Journal of Cleaner Production 108 (2015) 1092–1104

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Spatial contexts and firm strategies: applying the multilevel perspective to sustainable urban mobility transitions in Brazil

Roberto Marx [a], Adriana Marotti de Mello [b], Mauro Zilbovicius [a], Felipe Ferreira de Lara [a, *]

[a] University of São Paulo, School of Engineering, Department of Production Engineering, Brazil
[b] University of São Paulo, School of Economics, Business Administration and Accounting, Brazil

ARTICLE INFO

Article history:
Received 14 October 2014
Received in revised form
30 August 2015
Accepted 1 September 2015
Available online 15 September 2015

Keywords:
Sustainable urban mobility
Multilevel perspective
Automotive industry

ABSTRACT

The Multilevel Perspective on Sustainable Transitions (MLP) has been widely used to explain different patterns of technological, societal, cultural and normative transitions in an integrated and systemic way. This framework has been used to analyze individual transportation based on internal combustion engine automobiles and to develop niches that can challenge the existing dominant regimes in favor of more sustainable urban mobility systems. In a recent and relevant work, Markard et al. (2012) thoroughly discussed MLP, highlighting gaps and research opportunities. One such gap is that much of the research developed using this framework was conducted primarily using European scenarios, omitting various aspects of regional or country diversity, or the role of firm strategies failed to be considered. Therefore, we propose to analyze and compare Brazilian and German case studies regarding sustainable urban mobility transitions. To accomplish this goal, we analyze the diffusion level and different characteristics that explain the current development level of four niches: electro mobility, car sharing schemes, intermodal transportation, and innovation in public transportation. Using the multiple case study method, we compare the sustainable mobility initiatives and innovations undertaken by two German automotive companies in Brazil and in Germany. The results of the research conducted with both companies show that mobility initiatives in Brazil remain very limited. Manufacturers remain much more concerned with selling traditional products (in a much faster growth market than in Germany) than with initiating more aggressive strategies oriented to mobility. Even in their mother countries, mobility innovations can be considered moderate. Our main conclusions are that mobility initiatives in Germany and in Brazil are very different for a number of reasons, such as different pre-existing infrastructures to support new mobility initiatives, public pressure for mobility solutions, different growth patterns concerning car sales and different institutional and legal conditions regarding public and private participation in mobility issues. Therefore, the MLP framework would generate different trajectories and outcomes; in addition, firm strategies should be considered in the framework, particularly in a sector such as the automotive industry, in which firms have considerable influence.

1. Introduction

The Multilevel Perspective on Sustainable Transitions (MLP) (Kemp, 1994; Geels, 2002; Geels and Schot, 2007) has been widely used to explain different patterns of technological, societal, cultural and normative transitions in an integrated and systemic way. From the socio-technical approach (a term derived from the organizational literature of the 1960s), an analytical framework has been created to understand the macro processes of technological transitions and systemic innovations.

This approach also argues that special attention should be devoted to niche development and stimulus – "Strategic Niche Management" (Kemp et al., 1998). According to this view, the niche provides protection to radical innovations, acting as incubation rooms, which enable those innovations to develop and eventually become competitive, thus contributing to changes in the course of Sustainable Transitions (van den Bergh et al., 2011; Markard et al., 2012).

This framework can be used, and has previously been used, to analyze individual transportation based on internal combustion-

* Corresponding author.
E-mail address: fflara@ifsp.edu.br (F.F. Lara).

http://dx.doi.org/10.1016/j.jclepro.2015.09.001
0959-6526/

propelled automobiles and to develop niches that can challenge the existing dominant regimes in furtherance of more sustainable urban mobility systems (see for example, Geels et al., 2012; Spickermann et al., 2013; Marletto, 2014). We can understand these niches to include, for example, new propulsion forms, such as electrical, hybrid or fuel cell engines, and innovations in public transportation or intermodal mobility.

In a recent and relevant work, Markard et al. (2012) thoroughly discussed MLP, highlighting its gaps and research opportunities. We highlight two of those gaps: lack of territorial sensitivity and of strategies of firms. Much of the research developed using this framework has been conducted primarily using European case studies, neglecting different aspects of regional or country diversity and omitting the role of firm strategies from consideration. Coenen et al. (2012) criticized MLP, specifically for its failure to explain whether and how spatial contexts matter.

Therefore, we propose to deepen the discussion about MLP, including two variables initially neglected in its theoretical framework: spatial sensitivity and strategic role of firms, trying to explain if and how these two issues matter in MLP, increasing its validity as a theoretical model. In order to do so, in this paper we analyze and compare Brazilian and German case studies regarding sustainable urban mobility transitions, from the standpoint of automotive firms strategies.

To accomplish this goal, we analyze the diffusion level and different characteristics that explain the current level of development of four niches: electro mobility, car sharing schemes, intermodal transportation, and innovation in public transportation. We compare the sustainable mobility initiatives undertaken by two German automotive companies in Brazil and in Germany to analyze how different socio-spatial contexts and firm strategies would affect transitions toward a Sustainable Urban mobility system.

Brazil is an emergent country that, unlike Germany and other mature markets, has experienced huge growth in both market size and car production since 2004. With its pre-salt oil reserves, Brazil has become a country with unprecedented growth in fossil fuel reserves, in addition to its high and disseminated use of ethanol as fuel (Mello et al., 2013). These combined factors could hinder sustainable mobility in the country.

In brief, Brazil must cope with distinct realities. On the one hand, there is a growing demand for passenger cars and dependence on the automotive industry, which represents approximately 20% of the industrial GDP. On the other hand, there is a growing demand for sustainable urban mobility and better public transportation. Three main questions arise from this discussion and will be taken as a guide for the analysis we intend to conduct:

1) *Is the automotive industry in Brazil reacting to this scenario?*
2) *How deeply are subsidiaries located in the country really involved and/or interested in new mobility initiatives?*
3) *Given that all the automakers that operate in Brazil are subsidiaries of global international companies (primarily American, European and Japanese), would there be differences between strategies adopted in Brazil and in the countries of origin?*

The article is organized as follows. Section 2 discusses how automobiles evolved from a “mobility solution” to an “environmental villain”, as well as a brief overview about the current situation regarding sustainable urban mobility in Brazil and in Germany. In Section 3, the conceptual basis of the study is synthesized, and our research hypotheses are stated. Section 4 presents the research methodology, and Section 5 presents the cases studied and discusses the results. Finally, in Section 6, conclusions are presented, noting study limitations and suggesting further research.

2. Car in the 21st century – from mobility solution to “environmental villain”

In the 20th century, the automobile has become the central element of personal mobility in urban societies, with its market increasing and many positive consequences in terms of convenience, speed, comfort and personal freedom. In contrast, a number of social problems associated with this mobility model have emerged, such as congestion, accidents and deaths, local air pollution and noise, global warming, social exclusion, and oil dependency (Banister, 2008).

In the second decade of the 21st century, this industry is at a crossroad: although the car remains the most popular means of transportation in the world, it is considered an environmental villain by many because the automobile is inefficient both in energy and in social terms, causing air pollution and congestion in large and mid-sized cities, particularly in emergent countries, such as Brazil.

Despite its growth in developing countries in recent years, the global automotive industry has been living in persistent “crisis” for decades. The profitability of automakers and parts suppliers, even with all efforts targeted at improving economic efficiency (such as lean production, modularization, and product platforms), is decreasing. The competitiveness of the industry has increased with the introduction of new global players; Korean, Chinese and Indian automakers are expanding their role in the global scene.

However, it would be precipitous to affirm that the automotive industry is in an inexorable decline. The 21st century may mark the end of a given mobility, business and production model, but it could also point to new opportunities in the automotive industry – new business models and products.

The social and legal pressure for lower rates of greenhouse gases emission, air pollution and more efficient recycling has introduced the need to develop new and more efficient motorization and product-building technologies.

Faced with the above challenges, the industry needs to transform its product and most likely its business model. Geels et al. (2012) state: “Economically, socially and environmentally, motorized transport based on fossil fuels is not sustainable.” However, the industry emits mixed signals: there are initiatives such as the launch of hybrid and/or electric vehicles and a systematic increase in investment in R&D in this area. In contrast, there is a kind of technological inertia, with many incremental innovations occurring in the context of a dominant model; most of the patents deposited by automakers in recent years are related to internal combustion engine improvements (Oltra and Saint-Jean, 2009).

Wells et al. (2012) discuss the profound stability of the automotive industry and suggest that there will be no radical change in the concept of this industry without the participation of the major automakers.

Another point of discussion is whether and how the industry is considering the needs of users in their innovations. A passenger car is currently a more complex product than an airplane; the first has an average of 10 million lines of software, while an airplane has only 1.7 million (MacDuffie and Fujimoto, 2010). Does the market want (or even need) this kind of product? A survey conducted by consulting firm Oliver Wyman says no; only 17% of the innovations offered by automakers are actually purchased by consumers (Dannenberg and Burgard, 2007). However, there are no signs, at least in the short term, indicating that the product development model of major automakers will change (Wells et al., 2012).

