

# The Flow and Use of Knowledge in Networks of Electric Mobility: A Theoretical Development

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*The paper discusses the main drivers of the flow and use of knowledge in decision networks of sustainable electric mobility. Electric mobility can have a significant impact in a transition to a more sustainable mobility system. There are reasons to believe that this transition can be knowledge-dependent. Examples suggest that the use of bits and concealed tacit knowledge in decision networks are significantly relevant to this transition. Literature shows that transfers of tacit knowledge occur in networks with developed individual social capital and are conditioned by earlier personal interactions. Social capital can provide centrality and power to actors in networks. It can be enhanced by developing trust and displaying and/or implying possession of knowledge relevant for present or future action. Tacit knowledge in technology innovation decisions, in particular, is thought to be significantly valued, because innovation is permeated by strong elements of uncertainty and complexity that drive actors to seek for non-explicit forms of knowledge in networks of near-peers. The paper concludes that the urge for knowledge in situations where not much can be found may drive decision-makers to over rely on partial and partisan knowledge during decision-making. The paper ends with a discussion about the need for more research concerning knowledge in emergent decision networks of electric mobility.*

**Keywords:** Electric vehicles; knowledge management; sustainable mobility; decision networks; technology assessment

## Introduction

The conclusions of the 2015 Climate Conference in Paris reinforced the notion that sustainable mobility strategies are important to foster low-

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carbon policies, improve energy efficiency and mitigate anthropogenic climate change. The uptake of electric propulsion engines is an essential part of a transition to a more sustainable mobility system. It has been pointed out, moreover, that ‘technological niches’ of green propulsion technology are potentially better placed to foster a low-carbon transition in transport systems (Geels, 2012). Dijk, Orsato, and Kemp have even argued that electric mobility has now crossed a critical threshold in this transition – not least as it benefits from high oil prices, carbon constraints and rise of organised car sharing and intermodality (Dijk, Orsato, and Kemp, 2012).

There are reasons to believe that contributions to an electric mobility transition are knowledge-dependent. In a famously failed strategy from 1973, for example, Electricité de France predicted the end of the internal combustion engine due to improvements in electrochemical generators (Callon, 1986). To support their narrative, the engineers included knowledge related to electrons, hydrogen fuel cells and zinc/air accumulators, but purposefully ignored other knowledge such as catalysts, companies’ self-interests and customer preferences. Thus, engineers in fact drew on selective bits of knowledge to support their case for electric vehicles.

This paper argues that a focus on the flow and use of knowledge in networks is needed to support a transition to electric mobility. It investigates the literature of how and why knowledge is used in decisions, and discusses the nature of decision-making in technology innovation to understand implications for decision makers and other epistemological actors. The paper first presents the main literature on centrality of knowledge in decision making, and describes an operational frame of types of knowledge. It discusses how knowledge intermediators involved in networks of technology innovation can instrumentally use knowledge to empower themselves or their agendas. In the second part, the paper elaborates on the relevance of uncertainty and complexity to understand the importance of tacit knowledge to decision makers. Finally, the paper discusses the main implications to future research of using a focus on knowledge flows and use in these networks.

## **Knowledge in decisions of electric mobility**

The recognition of the centrality of knowledge in decision-making has led researchers to reflect upon how selective knowledge reaches and influences policymakers and other stakeholders. It is known that the selective use of knowledge during decision-making processes can empower

some policy actors over others, establish the agendas, frame the problem, become part of the mythologies that shape public life and set the terms for negotiation and public discourse (Innes, 1990; Ivory, 2013). Many authors underlined the need for more research to determine the processes by which knowledge is in fact reaching, being influential or being excluded from decision-making (Stoker and Evans, 2016; Weiss, 1999; Miller, 2005).

