Utrecht University

The Role of Electric Motorsport in the Sustainable Mobility Transition

Master Thesis – Master Sustainable Business and Innovation

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Abstract

Electric vehicles (EVs) are perceived as a viable technology for the replacement of combustion engine vehicles for a transition towards a more sustainable mobility system. Transition theory emphasizes that development of sustainable technologies such as EVs can be achieved within niches, which are protective spaces that shield sustainable technologies from mainstream market selection pressures. An interesting environment that has generally been known for innovative developments with regard to mobility has recently seen an increased usage of EVs. This environment is the motorsport. This paper therefore aims to identify the role that the electric motorsport as niche plays in the development of EVs for a transition towards a more sustainable mobility system. In order to fulfil this aim, a qualitative research approach was used where both semi-structured interviews and grey literature was analysed. The electrification of certain categories of the FIA World Rallycross Championship as well as the Extreme E were selected to exemplify the entire electric motorsport. The protective space conceptualisation of Smith and Raven (2012) that focuses on shielding, nurturing and empowering processes was used to conduct the analysis and describe the electric motorsport as a niche. The analysis showed that the electric motorsport as niche shows great capabilities of making contributions towards the development of EVs, but currently is not utilised to this potential. The involved actors showed a focus which is more inward-oriented to EV development processes that were deemed beneficial for the sport rather than for the society. However, whilst focusing more inward, some valuable contributions are still made towards the general development of EVs. It was found that the electric motorsport mainly contributes to the acquirement of technical knowledge on EVs, development of the technical design of EVs, and demonstration of the capabilities of EVs towards a large audience. Based upon these findings, this paper suggests how further analyses can be made and other studies can benefit from this research.

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1. Introduction

Our current transport system, which is dominated by internal combustion engine vehicles (ICEVs), is considered environmentally unsustainable (Leibowicz, 2018). Fossil fuel combustion for transportation is a major source of air pollution, which is the leading cause of environmentally related deaths worldwide (Lanzi, Dellink, Chateau, 2018). Transportation has accounted for 14% of global greenhouse gases (GHG) in 2010, making it the fourth largest polluting sector (IPPC, 2014), where the largest contributor to GHG emissions is road transport (European Commission, 2020). Furthermore, road transportation also emits other harmful gases such as volatile organic compounds and particulate matters, which damages human health, materials and the environment (Symeonidis, Ziomas, Proyou, 2004; EPA, 2020a; EPA, 2020b).

These severe consequences related to the currently unsustainable mobility system have not gone unnoticed and has led to increased interest in policy development that enables a transition towards a sustainable mobility system. A number of promising technologies have emerged that offer a different vision of what the sustainable mobility system could look like (Leibowicz, 2018). One of the most promising technologies of achieving sustainable mobility are electric vehicles (EVs), which have achieved increased attention from policy makers, investors and car manufacturers (Orsato et al., 2012). Even though EVs are considered a viable technology to achieve more sustainable mobility, there is a lack of market penetration (Krishna, 2021).

Many different studies have tried to explore how to promote the development of EVs, where recently the sustainable transition theory has received increased attention for studying this phenomenon (Xue, et al., 2016; Whitmarsh, 2012). Sustainable transition studies argue that the transport sector is a socio-technical system which is a configuration of elements including technology, policy makers, consumer practices, infrastructure, cultural meaning and scientific knowledge (Geels, 2012). Achieving a sustainable mobility system requires radical systemic innovation, often referred to as a ‘transition’, to move away from the current unsustainable system (Nykvist & Whitmarsh, 2008). However, transitions led by sustainable innovations are hard to achieve because they involve changes in the socio-technical systems which are characterized by lock-ins and path dependencies (Meelen, 2018; Xue et al., 2016).

One of the most common approaches for studying sustainable transitions is Strategic Niche Management (SNM) (Sushandoyo & Magnusson, 2014). The core assumption of SNM is that sustainable innovation journeys, can be facilitated by protected spaces, better known as niches, in which promising technologies can be used and developed by means of experimentation (Kemp, Schot, Hoogma, 1998). Initial protection of sustainable technologies is deemed essential as path-breaking innovations fail to successfully compete within selection environments embodied in incumbent socio-technical regimes, which can be defined as the dominant culture, structure and practices (Nykvist & Whitmarsh, 2008; Smith & Raven, 2012). Current research that have adopted SNM for studying sustainable mobility

transitions have mainly focused on historical case studies in order to explain different aspects such as barriers and drivers of development and diffusion of technologies (Xue et al., 2016; Sushandoyo & Magnusson, 2014). However, an interesting environment that possesses innovative capabilities with regard to mobility is the motorsport, which currently has not received attention from SNM literature.

Motorsport around the world occupies an important place in sporting culture and it has always been seen as a test bed for technological innovation (Dingle, 2009). Examples of technologies that originated from motorsports are turbocharging, disc brakes, all-wheel drive, and multi-valve cylinder heads (FIA Formula E, 2020a; Zapata & Nieuwenhuis, 2010). The relationship between motorsport and commercial automobiles have traditionally been portrayed as a process of radical innovations developed on the racetrack, transferred and adapted to road-going vehicles and marketed to the general public. However, some scholars such as Foxall and Johnston (1991) argued that modern motorsport rarely produces genuine breakthroughs, that technological innovations had become more incremental, and that motorsport had become more of a marketing platform. Within a more recent study by Skeete (2019) it was however found that as a consequence of the recent EU's stringent emissions regulations, the motorsport within the last decade has played once again a more important role in the development of energy efficient and low carbon technologies.

Policy changes and emergence of sustainable technologies have also affected motorsports which has resulted in the introduction of EVs and the start of the electric motorsport. The best example is the Formula E, which has emerged since 2014 (FIA Formula E, 2020b). Other examples of electric motorsports are MotoE, Projekt E and Extreme E (MotoGP, 2020; FIA World Rallycross, 2020a, Extreme E, 2020a), but also the World Solar Challenge (World Solar Challenge, 2020). Electric motorsports are not only significantly different from other motorsports in the sense that the races are done with EVs that are entirely powered by electricity, but also because there seems to be an increased awareness for sustainability. As a result of this, some electric motorsport series have implemented certain sustainability goals. The Formula E for example has implemented a sustainability approach with the aim of increasing awareness on the benefits of EVs and also transferring technologies from the race track to the road (FIA Formula E, 2020c).

Since the relatively new and emerging electric motorsport series have shown an interest in sustainability aims as well as the fact that it was found that motorsport once again to some extent plays a part in the development of specific sustainable technologies, this research studies what the role of the electric motorsport is in the worldwide transition towards more sustainable mobility by functioning as niche for the development of EVs. Therefore the main research question is formulated as:

What is the role of electric motorsport as niche in the development of electric vehicles for a transition towards a sustainable mobility system?

In order to answer this main research question, this research analyses the electric categories of the FIA World Rallycross Championship (World RX) and the Extreme E in order to identify how and whether the electric motorsport functions as a niche. This is done by combining the frameworks of SNM and that of Smith and Raven (2012) for studying protective spaces. The framework of Smith and Raven (2012) consists out of three processes, which are shielding, nurturing and empowering. Shielding refers to the process of creating a protective space by exempting an innovation from mainstream selection environments. Nurturing is about work aimed at improving an innovation's socio-technical performance, and for this the internal processes of SNM are used. These internal processes are expectations, network formation, and learning. Finally, empowering is about work aimed at either alternating mainstream selection environments or making an innovation competitive within existing mainstream selection environments. By assessing how the selected electric motorsport cases adhere to these aforementioned processes, it can be identified whether electric motorsport functions as a protective space and to what extent the electric motorsport contributes to the development of EVs.

This research mainly focuses on expanding the applicability of general niche oriented studies by focusing on projects where sustainability goals and purposive creation or utilisation of the protective space is not evidently present. Furthermore, the application of the framework of Smith and Raven (2012) on the electric motorsport contributes to the call of their article to test the framework within an empirical research. Finally, the usage of SNM for the nurturing processes tests the applicability of SNM on an emerging protective space rather than a historical case study approach which is often used (Schot & Geels, 2008; Mourik & Raven, 2006). This research also provides insights of how electric motorsport as niche makes a contribution to society's transition towards a more sustainable mobility system with EVs. Policy makers within and outside of the electric motorsport might from this study then gain insights on how electric motorsport series can play a more significant role in developing but also promoting EVs. Besides this, actors more active within the specific electric motorsport projects might obtain more of realisation of their importance in the development and uptake of EVs and insights on how they could take a more active role in achieving development and uptake of EVs.

This research is structured as follows, Section 2 provides a theoretical background on sustainable transition studies, SNM, the protective space framework by Smith and Raven (2012), and how electric motorsport is conceptualised as a niche. Section 3 provides an overview of the methodological approach used to conduct this research. Section 4 provides general information about the selected cases in order to gain a better understanding of what these entail. Section 5 elaboratively describes the findings related to how the aforementioned processes of a protective space are present for the selected cases. Section 6 provides a concluding section, and finally Section 7 provides discussion consisting of a theoretical and practical implications, limitations, and recommendations for future research.

2. Theoretical Background

This section provides a background for understanding theoretical concepts relevant to this study. Section 2.1 provides a background on the origin of the Multi-Level Perspective (MLP) and Strategic Niche Management (SNM). Section 2.2 more elaborately describes SNM. Section 2.3 elaborates on processes identified by previous SNM research as important for successful niche development. Section 2.4 elaborates on the protective space conceptualisation of Smith and Raven (2012). Finally, section 2.5 elaborates on electric motorsport as protective space.

2.1 Origin of Strategic Niche Management and the Multi-Level Perspective

The origin of SNM can be traced back to Nelson and Winter (1982), and Dosi (1982), who combined insights from constructive science and technology studies into evolutionary economics (Schot & Geels, 2008). The approach of SNM started from the observation that many technologies, especially ones with sustainable promise, never leave the showroom, or worse, remain on the shelves of laboratories as prototypes. Early research by for example Schot et al. (1994) and Kemp et al. (1998) investigated early market experimentation in order to identify reasons for success and failure. The factors hampering innovation, that were found by Kemp et al. (1998), exist because new technologies compete with well-established technologies, which are embedded in *technological regimes*. The technological regime is defined as "the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems - all of them embedded in institutions and infrastructures" (Rip and Kemp, 1998, p. 338). These rules limit firms' views on alternative technologies and leads them to prefer to build upon the well-established technological trajectories that developed out of the past (Mourik & Raven, 2006). Geels (2002) widened this concept of technological regime as he argued firms are not the only ones bounded by rules but also other social groups such as users, policy makers, societal groups, suppliers, and scientists. The widened concept was called the *socio-technical regime*, which refers to the set of rules carried by different social groups and can be identified as the dominant way of doing things.

Some radical innovations however did manage to become successful, which was also highlighted by a variety of scholars (Winskel, 2002). In order to study these regime shifts, a multi-level perspective was developed which added two additional levels to the socio-technical regime, and is shown in figure 1 below (Mourik & Raven, 2006; Geels, 2002). The top level is the *socio-technical landscape* which consists of material and immaterial societal factors. Examples of such factors are demographics, political culture, lifestyles, and macro-economic aspects such as oil prices and recessions, and these factors often change slowly over time (Raven, 2005). However, from the landscape level, rare and rapid historical shocks and events such as the Chernobyl explosion and the oil crisis of 1973 might also emerge (Van Eijck & Romijn, 2008). Each of these landscape events put pressures on the existing regimes and

therefore create opportunities for new radical innovations. The bottom level are *niches* which build upon insights from SNM. These niches act as 'incubation rooms' for radical novelties, and they are protected or insulated from 'normal' market selection in the regime (Geels, 2002). Radical new technologies, which sustainable oriented technologies often are, need such protection because they have relatively low technical performance, are often cumbersome and expensive. An example of such a protected space is the Army, which has stimulated many radical innovations in their early phases, such as the digital computer and radar (Geels, 2002). Niches are essential for maturing innovations and regime shifts. SNM scholars argue that sustainable development requires interrelated social and technical change, which can be achieved within these niches.

The socio-technical regimes which function as selection environments and from which niches shield radical innovations, consist of multiple elements. First of all, industry structures form a selection environment through established networks relations, industry platforms, shared routines and heuristics, existing capabilities, among other processes. Secondly, dominant technologies and infrastructures form a selection environment through aspects such as technical standards and infrastructural arrangements. Thirdly, the knowledge base forms a selection environment as guiding principles and socio-cognitive processes are geared towards incremental knowledge development rather than paradigmatic shifts. Fourthly, markets and dominant user practices form a selection environment through for example stablished market institutions, supply and demand, and user preferences. Fifthly, public policies and political power form a selection environment through aspects such as prevailing regulations, policy networks, and relations with incumbent industries. Finally, cultural significance attached to a specific regime forms a selection environment though for example widespread symbolic representation and appreciation (Kemp et al., 1998; Smith & Raven, 2012).

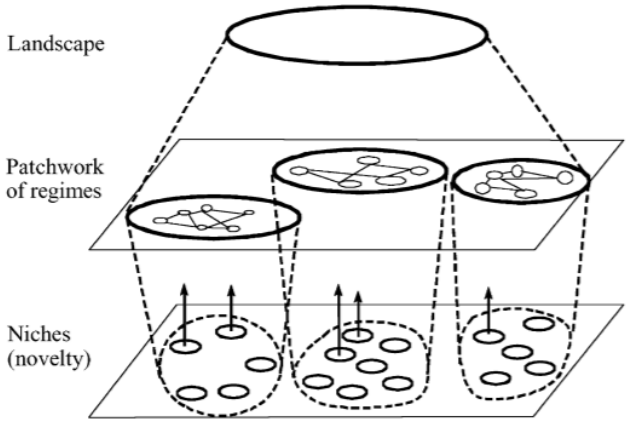

Figure 1: Multi-level perspective of technological transitions (Geels, 2002)

2.2 Strategic Niche Management

SNM can be used for both understanding the process of technological development and influencing this development in a desired direction. Therefore, SNM is considered to be both applicable as analytical

tool as well as policy tool. As policy tool, SNM presents an approach based on improving the innovation process through learning and articulation, rather than based on defining the end-state and implementing incentives to reach that state (Raven, 2005). For this study, SNM will be used as analytical tool, as it has proven to be effective for analysing and explaining emerging innovations (Mourik & Raven, 2006).

The notion of niche has been further developed by SNM scholars, while earlier innovation literature already emphasized the importance of niches for radical innovations. Earlier research focused on *market niches*, which are relatively small market segments where demand for radical innovations exist (Raven, 2012). However, SNM scholars argued that for many radical innovations, especially with sustainability promise, market niches are not readily available because these innovations are not minor variations from the prevailing set of technologies, but radically differ from them (Schot & Geels, 2008). SNM literature therefore suggests special application domains for these radical innovations have to be created and these spaces must provide protection from mainstream market selection pressures (Schot & Geels, 2008). SNM scholars have called these protected spaces *technological niches* (Mourik & Raven, 2006). Technological niches therefore can be defined as a "protective space in which inventions can be tried out and further developed as long as they do not compete and survive in mainstream markets" (Schot & Geels, 2007, p. 615). According to Hoogma et al. (2002), technological niches come about in the forms of experiments, pilot projects, and demonstration projects.