It is mandatory to consider the Sustainable Urban Mobility (SUM) paradigm to fully consider current urban users' needs and preferences. Policies targeting improvements in sustainable mobility should include all societal agents, including the

automotive industry. Banister (2008) lists four main points to consider for developing a SUM model: urban planning; demand management; development of multi-modal shifts; and energy efficiency.

Although all four points affect the automotive industry, the latter two directly impact automotive firm strategies. We can foresee the following threats and opportunities for the automotive industry, considering the four points above (Table 1).

Currently, the automotive industry can be said to be in the middle of a process of unprecedented development of new technologies that could transform the industry dynamics. If the electric powertrain earns significant space in the future, the competitive basis of the industry may change, exerting even more pressure and increasing survival risks for traditional companies and business models (Banister, 2008; Canzler and Knie, 2009).

However, this process does not solely affect the development of new or improved cars. The exhaustion of traditional cars as a means of individual transportation in urban centers is blatant. Large cities in developed countries and even more so in emerging countries are close to chaos from the perspective of urban mobility. The mobility issue will not be solved solely through environmentally better cars but requires more appropriate policies to guide and to encourage other collective means of locomotion, as an alternative or complement to the use of individual modes (Hildermeier and Villareal, 2014).

We can say that both automotive industry and urban mobility are in a process of change, which would transform their current socio-technical paradigms. This transformation process would last for decades, and this situation poses challenges to each of the agents of the current stakeholders of the industry – consumers, companies, governmental agents, universities, and NGOs (Canzler and Knie, 2009). An integrated and negotiated approach involving institutions and individuals is essential for (re)defining the concept of a mobility model and products to fit it.

The complete technical, social and political solutions to overcome the urban mobility "crisis" are yet to be defined. There are different possibilities that would fit in different social and special contexts; however, thus far, it has been difficult to foresee a winning dominant model. Yet, it is not a matter of waiting to see where events lead. Agents can interfere regarding which path a given societal group would take. Therefore, investors, government, research institutions, and industry professionals need to assess future scenarios in an integrated manner; they must also take positions.

One can distinguish different sustainable urban mobility-related interest groups around the world, including in Brazil. Traditional automakers tend to adhere to the current technology and defensively research other possibilities for products, engines, or new materials (Wells et al., 2012).

Additionally, agents who will benefit from the discovery of the pre-salt oil reserve tend to advocate adherence to the current technology; Brazil will be a country with unprecedented growth in fossil fuel reserves, which could eliminate the need and strategic importance of the electric car to the country. This position can also be strengthened by people who see ethanol as an ultimate Brazilian alternative to the issue of sustainability in mobility (Mello et al., 2013).

Therefore, although efforts to improve energy efficiency and reduce emissions in car engines remain necessary and urgent, the issue of sustainable urban mobility requires other innovations, particularly regarding the generation of solutions targeted at integrating the use of automobiles and other transport solutions. The issue involving the use of modal integration is a priority for any effort in this area (Banister, 2008).

As modal integration, we mean the combined use of trains, buses, bicycles, subways, cars and other means of transport (collective or public) that contribute to reducing traffic congestion and pollution. To effectively implement this transportation model, a complex and interacting set of factors should be considered and treated, namely:

- The integration of different modes of transportation should be managed; this process requires a project coordinator strong enough to negotiate and to establish operation standards for the system. For this purpose, different companies and institutions that manage each mode should agree on how the business model should be designed and implemented, for example, on establishing fares and forms of payment.
- New business models could emerge from governmental stimulus and/or NGOs and automakers initiatives for integrated transport solutions, such as car-sharing schemes, development of small electrical vehicles designed for short-distance trips, and information systems that inform about the availability and speed of access to each of the integrated transport options. Although a number of successful cases in this area already exist in Europe, they remain a small part of the transportation business, a niche.
- The automotive industry, thus far almost exclusively focused on technological enhancement for the product it develops, should gradually be affected by the change in demands by its customers and forced to introduce new businesses in addition to the car in its product portfolio.

2.1. Current Brazilian and German status in sustainable urban mobility

As mentioned in Section 1, Brazil has experienced a huge growth in both market size and car production since 2004. With its pre-salt oil reserves, Brazil has become a country with unprecedented growth in fossil fuel reserves, in addition to its high and disseminated use of ethanol as fuel (Mello et al., 2013).

The private car is widely used as a main transport means, even among the lower income population, causing traffic congestion, even in mid-size cities. Large cities, such as São Paulo, have chronic congestion and mobility problems. Public transportation, despite the high investments in recent years, remains low in quality: it is considered slow, expensive and overcrowded (IPEA, 2012).

In 2013, a series of massive public demonstrations in all major cities showed people's dissatisfaction with transportation policies.

Table 1
Threats and opportunities for the automotive business in the SUM paradigm.

Threats	Opportunities
• Market decreasing for passenger cars (especially in developed countries) • Car considered an environmental "villain"	• Environmentally friendly cars connected to multi-modal transport schemes • Growing market for omnibuses • Integration/communication with ICT

Source: elaborated by the authors.

Since then, federal, state and municipal governments have put more effort into policies targeting improvements in public transportation quality. The federal government announced large investments in BRT (Bus Rapid Transfer Systems) and metro projects in different states and cities; the state of São Paulo is building three new metro lines, and the city of São Paulo has introduced a large bus exclusive-lane (a simpler version of BRTs) program on larger avenues. BRT is a bus system that provides segregate infrastructure and traffic priority to buses, in order to improve speed and to deliver a better quality of service, with rapid stops. It is compared to a "metro on wheels" service, with the advantages of metro systems at lower costs (Wright, 2011).

The pressure that the government may exert on automotive companies is particularly important for Brazil, where environmental discussion is still incipient, and public pressure toward different mobility alternatives remains very low. It appears that different scenarios would be observed if different stakeholders, including consumers and local, regional and federal governments began to exert more direct and indirect pressure on the manufacturer's orientation.

Nevertheless, the city of São Paulo (traditionally, a pioneer in mobility initiatives in the country) has introduced a series of new initiatives concerning mobility; the starting point is the assumption that public transport is the priority.

These initiatives include exclusive corridors for buses and bikes and greater limitations for car parking inside residential buildings and in the streets. Those initiatives may represent a starting point for creating new coalitions and niches but so far, assemblers have not participated in or directly or indirectly supported those initiatives.

Is it normally accepted that automotive companies are a very traditional and conservative industry. Public and government pressures could be changing (at slow pace) the business model in Europe. However, in an expansion market such as Brazil, which is the world's 5th largest market, the potential for growth and the absence of a Brazilian-owned manufacturer reduces the feasibility of creating a new business model as compared to other countries.

On the other hand, Germany has a mature, consolidated market for passenger cars. Since the financial crisis in 2008, German companies have suffered with overcapacity and lower profit margins. Besides, stricter regulations about gas emissions and higher taxes on automobiles purchase and use pose future challenges to the survival of the industry in the long term.

Although private motorized transportation remains dominant, both public transportation and bicycle traffic slightly gained importance in the last decade (Canzler and Knie, 2009). Initiatives such as BeMobility (Berlin) of intermodal integration (trains, electrical cars and bikes), and Car2Go (car sharing scheme from Daimler) are growing in many cities throughout Germany (Hildermeier and Villareal, 2014).

Aiming at reducing the environmental impact of passenger cars in cities (measured by noise, air pollution and traffic congestion) and concurrently giving incentives to innovation and growth of new businesses models in the automotive industry, the German Federal Government launched various support programs to stimulate the development of new businesses in mobility, although without central coordination (Canzler and Knie, 2009). According to Schöller-Schwedes (2010), policies to integrate different modes and initiatives of mobility in Germany had already failed in other opportunities due to lack of political conditions, which are an extra challenge regarding this issue.

As discussed above, Brazil and Germany have different situations regarding SUM, including:

- different pre-existing infrastructure to support new mobility initiatives;
- different public pressures for mobility solutions;
- different situation of growth patterns concerning car sales;
- different institutional and legal conditions regarding public and private participation in mobility issues;

Our research intends to discuss how these differences would impact transitions toward a Sustainable Urban mobility system, especially regarding automakers strategies.

3. Theoretical background

The conceptual basis of this project is grounded in a systemic view of innovation, particularly on Geels' (2004) concept of Socio-Technical Innovation and the Multilevel Perspective on transitions between socio-technical (MLP) systems by Geels and Kemp (2012). From these concepts, we will develop a model to describe how (or whether) the transition into sustainable urban mobility is evolving in Brazil. Specifically, we will discuss the role of carmakers and how they are reacting to this issue in comparison to the strategies they adopt in their countries of origin; in addition, we will examine the socio-spatial context and enhance the role of firm strategies in the MLP framework.

