Centre of Research In Just Transitions

The Frankenstein Monster Syndrome:
What holds sustainable Mobility as a Service from surviving in the open market

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Abstract

Mobility as a Service (MaaS) is a personalised, one-stop travel management platform, which digitally unifies trip purchase and delivery across all transport modes. MaaS promises to reduce the environmental impact of personal mobility, however most of its exemplars are "hopeful monstrosities," small scale demonstrator projects established in protected strategic niches or "living labs." Few MaaS offerings survive in the open market, a phenomenon that this paper dubs the *Frankenstein monster syndrome*. The paper claims that in addition to ordinary market pressures, MaaS experiments, supported by networks of providers, academia, policy makers and not-for-profit organizations, find it difficult to integrate in larger scale networks in the "real world." The paper reports research on this phenomenon through the lens of the *Industrial Marketing and Purchasing* group interaction approach, which offers analytical framework to investigate how MaaS providers may reproduce the experimental networks they based their pilot offering on larger scale. The research draws on data from nineteen interviews with stakeholders to MaaS offerings. The findings suggest that the challenges to establish networks include hard to establish trust, asymmetry of relationships and conflicting interests, and that Government intervention is indispensable to establish MaaS networks.

Key words

Interaction Approach; Government Intervention: Mobility as a Service; Networks; Sustainable Transport

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1. Introduction

The sustainability imperative and the supranational and national policies to achieve zero carbon call for research into innovative offerings that enable responsible production and consumption, objective 12 of the UN compact (UNECE). Production and consumption of goods deplete natural resources, exhaust materials and generate waste and CO2 emissions (Haward, 2018). One way to address these issues is the transition to more sustainable ways of consumption that minimise waste and support recovery, reuse and recycling of materials and resources. Important research has been conducted in types of offerings for consumption which turn products into service offerings (Bocken et al., 2018), so consumption does not depend on acquiring ownership of products but rather on accessing these products for use and sharing them (Belk, 2014), as part of what is sometime known as the sharing economy (Aspara and Wittkowski, 2018). The hoped-for outcome of the transition towards these service-oriented offerings is that they have lower material intensity and greater resource efficiency than would be the case with traditional modes of consumption, they help reduce emissions and have higher social affordability than conventional products (Vezzoli et al., 2015; Schmidt-Costa et al., 2019). From a business perspective, these service shaped offerings allow companies to integrate sustainability into their business (Bocken and Short, 2016).

These “sustainable” offerings have been theorized in several typologies. One of these are the *Product Service Systems* (PSS), offerings that can support these objectives. PSS are defined as “systems of products, services, *networks of actors* and *supporting infrastructure* developed to be competitive, satisfy customers and be more environmentally sound that traditional business models” (Mont, 2002: , 239). Examples of PSS include car sharing (Cherubini et al., 2015) and bicycle sharing offerings such as the Vélib system in Paris (Zademach and Musch, 2018).

A context of consumption, which is particularly critical for environmental impact, is personal mobility, which with the associated transport vehicles is the object of special attention by policy makers. One of the Sustainable development goals is the development of “sustainable transport, which is safe, clean and competitive” (UNECE/Transport). One service shaped offering that promises this is Mobility as a Service (MaaS), a personalised, one-stop transport management

platform, digitally unifying trip creation, purchase and delivery across all modes of transport (Ho et al., 2018). MaaS promises environmental benefits by encouraging walking and cycling, improving utilization rates and reducing single occupancy ridership (Jittrapirom et al., 2017). Similarly to PSS, MaaS is supported by a *network* and by *infrastructure* (Hensher et al., 2020), which are key components of these service shaped offerings for consumption.

PSS and MaaS are seen as "hopeful monstrosities", combining elements from traditional consumption with new ones – hence the Frankenstein analogy in the title. The term "hopeful monstrosity" was first used to describe sustainable innovations by Mokyr (1990) and more recently by Schot and Geels (2008), to describe innovations that promise benefits – such as sustainability (Tukker, 2015) but "do not fit" in the current regime because of poor price/performance characteristics (Geels and Schot, 2010a) and therefore have problems to get accepted and established, with high probabilities of failure. Indeed, these offerings have generally been proposed as part of small-scale pilots which confirm a promise of sustainable consumption but are rarely successful in the real world, which is true for PSS (Vezzoli et al., 2015) and MaaS alike (Hensher et al., 2020). MaaS and PSS often exist as demonstrator projects within protected *strategic niches (Living labs)* (Hensher et al., 2020). A strategic Niche is a protected (artificial) space "isolated" from the influence of the dominant socio-technical regime (Ceschin, 2013). Often PSS and MaaS have poor uptake when they are scaled up and move out of protected niches into the open market (Ibid.). Like the Frankenstein monster when escaping from the (living) lab, the hopeful monstrosity enters the "village" and attempts integration into the incumbent network of production and consumption. Like the monster, however, MaaS – and its cousin PSS – are rejected and "chased away". This failure of integration can be called the "Frankenstein monster syndrome" of sustainable innovation. This phenomenon creates the need to investigate what hampers the implementation of MaaS and other service shaped business models from both supply and demand side. The research gap addressed by this paper is that *we do not know enough about why the "hopeful monstrosities", sustainable innovations which seem to work as demonstrator projects in protected niches, do not survive exposure to the open market.* Is it the case that the design of the offering is flawed or that to succeed, a network and associated relationships need to be developed in the open market for successful implementation, which the offering fails to do?

The point of departure is that service shaped innovations designed in protected Strategic Niches result from collaborations amongst coalitions of parties including business, third sector, academia, and the public. These relationships integrate different capabilities and resources which result in

co-creation of innovations but come apart when attempting to scale the innovation up in the open market (Catulli et al., 2021). The research question is therefore:

How can networks and relationships be initiated in the open market to implement sustainable service-based innovations such as MaaS?

The planned contribution is to shed insight into how to redesign supporting networks which can cure the "Frankenstein monster syndrome". This is explored regarding MaaS. The paper is structured as follows: it outlines the theory of how MaaS is developed in Strategic Niches. It describes and explains the IMP interaction approach, a theoretical framework suitable to study networks, and explains the methods used. It then presents results and discussion and finally concludes.

2. MaaS in Labs

Much research in PSS and, importantly, MaaS, has been conducted as small-scale demonstrator projects within "Living Labs", with the hope that these propositions could then emerge successfully in open markets (Ceschin, 2013). Most of this research drew for its theoretical frameworks on the Multi-Level Perspective, or MLP (Geels, 2002; Geels, 2004).

The MLP is rooted in a cross-fertilization of the theoretical constructs of Science and Technology Studies (STS), Giddens (1984)' theory of Structuration and Evolutionary Economics (Geels and Schot, 2010a) and focuses on long term technological transitions (Ibid.). For example, these transitions involve innovative low carbon products and technologies, which are introduced in markets (Geels et al., 2016) but importantly, transitions to practices and social elements which are associated with these innovative technologies (Shove and Walker, 2010). The MLP therefore attempts to describe and explain the complexity of sustainability transitions, multi-dimensional, non-linear processes of change, and why these transitions often fail. The MLP describes sustainability transitions as resulting from interplay of developments at three analytical levels (Geels, 2002; Geels and Schot, 2010b):

- The Socio-technical landscape (at the macro-level)
- The Socio-technical regime (at the competitive environment level)
- Socio-technical niches (at the micro-level)

Whilst the socio-technical landscape encompasses macro-elements such as social, political, cultural and technological aspects which are above stakeholders, regimes and niches encompass actors and social groups which carry and reproduce practices, constituted by materials, meanings and competences (cf. Shove et al., 2012). The MLP straddles across agency, the initiative by actors in introducing and interpreting new technologies (Geels and Schot, 2010a) and structure, the framework of institutions (rules and routines) (Hodgson, 2006), practices (Shove et al., 2012) and geographical landscape (Watson, 2012), enabling and or constraining innovation. Transitions to new sustainable regimes cannot just be the result of the introduction of new technologies but also need the recruitment of actors including providers and users in new practices, a recruitment which is not always successful, because the current practices are obdurate (Shove et al., 2012). However, whilst these transitions are difficult in the open market, innovations and associated practices can be implemented and tested in strategic socio-technical niches. A Strategic Niche is a space "…where radical innovations such as PSS and MaaS and associated novel social practices are introduced by small networks of dedicated actors (Geels and Schot, 2007) and can be tested through socio-technical experiments, initiatives which test innovations whilst unencumbered by "the material, institutional and cognitive obduracy of incumbent sociotechnical systems central to our way of life." (Sengers et al., 2019, 161). The innovation can then be developed in isolation from the current regime practices and institutions" (Ibid.).

A strategic niche can be seen, in other words, as a space where agency is less constrained by structure than in the "real" world. Another term that can be used to describe a strategic niche is a living lab, a user-centric innovation milieu built on everyday practice and research in real-life contexts, with an approach that facilitates user influence in open and distributed innovation processes (Bergvall-Kåreborn et al., 2009). An example of a living lab is the *IMOVE* Maas pilot in Manchester (de Prez, 2019), where developing innovations such as public transport, electric car and bicycle sharing are offered in a geographically limited area, whilst the innovations are being researched. Within strategic niches, the "monstrosity" is protected by several processes (Sengers et al., 2019):

- *Shielding*, which holds off the competitive pressures innovations are subjected to in open markets.
- *Nurturing*, which supports development of path-breaking innovation and
- *Empowerment*, which makes niche innovations competitive vis-à-vis regimes.

Empowerment can occur through the processes of (Köhler et al., 2019):

- Interaction between regimes and niches, through which actors which are established in the regime can collaborate with actors who are conducting experiments. For example, Catulli et al. (2021) conducted an experiment with an offering of infant mobility products such as strollers and safety car seats – a PSS - which enrolled organizations well established in the regime of infant mobility products.
- *fit-and-conform*, development of niche innovations to fit existing rules and institutions, such as compliance with laws and regulations, for example quality assurance of infant mobility products.
- *stretch-and-transform,* the adjustment of rules and institutions to suit niche innovations, for example because of collaboration between innovators and policy makers which may result in changes in legislation following lobbying efforts.

Strategic niches can be deliberately designed and established (Catulli et al., 2021) through a process dubbed Strategic Niche Management, the "*creation, development, and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation*" (Kemp et al., 1998, 186).

In summary, conducting socio-technical experiments within strategic niches can give the promising innovation (a technology or service with associated social practices) the best chance of development and then enable it to become able to compete once the innovation moves into the socio-technical regime. If it then fails, it is likely to be a flawed core design, or because, like the "Frankenstein monster", it encounters resistance by the actors and groups embedded within the incumbent regime.

3. Why sustainable innovations fail when scaled up out of niches

There is a long history of sustainable service led offerings failing to become established in the open market. This phenomenon affects PSS in consumer markets (Vezzoli et al., 2015) and MaaS, which seems to fail to go beyond local demonstrator projects (Hensher et al., 2020). First, when the innovation emerges in the open market, some of the elements protecting it described by Sengers et al. (2019) are removed, e.g., the innovation is no longer shielded, and this might occur when the innovation is not yet ready (Geels and Schot, 2010b). Second, as "projects" are scaled up and move out of the strategic niche, the relationships in the "living lab" are strained (Catulli et al. 2021) and come apart. For example, in Catulli et al. (2021)'s socio-technical

experiment on infant carrier rentals, a network encompassing an infant mobility provider, a third sector actor and a university, failed because the non-business partners could not scale up to a commercial level. Outside the niche, existing relationships discourage implementation, e.g., in the same experiment, infant mobility retailers threatened retaliation by boycotting the provider involved in the experiment and it was difficult to see who could perform large scale refurbishing and logistics. Catulli et al. (2021) outlined several "practical" reasons for failure of the innovation to succeed in the open market:

- Resource issues, e.g., would be providers need to invest in digital resources, marketing, and logistics.
- "sharing" business models are hit by "attrition" problems, i.e., the damage or disappearance of products during use when they are rented out for access.
- Several liabilities that would be providers may fear.
- Possible retaliation from value chain participants, such as retailers when providers try to go direct to consumers.

A very possible barrier, however, is the complexity to redefine a suitable network and the inertia which besets change (Håkansson and Gadde, 2018). Like the Frankenstein monster, the sustainable innovation needs to integrate within the networks of providers. However, as the monstrosity exits the niche and enters the "village" where prospective network partners are based, these "villagers" reject and chase the monstrosity away. In other words, actors in the niches fail to interact with established actors in the regime to benefit from their collaboration as described by Köhler et al. (2019), as regime actors defend their position from a disruptive innovation (Geels and Schot, 2010b). An example of how an innovation in transport can be hindered by the landscape and its associated structure, is the many incidents that beset attempts by Tesla to introduce autonomous electric vehicles, which seem to delay diffusion of these systems because of their failure of integrate within the socio-technical landscape (Clarke, 2022).

MaaS offerings fail to integrate within "real world" networks. Work is needed to understand what stops these innovations to integrate in the networks established in the socio-technical regime.

The next section describes a framework that can help plotting pathways that the "hopeful monstrosities" can thread to become integrated in supporting networks, or at least it can help to identify the stumbling blocks to establish such networks.

4. The Industrial Marketing and Purchasing Group Interaction Approach

An Interaction Model helps to identify key factors of success and failure in establishing networks in the open market, which can support MaaS. A popular model of interaction which features detailed study of industrial networks is the one disseminated by the *Industrial Marketing and Purchasing Group* (IMP), which started from a series of conferences (Håkansson and Gadde, 2018) and with time developed in an accepted analytical framework in the industrial marketing discipline (Håkansson and Waluszewski, 2016). The framework is rooted in the discipline of industrial – or business-to-business – marketing and it is apt to describe and explain how interactions between commercial and other organizations occur and how these organizations aggregate around industrial networks. Importantly, the IMP framework is suitable to be operationalized, i.e., inform strategic choices to form networks.

The first extensive explanation of the IMP approach is found in Håkansson (1982). The interaction approach argues that buying and selling in industrial contexts are similar processes that should be studied simultaneously (Ibid.) and that relationships rather than discrete transactions are appropriate units of analysis in business markets (Ibid.); that both buyers and sellers are active participants in an interaction process and that there is considerable stability of relationship structures in business markets (Håkansson and Snehota, 1995). The central conceptual framework was the Interaction Model, comprising the buying and selling parties to the relationship (each sub-divided into the individual and the organizational level), the interaction environment (e.g. market structure), the relationship atmosphere (power-dependence; conflict-cooperation; closeness-distance; mutual expectations), and the elements and processes of interaction (short-term exchange episodes and long-term relationship processes).

In the IMP conception, buyers and sellers are both active participants in interaction within business *networks,* where Relationship structures are stable and obdurate, which can foster but more often hampers innovation (Håkansson and Gadde, 2018; Håkansson and Waluszewski, 2016).
Within the relationship unit of analysis, structural elements of relationships (continuity, complexity, symmetry, and informality) and process elements (adaptations, cooperation-conflict, social interaction, and routinization) are important. However, the influence of one relationship on another takes center stage, with chain dependencies between relationships resulting in "a form of organization we have chosen to qualify as a network" (Håkansson and Snehota, 1995,19).

Change in one relationship can propagate through the network of interconnected relationships, and the network "form of organization" is a curious one that has neither a center nor boundaries. IMP conceptualizes relationships as having three layers, and each business relationship can be characterized in terms of the relative importance and the complexity of each of the three layers. These three layers are the elements of the best-known conceptual framework proposed by Håkansson and Snehota (1995), the ARA (Actors, Resources, Activities) model. The relationships within an industrial network can be analyzed in terms of the links between their activities, the ties between their resources, and the bonds between their actors. Håkansson and Waluszewski (2002) divided resources into two categories, technological and organizational resources, and then sub-divided each category into a further two categories, constituting the 4Rs model of resources—products, production facilities, organizational units, and organizational relationships. From the IMP perspective, firms implement adaptions in their business operations both for individual dyadic partners (inter-firm adaptations) and at the market, network, or environment level (Hallén et al., 1991; Brennan et al., 2003). Inter-firm adaptations can be classified in terms of their scope and the degree to which they are planned (Brennan and Turnbull, 1997).

Industrial networks contribute to shaping the market for a given product or service offering. Indeed, Araujo et al. (2010) argue that markets are not passive backgrounds against which marketers operate their marketing strategies. The marketing activities of network actors are performative, that is, they contribute to the construction of markets (Ibid.). Furthermore, Doganova and Karnøe (2015) claim that if markets are not natural, impartial arenas for competition but are constructed, then they can be hostile to products with new qualities that do not conform to the rules and metrics of existing market architectures. Ibid., 23 argue that this is particularly the case for offerings, such as MaaS, with new, environmentally friendly qualities where: "existing market architectures are transformed, and value metrics are extended beyond the economic performance of goods to include their environmental impact". From this point of view, a key role is played in the formation of markets by market devices: "material and discursive assemblages that intervene in the construction of markets" (Muniesa et al., 2007, 2). An example of this is an industrial standard such as ISO14001 or a regulation of manufacturing processes. In short, markets as shaped by industrial networks strongly contribute to the formation – and inertia - of socio-technical regimes as described by Geels (2002), regimes from which offerings such as MaaS may be rejected and, like the Frankenstein monster, are not able to integrate in incumbent business networks. The theoretical elements described in this section can be represented by a framework which integrates the main concepts and is summarized in Table 1.

Table 1 Principal Concepts

Concept	Source

The ARA framework
• Actor – actor bonds
• Resources – Resource ties
  ○ Technological Resources – Products and Production Facilities
  ○ Organizational resources – Organizational Units and Organizational Relationships
• Activity links
• (Ideas – Idea couplings)
	Freytag and Young (2014)
	Håkansson and Snehota (1995)
	Håkansson and Waluszewski (2002)

Governmental actors	Johansson (2012)
Established business relationships	Johansson (2012)

Dyadic and Network effects
• Trust
• Cooperation – Conflict
• Power
• Adaptation (at the Environmental and Dyadic levels)
  • Strategic
  • Emergent (Evolutionary)
  • Tactical
  • Socialization
	Håkansson (1982)
	Håkansson and Waluszewski (2002)
	Brennan et al. (2003)
	Brennan and Turnbull (1997)

Market Devices	Doganova and Karnøe (2015)

This framework helps the analysis of network marketing strategies. For example, to generate trust the managers of each organization will design communications and practices to foster it. It is social interaction between company executives which builds Actor bonds, whilst activity links arise from collaboration between actors. In summary, the framework can be used as a “blueprint” for short term action, however the operations informed by this framework have a requirement of reciprocity and they are operationalized over the medium-long-term following Håkansson and Snehota (1995)’s observation on relationship stability. If a comparison should be made between the IMP interaction approach from which these concepts are drawn and the MLP, the framework

in Table 1 offers a detailed description of the dynamics occurring in socio-technical regimes, focusing on the "social" aspects. Whereas the MLP straddles across "structure" and "agency," the IMP ideas focus more specifically on agency. Even market devices, although they are beyond the control of industrial actors, they are within the agency of policy makers. In line with the Frankenstein monster metaphor described in the introduction, the framework helps describe the reaction of the villagers to the arrival of the hopeful monstrosity, where market devices are a rule introduced by the "village mayor" to facilitate interactions.

An example of how mobility innovations can be hampered by network interactions are the issues that beset Ùber attempts to get established in the landscape. Despite consumer acceptance and compatibility with socio-technical aspects of the landscape, the offering has been opposed by existing actors such as taxi companies and other transport operators which brought about several legal challenges to Ùber's business model (Murgia et al., 2021)

5. Method

To investigate how MaaS offerings are received by industry and local authority actors and how existing networks are open to MaaS, the research drew on nineteen expert qualitative interviews with providers, policy makers, users and experts, including academics and practitioners.

Expert interviews can be considered qualitative elite interviews (Brinkmann and Kvale, 2015) and aim at drawing together the opinions and thoughts of experts, often generating epistemic (accepted) knowledge rather than mere doxastic opinion (Ibid.). A breakdown of these interviews is as follows:

Table 2 Participants' types

Type of participant	Number
Consultant / expert	5
Car club provider	2
MaaS / apps providers	2
Local authority representatives Hertfordshire County Council and Department for Transport	3
Bicycle manufacturer/ bicycle sharing operator	1
Academics	3
Users	2

The interviews were supported by a semi-structured Interview guide which had questions informed by the IMP framework explained in section 4 and probing how business networks would be established – or not. The interviews were conducted online through Zoom by the author, due to constraints instigated by the Covid 19 pandemic, recorded and the audio files were transcribed by a professional agency. The data were analysed through NVivo, a software package for analysis of qualitative data. The coding was structured using a flexible template (Miles and Huberman, 1994) based on the IMP framework described in section 4.

6. Results

1.1 Actors' bonds

In the context of MaaS in the United Kingdom (UK), the network that MaaS providers need to integrate within is composed of private and public sector organizations, such as train and bus operating companies and their suppliers, infrastructure operators such as Railtrack in the UK, car and bicycle sharing companies, taxi companies, airlines, and other transport operators from the public and private sector. In most countries, Governments play a key role in public transport – transport providers often being of public ownership. The UK is a country where rail and bus operators have been privatized. Key Actors are from the transport sector and yet they are diverse and have loose ties. These actors are asymmetric in size and power. Train companies are countrywide and enjoy considerable power, whereas bicycle sharing companies are smaller in size and tend to be local. In addition, whilst train and bus companies are established, car and bicycle sharing companies may be based on small-scale demonstrator projects where the managers are trying to scale up their offering. A participant described the result as "*David – Goliath Relationships*". The bonds between these parties are digital (such as apps and data interchange) rather than social bonds. These actors compete for consumers of mobility with automotive networks, composed of car manufacturers and traders and their network associates such as component and spare parts manufacturers, insurance and financial services, the government and the driving licence system, car aftermarket services providers, as well as engineering and marketing actors from universities and advertising agencies.

The founder of a prominent MaaS operator claims that in his view, all the public and shared transport actors "*compete with the private car…. yet they have diverging interests*". They may also compete between each other, so it might be difficult for MaaS operators to bond large operators with smaller ones.

Local authorities, which are Government actors (see table 1) are responsible for the availability of travel options to users. They have an interest in taking action to enable MaaS, but policy issues might make them unhelpful. For example, local authorities may give priority to "regular" services (bus and trains) and leave MaaS and other similar shared mobility offerings in a "*nice-to-have*" position, as a local authority participant describes it. Existing relationships between local authorities and incumbent transport providers may "shut" MaaS operators out of the market.

Ironically, public transport is often the "weakest link", as these existing providers may have a limited coverage and MaaS apps may not always be able to interface with a train or bus service and therefore the user is not able to book it. The private car network is closely knitted and MaaS providers therefore are at a disadvantage as they face challenges in "reconfiguring" the "public and shared transport" network.

1.2 Resources ties

Vehicles, locations (e.g., railway stations, charging stations, mobility hubs) and importantly, apps and databases, are "tied" by a MaaS "app", the interface between providers, which is a digital resource. Apps need to convey information to users, such as the environmental performance of a transport offering. Incompatible *Application Programming Interfaces* (API) impede digital ties between these resources. An API is a software interface which offers a service to other pieces of software to create a connection between computers or between computer programs (Reddy, 2011). To create ties between their digital resources, providers need to adopt common API specifications, documents or standards that describe how to build or use such a connection or interface (Peters and McClennen, 2016). Refusal to adopt common API specifications for any reason will not enable data sharing, i.e., resource ties.

Operators' withdrawal of services or bankruptcy mean that resources can suddenly disappear, and service promises made to users may not be kept. For example, a user who learnt that a specific bus service could be booked through a MaaS app might suddenly find that the service is no longer available.

Quality of information given to users is vital for success and service promise, to enable this it is necessary that digital resources are of sufficient specification. Some providers such as bus companies in the opinion of a participant, might have less advanced ICT resources than other operators.

1.3 Trust

Activity links need to enable presentation of mobility options to users, e.g., train vs car sharing vs active transport such as bike sharing and even walking. The delivery system needs to be fair to providers – all of whom need to make money from activities.

Trust is a hard barrier to the adoption of MaaS by providers. MaaS' operator's position is delicate - they must guarantee users service levels, and therefore they need to take up responsibility for service quality on behalf of transport operators. Providers believe they are vulnerable if they share data, as they believe they might have business taken away from them. Operators may try to persuade users to select their service over another. Covid brought that about as train companies were able to share information such as which services were crowded. Operators can see MaaS as an unwelcome intermediary. Therefore, strong trust (and transparency) is needed between providers.

1.4 Conflict - Cooperation

Governance mechanisms are needed to support "good MaaS". This has been encouraged by local authorities, like in the case of Manchester ((TFGM); de Prez, 2019). Governance can reassure providers to "bond, link and tie". Governance should inform users on the greenest and healthiest transport options and enable disabled users.

Local transport authorities have the *power* to issue licences and impose a Congestion Charge, which can encourage MaaS. Power of providers comes with size. Train and bus companies have considerable power, because they are large and resourceful – they also command resources such as stations and mobility hubs that accommodate resources such a shared bicycles and cars.

1.5 Market shaping

Local and central governments have a role in shaping the markets for MaaS. The tools to shape markets, governments have at their disposal are market devices (see Table 1). Such a device can be an API specification. Encouraging the adoption of common API specifications by providers can shape the market and encourage integration between providers through data sharing. To achieve this, governments can leverage their power to award licenses to operate transport services to require providers to share and integrate data. This authority-based ability may facilitate collaboration between MaaS providers and network actors, help overcome the lack of trust between parties and facilitate the establishment of Actor bonds, activity links and resource ties. An example of the market shaping power of Government has been the case of the reaction to the Covid-19 pandemic erupted in 2020. In that case, central or local Governments' directives were that travel should be minimised and providers would have to comply with these rules. As a

participant says, "*The technology (MaaS apps) has to follow public health guidelines in what it's displaying*" and this shapes the information that is delivered to users through MaaS apps.

1.6 Adaptations

Each partner needs to put systems in places and *possibly invest* (e.g., in API update). This involves carrying and reproducing "social" practices, e.g., standardized approaches to hygiene, *vision,* and *mission* change. The common competitor is the private car; this should drive the strategic adaptation of public and shared transport to join a common network to outcompete the private car network.

Resistance to data sharing means that adaptation is evolutionary rather than revolutionary or strategic. The interaction is driven by API and other ICT interfaces.

Trust between organizations can be damaged by attempts to influence users away from other partners in damaging, untransparent ways, e.g., through competitive pricing information and sales promotions. Participants also raised questions of liabilities, such as what happens if accidents happen, for example with autonomous vehicles, such in the case of Tesla? Is it the MaaS provider or the service operator who is at fault? Another example is the failure of resources. What happens if operators withdraw services? Who is responsible if someone gets infected with Covid because of sharing space within vehicles? Whose brand is represented? Who owns the very valuable trust of the user?

7. Discussion

The point of departure of the paper was that to manage a successful implementation of sustainable "monstrosities" such as Mobility as a Service outside a protected niche, providers need to develop relationships and supporting networks in the open economy to integrate into the socio-technical regime. This consideration is especially important for the management of MaaS and its cousin PSS, because, by definition, these offerings are designed to be supported by providers' networks. The carrying and reproducing of the sustainable production and consumption practices (Geels, 2002) need to extend to "real" networks in the "open" market. Therefore, the IMP framework is proposed in this paper to investigate the establishment of networks that can support MaaS in the real world and describe the activities that occur in the socio-technical regime. IMP, as described in the paper, has the potential to complement the MLP by contributing analytical tools to explain the obduracy of current (industry) regimes and the difficulties that MaaS encounters in establishing networks. From a MLP perspective, MaaS innovations could be seen

as a reconfiguration and establishment of a symbiotic relationship (Geels and Schot, 2007; Geels and Schot, 2010b), which could enhance the sustainability performance of the public and shared transport network. In contrast, MaaS innovations can arguably be characterized as a technological substitution in respect to the network that supports the private car and have a disruptive relationship with that network (Ibid.).

However, sustainable innovations might be shut out as they are incapable to integrate within the existing public and shared transport networks – and "make their market" (Doganova and Karnøe, 2015). In the case of MaaS, large transport operators such as train companies have diverging interests than smaller mobility outfits such as car and bicycle sharing companies. Actor bonds and trust are hard to establish, because of power asymmetry and concerns with revenue sharing. Conflict may arise as providers might want to influence customer choice to privilege their interests. As a marketing framework, IMP suggests implications of the agency the actors have to support (or not) the success of MaaS. Providers should evaluate the opportunity to design communications to win trust and establish relationships with other actors in the network, including policy makers. Furthermore, MaaS providers can assess opportunities to establish actor bonds (including establishing inter-personal relationships) and activity links between the parties. Creating resource ties, including adoption of common data infrastructure, requires trust and market shaping efforts by policy makers.

Market shaping in this context is challenging, because policy makers have little power on the most powerful actors. *Market devices* such as API specifications can help shape how apps work to show users the best options, but lack of trust in data sharing challenges their implementation, complicated by actors being "natural" competitors. This makes creating *Activity Links* and *Resource Ties* challenging.

Scaling up beyond small scale demonstrator projects has prohibitive challenges (Ceschin, 2013). Market failure means that actors, such as train and bus companies, often serve areas such as rural environment, badly. Actors need investing (e.g., in API updates) to get involved in and support MaaS diffusion. Traditionally, Governments have played a leading role in public transport – here they seem to have a "market shaping" role (cf. Araujo et al., 2010; Doganova and Karnøe, 2015) but also conflicting priorities between their "zero carbon" driven policies and "established" service policies that are shaped by local politics. The market device (Doganova and Karnøe, 2015) of data platforms and protocols has a central role in creating links and "normalizing" (legitimating) the network. Data are important to establish activity links and resource ties, and

require high level of trust, with Governments shaping these links and ties. Indeed, in the most established MaaS application, Whim, founded by MaaS Global, the legislation of the country of origin, Finland, was determinant in encouraging open data (Padam Mobility). Finland's pioneering role in nurturing MaaS is due to the country's government's direct involvement, starting from a merge of transport and communication government agencies, resulting in integrated policy making in transport and communications and policies encouraging experimentation and network formation (Kivimaa and Rogge, 2022). From this perspective, the market shaping activities by local and central Governments by legislation exercise some agency into shaping the socio-technical landscape, and the ability to investigate the associated processes further demonstrates possible cross-fertilization between IMP and MLP. In summary, the IMP offers a framework to investigate short and medium terms initiatives which can be operationalized to establish networks that support MaaS. These activities can further shape further longer-term evolution of the socio-technical regime and features of the socio-technical landscape.

8. Conclusions and directions for research

The key aspects of a service shaped offering such as MaaS are based on the integration of different "vehicles" and their providers. The establishment of this offering involves the reproduction of practices and building the business model around the data app. The interaction between actors is driven by the API. The paper has demonstrated that MaaS providers have some agency in their attempt to establish actor bonds, activity links and resource ties with incumbent network actors, however the interaction required face considerable challenges. The communications and practices necessary to establish interaction and building actor networks need to overcome constraints of size and power asymmetries to establish trust and these challenges may be impossible to overcome without local and central government intervention.

Governments have a role in shaping networks by using market devices such as encouraging the adoption of shared API specifications, and therefore in shaping the actor bonds, activity links and resource ties providers need to establish. This can be seen as a "stick" based approach – ushering a *landscape development* (because it is law) and it is likely to shape the "new" regime. Important knowledge gaps exist on how to address further dynamics that shape the supporting networks, such as who "owns" the user? Whose brand is promoted? Who enters a "contractual" relationship with whom? Relevant questions therefore are,

- How can exit from niches be "plotted" in terms of identifying the most suitable actors and facilitate relationships and networks formation?

- How can powerful organizations such as train and bus providers be persuaded to collaborate? This requires interviewing these organizations, which were difficult to approach in this research.
- What further Government intervention is necessary to foster the sustainable "monstrosities"?
- How can power asymmetry and trust issues between the actors in the network be mitigated?
- What is the Government's role in shaping value metrics and create demand?

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