An additional hypothesis of SNM is that these technological niches, which function as a sort of proto-markets, could result in the development of market niches, in which a technology design and user demands have become stabilised and the technology survives under prevailing market conditions (Weber et al., 1999; Schot & Geels, 2008). In early SNM studies, it was believed that the transformation from technological niches to market niches would eventually lead to a regime shift. Experiences in the niche are used to inform decisions about technical improvement and support policies, aimed at expanding the original niche and making a transition towards a more sustainable system (Kemp, Truffer & Harms, 2000). However, more recent studies show that changes at the landscape level and destabilisation of the existing regime are also of importance for new innovations to emerge (Schot & Geels, 2008). Furthermore, in more recent studies it was found that niche innovations not always need to compete with and substitute for the prevailing regime, but they may also be incorporated and transform the regime from within (Schot & Geels, 2008).

Current literature lacks a clear definition of the difference between experimental projects and niches (Mourik & Raven, 2006). Weber et al. (1999) make a distinction between experimental projects and niches as different levels of analysis. An experimental project is the first step towards development of a niche and a niche consists out of multiple local projects. A more clear distinction was made by Geels and Raven (2006) that conceptualised a niche to consist out of local practices and a global niche-level, as shown in figure 2 below. The global niche level is a cosmopolitan level and can be seen as some sort of proto-regime supported by a network of actors that is concerned with knowledge exchange and

resource flows transcending local contexts (Smith & Raven, 2012). Local practices, can be seen as local niches consisting of local projects with their own local expectations, networks, and designs of a certain technology (Bakker, Leguijt, Van Lente, 2015). These local niches add up to the emergence of a niche on a global level. Local niches form test beds for experimenting with certain ideas and space for elaboration of new ideas. Aggregation of the outcomes of local niches then results in more articulated, specific and stable cognitive rules at the global niche level, which is a process referred to as niche accumulation and shown in figure 3. The movement from a technological niche to a market niche then does not only entail exposure of technologies to more selection pressures, but also development of stable and shared rules (Schot & Geels, 2008).

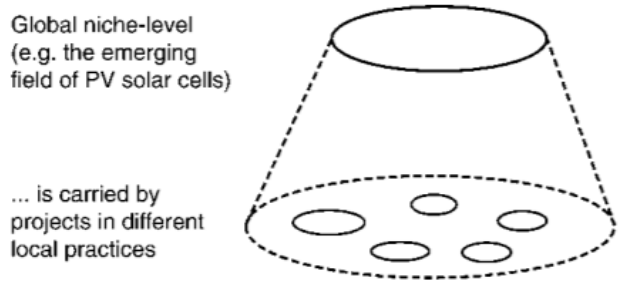

Figure 2: Local projects and global niche-level (Geels & Raven, 2006)

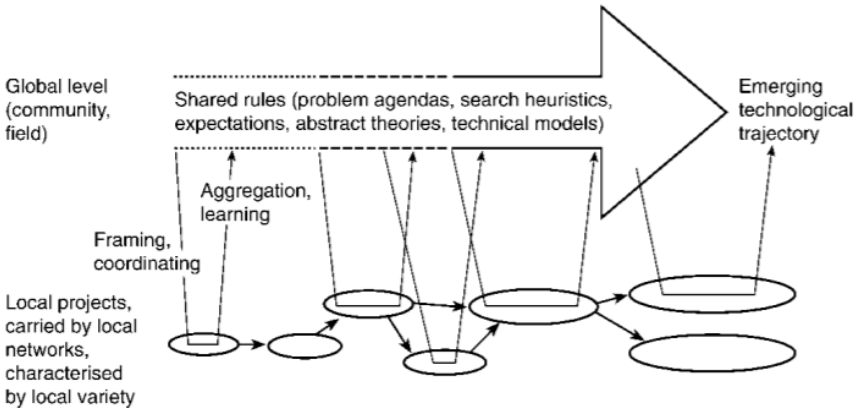

Figure 3: Technical trajectory carried by local practices (Geels & Raven, 2006)

SNM literature emphasizes that niches are essential for building up internal momentum for socio-technical transitions, and three internal processes of niches have been identified that influence the potential success of the introduction of an innovation in society (Mourik & Raven, 2006). These three internal processes are used within this research to evaluate electric motorsport its functioning as niche and how electric motorsport contributes to the development of EVs.

2.3 Internal Processes

2.3.1 Voicing and Shaping of Expectations

Expectations are promises of new technologies (Kemp et al., 1998) Especially at the beginning of developing innovations, the advantages of a certain technology are often not evident. The value of the technology still has to be proven and there are many forces of resistance (Weber et al. 1999). Actors involved with these technologies play an important role of developing it, but they may have different visions of the future and different expectations about the viability of the technology (Raven, 2005). Different actors might opt for different sorts of technological trajectories (Raven, 2005). Formulating expectations is crucial as they provide direction to learning processes, attract attention, and legitimate protection and nurturing (Schot & Geels, 2008). Promises made by interested actors that raise these expectations are especially powerful if they are shared, credible (supported by facts and tests), specific (with respect to technological, economic and social aspects), and coupled to societal problems which existing technologies are not expected to solve (Kemp et al., 1998).

2.3.2 Network Formation

Actors with vested interests are often not interested in new competing technologies. Furthermore, there are several examples of actors trying to slow down or even stop a niche from developing. Network formation is important for creating a constituency behind the technology and obtaining relevant resources such as money and expertise (Schot & Geels, 2008). In order to expand the niche it is essential to involve specific new actors and existing actors' activities and interactions should be changed with the introduction of these new actors (Kemp et al., 1998). Social networks are considered to be effective when a diversity of actors participate, such as firms, users, policy makers, and scientists, and the alignment amongst these actors increases through regular interactions between the actors (Van der Laak et al., 2007; Xue et al., 2016).

2.3.3 Learning Processes

There are several barriers that hamper the introduction and use of the new technology. It is essential to identify the barriers and determine how to overcome them (Xue et al., 2016). Learning about needs, problems and possibilities is therefore important as it enables the adjustment of the technology and societal embedding to increase the chance of successful diffusion (Kemp et al., 1998; Van der Laak et al., 2007). Successful learning processes should be done at multiple dimensions, where technical aspects and design specifications, market and user preferences, cultural and symbolic meaning, infrastructure and maintenance networks, industry and production networks, regulations and government policy, and societal and environmental effects are considered particularly important (Kemp et al., 1998; Schot & Geels, 2008). Furthermore, learning processes is considered to be effective when it entails both first-order and second-order learning. First-order learning aims at learning about the effectiveness of the technology to achieve pre-defined goals, which is done by accumulation of data and facts, and results

in verification only (Mourik & Raven, 2006; Xue et al., 2016). Second-order learning is a reflexive learning method which focuses on questioning the given norms and rules to reformulate expectations, redesign the technology and reconstruct the network (Xue et al., 2016).

2.4 Niches as Protective Spaces

SNM literature emphasizes that niches form 'protective spaces' for the configuration and development of sustainable innovations (Kemp et al., 1998). However, little scientific attention has been given to conceptualisation of 'protection' (Smith et al., 2014). According to Smith and Raven (2012), niches that are acting effectively as protective spaces facilitate three processes, namely shielding, nurturing, and empowering. Within the subsections below each of these three processes are described.

2.4.1 Shielding

Shielding refers to those processes that hold off certain selection pressures from mainstream markets. A distinction can be made between passive and active shielding. Passive shielding involves the exploitation of pre-existing, non-targeted spaces that provide some form of a protective shield for the specific innovation (Verhees, et al., 2013). Such spaces could be geographical locations, such as regions outside the reach of centralised energy grid infrastructures for which expanding the infrastructure would entail relatively high costs or would even be impossible. Alternative innovations such as solar cells might then become more feasible for such remote spaces (Oliver and Jackson, 1999). Passive shielding might also entail utilizing institutional spaces not linked to the specific innovation. For example, the generic public support for materials research was mobilized by academics to do research on solar cells (Knoppers & Verbong, 2001). Furthermore, passive shielding could also focus on an environmental milieu where there are different cultural values and whose members are willing to pay higher costs for an innovation that is more sustainable. Active shielding is about encompassing approaches to creating spaces that hold off mainstream selection pressures. Examples of such active shielding approaches are technology policies such as the Feed-in-Tariff intervention in electricity markets, or could be bottom-up initiatives such as Sieben Linden in Germany (Smith & Raven, 2012; Smith et al., 2014; Akizu et al., 2018).

2.4.2 Nurturing

When shields are established, a space becomes available that can be utilized for improving the socio-technical or economic performance of a certain technology. Nurturing therefore refers to the "processes that support the development of the path-breaking innovation" (Smith & Raven, 2012, p.1027). These nurturing processes are considered the domain of SNM and are also described as internal niche processes as also shown in section 2.3 above (Verhees et al., 2013). The nurturing processes of a protective space thus are voicing and shaping of expectations, network formation, and learning processes.

2.4.3 Empowering

Empowering is a "process through which the protective innovation is able to break out of its protective space and able to compete with or reconfigure the wider regime" (Fatimah, Raven, Arora, 2015, p. 3). According to Smith and Raven (2012) there are two different forms of empowering. The first type is called fit-and-conform and refers to the process where niche innovations develop in protective spaces and become competitive under the prevailing market selection environments. The niche actors find ways of adjusting the attributes of an innovation so that it is compatible with the prevailing regime. The second type is called stretch-and-transform and refers to a process that aims of undermining incumbent regimes and transmit niche-derived institutional reforms into restructured regimes. Thus with this process, niche actors aim at modifying the prevailing regime in ways favourable to the innovation (Fatimah, Raven, Arora, 2015).

2.5 Electric Motorsport as Protective Space

The electric motorsport is unlike other protected spaces and projects which have been studied from a SNM perspective. Previous SNM studies have mainly focused on experiments or projects that were conducted within a real world context (Xue et al., 2016; Van Eijck & Romijn, 2008; Valdez, 2015; Van der Laak, Raven, Verbong, 2007). Due to the focus on experimental projects within a real world context, the SNM literature emphasizes the essential role of users, especially for learning processes (Kemp, Truffer & Harms, 2000). Even though electric motorsport does provide experimentation with EV technologies in real life, it does not do so in a real world context. Users in the context of motorsport can be identified as the teams and drivers actually using the vehicles, whereas users within traditional studied experimental projects often refer to consumers that experience the technology in a way which resembles a normal market context.

The electric motorsport also is difficult to characterise as either a traditionally studied technological or market niche. Technological niches are intentionally created temporary spaces with the purpose of learning about new technologies (Raven, 2012; Raven, 2005). The three characteristics of technological niches, which are intentional, temporary, and purposive for learning, seem not be necessarily applying to the electric motorsport. Therefore, the electric motorsport seems to be more related to a market niche, a pre-existing small market segment with special requirements (Raven, 2012). However, a market niche is according to Schot & Geels (2008) a niche in which technology design and user demands have become stabilised, which also not appears to be the case for electric motorsport. Furthermore, for niches in general holds that they are often purposely utilised or created for developing promising technologies by means of experimentation (Kemp, Schot, Hoogma, 1998). The electric motorsport however does not seem to be mainly focusing on the development of EVs.

Even though electric motorsport is thus unlike other protective spaces or niches studied from a SNM perspective, it still can be an effective space for development of EVs as it apparently does functions as

an application domain for EVs and it is an environment outside of the general market selection pressures. Furthermore, motorsport has proven to be a test bed for developing technologies, as several technologies have emerged from the sport in the past (Zapata & Nieuwenhuis, 2010). Electric motorsport also is a highly visible place and possesses a large reach to different actors, because motorsport has an important place within sporting culture (Dingle, 2009). Therefore, electric motorsport seems to be a space with capabilities of shielding, nurturing as well as empowering technologies, which are essential processes of a protective space (Smith & Raven, 2012).

Considering the conceptualisation of local practices and a global niche level by Geels and Raven (2006), the different electric motorsport series such as the Formula E and Extreme E, are considered to be local projects that might contribute to the development of the local niche of electric motorsports. The electric motorsports as category of motorsports as a whole is thus considered as a local niche that is a small part of the larger global niche level which considers the emerging field of EVs. Furthermore, this electric motorsport niche is located within both the motorsport regime, but also the mobility regime. Figure 4 below visualizes this conceptualisation as described above.

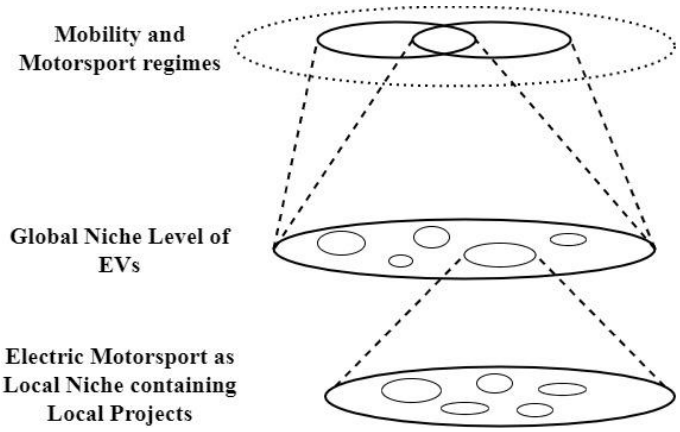

Figure 4: Electric motorsport as niche

3. Methodology

This section provides the methodological approaches taken within this study in order to answer the aforementioned research question. Section 3.1 provides a research design, Section 3.2 the case selection, section 3.3 the data collection methods, section 3.4 the operationalisation of most relevant concepts, and section 3.5 the different data analysing methods. Finally, section 3.6 elaborates on the methods taken to ensure trustworthiness and authenticity of this research, and section 3.7 provides methods regarding ethical issues of data.

3.1 Research Design

This study took a qualitative approach for answering the research question. A multi-case study approach was taken for conducting this qualitative study as the SNM approach has proven in past literature to be excellent for studying case studies (Sushandoyo & Magnusson, 2014). In order to increase the representativeness of the results, two different cases were chosen to be exemplifying for the broader category of electric motorsports.

3.2 Case Selection

For this study the FIA World Rallycross Championship (World RX) and the Extreme E are chosen to be evaluated from a protective space perspective based on a criterion sampling strategy to represent the electric motorsport as a whole (FIA World Rallycross, 2020a, Extreme E, 2020a; Bryman, 2012). Even though there are several other motorsports that make use of EVs, these two cases are chosen because of a variety of reasons. First, the World RX is chosen as it was one of the first motorsport championships that indicated their desire of implementing EVs in 2017, and also was one of the first championships to actually implement EVs in a support series called the Projekt E (Autosport, 2017; FIA World Rallycross, 2019a). Furthermore, it also is the first championship that changed one of its categories, the RX2, from combustion engines to fully electric-driven cars and renamed it the RX2e (FIA RX2e, 2021a). The Extreme E was chosen as it resembles a radical new motorsport championship in which the concept of sustainability is central and therefore EVs are used for the actual racing (Extreme E, 2021a). Furthermore, the Extreme E is racing is some of the world's most remote environments such as the desert in Saudi Arabia and the Artic in Greenland representing great challenges for EVs (Extreme E, 2021b).