Previous works about the role of knowledge in decisions of electric mobility have typically studied the use of explicit forms of knowledge (Boavida, 2015; Gudmundsson and Sørensen, 2013; Sébastien and Bauler, 2013). However, these works did not account for the influence of other forms of knowledge in these decision processes. Harry Collins defined tacit knowledge as that which cannot be or has not been made explicit. He subdivided tacit knowledge into three different types: relational knowledge when it is dependent of the relations between people and arising out of social interaction; somatic knowledge when it is inscribed in the brain and body; and collective knowledge when it is a property of society rather than the individual (Collins, 2010). In some cases of technology innovation, relational knowledge can be more influential to decision-making than any other form of knowledge. For example, Nissan managers provided concealed relational knowledge to Portuguese governmental members, about the timings to launch the electric vehicle Nissan Leaf in the market and its specifications and needs. The power of these memes of concealed relational knowledge was so significant that it pushed the decision-making process towards an investment decision in charging posts for electric vehicles as soon as 2012. This knowledge bound the governmental decision to invest in chargers across the country, and even led government to neglect existent explicit knowledge (Boavida, 2015). Decisions based on partial bits of knowledge can be a significant risk and, in effect, even today the chargers are underused. Presently, we know that the use of tacit knowledge in some decisions of automotive companies has influenced electric mobility transition. For example, Tesla's decision to install superchargers in Norway ahead of demand is having a significant effect in the transition to sustainable mobility (Figenbaum, Assum, and Kolbenstvedt, 2015). What we still need to understand is the exact mechanism by which tacit knowledge can play a constructive role in this type of decisions.

## Tacit knowledge in innovation networks

We know that the transfer of tacit knowledge occurs in networks with a developed individual social capital, normally through intimate personal interactions (Inkpen and Tsang, 2005). Hence, the use of tacit knowledge and, eventually, the final decision are conditioned by earlier interactions related to the creation and maintenance of network connections and relationships. Earlier interactions can include acquaintances, chats, negotiations, intrigues, calculations and persuasion acts. Through these interactions actors may gather recognition of social and capital, which grants them, at least temporarily, the authority to speak or act on behalf of another actor or force (Callon and Latour, 1981). Thus, the transfer of tacit knowledge is dependent of the personal interactions where recognition (or translation) of individual social capital occurs.

Another way to enhance social capital is by generating trust in the network (Nooteboom, 2007). Network members make inferences about trustworthiness based on the history of interaction with a partner and further draw on third parties to inform their trust judgments (Giest, 2017). According to the author, trust is a key element of networks because it forms a basis for relationships and provides the condition for cooperation and higher performance to occur. In innovation networks, trust is particularly important due to the nature of innovation efforts, with potentially high investments and long-term research efforts (Giest, 2017). Furthermore, there are two types of trust that worth mentioning in this context: there can be trust in (technical and cognitive) competence when one has a psychological state, belief or attitude towards another known individual (or institution) to fulfil expectations and its intentions to do the best of his/her competence; there is also trust in intentions when there is a belief about the will to act properly with attention, commitment and benevolence (Nooteboom, 2006). Both types of trust may be used to generate social capital and thus facilitate transfer of tacit knowledge.

More importantly, individual social capital in networks can be enhanced by display and/or implying possession of knowledge relevant for present or future action. These actions can occur using knowledge that already exists and/or that can be later created, as well as with contributions to its flow in the network and/or in the future decision-network. Innovation related networks, for example, rely on knowledge exchange for the ability to come up with new ideas and products (Giest, 2017). In these cases, knowledge becomes a valuable commodity to exchange among network members.

Thus, knowledge can enhance centrality and power to 'knowledgeable' intermediaries in decision networks.

The valorisation of tacit knowledge specifically in technology innovation networks is related to two other fundamental characteristics of innovation: uncertainty and complexity. Technology innovation is frequently associated with uncertainty because 'different people, and different organizations, will disagree as to where to place their R&D chips, and on when to make their bets' (Nelson and Winter, 1977, p. 47). Uncertainty motivates an individual to seek information, although it 'is often sought from near-peers, especially information about their subjective evaluations of the innovation' (Rogers, 2003, p. xix). Importantly, this exchange of perceptions about a new idea occurs through a convergence process involving interpersonal networks (Rogers, 2003). There are various types of uncertainty associated with the innovation process, although technological, market and regulatory uncertainties have an established status (Jalonen and Lehtonen, 2011; Sainio, Ritala, and Hurmelinna-Laukkanen, 2012). But more can be identified. For example, Carbonell and Rodríguez-Escudero (2009) considered only two aspects of uncertainty: technology novelty and technological turbulence. In a study on innovation in biomass gasification projects in the Netherlands, Meijer, Hekkert, and Koppenjan (2007) argued that technological, political and resource uncertainty are the most dominant sources of perceived uncertainty influencing entrepreneurial decision-making related to emerging renewable energy technology.

