critical variables of Rostock are Resource Efficiency (no. 2) and Energy Intensity (no. 4). They have both high active and high passive values and interact with one another. The influence routes of critical variables may also give background information on how the variables are interconnected. Both variables are especially influenced by Sustainable Housing (no. 13), Renewable Energy (no. 3), Public Transport (no. 8), Consumption (no.6) and other variables.

Economy (no. 22) is especially influenced by Tertiary Education Level (no. 25) and R&D (no. 26), whilst negatively influenced by Unemployment Rate (no. 23). These three variables are key factors on the development or decline in the economic performance of a city.

Renewable Energy (no. 3) is also an important variable of Rostock. Besides onshore wind energy, (NORDEX) with a large production in Rostock, there is also a construction side in the harbour of Rostock for offshore wind energy plants. Renewable Energy (no. 3) is only slightly influenced by other variables.

Concerning the types of variables, it can be noticed that the economic variables (no. 22 – 26) combined with closely related variables, like Renewable Energy (no. 3), Resource Efficiency (no. 2) and Energy Intensity (no. 4) have a very strong active impact on the set of variables.

Additionally, there are also some social and environmental variables playing an active role. These variables include Municipal Management (no. 20), the Risk of Poverty (no. 16), Sustainable Housing (no. 13) and Building Density (no. 14).

The buffering variables of Equal Payment by Gender (no. 17) and Waste Management (no. 7) may either have only a low impact concerning the other variables of the city of Rostock or the selected set of variables are lacking variables which are more strongly interconnected with these variables.

It is important to mention that inside this set of variables there are other relevant variables of this set, which are also interacting and influencing each other. It might even be the case that some variables not mentioned here with lower active values can make a very important impact e.g. by setting functional chains into power and changing many other variables. Notably, there are a lot of variables that were not included as part of this set but are already recognised as important aspects (see VIII.I.II Variable set).

VIII.II PCIA WORKSHOP REPORTING

VIII.II.I GENERAL INFORMATION

WORKSHOP DATES AND LOCATIONS

The workshop took place on 7 May 2015 in Rostock Warnemünde, Germany at the Technologiepark Warnemünde.

PARTICIPANTS

The third workshop was attended by 13 stakeholders from Rostock and four external participants – two from the Ecologic Institute and two guest speakers (see Table 26). Four of the 13 stakeholders attended for the first time and seven attended both previous workshops. The expertise of the participants included city planning, energy, transport, engineering, waste management, water provision, housing and employment. Two participants were from an environmental NGO. Many participants knew each other from the previous workshops, the master plan processes and other activities in Rostock. The two guest speakers were Ralf Bermich from the Agency for Environmental Protection, Trade Control and Energy of the city of Heidelberg and Hans-Joachim Ziesing, energy expert and German council advisor. The following table shows the participants and their attendance at the three workshops:

Table 26: List of participants in Rostock workshop

TITLE	LAST NAME	FIRST NAME	ORGANISATION	WS 1	WS 2	WS 3
	Albrecht	Stefanie	Ecologic Institute	x	x	x
	Arnim	Andrea	Environmental Agency Rostock	x	x	
	Bermich	Ralf	Agency for Environmental Protection, Trade Control and Energy of the city of Heidelberg			x
	Böhme	Steffen	Waste Disposal Rostock GmbH	x	x	
	Brückner	Ralf	Craftsman Association - Kreishandwerkerschaft		x	
	Czech	Thomas	Tenant Association - DMB Rostock e.V.	x		x
	Dengler	Cindy	Engineering Consultancy GICON GmbH	x		x
	Matthäus	Holger	Environment & Construction Senator	x		
	Grandke	Stephan	Agency for City Development, City Planning and Economy			x
	Grünig	Max	Ecologic Institute	x		
	Hübel	Moritz	Engine & Energy Research - FVTR GmbH / LTT, Uni Rostock	x		
Dr.	Jaudzims	Bernd	Technology Centre Technologiezentrum Warnemünde			x
	Kaufmann	Britta	Waste Disposal Company - EVG Entsorgungs- und Verwertungsgesellschaft mbH Rostock	x	x	x

TITLE	LAST NAME	FIRST NAME	ORGANISATION	WS 1	WS 2	WS 3
	Knoblauch	Doris	Ecologic Institute	x	x	x
Dr.	Koziolek	Dagmar	Environmental Agency Rostock	x		
Dr.	Lembcke	Hinrich	City Planning Agency - Amt f. Stadtentwicklung, Stadtplanung und Wirtschaft		x	
	Krase	Bernd	Public Utility Stadtwerke Rostock AG	x		
	Ludewig	Mario	Public Utility Stadtwerke Rostock AG	x	x	x
Dr.	Meyer	Andrea	Waste Disposal Stadtentsorgung Rostock GmbH			x
	Nispel	Hanno	Water Provider EURAWASSER Nord GmbH	x		
	Pfau	Rudolf	Pensioner Council Seniorenbeirat Rostock	x	x	
Dr.	Preuß	Brigitte	Environmental Agency Rostock			x
	Rath	Christian	Waste Disposal Company - EVG Entsorgungs- und Verwertungsgesellschaft mbH		x	
	Retzlaff	Kai	Industry Association IHK zu Rostock	x	x	x
	Riedner	Klaus	Engineer Association Verein Deutscher Ingenieure BV M-V e.V.	x	x	
	Schulmann	Peggy	Public Transport Rostocker Straßenbahn AG	x	x	x
	Schumacher	Susanne	Environmental NGO BUND M-V e.V.	x		x
Dr.	Sielberbach	Karsten	water provider EURAWASSER Nord GmbH		x	
	Söffker	Ulrich	Energy NGO BUND-Projekte Energiewende	x	x	x
	Stählke	Holger	Water Provider EURAWASSER Nord GmbH			x
Prof. Dr.	Weber	Harald	Uni Rostock, Inst. f. Elektrische Energietechnik	x		
	Zander	Kerry	Environmental Agency Rostock	x	x	x
	Ziesing	Hans-Joachim	Working Group on Energy AG Energiebilanzen			x