3.3 Data Collection

Data for this study was collected via two different research methods. The main resource of data are in-depth semi-structured interviews which were conducted in order to provide insights about the protective space characteristics of electric motorsports. During these interviews the focus was especially on the aforementioned shielding, nurturing and empowering processes of protective spaces. Semi-structured interviews were used as these provided both versatility and flexibility, in a sense that the interviewer

was able to ask follow-up questions, and it allowed space for participants' verbal expressions (Kallio, et al., 2016). Follow-up questions were useful to steer the interview towards useful topics as electric motorsports were found not to be purposely created projects for the development of EVs and therefore the interviewed actors within the cases needed some steering towards certain topics. In preparation for the interviews an interview guide was developed which was slightly adjusted over the data collection period by evaluation of the first few interviews. Furthermore, for each interview the guide was specifically adjusted to fit the function and case of the interviewee. In appendix A within this report, the basis of the interview guide can be found. For the interviews a snowball sampling strategy was taken as different perspectives of a variety of actors within the selected cases had to be taken into account. Furthermore, there only are a relatively small number of organisations involved with the selected cases, thus snowball sampling was particularly useful in finding additional interview participants. Snowball sampling can be defined as a sampling technique where initially a small group of people relevant to the research are interviewed and these people then propose other participants who also are relevant to the research (Bryman, 2012). A total of ten interviews were held of which one was done by email and one via a phone call. The list of interview participants can be found in Table 1 below where some interviewees are addressed by their actual function and others are referred to by a more generic function title in order to remain anonymity. The other eight interviews were held online via a video call using Microsoft Teams and were recorded and transcribed afterwards. The average duration of the eight online interviews combined with the one interview via a phone call was approximately 47 minutes, with the longest interview equalling 76 minutes and the shortest 22 minutes.

Table 1: List of interview participants

Function	*Case*
Championship Coordinator	FIA World Rallycross Championship
Project Leader at RX2e	FIA World Rallycross Championship
Project Executive at Projekt E Team	FIA World Rallycross Championship
Team Executive	FIA World Rallycross Championship
Executive EV Developer	FIA World Rallycross Championship
World RX & Extreme E Expert	FIA World Rallycross Championship | Extreme E
Team Principal	Extreme E
Team Principal at Rosberg X Racing	Extreme E

Team's Marketing and Communications Director	Extreme E
Technical Director at the FIA	FIA World Rallycross Championship | Extreme E | General electrification of the motorsport

Grey literature was used besides interviews in order to obtain supportive information about the protective mechanisms of the selected cases. This study has chosen to implement grey literature as it deals with information in its earlier forms given the significant time lag between research and publication (Pappas & Williams, 2011). This is especially useful for the case of the immature electric motorsports as the first fully electric racing in the World RX started in 2019 and the first race of the Extreme E started in 2021 (FIA World Rallycross, 2020a; Extreme E, 2020a,). The articles identified as grey literature were obtained from Nexis Uni, an online platform providing a database of news articles from all around the world (LexisNexis, 2021). The search terms used for both cases can be found in Appendix B. It should be noted that for the World RX the search term did not specify the World RX as a championship but rather rallycross in general. This decision was made in order to increase the number of articles found by the database from 145 to 569 so that articles that did not specify the World RX but could be relevant to this study would not be excluded. For the Extreme E precisely 1000 articles were found. Out of the 569 articles on rallycross and electric racing a total of 48 articles were selected and out of the 1000 articles on the Extreme E a total of 81 articles were chosen. The selection process of these articles was done by reading both the title of the article as well as the preview where the articles showing niche related words such as learning, expectation, and development were selected. In Appendix C within this report the selected articles can be found.

3.4 Operationalisation

Table 2 below provides an overview of the framework used for the operationalisation of the most important concepts for studying niches which were already introduced above in Section 2, Theoretical Background. This framework was based upon Verhees et al. (2013) and focuses on the internal niche processes. The third column shows examples of questions related to certain concepts that were asked during the interviews

Table 2: Operationalisation of most important concepts

Conceptual lens	**Criteria**	**Questions**
Shielding	Active	Has there been any financial support for the series?

	Passive	Are there geographical benefits of using EVs in this series?
*Nurturing	Coupling of expectations*	Shared	What were your expectations of the usage of EVs in this series?
	Credible	Why do you have these expectations with regard to the usage of EVs?
	Specific	Which steps should be taken to realise your expectations?
*Nurturing	Network Formation*	Variety	Which organisation are involved with this series?
	Alignment	Do these different organisations interact with each other?
*Nurturing	Learning Processes*	Diversity	What can in your opinion be learned from the application of EVs in this series?
	First-order learning	Have there been made any specific learning goals?
	Second-order learning	What are the obstacles for using EVs in this series?
Empowering	Fit and conform	Do you believe that changes should be made in the motorsport in order to increase the usage of EVs?
	Stretch and transform	What is in your opinion the future of EVs in motorsport?

3.5 Data Analyses

The semi-structured interviews were transcribed and analysed with use of a thematic analysis. A thematic analysis can be described as an approach where transcripts are coded within themes and subthemes, and is done to identify the relevant patterns of data for a particular research question (Bryman, 2012; Braun & Clarke, 2012). The themes and subthemes were developed based on a combined concept-driven and data-driven approach. A concept-driven approach means the themes and subthemes are related to theory and literature on SNM and technological niches, and a data-driven approach refers to an open coding process where additional themes or subthemes are added during the

process of analysing. The first step of the coding process was this data-driven approach where concepts were created that categorised the findings in the interviews. These concepts were then later with the use of the concept-driven approach linked to one of the concepts introduced above in Table 2. The process of coding was done with NVivo, a software tool for qualitative data analyses (NVivo, 2020). Grey literature was also analysed based upon this thematic analysis approach and was coded on in the same manner as the interviews.

3.6 Trustworthiness and Authenticity

Where often research refers to validity and reliability, this study builds upon the alternative primary criteria for qualitative studies as addressed in Bryman (2012). First of all, trustworthiness of a qualitative study is made up from four different criteria: *credibility*, *transferability*, *dependability*, and *confirmability* (Bryman, 2012). This study assures credibility through the use of two sorts of triangulation, namely methods triangulation and triangulation of sources. Method triangulation is achieved by using both grey literature and interviews as sources of data, and triangulation of sources is achieved by checking the consistency of the interview data achieved from the different participants (Patton, 1999). Transferability of this research is relatively low due to the specificness of the studied cases. However, by clearly describing the cases within this report, the readers might be able themselves to assess whether the findings are transferable to another context (Kuper, Lingard, Levinson, 2008). Dependability is achieved by keeping records of all the progress made over time within the research and sharing the progress on periodic meetings with supervisors. Furthermore, dependability is achieved by clearly described each step that has been taken in this research within the methodological section. Confirmability is achieved by presenting the interview guide and by supporting claims made within the findings section by multiple quotes from the interview transcripts as well as supporting it with grey literature. This makes the research process transparent and allows readers to make their own interpretation of the data (Drisko, 1997; Kallio, et al., 2016).

The second key criteria for qualitative studies is authenticity which is achieved by using the snowball sampling strategy. This provided a wide representation of people that are relevant with relation to both cases. It was first assessed which of those proposed people added diversity to the initial interview group, and those that seemed relevant to this research were approached for an interview. Furthermore, by having periodic meetings with the supervisor, the progress of this research was continuously reviewed and criticised (Johnson & Rasulova, 2017).

3.7 Ethical Issues Regarding Data

According to Diener and Crandall (1978) there are four main areas to consider with regard to ethical principles in social research. First of all, harm to participants, which in this research was managed by informing participants of interviews that they have the ability to stop the interview at any time and skip any question they do not wish to answer. Secondly, lack of informed consent was solved by informing

the participants of interviews about the aim of this research and sharing the interview guide at least 24 hours before the actual interview. Thirdly, invasion of privacy, which was addressed by keeping the participants of interviews anonymous. Furthermore, the transcribed interviews were shared with the participant so that he or she is able to exclude any answers they feel uncomfortable with. Finally, deception was managed similarly to lack of informed consent, by clearly informing participants of interviews with all information they require for participating. Furthermore, they were asked to sign a informed consent form, which is shown in appendix D, after or before the interviews in order to check whether participants were fully aware of the meaning of their participation and the rights they had regarding the recordings and transcripts.

4. Case Description

This section provides background information on the selected cases that were analysed within this research. Section 4.1 elaborates on the three different electric FIA World Rallycross championship series. Section 4.2 elaborates on the Extreme E.

4.1 Electrification of The FIA World Rallycross Championship

Rallycross is a motorsport category in which modified production or road cars are racing short and explosive laps on a mixed-surface circuit for about four to six minutes. The sport has been around since 1967, when the first event was held at Lydden Hill in the United Kingdom (FIA World Rallycross, 2021a). Around the world there are different rallycross events such as the Nitro Rallycross, the British Rallycross Championship, and the World RX (Nitro Rallycross 2021; British Rallycross Championship, 2021; FIA World Rallycross, 2021a). The World RX probably is the most prominent rallycross championship and has seen the involvement of some of the world's largest automotive manufacturers such as Peugeot, Audi, and Volkswagen. Furthermore, it had an estimated TV audience of 35 million people around the world for the 2018 season (FIA World Rallycross, 2019b). The World RX has always seen the usage of internal combustion engines, but in 2017 the World RX announced that it was going to implement electric vehicles in the sport as of the year 2020 (Autosport, 2017). However, a year later, in 2018, it was announced that this plan was postponed with a year to 2021 as there was a lack of commitment from automotive manufacturers (FIA World Rallycross, 2018). Nevertheless, in 2019 the World RX announced a new supporting series initiated by STARD and IMG, called the Projekt E, which was the first ever usage of electric-powered cars in the World RX (FIA World Rallycross, 2019a). Later in 2019, the FIA released three tenders for the electrification of the main categories of the World RX. These tenders referred to the supply of a World Rallycross battery and powertrain kit for the supercar category, the complete car supply and championship organisation of the junior category on an all-inclusive arrive and drive format, and finally the supply of charging power and infrastructure (FIA, 2019). These tenders lead to the introduction of the RX1e, the first FIA initiated electric supercar division and the RX2e, the first FIA initiated electric single make support division of the World RX. Below a further description is given for each of these three aforementioned World RX series that include the usage of EVs. For this research all three series have been discussed with interviewees, however the emphasis has been on the Projekt E as this has been the only series that has already had one full season in the World RX.

4.1.1 Projekt E

The Projekt E was a collaboration with IMG, the former World Rallycross Championship promotor and STARD, an Austrian Research and Development company that is mainly active within the motorsport industry. The technical concept of this racing series was developed by STARD and is called ERX. The underlying aim of the Projekt E was to evaluate electric race cars in the environment of World RX in

accordance with the roadmap for the electrification of the World RX which was ratified by the FIA (FIA World Rallycross, 2019c). For the Projekt E series, STARD developed the so-called REVolution EV powertrain system which allowed participating teams to converse their own cars into an electric powered vehicle or develop a completely new car according to the chassis regulations using STARD's electric drivetrain. The REVolution powertrain system was a technological advanced drivetrain as it produced approximately 450 kW of power, which is equal to 600 bhp and 1100 Nm of torque making the motors rotate up to 14000 rpm and providing a top speed of 240 km/h. Furthermore, the powertrain system is able to utilise road car electric motors which allowed manufacturers to use their own motors. (FIA World Rallycross, 2019d).

Since the first announcement of the Projekt E, several rallycross teams and individuals committed to the series. Within Table 3 the different individuals, rallycross teams, and organisations that have been involved with the series are shown. Also involved with the Projekt E is the FIA, which granted the Projekt E an FIA International Series status in 2020 (STARD, 2020). The FIA sanctioned the regulations developed by STARD. Besides the FIA there is also IMG, which was the official promotor of the World RX, and STARD which has developed the technical concept, the electric powertrain system and several cars based upon a Ford chassis. Finally, there are the teams that committed to series and therefore either bought a car developed by STARD or the powertrain system to develop a car of their own.

Table 3: Actors involved with the Projekt E

Organisation	**Role**
Holten Motorsport	Race Team
Rallytechnology	Race Team
Volland Racing	Race Team
Hoonigan Racing Division	Race Team
Ferratum Team	Race Team
Citroen Racing	Race Team
IMG	Former Promotor
STARD	Powertrain and car Developer
FIA	Governing body

The original plan of the Projekt E series was to deliver a total of five races in Belgium, Norway, Germany, and Latvia, and Sweden, which later was changed to four as Norway was eliminated. However, due to the COVID-19 pandemic only two races were held in Sweden and Latvia. In the 2021 season, the Projekt E has left the World RX which was mainly related to the leave of IMG as promotor the World RX. As of today, the ERX, the technical concept of STARD, still exists, and their developed powertrains and cars are still active in rallycross series within for example Great-Britain and the Nordic countries.

4.1.2 RX2e

The FIA RX2e Championship is a joint venture between the Spanish company QEV Technologies that specializes in electric mobility and Swedish rallycross team Olsbergs MSE. It has been created to replace the RX2, the junior category of the World RX which has always used internal combustion engines. The goal of the RX2e is to provide a pathway for young talented rallycross drivers in an arrive-and-drive concept. This means that there will be no manufacturers or teams included in the series and all drivers will be racing in identical cars (FIA RX2e, 2021a). QEV Technologies together with Olsbergs MSE developed the RX2e car that generates 250 kW, which equals 335 bhp of power and a total of 460 Nm of torque with a drivetrain running at more than 12000 rpm (FIA RX2e, 2021b). This is considered a significant improvement in comparison to the predecessor which had a traditional combustion engine that delivered 310 bhp of power and 300 Nm of torque (RX2, 2021).

Due to the arrive-and-drive concept, only relatively small amount of companies are involved with the series. Again the FIA is involved as governing rule making body. There used to be the IMG as promotor of the series, however with their withdrawal of the World RX, the WRC stepped in as the new promotor, who also is responsible for the charging infrastructure at the local events. Furthermore, there are as mentioned earlier, QEV Technologies who has mainly been responsible for the development of the purely electric powered RX2e car in collaboration with Olsbergs MSE. Furthermore, QEV Technologies also takes the responsibility responsible of operating all the cars and will provide the appropriate staff members for each drivers such as mechanics and engineers. Table 4 below provides an overview of all the involved organisations.