Furthermore, complexity in technology innovation can be understood as components that, when integrated together, cause difficulties for the transformation into successful products or processes (Chapman and Hyland, 2004; Rycroft, 2007; Waelbroeck, 2003; Wonglimpiyarat, 2005). Complexity can be enclosed in technologies, products, customer interfaces and organizational setups (Chapman and Hyland, 2004). It has been associated with experiences where information is incomplete or ambiguous and the consequences of actions are highly unpredictable (Aram and Noble, 1999). Therefore, it can be argued that bits and relational tacit knowledge in innovation contexts have the propensity to be significantly valorised, because technology innovation decisions are permeated by strong elements of uncertainty and complexity that drive actors to seek for non-explicit forms of knowledge among their network of near-peers.

The urge for knowledge in these types of situations, where often not much can be found, induces decision makers to over rely on knowledge gathered through trusted networks of near peers. Hence, the partial and/or

sometimes partisan use of knowledge during decision-making is a significant factor to explain the perils of decision making in networks of electric mobility for main two reasons. First, past actions built these networks in a different context from the decision. These interactions were built through social acquaintances, negotiations, intrigues, calculations and persuasion acts. Second, networks of near-peers are built on trust enhanced by vulnerable recognition of competence and/or intentions through judgments about past interactions and third parties. The problem is that competence is rather difficult to establish in uncertainty and complex environments, and trust in intentions is no more than a belief that the other will act properly with attention, commitment and benevolence. Thus, electric mobility decisions are based on knowledge assessed and valued by significantly vulnerable casual social interactions and beliefs about who to trust.

## Conclusion and discussion

The uptake of electric vehicles is an essential part of a transition to a more sustainable mobility system. There are reasons to believe that the transition to electric mobility is knowledge-dependent. Several examples suggested that the use of bits and concealed tacit knowledge in decision networks are important to the success of these decisions. Transfers of tacit knowledge occur in networks with a developed individual social capital and are conditioned by earlier personal interactions. Social capital can provide centrality and power to actors in networks that will eventually constitute a decision network. More importantly, individual social capital can be enhanced by building trust with network members and by displaying and/or implying possession of knowledge relevant for present or future action. Furthermore, tacit knowledge in technology innovation decisions is thought to be significantly valorised, because innovation is permeated by strong elements of uncertainty and complexity that drive actors to seek non-explicit knowledge in their networks of near-peers. The desire for knowledge in situations where not much exists appears to explain the overreliance on partial and partisan relational tacit knowledge found in some decision-making.

More research about the use of knowledge in emergent decision networks of electric mobility is needed not only for sustainability reasons, but also to question assumptions of theories of knowledge, elaborate on evidence-based policy concepts and deepen our understanding of innovative business practices. The need for a better understanding of how

tacit knowledge flows and is used in decision-making practices of technology innovation is pressing for three main reasons. First, theories of knowledge in policymaking often presuppose voluntarist attitudes in the formulation of policies, assuming that decision makers act rationally and want to maximize the use of evidence, ignoring the primacy of politics in decision-making (Flitcroft et al., 2011). A more nuanced account of decision-making around electric mobility could significantly contribute to clarify decision makers' attitudes towards tacit knowledge and to promote more reflective practices amongst policymakers. Second, the definition of evidence in policy making can vary significantly, from rigorous scientific evidence to the selective use of information of varying and uncertain reliability used to create underpinning rationales (Flitcroft et al., 2011). This suggests the need for a closer and more rigorous examination of the types of knowledge used as evidence in decisions. It should be clear which types (and bits) of knowledge can constitute evidence not least as there is increased pressure to formulate evidence-based policies, particularly in countries with policy and research cultures oriented to transparency and rationality in the decision processes (Head, 2010; Juntti, Russel and Turnpenny, 2009; Sorrell, 2007). Last, the literature on electric mobility also lacks research about the flow and use of knowledge in business contexts where developments in transition have occurred, as previously mentioned.

The aim of future research should, therefore, be oriented to improve our understanding of how different bits and types of knowledge are deployed in strategic decision-making around new technology investments in electric mobility. It should target contrasting strategic decisions, such as the deployment of electric and diesel engines in policy and business contexts, by scrutinizing what sort of knowledge was involved in underpinning key decisions and how it was used. It can be envisaged that a careful selection of cases using social network analysis can be useful to enlighten these efforts. The cases should include considerations about the importance of the decision in triggering a sustainable transition to a new system of transportation, as well as a decision based on quantified measures (i.e. explicit knowledge) and a second one based on broader objectives to guarantee a comprehensive use of different types of knowledge.

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