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E-VEHICLES IN CITY LOGISTICS: A POTENTIAL FOR INNOVATION UPTAKE

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ABSTRACT

The adoption of innovation has frequently been described as path-dependent, highlighting the randomness in overcoming barriers. Addressing these issues within a system provides an improved understanding of the forces at work and allows for the planning and implementation of policy interventions in favor of innovation uptake especially when the objective is welfare.

Extending the Systems' Innovation (SI) approach, a framework for policy support is proposed to assist in indicating when and how to intervene in the adoption and technology transfer process. The proposed framework considers the innovation process as it develops over the various stages, takes into account its specific characteristics (technological, managerial/ operational and/or cultural innovation) and whether is objective is commercial or social welfare.

The framework analysis is applied to the introduction of e-vehicles in city logistics. Findings indicate the dependence of the innovation uptake on the innovation leader/champion and the need to transfer leadership from central authorities to municipal authorities in order to move from the initiation stage to the implementation stage. The importance of strong networks between innovation actors and respective building of capabilities, which may also work in favor of other competitive innovations, is also derived from the analysis.

Keywords: Systems' Innovation, E-vehicles, city logistics

INTRODUCTION

Innovation may be considered a technological or organizational (including cultural and marketing, as a separate sub-set) change to the product (or service) or production process that either reduces the product (or service) or production process costs or increases the quality of the product (or service) to the consumer. The definition is derived from the seminal work of

Schumpeter and other scholars (cf. Smith, 1998; Sundbo, 1998) and leads to the introduction of two broad categorizations: commercial innovations motivated to achieve either revenue generation or cost-reduction; and public innovations/policy initiatives aiming at achieving an increase in socio-economic welfare. In both cases, innovation is acknowledged to be a key driver of economic growth and, as such, has been included as an essential element of the Lisbon strategy launched in 2000, further defined by the Barcelona Research Council in 2002.

Electric Vehicles (EVs) are not a new innovation and have experienced a turbulent history over the past 100 years: starting from an established market to their displacement by the internal combustion engine vehicles in the early 1900s to the recent revitalised interest generated by firms and governments (IEA, 2011). Multiple efforts to (re)introduce electric vehicles have failed (Hard and Knie 2001). Many attribute this to their high purchase cost, technological immaturity and/or low functionality characteristics (driving range), which is reflected in behavioral aspects (cf. Struben and Sterman, 2008). Considering these shortcomings, EV manufactures have been emphasizing sports cars (where cost is not an issue), small cars (where expected functionality is small) and low speed vehicles (LSV) commonly used in city logistics, indicating the expectation of a commercial adoption of the technology (Sierzchula et al, 2012). Various levels of public governance have introduced a mixture of measures, in support of EV uptake. These include subsidy to purchasers, subsidy to car manufacturers, subsidy to R&D, infrastructure development, introduction of EVs to government commercial fleets (eg. La Poste), preferential access, measures to increase public familiarity and others (RAND Europe, 2012).

These reflect common policy instruments available to the public promotor/ policy maker, such as Public Procurement, Regulations, R&D subsidies and the Scientific and Technological Infrastructure (Rothwell and Zegveld, 1981 and Geroski, 1990). All involved forms of public funding are suitable for all sectors of the economy. However, as opposed to evidence from other sectors, the transport sector displays poor innovative strength. A comparative study by Dialogic and NEA (2002) on behalf of the Transport Research Centre (AVV) in the Netherlands has shown the transport sector to score less than the average for the economy as a whole when it comes to innovation.

It seems that focusing policy interventions solely on the cost structure, and respective “market failures”, has not lead to appreciable results. More specifically, the common policy approach supports the linear model of innovation and its economic argument for innovation policy measures, which is based on correcting for two principal “market failures”: (i) innovation can be imitated once successful so innovators cannot appropriate the full benefits of their investment and social returns of innovation exceed private returns: this means that private firms do not have sufficient incentives to undertake innovation to socially efficient levels (Arrow, 1962); (ii) negative externalities provide the rationale for economic and other instruments to “internalize” these externalities. This approach, also, provides the theoretical basis for public support to innovation directly (through subsidies) or indirectly (through funding of linear components of innovation). However, this approach has limited potential in the development or assessment of specific innovation policies, as it does not indicate the particular fields in which they are required, or the type of intervention required (cf. Edquist and Hommen, 1999).