Table 4: Actors involved with the RX2e

Organisation	**Role**
QEV Technologies	Car Developer
FIA	Governing Body
Olsbergs MSE	Car Developer

WRC	Promotor
BRAID Wheels	Technical Supplier (wheel rims)
Cascadia Motion	Technical Supplier (inverters)
OMP Racing	Technical Supplier (accessories)
R53 Engineering	Technical Supplier (shock absorbers)
AP Racing	Technical Supplier (brakes)
ZeroNoise	Technical Supplier (sound supplier)

4.1.3 RX1e

The FIA RX1e Championship is similar to Projekt E conceptual wise as it allows participating teams to integrate an electric powertrain into their existing cars or build a new car around it. The Austrian company Kreisel Electric has won the tender for the RX1e and is the developer and only supplier of the electrification kit for the championship. The kit consists out of two 250 kW motors providing a total of 500 kW of power, which is equal to 680 bhp and 880 Nm of torque, two invertors and an innovative cooling system. The performance of the RX1e cars will be higher than the predecessor combustion engine supercars as there is a significant power and torque increase with a slight weight gain (FIA, 2020a). The original plan of the FIA was to launch the RX1e together with the RX2e in the 2021 season, however the first season has been postponed to 2022 due to economic challenges presented by the COVID-19 pandemic (FIA, 2020b).

The organisations involved with the RX1e are shown in Table 5 below. The main entities involved with the series are the FIA as governing body, the WRC as promotor and Kreisel as developer of the electric powertrain kit. Other involved actors are still unknown such as the teams that will be participating in the RX1e series.

Table 5: Actors involved with the RX1e

Organisation	**Role**
FIA	Governing Body
WRC	Promotor
Kreisel	Powertrain Kit Developer

4.2 Extreme E

The Extreme E is a new innovative motorsport series that involves electric SUV's racing on the most remote locations around the world such as the desert in Saudi Arabia and the rainforest of Brazil with the main purpose of raising awareness for climate change. The idea of the Extreme E was found in 2018 and first presented to the public in January 2019 (Extreme E, 2021d). Within two years' time since the announcement, the Extreme in collaboration with STARK Racing Technology and Williams Advanced Engineering has developed an all-electric SUV, called the ODYSSEY 21, found five locations to race, and filled the grid with some of the biggest names within the world of motorsport, such as Nico Rosberg, Jensen Button, Lewis Hamilton, Sebastian Loeb, and Carlos Sainz, among many others (Extreme E, 2021d; Extreme E, 2021f; Extreme E, 2021g).

The Extreme E is unlike any other motorsport series as it was build out of the concern for the climate crisis. The Extreme E has developed five goals which are promoting greater environmental responsibility, reducing the overall climate impact from sports, using its platform to educate for climate action, promote sustainable and responsible consumption, and advocate for climate action through its communications (Extreme E, 2021h). That the Extreme E is concerned for the climate crisis can also be identified in the fact that the entire championship's freight and infrastructure is transported with the use of a gigantic ship called the St. Helena to reduce emissions. The ship also includes an on-board laboratory for a group of scientists to conduct research connected to advancing climate science (Extreme E, 2021i; Extreme E, 2021j). Furthermore, the Extreme E also conducts legacy programmes integral to the series that aim to provide both social and environmental support in each of the visited locations (Extreme E, 2021k).

The championship is a one design series, meaning each participating team is using identical cars apart from the bodywork. The ODYSSEY 21 provides 400 kW of power, which is equal to 550 bhp, and weighs 1780 kilograms, making it go from 0-62 mph in 4,5 seconds and is able to drive at gradients up to 130 per cent (Extreme E, 2021e). Involved with the development of this car are a variety of organisations. SPARK Racing Technology is a motorsport manufacturer that is specialized in the development of high-performance electric vehicles. It was originally found to become the sole chassis supplier of the Formula E, but is now also involved with the Extreme E as official supplier and developer of the ODYSSEY 21. Williams Advanced Engineering are a company born out of the Williams F1 team that specializes in high performance batteries, which have developed the batteries for the ODYSSEY 21 to withstand the extreme temperatures and conditions of the Extreme E events. Continental is a company that specializes in different automotive parts but is most known for its tires and also developed the tires for the ODYSSEY 21. Finally, CBMM is the official supplier of Niobium, a metal that is used within the ODYSSEY 21 car and is considered a more sustainable and efficient material (Extreme E, 2021e).

There are many more organisations involved with the Extreme E besides the ones that have been responsible for the development of the ODYSSEY 21. Table 6 below provides an indication of each of the organisations involved with the Extreme E. The most important entities are the FIA, which acts as governing body, the organisation which acts as promotor of the series, and the teams which are actually racing.

Table 6: Actors involved with the Extreme E

Organisations	**Role**
FIA	Governing Body
Extreme E Organisation	Promotor
SPARK Racing Technology	Car developer / part supplier
Williams Advanced Engineering	Battery developer / supplier
Continental	Tire developer / supplier
Allianz	Founding partner
Luisaviaroma	Founding partner / fashion supplier
Interproteccion	Founding partner / insurance broker
Zenith	Founding partner / official timekeeper
Niobium	Founding supplier
Polymateria	Founding supplier / biodegradable packaging supplier
EY	Innovation partner
Neat Burger	Plant-based partner
Allcot	Offsetting partner
Enel Foundation	Scientific partner
UIM	Institutional partner

Bosch	Supplier power tools
Kärcher	Cleaning supplier
Xite ENERGY	Energy drinks supplier
AFC Energy pls	Hydrogen partner / supplier
Velocity Experience	Event supplier
MPA Creative	Communications supplier
Interstate	Design supplier
MDD	Safety supplier
ABT Cupra XE	Race team
Acciona | Sainz XE Team	Race team
Andretti United Extreme E	Race team
JBXE	Race team
Rosberg X Racing	Race team
Segi TV Chip Ganassi Racing	Race team
Veloce Racing	Race team
X44	Race team
Xite Energy Racing	Race team
Science Team	Conducting research on board of the St. Helena as well as on the remote race locations

5. Results

Within this section the findings from both the interviews as well as the grey literature analysis are discussed. Section 5.1 elaborates on the purpose of the project in the two cases and how these differ for the participating actors. Section 5.2 focuses on the different ways electric motorsport provides shielding for EVs. Section 5.3 focuses on the different nurturing processes. Finally, Section 5.4 focuses on the empowering processes.

5.1 Purposes of Projects and Participants

This section elaborates on the main purposes of the projects and participating teams. Within SNM literature, studied projects or experiments are often created intentionally with the purpose of learning about and developing an innovation. As already mentioned earlier in section 2.5, the different electric motorsport series do not seem to be created with the main intention of contributing to EV development. Therefore, this study identified what the actual purposes are of the projects and what the different purposes are of the participating teams in order to gain a better understanding of what these projects actually entail. As will become clear later, these purposes also play a role in the extent to which these projects are able to function as protective spaces.

A clear distinction can be made between the World RX and Extreme E. Whilst some interviewees indicated that the electrification of the World RX takes into account a learning aspect related to the EVs, it was found that the biggest emphasis and therefore the main generic purpose of the different World RX series is to showcase EVs in an attractive manner to display their capabilities. This is exemplified by what was said by Torben Olsen[1]:

"Our aim is to showcase, by 2021 at the latest, future mobility and relevant technologies in the tough, competitive environment of rallycross with production-based vehicles that consumers can relate to." – Torben Olsen, former Managing Director of the World RX.

This quote confirms that the electric World RX projects are not developed with the main purpose of developing or learning about EVs, which you would ordinarily see for niche related projects, but rather focuses on showcasing EVs.

The purposes behind the participation of the teams however are different from this aforementioned main purpose of the electrification of the World RX. Several reasons for participation were mentioned, but the main reason that was indicated by the interviewed teams of the Projekt E was to obtain knowledge of EVs. This is exemplified by what was said by a Project Executive of one of the Projekt E teams:

"And the plan from there on was to first of learn all the technology and all the ins and outs and to see if we could do something from that point on to improve. You always improve, there is no way

[1] Sportzpower (2019). World Rallycross adds E-racing element to racing grid.

around it. And that's why it was so important for us to get on to an electric platform, that everything we do from here is going to have value in the longer run." - Project Executive, Projekt E

This quote shows that generally obtaining knowledge about the EVs and utilising the electric motorsport project as learning platform was the purpose of participating. But it also shows that teams are looking for aspects of the EVs which can be improved, which means that besides learning there also is development. Beside the teams, it was also found that the firms responsible for developing the EVs also utilise the projects for learning and developing processes, but they did not specifically mention this as their main purpose of being involved with the project. When comparing the purpose of the teams and that of the project in general, it is interesting that the projects are not necessarily initiated as learning and development platforms, but involved teams do utilise them as such. This could be an indicator of the functioning of electric motorsport as a niche.

The main purpose of the Extreme E is different than that of the electric World RX series. It was found that the Extreme E has integrated multiple purposes. According to the interviewees, these purposes are raising environmental awareness, being a sustainable motorsport event and promoting gender equality. Furthermore, from the grey literature analysis it became clear that besides these purposes, the Extreme E also consciously is using its platform to showcase the capabilities of all-electric SUVs in extreme conditions and further develop EV technologies. However, the biggest emphasis within both the grey literature and the interviews was put upon raising environmental awareness. Therefore, this can be considered to be the main purpose of the project. This is also confirmed by what was said by the Extreme E CEO, Alejandro Agag[2]:

"Extreme E can grow into a valuable platform to raise awareness of environmental issues, which is the main target[.]" – Alejandro Agag, CEO of the Extreme E

This quote thus exemplifies that Extreme E has not just been developed with the main purpose of acting as a test bed or learning platform for the development of EVs, which is similar to what was found for the World RX. However, the Extreme E does take into account that the development of EV technologies is a part of the series, whilst the World RX projects do not explicitly do this.

It was found that the participating teams within the Extreme E have differing purposes for their participation. During the interviews for example, one team indicated the main purpose was just to be involved with motorsports once again and learn how to manage the electric SUV, and another indicated that their main purpose is raising climate change awareness and being part of a sustainable motorsport event. Remarkable however was that none of the interviewees initially emphasized that they are part of the Extreme E to promote EVs or to further develop them. However, in the grey literature it was found

[2] Autocar (2020). Extreme E: the off-road race series trying to save the planet.

that a few teams actually indicated that part of their purpose is related to developing and showcasing EVs.

Considering the purposes of the projects, it can be concluded that the projects are not created with the sole purpose of developing EVs, which you would normally see within niches. Nevertheless, development of EVs is taken into account and some attention is paid to utilising the projects as learning and developing platforms. Interesting however is that none of the interviewees clearly stated that the purpose of these projects also simply relate to entertaining an audience, whilst that must be one of the main purposes of large sporting events. This does provide an indication that there is awareness within these projects that they are capable of more than just entertainment.

5.2 Shielding Mechanisms

This section elaborates on shielding mechanisms that are present within the electric motorsport cases. Section 5.2.1 explains how passive shielding is addressed within the sport, and section 5.2.2 explains the active shielding mechanisms.

5.2.1 Passive Shielding

Passive shielding processes are those processes that stave off pressures from mainstream selection environments. It refers to the mobilization of pre-existing non-targeted spaces that nevertheless provide a form of protective shield. The application of EVs in motorsports is a form of passive shielding as the motorsport is a pre-existing space which has certain conditions beneficial to the usage of EVs. The conditions of the sport were not adjusted or purposely created to introduce EVs, but are also present when conventional combustion cars are used. Therefore, the specific characteristics of the studied motorsport cases that enabled the mobilization of the motorsport as protective space are shown below.

Actors especially related to the World RX emphasized that EVs are providing excellent technological performances. EVs are considered extremely powerful and are capable of producing large amounts of torque, and these characteristics of EVs can be used to their maximum potential within the short format of rallycross races. Issues with EVs are the short driving range due to limit battery capacity and long charging times, however this is not an issue for motorsport series that involve short and explosive laps such as rallycross, but also the Extreme E. This is exemplified by what was said by the Project Leader of the RX2e:

"I mean the rallycross is the perfect motorsport to introduce the electric vehicles. It is clearly the perfect bubble inside of the motorsport world. […] [R]allycross is the perfect category to develop electric vehicles and to evolve that. It's really intense races of six, seven minutes where you can really push to the limit the electric vehicles, you can use all torque, all the power that is has and all the features that you can add to the cars." – Project Leader, RX2e

This quote shows that the short and explosive racing format of rallycross fits with the capabilities of EVs and therefore the format of rallycross forms some form of passive shielding for the usage of EVs. The same can probably be said of the format of the Extreme E.

Another favourable aspect of EVs in motorsport is that these vehicles have much lower maintenance costs. Again, especially in the interviews with actors related to the World RX, it was mentioned that the severe conditions of rallycross tracks combined with a driver that is pushing the car to its absolute limits results in maintenance costs that are very high as different parts of the car tend to break quickly under these circumstances. However, EVs have less moving parts and therefore the probability of parts breaking is much lower. Even though not emphasized within interviews of the Extreme E, this argument again probably also holds for this series.

"The most surprising part to us with the electric car was maintenance. This car has done three races, three rounds with full heats and full qualifiers and everything. And the only thing we had to change was the brake pads. So after three rounds we saw that the brake pads are a little bit warm on the front wheels. If you compare that to a supercar or a WRC Rallycar whatever, it is such a cost saving that it's hard to describe with words. If you have a supercar, you typically have an engine rebuild in that time. But new turbocharger, ten thousand euro turbocharger to be replaced, gearboxes to be open, differentials to be serviced. So, I say we looked at probably eighty thousand euros savings in maintenance on racing costs" – Project Executive at Projekt E team

This quote shows that huge savings can be made for racing teams in motorsport by switching to EVs. Whilst less maintenance costs of course are beneficial to all environments that are currently using some type of vehicle, it is assessed to be especially valuable for motorsport as within his environment parts tend to break down much faster than with 'ordinary' usage of EVs. The expensive maintenance as found in motorsport in some way thus forms a passive shield for EVs as it makes usage of EVs way more beneficial than traditional combustion engines in the long run.

A final favourable application of EVs in motorsport which was especially highlighted within the interviews with Extreme E actors, but also by the FIA, is that motorsport is experiencing societal pressure to become more sustainable. This is exemplified by what was said by the Technical Director of the FIA:

"I think motorsport in general need to be more sustainable, because this is a request. If we want to continue motor racing we need to adapt to the society, to the reality of the society." – Technical Director, FIA

This quote shows that in order for motorsport to keep its existence, changes have to be made towards the sustainable requests of society. Implementation of EVs within the motorsport is seen as a solution for obtaining this sustainable image. The societal pressure of becoming more sustainable is thus in some

way a form of passive shielding, as due to this pressure, EVs are preferred over conventional combustion engines and in therefore protected.

5.2.2 Active Shielding

Active shielding processes are those that are deliberately initiated to create a protective space around an innovation. The most common examples of such processes are financial support, exemptions of regulations, and tolerance towards either poor economic or technological performances of the innovation. In comparison to passive shielding processes, there are significantly less active shielding processes present in the case of EV usage in motorsport. This not remarkable as the section above showed that the pre-existing characteristics of the environment of motorsport already provided several passive shields for the usage of EVs. Therefore, there is no urgency for the deliberate creation of shielding mechanisms. This section elaborates on whether the electric motorsport projects show the presence of the aforementioned most common active shielding mechanisms.

