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IOT LIVING LABS

GUARANTORS OF IMPLEMENTATION FOR SMART CITIES AND SMART REGIONS

ZDE ZENTRUM FÜR DIGITALE ENTWICKLUNG

GREETING

"The Central and Eastern European region has faced significant challenges in implementing the Smart City concept. Through our work at the Ministry, we traced these difficulties back to their core cause: a highly fragmented local government structure combined with weak innovation ecosystems where key actors rarely collaborate. Discovering the agile piloting method in Finland felt like finding the missing piece of the puzzle. We believe that experimenting with Smart City solutions in real urban environments, guided by expert supervision, could be the game-changer our innovation ecosystems so urgently need. The PilotInnCities project, carried out with partners from six countries, is our flagship initiative to drive meaningful change across the entire region based on our joint know-how."

MIROSLAV SCHEINER

Project Manager, Ministry of Industry and Trade of the Czech Republic.
Leading coordinator of PilotInnCities project.

Find out more about agile piloting and PilotInnCities on the following pages!

EXECUTIVE SUMMARY

IOT LIVING LABS
GUARANTORS OF IMPLEMENTATION FOR SMART CITIES AND SMART REGIONS

MANY PROJECTS IN THE GERMAN SMART CITY AND SMART REGION SECTOR ARE CURRENTLY IN A DECISIVE PHASE:

strategies have been written, citizens have been involved, projects and measures have been decided. The task now is to press ahead with implementation. High expectations have been raised and a wide range of topics relating to climate impact adaptation and sustainability have been addressed. The first immediate measures have been successfully implemented in the cities and this has awakened the desire for more. Consequently, the start of consistent implementation is not easy. However, in this paper, we would like to show you how it can succeed, what smart approaches are already available on the international scene today and

what needs to be taken into account. Specifically, we will focus on real-world laboratories. In practice, these appear in various forms and under a wide variety of names such as 'living labs', 'citizen labs' or 'citizen workshops'. Clarifying the terminology is often not easy and the paths to realisation appear to be complex. Living labs empower, engage and bring the smart city and smart region to life. With this publication, we therefore also want to provide an overview of the possible terms and typologies and enter into the discourse. Because regardless of the exact name, a real-world laboratory is a guarantee for the implementation of your strat-

egies and concepts. A real-world laboratory is an easy introduction to topics such as citizen science, data analysis and management, efficient climate impact adaptation and the comprehensible application of sensor technology - so it is definitely worth looking into these forms and designations.

WHAT IS A LIVING LAB?

The use of IoT components and sensor applications, particularly in public spaces, is not yet common or tried and tested in the majority of German municipalities. A lack of financial and human resources and, in particular, a lack of experience often stands in the way of a consistent approach to this complex topic. At the same time, however, the requirements arising from the current challenges of climate impact adaptation, the design of liveable and climate impact-adapted city centres and rural areas, as well as a variety of other fields of action, can best be met on the basis of data. In fact, data in public spaces usually only makes the status quo visible and measurable in a validated way. This allows solutions and new approaches to be recognised directly and transferred to sustainable planning. An examination of the digitalisation of public spaces and the associated data collection in public spaces is therefore urgently required - also against the backdrop of the looming shortage of skilled workers in the public sector.

Against this backdrop, many specialists and managers are faced with the question of how to approach this topic. In abstract terms, the first step is to create initial points of contact, remove barriers to entry and build up empirical knowledge. Municipal real-world laboratories, which offer administrations a protected space for trialling and experimenting with modern technologies, are suitable for this purpose. The living lab or city lab has long been in use in the European municipal context and is used here as an innovation platform for municipal development. The realisation of living labs offers the opportunity to achieve a paradigm shift from excessive perfectionism to a culture of collaborative experimentation in the sense of 'try and fail' and pragmatic project approaches.

