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From freight partnerships to city logistics living labs – Giving meaning to the elusive concept of living labs

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Abstract

The paper discusses the growing importance of urban freight research given the increasing urban population trends. The complexity of urban freight systems means that it is essential for the public and private sectors to work together - one way to achieve this has been through freight partnerships. A short review of freight partnerships highlights the way in which they have fostered mutual understanding among urban freight stakeholders. The literature on shared situational awareness (SSA) and joint knowledge production (JKP) has been adapted to position freight partnerships and to further develop and link these partnerships to the concept of a living laboratory concerned with urban freight transport. This novel application of the living lab concept is introduced. Next, the first phases of a city logistics living lab brought in practice in Rotterdam are shortly mentioned. The living lab concept fits the complexities of the urban freight system well and has been a cornerstone of a recently started major freight project in the EU (CITYLAB).

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Keywords: freight partnerships; living labs; shared situational awareness; city logistics

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1. Introduction

More and more people live in urban areas; WHO accounts that in 2014, 54% of the global population lives in urban areas (as opposed to 34% in 1960; www.who.int). It is estimated that by 2017, even in less developed countries, a majority of people will be living in urban areas. But also, for example in Europe, an increase is expected (Alice/Ertrac, 2015): from 72% EU population that currently lives in cities, towns and suburbs to 80% in 2020. At the same time, WHO finds that air pollution is now the world's largest single environmental health risk. Urban freight is responsible for 30 to 50% of other transport-related pollutants (particulate matters, Nitrogen Oxide (NOx). Sometimes even more, as was estimated for the Netherlands, where vans and trucks represent approximately 10% of the total national fleets (BOVAG, 2014), but are responsible for about 70% of the road transport related NOx concentrations in cities (TNO, 2015). In other words: air quality is a serious health problem in cities and urban freight transport is a big contributor to this problem. For EU member states, the National Emission Ceilings (NEC) directive (Directive 2001/81/EC) sets upper ceilings (or limit values) from 2010 for four key air pollutants: nitrogen oxides (NOx), sulphur dioxide SO_2, non-methane volatile organic compounds (NMVOCs) and ammonia NH_3. These limits are not met in many cities (see also FREVUE, 2015). Next to this, urban freight transport is also responsible for about 25% of urban transport-related CO_2 emissions, and has other negative effects for people living in the cities: i.e. traffic safety, congestion and accessibility (see for example Alice/Ertrac, 2015). Although these problems are not solely caused by urban freight transport, urban freight transport is a major contributor to these problems. On the other hand, it is important to recognise that cities themselves become economic powers and that cities account for over 80% of the global GDP today (McKinsey, 2011). In order to function as an economic power and to support all people living in these cities, an efficient urban freight transport system is essential.

In order to solve these grand challenges, a serious transition in the urban freight transport system is necessary. Realising such a transition appears to be very difficult, as many trials and field tests that have been undertaken in the urban freight transport field, but major transitions are lacking. Urban freight transport issues are complex to solve, as there is usually no single problem-owner and the many different stakeholders have different objectives and stakes. As a result, simple solutions that can be implemented by one stakeholder are not sufficient to deal with urban freight transport's grand challenges. In this paper we argue that in order to actually make a considerable change in the urban freight transport system, it is necessary to align the stakeholders, their objectives, their abilities to act, and their perceptions on the problems that have to be tackled. We introduce the theoretical notions of Shared Situation Awareness (SSA) and Joint Knowledge Production (JKP) to position the currently frequently used best practice in urban freight transport stakeholder-collaboration, i.e. freight partnerships, and a proposed meta-methodological concept, i.e. a city logistics living lab. We argue that in order to really make a transition in the urban freight transport system, both a high level of SSA and JKP should be in place. The paper discusses the results of examples where the level of SSA and JKP is higher than average: i.e. the 'freight partnerships'. Next, we introduce the concept of 'living labs' and relate it to city logistics. In these living laboratories, the levels of SSA and JKP are expected to be high. We discuss what living labs can be, and how these living labs could contribute to making the urban freight transport system better.

2. Necessity for more shared situational awareness in the urban freight transport system

2.1. Making changes in urban freight transport system

Over the last years, research in the field of urban freight transport has increased; more and more, urban freight transport is recognized for its importance in the functioning of cities, not only by research but also by local administrations. As a result, the number of studies and trials showing solutions for issues in and due to urban freight has risen. Although, this growth is encouraging, eventually one thing is striking: it is not easy to actually make lasting transitions in the system for the better, e.g. small scale solutions are not scaled to a larger area nor copied to other cities. Even successful trials and demonstrations are often terminated at the end and are not continued in daily city logistics operations.