An alternative approach to the linear development of innovation is the *system-oriented* approach. The Systems' Innovation (SI) approach views innovation as an interactive, non-linear process, in which actors interact with other organizations and institutions (laws, regulations, values etc.). This complex process, characterized by reciprocity and feedback mechanisms, determines the success of innovation (cf. Lundvall, 1992; Nelson, 1993 and Edquist, 1997). By identifying the interactions between actors and institutions, the SI approach uncovers the actors and mechanisms that lead to successful innovation. Through system analysis and the identification of the so-called system "failures", new rationale is provided for policy intervention (Edquist, 1997 and Edquist et al, 1998).

The main objective of this paper is 'to propose a framework by which to assess the conditions, including policy support, under which innovative concepts have a high chance of getting adopted and being successful'. Hardly ever has the innovation process as such been assessed, and have generic conclusions been drawn with respect to factors, which benefit or dis-benefit the successful adoption of innovative ideas in the transport sector. Exceptions are Garrison (2000), who has also derived generic understandings in the relationship between innovation and transportation technologies, and Hoogma *et al*. (2002), who draws generic conclusions from the study of eight examples of innovation concepts in the field of sustainable transportation. Furthermore, the present approach differs from proposed socio-economic evaluations (cf. Figliozzi et al, 2011; Brady and O'Mahony, 2011) as the introduction of policy-driven innovations are subject to the interaction of a complex system of actors and market conditions, as presented herewith and not necessarily subject to rational decision making. The present research responds to this knowledge gap through the presentation of the proposed Systems' Innovation Framework (SIF) and, respective, assessment methodology applied to the e-vehicle innovation to city logistics.

SYSTEMS' INNOVATION (SI) APPROACH

Background

The SI approach has its roots in the evolutionary theory (Nelson and Winter, 1982). Ever since its emergence in the early 1990's, SI has attracted the interest of international policy think-tanks such as the OECD (Mytelka and Smith, 2002).

In the SI approach, innovation does not take place in isolation. Actors, within the system, interact, cooperate and learn (Lundvall, 1992). Institutions hard (regulations, laws etc.) and soft (cultural norms, values, codes etc.) are crucial to economic behavior and performance. Institutions formulate the "rules of the game" or "code of conduct" (Smith, 1997). The system evolves, generates variety, selects across that variety and produces feedback (Norgren and Hauknes, 1999). This process of novelty and variety creation is the result of constant interaction among heterogeneous actors in a population (Smith, 1999). It is necessary to maintain the diversity that makes selection possible (McKelvey, 1997). Hence, under the SI approach asymmetries are essential in providing novelty and variety. Different actors and/or different institutions form different Systems of Innovation. In all these basic elements, systemic imperfections (or systemic problems) can occur, if the combination of mechanisms is not functioning efficiently. If so, innovation by actors may be blocked. These systemic problems as summarized by Norgren & Haucknes (1999), Smith (2000), Woolthuis *et al.* (2005) and Edquist & Chaminade (2006) include failures in following domains.