FORMAT AND METHODOLOGY

The format of the workshop was changed as the participants of the previous workshops requested more information on what other cities are doing. Hence, measures to reduce carbon emissions from Heidelberg and other master plan[3] cities in Germany were presented. The POCACITO city measures selected from the initial assessment report were also prepared for presentation; however, the time was filled quickly with discussion and the presentation was emailed to the participants instead. This led to most discussions and left no time for the evaluation of measures presented for Rostock. Doris Knoblauch instead discussed the POCACITO Critical Influences Assessment with a smaller group of

[3] Since 2012 nineteen Masterplan cities have been supported by the German Environmental Ministry to develop and implement measures to reduce 95% of their greenhouse gas emission by 2050 compared to 1990 levels.

experts on the topic of climate protection, cities and energy transition, namely with Hans-Joachim Ziesing, Brigitte Preuß and Michael Schock.

PRESENTATION

Dr. Brigitte Preuß, Head of the Environmental Agency Rostock, and moderator Doris Knoblauch, senior researcher at Ecologic Institute, opened the workshop. Dr. Preuß summarised the previous two workshops from what she had read in the protocols. She underlined the energy and mobility focus of measures as important for Rostock and its municipal administration towards a post-carbon future. In her experience, the main hindrances for environmental measures are lack of legal frameworks or financial means.

The introduction was followed by two presentations: one on the master plan procedure and measures of Heidelberg by Ralf Bermich, as well as a more general presentation on the process of the 19 master plan cities in Germany by energy expert and German council advisor Dr. Hans-Joachim Ziesing. Both presentations raised many questions. Interesting measures in Heidelberg are e.g. a free energy advisory service and a focus on low-energy building (Passivhaus). Heidelberg found it strategically helpful to have external renowned experts to present new concepts and ideas, which increased their acceptance. Dr. Ziesing showed presented further successful measures of master plan cities in Germany such as:

- political decision makers in position of power,
- recognition of climate protection manager (ideally in a staff position near the mayor),
- broad supportive/publicly exposed networks such as energy alliances,
- informative websites/social media/active consultation and information campaigns,
- economic solutions with the co-benefit of climate protection e.g. waste heat utilisation or LED lights,
- municipal e-mobility fleet,
- renovation of public property,
- municipal energy supply focusing on infrastructure provision instead of energy production.

The presentation on “sufficiency” by Doris Knoblauch led to most discussions. This approach, which is prominent in Germany, requires a reduction in the demand of goods in order to reduce resource use. Measures to support “sufficiency” for a municipality are:

- enabling “sufficient” behaviour though city development by e.g. reducing walking distance or reducing heated living space,
- improve or preserve local supply e.g. of food and other goods and resources,
- mixed-use e.g. of buildings and spaces,
- compact building structures,

- removal management,
- information campaigns,
- flexible forms of living,
- shared space,
- municipality as a role model e.g. in canteens or procurement,
- providing space or financial resources for private initiatives e.g. repair cafes,
- reduce/raise price of parking spaces.

Other private or business measures include the sharing or collaborative economy, measures of using-not-owning, regional consumption or substituting flights with phone conferences.

Complexity and multiple diverging interests complicate decision-making. One example for Rostock is the decision over whether to provide more sites for housing in Rostock. The population is predicted to decease in Rostock and its surrounding areas. However, there are a high number of individuals who commute to the city daily (35, 000 commuters per day), who might be encouraged to settle closer to the city.

Due to the fact that the variable set, the Impact Matrix and the systemic role figure was not presented and discussed with the stakeholders in Rostock yet, it would be good if the findings could be validated.

VIII.II.II GENERAL REMARKS

The Impact Matrix analysis showed the importance of economic variables, Resource Efficiency, Energy Intensity and Renewable Energy in Rostock. The Education and R&D variables have strong influence on these critical variables. Municipal Management and Budget Deficit are crucial factors for the city. Sustainable Housing and Building Density are also relevant. The environmental and social variables of this set are also highly interactive. However, the Impact Matrix and the underlying variable set have yet to be verified by the stakeholders for Rostock.

During the PCIA Workshop, stakeholders were very interested in activities of other cities and the (often more social) measures suggested by the concept of “sufficiency”. Compared to other POCACITO cities, Rostock is focusing more on technological measures in their master plan, with a focus on energy and mobility. However, Rostock does have social measures such as a repair café and the city is a Fair Trade City (public procurement from fair trade).

The programme was perhaps too ambitious, as not all issues were touched – the European context and an evaluation on the most relevant measures for Rostock were not covered.