3.1. Evolution of socio-technical innovation systems – the dynamic multi-level perspective (MLP)

Innovation has a systemic nature; companies rarely innovate in isolation. Instead, companies innovate in collaboration and interdependence with other organizations, including other companies (suppliers, customers, and competitors) or organizations such as universities, schools and public agencies. The innovative behavior of firms is influenced by institutions such as laws, regulations, rules and routines, which can both encourage and hinder innovation. These organizations and institutions are components of a system for creating and commercializing knowledge, in which innovations arise, forming the "Innovation System" (Edquist, 2005).

Geels (2004) included the demand side in the discussion. Innovation models in general have a strong direction for the development of knowledge and briefly discusses the diffusion, use and impacts of technology in society. In a system called "Socio-Technical Innovation Systems", Geels (2004) proposes the inclusion of a social function of innovation, considering the needs of users in relation to features of products and services developed. This system encompasses the steps of production, diffusion and use of technology; it can be defined as a set of connections among the elements necessary to meet societal functional needs, such as transportation, communication, and electricity.

Geels (2004) argues that production and the use of physical artifacts have become increasingly distant in the current industrial model. In social sciences and management studies, there is the same distinction – excessive focus on the production side. In contrast, the consumption and adoption of a new technology is not a passive act. Users need to integrate new technologies (particularly the most radical) into their daily lives, which mean the existence of a learning and a cultural chance process that need to be better considered and understood.

As the innovation system evolves and the characteristics of a given society change, how does this process occur? Geels (2004) proposes a model for the evolution of socio-technical regimes. An innovation system has certain stability within a valid set of rules (values, rules and cognitive patterns). The rules provide stability and generate perceptions in their actors. Moreover, socio-technical systems have a certain inertia, linked (among other factors) to sunken investments that do not allow radical or constant change. "*People adapt their lifestyles to artifacts, new infrastructures are*

created, industrial supply chains emerge, making them part of the economic system dependent on the artifact. Thus, technological momentum emerges" (Geels, 2004, p. 911).

This stability leads to a path dependence that encourages the adoption of incremental innovations in a socio-technical system, leading to particular innovation trajectories in a given system. Geels (2004) identifies three levels of increasing structuring of activities in a socio-technical system. Niches, Patchwork of regimes and Landscape. In Niches, operating rules, values and cognitive patterns are not yet well established; therefore, there is room to probe more radical innovations. Companies operating in niches need protection to survive (in the form of subsidies, or strategic business investments) because they rarely manage to achieve positive results.

In a collection of technological regimes (patchwork), the structuring of activities by local practices is much stronger than in technological niches and has coordination effects, guiding an actor's action. In this scenario, the level of structure is higher, and changing the rules is beyond the mere will of their agents because there is an accommodation to include broader aspects of society such as infrastructure, spatial arrangements of cities, capital investments in industries, behavioral and culture-shared values.

Niches emerge to address problems or gaps that may exist in regimes. Niche companies expect to be part of a system, but entering a system is not simple, as a system has certain stability, and radical innovations cannot fit the scheme immediately. However, innovation in systems occurs from the niches. There may even be multiple niches that compete with each other. In successful niches, learning processes are aligned, leading to greater stability.

When this process leads to a dominant design, developments become more predictable. Innovation may break out of its niche when ongoing processes in the regime and in the scenario create windows of opportunity. A system innovation occurs when the new innovation exploits a wider market share and links with ongoing processes in the regime. This is accompanied by greater adjustments in the socio-technical regime.

Therefore, system innovations involve not only technological and market shares but also changes in wider dimensions such as regulation, infrastructure, culture and industry characteristics. System innovation is thus the outcome of linkages between multiple dimensions; there is no single cause or driver for system innovation. Instead, there are simultaneous processes at multiple levels and dimensions (Fig. 1).

In an effort to make a further contribution on the dynamic of transition pathways, Geels and Schot (2007) propose two criteria to distinguish them: timing of landscape, niche and regime interactions and nature of those interactions. Using combinations of these two criteria, authors have developed propositions about four different transition pathways: transformation, reconfiguration, technological substitution, and de-alignment and re-alignment.

This conceptual tool may help to better understand future alternative pathways that may emerge as a consequence of different firm strategies or even for different regional strategies for the same firm. The MLP provides an appropriate framework to discuss transitions to the SUM paradigm. Geels (in press) used the MLP to assess the drivers, barriers and possible pathways for low-carbon transitions in the automotive industry for the UK and the Netherlands. He concludes that the automotive regime remains stable and dominant.

However, there are moderate cracks in this regime that pose certain challenges to the future of the industry: traffic congestion, growing concern (from society and government) regarding sustainable urban mobility, and weakening in the commitment of policy makers to the auto-mobility regime. One important work about transition pathways in the automotive regime is the one edited by Geels et al. (2012). Different chapters discuss different perspectives of the subject.

For example, Wells et al. (2012) discuss different causes of inertia in the automotive regime; Orsato et al. (2011) use this conceptual framework to analyze the transition pathways to the electrification of mobility.

Other authors, such as Marletto (2014) and Spickermann et al. (2013), also discussed urban mobility using the MLP perspective. Marletto (2014) created a graphic tool, the socio-technical map, to improve the representation of supporting actors, regimes, and niches in MLP. Spickermann et al. (2013) used the MLP approach in developing future mobility scenarios for Germany.

As the framework of Marletto (2014) will be more extensively used in the next items, is worth elaborating a little deeper into his contribution. The author positions his work in the future trends and scenarios research field, applying the MLP approach to study urban mobility in 2030. A socio-technical map of urban mobility is proposed to position innovative actors and systems in the current situation and in scenarios emerging from alternative transition pathways.

Marletto (2014) considers that actors are able to: a) implement innovative strategies, b) reconfigure coalitions and c) modify their influence on institutions and markets. The author also uses three variables that may change between current and future positioning: a) business models, b) propulsion technologies, both representing the technological competence and a third one, c) power, a variable that measures the ability of systems to influence institutions and markets.

Using a graphical scheme to represent the comparison between current and future scenarios, power is represented by rectangles used to symbolize systems: thicker for the dominant system, normal for other systems and dotted for niches. Other graphic symbols are used: dots representing actors and arrows representing competences (see Figs. 3–6 in item 5 of this paper to see the graphical application of Marletto's framework).

As a conclusion of the brief discussion made in this item, it seems that one of the main contributions that MLP could offer to the discussion regarding urban mobility is the integration, in one conceptual approach of technology and behavior change processes, which until recently, have divided the urban mobility studies into two independent research fields. Adding more and more complexity, different authors are still discussing and developing this framework such that it characterizes a still open and promising field oriented to better understand transitions in mobility and in other sociotechnical systems.

3.2. Limits and criticism to MLP and opportunities to improve it

Although MLP, particularly its application in the Sustainable Transitions field, has been widely used in Sustainable Urban Mobility studies (as previously discussed), the field narrows in certain regards. In an introductory paper with a section devoted to this issue in the Research Policy Journal, Markard et al. (2012) verified gaps and future theoretical development opportunities to overcome. We will devote attention to two of these gaps and theoretical development opportunities: spatial and institutional contexts and the role of firms in transitions.

According to Coenen et al. (2012), much of the literature produced regarding MLP and sustainable transitions is focused mainly on European contexts and lacks "territorial sensitivity" in its analysis: the literature fails to analyze the spatial particularities of transitions systematically, neglecting where transitions occur. Differences in socio-spatial contexts at the national, regional or local levels could lead to a much broader variety of transition pathways.

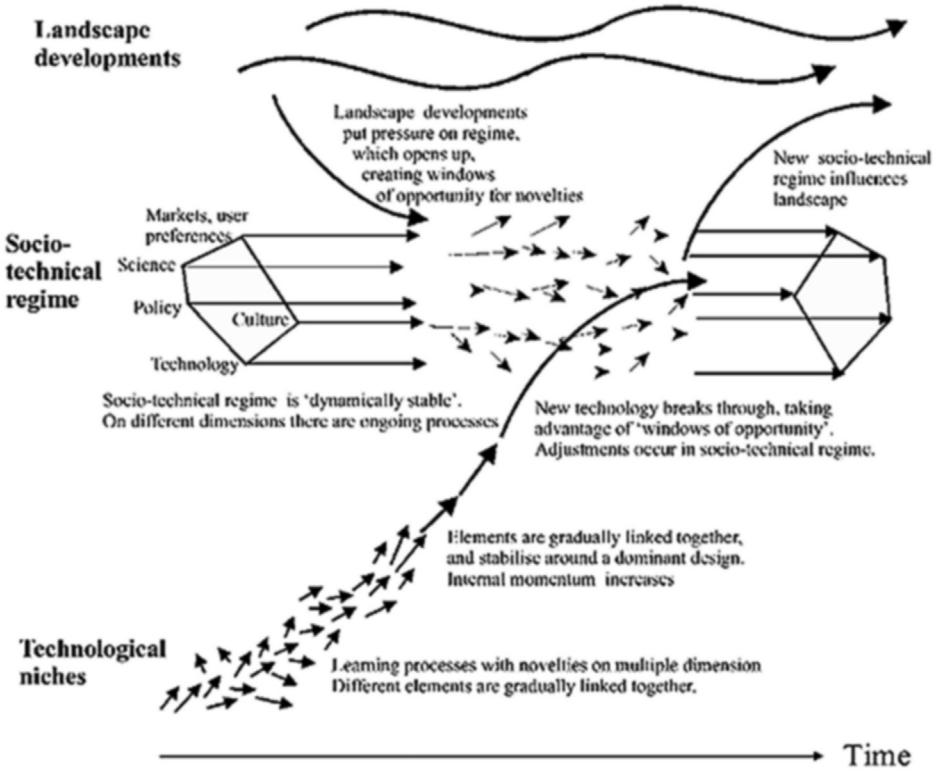

Fig. 1. Dynamic multi-level perspective on system innovation (Geels and Schot, 2007).

