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Morgenstadt: CityInsights. A Research Approach for Systems Research in Urban Development

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1 ABSTRACT

The biggest part of economic activity worldwide is already happening in cities, and the share of urban dwellers is rising continuously: by 2030 almost 5 billion people will be living in cities. Prof. Hans-Jörg Bullinger, the former president of the Fraunhofer Society said: "Cities are responsible for up to eighty percent of global greenhouse gas emissions. Whoever is the first to find the key to Morgenstadt [future cities], in other words a system approach to redesigning existing and newly emerging cities that are sustainable and enhances the quality of life, will chart the way for what may be the largest future market for the next few decades."

To tackle the this challenge, the Fraunhofer Society launched an innovation network called Morgenstadt: City Insights. For this system research initiative, 12 Fraunhofer institutes work together to analyze innovative solutions for a sustainable city. For this goal we developed a holistic research approach to analyze the city system in its interdependent structure. The following paper is an extract of the Morgenstadt: City Insights project description and the general research desig (Schatzinger et al. 2012; Fraunhofer-Institut für Arbeitswirtschaft und Organisation IAO 2012). We will describe in this paper the need for a systematic and holistic approach in city analysis and illustrate a possible research approach to do so.

2 INTRODUCTION

The urban knowledge economy is facing a tremendous transformation that will affect our society technologically, organisationally and systemically. Not only will individual technological sectors, such as energy or mobility, be affected but because the implementation of these sectors were highly cross linked, especially in cities and urban regions, the change in one sector will affect all others and the urban system itself as well. Particularly with regard to the reconstruction of the energy supplies, a holistic and systematic analysis of the city as the central anthroposphere of the modern society will be a critical success factor for future development. The challenge for a liveable and sustainable city will be the upcoming decisions regarding the long-term strategic orientation in the city. To achieve this goal it is essential to consider the interdependence of the involved sectors, as well as discernible trends, and adjust flexibly to future variances.

The trends that are essential for future city development towards a sustainable city and can already be seen today are: urbanization, rising resource consumption, demographic change, climate change, mobility, information and communication technologies, and civic participatio (Bundesregierung Deutschland 2012). Since 2007 more than 50 % of the world population live in an urban area. The urbanization process will lead to more than 70 % of urban residences in the next three decades (Heilig 2012). Together with the increase of the world population to 9.2 billion people, the population shift from the rural to urban areas will double the need for urban living space. The demographic change in the western civilizations will change the urban structure to a more elderly friendly city that requires new regulation and accommodation concepts. Even in a shrinking society such as Germany, the resource consumption of our growth oriented economy will lead to a higher consumption per capita. The climate change will force the society to rethink this growth strategy. Here the urban regions are the problem and the solution at the same time (Glaeser 2012). Today the urban regions are responsible for about 80 % of the CO2 emissions (WWF 2010). but one can already see the potential of these regions to be an important part of the solution because of the scaling effects. In highly urbanized countries the metropolitan areas have a lower CO2 balance per capita than the rural areas. One of the many reasons is the change in the mobility system. The traffic collapse in cities like London and New York, but also the rethinking process of more and more young people who don't see a car as a status symbol, leads to an increased demand for public transportation systems. These systems are especially profitable in high density areas where enough people use the system. The public transportation systems as well as vehicle sharing models and electro mobility will change the way we travel in the next decade to a more sustainable mobility. This will require new urban structures that have the potential to change the city to provide more

quality of life in the city. A lot of these trends require more sophisticated information and communication technologies. The increasing digitalization of our habitat by mobile internet and spatial cross linking of real time information allows an intelligent reconstruction of existing systems and offers the opportunities to create new approaches. These new approaches for a Smart City will already be developed in numerous research projects, but the potential according to sustainable urban development are still unexploited. One of the new opportunities is increased civic participation. Major projects in urban areas provoke socio-political discussions of a more and more informed population that wants to be part of the political process. Information and communication technologies can be an option to gain a sustainable consensus through population