1. *Infrastructure*: The physical infrastructure that actors need for functioning (such as IT, telecom, and roads) and the science and technology infrastructure may not be available hindering further development.
2. *Transition:* The inability of firms to adapt to new technological developments.
3. *Lock-in/path dependency failures*: The inability of complete (social) systems to adapt to new technological paradigms.
4. *Hard institutions:* The failures in the framework of regulation and the general legal system to support the development of a new application.
5. *Soft institutions:* The failures in the social institutions such as political culture and social values that hinder the uptake of the innovation.
6. *Strong networks:* The 'blindness' that evolves if actors have close links and as a result miss out on new outside developments.
7. *Weak networks:* The lack of linkages between actors as a result of which insufficient use is made of complementarities, interactive learning, and creating new ideas. The same phenomenon is referred to as dynamic complementarities' failure.
8. *Capabilities:* Firms, especially small firms, may lack the capabilities to learn rapidly and effectively and hence may be locked into existing technologies/patterns, thus being unable to jump to new technologies/business patterns. In an extension, it can also include *financial* capability.

Within the SI approach, policy interventions (Edquist & Chaminade, 2006) are needed either because: (i) there is no market mechanism operating at all and the activities are fulfilled through other mechanisms, e.g., regulation or (ii) the market mechanism does not lead to the fulfillment of the objectives established. In both cases, public intervention is expected to lead to "*additionality*" and not "*substitution*" of market activities.

Recent Developments

Woolthuis *et al*. (2005), in order to identify "system failures" and estimate the expected impact of innovation policy interventions, proposed a "Systems' Failure Framework". This concerned a matrix including all relevant market actors and the systemic problems, as identified previously. As such, the "Systems' Failure Framework" was proposed as a diagnostic tool, with respect to innovation failure.

The key characteristic of evolution is "time". Roumboutsos *et al*. (2011) introduced this temporal aspect by proposing the introduction of temporal frameworks representing the stages of innovation development. This allows for the study of the evolution of the innovation adoption process as the innovation matures. They, also, added "market demand" and competitors to the market mechanisms to be studied (see tables 1 and 2).

A further improvement to the "Systems' Failure Framework" was proposed by Aronietis *et al.* (2012). It concerned the registration of both positive and negative correlations between actors and institutions as opposed to only the negative correlations of the Systems' Failure Framework. This allowed for the mapping of the positive system forces and their respective study through case studies.

Vanelslander *et al.* (2012), reporting on the analysis of case studies following this approach, introduced "layers" in the analysis in order to guide the focus of the analysis. The first "layer" concerned the characterisation of the innovation as commercial or within the context of public policy depending on whether the primary aim was to produce profit or social welfare. This was important in order to focus on the potential innovation Champion. The second "layer" concerned the type of innovation: technological, managerial and/or cultural. The third "layer" was, finally, the Systems' Innovation Framework. This framework did not include *Transition* and *Lock-in/path dependency failures*.

Proposed Systems' Innovation Framework & Assessment Methodology

In addition to the above developments and in order to capture the impact of the global environment and respective competition, the proposed methodological framework foresees both the expected influence of these factors and the expected competitive advantage of competing technologies by introducing a qualitative scale of assessment in the framework.

With this latter addition to the Systems' Innovation Framework (SIF), the innovation methodology is structured improving on the multi-layer approach presented by Vanelslander *et al.* (2012). More specifically, the proposed SIF methodology foresees three layers of analysis. The first layer concerns the distinction between commercial innovations and those seeking to increase welfare.

The second layer of the methodology involves the identification of its predominant component/aspect, i.e. technological, organizational, managerial, cultural or policy. For example, an innovation may be characterized as predominantly "technological" and also include organizational change. In this layer other typical characteristics are also identified. These include determining the timeline of development of the innovation process as presented in the scientific literature: initiation, development, and implementation. In reality, the innovation process is actually a continuous process. This layer also concerns the assessment of whether the application of the specific innovation requires trans-sectoral collaboration and/or forms of cooperation in the transport chain (example e-freight applications) or whether the adoption of the specific innovation influences only local stakeholders and, hence, the innovation is confined to a specific location. That is, the impact of the innovation is characterized as specific to the business unit involved or as having a wider market focus.

The third layer of the methodology involves the use of the SIF. This framework provides a means to identify the set of external factors (the so-called ‘institutional environment’ and ‘rules’) and the ‘sets of actors’ involved in the innovation being analyzed. Defining all of the components of the innovation is important as the focus of attention and intervention may alter as the innovation moves through the process from initiation to implementation. Finally, the role and importance of the initiator of the innovation is explored.