In the context of municipal living labs, however, there is a variety of concepts and understandings of the design and functions to be fulfilled. The spectrum ranges from highly participative formats in the sense of open citizen

participation with citizen science approaches to the very technically oriented implementation of specialist use cases. However, the key differentiating factors are always the planned duration, the spatial level, usually also the technical complexity realised and also the involvement of citizens. In the technical debate, a clear differentiation of the facts helps to develop transferable concepts, simplify implementation for municipalities of all sizes and thus strengthen smart city and smart region approaches and accelerate their implementation.

WHAT IS A LIVING LAB?

In current practice on the subject of living labs, we recognise the following classification of approaches:

	Pop-up / small show case	City Lab / Urban Lab / Smart District / Living Lab	Challenge-focussed labs
Target group	Internal approach of the topic and / or citizen participation	+ stakeholders + citizens + startup companies	- internal stakeholders - experts - stakeholders
Time range	1 to 6 months	6 to X months	12 months to X years
Number of use cases	4 to 8	4 to 10	1 +
Number of sensors per use case	1 to 2	Not defined	Not defined
Complexity	O	+	+ / ++
Goal	Communication and experience	Scaling and experience	Solving a specific problem, scaling, insight
Spatial framing	Limited, small-scale	District plus X	Inter-district
Relation to a specific challenge	Not necessarily goven	Limited	Limited to high
Documentation, supervision, participation of target group	Awareness is key! May vary depending on goals and target groups.		

As can be seen in the table, there are already differences in the underlying objectives and therefore also the target groups. The spectrum ranges from team-internal familiarisation with new technologies and working methods to the search for a solution to a specific problem involving the general public. This also results in differences in the duration, complexity and spatial delimitation of the labs. Directly linked to this are the number of use cases processed and, on the technological side, the typical number of sensors used per use case. So before you start a lab project yourself, it is worth thinking about the goals you want to achieve and the parameters that depend on them.

Agile Piloting –
an approach from Finland

A promising tool for the quick and efficient implementation of pilot projects comes from Helsinki. As part of the major urban development project 'Smart Kalasatama', a methodology was developed there that is also extremely interesting for lab concepts elsewhere: 'Agile Piloting'. The basic concept is simple. Instead of a single, large-scale pilot project that involves a great deal of financial outlay, several small projects are launched at low cost. The problem to be solved is defined according to a predefined methodology. This is followed by an open call for solution ideas, which is carried out along the quadruple helix of stakeholders, i.e. with the involvement of science, business, civil society and administration. A jury of experts selects promising applications. The selected pilot teams then test different solutions in short, clearly defined iteration loops. This saves costs and significantly reduces the risk of complete failure. All of the

pilot projects are monitored and evaluated by the expert jury. This enables the transfer of knowledge between the project teams. By making small corrective manoeuvres in the pilot projects, this methodology can almost guarantee that a usable solution approach will be available at the end of the piloting phase.

Another advantage is obvious: by focusing on rapid, iterative testing under practical conditions, the project team in the background also recognises much more quickly which solutions do not work, according to the motto 'If we don't know how to do it, we first rule out the ways that don't work'. This learning effect can then be utilised by other pilot projects. In traditional pilot projects, this realisation is often only made at the end of the project, without the possibility of direct correction and after large sums of money have been spent. By defini-

tion, the budgets for the agile pilots are calculated in such a way that they fall within the applicable award thresholds. This allows the project organiser to award the pilots directly to the applicant teams. This ensures that the local and regional stakeholder ecosystem is optimally integrated, particularly through the quadruple helix concept. This low-threshold approach and the focus on networking regional stakeholders also makes agile piloting extremely interesting for small and medium-sized municipalities. Above all, because it is also a quick way to 'get things done'.

As part of the INTERREG project 'PilotInnCities', the authors are currently researching how the Agile Piloting methodology can be adapted to the conditions in Germany and the Danube region.