Coenen et al. (2012) say: "*The absence of concrete territoriality in the scales of transitions (inter alia the global being ubiquitously "out there" and accessible), overlooks the advantages, conflicts and tensions which arise in the wider networks of actors and institutions within which transition processes are embedded. This blind spot may very easily lead to the naive notion that sustainable transition may take place anywhere.*" This point is particularly important in discussing the SUM paradigm, which is strongly influenced by differing national or local regulations, cultural and social conditions.

According to Coenen et al. (2012) and Truffer et al. (in press), existing analysis fail to explain if and how spatial contexts matter in MLP – spatial context is often treated as a "passive background" rather than a important variable in MLP and Sustainable Transitions. Explicitly focusing on territorial embeddedness would help in disclosing the institutional contingencies and particularities of different contexts where transitions take place. Specific places, regions, cities would have different outcomes in sustainable transitions due to specific cultures, institutions, political systems, networks or capital stocks, which enable actors embedded in them to promote new technologies and policies in support of sustainability transitions. Acknowledgment of these factors would lead to a better understanding of why certain developments happen in particular places and not in others. It may also help policy makers and promotors of transitions to understand underline conditions that lead to successful initiatives in one place, providing insights as to whether or how they might be translated to other places.

Hodson and Marvin (2010) and Coenen et al. (2012) emphasize the important role played by cities (specifically global leader cities) and their relations to national and global institutions and demands in shaping SUM transitions pathways. A more explicit spatial perspective on Sustainable Transitions would contribute to the existing literature on the subject in 3 ways (Coenen et al., 2012):

a) Contextualization on the limited territorial sensitivity: there could be a naïve notion that transitions would occur anywhere, in the same way.
b) Explicitly discussion on diversity in transition processes that follow natural differences among countries and cities all over the world.
c) Provide an opportunity to connect to a body of literature geared to understanding the international, trans-local nature of transition dynamics.

The other gap identified in MLP by Markard et al. (2012) regards how to analyze the role of different firms in transition processes. Firms can be conceived as entities adapting to fundamental changes in their industry, drawing on their networks to influence ongoing regime shifts actively or constantly re-framing their identities and capabilities. Despite the important role of firms, their strategy or the role of strategic alliances within industries has received little attention in the existing body of literature on socio-technical transitions.

The strategic choices of firms could, therefore, influence the transition pathway. If we consider the automotive industry and its power to influence not only the entire automotive supply chain but also national governments, it is necessary to incorporate the industry's perspective into MLP studies for a deeper understanding of how transitions occur.

Another aspect that is not explicitly addressed by Geels (2004) is the coexistence of different regimes in the same industry, or the fact that a single "dominant-design" may not exist. If we consider the current powertrain development stage in the automotive

industry, we can identify different regimes coexisting in various regions according to developments in regulations and market conditions.

In different regions, companies are investing in different solutions: for example, in the United States, electric-hybrid vehicles are receiving much more attention than pure electric vehicles. However, in Europe and China, pure electric vehicles are more important to markets, such as in France. Additionally, the use of ethanol in flex-fuel vehicles is a solution adopted by all automakers operating in Brazil.

Freyssenet (2009) discusses this issue and says that the automotive industry must most likely accept the possibility that there will no longer be a single dominant design and that in different countries or regions, different local designs may survive or even prosper. Hence, various regimes will coexist in different regions.

Based on the aforementioned considerations, we intend to deepen the understanding regarding the MLP process in the transition to a SUM paradigm. Particularly, we will consider the Brazilian case, the relevant automotive industry strategies and how these strategies could affect and/or be affected by the current scenario evolution.

We consider whether the MLP model presented in Fig. 1, with different socio-technical conditions (market/user preferences, technology, science, cultural, policy and industry conditions) in addition to distinctly separate strategies taken by global players, will lead to various regimes and different conditions for the development and diffusion of niches. The application of this model to different countries/regions/cities could lead to different regimes and niches due to different socio-technical conditions, as shown in Fig. 2.

As discussed regarding the limits of MLP, different spatial contexts and firm strategies could lead to different transition patterns. Based on this premise, we can hypothesize that we would find a different approach to dealing with SUM in Brazil and in other countries, such as Germany. The current representation of MLP does not explicitly take into account these factors. Highlighting the role of spatial contexts in alignment and co-evolution in Sociotechnical Systems contributes to an improved understanding in if and how these factors would lead to different paths in sustainable transition, reinforcing the theoretical validity of MLP model.

In the next sections, we will attempt to demonstrate this difference. For this purpose, we analyze the strategies towards sustainable urban mobility in two German companies operating in Brazil (Volkswagen and Daimler Benz) in comparison to their headquarters in Germany.

4. Research method

The two case studies were developed with two empirical information sources: the sustainability report found on the company's website and a series of interviews conducted in Brazil and in Europe. In Brazil interviews were conducted with three new businesses and/or mobility issue managers at headquarters of Volkswagen/MAN and Daimler. In Europe the authors had the opportunity to interview distinctive specialists (one consultant and three academic researchers) in the German automotive industry. The sustainability report was used because it provides public information regarding new businesses and/or initiatives concerning those companies' mobility issues. Other documents and website pages were also selected and used as empirical information.

For Volkswagen, two interviews were conducted in Brazil. The first was conducted with two commercial managers of MAN (the company that purchased VW's commercial vehicles business unit, and is part of the VW Group). In this company, mobility issues are the responsibility of the marketing and sales department. The second interview was conducted with the strategic planning manager for VW do Brazil (passenger cars).

For Daimler, the interview was conducted with the business innovation (BI) manager. Although only commercial vehicles are designed and produced in Brazil, Brazil is one out of nine countries where branches of the business innovation department exist. The BI department is devoted to research and proposes new business mobility possibilities.

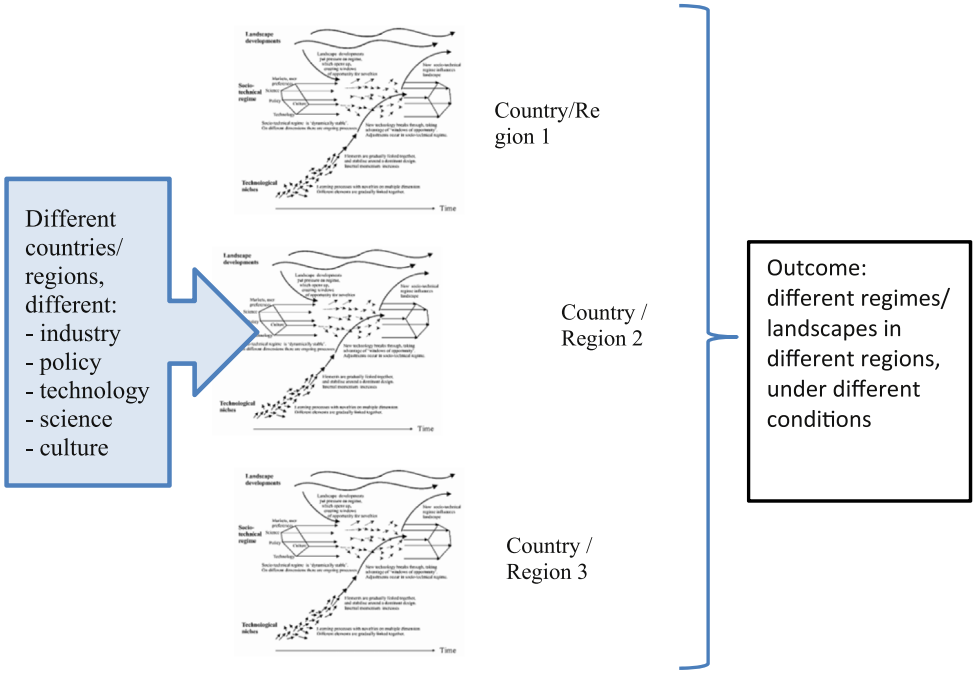

Fig. 2. MLP considering Spatial Context (authors based on Geels and Schot, 2007).