If we take a look at these enormous change dynamics while taking the low adaption rate of the cities into consideration, then it becomes clear that a singular change of single fields of action and planning areas can't be a solution according to the challenges the urban areas are facing. To tackle long-term sustainable strategies we have to synchronize the long-term and short-term innovation cycles, which are still developed independently (e.g. the fast development of the ICT sector versus the long-term life cycles of the transport infrastructure). Therefore, Fraunhofer launched the research initiative Morgenstadt – Future City with the goal to develop a consistent model for a sustainable urban development strategy that takes not just one sector into account but all, especially interdependent connections between the sectors. We understand Morgenstadt as a vision of a sustainable and liveable city. Therefore, we do not address only an urban center, but future cities will be more an interrelated structure of the city with their urban surrounding region.

The strategic focus of this project lies in discovering systemic approaches that successfully respond to the increasing problems of the selected technology fields in leading cities (see Figure 1). By detecting and analyzing innovative but already field-tested approaches, we evaluate their feasibility for new and complex environments and demands for an urban future. To verify this we pool expertise to develop smart and individually customized strategies together with our network partners, aiming at the future requirements for further concepts' efficient implementations. Adapted to distinct functions and consumers, unique but holistic and trans-sectoral solutions should be anticipated to meet future urban challenges and shape tomorrow's sustainable cities.