According to the interviewees of both cases, there seems to be no unordinary forms of financial support for both the series and the individual participating teams besides private investments and sponsorships which are assessed as common in the motorsport. Furthermore, for the RX2e, it was even found that there is no financial support whatsoever. This is exemplified by what was said by the Project Leader:

"No, there is no financial support at all from any company, neither from the administrative side or government side or something like that. There is nothing. The only support that we have is loans from the banks. So all the risks are on our side, there is no financial support from any entity." – Project Leader, RX2e

It is deemed remarkable that both the interviews and the grey literature made no mention of the attraction of additional funds from actors such as governmental institutions or scientific communities as a result of the application of EVs in the motorsport. Perhaps these actors, which are normally willing to invest in projects that contribute to the development of sustainable innovations such as EVs, do not see the benefits of EV development in the motorsport environment. But it could also very well relate to the fact that this additional financial support is not necessary as most series do benefit from private investments. Even though there are no unordinary forms of financial support and the RX2e does not even benefit from financial support, it was found that the Extreme E as well as the Projekt E do however benefit from large investments. In comparison to other studied niches, the large numbers involved with some of the electric motorsport projects can be seen as some form of active shield for EVs.

In terms of regulations, electric motorsport is unlike other studied niches in the sense that actors within the sport are complying to technical and sporting regulations, often developed by the FIA, rather than ordinary public regulations. One would therefore wonder whether exemptions have been made of these technical and sporting regulations so that EVs could more easily be used within the sport. However, it

was found that no exemptions have been made but rather new regulations were mainly developed by the FIA in order to establish safe usage of EVs in the harsh environment of motorsport. According to some of the interviewees, these new regulations are deemed even more stringent than the conventional ones for traditional combustion engines. This is exemplified by what was said by the Project Leader of the RX2e:

"FIA is really afraid about the electric vehicles and these batteries and high voltage […] and the stewards are not experts on the area [of safety with regard to EVs], so [the FIA is] really afraid, and the car is extremely safe. And there are extremely severe requirements on the safety side." – Project Leader, RX2e

This quote shows that it is believed that the FIA is careful when it comes to the regulations of EVs as it seems that the knowledge with regard to safety of the innovation in the environment of motorsport is still lacking. Furthermore, the quote shows that regulations for EV usage are more stringent than conventional ones. While stringent regulations can be considered disadvantageous for the implementation of EVs into the sport, it can be considered advantageous for the development of EVs as complying to stringent regulations bring on further safety development of the EVs.

From the analysis also became clear that for both the World RX and the Extreme E there is no need to expect bad economical or technical performances. Where traditional niches are actively shielded to make sure that there is a way to tolerate the bad performances of the innovation, EVs fit perfectly with the format of both projects. Some interviewees even indicated that EVs are on a similar performance level as the traditional combustion engines. Furthermore, economically speaking, it is even more beneficial to use EVs on the long term as maintenance costs are much lower than traditional combustion vehicles.

5.3 Nurturing

This section elaborates on the three key nurturing processes of electric motorsport as niche, which are voicing and shaping of expectations, network formation, and learning. By looking at both cases from an nurturing perspective, it was found that there are a variety of activities happening that contribute to the development of EVs.

5.3.1 Voicing and Shaping of Expectations

This section elaborates on the expectations that have been formulated by the variety of actors in both the World RX and the Extreme E. It was found that there is a general expectation with regard to the future of EVs in motorsport which is shared amongst the diversity of actors. Furthermore, it was found that most of the expectations are inward-oriented and do not cross the boundaries of the motorsport.

For both cases, it was found that there is a similar expectation shared amongst the different actor groups related to the future of motorsports. This expectation is that the amount of EVs will definitely grow amongst different categories of the motorsport. However, there seems to be no consensus amongst the

interviewees to what extent EVs will dominate the varying categories of the sport. One of the Team principals of the Extreme E for example indicated:

"I think, like we just said, that we're going to see different types of vehicles. So we have a format within Extreme E where we're looking at a 20 kilometres course that can be done on pure electric powered vehicles. I think that we will have sports like rallycross that will do the same, again is small and not so long format that can go electric. And then we will see things like Formula One and Dakar that will be some form of hybrid technology with a lot of regeneration going forward. So I think that there are going to be a number of different types of electric motorsport depending on the length of the track." – Team Principal, Extreme E

This quote shows that there is an expectation that the usage of electric technologies will increase amongst different motorsport categories, however EVs that are purely driven by electricity will only be viable for specific categories that suit the short range capacities of current EV designs. This means that for the development of purely electric driven EVs in motorsports, only a limited amount of categories is deemed suitable to function as test bed. This expectation however focuses very much on the capabilities of the current design of EVs, whereas some other interviewees formulated the expectation that the technical design of EVs is likely to change to make them compatible with other motorsport categories. The Project Leader of the RX2e for example argued:

"I don't have doubts about that electric motors will be the ones that will supply power to the wheels, but the power will probably come from a different source. It will not be batteries, it will probably be a different source. I don't know which one will be the best solution for that source of power, source of energy, but I don't think that is the battery in the long term." – Project Leader, RX2e

This quote indicates that a part of the design of EVs as we see it today in electric motorsports will remain, however it is expected that a different source of energy might be used to generate power for rotation of the electric motors. Interesting is that with this expectation it is assumed that EVs might adapt its current design in order to become competent for other motorsport categories which most likely are the ones where longer driving capacities of the vehicles are requested. The fact that these expectations are formulated is assessed as an indicator for the capabilities of motorsport as test bed for the experimentation of new technical designs of EVs.

These aforementioned expectations show some degree of specificity, because rather than arguing that the future will belong to EVs, it is argued that EVs are only a viable option for specific categories of the sport and that the current design of the EV also is likely to change in order to increase the uptake of the technology. Interesting however is that even though a similar expectation of a future with an increased number of EVs in motorsport is shared amongst different actors in both cases, the reasoning behind it is differing. One of the reasonings for the growth of EVs in motorsport, which was only emphasized by actors in the World RX, is that EVs have great potential and will therefore convince drivers and fans,

even the most sceptical ones, that EVs are able to outperform traditional combustion vehicles. This is exemplified by what was said by one of the Championship Coordinators:

"The performance is amazing, I have not met any race driver who has driven an electric, either even electric road cars or electric race cars of any kind, they just love them. Because the performance is unbelievable." – Championship Coordinator, World RX

This quote shows that some drivers that experienced driving an EV already are convinced of the high technical performances EVs can offer. This reasoning increases the credibility of the expectation that EVs will grow in motorsport, however it is not assessed as satisfactory enough. As SNM literature also emphasizes, credibility of expectations is achieved through actual support of facts and data, often obtained from other projects. It is therefore interesting that out of all the interviewees, only the FIA used the Formula E, the only well-known and established electric motorsport series, as reference to support their expectation of a future with more EVs. The lack of credibility amongst the interviewees makes it questionable whether the expectation of EVs in the future of motorsport can be assessed as legitimate. Furthermore, when aiming at attracting resources and expanding the network, it is inefficient to formulate expectations without credible argumentation.

Some of the interviewees also shared a similar expectation for the future of EVs within society, outside of the motorsport, as they have for within the motorsport. In other words, some interviewees indicated that they expect that there will be an increased number of EVs used within society. Interesting is that for this expectation some also argue that EVs first have to adjust its design and some also argue they will be used alongside other technologies. The latter is exemplified by what was said by one of the Team Principals of the Extreme E:

"And I don't think that 100% electric is the possibly the future. I think we will have different types of vehicles for different environments. I think if you live in the inner city now, your pure electric Nissan Leaf for example that maybe does a 120 km on a charge will be very acceptable. I think we will then have another group of vehicles which are not charging hybrids where you will get a very efficient petrol engine that will have a generator that will charge the battery that takes you to the next level of vehicle. I will think we will then start to see hydrogen powered larger vehicles, buses and trucks […] I think that we're going to see multiple types of energy sources used to pare of it. – Team Principal, Extreme E

This quote shows that different types of EV technologies are expected to be used for different lengths of transportation. The fact that this expectation for EVs in society is aligned with the expectation of EVs in motorsport is assessed as an indication that the actors within the motorsport expect that experimentation with EVs within the motorsport is to the benefit of society.

It was also found that besides EVs, it is also expected by some interviewees that there will be an increase of other sustainable technologies in the motorsport. The Team Principal of Rosberg X Racing in the Extreme E for example said:

"I think we're making very good progress with not only electric cars but hydrogen-powered vehicles and synthetic fuels too. ... Autonomous cars are progressing well too, and I think all of these different technologies will feature more and more in motorsport." – Team Principal Rosberg X Racing, Extreme E

This quote thus shows that besides EVs other sustainable technologies, which are already being developed, are expected to be used in the future of motorsport. This shows that motorsport might in the future not only function as test bed for development of EVs, but for other sustainable technologies as well. For these other sustainable technologies also hold that the actors expect, similar to what was mentioned above for EVs, that the usage of sustainable technologies in motorsport is to the benefit of society. This is exemplified by what was said by the Technical Director of the FIA:

"So we need to propose evolution of technologies that are in line with the expectation of the society, this can be electric, we spoke about hydrogen, we spoke about new battery technology, we spoke about also sustainable fuels, because we are also pushing a lot for fully 100% sustainable fuels, which are developing. We believe that if motorsport can use all this technology to push the technology knowledge then motorsport maintain, has always a sense in the future. So that's why we need to push this technology route and this is I think the best certification for motorsport that we can give." – Technical Director, FIA

This quote thus shows that technologies such as sustainable fuels, which would still require combustion engines, but also hydrogen, which already is used in some way within the Extreme E, might be coming to motorsport in the future depending on the needs of society. Hence, this again shows the close relationship between motorsport and society. This quote also shows some specific thoughts on how to actualise the expectation of motorsport dominated by more EVs, which is by following a so-called technology route where motorsport functions as test bed for the technical needs of society. This realisation as governing body of motorsport indicates that motorsport functioning as niche is likely to be continuing in the future, for EVs but also other sustainable technologies.

Interesting is that there is a great lack of expectations which focus on the effects of EVs on the environment of motorsport. Some interviewees, in the World RX especially, shared some expected effects such as larger grid sizes and more sponsorships due to the implementation of EVs, but none of the interviewees referred to phenomena such as decrease of emissions, which you would often see in previous studies. The fact that most expectations are formulated from such a specific inward oriented perspective and not crossing the boundaries of the motorsport also shows that motorsport is unlike other niches which often are created for the development of technologies for general use and mass markets.

Furthermore, this inward orientation is assessed as an indication that electric motorsport actors do not seem to have the intention to utilise the projects towards the benefit of global niche development.

5.3.2 Network Formation

Social networks are important for the development of technologies and are considered to be effective when a diversity of actors participate, such as firms, users, policy makers, and scientists, and the alignment amongst these actors increases through regular interactions between them. For both cases, it was found that there is a lack of diversity amongst the involved key actors. Interaction between these actors however seems to happen on a regular basis and was found to be resulting in some degree of alignment amongst the actors.

Initially by taking a look at the actors involved in the World RX and the Extreme E, which is shown above in Tables 3, 4, 5, and 6 within Section 4, it is identified that the Extreme E has a much broader network in the sense that a larger number of different actors are involved. However, when only taking into account the actors that are associated with EVs according to the interviewees, it was found that there are similar key network actors for both the cases. For the World RX it slightly differs per series which specific organisations are involved, but the general key actor groups are presented in Table 7 below. Also presented in this table are the key actor groups of the Extreme E that are associated with the EVs.

Table 7: Key Actors involved with EVs

World RX	
Actor group	**Role**
FIA	Governing and rule-making body
Promotor	Commercial rights holder
Teams	Users of the EVs and ones doing actual racing
EV developer	Either developer of the entire EV or an EV powertrain, depending on the series
Local event authorities	Organisations responsible for local events
Fans	Audience watching the sport

Technical Suppliers	Organisations that offer specific parts, equipment or complementary technologies needed for the usage of EVs
Extreme E	
FIA	Governing and rule-making body
Extreme E organisation	General organisation and commercial rights holder
Teams	Users of the EVs and ones doing actual racing
EV developer	Developer of the entire EV (ODYSSEY 21)
Fans	Audience watching the sport
Technical Suppliers	Organisations that offer specific parts, equipment or complementary technologies needed for the usage of EVs

Considering the very similar types of actor groups that are involved with the EVs in both cases, as shown above in Table 7 it can be concluded that these all are built upon similar types of actors, namely firms. The FIA as governing body of both the cases can be identified as a policy maker for motorsport series. Their involvement is considered to be useful for development of motorsport policies as they are able to take lessons learned from the World RX and Extreme E to further enhance their regulations and policies. Nevertheless, overall there is little diversity of the key actor groups, which is considered as unbeneficial for the development of EVs.

Interesting however is that many of the involved firms also have activities outside of the motorsport, mainly in the automotive industry. For the World RX it was found that the EV developers of each of the three different series all have some activities within the automotive industry and that even the teams that have been involved with the Projekt E have some connections to the automotive industry. One of the team owners of a team in the Projekt E for example said:

"Now of course, we understood that the future probably will change a little bit and we have to continue with developing ourself. So that's why it would to make sense to go in the electric direction. Because I work a lot for [a large car manufacturer] as an instructor and also as a trainer, so it makes sense for me." – Team owner, Projekt E

This quote shows that teams also in some ways are connected to the automotive industry and also influenced by the industry in the activities that they involve themselves in. The fact that many of the different involved actor groups have connections to the automotive industry is considered to be valuable for knowledge sharing and development of EVs in general, and this makes the electric motorsport also more relevant for global niche developing activities.

For the Extreme E it was found that there are even more connections of the different involved actors with the automotive industry. The Extreme E has involvement of actual EV manufacturers with Hispano Suiza and CUPRA, but also teams that partnered with firms that have activities in the automotive industry such as JBXE with Lotus Engineering, which is a high-end engineering consultant (Lotus Engineering, 2021). Furthermore, the FIA also has activities outside of the sport with for example campaigns for sustainable mobility and road safety. The fact that all these different key actor groups have some connection to society is deemed very valuable for the capabilities of electric motorsport as a niche. Knowledge obtained within the sport can therefore easily be shared with the automotive industry due to these connections, especially for the manufacturers that are involved in the Extreme E. The engineers of the manufacturers at the Extreme E are able to immediately apply their knowledge towards the technical designs of the EVs developed by these manufacturers.