E-VEHICLES IN CITY LOGISTICS

Introduction

Electric vehicles (e-vehicles or EVs) are not new. E-vehicles have been around in one form or another since the invention of the automobile. Throughout the 20th century, several models of electric vehicles were produced, but none became widely adopted by consumers. Vehicle technologies to enable a major reduction in emissions are already known in principle and are being actively developed. However, the auto industry has not yet changed its business model to switch to low-emission technologies as the basis of its products. Environmental innovation is still small scale, relative to conventional motor vehicles with Budd-type pressed steel bodies and internal combustion engines (ICEs) with mechanical transmission (Whitmarsh and Kohler, 2010). This is one of the major barriers to the adoption of the innovation as small production rates are reflected in high purchase prices, leading to small market uptake and underdeveloped support/service networks. This makes commercial innovation unjustifiable.

Focusing on city logistics, in terms of innovation costs, promotes larger scale deployment. In terms of transport planning, city logistics is the “last mile” of the transportation of goods in city centers. Most attempts to reduce environmental impact of urban freight are concentrated on access restrictions (alternative or low emission vehicles are included under this category), traffic management, land use management and public infrastructure. EVs are in the same category as other environmentally efficient alternatives, and more precisely, just like other alternative fuel vehicles. Moreover, alternative fuel vehicles are one of the proposed measures for reducing the environmental impact of city logistics and are viewed by transport city planners as a “combined” (supplementary) measure. This means that their impact is optimized when adopted in connection with other measures such as consolidated deliveries (achievement of high load factors), mini warehouses, night deliveries, traffic management etc.

City logistics (urban freight) are organized through regulations imposed by city traffic planners for passenger vehicles in the cities they address. Regulations concerning urban freight are set at a municipal level reflecting the cultural attitude towards environmental issues of the specific locality. City logistics and respective measures are normally implemented within the local (municipal) legal framework conditions by using different legal premises such as ordinary traffic regulations concerning parking and loading/unloading as well as specific transport regulations such as weight limits on specific routes. However, in the case of fundamental changes like the use of environmental zones within a city, new traffic regulation orders are needed which are based on the limit values on air quality set by the European Directives (Directive 1999/30/EC).

The Case Analysis

The methodology as described previously is applied with respect to e-vehicles in city logistics. This concerns the analysis on three layers. The third layer is the SIF.

Layer 1 Analysis

The key aspect of this introductory layer is to identify whether the innovation case concerns a commercial innovation seeking revenue increase or cost reduction or whether the ultimate scope is socio-economic welfare, describing a policy-driven innovation.

The introduction of EVs is connected to the introduction of measures concerning the environment (emissions and noise measures). Within this context, EVs are supported. In addition, as noted in the introduction of the case, small demand and respective small production levels do not allow economies of scale and, therefore, market values comparable to conventional vehicles. The need for improved environmental quality in urban areas is the underlining rationale of the “policy driven” support to this innovative application and reflects welfare gains (Leiby and Rubin, 2003). The strong political drive for this innovation also targets the underlining globalised automobile manufacturing industry.

This policy support for city logistics is demonstrated in the many EU funded research projects and initiatives. Examples are noted in Box 1.

Apart from these EU research funded programmes there are a number of national initiatives. Within the ELCIDIS project (1998 – 2002), pilot actions of EVs for City Logistics were introduced.

A best practice example has been recorded for the Municipality of Parma running the ECOLOGISTICS Project and the launching ECOCITY Service using methane-fuelled vans for city delivery within the restructuring of its distribution system. This is evidence of competitive innovations.