In Europe one consultant and one academic researcher were interviewed in a Berlin automotive research center and two more academic researchers were interviewed in Paris, during an automotive academic conference.

The analysis of the mobility initiatives were divided into four different niches, as described by Dijk et al. (2013), Harman et al. (2012) and Parkhurst et al. (2012):

- Electro mobility: Development and production of vehicles powered with electrical motorization, both hybrids (HEV) or pure electrical vehicles (PEV);
- Car Sharing Schemes: Short term car rental schemes, usually by the hour;
- Intermodal transportation: Systems for managing integration for different modes of transportation in one single trip;
- Innovation in Public Transport: Initiatives for quality, reliability, flow and comfort improvement, as well as diffusion of public transportation, including innovations in technology, organization and management, such as BRT (Bus Rapid Transfer Systems).

The main issues used to guide the interviews (which lasted between 1.5 and 2 h each) and the questions asked during the interviews can be found below:

- Organization structure to support mobility/new business issues (both in headquarters and in the Brazilian subsidiary);
- Primary initiatives concerning mobility (following the four main focus areas this research: electro-mobility, intermodality, car sharing and innovation in public transportation);
- Differences in approach, strategy and initiatives in both countries (reasons for those differences).

It was also discussed the possible participation of the companies in initiatives concerning mobility issues under development by cities and/or other institutions. Those initiatives were cited, and we asked whether the companies had participated previously.

5. Results

5.1. Sustainable mobility initiatives

Table 2 shows the main results of the sustainability report analysis based on “car sharing” schemes; “electro-mobility” initiatives; “innovation in public transportation” and “intermodal transportation”. The great majority of initiatives mentioned in the analyzed report refer to Germany. Topics that explain and present Brazilian initiatives are based on the previously mentioned interviews.

5.2. Differences in firm strategies in Brazil and Germany

According to the information from interviews in Brazil and the information from the corporate social responsibility reports of the companies surveyed, it is possible to identify two very clear conditions. In Brazil, the dominant model remains concerned with massive car sales in the consumer market, whereas in Germany, the issue of urban mobility is seen as an opportunity for testing, developing and enhancing new business models. Those points must be taken into account considering the fact that the Brazilian market is still a low-cost entry product market while the opposite is observed in Germany where the market is predominantly a high end product one. The product and production strategy of VW and Daimler is then different for the two countries: new technologies and the most advanced products are offered primarily in Germany instead of Brazil. Niche products are mainly launched in Europe and

Table 2
Sustainable mobility initiatives of Daimler and Volkswagen.

Sustainable mobility initiatives	Daimler	Volkswagen/MAN
Car sharing schemes	Car2go is a system of urban mobility that allows customers in various European and North American cities to rent an available vehicle in the applicable part of the city and return it elsewhere after the drive. Car2gether works as a car sharing community. Initially operated as a pilot project in Ulm and Aachen, car2gether used smartphones to link people who were seeking a ride with drivers who had space in their vehicles.	The car-sharing project Quicar, launched in Hanover in 2011. The number of rental stations has now increased to 93, and well over 8000 users have registered for this scheme. Quicar entered into new cooperation arrangements, for example, with the Edeka supermarket chain, with Studentenwerk, a students' welfare organization in Hanover, and with LifeThek, an online lending service for everyday articles.
Innovation in public transportation	Development and production of Hybrid buses (Citaro) that already operate in regular services in German cities: Hamburg, Krefeld, Müllheim and Sttugart. Development of Fuel Cell Hybrid Buses, with 22 currently in demonstration in several German and other European cities.	Volkswagen, together with the City of Wolfsburg, is working to improve traffic flow in and around its Wolfsburg site, in order to enhance traffic flow and parking, improve public transport, cycle tracks and footpath networks.
Electro mobility initiatives	Daimler has invested in a wind power facility to coincide with the market launch of the new smart for two electric cars. Plans to replace traditional internal combustion engine cars with electric models in the Car2go fleet.	The “Electric Mobility Fleet Test”, launched in 2008, examines the implications of large-scale use of renewable energy to power electric vehicles. Volkswagen is using 20 current generation Golf Estate twinDRIVE models as research vehicles in this test.
Intermodal transportation	Development of moovel – a smartphone app that displays services offered by various mobility providers, allowing customer to plan routes and even buy tickets. It is currently online in Stuttgart and in Berlin, and the company plans to expand into other cities and regions, also outside of Germany.	In this field, Volkswagen has currently no businesses, but is working on research with a range of organizations such as ETH Zurich or the Karlsruhe Institute of Technology (KIT), the Fraunhofer Gesellschaft, as the initiator of the Morgenstadt (city of tomorrow) initiative, the international think tank, EMBARQ, at the World Resources Institute Center for Sustainable Transport and the World Business Council for Sustainable Development (WBCSD).
Summary of Brazilian initiatives	There is a BI department to research new mobility business possibilities, but Daimler participates more as an observer in the country. There was an initiative (“Van with me”); however, the focus is bus sales and a service offer directly linked to BRT projects. Daimler created a local R&D department for BRT development and associated services to help cities design and implement the best alternative for a BRT project, such as in the city of Belo Horizonte, which bought 500 buses for its BRT project.	Traditional Car sale strategies remain the main concern in Brazil. Few projects and studies are being held in Brazil, under the Strategic Management department, which does not have a special structure devoted to the theme. In the bus market (MAN), the focus is on buses for the BRT project and associated services to help cities design and choose the best alternative for a BRT project.

sustainable related technologies follows that orientation. Furthermore, the market potential for expansion of traditional business models in Brazil inhibits the diversification of sustainable mobility initiatives.

It is also important to understand that the infrastructure, institutional and market conditions are different in the two countries. In Germany, there are more restrictive environmental laws, better infrastructure for public transportation and more government incentives for developing sustainable urban mobility, while in Brazil, there are fewer government incentives for new projects, and the infrastructure is precarious.

In Germany, initiatives are "niche", according to the definition proposed by Kemp et al. (1998), tested, supported by cities and local governments, such as the projects mentioned, related to the development of the electric car; these cases involve car sharing or car integration with other transport modes. Although those niches have been growing in the last years, and have a potential to grow further in the future, transportation based on individual cars is still dominant (Dijk et al., 2013). The German Federal Government sees the development of new businesses models in mobility as a way to incentive local automotive companies after the 2009 recession (Canzler and Knie, 2009).

Nevertheless, Daimler and VW strategy concerning sustainable initiatives are very different in Germany. Daimler is clearly more oriented to explore and find new solutions based on sustainable initiatives while VW is assuming a "wait and see" approach. If one explore the product strategy is possible to observe that Daimler has much more investment, expertise and product options incorporating electro mobility than VW does in the car segment. This fact confirms the importance of considering firm strategy in sustainable transition trajectories.

Brazil has invested in several models for BRT in several cities through the PAC federalprogram (namely the Growth Acceleration Program), which involves public-private partnerships for infrastructure development in the country. However, certain planned BRT projects have been delayed, and manufacturers are waiting to make new decisions. Figs. 3 and 4 below adapted the proposition of Marletto (2014), particularly the socio-technical map, to show the differences observed in Germany and Brazil. The main points observed with the help of these maps are as follows:

1. In both countries, the dominant system is represented by the individual car.
2. In Germany, car sharing schemes could be considered as niches. Both companies, Daimler and VW, are developing business models in this area but Daimler is much more aggressive in this respect. No such initiative is considered to have been initiated in Brazil, although Daimler attempted an experiment (the "Van with me"), which was unsuccessful.
3. In Germany, Daimler participates in a coalition led by the State railway company (Deutsche Bahn) to provide intermodal transport. In Brazil, both VW/MAN and Daimler offer products for the BRT solution. This initiative can be considered niches in Brazil. Public transport exists but has a weak supporting coalition with manufacturers, which offer their product and some service related to choosing the best solution to local governments.

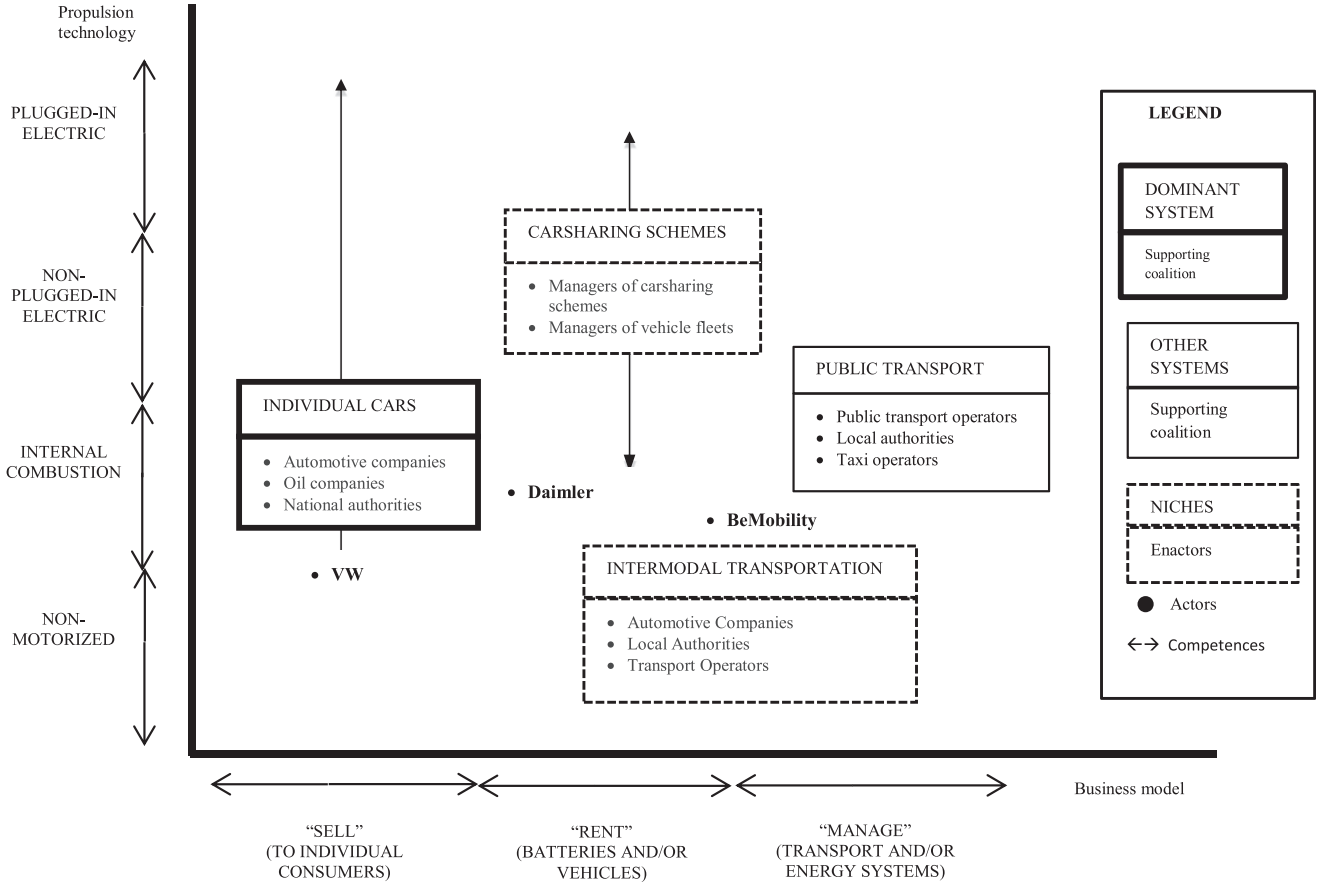

Fig. 3. A Socio-technical map of urban mobility: Germany current situation.
Adapted from Marletto (2014).

We developed possible future scenarios (long-mid-term) for urban mobility systems for Brazil and Germany, based in our research results, using the socio-technical map representation tool, as Marletto (2014) did in his work. But here, we considered the differences of Brazilian and German conditions. We considered a "ceteris paribus" approach, with no substantial changes in market and institutional trends.

The main points treated in the future scenarios are:

1. Intermodal transportation and car sharing schemes gain importance in Germany. Although the individual car remains important, it is no longer dominant, with greater importance directed to "rent" business models (in car sharing or intermodal schemes) for automotive companies. Electro mobility gains importance (Fig. 5). Daimler is more aggressive than VW in the car segment concerning all kind of sustainable initiatives. No such differences can be observed in the truck and bus segment concerning VW/MAN and Mercedes Benz/Daimler.
2. In Brazil, the individual car remains dominant, with car sharing schemes and intermodal transportation becoming niches, but without direct involvement from automakers. BRT gains importance in public transportation, with the participation of automakers in this issue. Electro mobility remains out of the table for automakers (Fig. 6).

As a final observation in this topic, it is worth stressing that the above mid-long term scenarios must be considered as mere exercises of future possibilities for both the Brazilian and German situation concerning urban mobility actors and initiatives. The objective here is to show the potential use of Marletto's framework as convenient to explain different situations concerning firms and/or countries if one takes into account the MLP framework. For a more precise future scenarios construction, it would be necessary to use specific and well known techniques (such as the Delphi methodology or even surveys involving specialists) to deepen the analysis. This effort might be considered by the authors in their future works development.

6. Conclusions and further developments

The main objective of this paper was to deepen the discussion about MLP, including two variables initially neglected in its theoretical framework: spatial sensitivity and strategic role of firms, trying to explain if and how these two issues matter in MLP, increasing its validity as a theoretical model. In order to do so, we compared the Brazilian and German automotive industry path towards a SUM system. In this regard, this work is the first step taken towards long-term and ongoing research conducted by the authors, and unprecedented (as far as the authors know) application of MLP in Brazilian automotive industry context. For that reason, the conclusions we present here should be considered a first effort to answer the research questions previously cited.

The VW and Daimler mobility initiatives in Germany and in Brazil are, of course, very different for a number of reasons that were discussed in Section 2.1.

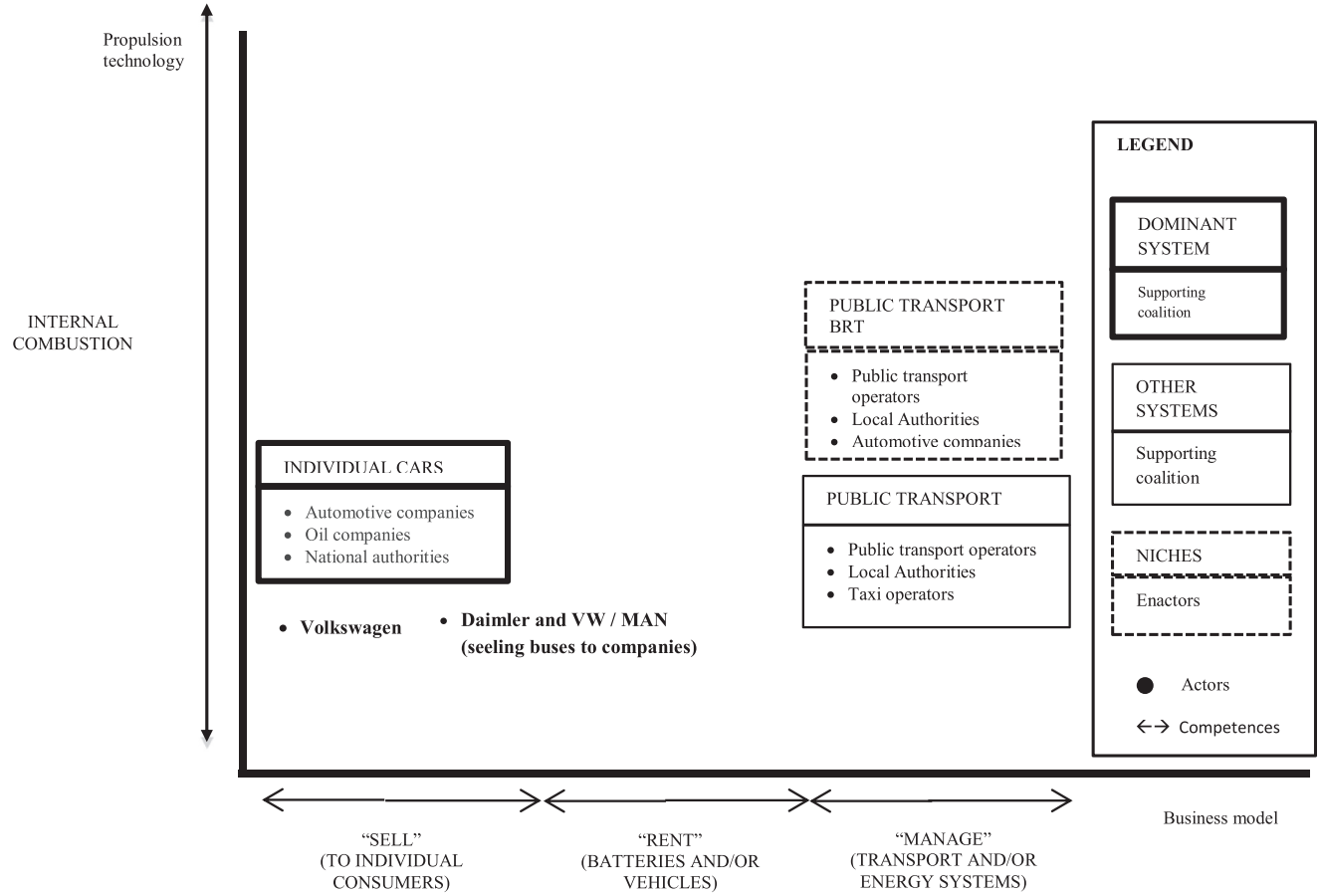

Fig. 4. A Socio-technical map of urban mobility: Brazil current situation.
Adapted from Marletto (2014).

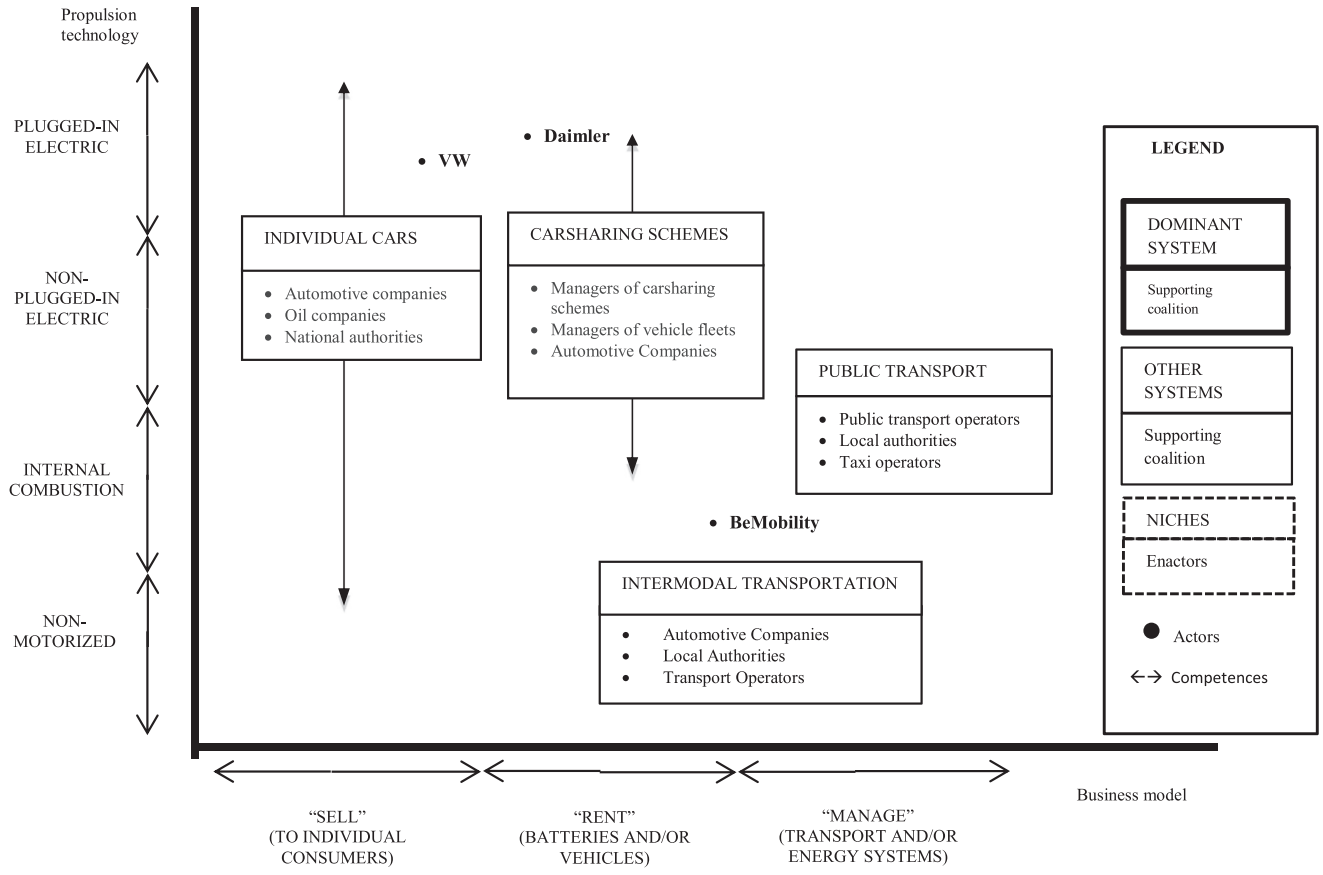

Fig. 5. Possible mid-long term scenario for German Urban Mobility.
Adapted from Marletto (2014).

Following the analysis of SUM initiatives taken by the two companies both in Germany and in Brazil, our main conclusions note that the MLP framework is a useful tool for understanding the transition process; however, this framework does not consider that the same company may behave differently in different countries and regions. As discussed in Section 3.2 and presented in Fig. 2, different transition trajectories and outcomes should be expected in different institutional and operational contexts, which reflects the role played by firms' strategic choices.

VW and Daimler mobility initiatives in Brazil remain very limited compared with their current efforts in Germany. Manufacturers remain much more concerned with selling traditional products (in a more rapidly growing market than German standards) than with initiating more aggressive mobility-oriented strategies. Even in their mother countries, mobility initiatives can be considered moderate; however, in Brazil, those firms can be positioned as observers rather than protagonists in certain initiatives. In fact, several of these initiatives have begun implementation (WRI in São Paulo; BRTs in different cities; bus corridors in SP), without the explicit participation of the firms studied.

Through incentive programs, the German Federal Government explicitly sees innovation in businesses models or sustainable urban initiatives as an alternative to foster growth for local automotive industry, specifically after the 2008 crisis. In Brazil, there is no program like that; on the contrary, until the late 2014, there was a tax reduction in order to improve car sales in domestic markets. This fact helps to explain the behavior differences between companies in both markets. On the other hand, is very interesting to point out that in Germany, VW and Daimler have very different strategies concerning sustainable initiatives like electro mobility, intermodality and car sharing, for example. While Daimler is assuming an aggressive strategy, building coalitions to establish a variety of new services and technological possibilities for their customers, VW is more conventional in this respect, assuming and "wait and see" approach and therefore minimizing risks of uncertain investments in not yet successful initiatives.

Both countries and cities should be considered locus of analysis in MLP. They can be seen as an interesting starting point to support coalitions for niche creation. Particularly for manufacturers, proximity to headquarters can be observed to be a crucial factor for manufacturers' choice of cities in which to invest in new mobility initiatives. Stuttgart for Daimler and Wolfsburg for VW could serve as examples of this. Naturally, other factors may explain the choices made by those firms, but the frontiers represented by cities and their proximity to manufacturer headquarters are factors that must be considered.

Of course, niches could be created (and certain initiatives could be detected) in Brazil, but agents other than the manufacturers would likely take the initiative. The federal or local government, startups and new entrants (such as Bolloré in Paris) would be more willing to assume risks and innovate in these areas than the traditional companies that continue to rule the industry. The fact that there is no national automaker operating in Brazil could be one explanation for the conservative behavior regarding SUM initiatives there.

Therefore, based on our results, we can conclude that MLP framework, as it is currently understood, cannot handle with different spatial contexts and does not take into account the role of firms' strategies – which is particularly important to automotive industry. So, in order to improve its validity, MLP should consider these two variables. Trajectories that result from different regions/

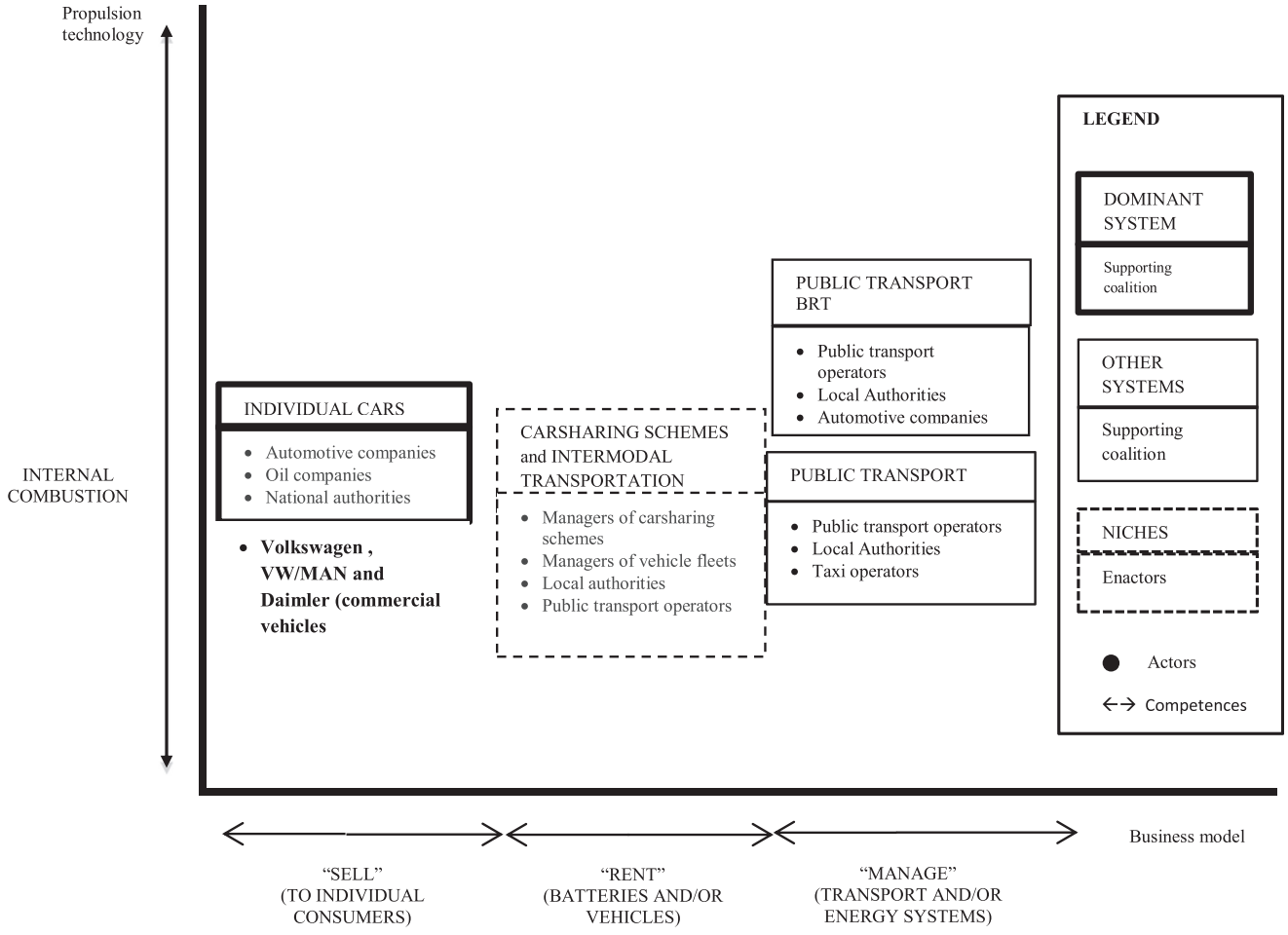

Fig. 6. Possible mid-long term scenario for Brazilian Urban Mobility.
Adapted from Marletto (2014).

countries or cities, considering their different institutional, cultural, social, technological and industry profile should be, as seen in Brazilian and German cases, different from each other.

As previously mentioned, this paper represents a first and unprecedented effort to discuss this issue in Brazil using the MLP framework, and contribute to the literature about Sustainable Transitions. Additional research on this issue is suggested, incorporating more actors in addition to the automotive companies, including other countries and companies. More specifically, comparing different regions or places, where the automotive industry has different strengths: for example, a country where automotive industry has a great influence in GDP with a country where it has not.

Our conclusions can also help policy makers to understand which factors would lead to successful initiatives in one place, providing insights as to whether or how they might be translated to other places.

References

Banister, D., 2008. The sustainable mobility paradigm. Transp. Policy 15, 73–80.
Canzler, W., Knie, A., 2009. Green solutions to the auto crisis – from auto makers to mobility service providers, strategy paper. In: Heinrich Böll Foundation (Ed.), Publication Series on Ecology, vol. 4. Berlin.
Coenen, L., Benneworth, P., Truffer, B., 2012. Toward a spatial perspective on sustainability transitions. Res. Policy 41 (6), 968–979.
Dannenberg, J., Burgard, J., 2007. 2015 Car Innovation: a Comprehensive Study on Innovation in the Automotive Industry, Oliver Wyman, Automotive.
Dijk, M., Orsato, R.J., Kemp, R., 2013. The emergence of an electric mobility trajectory. Energy Policy 52, 135–145.
Edquist, C., 2005. Systems of innovation: perspectives and challenges. In: Fagerberg, J., Mowery, D., Nelson, R. (Eds.), Oxford Handbook of Innovation. Oxford University Press, Oxford.
Freyssenet, M., 2009. Wrong forecasts and unexpected changes: the world that changed the machine. In: Freyssenet, M. (Ed.), The 2nd Automotive Revolution – Trajectories of the World Carmakers in the 21st Century. Palgrave Macmillan, Hampshire.
Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Res. Policy 31, 1257–1274.
Geels, F.W., 2004. From sectoral systems of innovation to socio-technical systems: insights about dynamics and change from sociology and institutional theory. Res. Policy 33, 897–920.
Geels, F.W., Schot, J., 2007. Typology of sociotechnical transition pathways. Res. Policy 36, 399–417.
Geels, F.W., Kemp, R., 2012. Findings, conclusions and assessments of sustainability transitions in transport. In: Geels, F.W., Kemp, R., Dudley, G., Lyons, G. (Eds.), Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport. Routledge, New York.
Geels, F.W., 2012. A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies. J. Transp. Geogr. (in press).
Geels, F.W., Kemp, R., Dudley, G., Lyons, G. (Eds.), 2012. Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport. Routledge, New York.
Harman, R., Veeneman, W., Harman, P., 2012. Innovation in public transportation. In: Geels, F.W., Kemp, R., Dudley, G., Lyons, G. (Eds.), Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport. Routledge, New York.
Hildermeier, J., Villareal, A., 2014. Two ways of defining sustainable mobility: Autolib and BeMobility. J. Environ. Policy Plan. 16, 321–336.
Hodson, M., Marvin, S., 2010. Can cities shape socio-technical transitions and how would we know if they were? Res. Policy 39, 477–485.
IPEA (Instituto de Pesquisas Econômicas Aplicadas), 2012. Sistema de Indicadores de Percepção Social: Mobilidade Urbana, 2a.Edição. Available at: http://www.ipea.gov.br/portal/index.php?option=com_content&view=article&id=24443&catid=120&Itemid=2. (accessed March 2015.).

Kemp, R., 1994. Technology and the transition to environmental sustainability: the problem of technological regime shifts. Futures 26, 1023–1046.
Kemp, R., Schot, J., Hoogma, R., 1998. Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. Technol. Anal. Strateg. Manag. 10, 175–195.
MacDuffie, J.P., Fujimoto, T., 2010. Why dinosaurs will keep ruling the auto industry. Harv. Bus. Rev. 601–603.
Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: an emerging field of research and its prospects. Res. Policy 41, 955–967.
Marletto, G., 2014. Car and the city: socio-technical transition pathways to 2030. Technol. Forecast. Soc. Change 87, 164–178.
Mello, A.M., Marx, R., Souza, A., 2013. Exploring scenarios for the possibility of developing design and production competencies of electrical vehicles in Brazil. Int. J. Automot. Technol. Manag. 13, 289–314.
Oltra, V., Saint-Jean, M., 2009. Variety of technological trajectories in low emission vehicles (LEVs): a patent data analysis. J. Clean. Prod. 17, 201–213.
Orsato, R.J., Dijk, M., Kemp, R., Yarime, M., 2011. The electrification of automobility: the bumpy ride of electric vehicle toward regime transition. In: Geels, F.W., Kemp, R., Dudley, G., Lyons, G. (Eds.), Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport. Routledge, New York.
Parkhurst, G., Kemp, R., Dijk, M., Sherwin, H., 2012. Intermodal personal mobility: a niche caught between two regimes. In: Geels, F.W., Kemp, R., Dudley, G., Lyons, G. (Eds.), Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport. Routledge, New York.
Schöller-Schwedes, O., 2010. The failure of integrated transport policy in Germany: a historical perspective. J. Transp. Geogr. 18, 85–96.
Spickermann, A., Grienitz, V., von der Gracht, H.A., 2013. Heading towards a multimodal city of the future? Multi-stakeholder scenarios for urban mobility. Technol. Forecast. Soc. Change 80, 1615–1628.
Truffer, B., et al., 2015. The geography of sustainability transitions contours of an emerging theme. Environ. Innov. Soc. Transit. (in press) http://dx.doi.org/10.1016/j.eist.2015.07.004.
van den Bergh, J.C., Truffer, B., Kallis, G., 2011. Environmental innovation and societal transitions: introduction and overview. Environ. Innov. Soc. Transit. 1, 1–23.
Wells, P., Nieuwenhuis, P., Orsato, R.J., 2012. The nature and causes of inertia in the automotive industry: regime stability and non-change. In: Geels, F.W., Kemp, R., Dudley, G., Lyons, G. (Eds.), Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport. Routledge, New York.
Wright, L., 2011. Bus rapid transit: a review of recent advances. In: Dimitriou, H., Gakenheimer, R. (Eds.), Urban Transport in the Developing World: a Handbook of Policy and Practice. Edward Edgar, Cheltenham, U.K., pp. 421–455