That there are connections between the electric motorsport as niche and the automotive industry on a higher regime level also makes one wonder in which way they are influencing each other. It was found that this is happening in both directions. For the World RX, it was mentioned that large automotive manufacturers have been one of the reasons that the Projekt E was initiated. This is exemplified by the following quote which refers to Paul Bellamy, the former Managing Director of the World RX[3]:

"Peugeot, Volkswagen, and Audi, who all support current World RX teams, have previously expressed interest in bringing EVs to the series. World Rallycross Managing Director Paul Bellamy told Motorsport that the concept comes from the wishes of the manufacturers." – AutoblogGreen

Besides the influence of the automotive incumbents on the motorsport as niche, it was found that the motorsport itself also influences these regime actors. The Technical Director of the FIA for example said:

"[W]e are looking to all technology we believe are relevant for the future of automotive and the future of technology and try to bring them into motorsport. At least defining how to use them safely in the first step and then in what championship it makes sense […] And then we discuss also with the manufacturers where the things are interesting, but sometimes you need to push a little." – Technical Director, FIA

[3] John Beltz Snyder (2017). World Rallycross looks to incorporate EVs. AutoblogGreen

This quote shows that the FIA as governing body always is looking to implement technologies within the motorsport which are deemed relevant for the future of the automotive industry. Furthermore, it also states that often it is discussed with automotive manufacturers which technologies are relevant, but sometimes the motorsport pushes the manufacturers towards usage of certain technologies within the sport. The fact that the motorsport thus pushes regime incumbents is considered as an indication of the motorsport's functioning as niche and provides an indication that this could be done for EV related technologies as well.

What also is interesting is that both cases have a relatively large fan base and audience to which the events are shown. Even though these actor groups are not directly involved with development of EVs, they are considered to be relevant for the general development of EVs. The way in which this exposure contributes to the uptake of EVs is exemplified by one of the Team Principals of the Extreme E:

"And I think that Extreme E will help through its publicity let's say and its awareness will make vehicles much more mainstream to the average person I think. And the more that it becomes more mainstream, the more the manufacturers see it as a mainstream product, the costs of producing those electric vehicles will put down massively because it will just become mass manufacturing instead of a specialist nature." – Team principal, Extreme E

This quote shows that the large reach of electric motorsports is useful for convincing consumers that EVs are a viable mode of transportation. Furthermore, it is argued that once more consumers become convinced of the viability of EVs, manufacturers will cohere to the request of consumers and this will result in the uptake of EVs within society. This large reach of the sport makes it besides a test bed also a demonstrating platform, providing additional capabilities to the motorsport as niche in comparison to traditional niches. This will be elaborated on later within section 5.5, Empowering.

The interaction within the different electric motorsport projects is according to the interviewees of both cases well established and happening on a regular basis. The fact that there is good interaction can also be seen when considering the alignment of aforementioned expectations. Even though some of these still are differing, which is not remarkable considering the relatively short existence of the projects, the general expectation of a future with more EVs is similar amongst most of the key network actors. Furthermore, since there is good interaction, the alignment amongst the expectations might even become better with time.

5.3.3 Learning Processes

Learning processes are important as it enables the adjustment of the technology and societal embedding to increase the chance of successful diffusion. For learning in the electric motorsport, it was found that it mainly relates to technical lessons with regard to the performance and safety of EVs. Furthermore, it was found that motorsport offers a platform for technical lessons with regard to infrastructural

technologies. In terms of first-order learning, almost none of the interviewees indicated any learning goals, and second-order learning was found to be very limited as well. Overall, similar to what was found for the expectations, many learning processes seem to be mainly inward-oriented.

For both the World RX as the Extreme E it was found that learning mainly relates to the acquirement of knowledge on technical aspects and design specifications of EVs. It was found that most technical lessons relate to the performance enhancement of different components and systems of the EVs. This is exemplified by what was said by the expert of the World RX and Extreme E:

"What else did we learn about using electric vehicles? Yeah for me it all relates to technology. Can the battery work when it's minus thirty. It will come back to the R&D thing for me" – Expert, World RX and Extreme E

This quote shows that learning in the electric motorsport mainly focuses on the technical aspects of EVs. This means that the capabilities of electric motorsport as test bed is currently quite limited when it comes to the diversity of learning. This is also not remarkable as learning towards aspects such as market and user preferences or industry and production networks are difficult due to the difference of electric motorsport projects and more ordinary niche projects that happen within the normal market context.

It was also found that besides acquirement of knowledge with regard to the technical performance of EVs, also many lessons within both cases relate to safety aspects of the vehicles. As already mentioned earlier within this report in section 5.2.2, Active Shielding, stringent regulations were made by the FIA for usage of EVs in motorsports. Due to these regulations, different involved people amongst the key actors groups, such as personnel of teams and local track marshals, were forced to develop knowledge about safely handling EVs. Furthermore, there have been many safety tests which have also resulted in an increase of knowledge about safety design specifications. This safety knowledge was used to develop complementary technologies to be compatible with EVs, such as fire extinguishers, but was also applied for further development of the actual EVs. The expert of the World RX and Extreme E for example told about the Projekt E vehicles that:

"So the batteries have to be encased in a certain way, they have to be crash tested by the FIA, there is various safety measures. For instance, in Projekt E the battery could be flooded from the outside with an extinguisher basically using a nozzle on the outside. So if temperatures got too high or if a reaction starts within the battery which was going to end up with combustion then there was a way to literally plug it in and just flood it and in theory kill it within its own case. There are certain things you know there are things like there are LEDs on the cars and there are rules about when you can and can't touch them, because they're live or not live, there is specific training for the drivers, the mechanics, the marshals and the rescue teams which is all specific to electric." – Expert, World RX and Extreme E

This quote shows that besides acquiring knowledge about which design aspects of EVs are deemed relatively unsafe, actual developments are made in the electric motorsport projects to immediately adjust

the EVs towards a design that is considered to be safe for the harsh environment of sport. This thus shows that besides a learning platform, the electric motorsport also functions as an actual development platform.

Interesting is that besides what already has been learned within the electric motorsport's testing environment, many more safety lessons are likely to be learned in the future of electric motorsports. One of the championships coordinators of the World RX said:

"Yeah I think, I mean every time there is an accident or an incident, you know a big accident in motorsport it gets investigated really thoroughly these days. […] I am sure we will see incidents with electric race cars having fires or thermal runaways or by any manner of problems, anything could have caused it. And then they will be investigated and there will be some kind of outcome at the end of that. So yeah that will help the learning process and that's in lots of ways that's where motorsport does its best work now." – Championship Coordinator

This quote thus shows that motorsport in general focuses a lot on investigating incidents which have happened during actual racing. These investigations may result in valuable lessons with regard to safety of EVs. This means that electric motorsport will remain relevant for obtaining safety knowledge with regard to EVs, even during the actual racing season. All these lessons and developments with regard to the safety of EVs are considered to be useful for the development of EVs on the global niche level, but not that essential for the general development and uptake of EVs within society. Under the 'ordinary' circumstances of mobility, safety is considered less important as users tend to drive the vehicles more careful than within the motorsport. The learning with regard to safety therefore is assessed as mainly inward-oriented, as the benefits mainly lie within the boundaries of the sport.

Besides technical aspects related to the EVs performance and safety, some interviewees of both cases also indicated technical lessons could be learned with regard to complementary infrastructural technologies. With the introduction of EVs it means that there also must be charging facilities at the local events in order to recharge the vehicles in between different racing sessions. For the Extreme E in particular an interesting innovation as charging facility is used, namely a hydrogen fuel cell system, as already slightly introduced in this report within Section 4. The practical application of such an innovation in the remote places that Extreme E is racing may provide valuable lessons for AFC Energy, the company that provided these hydrogen fuel cells.

That different technical lessons, as described above, can be achieved within the electric motorsport is related to the unique characteristics that both of the studied cases possess. Motorsport in general always entails a very controlled but competitive environment where drivers are pushing the vehicles to their limits, which already is deemed useful for obtaining data and further development of EVs. However, both the World RX and Extreme E add a series of additional extraordinary conditions. The races in both cases are short, which means there is no need to save energy which results in drivers pushing the vehicle

even more than in other motorsport categories. Furthermore, both cases are driving under extreme temperatures in some of the world's toughest environments on surfaces such as ice, sand, and gravel. This is exemplified by the CEO of one of the EV developers:

"In motorsport we have a possibility to test, develop and optimize specifically new technology, much faster in a safer environment and with shorter development cycles than you can do in automotive. And that's where motorsport can become again let's say in a wider range a very important element of automotive development technology, because there is so much to be developed, there is so much challenges around electric powertrains and motorsport is a fantastic test sheet to develop such technologies, to try them out in extreme conditions, still in a safe environment and to extremely shorten development and testing times compared to a usual automotive approach." – Executive EV Developer, World RX

This quote thus shows the motorsport offers great conditions for acquiring knowledge and developing EVs. Furthermore, it also states that motorsport accelerates the development of certain technologies as developments in motorsport are happening faster than with the usual automotive approach. This offers additional interesting characteristics to the electric motorsport as niche as it not only provides a generic application domain for experimentation with technologies, but also functions as a development accelerator.

What also makes the motorsport interesting as niche for the development of EVs is that interviewees claim that the technical knowledge and development of certain aspects of EVs almost all have some form of relevancy towards to automotive industry. Even though, one could imagine that due to the specific requirements of the sport, the technical lessons obtained within the projects are less relevant for the automotive industry. This is exemplified by what was said by the Technical Director of the FIA:

"[S]ome engineering companies that worked on the first electric racing cars are working also on projects for road cars now. They build a technology leadership working on racing cars, because now they know these extreme applications they can work also on road cars. But it's very in a similar way, you have the same needs for battery design, battery architecture, battery cooling, motor cooling, and also the motor management and safety management of the high voltage, all this is a common experience that you can use in both cases, so in racing and in road cars." – Technical Director, FIA

This quote thus shows that knowledge obtained and technologies developed by firms within the electric motorsport are useful and applicable for the automotive industry. It therefore appears that motorsport to some extent functions as niche to the benefit for development of EVs in society. It should be noted however that some interviewees emphasized that even though knowledge obtained in the sport is relevant and also applied within the automotive industry, it might take time before it is integrated into the designs of EVs we see on the road. However it was found that one of the EV developers for the World RX already has benefitted from technical lessons within the sport and applied it to another project

outside the sport. This is exemplified by what was said by an Executive of one of the EV developers:

"So there was a lot of challenges which we had to overcome and many many many of them can be directly carried over to road car technology. Of course in a slightly different let's say constellation, a slightly different use, but from the principle absolutely. We actually have, just recently a funding project for special battery cooling system, so we have also which was targeting ultra-fast charging capabilities of lithium-ion batteries. And there we have applied partly our cooling systems which we have developed for rallycross and that was a huge success." – Executive EV Developer, World RX

This quote shows once more that knowledge obtained within the electric motorsport is useful for application in the automotive industry, but also provides a concrete example that this knowledge is actually applied in other projects to the benefit of EVs. It does however seem to be related more towards an incremental development of the EVs rather than a more radical adjustment which is considered to be more beneficial for the general development and uptake of EVs.

For both cases, it was found that almost none of the actors had specified their learning goals for the series. The FIA however did indicate that one of their learning goals was to obtain technical knowledge with regard to the safety of EVs in order to further develop technical regulations. Furthermore, for each of the World RX and the Extreme E, there was one team that indicated that their learning goal was familiarizing themselves with the electric racing car, which is exemplified by what was said by one of the Team Principals of the Extreme E:

"Our main goal in the first season of Extreme E is to better understand the technology in the car, looking at how the battery and motor in particular perform in each set of conditions we race in." – Team Principal, Extreme E

This quote shows that technical lessons are indeed made as learning goal, which in the paragraphs above is also mentioned by many actors as the main lessons to be learned from utilising the electric motorsport as test bed. It is however remarkable that only two interviewees indicated that they formulated this specific learning goal, whilst it seems evident amongst all actors that this is a learning process that is happening within both the projects. Furthermore, interesting is that this learning goal seems to be inward-oriented in the sense that the goal is to obtain knowledge that specifically relates to the conditions of the motorsport environment. In terms of first-order learning, there thus seems to be a lack of intention to learn to the benefit of the global niche level of EVs.

In terms of second-order learning, not many processes were identified. Furthermore, the ones that were found did not focus on learning with regard to EVs, but rather towards the motorsport environment. For example, some interviewees learned that many traditional fans are sceptical towards the usage of EVs in motorsport, but they are argue that these fans are going to be convinced about the capabilities of EVs when they see them in reality. Furthermore, it was also learned that electric motorsport attracts different audiences than one would normally see for motorsport, especially at the Extreme E. The expert of the

World RX and Extreme E said for example about the Extreme E:

"And some interesting stuff too, definitely the audience is not what I would expect from a normal traditional motorsport audience, it's a different audience. And I guess that's a good thing for the series, you know it's obviously hitting its marks, because it's not just to appeal to motorsport fans, it's supposed to appeal to I don't know your equality set, your environmental set, you're motorsport set, they're trying to pull all of those interests" – Expert, Extreme E

Besides, it was also found that some interviewees question the current stringent technical regulations for the EVs. It was found that these regulations hamper development and knowledge acquirement as for both the Extreme E and the World RX, the teams will be unable to integrate their own technologies within the EVs as there is a fixed design. It was however indicated that plans are made for slowly opening up technologies towards the participating teams, however the aspects of EVs which are deemed as the holy grails for development will most likely not open up in the upcoming years. These holy grails are the battery and charging systems of the EVs. The opening of these aspects of EVs however contain a fine balancing act between the entertainment and development aspect of the sport. This is exemplified by what was said by the Expert of the World RX and Extreme E:

"[Y]ou don't want a manufacturer to come in and [spend a lot of money] immediately, because it kills the sport. So I think the model of a one-make series is the right way to do it and then what you do is slowly release things to the manufacturers. Now what would really speed up the development of road cars the most is if you release to [the manufacturers] the battery and the charging. […] [Manufacturers] want to R&D the crap out of battery and charging. The problem is that is the area that you can spend the most money the quickest. You know, we got electric motors and electric drivetrains, yes there is development to be done. But if you start saying to them you can make the battery, you can make the charger, you know they will start spending money very quickly indeed." – Expert, World RX and Extreme E

This quote shows that manufacturers are deemed important for the technical developments of EVs as they are willing to spend a lot of money on certain aspects which are important for the development of EVs in general. Opening up technical regulations could therefore attract manufacturers to the electric motorsport projects and speed up the process of technical EV development, which is beneficial to society. However, this could also ruin the entertainment aspect of the sport and also scare away organisations with smaller budgets. Most of the interviewees therefore argued that the current approach of a fixed car where technical adjustments slowly open up to the teams is the appropriate approach. However, from a niche perspective this is considered inconvenient as the sporting aspects apparently outweigh the development aspects of the electric motorsport with regard to EVs.

5.4 Empowering Processes

Empowering refers to outward-oriented activities of niche advocates aimed at changing mainstream contexts. It was found that for the electric motorsport, empowering processes are twofold in the sense that the electric motorsport purposely aims at demonstrating EVs towards a large audience and uses sustainable oriented narratives to increase the number of EVs within the entire motorsport.