IX ZAGREB

IX.I PRE WORKSHOP ACTIVITIES

IX.I.I SYSTEM DESCRIPTION

Zagreb as a system is described by its municipal boundaries. Surrounded by river and mountain, it has had very few phases of expansion. Following the global financial crisis, and a plateauing of population, expansion has begun to decline. Ecological issues are becoming increasingly important to citizens, who are largely unsatisfied with municipal governance which does little to deter unsustainable development.

Zagreb has several challenges including high employment, poor economy, poor traffic infrastructure and low ecological awareness. There also appears to be a lack of a long-term vision to foster the required sustainable development.

IX.I.II VARIABLE SET

An initial set of variables was developed by the case study team, which was then reviewed against the findings from the previous POCACITO workshops. Other information and reports were also used such as ZagrebPlan[4]. Stakeholders from previous workshops were then contacted to review the list of variables and some modifications were made. The final list of variables and descriptions are shown in Table 27.

Table 27: List of variables and descriptions for the Zagreb

TYPE OF VARIABLE	VARIABLE	DEFINITION
Society	Awareness	The level of environmental awareness through appropriate information and education
	Education	The quality of education and competitiveness of future employees
	Population	Population trends and uniform spatial distribution of the population
	Quality of life	Activities, security, Flexibility at work, Health
	Social inclusion /equality	The degree that the diverse people are well integrated into the general population
	Macroeconomics	Macroeconomic indicators
	Employment	Ability to find a satisfactory and decent job

[4] City of Zagreb Development Strategy, working version, February 2015

TYPE OF VARIABLE	VARIABLE	DEFINITION
Economy	Circular economy and sharing	Circular consumption and sharing, synergies with agriculture
	Social entrepreneurship	Company owned by its employees and the local community
Space/ Environment	Land use and land use change	Balanced development of the city, the sustainable use of resources, management of urban land allocation and land use
	Green space and corridors	City parks and green natural corridors with preserved ecosystems and biodiversity
	Environmental quality	Number of days per year exceeding of the limit values for pollutants SO2, NO2, O3 and PM10), and soil (eg. number of old industrial plants, the number of untreated landfill waste and illegal dumping, the number of abandoned quarries and gravel ...) the quality and quantity of available water
	Local food production	Local and organic food
	Sustainable energy	Renewable energy, self production, efficient buildings
	Resource efficiency	Use of raw materials, energy and water. More with less. Reuse of building and infrastructure materials. Waste reuse and recycling.
Managment	Public Transport	Good connections and service quality of public transport
	Bicycle and pedestrian traffic	The extent and quality of cycling and pedestrian infrastructure
	Resource/environment tax and charges	Economic incentives to improve environmentally responsible behaviour
	Development and transport plan	Urban Strategies, programs and plans
	National policies	Compatibility of national policies with local strategies and plans

IX.I.III IMPACT MATRIX

Two members of case study team were involved in the process of filling the impact matrix. The general understanding and thoughts on the variables were the same, but the score for the influences strength was sometimes different. These occasions required extra discussion to reach agreement on the final value. The initial impact matrix is shown in Figure 25..

		1 Awareness	2 Education	3 Population	4 Quality of life	5 Social inclusion /equality	6 Macroeconomy	7 Employment	8 Circular economy	9 Social entrepreneurship	10 Land use and land use chan	11 Green space and corridors	12 Environmental quality	13 Local food production	14 Resource efficiency	15 Public Transport	16 Bicycle and pedestrian traf	17 Resource/environment tax	18 Development and transpo	19 National policies	20 Decentralized energy proc	Active (AS)
1	**Awareness**	X	3	0	2	1	0	0	1	1	2	2	2	2	3	2	2	1	2	2	2	30
2	**Education**	3	X	1	1	1	2	2	2	2	2	0	0	2	2	2	2	1	2	2	1	30
3	**Population**	0	2	X	2	1	2	2	1	1	1	1	2	1	2	1	1	0	2	0	1	23
4	**Quality of life**	1	2	2	X	2	3	2	2	1	2	2	2	2	2	1	2	1	2	2	0	33
5	**Social inclusion /equality**	1	1	1	2	X	1	1	2	3	2	0	0	2	0	0	2	1	1	1	1	22
6	**Macroeconomy**	0	1	1	2	1	X	3	3	2	1	1	0	1	0	0	0	0	2	2	1	21
7	**Employment**	1	2	0	3	3	3	X	3	2	1	2	0	1	0	1	1	1	1	1	1	27
8	**Circular economy**	2	1	1	3	2	1	2	X	2	1	1	1	1	3	2	2	1	2	2	2	32
9	Social entrepreneurship	1	1	0	3	2	0	0	2	X	1	0	0	0	0	0	0	0	2	1	1	14
10	**Land use and land use change**	2	0	1	2	2	0	0	2	0	X	3	2	2	3	0	1	0	2	1	2	25
11	**Green space and corridors**	1	1	1	3	2	0	0	0	0	2	X	3	1	2	1	2	1	1	1	0	22
12	Environmental quality	0	0	1	2	0	0	0	2	0	1	0	X	0	0	2	1	1	1	1	0	12
13	Local food production	1	1	1	3	3	1	1	2	3	2	1	1	X	2	0	0	0	2	2	3	29
14	**Resource efficiency**	2	1	2	2	1	1	0	3	1	2	2	3	1	X	1	2	1	2	2	2	31
15	**Public Transport**	1	0	0	2	2	1	0	1	0	1	2	2	1	1	X	2	1	2	1	1	21
16	**Bicycle and pedestrian traffic**	2	1	0	3	3	1	0	1	1	2	3	3	1	2	2	X	1	2	1	1	30
17	**Resource/environment tax and charges**	1	1	0	0	0	2	1	1	0	1	2	2	2	1	3	3	X	2	1	2	25
18	**Development and transport plan**	1	1	2	2	2	2	2	2	2	3	3	1	2	2	2	2	2	X	1	2	36
19	**National policies**	1	3	2	1	2	2	2	2	2	2	1	0	1	2	2	1	2	1	X	2	31
20	**Decentralized energy production**	1	1	0	2	2	1	1	3	1	2	1	3	3	3	1	1	2	3	2	X	33
	Passive (PS)	22	23	16	40	32	23	19	35	24	31	27	27	26	30	23	27	17	34	26	25	