There has been extensive experimentation with innovations in city logistics in the past decades. Studies looking into factors of success and failure of initiatives are rare (BESTUFS (see www.bestufs.net), Visser et al. (2008), Quak et al. (2008), Van Binsbergen et al. (2014), Gonzalez-Feliu and Morana (2010), Vaghi and Percoco (2011)). Causes of failure generally point towards a poor preparation of innovation deployment processes, due to limited stakeholder involvement, unclear business models or uncertainty in the environment.

It is also evident that there is sometimes a mismatch between the ambitions of the public sector (exemplified by city authorities) and those of the private sector (transport operators and receivers for example). Policy and business time cycles are often rather different with the private sector needing to concentrate on shorter term payback for project commitment and roll-out. Bringing public and private sector decision-makers together in freight partnerships is an important step in building trust and enhancing the uptake of urban freight initiatives. Freight partnerships are an established way to enable collaboration at a local level (Lindholm and Browne, 2013). The possibility to interact between various levels is also supported by such partnerships. This interaction and building a community in which different stakeholders share an understanding of the stakes and objectives of others in the urban freight system appears to be one of the most important elements to improve the urban freight transport system. Next, including researchers in these partnerships might not necessarily result in better interaction or understanding between actors, but it might help in finding common solutions or objectify effects of actions, which are required to improve the system.

2.2. Shared situational awareness in the urban freight transport system

Urban freight transport systems can be characterized as sociotechnical systems. The urban freight transport system is a complex compilation of technical and infrastructural systems and includes networks of interdependent stakeholders. The urban freight transport system includes different elements, such as vehicle technology, ICT applications, regulation, user practices and markets, several networks, such as infrastructure, supply and demand, and maintenance. In such a sociotechnical system, decision making is complex. It becomes even more complex in case such a system should change according to challenging ambitions set by for example the European Commission (2011), i.e. (near) zero-emission urban logistics by 2030.

Table 1. Maturity levels SSA in related to objectives and requirements in urban freight transport systems (adapted from Kurapati et al., 2012).

SSA Maturity level		*Objectives SSA in urban freight transport system*		*Requirements SSA in urban freight transport system*	
		Individual	System	Individual	System
High	Participation	Flexibility to adapt and respond to unexpected situations	Innovation in the processes, operations and technologies is essential; JKP is one way to innovate. Synergy is key ingredient for cooperative joint actions.	Spatial abilities, attention sharing, memory capacity, perceptual and analytical skills, cognitive complexity, field independence for flexible and effective response.	Community of practice. Groups who regularly engage in sharing and learning (high level JKP) can create an environment for better performance and innovation in complex systems. Shared values and visions strengthen cooperative efforts.
	Prescription	Compliance to planning is crucial to prevent deviations that could affect others in the system. The gap between what an individual perceives and what (s)he does needs to be reduced	Network governance to monitor each others' plans and actions, the system direction and to create a sense of community and shared destiny.	Feedback measures such as KPIs have proven to improve individual performance as well as contribution to systems' objectives	For network governance, interoperability is required to coordinate plans among stakeholders, to monitor plans and operations and take corrective decisions if needed.
Low	Perception	Goal orientation for individual goal setting	Positioning of a high level goal needs to be broad to allow negotiation, as well as steer the system in a direction	Individual goals and self awareness to determine requirements and integration of information and projection of future state of situations	Joint mission has to be established to have a platform for negotiations for an acceptable system goal

Making changes in complex systems, such as the urban freight transport system, is difficult, for several reasons: there are many different stakeholders with different and sometimes conflicting objectives. No single stakeholder has a complete image of the system, nor what the effects and rebound-effects of actions, policy measures or other interference are or will be. Or in other words, as Kurapati et al. (2012, p.47) state when they introduce the concept of Shared Situational Awareness: “during a problem situation, as the number of stakeholders increases, the conflicts of interests become greater, making decision making complex and challenging. Eventually, it may become impossible for any one actor to understand the situation in its entirety, which can be defined as lack of a ‘common operational picture’ or lack of shared situational awareness”. The term ‘Shared Situational Awareness’ finds its origin from situational awareness, which has its roots in the history of military theory and focusses on improving the decision making ability of fighter pilots. Situational awareness is defined in many ways, but we use the widespread definition of Endsley (1995): “the perception of the elements in the environment within a volume of space and time, the comprehension of their meaning, the projection of their status into the near future, and the prediction of how various actions will affect the fulfilment of one’s goals”. Following this, Endsley and Jones (1997) define SSA as the degree to which the actors possess the same situational awareness on SSA requirements. For the urban freight transport system, this would mean that not all actors need to be aware of all information, as this would certainly imply an overload on information. However, the stakeholders should be aware of that part of information that is relevant to the SSA requirements. These SSA requirements for urban freight transport actors are listed in Table 1.