Interreg Danube Region

Co-funded by the European Union

PilotInnCities

The „Smart Kalasatama" project in Helsinki	„PilotInnCities" project website	The Agile Piloting Cookbook from Finland

PilotInnCities: National Workshop in Berlin
September 2024

On 11 September 2024, the first national workshop on 'Living Labs and Agile Piloting' took place in Berlin as part of the INTERREG project PilotInnCities. In this context, 30 representatives from politics, administration, universities and business - including the Czech Ministry of Industry and Trade, the Embassy of the Czech Republic, individual German federal ministries and representatives from the field - spent an afternoon at CityLAB Berlin discussing the topics of 'Real-world labs, living labs and pilots'. The results have been incorporated into this paper. The workshop emphasised the importance of city/living labs as a guarantee for the implementation of smart city projects and applications

through the direct involvement of citizens and other interest groups at an early stage. After the introduction to the topic and the contributions from the CityLAB Berlin, the City Lab of the city of Herne and the FichtelLAB in the district of Wunsiedel, it became clear that closer networking of the living labs and real-world lab scene in Germany is crucial in order to strengthen them, make learning effects efficiently usable and increase their reach. It also became clear that the funding of smart city model projects by the Federal Ministry of Housing, Urban Development and Building is increasing the importance of living labs through the possibility of immediate measures and that a paradigm shift is slowly gaining

ground in the funded projects. Unfortunately, the results of the immediate measures from the strategy phase of the pilot projects have not yet been sufficiently evaluated in this respect to provide a comprehensive overview. It will be exciting to measure the impact over the next few years. It also became clear that the topics of 'citizen science' and 'living labs' are not yet sufficiently anchored in funding programmes and in the administrative world to achieve the intended impact. There is a discrepancy between the desired funding objectives on the part of politicians and ministries and the local and regional reality. However, all participants agreed that real-world laboratories can lead to 'realisation' if they are well managed

and these discrepancies are actively reduced. In this context, however, it is important that communication is sustainable, the impact of the real-world labs is properly evaluated and the results are then presented transparently. This requires structures such as the CityLAB Berlin or the FichtelLAB. Structures that actively bring technology into realisation and that master and consistently implement the corresponding participation processes. Like smart city departments, these structures are still uncharted territory for many administrations, but they also indicate the fundamental change in the administrative profession in Germany. By focussing on clearly defined topics, living labs act far more agilely than some specialist departments can and therefore achieve success faster than would be possible through traditional administrative processes. The stories told by many real-world lab creators during the workshop also

clearly showed that there is often no way around making the real-world lab topics that are recognised as essential a matter for the boss. In concrete terms, this means that a living lab needs the necessary freedom within the administrative structure to find the best possible way to implement it efficiently. In extreme cases, this can go so far that specialist departments, if they do not recognise the need to implement the real-world laboratory and threaten to slow down or even prevent the development of sustainable solutions, are obliged to provide support by means of direct intervention from the top management or, in some cases, are even left out of the project at the start. The project teams benefit from the fact that smart city departments are often attached directly to the top management as staff units. Of course, this brings with it the problem that the relevant departments may feel left behind, which can result in a negative

internal image of the real-world laboratory project. This is a major challenge for internal communication, which in turn emphasises the need to redefine administrative communication both internally and externally.

A consistently implemented living lab project therefore automatically initiates the urgently needed structural change towards more agility in administrations, albeit sometimes with certain collateral damage.

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CITIZEN SCIENCE AS AN IDEAL ACCOMPANYING MEASURE

Citizen science is a concept in which the public is actively involved in scientific research or in the development of smart city projects. Classic fields of application for citizen science are, for example, data-intensive projects in which citizens make it possible to collect the required amount of data in the first place. The aim here is to generate community knowledge from which the entire urban population can benefit in the case of a smart city. In many cases, the combination of a real-world laboratory and measures from the field of citizen science is an ideal tandem for generating knowledge and experience both within the team and among the population. However, it is important to note that citizen science projects require active supervision. Various social science methodologies should also be incorporated here, such as ongoing surveys, review loops and workshops.

EXAMPLES FOR CITIZEN SCIENCE:

Chronolog

The 'Chronolog' project collects photographic documents from the public in order to visualise long-term environmental effects using time-lapse photography. Setting up an infrastructure specifically designed for this purpose would be extremely expensive and the slow developments in the ecosystems under consideration mean that usable results are a long way off. The situation is completely different if existing photographs from the public are used.

www.chronolog.io

AHSRadon Hunt

'AHSRadon Hunt' is a Polish project that measures the actual radon exposure in school buildings and drinking water, among other places. A comprehensive supply of real data can only be achieved by distributing the measuring points widely, i.e. among the population.

www.radonorm.eu/activities/radonorm-citizen-science/

Citizen science also offers potential for public participation, can help to ensure the success of the project and contributes to its image. Local potential can also be recognised through such projects and integrated into future developments if, for example, it becomes apparent that there is a local community that is active and competent in a certain field of technology of its own accord. The projects also enable citizens to be sensitised to the data process, making it easier to work on data strategies and gaining additional supporters.

There are platforms for both Germany and the EU level that provide best practices, exchange opportunities and project overviews on the topic of citizen science:

www.mitforschen.org

EU-Citizen-Science-Platform

Two birds with one stone: citizen science and participation

The participation of citizens and other stakeholder groups is the basis for the meaningful implementation of digitalisation and innovation projects. At the same time, however, it represents a major and perpetual challenge for project organisers. A comprehensive overview of the stakeholder landscape in the project environment is often lacking at the start of the project. In other cases, the involvement is perceived as successful by all participants, but it is directly linked to a single project and the 'good connection to the citizen' breaks off again after the end of this project. Citizen science offers at least partial relief for these difficulties. The need to recruit citizens and other stakeholders as part of the citizen science approach inevitably results in a better picture of the stakeholders in the project environment. Ideally, the quadruple helix with the four dimensions of stakeholder consideration is also taken into account here. The positive atmosphere of meaningful, fulfilling participation can also develop a radiance of its own accord that,

from the citizens' perspective, extends beyond the specific project. Ideally, this positive moment can be taken on board and the relationship between the project organiser and the citizens involved can be put on a new, constructive footing through the shared sense of achievement. Citizen science in conjunction with a living lab boosts the implementation success of your own smart city strategy and makes it sustainable, because the actors and citizens involved enter into a new form of participation and get involved in the direct 'making', the so-called 'co-creation aspect' and thus have a positive influence on the project development. This in turn enables the development of a community and binds fellow campaigners to the development towards data-based administration. Living labs with citizen science approaches empower participants better and contribute more directly to digital and data literacy.

,,CLASSIC CASE''
WITHOUT CITIZEN SCIENCE

Participation   Implementation

Participation

Implementation

By applying the principles of citizen science, implementation and participation are inevitably interwoven. The danger of these two dimensions 'coexisting' without serious thematic cross-references is averted. Participation and implementation favour each other and are mutually dependent.

The Internet of Things as an enabler for the smart city

A positive side effect of piloting sensor solutions in a real-world laboratory is that it lays the foundation for further sensor applications. By working with technologies and applications as part of the living lab, valuable experience and technical expertise are built up that will contribute to all future applications. Another positive side effect is the networking of public space as an important data point and the visible merging of result and effect, or measurement and resulting action.

IOT IN THE SMART CITY CONTEXT

The Internet of Things plays a central role in the realisation of almost all applications in a smart city. The realisation always involves recording and collecting data, on the basis of which applications and recommendations for action can be created. To collect this data, sensors are required that communicate via a sensor data network and can therefore deliver the recorded measured values to the central data platform. This lays the foundation for data-based decisions and data-driven applications in the smart city.

The Internet of Things therefore forms the essential technical basis for the implementation of smart city applications. A living lab accelerates the implementation of IoT applications in public spaces immensely due to the time limit and ultimately even leads to the roll-out of standards because the stakeholders develop an understanding of the possibilities more quickly. In fact, they are involved in the necessary processes behind it and can adopt them in their own actions.
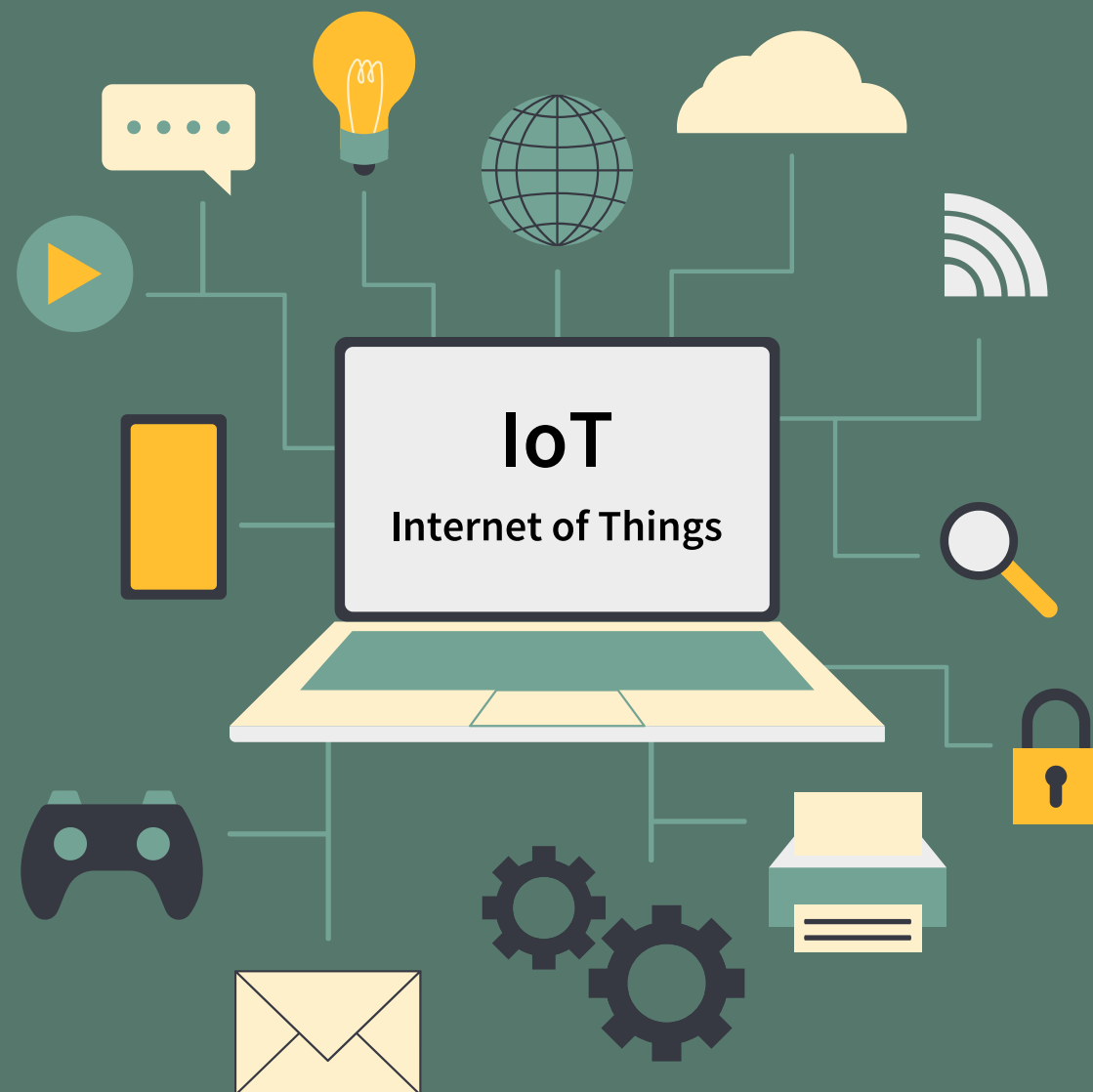
SENSORS AND SENSOR NETWORKS

A basic sensor network can already be implemented as part of a living lab, which can be extended step by step to the entire relevant area (project area, neighbourhood, urban area, district, …) as demand increases.

THIS ENTRY INTO THE WORLD OF IOT OFFERS THE OPPORTUNITY TO FIND AND TEST SUITABLE SENSOR INFRASTRUCTURE FOR SPECIFIC CIRCUMSTANCES AND ENVIRONMENTAL SITUATIONS. IDEALLY, THE PROJECTS SUCCESSFULLY IMPLEMENTED AND TRIALLED IN THE LIVING LAB CAN SERVE AS A BLUEPRINT FOR EXTENDING APPLICATIONS TO THE ENTIRE CITY OR REGION.

But what is the Internet of Things (IoT) anyway?

The Internet of Things (IoT) refers to a networked system in which everyday objects and various items (things) can communicate either with each other or independently of each other via the Internet. These objects are each equipped with electronics (computing unit, sensors, wireless technology) and software that enable the recording and transmission of environmental conditions. Well-known applications of IoT in everyday private life include fitness watches and smart homes. In urban or public areas, IoT is primarily used for the realisation of smart city projects. One concrete example of this is

the targeted irrigation control of urban green spaces and trees. To do this, it is necessary to know the moisture values in the root area of the plant. Sensors can first be used to measure this moisture level and then transmit the respective measured values in coded form to a sensor network. The IoT therefore uses sensors to translate and transfer information from the environment into usable knowledge. With the right technology, these values can be visualised, irrigation schedules can be created or automatic irrigation measures can be controlled.
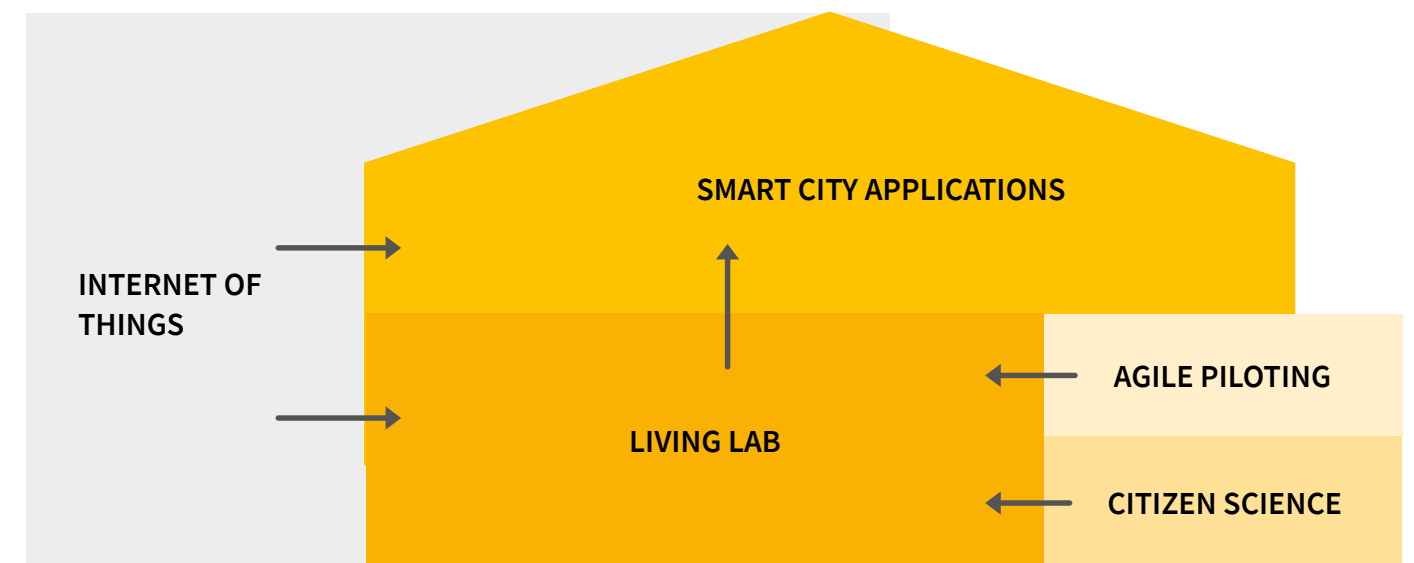
CONCLUSION

You may be wondering at the moment how the topics in this paper are connected. This question is quite justified and leads to an even bigger question, namely what role a living lab can play in the emerging eco-system of your smart city or smart region. In the introduction, we claimed that the living lab is a gua-rantor of implementation. In order for it to fulfil this promise, we sug-gest that you consider the topics of citizen science, agile piloting and the Internet of Things in your living lab concepts. After all, a living lab is not just about gaining initial experience in dealing with certain technologies and familiarising citizens with them. Rather, the real-world laboratory provides you with valuable insights for the possible further roll-out of

smart applications. The ideas and projects developed in the context of citizen science or agile piloting can be tested, iteratively developed and clearly demonstrated in the living lab. In most cases, the recipe for success is to start small and expand step by step. This is ideally possible with a living lab and is optimally suppor-ted by the modular nature of all the topics listed. On the technological side, the 'IoT' complex is the most important enabler for your applica-tions. The architectures of common IoT data networks such as LoRaWAN or NBIoT are designed in such a way that they can be adapted step by step to changing requirements or larger catchment areas. This means that you don't need to know exactly what the final expansion stage of your net-

work will look like at the beginning - it grows with the requirements and iterations that emerge from the living lab and the agile pilot projects. In this way, you open the 'black box' IoT step by step and create infrastructure that can be used in the long term right from the start.

Possible set-up of a smart city ecosystem with a living lab as a central interface.

However, this strong link between different subject areas with a long-term focus also requires that your communication and participation measures are strategically planned accordingly. We therefore recommend a participation concept that takes the aforementioned aspects of citizen science into account from the outset as a supplement to every living lab project. Agile piloting requires a high degree of active communication on the part of the project organiser in order to be successful. However, focussing on a living lab also offers the communicative opportunity to make complex interrelationships of the smart city or smart region tangible using a manageable set of examples. Experienced smart city managers know how complicated it is to create public understanding for all the large and small interrelationships of this type of project. The living lab helps here too. A comprehensive communication concept, ideally combined with long-term considerations on stakeholder and issues management, facilitates project management, enables targeted dialogue with your stakeholders and reduces project risks. What should also not be missing: A defined minimum level of technical standards to enable subsequent compatibility and scalability as described. The basis for these standards is often initially derived from the first use cases that are considered. In other cases, the development of technical standards helps to define

worthwhile applications for the living lab. The direction you want to take depends, among other things, on the intended character of your living lab (see typology in the section 'What is a living lab?'). In any case, it is worth getting expert advice at an early stage to avoid unpleasant surprises later on, e.g. due to silo solutions that are not scalable as desired.

As the necessary expertise for the essential preparatory measures in the area of communication and participation and possibly also for the general conceptualisation of the living lab is not available internally, it is advisable to call in external expertise. Nevertheless, the local or district administration or the project organiser commissioned by these bodies (e.g. business development agency) should be in charge of the project. This is conducive to building a good relationship with local or regional stakeholders in the long term.

Especially in Germany, the creators of city labs, living labs, maker and coworking spaces need to be networked even more closely because they are key drivers of open source developments and are therefore drivers of innovation for smart city development in Germany. This networking can create an ecosystem that sustainably transforms administrative structures and processes, making administrative work

efficient, innovative and attractive for new generations. These „movers and shakers" are currently still pioneers and first movers. It will be important to make their work more easily accessible and, with this in mind, to design the solutions marketplace envisaged in the Smart City step-by-step plan to be user-friendly and as accessible as possible. There is now a wealth of experience in Germany, it is just a matter of harnessing this and promoting the use of existing knowledge in a targeted manner.

This also requires the creation of suitable funding opportunities for the future. With the Smart Cities Model Projects funding programme, Germany has created an internationally respected structure and has definitely taken a big step in the right direction. Synergies with other funding programmes can be found in many projects. The task now is to nurture the tender plants that have grown within the framework of the programme. In times of tight public budgets, we must also work towards efficient, targeted funding of small but effective measures with maximum leverage. The agile piloting approach appears to be suitable for this, but has yet to prove itself in practice in Germany and the Danube region.

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We hope that we have been able to arouse your interest in the topic presented in this paper and that we managed to provide you with one or two interesting ideas along the way.

Do you have experience with living labs or questions on any of the topics we have discussed?

Then please feel free to share them with us!

IMPRINT