Figure 25: Impact matrix for the Zagreb

IX.I.IV ANALYSIS OF VARIABLES

The bar chart for influence strengths is shown in Figure 26. The systemic role (showing the variables as numbers and where they are located in terms of active, passive, critical, buffering and reactive is shown in Figure 27. This suggests that the city system is highly critical, with a many variables located towards the critical top-right corner.

The ranking of the variables for active-reactive influence and critical-buffering are found in Table 28 and Table 29, respectively

Some of the most active variables were resource/environment tax and charges, population, employment and awareness. The most passive ones were environmental quality, social entrepreneurship and social inclusion/equality. There were many highly critical variables, in order of criticality: quality of life, development and transport plan, circular economy, resource efficiency, decentralized energy production, bicycle and pedestrian traffic. This means that this city system is potentially quite unstable and many variables can influence how the city develops.

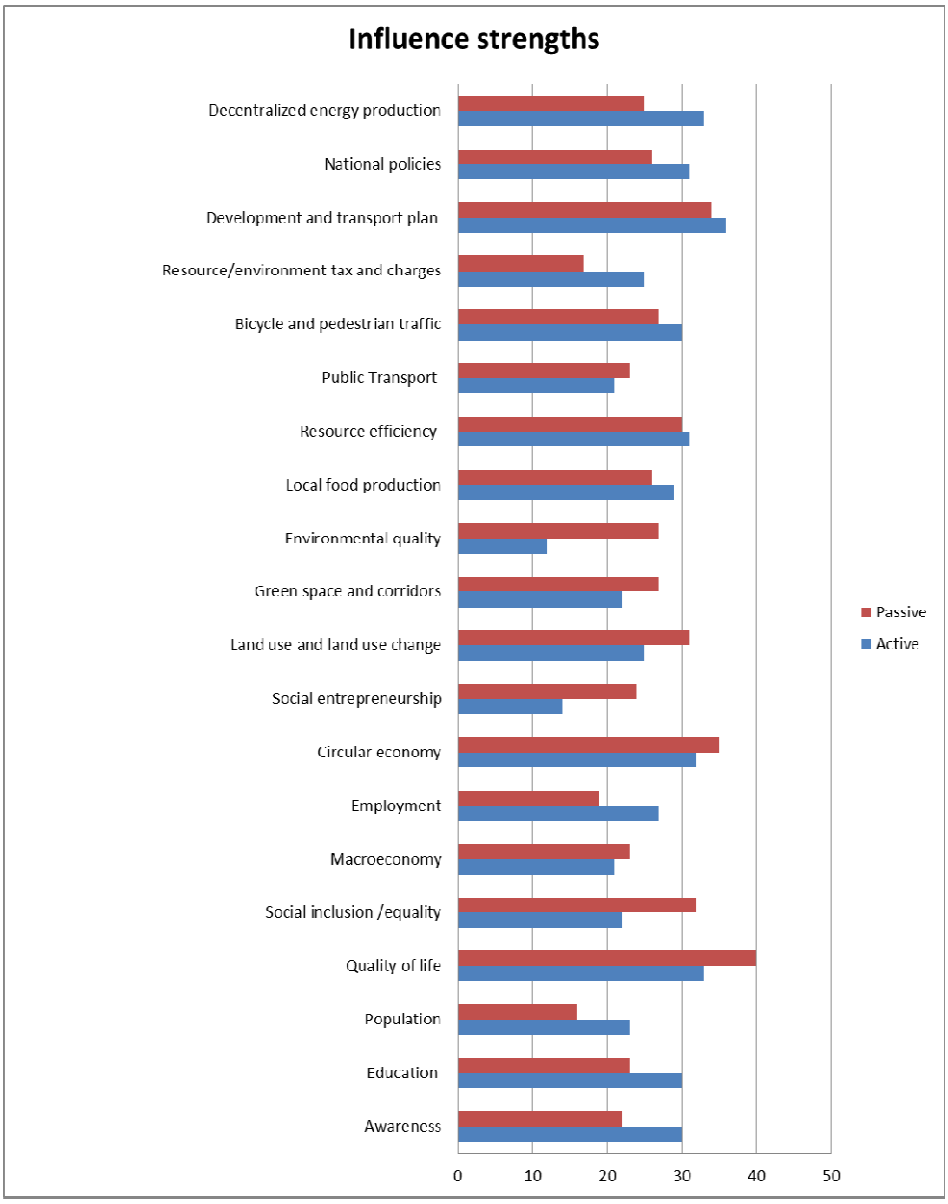


Figure 26: Bar chart for influence strength of the Zagreb matrix variables.

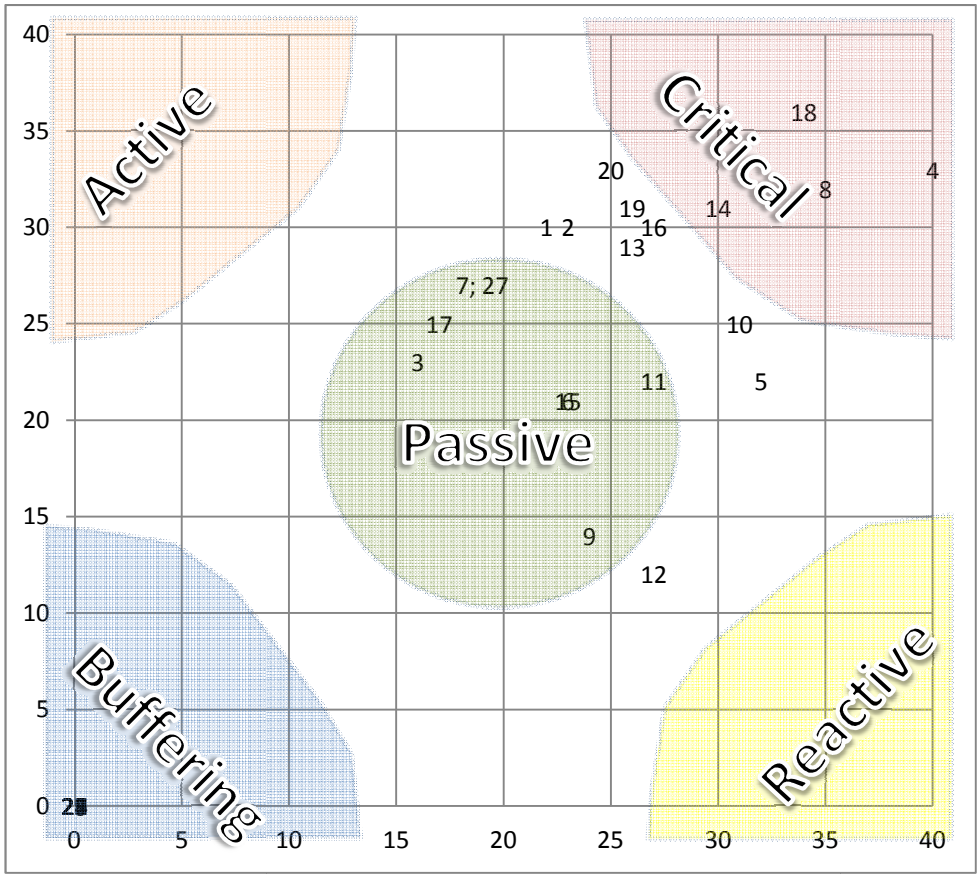


Figure 27: Systemic role figure for Zagreb.

Table 28: The degree of how active or passive are the variables for Zagreb

ACTIVE-PASSIVE RANKING	VARIABLE NO.	VARIABLE NAME	P-VALUE
Slightly active	17	Resource/environment tax and charges	1.47
Slightly active	3	Population	1.43
Slightly active	7	Employment	1.42
Slightly active	1	Awareness	1.36
Neutral	20	Decentralized energy production	1.32
Neutral	2	Education	1.30
Neutral	19	National policies	1.19
Neutral	13	Local food production	1.11
Neutral	16	Bicycle and pedestrian traffic	1.11
Neutral	18	Development and transport plan	1.05
Neutral	14	Resource efficiency	1.03
Neutral	8	Circular economy	0.91
Neutral	15	Public Transport	0.91
Neutral	6	Macroeconomy	0.91
Neutral	4	Quality of life	0.83
Neutral	11	Green space and corridors	0.81
Neutral	10	Land use and land use change	0.81
Slightly passive	5	Social inclusion /equality	0.69
Passive	9	Social entrepreneurship	0.58
Passive	12	Environmental quality	0.44

Table 29: The degree of how critical or buffering are the variables for Zagreb

CRITICAL – BUFFERING RANKING	VARIABLE NO.	VARIABLE NAME	Q-VALUE
Highly critical	4	Quality of life	1320
Highly critical	18	Development and transport plan	1224
Highly critical	8	Circular economy	1120
Highly critical	14	Resource efficiency	930
Critical	20	Decentralized energy production	825
Critical	16	Bicycle and pedestrian traffic	810
Critical	19	National policies	806
Critical	10	Land use and land use change	775
Critical	13	Local food production	754
Critical	5	Social inclusion /equality	704
Critical	2	Education	690
Critical	1	Awareness	660
Slightly critical	11	Green space and corridors	594
Slightly critical	7	Employment	513
Slightly critical	15	Public Transport	483
Slightly critical	6	Macroeconomy	483
Neutral	17	Resource/environment tax and charges	425
Neutral	3	Population	368
Neutral	9	Social entrepreneurship	336
Neutral	12	Environmental quality	324

IX.II PCIA WORKSHOP REPORTING

IX.II.I GENERAL INFORMATION

WORKSHOP DATES AND LOCATIONS

Date: May, 28, 2015

Location: UNDP Croatia, Radnička Street 41, 10000 Zagreb

PARTICIPANTS

Many sectors were represented by the 12 participants, who came from diverse institutions and fields: Nongovernmental Organizations, Institute of Social Science, Political Foundation, National Energy Institute, social enterprise, energy company, Faculty of Mechanical Engineering and naval architecture, Faculty of Architecture, Association of Architects of the city, media representatives, health institute, ethical bank and others (see Table 30).

Table 30: List of the participants for Zagerb PCIA workshop

NAME OF THE PARTICIPANT	AFFILIATION	PRESENCE AT WORKSHOP 1	PRESENCE AT WORKSHOP 2	PRESENCE AT WORKSHOP 3
Valerija Kelemen Pepeonik	City Office for Strategic Planning and Development of the City	YES	YES	no
Vladimir Lay	Institute of Social Sciences Ivo Pilar	YES	no	YES
Jelena Puđak	Institute of Social Sciences Ivo Pilar	YES	YES	no
Tomislav Tomašević	Heinreich Boell Stiftung	YES	no	YES
Tena Petrović	Zagreb Society of Architects (DAZ)	YES	YES	YES
Lidija Srnec	Croatian Meteorological and Hydrological Service	YES	YES	no
Željka Fištrek	Energy Institute Hrvoje Požar	YES	no	no
Željko Jurić	Energy Institute Hrvoje Požar	no	YES	no
Gordana Dragičević	NGO Parkticipacija	YES	YES	YES
Vladimir Halgota	NGO Cyclists Union	YES	no	no
Vera Đokaj	Cluster for Eco-Social Innovation and Development CEDRA	YES	YES	no
Edo Jerkić	Energy Cooperative ZEZ	YES	YES	YES

NAME OF THE PARTICIPANT	AFFILIATION	PRESENCE AT WORKSHOP 1	PRESENCE AT WORKSHOP 2	PRESENCE AT WORKSHOP 3
Maja Božičević	Society for Sustainable Development Design (DOOR)	YES	YES	**no**
Žana Barišić	Political Party ZA GRAD	YES	no	YES
Lin Herenčić	Energy and Environmental Protection Institute	YES	YES	no
Kata Marunica	Zagreb Society of Architects (DAZ)	YES	no	no
Matijana Jergović	Health public institute	YES	YES	YES
Goran Krajačić	Faculty of mechanical engineering and naval architecture	YES	YES	YES
Ivan Kardum	Ethical Bank	YES	no	YES
Rene Lisac	Faculty of architecture	no	YES	no
Kristina Careva	Faculty of architecture	no	YES	YES
Cvijeta Biščević	NGO Parkticipacija	no	YES	no
Marina Kelava	Association for Independent Media Culture	YES	YES	YES
Neven Višić	NGO e-Student	no	YES	no
Robert Pašičko	UNDP Croatia	YES	YES	YES
Sandra Vlašić	UNDP Croatia	YES	YES	YES
Zoran Kordić	UNDP Croatia	YES	YES	YES

FORMAT AND METHODOLOGY

The format outlined in the PCIA guidelines, as well as experience gained from Malmö workshop was followed for the workshop. The only modification was that the results from the three groups (the number of groups was decided prior to the workshop) for top 6 variables were integrated immediately into the excel tool. This enabled participants to see how the selected variables influenced the system before the end of the workshop.

PRESENTATION

The stakeholders mainly agreed that the variable set chosen by the case study team before the workshop, covered all the issues related to Zagreb. However, they thought that some variables were not sufficiently defined and they were therefore modified after discussion.

The main discussions related to: governance and including citizens in decision making; finding a suitable balance between top-down, policy makers, and bottom-up, community led interventions. Zagreb's ecological problems were also discussed and new variables suggested were: effective citizens participation, waste management, and effective energy management. Out of 23 proposed variables, a

refined list of six was selected for a group exercise on scoring the impact matrix. The main purpose of this was to increase the participants' understanding of the impact matrix. The most important variables selected for this exercise were: education, resource efficiency, circular economy, effective citizens participation, land use and social equality

Each group then scored these in an impact matrix, and the analysis showed that each of the variables was either critical or highly critical (seeTable 31) . Efficient management and participation was introduced by participants as a new variable.

Table 31: The top 6 variables from the group exercise.

Highly critical	4	Social equality
Highly critical	6	Land use
Highly critical	3	Circular economy
Highly critical	2	Resource efficiency
Critical	5	Effective citizens participation
Critical	1	Education

IX.II.II GENERAL REMARKS

There were no new people at the workshop compared to previous workshops. The group was enthusiastic about the project outcome and interested to try out different methods and approaches.

The methodology of the impact matrix was initially somewhat confusing, but understanding increased after further explanation and the group became enthusiastic. There was a general feeling from the group that the method was interesting but insufficiently developed.

However, the hands-on approach rather than only discussion was warmly welcomed by the group. At the end, they were satisfied to have experienced this new approach. Showing them the results from excel tool for top variables right before the end of the workshop proved add value for the participants.

X DISCUSSION AND CONCLUSIONS

X.I THE PCIA PROCESS

Overall, the PCIA process has helped identify the main variables (or factors) that are important for the modelling and quantification stage (the next stages of WP5) of each individual city.