We argue that one way to actually make transitions in the urban freight transport system possible, is by increasing the SSA of the relevant stakeholders in this system, implying that the SSA Maturity level increases, following Kurapati et al.’s (2012) theoretical framework for SSA in sociotechnical systems (see Table 1).

2.3. Shared situational awareness in the urban freight transport system

In order to use it, Kurapati et al.’s (2012) framework has been slightly adapted to the urban freight transport system in this paper, and one extra element has been included: i.e. JKP. JKP “implies that scientists, policymakers, and sometimes other societal actors cooperate in the exchange, production and application of knowledge” (Hegger et al. 2012). This is not an obvious way of developing knowledge, as scientific research-based knowledge often does not match the wishes of policymakers (and visa versa) due to differences in time frames, incentives, objectives, vocabulary, etc. Hegger et al. (2012) argue that JKP is necessary to develop and eventually utilise to actually make transitions in existing systems that are necessary to solve complex problems, such as the change to sustainable development or in our case a more sustainable urban freight transport system. The idea of JKP is that it enables the connection between long term research objectives and short to medium term policy aims. For issues concerning sustainable urban freight transport innovations or development, we argue that scientists, policy makers as well as private companies develop knowledge. But, for the case in which we work on SSA, JKP is one important element. JKP, defined as “direct collaboration of scientists, policymakers and other societal actors in specific projects” (Hegger et al. 2012, p. 54) is what brings them together in the field of urban freight transport, i.e. to actually make a transition in this system.

Table 2. Expected success factors of JKP projects (Hegger et al., 2012)

Dimension	*Expected success condition*
Actors	Broadest possible actor coalition
Discourses	Shared understanding on goals and problem definitions
	Recognition of stakeholder perspective
Rules	Organization reflection on division of tasks by participating actors
	Role of researchers and their knowledge is clear
	Presence of innovations in rewards structures
Resources	Presence of specific resources such as boundary objects, facilities, organization forms and competences

Therefore, we use the framework of Hegger et al. (2012) as well; showing the (potential) relationship between success conditions for the dimensions (actors, discourses, rules and resources), salience, and legitimacy. In the high SSA Maturity level, i.e. the participation phase, we expect JKP to be one of the elements that adds to the degree of success stakeholders are able to innovate and change the system. We expect that in case the success factors (listed in Table 2) are all fulfilled; the SSA maturity level is high; for the medium level we expect some of the conditions to be fulfilled but not all, whereas for the low level only one or two.

2.4. Bringing SSA and JKP concepts into the urban freight transport practice

Large scale innovations or system changes in the urban freight transport system are limited. Many innovations or measures are not transferred to other regions or are not implemented on a larger scale within a city (see e.g. Quak, 2011). In general, not counting exceptions, we argue that the SSA in many local urban freight transport systems, is at the lowest maturity level. This implies most actors act on their own objectives and there is often not a system goal, but a set of conflicting objectives. Obviously, there is knowledge production in the current system, but often no more than one of the JKP success factors is really in place. The low SSA maturity level, together with the limited JKP could be the cause of the relatively low success rate of actually making changes in the system. Existing success stories, where the system was changed, for example the New York off peak project, also show that increasing the SSA in the system is one of the most difficult things to do (Holguin-Veras et al., 2011). But, once that hurdle has been taken, the results can be very positive. This example also shows that JKP indeed can help in making an initiative to a success.

Freight partnerships can be considered an important step in reaching a higher SSA maturity level. The next section discusses these freight partnerships. In case a transition is required in the urban freight transport system, we argue that an even higher maturity level of SSA than that in freight partnerships, is necessary. Therefore, we propose, in the section following this current best-practice in urban freight transport, a new approach towards freight transport in urban areas that would fit the highest SSA maturity level and contains all JKP success factors: i.e. a city logistics living lab

3. Freight partnerships

Local public-private partnerships in urban freight transport do occur in the form of freight partnerships, even though the partnerships might be called different things in different cities; Freight networks, Freight charters, Peer to peer exchange etc. Freight partnerships is therefore a general term used in this paper to describe different types of approaches to involve stakeholders with the definition: *A long-term partnership between freight stakeholders concerned with urban freight, that on a formal or informal basis meet regularly to discuss (and sometimes find solutions to) problems and issues that occur in the urban area* (Lindholm and Browne, 2014, pp. 3).

The term freight partnership differs from the more traditional term “Public private partnership (PPP)” in that a PPP refers to the bringing together of at least two parties, representing both public and private actors for e.g. funding of a specific project (e.g. European Commission, 2004; Peters, 1998). Browne et al. (2003) uses a broad definition of PPP that refers to also involving private stakeholders for consultation and dialogue in public decision-making.