BOX 1
Example EC Funded Research with respect to city Logistics
UTOPIA, REFORM, FV-2000, IDIOMA (FP4); BESTUFS and D2D, Demonstration projects within the CIVITAS I Initiative such as VIVALDI, TELLUS and MIRACLES, CITY FREIGHT, GIFTS, MOSCA and eDRUL etc. (FP5); projects within the CIVITAS II Initiative such as CARAVEL, MOBILIS, SMILE and SUCCESS, BESTUFS II (FP6).

EC Initiatives for Evs
European Green Car Initiative (EGCI, FP7) and projects under this initiative. Such as DELIVER, ESYBAT, ECOGEM, e-DASH etc.

Layer 2 Analysis

When characterizing the innovation, this is, obviously considered a technological innovation (introduction of the Electric Vehicle) but its application also requires managerial, organisational and cultural changes in city planning to take place. Technological advancement in manufacturing is required with respect to EVs but also for the development of "support" infrastructure (e.g. a network of (re)charging points etc.) and the respective capacities (e.g. network of maintenance/repair services etc.). This leads to the need for joint development of EVs and respective infrastructure (cf. Wirges *et al*, 2012).

The introduction of EVs in city logistics is a complex issue as it is dependent on the approach each municipality has towards the organization of its distribution system; the incentives and disincentives introduced; the selected technology, as EV are in competition with other alternative fuels for powering vehicles; the advancement of the EV technology, which is highly supported by EU funds under FP7 and the EGCI; the cost (purchase and life cycle) of EVs, which is dependent on its mass production and consequently on the number of municipal distributors making the change. Finally, as the increase in distribution needs is dependent on city consumption levels, potential changes are also dependent on growth prospects and macroeconomic figures of the economy.

The adoption of EVs in city logistics is culturally bound. No reported evidence was found with respect to their acceptance level as vehicles for urban freight. However, some indication may be derived through the March 2011 Eurobarometer. According to the pole, EU citizens would sacrifice speed and size but not price.

Hence, barriers to this innovation are concentrated on cultural, organisational and planning issues with respect to the municipal management of the distribution of goods; the willingness of municipalities to introduce incentives and disincentives supporting EV and discouraging the use of conventional vans; retailers' & distributors' willingness to pay the additional cost of the EV investment; technological barriers in connection to the EV technology; the current level of demand for distribution services; competition from other forms of low-emission vehicles. Enablers may be considered cultural changes in society and the emphasis on environmental issues; EU & international legislation focusing on air quality; the potential competitiveness of the EU auto industry and respective job creation.

EVs in city logistics may be considered to be in the initiation stage of the innovation, i.e. there are few such examples based on pilot activities. Examples of application of e-vehicles in city logistics are scarce and not included in demonstration cases of respective networks such as CIVITAS (http://www.civitas-initiative.org).

In addition, the innovation is applied at a local level and is rather independent on developments elsewhere, which are only influenced "culturally" as success or failure case reputation or "word of mouth" (Struben and Sterman, 2008). .

Layer 3 Analysis

The third layer analysis concerns the application of the SIF, with the identification of actors and their relations within the context of the various mechanisms (institutions, networks, capacities). It also involves the assessment of existing measures taken and the potential trend in new measures in order to improve on socio-economic gains, which should be the driver for policy measures. Layer 3 analysis is illustrated in tables 1 and 2, representing the current stage of development (initiation) and the next stage (implementation). The influence of a specific actor with respect to a "mechanism" is depicted qualitatively within the range [-3, +3], describing the level of positive and negative impacts.

In order to address layer 3 of the analysis, it is important to select the "system" upon which the analysis will focus. In the case of investigating the introduction of EVs in city logistics, the "system" could be the specific "city" in which the innovation takes place. The "system" could also be at the European level or, even, the international level depending on the focus of policy intervention measures to be introduced. When selecting the one focal system, all others will always play a boundary role in the analysis. In the present analysis, the "system" is selected to be at the European level seeking to identify policy measures at the EU level.

Actors: When studying the innovation at a European level, the actors to be considered are those acting at the specific level. Therefore, associations of involved stakeholders are considered. These may include: associations of manufacturers, distributors, retailers, environmental lobbyists (like The European Federation of Clean Air and Environmental Protection Associations (EFCA)), city planners, municipalities and city/local authorities, auto-manufacturers, the European Commission, standardization bodies and research institutes. These actors are indicated in tables 1 and 2. Their relations with respect to institutions and between them are depicted in the same table. Their qualitative assessment with respect to "system mechanisms" is discussed in the following paragraphs.

Infrastructure Conditions:

In the *initiation stage* (table 1), emphasis is placed on developing the technology and its peripheral issues (e.g. battery cells, light automobile structures etc.). The EU, through the EGCI and other programmes, is supporting city logistics and providing the initial platform. These research-funding initiatives are amongst the most reputed in the FP7 and are foreseen in the Horizon 2020 (Sierzchula *et al,* 2012). In the *implementation stage* (table 2), downstream infrastructure will be required such as charging units, maintenance centers etc. This factor, especially with respect to retaining cultural processes, is important for the uptake of the technology (Wirges *et al*, 2012).

Institutional Conditions:

Hard Rules. This innovation case has both policy and technological components. Hard rules with respect to legislation have already been set and further activities are envisaged. Various legislations and EU Directives are designed to influence both demand and supply by introducing at a national or local level incentives (tax reliefs etc.) and disincentives (taxing, city entry restrictions, fuel tax etc.). On the supply side, delivery vans follow measures relevant to passenger cars. The main measure implemented so far for passenger cars is the European Automobile Manufacturers' Association (ACEA) voluntary agreement on increased efficiency of new vehicles (EU wide), which aims at reducing emissions for new cars sold in the EU to 130 g CO_2/km average by 2015, with an additional 10g reduction coming from 'complementary measures' including a greater use of biofuels. These measures are supported by a range of policies differentiated between member states, including standards, liquefied natural gas (LNG) subsidies, as well as cross-sector R&D networks (for example, for hydrogen and fuel cells). In general, Directives influencing the uptake of this innovation (but not specifically the electric vehicles) are shown in Box 2.

BOX 2

EC, 2008:
CONCAWE, EURCAR (European Council for Automotive R&D), JRC (EU Joint Research Center) well-to-wheels analysis of future automotive fuels and power trains in the European context;

EC, 2009a :
Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reducing CO_2 emissions from light-duty vehicles;

EC, 2009b:
Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC

EC, 2009c:
Directive of the European Parliament and the Council on the promotion of the use of energy from renewable sources amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

EEA, 2009:
Environmental impacts and impact on the electricity market of a large-scale introduction of electric cars in Europe

The above measures introduce "hard rules" in the market. The introduction of "technological rules" so as to allow for the development of an upstream and downstream market has been initiated. This requires the collaboration of a great range of actors (standardizing bodies, initiators/ entrepreneurs, developers/ industry, transport operators and lobbyists) in all three stages of innovation. In order to introduce the *implementation stage*, municipalities will need to follow measures uptaken by standardization bodies and central European legislation concerning the environmental operation of vehicles within city limits. These, however, cannot be in favour of EV specifically but will concern emission and noise level values of vehicles, in general.

Soft Rules. These are considered the most important for the promotion of cultural innovation. It has been identified that changing the culture of cities and promoting a strong environmental image are important pre-requisites for the adoption of welfare innovations. In business unit cases, it has been shown (Vanelslander *et al.*, 2012) that in this approach, strong leadership on the side of the "initiator" is required. Demand for the innovation stems from a general cultural change. This can be introduced with radical behavioural changes. This latter condition sets the municipalities as potential leaders of the innovation (table 2).

Interaction Conditions:

Weak Network Conditions. Weak networks may have a positive impact on this technology. A strong driver is the auto manufacturing industry in Europe, which must take a positive stand towards the EVs. If influenced by "strong network conditions", which do exist between manufacturers at a global level, efforts to introduce EVs in city logistics may be hampered by differential emphasis on other low–emission auto technologies. Weak network conditions between municipalities are positive at the *initiation stage* as shortcomings and teething problems are not communicated. In the innovation *implementation stage*, weak network conditions between municipalities have a negative effect, as a "push" for the innovation is not accomplished. These weak networks need to develop into "strong networks" in order to support the transfer of knowledge and experience as well as the creation of the "feeling of innovation lag".

Strong Network Conditions. Strong links between members of the global auto industry play a negative role in the promotion of the EV as, depending on international trends, emphasis is shifted. Patent analysis indicates relative homogeneity within the automotive industry in its focus of R&D: during the 1990s, this was primarily in favour of the battery-electric vehicle (BEV); in the early 2000s, there was a shift towards fuel cell and hybrid vehicles; but more recently, there has been a reversal of this trend in favour of BEVs again (Whitmarsh and Kohler, 2010).

The European Commission (EC) through various fora, technological platforms and EC-funded research is trying to develop network conditions between the actors involved in this innovation. As the EC is funding research in the initiation stage of the innovation, it is considered a "leader". However, sustaining strong links when conducting "competitive research" is questionable.

	Research Institutes	EC	Stand. Bodies	Assoc. Logistics (users)	Assoc. Retailers (users)	Assoc. Manufa cturers	City Planners	Municipal Authoritie s	Lobbyis ts
Infr/ture	+1	+2	+1	- 3	- 3	+2	+2	-1	+2
Hard Inst/ions		+3						+2	
Soft Inst/ions	+1	+3		- 3	- 2	+2	-1	-1	+1
Weak Networks	-1/ +1	- 1/ +1						+2	
Strong Networks		+2				-3		- 3	+3
Capab/ties	+1	+1	+1	-1	-1	+2	+1	-1/+2	+3
Market Demand	+1	+1	+1	- 2	- 2	+3	+1	-2	+3
Competito rs	+1	+1	+1	+1	+1	+1	+1	+1	+1

Table 1 – SIF Applied at the Initiation (Current) Stage of Development

Strong networks need to be developed between similar actors in different municipalities. EC funded projects are implicitly contributing on this front but more emphasis has to be placed in the *implementation stage* mixing innovation initiators and those who lag behind. Furthermore, in the implementation stage strong relations need to be developed between manufacturers and municipality actors in order to support pilot/demonstration activities and secure commitment on both sides (supply and demand).

Capabilities.

The policy maker, when promoting the development of this innovation case, should take the capabilities of the actors implementing the respective technologies into account. The support for development of capabilities of the actors is needed mainly in the development and implementation phases of the innovation. It is interesting to note that while the natural leader and policy maker during the initiation stage is the EC policy maker, in the implementation stage, this would naturally be the municipal authorities. Training and development of respective capabilities is considered important.

During the research, it was noted that the policy maker has taken a proactive approach by supporting capability development already in the initiation phase of the innovation by providing funding to several research projects dealing with development of the technological components and necessary infrastructure.

Market Demand.

Market demand is a very important component of this development and concerns both the ability of the manufacturing industry to reduce purchase and life cycle costs and "push" in the local community for more efficient urban freight services. Consumption levels may severely influence the enforcement of low-emission technologies as reduced consumption may lead to the same overall emission generation. This factor influences all actors and the uptake of the innovation. Little can be done on this aspect, as it is more depending on local growth rates.

Key Competitors.

The innovation has a number of key competitors. Emission & noise control of urban freight may be also addressed by purely organizational /planning measures, which do not impose extra costs especially to distributors. These approaches have been addressed in the city logistics literature and are promoted as best practices. On the technology front, low emission levels are also achieved by other auto technologies, which in addition require less cultural change. From a welfare point of view they achieve similar results in terms of municipal objectives.

Policy recommendations as identified by the SIF Analysis

While presenting the current situation, the anticipated development of the next stage (implementation) and the requirement for positive assessment of relations was identified. This is illustrated in table 2.

One major change to be effected in order for the innovation to be implemented is the transfer of leadership (innovation champion) from the EC to the municipality. The introduction of new local actors requires the development of strong networks and the gradual build-up of capabilities. Standardization bodies need to proceed with the required "technology rules" in order to streamline the upstream and downstream market. Market demand is a crucial aspect related to all actors.

	Research Institutes	EC	Stand. Bodies	Assoc. Logistics (users)	Assoc. Retailers (users)	Assoc. Manufacturers	City Planners	Municipal Authorities	Lobbyists
Infr/ture	**+1**	**+2**	**+2**	**+2**	**+1**	**+3**	**+2**	**+2**	**+2**
Hard Inst/ions		+3	+2					+2	
Soft Inst/ions	+1	+3		+2	+2	+2	+2	+2	+1
Weak Networks	+1	+1						+2	
Strong Networks	+1	+2	+1	+1	+1	+1	+1	+2	+3
Capab/ties	+1	+1	+1	+1	+1	+2	+1	+1	+1
Market Demand	+1	+1	+1	+1	+1	+1	+1	+1	+1
Competitors	+1	+1	+1	+1	+1	+1	+1	+1	+1

Figure 2 – Anticipated Development of the Innovation in the Implementation Stage

As EVs in city logistics reflect environmental measures to emission and noise reduction, market demand and competition is related to how these conditions could be met. Possibly, these conditions may be met independently from the analyzed technology. For example the enhancement of relations between local actors, which is important in the process of adoption of innovation, might equally facilitate the adoption of other alternative fuel vehicles or even the implementation of managerial changes in support of city logistics. The result will then totally depend on the particular innovation champion.

Already a number of leading municipalities have become active champions. Their intervention, as anticipated, is focused on providing preferential access for EVs (but also to other Alternative Fuel Vehicles) to city centres. Examples include: exempt from congestion charge in London; free parking in Copenhagen; single occupancy in high occupancy lanes in Ontario; Autolib scheme in Paris for familiarisation; La Poste commercial fleet in Paris; the promise of introducing 1,000 EVs in government fleet by 2015 in London (RAND Europe, 2012). However, while these are measures in support of EVs' adoption, the development of strong networks is needed for the deployment of the innovation, as shown in figure 2.

CONCLUSIONS

The present research takes a Systems' Innovation approach and proposes a "Systems' Innovation Framework". This considers the actors and institutional factors of the framework as proposed by Woolthuis *et al*. (2005) and also the temporal conditions as introduced by Roumboutsos *et al*. (2011). The framework considers positive and negative correlations as introduced by Aronietis *et al*. (2012) and, finally, employs the socio-economic positive trend and the existence of the "initiator" as drivers of the respective analysis. In the current methodological development, the effect of other systems and markets is also considered. The proposed framework is used for assessing the potential of e-vehicles in city logistics[1]. Relevant information with respect to e-vehicles was collected through desk research. Findings indicate the dependence of the innovation uptake on the innovation leader/champion and the need to transfer leadership from central authorities to municipal authorities in order to move from the initiation stage to the implementation stage. The importance of strong networks between innovation actors and respective building of capabilities, which may also work in favour of other competitive innovations, is also derived from the analysis.

The Systems' Innovation Framework presented combines in a matrix the actors, the mechanisms and market conditions and provides a tool by which to qualitatively assess the current status and estimate future requirements and pre-conditions. Hardly ever has the innovation process been addressed, especially in the transport sector, which is under-performing when it comes to innovation and technology transfer. The present research responds to this knowledge gap through the proposed Systems' Innovation Framework (SIF).

The developed framework is interesting, both methodologically and from a social point of view. As to the method, it provides a novel approach for dealing with innovation processes rather than just outcomes. In that respect, the methodology is applicable to the various types of innovation in transport and outside. For society and policy makers, it is relevant to see where and when innovations can be supported by which actor, so as to achieve maximum results, and avoid negative impacts of wrong intervention.

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