The initial analysis stage by the case study leaders went well and seems to have been quite straight forward, as there were limited follow-up questions. The understanding of the PCIA process amongst the case study leaders appears to be generally good, although there does appear to be a difference in the approach to scoring the matrix. For instance, some scoring was very "generous" or high (in the case of Zagreb, Milan/Turin) whilst other (e.g. Litoměřice) was quite minimal. Although as long as the same consistency was applied to all scoring, this should not have significant impact on the overall findings. This is because we anticipate that the influence will be still be scored in proportion to other variables and the most important variables will still receive the highest overall scoring.

In addition, as the work was then presented to the stakeholders in the PCIA workshops, there was an opportunity for review and further iterations. However, it does appear the high scoring has made the city systems appear quite "critically" balanced in that there are more variables with a high criticality score. In some cases, such as Zagreb though this appears to quite accurately reflect the reality, because there is a certain degree of political instability and many factors could lead to either positive or negative change.

The adapted process is somewhat open to criticism in that the main identification of the variables and the scoring of the matrix are performed by the case study leaders. This is opposed to the Sensitivity Model process that generally constructs the variables and the matrix with a group of stakeholders. However, in defence, the PCIA process is still an iterative process and the workshops were designed to verify and draw out the opinion of the stakeholders. In that sense it is fairly robust (relative to the Sensitivity Model), and has the option for further iterations if necessary, just as with the SM.

On the whole, the PCIA workshops were viewed favourably by the participant and it helped them understand how different variables within their cities influenced one another. There was also general agreement on the findings of the initial analysis and the impact matrix.

X.II PCIA ANALYSIS

Table 32 and Table 33 shows the summary of the most active, critical and reactive variables for each city (where a PCIA workshop has been performed). Active variables are those that have a strong effect on other variables in the system. The larger the critical value of a variable, the greater the role that variable has in affecting the way a system behaves. Reactive variables are according to the SM literature generally good indicators, which is what was found from the PCIA exercise.

There are quite a few similarities with typically economy/circular economy and mobility being common critical variables, whilst renewable energy, resource/energy efficiency and policies being very active variables.

Table 32: Main active-passive variables for the case study cities

	Barcelona	Copenhagen	Litoměřice	Malmö	Rostock	Zagreb	Milan/Turin
Active	• National policies • Population • Governance • Industrial areas • Tourism • Robust economy	• Compatibility of national policies with local plans and strategies • Economic incentives to drive behaviour • Urban plans and strategies in energy, waste, transport • Balance between development and green spaces	• Improving the energy performance of buildings • Industry in the city and its surrounding • Information and communication technologies in transport • Natural disasters (floods) • Education and awareness	• National policies • Segregation of housing • Robust economy • Resource/ environment tax & charges	• Budget Deficit • Building Density • Demographic Trend (age > 65) • Sustainable Housing	• Resource/environment tax and charges • Population • Employment • Awareness	• Post-carbon strategic planning
Passive/ reactive (indicators)	• Water body quality • Attractiveness • Quality of life • Waste management • Heat islands	• Corridors for biodiversity • Water quality • Waste recycling • Circular consumption	• Quality of life • Quality of environment • Energy self sufficiency • CO2 emissions • Air quality • Waste production	• Quality of life • Attractiveness	• Air quality • CO2 emissions	• Environmental quality • Social entrepreneurship • Social inclusion/equality	• Air quality • Natural and green areas • Soil consumption

Table 33: Main critical and buffering variables for the case study cities

	Barcelona	Copenhagen	Litoměřice	Malmö	Rostock	Zagreb	Milan/Turin
Critical	• Robust economy - business/financial service /IT • Attractiveness • Environmental Awareness • Governance • Green transport • Quality of life (interaction)	• Urban plans and strategies in energy, waste, transport • Bike network • Balance between development and green spaces • Robust economy based on service and knowledge industries • Traffic pollution management	• Economic development of the city • Energy consumption • Traffic volumes	• Circular economy and sharing • Development and transport plan • Land use • Public Transport and bike network • Robust economy	• Resource Efficiency (DMC) • Energy Intensity (TOE/EUR) • Economy (GDP per capita) • Renewable Energy (%) • Municipal Management	• Quality of life • Development and transport plan • Circular economy • Resource efficiency • Decentralized energy production	• Sustainability awareness • Policies for resource efficiency • Circular economy • Post-carbon strategic planning • Smart city policies
Buffering	• Heat islands • Energy efficiency • Public space • Water body quality	• Economic incentives to drive behaviour synergies with agriculture • Quality of the water in the surroundings • Reuse of raw materials, water, building and construction materials • Compatibility of national policies and local	• Energy flows optimisation • Information and communication technologies in transport • Energy self-sufficiency • Economic development of the region • Improving the energy performance of buildings	• Smart logistics • Segregation of housing areas • National policies • Resource/environment tax and charges • Industrial areas	• Waste management • Demographic trend (>65) • Equal pay by gender	*(no buffering variables were found, the below were classed as neutral)* • Environmental quality • Social entrepreneurship	*(no buffering variables were found, the below were classed as neutral)* • Demographic structure of the population • Social inclusion • Human capital enhancement

As systems, Copenhagen, Zagreb, Rostock and Milan/Turin appear quite critical with more critical variables than the others. This could signify that the systems are relatively unstable, but could also be partly the result of high scoring within the impact matrix, or that some balancing/buffering variables are missing. From a systems analysis few point however, this means that there are many "accelerators and catalysts" that could be used to stimulate change in a desired direction. However, caution is required in the use of critical variables as change can be significant. These can also be considered as risk factors.

In contrast, Litoměřice has many variables towards the bottom-left hand corner of the systemic role figure, meaning there are more buffering variables. However, Litoměřice also has a fairly high number of active variables meaning there are quite a few "control levers" that can be used to balance the system.

In each system, it is important to identify those variables which can be considered in the modelling and quantification of the BAU and PC 2050 scenarios. These are the factors that are important to consider in how they will mould the city system towards 2050.

Typical reactive variables were found to be water body quality, quality of life, air quality, environmental quality (or corridors for biodiversity/natural green areas) and CO2 emissions. Quality of life was a consistent highly reactive variable – which is why it makes a very suitable indicator (although quality of life is itself difficult to measure directly and requires further indicators). However, in the case of Zagreb quality of life actually came out as one of the most critical variables, which perhaps demonstrates the importance of this variable to the city (and possibly the desire to improve it).

In the Malmö case, one criticism from the workshop attendees, of the initial impact matrix analysis was that buildings / built environment should be more important than was illustrated. However, this is one of the uses of the impact matrix, in that it can help identify which variables are important as opposed to those that are *perceived* to be most important. That is the intended purpose of the PCIA exercise – to remove political and subjective opinion in order to be able to focus on the variables that are important for the system.

Schools and education are usually high on the list of important factors in a city or country, but the PCIA exercise demonstrated that generally they have little effect on the systems analysed. That is in the current systems, where generally in European countries standards are already at a good level, above that which would cause a significant effect on the system. That is not to say that if standards dropped to a very low level that the rest of the system would not be affected, but currently standards are generally high enough not to affect the system significantly. However, awareness was shown to be critical for Milan/Turin and active for Litoměřice (although this was actually Education and awareness.

In summary, the PCIA process has identified some unique factors that can be focussed on in the modelling and quantification stages of WP5. The most prominent common variables are as follows:

- economic based,
- improving energy efficiency,
- developing renewable energy,

- resource efficiency/circular economy,
- creating awareness amongst citizens,
- traffic/mobility.

These will generally be considered for all cities in the modelling. Variables that attain high passive scores may also deserve as much attention in the quantification stages of the POCACITO project.

Individually for the cities, variables shown in Table 34 are uniquely important for a particular focus in the modelling exercise and the quantitative assessments, of WP5 to the corresponding cities. The table has divided the top active and critical variables into either social, environmental, economic or strategy/policy and plans. This helps highlight which areas are important for each city and appears to largely reflect what we may expect is important for the cities. Zagreb for instance, which has one of the lowest GDP's of the case study cities has a focus on social related issues such as population, employment and quality of life.

The next stage of modelling will also need to decide how to incorporate the fact that variables such policy variables were high on the list for some cities, and especially Milan/Turin (but also Malmö and Zagreb). However, in the case of Milan-Turin there appears to be an imbalance in the system, which will require further investigation. This is because the variables are very policy and strategy biased which are largely not quantifiable in terms of sustainability impact. This seems to reflect a bias from the case study leaders in the case study team, and may need further revision of the variables and iteration of the impact matrix.

Policies are important, but are not variables that can be quantified for BAU or 2050, but can be incorporated in the individual actions and milestones which will influence the probable 2050 scenarios.

Table 34: Individual important factors for consideration in the modelling and assessment

Type of variable	Barcelona	Copenhagen	Litoměřice	Malmö	Rostock	Zagreb	Milan/Turin
• Social	• Attractiveness • Quality of life (interaction) • Population	•	•	• Segregation of housing	• Demographic Trend (age > 65) •	• Population • Employment • Quality of life •	•
• Environmental	•	• Bike network • Balance between development and green spaces • Traffic pollution management •	• Natural disasters (floods) • Improving the energy performance of buildings •	• Land use • Public Transport and bike network	• Building Density • Sustainable Housing • Green Space and Corridors •	• Decentralized energy production •	•
• Economic	• Industrial areas • Tourism	•	• Industry in the city and its surrounding •	•	• Budget Deficit •	•	• Economic specialisation*
• Plans and strategies and policies	• Governance • National policies •	• Economic incentives to drive behaviour • Urban plans and strategies in energy, waste, transport • Compatibility of national policies with local plans and strategies •	•	•	•	• Development and transport plan •	• Post-carbon strategic planning • Policies for resource efficiency • Smart city policies
Passive/ reactive (indicators)	• Water body quality • Waste management • Heat islands	• Corridors for biodiversity • Water quality •	• Quality of life • Quality of environment •	• Quality of life • Attractiveness	• Air quality • CO2 emissions	• Environmental quality • Social inclusion/equality	• Air quality • Natural and green areas • Soil consumption

**This variable resulted from the Milan-Turin workshop*

X.III NEXT STEPS

The identified variables now need to be considered alongside the findings from the initial assessments of WP3 and D4.2 (Report on Stakeholder Workshops) to see what should be modelled and focused upon in each individual case study.

The scoring of the PCIA matrices can make quite a difference as to which variables appear “on top”. Some of the currently highlighted variables are followed quite closely in the table by other variables, so there will have to be considered alongside the others in the modelling process. This will be determined not only by which variables appear at the top, but by considering other information on what might be important in 2050, what can be modelled and what data is available and whether some of the variables are, or can be, covered by other variables or indicators.

Hence the modelling task in WP5 will now need to translate these variables into a set of indicators in order to model each city individually.

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