In literature, the concept of including freight and involving private stakeholders in public initiatives in a longer perspective is first seen in the early 1980’s, when freight was included into French mobility plans for major urban areas, within the concept of PDUs (Plans de déplacements urbains). A more specific stakeholder involvement was recognised when FQPs was highlighted by the UK government in the DETR report (1998), but already initiated in 1996 by the Freight Transport Association (FTA, 1997). However, the UK government have promoted this initiative since and states that partnerships can have a significant role in developing common understanding between public and private stakeholders regarding freight issues (Department for Transport, 2008). Allen et al. (2010) identified 87 on-going FQPs in UK in a study, and recognised that 38 of those had a specific urban focus.

Partnerships has been recognised as an approach to involve private stakeholders in urban freight planning by public parties all over the world, e.g. a report by Lindholm and Browne (2014) compares the characteristics of 16 partnerships and identifies several common features. Most of those partnerships have been initiated in the last ten years, but examples from e.g. Sweden and the Netherlands shows earlier initiatives.

A partnership has three key criteria that are relevant to discuss: Formation, Management and Outcomes. This is presented by Lindholm and Browne (2013) as:

- The formation of a partnership could include to set up an objective that are related to the members of the partnership, to involve relevant and a variation of stakeholders, and to gain political involvement.
- The management could include to set up an action plan, to manage the number of participants (usually 10-20), to make sure that partners attend the meetings on a regular basis and to see to that the partnership is managed and chaired in a good way.
- The outcomes of a partnership could be either soft results (e.g. information exchange, improved communication) or physical outputs (e.g. regulations, new loading bays).

3.1. Freight Partnerships leading to increased SSA and JKP

A freight partnership could be an attractive approach to stakeholders' involvement, since it is a way of achieving valuable results with a relatively low budget. To illustrate how freight partnerships can work, we discuss the cases of Gothenburg and London that have had partnership approaches for many years. Both partnerships were initiated in 2005 and even though the cities differ in both size and context, the partnerships are formed in similar ways when it comes to type and number of stakeholders, number of meetings and topics discussed. Participants from both partnerships agree that the there is a high value to keep up to date with initiatives, and to share information between different stakeholders. The informal network between stakeholders in between meetings is equally important. The long-term approach with input to strategies in an early stage, as well as finding solutions to day-to-day problems is something that makes it worth attending meetings. It is, however, important to keep the interest of the stakeholders through interesting topics on the agenda in order to make sure they attend meetings. A number of outputs from freight partnerships in Europe have been summarised in Table 3.

Table 3. Outputs from Freight Partnerships (adapted from Lindholm and Browne 2013 and 2014)

Utrecht: The effects of the Utrecht partnership have been, among others, a lot of attention to distribution for new developing areas, direct influences on plans and policies, an air quality action plan and, stopping of a plan for a new shopping centre due to points about problematic freight transport and consequences for cycling safety raised by the partnership.
Paris present outcomes of this partnership to be an agreement of redefinition of regulations regarding freight transport in three areas: delivery regulations reserving a time window for the least polluting vehicles, providing better on-street delivery with better enforcement and planning and zoning regulations for the land use master plan.
Gothenburg: Key outcomes of the partnership approach in Gothenburg include a better exchange of information between participants and an increased understanding of each other's problems. Concrete effects of the partnership have been a higher level of successful enforcement of regulations within the urban area, outcomes have been of for example a brochure on parking restrictions for heavy vehicles, increased number of 'walking speed areas' (that enable deliveries to be made as long as vehicles drive at 'walking speed') and a length limitation for vehicles in the inner city.
Central London Freight Quality Partnership (CLFQP): The most important outputs from the meetings, according to the participants, have been specific projects with outputs, for example: Loading and unloading code of practice, reduction in penalty charges for loading offences and an electric vehicle charging point initiative.

The outputs clearly demonstrate the importance of trust and dialogue between stakeholders and represent a step in increased SSA in the several local urban freight transport systems, whereas the JKP results are still limited to sharing rather than together producing knowledge in these partnerships. For example the production of a London Guide to Loading and Unloading (see Table 3) is a clear outcome of sharing knowledge in order to achieve greater understanding and find solutions to urban freight problems. Furthermore this sharing of knowledge also enhances the adoption of the new practices that are identified. Without the partnership approach the uptake would be far slower and efforts more dispersed because the SSA would be much more limited. Nevertheless there are some weaker aspects to freight partnerships and the following sections in the paper highlight how the introduction of a living laboratory approach to city logistics could help in offsetting or reducing some of these weaknesses.

Whilst the strengths of the partnerships could be generalised as information sharing, cooperation and taking part of the development of the urban freight situation in the city, the weaknesses should not be forgotten. Weaknesses could be grouped into five main areas: Outputs (e.g. a slow implementation of initiatives, politicians are not included in the process, suboptimal solutions); Meeting structure (e.g. many stakeholders come to meetings without sharing information, no active discussions including all partners); The partnership group/members (e.g. lack of participation of stakeholders from certain industry sectors, it is hard to reach consensus within the group, the group is either too large or too small); Authority activities (e.g. there is a general lack of understanding of freight activities amongst authorities) and Resources (e.g. there is a lack of funding to hold meetings, lack of resources in time to attend meetings).

A specific concern raised in some of the partnerships studied by Lindholm and Browne (2014) was that when some participants are not fully involved and engaged in a decision or plan then there can be difficulties later. It seems that the need to find ways to engage the full membership of a partnership remains a challenge.

4. Towards living laboratories for city logistics

Where freight partnerships bring together the various stakeholders, collaborative and joined innovative actions and ambitions are often not the direct result of these partnerships. A way to develop a more action-driven form of these partnerships follows from a solution approach, which has proved successful worldwide in fostering innovation deployment, but has not yet been applied explicitly in the domain of City Logistics: Living Labs. These Living Labs are a way to increase the JKP in the urban freight transport system as well as to increase the SSA Maturity to the highest level, i.e. the participation level (see Table 1). The concept of Living Labs is credited to William J Mitchell of MIT in early 2003. Mainly owing to insights into the potentials of information technology, he proposed to move R&D to in vivo settings—in other words, to 'wired' living settings such as in a building or part of a city—thereby enabling to monitor and respond to users' responses and interactions, with the ultimate aim to speed up development and deployment of innovations. In Europe, the concept of living labs was already recognized by the European Commission in 2006 as a key tool for open innovation. Since then, living labs have spread over Europe in various waves, first focusing on new ICT tools but later extending to other fields, such as sustainable energy, health care, and safety. The achievements of the living lab movement went beyond fostering the development of demos, pilots, experiments and test beds: it changed the emphasis from the solution as an isolated object to the process of integration with its environment. It allowed the creation of experimentation environments that were sufficiently connected with real world stakeholders and their business models, to allow near-simultaneous development and deployment (see e.g. Almirall & Wareham (2008) and Følstad (2008).

Although there are several initiatives that carry the Living Labs title and there is interest in City Logistics from the Living Labs communities of practice (see e.g. www.openlivinglabs.eu), we are not aware of any discussion in the literature about the operationalization of the concept within city logistics. In this paper, we explore some main characteristics that Living Labs should have within cities. For city logistics, we argue that the set-up of a Living Lab has to fulfil three important conditions:

- Inclusiveness: connection of all relevant stakeholders and business models within a city, with a joint recognition of a problem and solution spaces.
- Anticipatory capability: means to (collectively) make predictions of the effects, based on simulations, gaming or more simplified means of analysis.
- Responsiveness: measuring of impacts and agreements to respond to this with the aim to ultimately deploy a solution.

Recently Lucassen et al. (2014) have proposed a framework for Living Labs that mainly addresses the governance challenge: it sketches a process to follow between stakeholders in a living lab, see Fig. 1. It is based on the continuous improvement cycle (also known as quality management cycle) of Deming, popularly known as the plan-do-check-act cycle (see Deming, 1986). This cycle should be carried through collaboratively by the city stakeholders. Although the framework was proposed within the context of a port customs system Living Lab, we believe that it is sufficiently generic to transfer to cities.

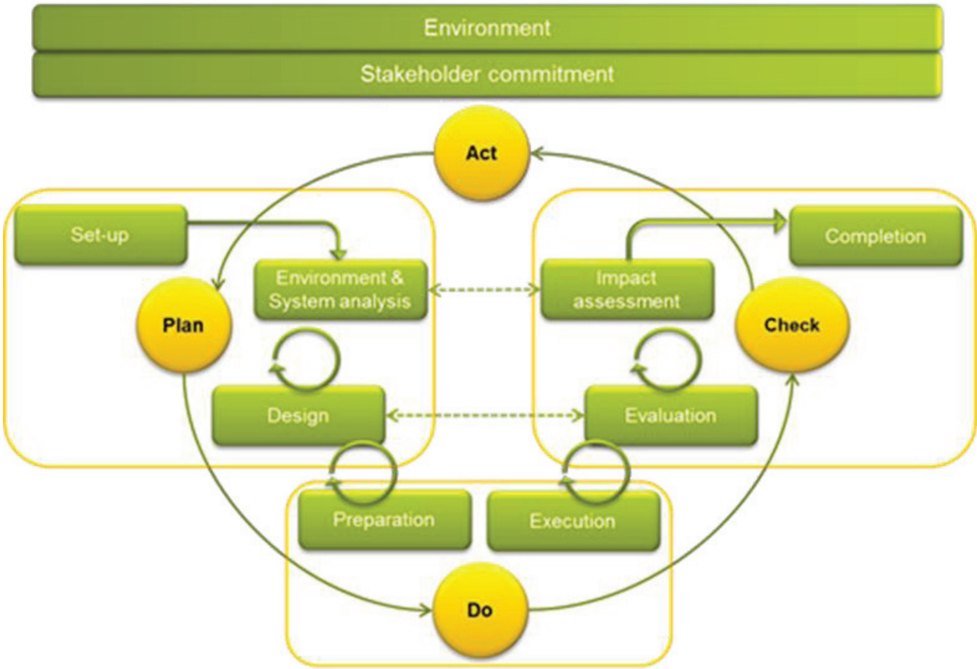

Fig. 1. A process perspective on a Living Lab in logistics (Lucassen et al., 2014).

The typical steps of the PDCA cycle are operationalised as follows:

- The "Plan" phase includes the setting of shared objectives and ambitions, agreement on the current state of the system (problem identification and system analysis) and the first ideas on design, or concepts to be implemented. It includes the preparation of the system for carrying out experiments, including the design of appropriate operational processes, regulatory exemptions and measurement systems. As stated above, this stage should have all stakeholders involved, include a study of the expected effects of the measures and include broad acceptance of these consequences.
- The "Do" phase installs the experimental environment and deploys the innovative measures. Next, the operation of the system is the main part of this execution phase, where the new concepts are tested in a real world environment. System should be installed to measure effects, addressing the effects of interest (also potentially unintended ones) to all stakeholders.
- The "Check" stage involves the processing of the results. This involves the pre-processing and visualization of measurement results, an impact assessment to understand causal relationships between impacts and an evaluation to gain shared awareness and acceptance of the results.
- The "Act" stage (sometimes also referred to as the Adjust stage) involves the adaptation of actions by learning from the previous stage. In a LL, this includes the decisions (a) whether or not to mainstream the experiment to become a permanent part of stakeholders' processes and/or (b) to enter into a new, modified experiment cycle. It will be clear that the decision (a) cannot be taken if parties have not prepared to consider mainstreaming of the experiment.

The above processes will have consequences for the information systems (models and data) used for decision support. These systems can support all stages in the process. The planning process requires tools to generate designs, identify preferences of stakeholders and perform ex-ante evaluations, of the innovative concepts and the experimental environment. The execution stage requires tools to monitor impacts, and communicate these to stakeholders. The evaluation stage requires tools to evaluate ex-post the impacts of changes, filtering out disturbing influences. The “act” stage involves in essence the same tools as in the first stage, but requires the capability to recalibrate assumptions based on the effects measured. Functional relationships between these systems and the relevant data inputs and outputs are shown in Fig. 2.

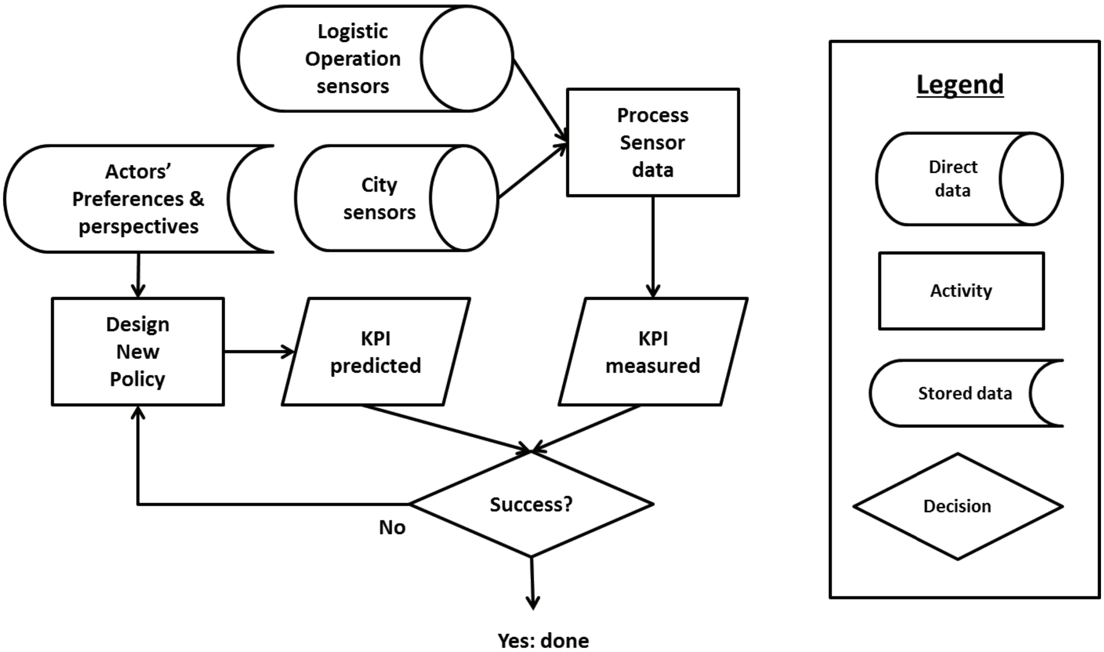

Fig. 2. Flowchart outlining role of models and data in a Living Lab process.

Often, tools are available at the individual stakeholder level, which allow individual information needs to be fulfilled. Typical for Living Labs however is the need for information that takes the point of view of the collective interest. Needs from this respect include the following:

- Specific groups of stakeholders, like citizens or SMEs, may be ill-equipped and could benefit from access to public systems or simple proprietary monitoring approaches.
- In addition to individual information systems, shared systems are needed that work on the basis of shared viewpoints and stimulate broad support for decisions.
- As some stakeholders may not have the expertise necessary to understand (and hence trust) the system design, new ways of presenting and discussing information are needed (e.g. simulation and gaming).

Besides the collective nature of the process, another reason to give extra attention to information systems is that the current information systems are not at all equipped to support PDCA-type processes. Typical problems that require new research include:

- Recording stakeholder perspectives and preferences, in a way that the stakeholders are represented correctly in evaluation models. Questions that go beyond current behavioural research include methods to record stakeholder perspectives, their preferences in logistics decisions and group behavior.
- Using operational systems in logistics (e.g. TMS, WMS, ERP, CRM[1] systems) to create data for monitoring of impacts of innovation. Currently, proprietary data is not being used to support monitoring of freight systems within cities.
- Agent based models that mirror decision making by all relevant individual stakeholders but also show emergent impacts of these decisions. Behavioural models and agent based models could be integrated to reliably show system level, emergent impacts of logistics innovations.

4.1. First steps in setting up a city logistics living lab

'Living lab' itself is a popular term in many proposals and is often employed in more or less the same way as demonstration, field test, or trial was used in earlier writings. We emphasise that the living lab approach is a new way of working, that could enable a transition due to the high level of SSA maturity of the urban freight transport actors and enables the full potential of JKP, where research institutes, industry actors and local authorities work together in experiments, adjustments based on monitored effects, as well as new concept developments all following from a shared ambition.

Table 4. Distinction between past field tests and demonstrations and living labs (CITYLAB, 2014 based on Lucassen et al., 2014).

Past field tests, demonstrations (low SSA maturity level and hardly JKP)	*Living labs (high SSA maturity level and JKP)*
Characteristics	
Simple	Complex
Linear development	Iterative, cyclical development
Predetermined	Learning effects and improvements during activities
Isolated environment	System in system, real-life environment
Individual values	Shared values
Mainly operational goals	Grand challenges
Single actor as driver and owner	Multi-stakeholder and collaborative governance (incl. public-private partnerships)
Little uncertainty	Deep uncertainty
Short to medium term orientation	Medium to long term orientation
Re-active planning and steering	Adaptive and pro-active planning and steering
Purpose	
Closed research & development	Open innovation and live analytics
Expert design	Co-creation of multi-stakeholders
Closed system evaluation	System in system evaluation
Analysis for single department / actor	Analysis for multi-department / multiple actors

Table 4 shows how the living lab approach differs from the current state-of-the-art field tests and evaluations. Traditionally private companies, local governments or a public-private partnership initiates a demonstration, followed by analyses of the results and impact on the stakeholders. The living lab approach ensures that the stakeholders are involved much earlier in the in planning and implementation processes, and that the proposed

[1] Transport Management System, Warehouse Management System, Enterprise Resource Planning, and Customer Relationship Management.

implementation is revised and continuously improved to meet stakeholder needs and obtain maximum impact during the project. The living lab characteristics and purposes (Table 4) do correspond to the high level (participation) SSA Maturity objectives and requirements in Table 1. In contrast: the characteristics mentioned in Table 4 under 'Past field tests, demonstrations' qualify for the lowest level of SSA Maturity, as these are often simple and single-stakeholder activities, that fit perfectly in temporarily project, that is a planned and executed in a linear way, finishing with an evaluation. One of the main differences between the living lab approach and the traditional approaches is that the living lab approach needs to start from a shared ambition, whereas the actual activities necessary to eventually achieve this ambition could be sometimes not entirely clear. The activities undertaken in a living lab contribute to achieving the ambition, but in time new, adjusted or other activities might become necessary as whereas the results show that this is needed to eventually achieve the ambition. This implies that there is no full planning of all activities in a living lab in advance, and maybe not even full budget. But the stakeholders commit to finding activities and funding in this process so that the objectives are met in the end. This is opposite to the traditional way of working, where many demonstrations and field tests are fully planned and funded in advance and for a (short) limited period, including the evaluation, and as a result do not make adjustments possible and often terminate after the planned period.

The Horizon 2020 project CITYLAB (2014) is a project that addresses these challenges and aims at developing a methodology for city logistics living labs that should enable local authorities, in collaboration with both research institutes and industry, to set-up a living lab. The first steps that are planned, next to developing practical guidelines, is to generate local roadmaps with the stakeholders of the participating cities in CITYLAB (i.e. Oslo, Rome, London, Brussels, Rotterdam, Paris, and Southampton). These roadmaps entail the shared vision of the local actors, and form a start of joint actions (of which some are already defined and funded from CITYLAB).

In the city of Rotterdam the first steps in establishing a city logistics living lab were taken (end of 2014). These first steps only cover the first blocks of the Living Lab process in logistics as depicted in Fig. 1: the plan phase and some elements of the do-phase. This implies that the current SSA level is still at the prescription-phase (comparable to that of freight partnerships), as is the current level of JKP. The intention, however, is to increase these levels and establish a city logistics living lab in Rotterdam in the coming years. Table 5 explains the details on these first activities in the plan-phase for Rotterdam's city logistics living lab.

Table 5. First steps towards a city logistics living lab in Rotterdam

Immediate cause for starting planning of living lab: several elements came together and formed the actual starting point. First of all, research institutes TNO and TU Delft are core research partners in the VREF Center of Excellence for Sustainable Urban Freight Systems (see https://coe-sufs.org/) and Rotterdam is core city partner in the center, secondly Rotterdam established a star-system that supports and rates (local) carriers in Ecostars (see http://ecostars-rotterdam.nl), and finally on a national level in the Netherlands, agreements were made between the national government and other partners (e.g. companies, other authorities, NGOs, etc.) in order to become more sustainable. One of these so-called 'Green deals' was on zero emission city logistics and included the opportunity to develop local living labs that contribute to finding solutions that can lead to zero emission city logistics.

1. Technical: aiming at collectively buying electric (zero emission) trucks, developing the necessary charging infrastructure, and improving the development of vehicles (together with manufactures). One of the first actions here is to further invest the possibilities for larger (serial plug-in hybrid) trucks.
2. Logistics: aiming at developing local bundling and decoupling points, and fit for use vehicles.
3. Behavioural: emphasis on fuel-efficient driving (start) and monitor vehicles and drivers and establish feedback on performance in game-form.
4. Regulation and stimulation: where local authorities together with front-runners look at positive incentives for zero-emission vehicles and regulatory measures like further developing low emission zones.

First actions (do and check): After collectively developing this roadmap, the first actions are undertaken, and together the stakeholders look for opportunities to achieve this ambition. Parallel to these lines of actions, monitoring and improving urban freight transport data are actively worked on, not directly by new monitoring systems or data collection activities, but by making more sense of already collected data (e.g. traffic models and counts, camera data, existing surveys, production/attraction (PA) of transport demand in the city in details based on existing data.

5. Conclusion

Urban freight partnerships have resulted in a growing mutual understanding of problems among a broad range of public and private sector stakeholders. In some cases these partnerships have also led to solutions to urban freight problems. These solutions have been grounded in sharing knowledge and ideas and in a greater shared understanding of the needs of the public and private sectors within the urban freight system. Research on how best to deal with complex sociotechnical systems (of which urban freight is an example) suggest that shared situational awareness (SSA) is a critical step. Further work highlights the importance of solving problems through joint knowledge production (JKP). Freight partnerships exhibit these actions but often in a somewhat informal setting.

In addition it can be argued that freight partnerships sometimes lack the full engagement of all relevant stakeholders and have tended to focus on the discussion of problems rather than the robust testing and development of solutions. Applying the concept of living labs in the context of urban freight within a city may be an important way to enhance the achievements of freight partnerships. The living lab concept fits very well with the complexities of the urban freight system and has been a cornerstone of a recent proposal for a major freight project in the EU (CITYLAB). The first steps from the urban freight living lab in Rotterdam already demonstrate that the concept can be applied in a city. Next, it is to show that the results reinforce the activities of freight partnerships and can add new dimensions in terms of problem solving and the potential for scaling up the initiatives. This paper is a first step to chart the developments in this field and it will be valuable to continue the thread in order to see where and how more can be achieved.

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