It was found that in terms of empowering, the electric motorsport as niche focuses on two different sorts of outward-oriented activities. First of all, there is an outward-oriented process where the electric motorsport focuses on empowering EVs for society in general. Most of the narratives, which are considered the main approach for empowering, amongst the niche actors are focused on the empowerment of EVs amongst the entire motorsport, as will be discussed below. However, it was found that the niche actors of the electric motorsport follow a different approach for empowering EVs towards society. The electric motorsport actors are consciously aware of the role that electric motorsport plays in showcasing the capabilities of EVs and with that promoting EVs amongst potential consumers. This was already slightly discussed within section 5.1, as some of the interviewees said that a purpose of the electrification of the motorsport is related to showcasing EVs in general. The Technical Director of the FIA for example said:

"We believe it is quite important that we can demonstrate, you know motorsport is a laboratory, but it is also a demonstrator, that motorsport can demonstrate that yes fast charging is a reality…[J]ust to demonstrate, yes you can have a short pit stop and charging and then the car will go on racing. So I think it's a part of the demonstration that the technology is there and that you can rely on it. – Technical Director, FIA

This quote shows that electric motorsport is purposely aiming to show the latest developments that have happened with regard to EVs, such as fast charging. This provides an indication that there is conscious awareness of the electric motorsport acting as demonstrator of the capabilities of EVs. The electric motorsport is trying to convince the consumers that EVs are not some sustainable innovation, but rather something that can be considered convenient as mode of transportation. This form of empowerment is assessed as some form of a stretch and transform strategy as it very much focuses on changing the psychological perception of consumers towards EVs, which can be considered a selection environment.

The second form of empowerment that was found relates to a process of empowering EVs as viable innovation for the usage of multiple motorsport categories rather than a small segment of all the motorsport. Most of the narratives of the interviewees relate to the more sustainable image the motorsport is trying to obtain and that this can be achieved through the replacement of combustion engines for EVs. This is exemplified by what was said by one of the Championship Coordinators of the World RX:

"I suppose a lot of is the environmental image, the projective view of the championship is being up to date. It is not being you know anachronistic and continuing to develop petrol engine cars, which are really exciting to watch but not economical. … So, yeah I suppose it's that whole, the projection is a move towards more sustainable sport." – Championship Coordinator, World RX

This quote shows that the World RX is aiming at obtaining an environmental image and with that is willing to step away from the conventional combustion engine cars, which are deemed outdated. The integration of EVs in the World RX is thus considered as a solution for obtaining this environmental image. This is identified as a form of stretch and transform empowering because rather than running alongside combustion engines, EVs are framed as replacement of the conventional motors. This replacement would require a change in selection environments such as infrastructure in the form of charging facilities, the knowledge base, technical regulations, and attitude of the fans. This latter is also mentioned by some of the interviewees as one of the major obstacles for the integration of EVs, as many fans dislike the removal of the loud noise coming from the exhaust pipes of combustion engines. Nevertheless, the interviewed EV advocates frame a change of attitude as necessary for the fans as EVs are eventually going to replace the combustion engines within the motorsport. Even though this form of empowerment is not directly relevant for the uptake of EVs in our current mobility system, it can be considered relevant to support the aforementioned empowering process. If these empowering narratives result in the usage of EVs in more motorsport categories, then more potential consumers will be exposed towards the capabilities of EVs. Besides this, usage of EVs in other motorsport categories may result in more technical lessons and this knowledge can be used for the general development of EVs within society as discussed above in section 5.3.3.

6. Conclusion

This research aimed to identify the role that the electric motorsport as niche plays in the development of electric vehicles (EVs) for a transition towards a more sustainable mobility system. In order to fulfil this aim, a qualitative research approach was used to analyse the electrification of certain categories of the FIA World Rallycross Championship as well as the Extreme E. Data on the aforementioned cases was collected through semi-structured interviews as well as grey literature. In order to analyse the electric motorsport as a niche, this research build upon the protective space conceptualisation of Smith and Raven (2012) that focuses on shielding, nurturing and empowering processes of niches. For each of these three processes, this research found mixed indicators of the electric motorsport its functioning as a niche.

The analysis showed that the studied electric motorsport projects have differing purposes. For the World RX the main purpose of the different electric categories are showcasing the EVs and for the Extreme E the main purpose is to raise environmental awareness. These purposes are unlike other studied niche projects which often purposely focus on the development of a specific innovation. This thus shows that the electric motorsport is not necessarily intentionally created to function as a niche. However, the analysis also showed that the electric motorsport does have the potential to function as a niche and to some extent is also utilised by the electric motorsport actors as such.

In terms of shielding, it was found that the application of EVs in the motorsport projects mainly benefits from a passive form of shielding. Both the nature of the motorsport projects and the relative improvement in maintenance that EVs bring to some extent makes motorsport a perfect ‘bubble’ to experiment with EVs. Due to this excellent match between EVs and these projects, it was found that there is no need for more active shielding measures.

For the nurturing processes, it was found that the electric motorsport to some extent contributes to the development of EVs. The main expectation shared amongst the interviewees is that EVs will continue to grow in numbers amongst the motorsport categories that fit the capabilities of the EVs. Furthermore, it was found that most of the formulated expectations are inward-oriented, meaning that there is lack of expectations formulated to what the effect of using EVs within the sport is for the general uptake and development of EVs within society. The network involved with the electric motorsport consists mainly out of similar types of actors, namely firms. Interesting however was that many of these firms do have some connection towards the automotive industry through either actual activities or relationships with automotive incumbents. This is considered useful for knowledge sharing and the general development of EVs. Finally, for the learning processes happening within the electric motorsport, it was found that the electric motorsport offers a controlled environment with unique conditions that is mainly used for technical lessons with regard to the performance and safety of EVs. Interesting however was that the knowledge obtained from these lessons is immediately used for the development of the EVs, making

the electric motorsport not only a learning, but also a development platform. Even though the lessons learned are not diverse as they all address technological aspects and also did not specifically focus on societal needs, it was found that many of them are deemed relevant for the development of EVs within the automotive industry. These nurturing processes, especially in terms of the network involved and the lessons to be learned, showed that the electric motorsport has the potential to utilise itself as a local niche that contributes to the general development of EVs on a larger global niche level.

In terms of empowering, it was found that electric motorsport as local niche focuses on two outward-oriented activities. First of all, the actors within both the electric motorsport projects are consciously aware of the large reach and influential capacity of their platform. The actors therefore indicated that they aim to promote EVs amongst potential consumers by showcasing the capabilities of EVs in an attractive manner. Second of all, the narratives of the interviewed actors followed an inward-oriented approach of empowering EVs within the motorsport with the aim of increasing the usage of them amongst an increased number of categories.

To conclude, it was found that the electric motorsport as niche shows great capabilities of making contributions towards the development of EVs, but currently is not utilised to its potential. The focus is put more towards inward-oriented processes that are beneficial for remaining the general existence and relevancy of motorsport in general. However, whilst focusing more inward, some valuable contributions are still made towards the development of EVs. Especially the empowerment process of showcasing EVs is assessed as electric motorsport its biggest contribution to the development of EVs. Besides this, the learning and developing processes also are deemed valuable. The role of electric motorsport in the development of EVs for a more sustainable mobility system is thus increasing the knowledge base with regard to EVs, enhancing the technical design of EVs, and changing the psychological attitude of consumers towards EVs.

7. Discussion and Limitations

7.1 Discussion

This research contributes to the existing SNM literature by using Smith and Raven (2012) their protective space conceptualisation to study how projects within a space which is not purposely created or utilised for development of an innovation by means of experimentation, do to some extent deal with niche related processes. Previous research that focused on the contribution of projects towards niche development only analysed projects which intentionally are created with the purpose of developing a specific niche innovation (Xue et al., 2016; Laak, Raven, Verbong, 2007; Ulmanen, Verbong, Raven, 2009; Valdez, 2015; Sushandoyo & Magnusson, 2014). However, to the best of my knowledge, no previous studies have aimed at studying these specific projects that are not purposely created or utilised for development of an innovation. By studying the electric motorsport, it was found that such specific projects do contribute to certain niche related activities, but not to an extent of which it has the potential. The actors within such projects seemed not to have the intention to purely focus on niche developing processes. It was found that the focus is put more towards inward-oriented processes that are beneficial for remaining the general existence and relevancy of motorsport in general. However, whilst focusing inwards, valuable contributions were still made to the general development of the niche innovation, especially due to learning and empowering processes.

This research has responded to the call of Smith and Raven (2012) to test their framework within an empirical research. It was found that the three processes of protective spaces as proposed in this framework are useful for studying niches that are not purposely created or utilised for development of an innovation. Furthermore, this research also has shown that SNM as analytical framework not necessarily has to be used as ex-post evaluation framework for historical case studies which thus far mostly has been done within literature (Schot & Geels, 2008; Mourik & Raven, 2006). The electric motorsport projects within this study are relatively young projects and it was found that with the framework of SNM it could be assessed which internal processes currently happening are contributing to the development of the innovation.

Finally, this research has shown that the electric motorsport makes a contribution to the development and uptake of EVs. It was found that this mainly relates to the acquirement of technical knowledge, development of the technical design of EVs, and demonstration of the capabilities of EVs towards a large audience. The electric motorsport therefore in some extent contributes to overcoming certain technical barriers and attitudinal barriers that currently hamper the uptake of EVs within society (Berkeley et al., 2017; Krishna, 2021). The fact that electric motorsport, which in essence is considered to be an entertainment platform, contributes to overcoming these barriers is assessed as very valuable. However, as already described above, the projects have the potential to make a much larger contribution from a niche perspective. It is therefore recommended that electric motorsport actors consult actors such

as scientific communities and governmental institutions to specifically identify which technical and attitudinal barriers can be removed amongst consumer through the usage of EVs within motorsport.

7.2 Limitations

For this study, a variety of actors have been interviewed amongst the two different cases. However, some important actors, especially for the Extreme E have not been interviewed. Examples of these actors are the developer of the electric SUV of the Extreme E, as well as the organisation of the Extreme E. The lack of these important actors within the sample of interviewees is assessed as a limitation to achieving data saturation. The main issue related to the absence of vital actors is related to the fact that this research has taken place during the first season of the Extreme E and just prior towards the start of the World RX. Potential interviewees therefore indicated that they were unable to schedule an interview.

Another limitation with this study is that the general motorsport regime was not studied as it initially was assessed as irrelevant to the main research question. However, during the research it became evident that many of the internal niche processes focused on the development and uptake of EVs within the current motorsport selection environments. Future research could therefore focus on describing the current motorsport regime and identifying what the biggest barriers are for the uptake of EVs within this regime.

The representativeness of this research for the entire electric motorsport, as category of motorsport in general, is questionable as the studied cases are relatively young and both only use cars. It is therefore debatable whether the findings of this research also hold for electric motorsport series such as the MotoE, which is the electric division of the MotoGP, and the E1 series, the world's first electric powered boat race (MotoGP, 2020; E1, 2021). Furthermore, the most evident electric motorsport series to be studied from a SNM perspective as a historical case description could have been made is the Formula E, which has not been included in this research. The reason for this exclusion relates to the fact that many Formula E actors have been approached, but were unable to participate in an interview due to confidentiality reasons or the fact that the championship had started whilst this research was executed. Future research could therefore focus on studying a larger sample of electric motorsport cases in order to identify whether the findings of this research hold for the entire electric motorsport category.

Finally, this study only focused on the specific case of electric motorsport for the elaboration and validation of the SNM approach for analysing niches which are not purposely utilised or created for developing an innovation. It was found that the electric motorsport projects investigated within this research are very specifically related to the automotive industry and therefore a small segment of the entire mobility regime. It is therefore questionable whether similar niche processes can be identified for other niches that are not purposely utilised or created for developing an innovation, as these may focus on different technologies that cope with selection environments of different regimes. Future research

could therefore focus on analysing other niches that are not purposely utilised or created for developing an innovation in order to identify if similar niche processes are found as within this research.

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Appendices

Appendix A: Interview Guide (General Guide)

This interview guide has been made as supportive tool for the semi-structured interviews. Stated below are a variety of questions related to topics of electric motorsports as protective space for developing technologies related to electric vehicles. It should be noted that these questions are not definitive and that it is likely that during the interviews other questions will be asked. Furthermore, besides acting as supportive tool, these questions were provided to the interview participant so that he or she knows what to expect.

Introduction

- Ask participant whether he or she is comfortable in this interview setting
- Provide introduction of myself and the purpose of this interview
- Ask whether you may record this interview to properly process it afterwards
- Indicate how in the end this interview will be transcribed and the participant may see this transcript
- Indicate that the participant will remain anonymous unless he or she prefers to be named
- Ask whether you may use quotes from the transcript for in the report itself
- Start recording
- Ask participant to give a short introduction about him- or herself

Potential Questions:

Electric motorsports for developing electric vehicles

- What are the main reasons this specific motorsport event was created?
- Is one of the reasons also the development of electric vehicles?
- What makes the environment of the motorsport so sufficient for development of electric vehicles?

Shielding mechanisms

- What enables the possibility to experiment or develop electric vehicles in the electric motorsport event?
- Is there financial support for those involved in developing electric vehicles?
- Are there exemptions of certain rules of daily life within the motorsport?
- Are there financial benefits of developing electric vehicles in the electric motorsport?
- Are there geographical benefits for developing electric vehicles in the electric motorsport?

Nurturing processes:

Voicing and Shaping of expectations:

- What are the expectations for EVs by using it in the electric motorsport?
- Are these expectations shared by everyone involved within the sport?
- Why do you have these expectations with regard to the usage of EVs?
- Which steps should be taken to realise your expectations?

Network formation:

- What types of organisations are involved in the electric motorsport?
- Which organisations are involved with the development of electric vehicles?
- How many organisations have joined the electric motorsports for development of electric vehicles?
- How do these different organisations interact with each other?
- What are the roles of these different organisations in the development of electric vehicles?

Learning processes:

- What can be learned from experimenting with electric vehicles in electric motorsport?
    - Besides technical and design aspects, can within the sport be learned about:
        - Infrastructure and maintenance issues
        - Cultural issues
        - User preferences
        - Production issues
        - Additional regulations
        - Societal and environmental effects
- Have there been made any specific learning goals?
- What are the obstacles for using EVs in this series?
- Have there already been changes in the sport so that the electric vehicles can be used more effectively?

Empowering processes:

- What is in your opinion the future of EVs in motorsport?
- Do you believe that changes should be made in the motorsport in order to increase the usage of EVs?
- Will the contribution of electric motorsport in the development of electric vehicles change in the future?
- Do you believe that changes should be made in the motorsport in order to increase the usage of EVs?

Other:

- How was the electric vehicle used within the events designed?

- Are learning experiences achieved within the sport also shared with other organisations (that not necessarily have to be involved with the sport)?
    - How are these learning experiences shared with these organisations?
- Are there already certain technologies related to the electric vehicle used for racing that have already been implemented by automotive manufacturers?