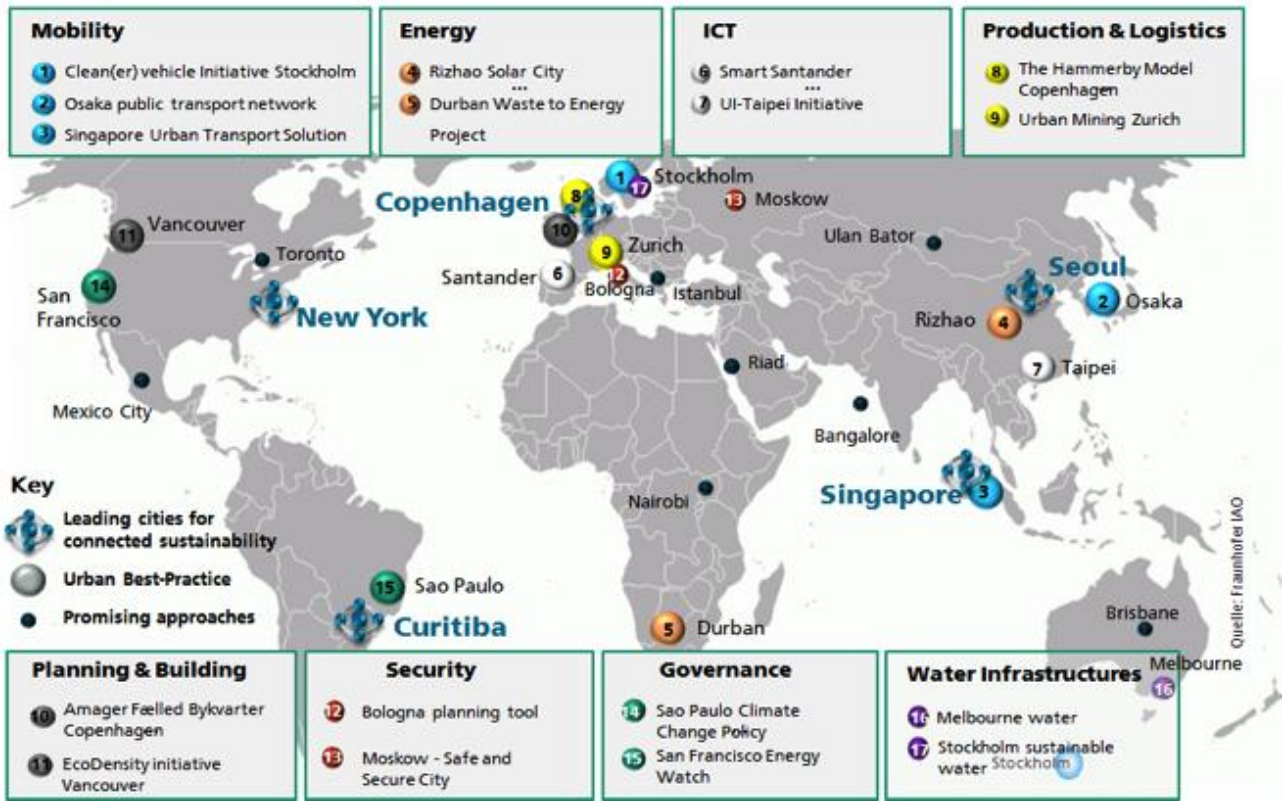

Figure 1: Exemplary overview on existing global best practices for sustainable city solutions

3 PROJECT APPROACH

The goal of the Morgenstadt: City Insights project is to identify the status quo and establish a starting point for the research and development of innovations for urban systems. For this we will develop a systematic understanding of the investigated cities and describe a generalized fundamental model of the urban city system based on the investigated cities.

In the past, one of the greatest challenges in researching cities has been how to manage the high level of complexity inherent to urban systems. Sector-specific analyses conducted by experts of various disciplines allows for in-depth research into specific individual areas of interest. This type of research results in highly specialized solutions for individual areas of application within the city, which represent only isolated solutions within specific fields that do not fit into the city system context as a whole. Innovative facades, local energy production via solar panels, electric vehicles and the ubiquitous availability of information via smart phones are impressive examples of such an approach, and have undoubtedly been successful. In order to analyze and shape sustainable city systems, however, a detailed inspection of individual sectors as well as a systematic analysis of the city as a whole is necessary. Therefore, the project structure is defined by three work packages. The first preliminary research module is the preparation of a global survey on existing urban solutions and detailed studies on future cities. This is followed by a second in-field research module covering in-depth studies in the jointly identified leading cities worldwide. The project will be completed by a third research module compiling the results, comparing the cities and developing a prototype model of an urban system. To achieve this, the project analyzes the following eight most important technology sectors of the city of tomorrow with respect to best practices, ground-breaking pathways and existing challenges and innovation barriers that have to be overcome. As facilitator to the organization of city-systems, governance represents a key-scope of the analysis. In addition, the field of security, representing a genuinely cross-sectional system of importance for all other sectors, will be analyzed in detail.

Mobility

How can the masses of people in tomorrow's cities be moved most effectively while at the same time assuring quality of life and zero impact on the environment? Highly efficient mass transit systems, like in Hong Kong, or emission free mobility-on-demand solutions represent some of the ground-breaking solutions to be analyzed and developed further.

Energy

The future city will not depend on fossil energy. Renewable energies, energy efficient technologies and communicating energy grids will become the drive-train of tomorrow's cities. But where will the energy be produced? Today, energy-plus-houses already produce more green energy than they need. Integrated community energy solutions that link houses, wind- and solar parks, biomass sites and electric vehicles can be a starting point for an integrated urban energy system of the future.

Communications

Technologies already exist that enable communication between devices, buildings, vehicles and people. Geographic information processing, wireless internet and smart-phone technology possess almost infinite potential for the development of smart solutions for urban systems. Some cities like Qatar or Mannheim already try to make use of this potential and thereby provide the framework for innovative business- logistic- and transportation processes.

Buildings

There are several ground-breaking technologies that allow buildings to communicate with their environment, to produce more energy than they consume and to work with light, biomass and air from the local environment. In a future city these technologies will be integrated into systems that allow groups of buildings to create closed cycles of energy- and material flows and to shape the micro climate of a city.

Production and Logistics

The big challenge of future urban systems is the smart and sustainable use of resources. Full integration of advanced recycling, recovery and reuse techniques into urban material flows and the holistic use of cradle-to-cradle systems for production, services and consumption will be imperative for the sustainable megacity of tomorrow. This also implies innovations in product design with a highest possible share of biodegradable

materials or recyclable product concepts. Smart city logistics complete a resource efficient production chain for sustainable distribution of goods within our cities.

Governance

A new urban paradigm needs efficient governance concepts that enable participation and acknowledge the complexity of systems innovation. Frontrunners like Zurich, Copenhagen, Amsterdam or Sydney are already working with systems that integrate citizens into decision structures and create smart collaborations between city administrations, innovative companies and research institutes.

Security

The resilient city of the future will integrate security concepts and systems at the design stage of urban planning and policy implementation, therefore ensuring the capability to identify and dominate emerging risks as well as to effectively manage catastrophic situations and quickly return to normal status. New smart and multifunctional protection technologies and materials complemented by sophisticated planning tools will ensure the security of the future urban system while not affecting the civil liberties of its citizens.

Urban Water Infrastructure

Full integration of advanced water treatment, recovery and reuse techniques into urban systems will be imperative for the sustainable city of tomorrow. This implies innovations in the water supply and sanitation sector with a highest possible share of recovery of energy, water and nutrients and interlinkage to other sectors for most efficient resource reuse.

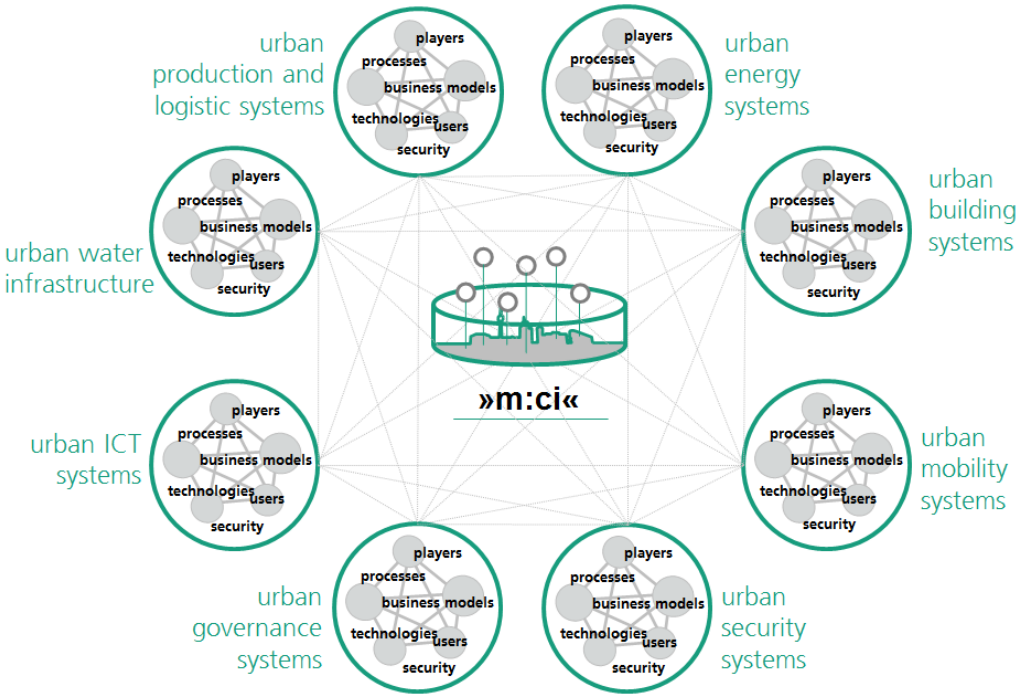

Figure 2: Determination of the main urban systems as relevant drivers for sustainable cities.

In addition, both the research design and the data collection need to establish the foundation that will enable the transfer of solutions such as future system innovations. In order to achieve this, we developed an approach entitled City Insights Engineering (CIE) at Fraunhofer. In four consecutive steps, based on the analysis of currently existing urban system solutions, this approach is designed to generate exemplary processes for the transfer of successful solutions, as well as to facilitate the development of additional solutions for the sustainable transformation of cities.

City Insights Engineering is a long-term concept which aims to systematically build on the data collected within the Morgenstadt: City Insights project. Morgenstadt: City Insights thus represents the starting point for a long-term, systematic research of cities. In Phase I (analyze) the focus will be the analysis of the current situation in the city as well as the holistic and sector-overlapping analysis of existing Best Practice examples in the according city. In Phase II (explore) we analyze the prospective development of each Best Practice Example with the sector specific scientific methods. We further assess the frame conditions of the according

field of application for each best practice example. Both phases take place before and during the particular field trips in the according cities. In Phase III (design) we will focus on the definition of requirements for the analyzed best practice examples. For this we will perform a multi level analysis of actors, business models and use processes. A very important aspect will also be the interdependent interrelation of the individual players in the different sectors. In the last phase, Phase IV (transfer), we analyze the city's independent systematic relationships and effects.

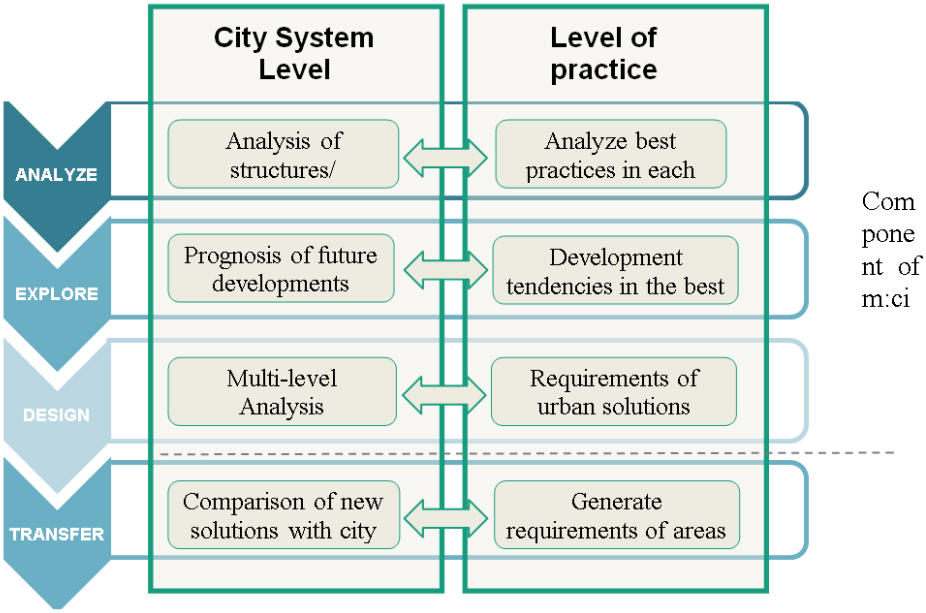

Figure 3: Application of the research approach to both levels

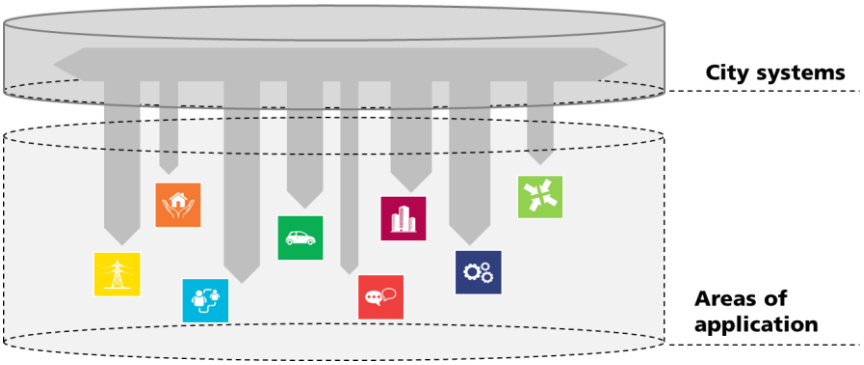

Figure 4: System analysis of cities on two levels

To link the data and information, which are generated on both levels, a transdisciplinary research approach is necessary. With such an approach, relevant actors on the city level, processes and structures, as well as general drivers of the city system as a whole can be identified, analyzed and described. Alongside a continual dialogue between the transdisciplinary City-Team, two workshops (the so called Morgenstadt Labs in each of the investigated cities) represent the most important transdisciplinary element within the Morgenstadt: City Insights project. These are transdisciplinary workshops in which Fraunhofer researchers analyze, reflect upon and transform their findings and hypotheses into additional research questions.

3.1 From sectors to areas of applications

To achieve the set goals of the Morgenstadt: City Insights project we have to come from the individual sectors to a comprehensive model of the city with all its subsystems and components. For this we divide the research process into seven phases which are shown in Figure 5. By taking apart and interpreting existing practice examples and exemplary sustainable solutions, the research design shown in this figure attempts to recognize and describe systemic interconnections between various key drivers. While at first different sectors such as mobility, energy or ICT are still considered individually to make an initial structuring of the current practice examples possible, the final result of the current research phase will present new multidisciplinary areas of application which can provide valuable information on promising technologies, industrial markets,

forms of cooperation, implementation processes and business models. The research process within the CIS model is shown in Figure 6.

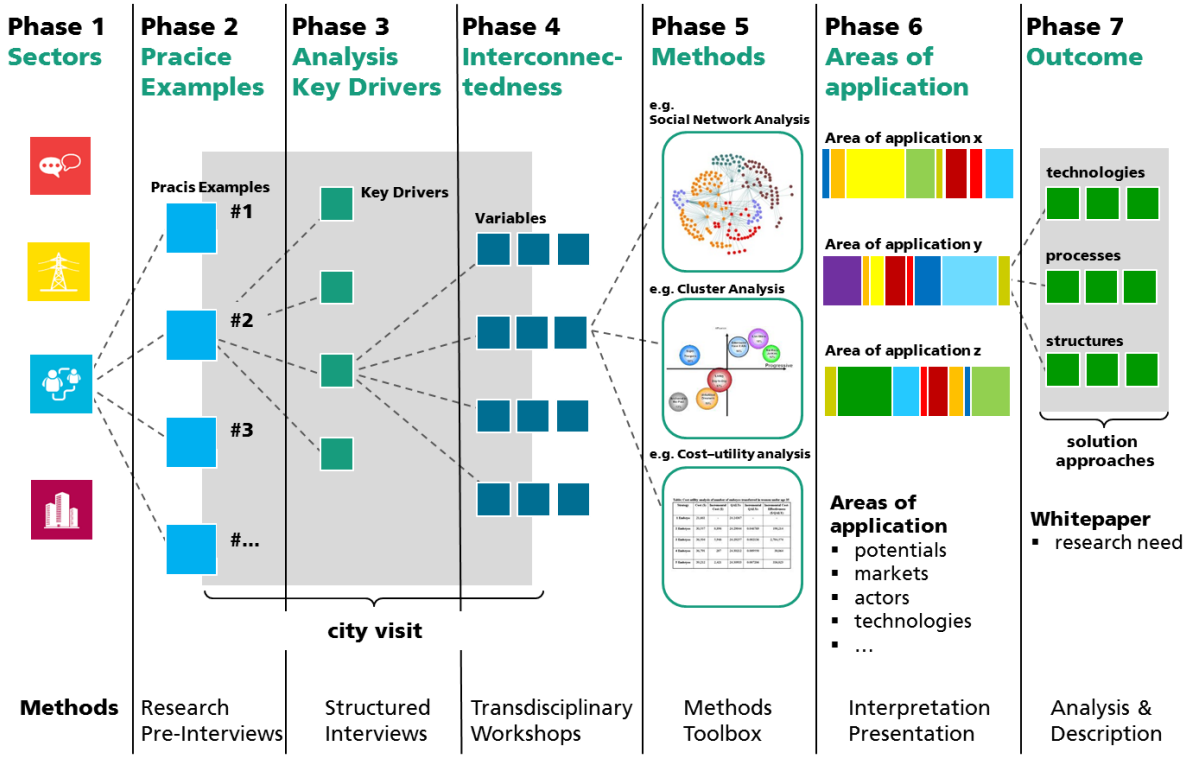

Figure 5: Overview of the research process from sectors to areas of application

The two-week research stay in the cities themselves provides the opportunity to analyze the practice examples in a transdisciplinary and coherent manner and to understand each within its particular context. The practice examples will be broken down into key drivers which, in a joint venture with additional experts, will be evaluated regarding their future effects (for example technical, process-related, regulatory or other changes in the future) and then compiled into new areas of application in regards to the entire city system. This will be done with the help of appropriate scientific methods such as Social Network Analysis, Cluster analysis, SWOT Analysis, or cost-utility analysis.

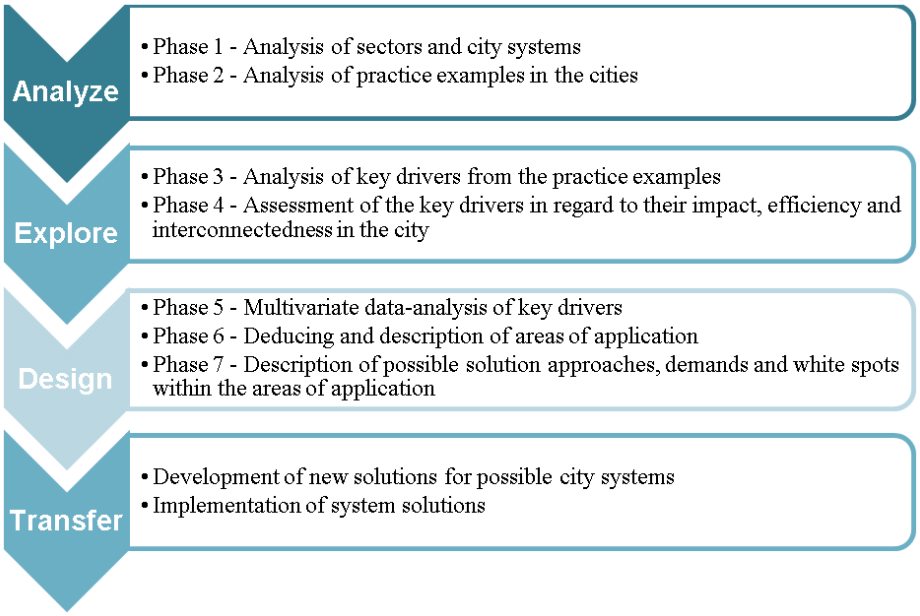

Figure 6: City Insights Engineering model with integrated research process

3.2 Structure of the research stays within the cities

After the preparatory phase, a team of Fraunhofer experts (the City Team) will travel to the city, to spend at least two weeks on-site answering and developing upon the existing research questions.

In the first week, each City Team member will interview experts from within their particular sector, analyze practice examples and outstanding sustainable solutions within that sector, and document and interpret the data collected. Interviews can be conducted individually, however, researchers aim at conducting them in a two-person team. At the same time, each City Team member will formulate hypotheses regarding the current and future suitability of the solutions they are researching. Near the end of the first week, the entire City Team will participate in a joint one-day workshop: the Morgenstadt Lab I. The purpose of this workshop is to discuss and verify the insights and hypotheses gained during the first week with the other Fraunhofer experts looking at different sectors. The goal is to analyze and describe success factors that are relevant to all sectors on a city level. Patterns and structures at work within the city can thus be understood.

The second week is dedicated to deepening the data collection phase. Using the insights resulting from the Morgenstadt Lab I, additional interviews, analyses, and observations will be conducted within each of the sectors. The interviewees may include new individuals; however, the goal is primarily to deepen the questions and to consult the original interviewees on these questions as well. All data collected will be documented immediately. The Morgenstadt Lab II is scheduled for the end for the research stay. The same procedure will be applied as in the Morgenstadt Lab I. In addition, previously defined urban framework conditions will be discussed in terms of their relevance to the city in question. The goal is to capture and document the most important key drivers on a city level.

4 NEXT STEPS

The first work package of the Morgenstadt: City Insights project consists of the research of global best practices and the definition of leading cities in the field of urban sustainability. With the desktop research, we evaluated more than 50 cities and extracted 80 best practices. The result is a catalog of existing approaches towards improving urban sustainability (Fraunhofer IAO et al. 2012). The aim of this research was not only to identify inspiring and trendsetting solutions for future cities, but also to find examples of cities that are already performing extraordinarily well in terms of linking sustainable solutions from various fields and thereby creating a systemic approach towards becoming a sustainable city. Many of the solutions under analysis were shown to be relevant not only for one specific sector but also for the city system as a whole, featuring several important cross-linkages with other sectors. Trendsetting energy solutions often rely on innovative ICT systems, as do mobility systems that aim to reduce emissions and enhance traffic flow. Building standards, transport regulations or carbon finance approaches cannot function without sound governance and long term planning reliability.

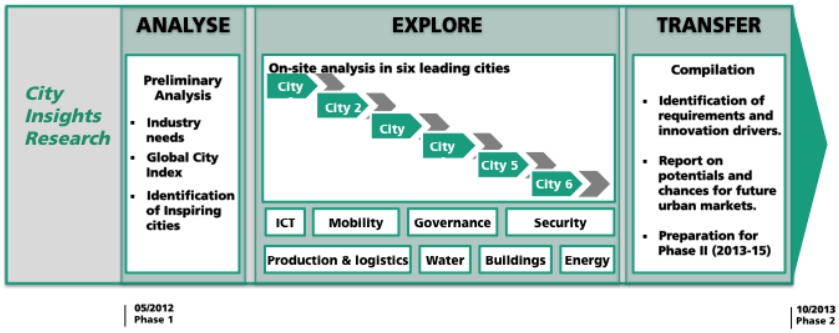

Figure 7: Morgenstadt: City Insights research process

We therefore selected 12 cities by more than 26 quantitative and qualitative indicators with 35 trendsetting solutions that were comprehensively described in the catalog. From these 12 cities we selected, together with our partners, six cities (Freiburg, Berlin, Copenhagen, New York, Tokyo and Singapore) that will be analyzed in field excursions by Fraunhofer researchers in the next six months. In the field excursions, a Fraunhofer expert from the according sector will do narrative expert interviews with experts from the to be examined best practices and the government in the according city. With these interviews, we assess the essential frame conditions and key actors at the city level and relate them to the project level. Each practice example will than be analyzed within a holistic framework, researching data on finances, resources,

technologies, processes, structures and outcomes. Therefore, each practice example is assessed with the same extensive template. Because each researcher comes from a different science sector, the transdisciplinary labs are very important. The environment where we bring together all the results from the interviews in the different sectors and analyze them together in a hypothesis generating process is the Morgenstadt Lab, which is based on the collaborative consulting methodology.

We further define one to three essential indicators per practice example that clearly show us the success of the practice example in terms of enhanced sustainability. The indicators are defined with reference to our Morgenstadt definition of sustainability. These indicators will be assessed based on quantitative data that corresponds to the indicators. Success factors can be certain financial innovations, organizational structures, strategies, single actors, etc. Each success factor is assessed with the same template. The most important success factors for each practice example will then be correlated on a time-scale with the defined indicators. In order to find out about greater leverage points for each city, all success factors of all practice examples in one city will then be related to each other. Finally we will analyze the success factors and frame conditions for each city and bring them into an interdependent model. The comparative analysis will then relate all data assessed within the 6 cities with each other by applying a variety of mathematical, logical and statistical methods.

The first city, Freiburg, was already investigated in February. We are going to analyze the adaptability of our research concept before we start the other city investigations. We expect the first results of the field trips in June 2013 and the final results by December 2013.

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