Closing questions:

- Are there still some things you believe are worth mentioning?
- Do you have any questions or comments?
- Do you know anyone that is relevant for me to speak to?
- Are you willing to share the contacts of these people?
- Thank participant for the interview

Appendix B: Search Terms Nexis Uni

FIA World Rallycross Championship

Search term used: Rallycross AND Electric.

Additional features added:

- Language = English
- Group Double Articles = ON
- Sources = Newspapers or Newswires & Press Releases or Industry Trade Press or Blogs or Magazines & Journals or Web-based Publications or Aggregate News Sources or Law Reviews & Journals or News

Extreme E

Search term used: “Extreme E”

Additional features added:

- Language = English
- Timeline = 2019 - present
- Group double articles = ON
- Sources = Newspapers OR Newswires & Press releases OR Web-based Publications OR Magazines & journals OR Blogs

Appendix C: Grey Literature Articles

FIA World Rallycross Championship

Auto Express (2017). Audi announces World Rallycross backing for Mattias Ekström.

AutoblogGreen (2016). VW tech boss pushing for EV class in World Rallycross.

AutoblogGreen (2017). World Rallycross looks to incorporate EVs.

AutoblogGreen (2018). World Rallycross Championship could go electric in 2020.

Autocar (2016). Hyundai eyes World Rallycross and Formula E in big motorsport push.

Autocar (2016). Official: Volkswagen to quit World Rally Championship at end of 2016.

Autocar (2016). Peugeot backs all-electric rallycross series.

Autocar (2016). Volkswagen wants all-electric supercars in World Rallycross.

Autocar (2017). Audi Sport enters World Rallycross Championship via EKS RX team.

Autocar (2017). Electric rallycross might join Formula E in city centres.

Autocar (2017). Electric rallycross series could run alongside Formula E.

Autocar (2018). Electric Global Rallycross racing series confirmed for 2018.

Autocar (2018). Interview: Petter Solberg on his rally return and electric motorsport.

Autocar (2018). Lessons in gravel and jumping with Audi's rallycross stars at Silverstone.

Autocar (2018). Manufacturers given more time for electric rallycross switch.

Autocar (2018). World Rallycross Championship's switch to electric cars approved.

AutoCar (2020). CHASING THE SPARK; Two new electric racing series represent a pioneering spirit.

AutoCar (2020). How we created our own car brand; How hard can it be to come up with a desirable new car brand and make its launch model a success? Only one way to find out.

AutoCar (2020). Supercharge electric crossover racing series to launch in 2022.

Autocar (2021). British Rallycross will include 600bhp EV racers in 2021 season.

Autocar (2021). First drive: STARD Ford Fiesta ERX electric rallycross review.

Autocar (2021). Manfred Stohl: ERX electric rallycross just as competitive as ICE.

Autocar (2021). Opinion: This is the future of rallycross.

Automotive : Plans & Government Policies (2016). First fully electric rally car unveiled.

Automotive : Plans & Government Policies (2020). Volkswagen shuts Motorsport affairs; to focus more on evolving electric vehicles.

AutoWeek (2017). Jump Start; Electric car class could give Red Bull Global Rallycross a boost in 2018.

Business Wire (2020). Groundbreaking Nitro Rallycross Launches New Era With Global Expansion and Cutting-Edge Electric Series; Network of Purpose-Built Tracks Announced As Part Of Ambitious New Worldwide Motorsports Championship; Transformational Electric Competition Coming in 2022.

CleanTechnica (2016). Red Bull Global Rallycross To Add Electric Racing Class In 2018.

Comtex News Network (2019). Ferratum Group announces new title sponsor partnership with STARD for the 2019 FIA World Rallycross Championship.

Contify Automotive News (2019). Audi e-tron extreme: Technology demonstrator on legendary "Streif".

Contify Automotive News (2020). SAE: Xtrac readies e-tech for Rallycross World Championship.

Evening Chronicle (2016). VW quits world rally series on high note.

Evo (2018). Next-gen Peugeot GTis to gain electric powertrains.

Evo (2018). Volkswagen R to diversify and push next-gen models to the extreme.

Formula1blog.com (2016). Audi Sport withdraws from FIA WEC at the end of the 2016 season.

Gas 2.0 (2016). Volkswagen Wants Category For Electric Cars In World RallyCross Racing.

Gas 2.0 (2017). Professional Rally Racer Puts His BMW i3 Through Its Paces.

Hybrid Cars (2018). Global Rallycross is Adding Battery Electric Series in 2018.

IHS Global Insight (2016). VW pushes for EV class in World Rallycross Championship – report.

IHS Global Insight (2017). Audi backs plans for EVs to compete in World Rallycross championship.

IHS Global Insight (2017). VW EV racer to compete at Pikes Peak hillclimb.

Namibian Sun (2018). Green light for electric World Rallycross series.

News and Star (2021). Electric car rally driver has an environmental point to prove.

Newstex Blogs (2020). Rallycross is going electric in 2021 with a chaotic new race series across Europe

PR Newswire (2014). Electric Drive Transportation Association and Andretti Formula E Team Up to Promote Mainstream Adoption of Electric Vehicles.

SportzPower (2019). World Rallycross adds E-racing element to racing grid.

Telegraph.co.uk (2020). New electric touring car racing series aims to smash the respectable image of zero-emissions propulsion; Although Formula E has taken electric racing into the mainstream, a new series for showroom-based cars is adding to the spectacle.

The New Zealand Herald (2019). Driven's guide to the world of electric events.

Extreme E

Al Riyadh (2021). Interview with Prince Khalid Bin Sultan Al Abdullah Al Faisal, Chairman of the Saudi Automobile and Motorcycle Federation (SAMF).

Arab News (2021). All you need to know about Extreme E series.

Arab News (2021). Catie Munnings embracing Extreme E's electric racing as she plots path to glory in AlUla desert.

Arab News (2021). Extreme E announces new Red Sea conservation initiative.

Arab News (2021). Extreme E organizers promise whole new experience for drivers, audience as 'Star Wars pod racing meets Dakar Rally' in AlUla.

Arab News (2021). Prince Khaled says Extreme E launch is 'latest exciting moment in our motorsport history'.

AutoCar (2020). CHASING THE SPARK; Two new electric racing series represent a pioneering spirit.

Autocar (2020). Cupra joins Extreme E race series as Abt Sportsline partner.

Autocar (2020). Extreme E: the off-road race series trying to save the planet.

Autocar (2020). Racing lines: two new EV racing series are chasing the spark.

AutoCar (2021). BUILT ON SAND?; We report back from the inaugural Extreme E race in Saudi Arabia.

AutoCar (2021). CHADWICK GOES EXTREME; Why W Series champion is diving into new electric off-road series.

Autocar (2021). Extreme E 2021 series preview: "A new volume of motorsport history".

Autocar (2021). FIA details all-new electric GT racing category.

Autocar (2021). Opinion: FIA electric GT - should Formula E be worried?

Autocar (2021). Racing Lines: Is Extreme E's success built on shifting sands?

Autocar (2021). Revived Hummer to compete in Extreme E off-road series.

Autocar (2021). Tarmac to dirt: Jamie Chadwick on her Extreme E debut.

Autocar (2021). Why Extreme E will begin a new era for motorsport in 2021.

Autocar (2021). Williams and Italdesign offer firms 'turn-key' EV package.

Automotive News (2021). JBXE Racing and Lotus Engineering join forces in Extreme E Technical Partnership Contify.

Business Wire (2021). Extreme E Joins Forces with Polymateria to Tackle Global Plastic Pollution.

Canadian Press (2020). Andretti, Ganassi commit to new Extreme E Series for 2021; Andretti, Ganassi commit to new Extreme E Series for 2021.

CE Noticias Financieras (2019). Competition in the Arctic: what the first car race will look like in Greenland.

CE Noticias Financieras (2020). ACCIONA, Carlos Sainz and QEV Technologies form teams to compete in Extreme E.

CE Noticias Financieras (2020). Audi: the new Dakar track for Carlos Sainz.

CE Noticias Financieras (2020). Lewis Hamilton to have electrical equipment.

CE Noticias Financieras (2021). Agag: "Formula One and Formula E will eventually converge".

CE Noticias Financieras (2021). Santander Private Banking sponsors the team of Carlos Sainz and Laia Sanz of Extreme E.

City A.M. (2019). ELECTRIC RACING SET FOR EXTREME MAKEOVER; Formula E's boss tells Michael Searles why he is launching a new series for SUVs.

CleanTechnica (2019). Off-Road Electric Race Series Is Off — Continental Officially A Founding Partner Of Extreme E Series.

CNN.com (2019). From destroyed Amazonian rainforests to the Himalayas, Extreme E is 'future of off-road racing'.

Contify Automotive News (2020). Continental: Tires for Extreme E Series to Feature ContiConnect Tire Management Solution.

ENP Newswire (2020). -CUPRA shows its more radical racing side in the Extreme E official tests.

ENP Newswire (2020). CUPRA inaugurates the first CUPRA Garage in Europe and announces its participation with ABT in Extreme E.

Express Online (2019). Alejandro Agag opens up on Extreme E legacy, racing in Saudi Arabia and QPR four-year plan; EXCLUSIVE: Alejandro Agag has enjoyed success in politics, business, football and motorsport during his remarkable career, and the Spaniard is now targeting more of the same at the helm of Extreme E.

Express Online (2019). Extreme E launches cutting-edge SUV designed by Formula E supplier for new off-road series.

Express Online (2021). Extreme E star Catie Munnings says Odyssey off-road car is almost 'spot on'.

Financial Times (2020). Veloce merges esports and racing outfits; Technology.

FT.com (2020). Veloce merges esports and racing outfits for Extreme-E challenge.

General News Service (2019). Interview: Extreme E founder Agag eager for Chinese input Xinhua.

Global Data Point (2021). NEPs Solution for Aurora, North One and Extreme E Tests Its Metal In Some of the Worlds Harshest Conditions.

GlobeNewswire (2021). KULR Becomes Official Thermal Management and Battery Safety Provider for Andretti United Extreme E.

Hawke's Bay Today (2021). Motorsport charges to an electric future.

Impact News Service (2021). Founder and CEO of Extreme E: Saudi Arabia is Perfect Destination to Host First Launch of New Extreme E Series.

London Stock Exchange Aggregated Regulatory News Service (2021). AFC Energy Plc Hydrogen Fuel Cell System for Extreme E Unveiled.

MailOnline (2020). SMALL CAP IDEAS: AFC Energy's rally deal highlights its leading position in hydrogen fuel race.

Mirror.co.uk (2020). Alejandro Agag: Why sport must change ways and look long-term on climate change; EXCLUSIVE: On Earth Day, the Formula E and Extreme E founder has spoken about why the coronavirus pandemic should open the eyes of people in sport to wider problems.

National Post (2020). Motor racing-Ganassi to take on Andretti in Extreme E electric series.

Newstex Blogs (2021). AFC Energy unveils power generator that will feature in the Extreme E electric SUV championship.

Newstex Blogs (2020). Sport and Sustainability to the Extreme.

Newstex Blogs (2021). AFC Energy explains how it will power Extreme E.

Newstex Blogs (2021). Extreme E 2021: full preview and race guide.

Newstex Blogs (2021). Hamilton And Button On Board As Green Machines Go To Extremes.

Newstex Blogs (2021). Student Opinion: The Benefits Of Electric Motorsport.

Pivotal Sources (2021). The ACCIONA|SAINZ XE Team debuts in Saudi Arabia in Extreme E, the new sustainable competition.

PR Newswire (2020). Sycamore Entertainment and SEGI TV Sign Primary Sponsorship Deal With Chip Ganassi Racing For New Extreme E Racing Series.

PR Newswire Europe (2020). CUPRA is the first automotive brand to participate in Extreme E.

SportzPower (2020). Formula E takes minority stake in Extreme E.

STUFF.CO.NZ (2020). Fisker to enter Formula E-inspired off-road series.

Telegraph.co.uk (2021). The Extreme E chief racing to promote an environmental message.

Thai News Service (2020). World: Alejandro Agag: tearing up the motorsport rulebook - for equality and the environment.

The Independent (United Kingdom) (2021). Why AlUla and Extreme E make a perfect duo in the fight against climate change.

The Independent (United Kingdom) (2021). Can high-speed SUVs save the planet? Extreme E begins bold new mission with first Desert X Prix.

The Independent (United Kingdom) (2021). How AlUla stands to reap lasting benefits from Extreme E's race to stop desertification.

The Independent (United Kingdom) (2021). Jenson Button on Extreme E: 'In a race car you're lying down. This is like driving a bus'.

The Independent (United Kingdom) (2021). Nico Rosberg: 'We must build the whole of sport on the foundation of social cause, for the greater good'.

The Independent (United Kingdom) (2021). Why climate will be the winner when revolutionary 4x4 cars race through the Saudi Arabian AlUla desert.

The Morning Call (2021). Andretti builds different racing name as team owner Auto Racing.

The National (2021). Disintegrate after use: Polymateria offers cupful of green hospitality at Saudi Extreme E race.

The New Zealand Herald (2020). Move over Formula E, for the off-road version.

The Press and Journal (2020). Rallying to become supercharged.

The Sun (England) (2020). …Electric motor; LEW STARTS OFF-ROAD ECO TEAM.

The Times (London) (2020). Race teams must include female driver.

The Times (London) (2021). Desert, electric cars ... and Hamilton; Extreme E series.

The Vancouver Sun (British Columbia) (2021). F1 vet adapting to a new off-road role; World champion in 2016, Rosberg is now team owner in Extreme E electric series.

Top Gear (2021). CHRIS HARRIS; Is Extreme E the future of motorsport? Harris isn't sure, and wonders if we should be asking a different question.

Top Gear (2021). FREDDIE'SPICK EXTREME/E/; Extreme E is off and running and we were there, in Saudi, to witness the first event. So, the future of racing or total greenwash?

Xinhua General News Service (2021). Extreme E launches fan challenge to cut carbon emissions.

Xinhua General News Service (2021). Feature: Andretti United fully charged for Extreme E curtain-raiser.

Appendix D: Informed Consent Form

Utrecht University

INFORMED CONSENT FORM | for participation in an interview with regard to the research on the role of electric motorsport in the development of electric vehicles.

To be completed by the participant:

I confirm that:

- I am satisfied with the received information about the research;
- I have been given opportunity to ask questions about the research and that any questions that have been risen have been answered satisfactorily;
- I had the opportunity to think carefully about participating in the study;
- I will give an honest answer to the questions asked.

I agree that:

- the data to be collected will be obtained and stored for scientific purposes;
- the collected, completely anonymous, research data can be shared and re-used by scientists to answer other research questions;
- video and/or audio recordings may also be used for scientific purposes.

I understand that:

- I have the right to withdraw my consent to use the data;
- I have the right to see the research report afterwards.

Name of participant : _____

Signature: _____ Date, place: ___ / ___ / ____, _____

To be completed by the investigator: I declare that I have explained the above mentioned participant what participation means and the reasons for data collection. I guarantee the privacy of the data.

Name: Bram Weggemans

Date: __ / __ / ____

Signature: