Caught in Diversification

Methodological pluralism to review and investigate local climate mitigation actions in Taichung City - Taiwan

Lars Holländer

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LUCSUS
Lund University Centre for Sustainability Studies

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Submitted May 16, 2017

Supervisor: Torsten Krause, LUCSUS, Lund University

Abstract:

Climate change as an environmental and social phenomenon exacerbates the increasing ecological strain on Earth. Therefore, a plethora of measures is needed to get onto a more sustainable track towards a low-carbon society. We need to act fast as we are approaching the point of no return. Many strategies to mitigate and stabilise the climate have been developed, one of them being low-carbon initiatives. But the real question is: are they not rather maintaining the status quo under the guise of climate change action?

My thesis sets out to investigate the local dimensions of Taichung City's low-carbon initiative in Taiwan via a single case study. The unit of analysis being the implementation processes of that low-carbon initiative. A mixed method approach was applied as a toolset to collect data. Taichung City as a 2-wheel society is encircled by rural areas. There is a diversity of actors, technologies and policies surrounding this initiative that raise one key research question (RQ): How important are local context-specific factors in low-carbon initiatives to enable a sustainability transition?

Transitions do not only affect societal structures, as the social systems are entangled with the natural systems. But transitions are also deeply political. Therefore, the system boundaries can be summarized as being socio-technical-ecological. Analytical frameworks applied were the multi-level perspective and the typology of regional diversification.

The results suggest that the rural district Xinshe, although other rural areas are descriptively mentioned in the governmental white papers, is not included by collaborating with them through projects. This leads to the conclusion that Taichung City's low-carbon initiative is not acknowledging its local context, that is the social focus on motor scooters and the sufficient inclusion of its rural district Xinshe. With the shortcomings found, Taichung City rather maintains the status quo instead of getting onto a low-carbon pathway.

Keywords: Sustainability Science, Transition Theory, Low-Carbon, Taiwan, Green Transport, Rural Areas

Word count: 13 916

Acknowledgements

Various frameworks (contexts) leave their mark on us throughout our life. Let us characterize the 2-year master's programme framework (LUMES) as a learning zone of diversity. This thesis is an outcome of the last couple of month's research. More than that, this thesis is also a result of the experiences I made and the knowledge I gained within that LUMES-bubble. There are several persons I am thankful for.

For the supervision, I want to express my sincere thanks to Torsten. Thank you for all your constructive feedback, for your mental flexibility and your advice that pointed the way ahead. Words of thanks also go to my supervision group. Especially to Hanna, thanks for your honest und direct feedback. Reflecting and incorporating your thoughts of advice really improved the quality of my thesis. Which brings me to Henner. Thanks for your additional thoughts and reflections along the way.

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Abbreviations

BRT	Bus Rapid Transit
CO2	Carbon Dioxide
EMS	Electric Motor Scooters
EV	Electric Vehicles
GT	Green Transport
ICLEI	International Council for Local Environmental Initiatives
IPCC	Intergovernmental Panel on Climate Change
LCI/LCI-I	Low-carbon Initiative / LCI-Implementer
LCO	Low-carbon Office
MLP	Multi-level Perspective
MT	metric ton
NDC	National Development Council / Nationally Determined Contributions
UNFCCC	United Nations Framework Convention on Climate Change
RE	Renewable Energy
RQ	Research Question
SS	Sustainability Science
SPO	Strategic Performance Objective
STRN	Sustainability Transitions Research Network
TEPA	Taiwan Environmental Protection Administration
WNA	World Nuclear Association

1 Introduction

Climate change is one of the biggest challenges worldwide (IPCC, 2013, 2014) and one of the biggest threats to mankind (He, 2016) in the 21st century. A phenomenon, we are facing right now and will do so during future decades to come (Lu et al., 2013). The IPCC emphasized in their 5th assessment report to control global temperature rise within two degrees Celsius (IPCC, 2014). The UNFCCC Paris agreement's central aim is to keep the global temperature rise well below two degrees Celsius above pre-industrial levels (Höhne et al., 2017). So, one could say that climate stabilization could be described as a collective action problem due to its magnitude (Brechin, 2016). There is a plethora of measures currently being developed and implemented. One group are the low-carbon initiatives. The aim of this thesis is not to solve the global climate change challenge, but rather to contribute to the evaluation of mitigation efforts, i.e. low-carbon initiatives and their local contexts.

Such mitigation actions want to solve a worldwide and wicked phenomenon (Rittel & Webber, 1973). This cannot be analysed from only one discipline as too many factors are interlinked. One field of research that aims to shed light on this by focusing on global ecological and societal processes (Kates et al., 2001), is Sustainability Science (SS). In the tradition of Karl Popper, SS is often characterised to be problem driven, whereas most other research spheres are discipline-driven (Thorén, 2015). This allows SS to be multi- and transdisciplinary by connecting different scientific disciplines (Kates, 2011). Kates (2011) formulated seven overarching research questions for SS. My master thesis can be best linked to his sixth proposal "How can society most effectively guide or manage human environment systems toward a sustainability transition?" (Kates, 2011, p. 19450). Two keywords, society and sustainability transition will be further specified for purposes of my research. The focus is on Taiwan's society and particularly on the single case study region of Taichung City. For further explanation on the location, see sections 4.2 & 4.3. The definition of sustainability transition applied here, was defined by the Sustainability Transitions Research Network (STRN). According to them it is a transformative change on the system level including new approaches to production and consumption (STRN, 2010). Such changes can lead to a more sustainable and therefore low-carbon society.

2 Research Purpose and Scope

The purpose of my thesis is to increase understanding of how low-carbon initiatives take into consideration the local context and particularly spatial features. Hence, analysing a local low-carbon initiative by critically questioning the way it was planned and finally implemented is part of the overarching aim for my master thesis. In the longer run only a tailored low-carbon initiative, respecting the local context will be successful. For Taichung City, one local characteristic is the high density of motor scooters. Another one is its nature as a special municipality (merger of the urban and rural areas).

The main focus is twofold. First it is important to understand the region and the context of this low-carbon initiative by applying green transport as a lens to analyse the municipal government's effort made so far. Second, the level of abstraction will change and it gets more locally focused to understand the interaction between the low-carbon initiative and the rural district Xinshe of Taichung City.

2.1 Main Research Question

Bearing in mind the previously described research scope, I intend to answer the following overarching research question:

1. How important are local context-specific factors in low-carbon initiatives to enable a sustainability transition?

2.2 Sub-research Questions

The above-stated overarching research question is operationalised through the following sub-research questions:

a) To what extent is Green Transport included in Taichung City's low-carbon initiative?

b) To what extent are rural areas included in Taichung City's low-carbon initiative?

3 Context

3.1 Overview of the debate

3.1.1 Low-carbon initiative

Research in the field of low carbon societies is growing and gaining more interest among researchers (Wang, Zhao, Mao, Zuo, & Du, 2017). One strategy from many members of the global community is to pursue a low-carbon future (Khan, 2013; Mehta, Shankar, & Bandopadhyay, 2016; Zhou et al., 2015) within networks that give them mutual support on a more regional and local level (Freeman & Yearworth, 2017). One example is the *International Council for Local Environmental Initiatives* (ICLEI), which is a global network of more than 1,500 cities who committed themselves on sustainable transitions (ICLEI, 2017). A more in-depth analysis of the functions of such climate networks can be found in (Busch, 2016). One pressure for action for many countries are the nationally determined contributions (NDCs). But what about countries that are not a full member of the UN and did not commit themselves to binding agreements.

3.1.2 Taiwan's approach

The island state Taiwan is such an example. Taiwan was a full member of the UN until 1971 when they lost this seat to China (Jacobs, 2016; Winkler, 2012). Although Taiwan cannot take part in the UNFCCC meetings and discussions (Winkler, 2012), Taiwan considers itself as an equal part of this global village and nevertheless take actions (TEPA, 2009a). The global community needs such nations who take actions because they see the necessity and not only because they must by binding agreements. Taiwan is a case worth analysing as its economic transformation while being part of the first generation of Tiger states was growth-oriented, lead top-down by the national government (Wong, Hu, & Shiu, 2015). Most of the advocates and supporters were technocrats at that time (Wong et al., 2015) and laid the groundwork without thinking too much about the environmental impacts (Ho, 2005). This resulted in severe environmental damage (Grano, 2015). One of the most visible ones is air pollution (Ding, Wang, Chen, & Wan, 2016; Lee et al., 2016). Tewes-Gradl and colleagues (2016) argue that "the shift to a low-carbon economy is the most fundamental challenge of this century" (p. 16). Tsai (2014) states that Taiwan as a country is on its way to become a low-carbon economy. The national government in Taiwan announced 6 pilot regions for a low-carbon transition in 2009 (TEPA, 2009b). One of them is the region Taichung City in central Taiwan, which was the first regional government in Taiwan to introduce a pilot programme to promote low-carbon transport (Nikowitz, 2016).

3.1.3 Low-carbon strategies

Developing a low-carbon strategy is the first step in the direction towards a more sustainable society. The next step is to make sure that the low-carbon strategy is linked to the local conditions and not universally applied or copied from other countries. However, most of the low-carbon strategies are focusing on low-hanging fruits, initiatives they can easily implement instead of radical system changes (Lo, 2014). As on ICLEI's website visible it became clear that some of the current low-carbon strategies are focusing on such low-hanging fruits, which are also most of the time in urban areas (de Jong et al., 2016; Fenton, 2016; Wei & Tang, 2014). By this, I do not want to state that urban areas are low-hanging fruits per se. Instead I want to highlight that besides the focus on strategies that are fast and easy to implement, most of the strategies are also solely aiming for urban areas. Affolderbach and Scholz remind us that urban areas are not the only scene for pathways to a more sustainable future, as most of the transition town movements occurred in rural areas (Affolderbach & Schulz, 2016). There are scholars who describe transitions as "urbanism" (Mason & Whitehead, 2012, p. 494). But if one looks at the transition culture, it bears rural elements like permaculture, leisure, etc. (Neal, 2013). Location and place are also central components of transitions (Neal, 2013).

3.2 Other analyses of low-carbon initiatives

Despite a growing body of literature on low-carbon initiatives there are only few studies that have addressed the role of rural areas and their function. A thorough literature review has shown that so far most of the English speaking academic peer-reviewed articles on low-carbon transition did not pay attention to rural areas (see Appendix 1 for the search strings). As colleagues highlighted in their study, they are spatially blind (Markantoni & Woolvin, 2015). This section aims to give an overview of already conducted analyses on low-carbon initiatives, to highlight their findings and to apply them to my own research. The peer-reviewed articles chosen, were part of the results of my literature reviews (see Appendix 1). Out of the total result on search sets, only five of them complemented each other. Reviewing them helped me to situate my own research into the current debate. In addition, it allowed me to close current research gaps by formulating new research questions and answering them. The five articles on low-carbon initiatives to tackle climate change, presented here, were all focusing on a rather abstract level, on giving overviews of the topic, rather than diving deeper into one single case.

Already in the beginning of the 21st century, Brody and Highfield (2005) reminded us that much research remains to be done to analyse policy plans. A lot of research focused on how to implement policies, but not on measuring the effectiveness of the implementation process (Brody & Highfield, 2005). Further, Brody and Highfield (2005) argue being able to conduct the latter one is of major importance when it comes to blueprints for the transformation of urban areas.

Wheeler (2008) focused on analysing an overview of various states or municipalities in the United States of America and their climate change plans. Bearing this more abstract scale in mind, he could not ask in-depth questions about implementation processes. He also highlights that most of the analysed plans focused on mitigation rather than adaptation (Wheeler, 2008). Saavedra and Budd (2009) highlight the argument that climate change actions must be local, by not dismissing the importance of national policy framings. Moreover, they acknowledge the fact that pursuing a transition to a sustainable society, translating global scientific knowledge into local contexts is of crucial importance (Saavedra & Budd, 2009).

Not many researchers so far focused on analysing local climate change plans, (Zhenghong, Brody, Quinn, Chang, & Wei, 2010). Top-down directives can increase the quality of climate change plans (Zhenghong et al., 2010). Zhenghong and colleagues (2010) defined the quality of a climate change plan with the indicators – capacity (e.g. political will), climate risk factors and emission stress. Like Brody and Highfield (2005), they also argue that "Future studies should address the implementation effectiveness of local climate change planning" (Zhenghong et al., 2010, p. 58).

Finn and McCormick (2011) point out that research shows most of the climate change plans fail to address the issue from a holistic sustainability perspective. They define a holistic sustainability perspective as the balance between economic development and environmental justice (Finn & McCormick, 2011). They wanted to find out if climate change plans are taking a holistic approach on the example of 3 cities in the US (Finn & McCormick, 2011). Therefore, they came up with six components of sustainability as metrics. Their definition is close to the way I approach the issue too. However, the scope I have available and the limited email interviews I got, do not allow me to conduct such an in-depth analysis. I focus more on the implementation processes and thereby on two context specific factors and analyse their development.

To sum up, from the reviewed scientific articles it is evident that most of the low-carbon initiatives somehow are adapted to the local context. My research adds the dimension of how low-carbon initiatives acknowledge the local context and whether they include the 'right' local context. This dimension helps to evaluate the effectiveness of low-carbon initiatives.

3.3 Research Gap and Project Aim

Low-carbon initiatives have been around and analysed for some time. Therefore, it is important to stop analysing on an abstract level the nature of the low-carbon initiatives. Instead, the next step and the focus of my research is to analyse the effectiveness of their implementation processes while focusing on the local context to gain knowledge for future low-carbon projects in general and maybe for other countries. Effectiveness for this research will not be assessed from a quantitative point of view. Rather from a qualitative perspective by analysing how Taichung City's government adequately accomplishes their goal. In other words, effectiveness in the sense of producing the intended result, i.e. low-carbon city. Hodson and Marvin (2010) applied a similar approach for understanding socio-technical transitions on the city-level. Since low-carbon initiatives depend on their context and their local conditions (Saavedra & Budd, 2009), analysing their effectiveness is of importance. It can give insights to understand their contribution for tackling climate change.

Changing production and consumption processes in a low-carbon strategy and thereby pursuing a more sustainable future will bring change. Products and services are the fundamental elements of each firm (Baecker, 2006). Firms are essential parts of our societies. Understanding which products form daily lives' and consumption patterns is important for being able to analyse low-carbon initiatives in a critical manner. One element of daily life in the special municipality Taichung City, as in many cities in Taiwan, is being on the way with motor scooters (Fulco, 2017). Transport is Taiwan's second largest CO2 emitter (Chen, Lo, & Yu, 2012) and in Taiwan two-thirds of the total vehicle fleet is comprised by motor scooters (NDC, 2016) that are the main source for air pollution (TEPA, 2015a). Transportation, especially by motor scooter is the first context specific factor, which was analysed as a sub research question to answer the overarching research question. Answering this sub-RQ, helped me to understand if the development pathway of EVs in Taiwan is the reason why the regional government in Taichung is paying that little attention to it. This first part further helped me to understand the region and the context of the low-carbon initiatives from a socio-technical perspective. Thereby informed the second scale of the case study, the rural area Xinshe district on a more socio-spatial perspective.

The second context specific factor for Taichung City is its special municipality status. Taichung City is a special municipality and was formed in 2010 with a merger between Taichung City and the Taichung County region (Huang & Hsieh, 2014). This administrative region shall follow a pathway towards a low-carbon transition, initiated by the municipal government. In other words, urban and rural areas shall be transformed to a low-carbon city. To analyse the effectiveness of Taichung City's implementation process, the second sub-RQ about the involvement of rural areas is important to answer.

To sum up, I argue that in Taichung City's low-carbon strategy the focus was on other forerunners' activities instead of concentrating on the own local context. Examples for foreign countries are Japan's Tokyo Chiyoda, Canada's Toronto, China's Tianjin or Denmark's Samso island. Additionally, it is analysed to what extent they acknowledge their local context, that is motor scooters and the surrounded rural areas on the example of Xinshe district.

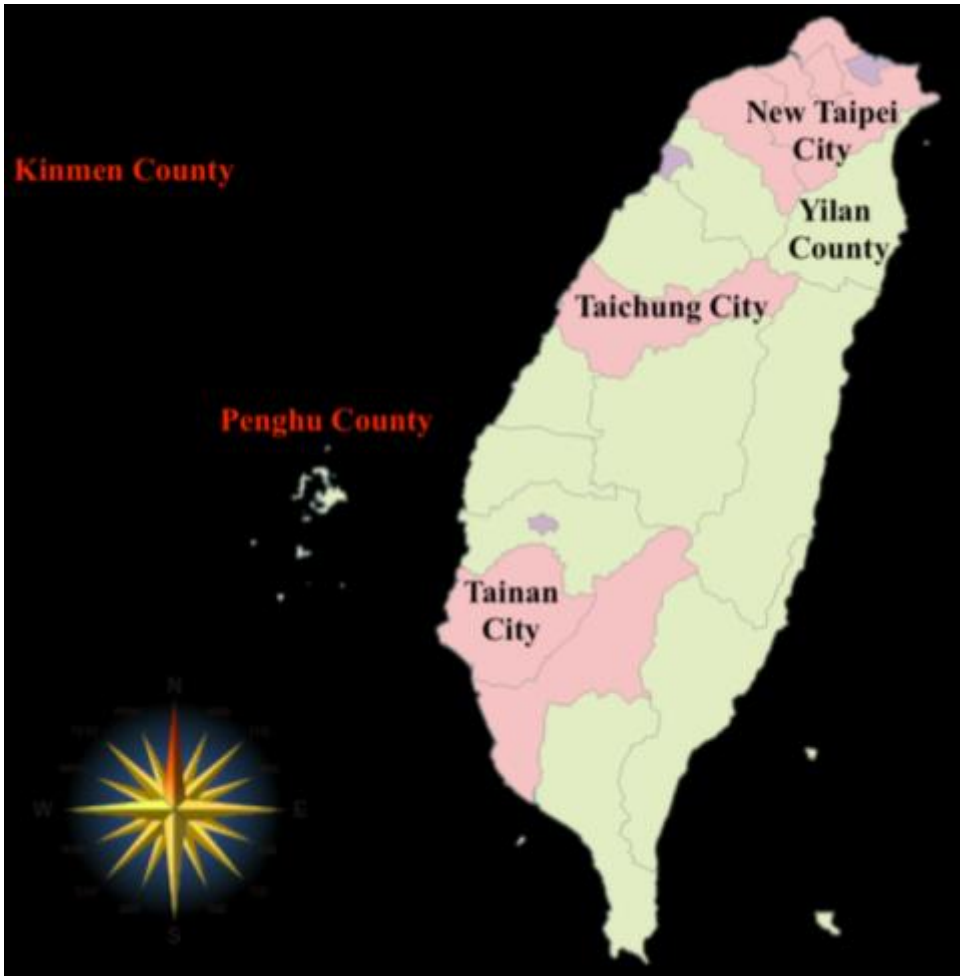

Figure 1. Taiwan - Case Study Area Taichung City – other pilot regions, figure adapted from original image by Liaon98, retrieved from (Wikimedia Commons, 2014)

4 Research Context

4.1 Cities and Climate Change

Urban areas are the hotspot where most actions in shaping a sustainable future might happen (Mehta et al., 2016). Cities and their governments are one of the major actors towards a low-carbon future, but can also hinder such a development (Khan, 2013). The variety of actors and stakeholders with different motives for achieving a low-carbon city, might make such an achievement more difficult (Khan, 2013).

Cities are also one of the biggest contributor to greenhouse gas emissions (Lo, 2014). The phenomenon of low-carbon cities began in the 1990s (Lo, 2014). It started in highly developed cities in Europa and USA, and is nowadays globally perceptible (Lo, 2014). Lo (2014) also sees municipal governments as key players for a low-carbon society. The diversity of interests in a municipality are a threat to the achievement of a low-carbon society (Lo, 2014). He points out that the framing and the effectiveness of a low-carbon initiative depends on the framing of climate change (Lo, 2014). One municipality might define their aim as smart-growth, another as air pollution and other cities as the goal to update old production sites (Lo, 2014). I would add that not only the framing of climate change is important but also the perception of climate change by public citizens. The latter might have an impact on the acceptance of low-carbon strategies and initiatives.

4.2 Why Taiwan

Taiwan is an island state in East Asia (Zhang & Lawson, 2017). Taiwan gives a very interesting case, studying low-carbon initiatives, as Taiwan's government acts voluntarily without binding agreements. Arora and Ratnasiri (2015) argue that Taiwan serves as an example to emerging economies. They refer to the four Asian tigers and their high economic growth-rates since the 1960s. Back then Taiwan could transform its economy into a highly productive one and increase the wealth of its citizens. Moreover, Wong and colleagues (2015) have already analysed the transformational pathways of Taiwan's development to a knowledge-based economy. Nowadays, Taiwan as a country is on its way to become a low-carbon economy (Tsai, 2014). In other words, we are witnessing another transformation, but can it be a second time successful? Taiwan's transformation from an underdeveloped economy with a low-skilled workforce to a high-tech knowledge-based economy and society had one foundation. The government pathed the way for that development in three steps (Wong et al., 2015). First via a top-down manner macro-level policies were implanted, then a multi-agent structure on the meso-level for techno-entrepreneurs and finally at the micro level collaboration platforms (Wong et al., 2015). In other words, the government and professional technocrats designed those policies and protected the different niche-spaces for technological innovation. Bearing in mind Taiwan's current transition towards a low-carbon economy, similar structures can be detected. The national government set out the roadmap for six low-carbon pilot regions, while being part of the ICLEI framework. The respective regional governments were taking the lead by starting off with policy-led initiatives. If those initiatives shall lay the groundwork for the take-off phase of this transition, then they should be context specific, to take advantage of the local conditions.

Taiwan's population accounts for only 0.35% of the world population but for 0.97% of the worldwide CO2 emissions (Trappey, Trappey, Lin, & Chang, 2011). The current policies implemented in Taiwan to

reduce GHG emissions and to transform the economy towards a low-carbon one have already been analysed (Chao, Ma, & Heijungs, 2013). The authors conclude that the emission pledges made by the Taiwanese government will not be fulfilled until 2020 (Chao et al., 2013). One of the main reasons is the focus on the domestic carbon budget on the expense of the foreign GHG emissions (Chao et al., 2013). The latter one plays a more important role than the former one, as Taiwan is an export-oriented economy (Chao et al., 2013). If the national GHG reduction targets are doomed, then it is important to question the regional goals. Taiwan needs to import 97.5% of its energy resources (WNA, 2017). A transition towards renewables is not only from a climate change perspective desirable. But also from an economic point of view, in terms of independence and resource costs. Taiwan has 3 nuclear power plants, with a share of 18.61% on the total electricity generation (Shih, Shi, Tseng, Pan, & Chiang, 2016). With the first elected president from the democratic party, the slogan *nuclear-free homeland* moved with the administration into the office (Shih et al., 2016). From there on, it was decided that to build a fourth reactor, a public referendum needs to be held. The current administration under president Tsai Ying-wen decided for a nuclear bail-out in 2025 (WNA, 2017).

A total of 40 Mwh of electricity generation must be replaced, between 2018 and 2025 (Shih et al., 2016). Since 2000, the Taiwanese government tackles air pollution by eclectic scooter promotion (Fang, Chang, & Yu, 2015). In 2011, former president Ma Ying-Jeou introduced a blueprint for his national vision of the golden decade, with 8 key visions (The China Times, 2011). One of the them is to build a low-carbon society via a large deployment of renewable energies (The China Times, 2011). Currently it looks that the three nuclear power plants are going to be replaced by fossil fuel power plants, as large scale renewable energy projects have not been implemented yet. Shih et al. (2016) found out that a replacement of the three nuclear power plants with fossil fuels, would result in 715 annual premature deaths. The main cause would be the increasing air pollution. In 2015, the Greenhouse Gas Emission Reduction and Management Act was initiated as a law (TEPA, 2015b). The goal is to cut emission by 50% to 2005 levels in 2050. Hence, current initiatives and future visions, form a complex composition that is worthwhile being researched in depth. Figure 2 shows a map of Taichung City in Taiwan as the single case study region.

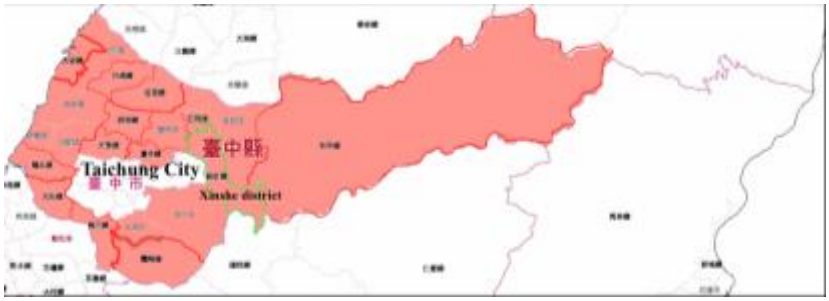

Figure 2. Taichung City District Map, circled in red the rural areas, in green the rural case, figure adapted from original image by webmap, retrieved from (Wikimedia Commons, 2007)

4.3 Setting the Scene

The case study region Taichung City is from a Taiwanese administrative perspective a so called special municipality (Chao, 2011), which can be compared with similar administrative rights provinces have. This special municipality was formed in 2010 with a merger between Taichung City and the Taichung County region (Chao, 2011). The municipal mayor is the highest-ranking official in charge. For the second sub-RQ, I planned to set the research focus on three rural districts of Taichung City with similar socio-economic characteristics to secure representativeness. Before the already described merger, Taichung County had 13 rural districts (see Figure 2, areas highlighted in red). Only 2 of them are outside of the evolved bigger suburban area of Taichung City, e.g. Xinshe and Heping. As one can see in the map, Heping is just too big for the scope of this research project. Therefore, finally a purposive sample was applied and Xinshe district chosen to be the focus of the field work on rural areas.

In 2009, Taiwan emitted 279 million metric tons (Mt) of CO2 (Chen et al., 2012). The transport sector is Taiwan's second largest CO2 emitter, contributing 14% to the national carbon budget, 94% of those CO2 emissions are coming from road transport by cars, trucks and motor scooters according to calculations from 2005 to 2010 (Chen et al., 2012).

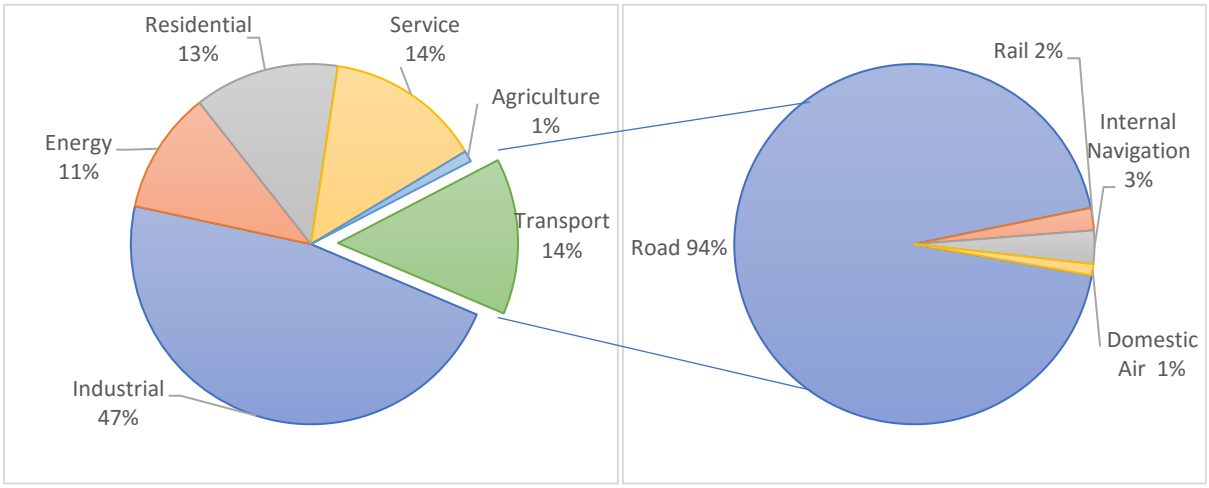

Figure 3. CO2 Emissions from Transportation Sector in Taiwan, 2005-2010 adapted from (Chen, Lo and Yu, 2012)

More recent calculations from 2013, reveal an estimate of 281 Mt of carbon dioxide equivalents (TEPA, 2014a). Compared to the 2005-2010 statistics, the industry sector gained 2% whereas the residential and the service sector each lost one, meaning that transport is still the second largest CO2 emitter (TEPA, 2014a). 82.9% of the Taiwanese households have at least one motor scooter, whereas only 58.7% have at least a car or a truck (NDC, 2016). A similar pattern can be observed when one looks at the number of vehicles being registered and on the roads. There are some 13.7 million motorcycles and only 6.4 million cars on the roads in Taiwan (NDC, 2016). Lin and colleagues argue that the CO2

emissions caused by the huge fleet of motorcycles, is one the most important factors in the total national CO2 budget (Lin, Lu, & Lin, 2006). Another important fact highlighted by those authors is, that motor scooters being used for short distances in town centres are more pollutant, as the motor cannot reach an optimal operating temperature (Lin et al., 2006).

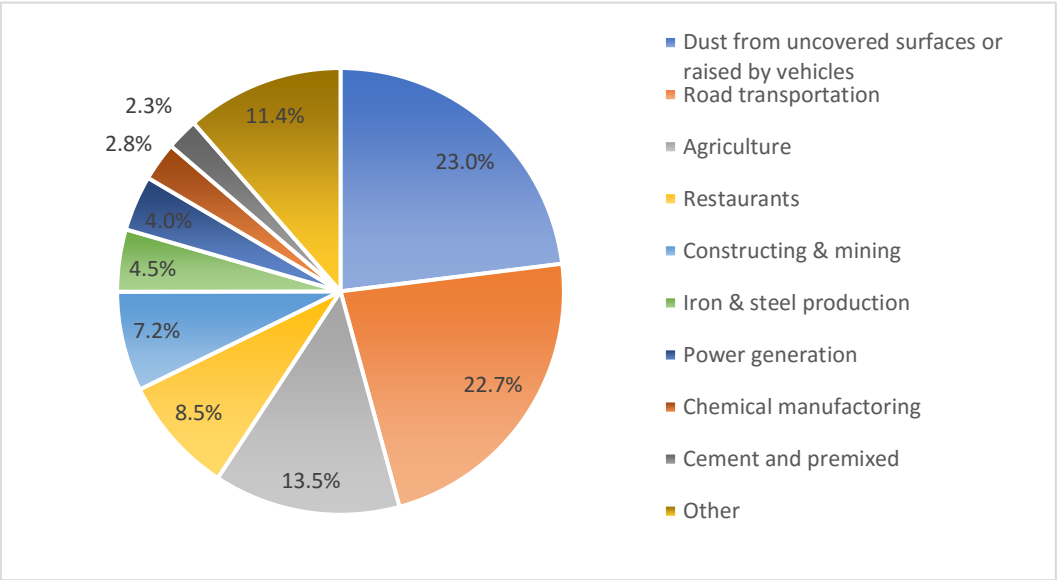

Figure 4. Emission proportions of the various PM2.5 pollution sources in Taiwan (TEPA, 2015a)

If one looks from a national perspective on Taiwan's sources for PM2.5, the two main sources are 1) with 23% dust created by uncovered surfaces or raised by vehicles and 2) with 22.7% road transportation (TEPA, 2015a). A later study in the same year revealed similar results, showing building and infrastructure construction dust being the main source with 37%, followed by industry (including power plants) and vehicle emissions (road transport) with both 23% (TEPA, 2015a). Platt and colleagues found out that motor scooters contribute the most to PM2.5 (Platt et al., 2014). Taichung City, Taichung County and Taipei City have the highest pollution levels for CO and NO2 among all cities and counties (Lee, Hsiao, Cheng, & Hsieh, 2007). The health effects on Taiwan's citizens are clear, this is of crucial importance as Taiwan ranks second in terms of population density among all urbanized countries worldwide (Ding et al., 2016). Taiwan's statistical data book of the year 2016 shows increases in the total number of citizens (end of 2015, 23,5 million) but with a steadily declining birth rate since 1955 from 4.53% to 0.91 and a decreasing death rate, meaning Taiwan's population is getting older (NDC, 2016). One disease that effects more and more older populations is Parkinson, traffic pollution in Taiwan (NOx and CO) can increase the risk of Parkinson disease (Lee et al., 2016). Having analysed the transportation sector from those perspectives, it is evident how important it is for the Taiwanese citizens. Motor scooters are not only the primary mode of transportation but also a threat to the health of all people living and working in Taiwan. A threat to the natural environment, which should be tackled with the current low-carbon initiative, including rural areas as well.

5 Theory

To answer the overarching RQ and the respective sub-RQs, different theoretical frameworks were applied. To enter the current debate on low-carbon initiatives, I chose to make use of the transition theory. In particular, the combined framework (see Figure 5) of multi-level and multi-phase perspective (Geels, 2002; Geels & Schot, 2007). This framework will especially be helpful for the first and second sub-RQ as it acknowledges socio-technical systems on different levels. Moreover, it gives me the opportunity to capture processes of change or the lack of it. To exit the debate by answering the overarching RQ, another framework proved to be of great help. In short, the typology of regional diversification (Boschma, Coenen, Frenken, & Truffer, 2017), combing a socio-technical lens with a socio-spatial perspective. This typology functioned as classification tool of Taichung City's low-carbon initiative. The effectiveness of their approach could be answered, but also to what extent their strategy was context-specific.

5.1 Transition Theory

Wiek and Lang are differentiating between two research streams within the sustainability science sphere: descriptive-analytical & transformational (Wiek & Lang, 2016). I applied the combined framework (transformational), as it addresses complex, unstructured and persistent problems that cannot be solved with simple, short-term solutions. To analyse the importance of local context-specific factors, I looked at Taichung City and Xinshe district as rural area from a transition perspective and analysed their regional governance initiative. I conducted an integrated transition analysis, a combination of 1) *traditional literature review and document analysis*; and 2) *interviews*. Both elements, the multi-phase perspective (Rotmans, Kemp, & Van Asselt, 2001) and the multi-level perspective (MLP) from Geels (Geels, 2002) were used by applying the combined framework (Geels & Schot, 2007). I analysed the effectiveness of Taichung City's low-carbon initiative by focusing on what happens, instead of how it happens. The latter one is the second step (see section 10.2). Consequently, I did not apply the multi-pattern approach (De Haan & Rotmans, 2011) as it focuses on transition paths. Accordingly, I am not making use of the transition management literature. Those approaches dive deeper into the governmental processes of a transition (Frantzeskaki, Loorbach, & Meadowcroft, 2012).

The low-carbon initiative from the Taichung City government as one solution to pursue a sustainability transition was analysed from a socio-technical and a socio-spatial perspective. This allowed me to consider different societal and economic stratifications, e.g. institutions, technologies, politics. To reach a sustainability transition, such a combination of different actors and agencies is necessary (Van

Den Bergh, Truffer, & Kallis, 2011). The field of transition studies systematically examines either transitions on a national level or specific economic sectors, e.g. manufacturing, transport, energy (Van Den Bergh et al., 2011). My research approach fits into the latter one, as I analysed a single region – Taichung City. Out of a critique on the innovation system approach (Jacobsson & Bergek, 2011), the MLP framework was developed (Van Den Bergh et al., 2011). Moreover, so far in transition literature the focus was not on where the transitions take place (Coenen, Benneworth, & Truffer, 2012) or on spatial aspects (Coenen et al., 2012; Hansen & Coenen, 2015). As Truffer and his colleague put it, most of the transition literature focused on the national level and thereby neglected other geographical areas (Truffer & Coenen, 2012).

5.2 Multi-level Perspective

One reason to apply the MLP framework is, because it helps me to not see Green Transport as a techno-fix. But rather to acknowledge the complexity and multi-dimensional forces at play. For instance, various institutional dynamics and different human actors can be traced. For this, the MLP framework has three levels – 1) landscape 2) regime 3) niches. The critique that the MLP framework is only a snapshot (De Haan & Rotmans, 2011), is a strength from my point of view. As I focused on what happens instead of how things happen, being able to concentrate on a specific timeline, made the analysis more stringent.

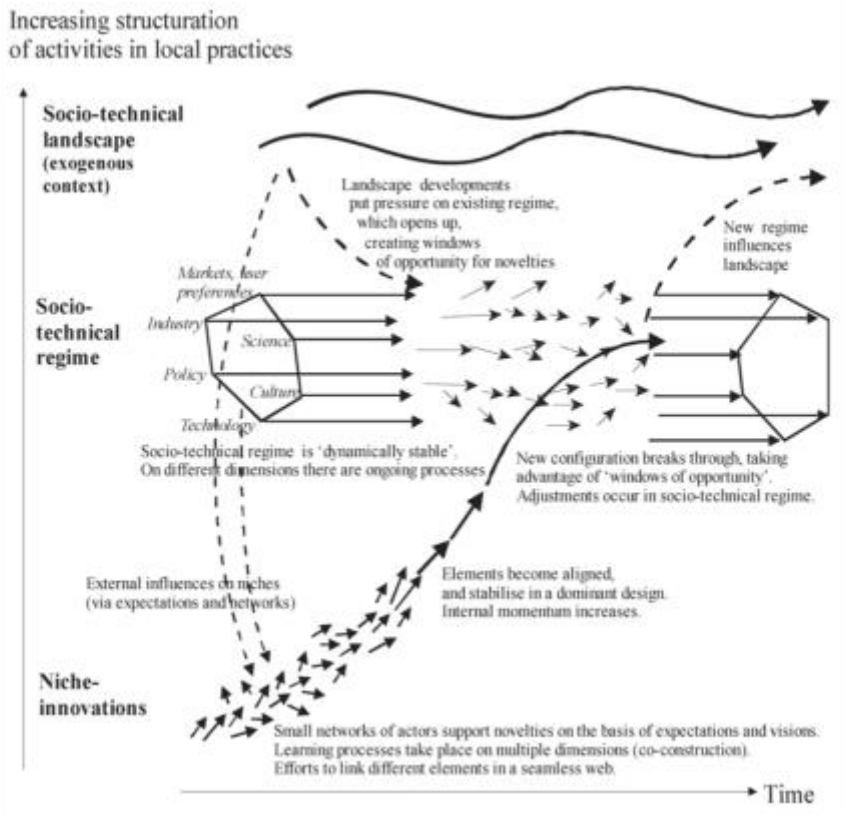

Figure 5. The combined framework, adapted from, (Geels and Schot, 2007)

I acknowledge other criticism that the MLP framework forgets to ask the question where the transition takes place and cities are not mentioned in the framework and might be considered as only receiving transitions (Hodson & Marvin, 2010). But as cities and their local government are an active stakeholder and my aim is to analyse what happens instead of how, applying the MLP framework to depict certain patterns was very useful.

Figure 5 shows, a transition can only take place if certain developments happen within all three levels. If one imagines that the Taichung City government is a “box”. Then things can happen inside or outside the box. Outside the box, external forces are titled socio-technical landscape. Applied to my single case-study region, factors like climate change, globalisation or macro-political developments. The box itself, the Taichung City government, is then defined as socio-technical regime. It is a stabilising factor for the existing infrastructures, as it processes are based on routines and defined pathways. Applied to Taichung City, the current economy developed from the massive investments and developments as a first-generation tiger state. But on some dimensions of Taichung City’s regime, new ideas start to form, visions of a low-carbon city. However, they have a hard time to break through as all involved want to keep the stabilisation. This is how another element inside the box comes into play, the niche innovations. Those are safe zones, where radical innovative products, services, solutions are developed while being protected from external forces. Such novelties are unstable and do not fit to the regime’s routines and the user practices. Applied to Taichung City, the Taiwanese start-up Gogoro, manufacturing electric motor scooters, is an example.

In addition, I used the MLP framework to analyse green transport and thereby it is linked to the sub-RQs of my thesis. With transportation and rural areas being the two key elements of my analysis, one could summarize the system boundaries as being socio- technical-ecological. Therefore, the municipal government, low-carbon task forces and the environmental protection administration are key actors and informants. Abson and colleagues defined three possible leverage points to transition towards a more sustainability society – 1) institutions 2) people’s connection to nature 3) knowledge production (Abson et al., 2016). The first one is the leverage point, which is one focus of my thesis. One key element for institutions being able to respond and support a sustainability transition is to be open for adaptation (Abson et al., 2016) from an institutional perspective. Such a window of opportunity is a low-carbon initiative and Green Transport.

The biggest chunk in the transition literature focused on technological transitions (De Haan & Rotmans, 2011). With my research, as I could not avoid it, I at least found a socio-technical and a socio-spatial condition. The latter represents the new and emerging field of space and spatial factors within transition research. Earlier on, I cited STRN's definition of a sustainability transition. That goes hand in hand with the general definition of a transition being a change in societal structures (economic, legal, physical), in culture and in practices (routines and habits) in a dynamic manner (Niki Frantzeskaki & de Haan, 2009).

It is evident that if one talks about a society's transportation system, there are more economic and societal stratifications involved, than only respective stakeholders. Legal and political institutions or power plant operators, to name a few. The focus of my research was not to analyse the different actors and stakeholders involved in the transition to a low-carbon city. Rather, the lens is on understanding the effectiveness of the implementation process of the regional government of Taichung City.

5.4 Typology of Regional Diversification

In the current scientific debate about transition theories the focus is on space. More and more scholars are developing new frameworks and concepts within the sphere of transition studies that acknowledge space (Truffer, Murphy, & Raven, 2015). One example of such an attempt is the typology of regional diversification (Boschma et al., 2017). Their thematic focus is about geographical regions and how new industries emerge in those (Boschma et al., 2017). For their typology, they combined insights from evolutionary economic geography with transition studies (Boschma et al., 2017).

		REGION	
		RELATED	**UNRELATED**
SECTOR	REGIME	Replication	Transplantation
	NICHE	Exaptation	Saltation

Figure 6. Typology of Regional Diversification (Boschma et al., 2017)

Key elements for industrial organisations are products or services and technologies (Baecker, 2006). If technologies are integrated and merged into something new with technologies that were not connected before, one can speak of unrelated diversification (Boschma et al., 2017). Unrelated diversification can also occur within a region by not relying on existing capabilities while developing a new activity (Boschma et al., 2017). Conversely, related diversification is based on existing capabilities and routines. The terms *regime* and *niche* have the same meaning as in the combined framework. Unrelated diversification and niche are very distinct. In the former one, they talk about place

dependency and that if something new develops, it is only new to the region (Boschma et al., 2017). Whereas in the latter one, if something new emerges as a niche creation they talk about path dependency of global socio-technical structures (Boschma et al., 2017). The first element of the typology *Replication*, which is a related regional diversification in the sector regime, is quite conservative (Boschma et al., 2017). New industries and approaches are developed within the existing regime structure with available capabilities by rearranging them (Boschma et al., 2017). The second one, *Transplantation*, differs in the capabilities used as they are new to the region and adopted from global socio-technical regimes (Boschma et al., 2017). With the third process, *Exaptation*, new industries and technologies to the region are developed from available capabilities, but this time they can enter new markets as niche innovations (Boschma et al., 2017). The last one, *Saltation*, is an unrelated diversification and therefore develops new approaches to the region and the world with new capabilities (Boschma et al., 2017).

I agree with Hansen and Coenen (2015) to distinguish between relational and economic geography while talking about space and sustainability transitions. I disagree with the positivistic perspective that space shall be an empty box (Hansen & Coenen, 2015). Therefore, I acknowledge that space is also a social production by different actors - relational geography (Boggs & Rantisi, 2003). For my thesis, I adopt the perspective from the economic geography literature, with a special emphasis on institutions. This allows me to focus on different institutional actors on an urban and regional scale as already quite a few other scholars did (Bulkeley, Broto, Hodson, & Marvin, 2010; Faller, 2014). This is important for this research as the area of investigation is a special municipality, where the regional mayor should collaborate with various district mayors of rural areas. The typology of regional diversification (Boschma et al., 2017) will function as an analytical lens to understand Taichung City's low-carbon initiative and its effectiveness. Furthermore, it will allow me to add a spatial dimension to my analysis, as that is currently missing in the MLP-framework. In short, I will use the MLP-framework to enter the field of my research (sub-RQs) and Boschma and colleagues' typology to exit it by answering the overarching RQ. This allows me to fully analyse and contextualise the collected data.

6 Methodology

6.1 Ontology and Epistemology

Critical Realism acknowledges and distinguishes between a biophysical reality that is real (independent from us) and the observations and mental constructions about it (Bhaskar, 2008). The former one, seen from a knowledge perspective, is defined as intransitive knowledge of things (Bhaskar, 2008). The latter ones are characterised as transitive objects of knowledge (Bhaskar, 2008). Roy Bhaskar (2008)

describes ontology with the question: “what must the world be like for science to be possible?”(p. 13). But the more interesting question, he raises, is: “what must science be like to give us knowledge of intransitive objects […]?”(Bhaskar, 2008, p. 13). The fact that critical realism notices an independent planetary system and reality from us, suits very well with my thesis and my approach to sustainability science. For Bhaskar (2008), knowledge, against other philosophies of science, is defined “as the structures and mechanisms that generate phenomena” (p.15). If we do not analyse events or artificial constructs created by us – empirical realism (Bhaskar, 2008) we can identify patterns that will help us make sense of our unit of analysis. Identifying patterns, while acknowledging that knowledge is socially constructed and not a concept of an empirical world (Bhaskar, 2008) suits to a solution-oriented research field like sustainability science. Speaking within the sphere of my research, the bad air quality and environmental destruction in Taiwan and Taichung City is empirical reality. While on the contrary the socio-technical-ecological inconsistencies between and among different actors inside and outside political frameworks, who follow different paradigms, are the social construction.

6.2 Research in Sustainability Science

My thesis endeavour starts with acknowledging that climate change is a planetary phenomenon with context-based effects in different regions of the world shaped by power structures that lead to different impacts and responses. My master thesis contributes to the ongoing debate about climate change and actions in the framework of climate stabilisation as low-carbon initiatives. I add new knowledge to a slowly emerging debate, specifically regarding the role of space and the impacts these initiatives have on rural areas. These are increasingly marginalized in a rapidly urbanizing world. The aspect of transdisciplinary is reflected in the way I framed the research problem and in the choice and application of my methods and data collection. In addition, I reflect on my role as a researcher throughout this process and how I engage and interact with the interviewees. One challenge might be the still ingrained face saving culture in Taiwan (see section 6.3.4).

Most of the current scientific discourses address sustainable issues from a disciplinary perspective (Abson et al., 2016), instead of analysing them from a problem-based perspective. Sustainability Science can be characterised as a solution-oriented research field that bridges different disciplines and their approaches, incorporating knowledge from outside academia (Miller et al., 2014). Jerneck and colleagues (2011) developed an integrated approach to sustainability science, where I positioned my research. My master thesis fits to the sustainability challenge climate change, to the core theme pathways, strategies and implementation and to both cross-cutting approaches problem solving and critical research.

6.3 Research Strategy & Data Collection

I chose a mixed method approach (triangulation) and a single case study design to answer my overarching and the specific RQs. I applied different theoretical lenses – the combined approach from transition theory (Geels & Schot, 2007) and the typology of regional diversification (Boschma et al., 2017). This formed an analytical intersection, suitable for this research. This combination allowed me to enter and be part of the current debate on low-carbon initiatives. But also, to explain the Taiwanese interpretation of a low-carbon initiative in Taichung City. The unit of analysis is the implementation process of the low-carbon initiative by the Taichung City regional government. The case study area Taichung City has two scales 1) Taichung City as a region 2) Xinshe district as a rural area. Thereby, I gained insights from academic, grey literature and experts by drawing out patterns. Finally, the patterns were analysed and contextualised. As I applied a purposive sampling technique and then a snow ball approach, the data was constantly evaluated to indicate who should be approached so all missing voices can be traced.

The Taiwanese low-carbon projects are not that well-documented in academic papers written in English. Some authors focused on the Pinglin district in New Taipei City (Li & Yu, 2016; Li & Yu, 2013) and others on Penghu Island (Fang et al., 2015; Hu, Wadin, Lo, & Huang, 2016). Therefore, I could not only rely on secondary data and chose a triangulation approach to collect comprehensive data. Academic and grey literature formed the main parts for the collection of secondary data. Consequently, I used 22 search strings which yielded a total of 2,035 peer-reviewed articles (see Appendix 1). I read several hundreds of papers in depth and found 4 dozen useful articles for the background sections. First, the literature on low-carbon economies and societies was screened to find a research gap. This was found in the fact that spatial patterns were not explicitly considered in such studies (Boschma et al., 2017; Coenen et al., 2012; Hansen & Coenen, 2015; Truffer & Coenen, 2012). An in-depth document analysis followed. The policy reports and strategy plans of the Taichung City government were all in Chinese. I read the ones, online available, which were in sum 1,503 pages and translated everything into English. Thereby, I not only eliminated the language barrier but also guarantee that any other researcher can retrace what I did and understand it. This lead me to dive deeper into the Taiwanese cases, where I found the same research gap. But throughout the reading process on the governmental white papers I became aware of the fact that among the 6 low-carbon initiative flagship programmes, Green Transport gets the least attention. This is surprising, since Taiwan has the highest motor-scooter density per capita in the whole world. This lead me to my overarching RQ. To get an understanding of the case study area, I visited Taichung City and the rural district Xinshe. Moreover, I carried out informal dialogues whenever I met local people on the street. I talked to them about my research idea and asked them about the regional low-carbon initiative. This

helped me to back up and prove my initial and preliminary research gaps. After I finished the literature reviews and document analysis, it was important to collect primary data via interviews, to cross-check my findings. The interviews helped me to answer questions that arose during the document analysis and to understand their concept in more depth. In other words, what we can read in articles or reports, is what the author wants us to read. Far more interesting and maybe even more important is what we cannot read in those papers. To talk about the unmentioned elements of their low-carbon initiative and to back up my preliminary findings I conducted the interviews. I planned to carry out face-to-face semi-structured in-depth interviews. However, I did not get positive feedback on my requests. So, I had to change my strategy. Once I asked for an email conversation, I finally got the approvals to interview them. I identified a regional governmental body as the implementer of the initiative, an EV advocacy group and a rural stakeholder of Xinshe district, as stakeholders to interview. This is how I ended up with asynchronous in-depth interviews conducted via email.

I planned to have an action research part in form of focus groups. But as I have only received three commitments for interviews, such engagement in normative debates on sustainability was reduced to informal discussions while being in the case study region and while attending public events like the "anti-pollution march" in Taichung City.

6.3.1 Interviews

Due to the lacking responses for proper face-to-face interviews, I adopted the qualitative research method of email interviewing (Burns, 2010; Edwards & Holland, 2013; James, 2015; Meho, 2006) as a measure of partially compensating the planned face-to-face interviews. The benefits of an email interview are manifold. Burns (2010) highlights the fact that respondents can change and revise their statements before handing them in. This would not be easily possible in a face-to-face setting, especially keeping in mind the Taiwanese societal norm of "Face-Saving". Asynchronous in-depth interviews allowed me as a researcher to interview more than one interviewee at the same time and it allowed them to answer whenever they find the time (Meho, 2006). There are for sure also limitations to that approach, one of the biggest challenges will be the validity and authentication of information and data. I agree with Meho (2006) that people who are not used to writing emails or who are a more effective speakers might be disadvantaged. The biggest weakness and challenge I faced was a time issue. In two cases I had to wait 1-2 weeks for receiving the signed letter of consent (see Appendix 3). Once the email interviews began, waiting 2-3 weeks for answers was normal. This made it very difficult for me, as a researcher, to develop an in-depth conversation with them.

6.3.2 Qualitative Data Analysis

There are different techniques and software available for analysing qualitative data. I decided to not make use of the most common software tool for qualitative content analysis named *MAXQDA*, but rather use *QCAmap*. Because it is an open access web application, I make sure that this part of my research is also available to everyone, without having to have a costly license. All interview responses were analysed (see Appendix 4) using a deductive category assignment (Mayring, 2014). The goal was neither a reduction of the material, nor to enrich respective parts, that needed explanation, with more information (Mayring, 2014). The aim was to structure the collected data by developing the categories from theory (Mayring, 2014). Nominal category systems were applied instead of ordinary ones, as the former ones allow me to develop lists of independent categories (Mayring, 2014). The theoretical concept used as an analytical framework for the sub-RQs was the MLP framework.

6.3.3 Limitations

Before I proceed towards an overview of the applied research methods and thereafter results, discussing limitations should not be forgotten. The biggest challenge, I faced, was during the data collection process. Trying to reach ten interview partners and getting three interviews in the end, is a response rate of 33%. Among the list of potential interview partners were other national and regional governmental institutions as well as respective stakeholders. Taiwanese research institutions and corporations from the mobility sector, were also contacted. Another difficulty occurred during the email interviews. The email interviews turned out to be very time consuming, as I had to wait weeks for responses. The limited availability of interview partners was addressed by applying a purposive sampling, which increased the pool of potential interviewees. However, unfortunately not the number of responses. In the end, I had to send the remaining interview questions at once. In sum, then, follow-up questions could not be asked. This fact makes my primary data's results not generalizable.

6.3.4 Ethics

Conducting research abroad, talking to and interviewing locals, made me reflect on the ethical grounds of my research. On many occasions, introducing myself and explaining my academic affiliation was the first step. Acquainting them with the purpose of my research, either through a conversation or via email was the next step. This was followed by sending the interview partners a letter of consent (see Appendix 3). The importance of saving face – not letting oneself or any other person lose face, made my primary data collection a challenge. Instead of giving me an honest answer, I often received a little white lie. Email interviews proved to be a solution, as they allowed distance and time to reflect.

6.4 Overview Research Methods

Table 1. Applied Research Methods

Research Method	Description	Purpose
Literature Review	Several rounds of literature reviews were carried out. The following databases: LUBsearch, Scopus and Web of Science, were used. The different search sets can be found under Appendix 1	Literature reviews were conducted to: - become familiar with the academic debate of low-carbon initiatives. - identify research gaps Application to: - Introduction/background - Research context - Analysis
Document Analysis	Grey literature, especially policy reports were analysed.	Documents were analysed to: - understand the low-carbon initiative - comprehend their approach - identify interviewees Application to: - Analysis & Discussion
Qualitative Interviews	Asynchronous in-depth interviewing conducted via email Purposive and Snowball sampling. A letter of consent was signed.	Interviews helped to: - tie up loose ends - add additional knowledge - understand motives behind their strategies - Analysis & Discussion

7 Results & Analysis – secondary data

This chapter and the following focus on results and analyses to answer sub-research question a) To what extend is Green Transport included in Taichung City's low-carbon initiative? and b) To what extend are rural areas included in Taichung City's low-carbon initiative? The results will be structured by investigating how the different flagship programmes were included.

7.1 First Part (Taichung City – Low-carbon Initiative)

To answer and analyse the sub-RQ, the governmental reports were analysed. It is important to highlight that two different reports could be found online. The Taiwan Environmental Protection Administration (TEPA) published different mid- and short-term administrative plans, while the low-carbon office (LCO) made various reports on their low-carbon initiative available. For the former one, I did find four reports and for the latter one only two. The original plan was to interview those two stakeholders individually. Although, I only could talk to a representative of the LCO, the administrative plans from the environmental protection agency are also included, as the low-carbon office reports to the TEPA. In the LCO's 2013 strategy plan, they clearly state in the abstract that feasible schemes for Taichung City were created by analysing international low-carbon initiatives (TEPA, 2013).

7.1.1 TEPA medium-term governance plan (2011-2014)

All the reports from the TEPA or the LCO follow a similar structure. 1) The strategic performance objectives (SPO) are stated 2) then it is indicated how those are going to be measured 3) finally a summary is presented. For the first medium-term plan from 2011-2014, under the strategic performance goal 1, it is clearly stated that one aim is to make the public citizens more aware of environmental damage and the importance of its protection (TEPA, 2014b). Already the next paragraph, under strategic performance goal 2, is titled "Clean Air Trio". Within these, it is not only said to reduce the CO2 emissions from the industrial sector but also to develop demonstration / pilot projects and promote EVs (TEPA, 2014b). Strategic performance goal 3 deals with the effort to construct a low-carbon city that promotes green transport. Again, the importance of EVs is highlighted and different initiatives such as charging stations, etc. are being presented (TEPA, 2014b). The other strategic performance goals are about waste reduction and recycling (Nr.4), green public spaces (Nr.5), handling of toxic chemicals (Nr.6), environmental protection (Nr.7), increase dust-carts in each district (Nr.8), environmental education (Nr.9), waste handling and landfills (Nr.10) and number 11 with water and soil protection (TEPA, 2014b). Strategic performance goal 6 – the handling of toxic chemicals, has allocated the lowest value with 2%, followed by Strategic performance goal 3 – Green Transport with 3%. This shows how little attention the current low-carbon initiative puts on an alternative for more sustainable transportation. Rural areas are not mentioned as an SPO, which reveals their unimportant status.

Table 2. Excerpt of medium-term governance plan 2011-2014 (TEPA, 2014b) (full table, Appendix 5)

Strategic Performance Objectives	Measurement	Actions
1. clean air trio • improve air quality by controlling industry, power plants • promoting green transport (GT) • tighten construction site pollution	• Number of days with a PSI value >100 • Measure O3, PM10 concentration • Number of vehicles at the scrap yard	Air quality monitoring, formulate new regulations for industries and power plant operators, EVs for police patrol, more vehicle charging stations, regular inspection, tree planting
2. low-carbon city / GT • become a sustainable life environment • government regulations for EVs • incorporate low-carbon thinking in all bureaus	• Number of GT demonstration communities • Number of electric vehicles • Number of bicycles, used	National low-carbon demonstration city, participate in international meetings, switch to EVs, cooperate with public transport,

7.1.2 TEPA medium-term governance plan (2015-2018)

The second medium-term governance plan (see Appendix 6 for full table), starts with the first couple of pages from a different angle than the previous one. The first difference is that an analysis of the current environmental situation is carried out (TEPA, 2015c). Then 9 existing programmes are listed. For the first point, three measures are being listed 1) tackle environmental issues with regional government concepts 2) build a sustainable city 3) actively promote environmental protection. Later, 7 SPOs are stated.

If one compares the two medium-term governance plans, one realises a mismatch between the stated SPOs for the first one and the ones stated as being implemented in the second plan. In other words, 11 SPOs were set out as a goal in the first plan. Out of the 11, eight were implemented and one new programme added to be in implementation for the second plan. The themes low-carbon transport, public information and enhance environmental protection were not implemented in the second plan. Enhancing the ability of environmental testing was added. Within the list of the 7 SPOs for 2015-2018, one could say that several topics are covered in one bullet point. In the first medium-term plan, each bullet point represented one topic. Now, in the second one, each bullet point has several topics. Bearing this in mind, the goal low-carbon green energy was added. The theme green transport has been deleted. This leads us to the LCO and the question how they see the role of GT in the Taichung City low-carbon initiative.

7.1.3 Taichung City – low-carbon white paper framework objectives

The vision and implementation strategy of Taichung City as a low-carbon city is summarised by the slogan "Carbon free – Trouble free". The focus is on three objectives: Green Energy & "Life Capital" (A), Energy Saving & Industrial Economy (B), Create a low-carbon and a sustainable environment (C). Six strategic flagship programmes, shortened in three categories:

1. Promote green and intelligent transport (A1) + Development of low-carbon communities and zero-waste recycling programme (A2)
2. Energy technology and green building projects (B1) + Sustainable and low-carbon tourism (B2)
3. Green living spaces (C1) + Environmental Education (C2)

form the low-carbon initiative (TEPA, 2013). Besides low-carbon tourism, the LCO does not focus on new themes for their SPOs. GT is again mentioned. However, after having read this report, I could not find more specific information on the importance of each element. It is a very long report with more than 900 pages, where the LCO describes in detail what their mission is and what they do.

7.2 First part Taichung City – green transport

On Taichung City's governmental website "低碳永續家園資訊網" (Low carbon sustainable home information network) one can get information about the different regions and their progress in terms of low-carbon development. There is an English version of the general website available, but the translated version does not offer that information feature about the implemented programmes and is in general very descriptive. If one clicks on Taichung City, one can see the so called "Action Item Execution Statistic" of the low-carbon initiative themes. I translated the Chinese version into English and focussed only on the overarching themes (see Figure 7).

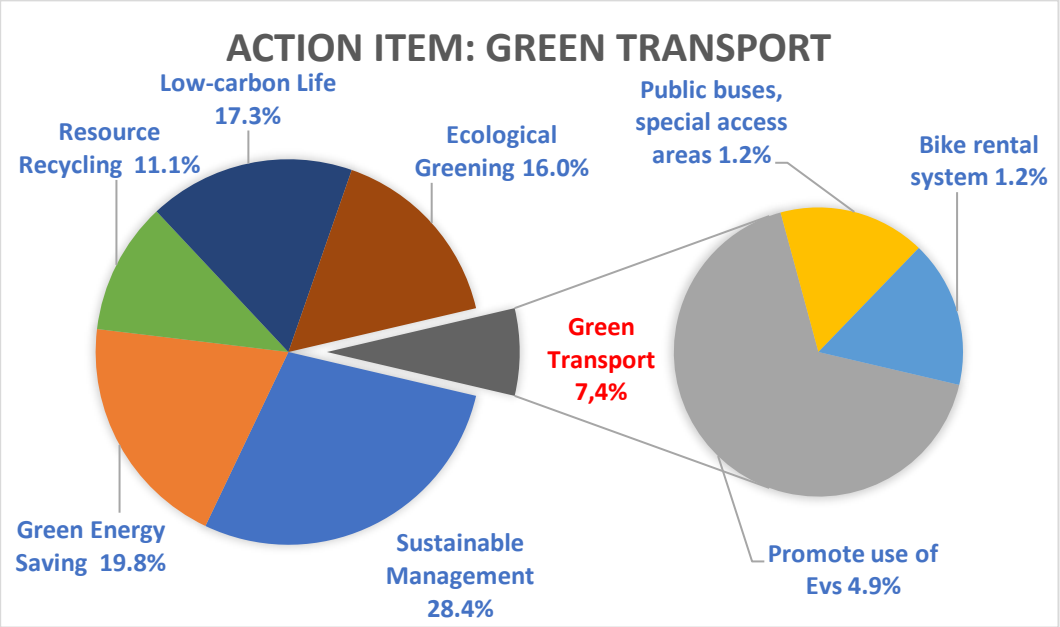

Figure 7. Taichung City - Action Item Execution Statistic (own portrayal)

The proportion of the individual action items is calculated with the equation: (the total number of individual actions submitted by each level unit participating in the city / the total number of individual actions submitted by the participating units at all levels). One can see that Green Transport is the least developed action item with only 7.4%. Sustainable Management is the most developed one with 28.4%, followed by Green Energy Saving (19.8%), Low-carbon Life (17.3), Ecological Greening (16%) and Resource Recycling (11.1%). Green Transport is further divided in the promotion of EVs (4.9%), the implementation of a bike rental system (1.2%) and public buses and special access areas for pedestrians (1.2%). Among the six strategic action items (see Figure 7), the theme “Green Transport” gets the least attention. To sum up GT is omitted since the second medium-term governance plan within the documents from TEPA. Although mentioned as the first flagship programme (A1) it is the action item with the worst performance record in terms of implementation (see Figure 7). Since none of the reviewed documents could deliver a satisfying answer, further clarification was sought via literature reviews and interviews.

7.2.1 Green Transport – the case of motor scooters

The first initiative steps for a development of an electric motor scooter started already in 1990 (Liu, Kuo, Pan, & Lin, 1994). Already in the late 20th century the total number of conventional motor scooters exceeded the 10 million mark (Liu et al., 1994). With 326 motor scooters per square kilometre, Taiwan has the highest scooter density in the world (Tso & Chang, 2003). Already in 1998, a prototype of a fuel cell scooter was developed in the USA with cooperation from Taiwan, the third generation was

commercially produced from 2004 onwards (Tso & Chang, 2003). So far, the poor performance of the batteries by the electric and fuel cell scooters, hindered Taiwanese citizens to buy a more environmentally friendly motorcycle (Tso & Chang, 2003). But with the motor scooter from Gogoro and a driving range of about 100km, this challenge should be solved. The Smartscooters from the start-up Gogoro have a 125cc engine and suit to the heavily built up cities in Taiwan (Tilley, 2015), where parking spaces are rare . Gogoro could be one key element for new business opportunities and to offer Taiwan's economy a more cleaner future (Wu, 2015). Gogoro offers four models between a price range of US$2,780 and US$3,890 (Lai, 2016). First presented to the public at the CES in 2015, there are currently up to 18,000 Smartscooters on the road (O'Kane, 2017).

7.3 Second Part Taichung City – rural areas

For the above-mentioned strategic reports from TEPA and LCO, I used the Adobe Acrobat Reader search function searching for specific key words about rural areas. In the following table, the results are being presented.

Table 3. Low-carbon strategy plans - Taichung City (own depiction)

	Report 13'	**Report 14'**	**Report 15'**	**Report 16'**
"縣" (County)	86	97	0	0
"鄉下" (Countryside)	0	0	0	0
"鄉村" (Rural)	7	0	0	0

For the 2013 strategic report, almost all results talked about other pilot regions like "桃園縣" (Taoyuan County) as an administrative unity and not specifically about a rural area. The strategic report from 2014 applied the search terms for mentioning that Taichung County and Taichung City got selected as a pilot region. The other pilot regions and the two pilot islands were also described. On other pages, Taichung City is described as the transportation hub of Taiwan and the plan to develop a new public transport system based on bus lanes named Bus Rapid Transit (BRT). The strategic reports from 2015 and 2016 did not mention one of the three terms at all.

In a report, TEPA defines major indices for the concept of low-carbon communities with the distinction between a rural and an urban type (TEPA, 2009b). The latter ones were classified based on GHG emissions and the former ones according to energy self-sufficiency (TEPA, 2009b).

8 Results & Analysis – primary data

8.1 Interviews

The results from the secondary data have been presented and structured. With this section I am going to cross check the results from the literature review and document analysis with the interview responses. The interview responses will be applied to the MLP-framework. For a transition to happen, all three levels need to be active (see section 5.2, Figure 5). The analysis will be framed by the three levels 1) Socio-technical landscape 2) Socio-technical regime 3) Niche innovations. What a sustainability transition for the case study Taichung City shall look like, has been already defined by the secondary data. However, I want to highlight again that, although strategic goals for combating air pollution were mentioned, transport specific factors were not taken into consideration.

8.1.1 Socio-technical landscape

Factors on this level include demographic changes, macro-political events and processes like climate change or air pollution that develop slowly. By the time I wrote my thesis, we exceeded the 410-ppm threshold (Kahn, 2017). Without climate change and air pollution being a threat to Taichung City's population, no efforts for transitioning to a low-carbon society would exist. Therefore, I wanted to find out how different actors associated with this low-carbon transition 1) perceive climate change and 2) how they think the public opinion was on climate change. A regional-governmental body (hereafter referred to as LCI-implementer) that is given the task to "develop a low-carbon programme for the city and to promote low-carbon projects in the city" (Interview II) said that the Taiwan government attaches great importance as they passed the GHG Reduction and Management Act (Interview II). An EV advocacy group (hereafter referred to as niche-occupier) said, "Amongst the general public, it seems non-urgent, if they are aware of it all […]" (Interview I). And an employee of the rural district Xinshe (hereafter referred to as rural stakeholder) stated because they are aware of the facts of climate change, the national government started the low-carbon initiatives (Interview III). To sum it up, "The preference seems to be to not disrupt the harmony of society by taking an extremely critical stance on matters […]" (Interview I).

8.1.2 Socio-technical regime

Within the Socio-technical regime category are six dimensions, some of them will function as guidance to construct a coherent picture of the interview responses. The first one is the policy dimension. The LCI-implementer is being positioned at the intersection of the current regime structure and the arena where new configurations are taking place (see Figure 8). They "control and monitor the results of the

implementation of low-carbon projects […]" (Interview II). The rural stakeholder is positioned within the current regime structure and, intersecting with the LCI-implementer (see Figure 8) as a collaboration between those two is assumed. Asking the participants how they have dealt with climate change in their daily work, for the rural stakeholder it is important to "promote energy-saving and carbon-reduction measures […]" (Interview III). The LCI-implementer is working at the "local level to promote greenhouse gas mitigation strategic units" (Interview II). One could interpret those two statements as a hint to a shared cognitive routine between those two actors.

The next dimension is culture, which considers the patchwork of regimes and how the six flagship programmes are perceived. Asking the rural stakeholder if they have heard from the low-carbon initiative by the Taichung City government, they do not refer to the formulated vision (see section 7.1.3). In contrast, they state "Taichung City government in response to climate change, wants to slow down the increase in emissions from greenhouse gases […] and develop a low-carbon sustainable city." (Interview III). Following up on a potential collaboration and asking if they are part of a working group on low-carbon issues, they responded "Yes, the responsibility to promote low-carbon work lies by district office." (Interview III). Both answers are on a very general and abstract level and let me conclude that a collaboration between those two actors does not exist. This confirms the finding from the secondary data, where no in-depth description between ongoing projects could be found.

Besides the LCI-implementer, the other two respondents consider the 6 flagship programmes as "broad ranging and ambitious" (Interview I) and "[…] a good idea." (Interview III). But the latter one also says that "perhaps it is a matter of values and education, but public opinion is not part of the low-carbon government affairs (some people do not care), the degree of cooperation is not high." (Interview III). The last statement not only points again to the fact that a collaboration between the LCI-implementer and citizens in general but also from that rural district is not high. It makes clear that the citizens just do not care too much about it. The next dimension which is labelled science, sheds light on another angle on how the six flagship programmes were perceived. "From an air quality standpoint, outfitting Taichung Power Plant with modern, up-to-date filtration […] must become more of a priority, […]" (Interview I). The respondent further said "[…] however, this most critical action item, does not, to my knowledge, appear to be on the plan. Its absence is striking." (Interview I). At least in the first medium-term governance plan they speak of new regulations for industries, in the second one it is completely unaddressed, they link air pollution to the industry sector but are not distributing more attention to it within their 6 flagship programmes.

A low-carbon initiative could not only result in a better climate-impact performance but also lead to a healthier environment for Taichung City's residents. It is a huge share the moto-scooters have on

Taiwan's road traffic and the pollution they emit (see section 4.3). However green transport is still not significantly part of public mainstream discussions on climate change as the following statements show: "There's reluctance to acknowledge the contribution that vehicles make to air pollution it seems." (Interview I). "In a sense, the scooters seem to have more rights, more freedoms, than humans do. And fuel prices in Taiwan are kept extremely low." (Interview I). Those two statements form a bigger and clearer picture if one bears in mind that the first medium-term governance plan mentioned GT as an explicit goal (see table 2). But the second and latest medium-term governance plan does not (see table 3).

At the end of section 7.1.2, I raised the question how the LCI-implementer would see the role of GT in the initiative. Asking them about least successful action item of the pie chart (see Figure 7), where it is evident that GT is far behind all the other action items, the respondent stated that "Taichung City also needs to strengthen the promotion of renewable energy, such as increasing the capacity of solar photovoltaic." (Interview II). This is an accurate statement as renewable energies are not part of the pie chart at all. However, this statement also shows the lack of acknowledging the relationship between GT and air pollution. The next dimension focuses on technology and the industry sectors, where the focus is on motor scooters. "Taiwan is currently seeing less than 30,000 e-scooters a year sold […] which, in contrast to the roughly 600,000 new gas scooters purchased annually, is quite low." (Interview I). "However, when looked at in terms of growth over previous years of e-scooter sales, the adaptation rate is improving significantly." (Interview I). Those numbers show that the market for e-scooters is still in its infancy and the user preferences still demanding regular gas scooters. Although one should acknowledge the adaptation rate and Gogoro's ground-braking Smartscooters.

8.1.3 Niche innovations

A niche-innovation from Taiwan's start-up sector could be a change maker. "Gogoro, along with other EVs, particularly in the 2-wheel realm, represent a key new pillar industry for Taiwan, part of the larger green tech sector." (Interview I). Moreover, "Embracing and emphasizing clean tech are essential moves for the transition to a more sustainable, and future prospering, economy and society." (Interview I). Those statements resonate very well with the question about the most effective action item and the respective answer from the rural stakeholder "Green transport is the most effective, […]" (Interview III).

9 Discussion

The aim of my thesis was to analyse how low-carbon initiatives take into consideration the local context and spatial features. Two local context factors for my single case study Taichung City, where extracted from a thorough literature review. To answer the two sub-RQs, I applied the MLP-framework. I am going to answer the overarching RQ by applying the typology of regional diversification. Before that I am giving a summary of the MLP-framework and will discuss it. My sections on contribution to SS and how my findings relate to similar studies can be found in this chapter.

9.1 Speaking back to theory – sub-RQS

9.1.1 MLP-framework summary

The globally accelerating patterns in climate change threatening our societies and the regional negative changes in air quality within Taiwanese cities (e.g. Taichung City), as well as the new national government lead by Tsai Yingwen paved the way for a need to set up pilot low-carbon projects in the sense of climate mitigation. In other words, climate change as pressures from a landscape level on the transport sector in Taiwan, could have triggered the development of Gogoro's business model. Or why was the first electric motorcycle already developed in the beginning of 1990 but never took up speed? Geels (2004) identified environmental impacts and health risks as negative external forces that put pressure on a regime. Taichung's air quality because of the road transport (especially by motor scooters) and the air quality in many other Taiwanese cities is an example of such a negative externality that leads to changes in the national and municipal governmental strategies (low-carbon initiatives). Although a new national government is in place, which is more environmentally friendly than the previous administration. There are still existing political and economic infrastructures that harm the environment and hinder new innovations. However, there are niches such as Gogoro that produces electric motor scooters that are one element to reach the goal of a low-carbon city.

The MLP-framework was very valuable for my research, as I analysed what happens within Taichung City's low-carbon initiative. However, taking the next step and question how things unfold, entails applying another theory. One suitable theoretical concept within transition theory is transition management as it asks questions about ongoing governance structures and processes (Loorbach, 2010). Hodson and Marvin (2010) pointed out in their study that the role of cities in the MLP-framework is still not clarified. While there is some truth to this critique, I argue that the original purpose of the MLP-framework was to analyse historical and past transitions on a national scale.

I concede that more and more studies are applying the MLP-framework to rather local contexts. With thought-out system boundaries, the MLP-framework is a powerful tool for urban transitions.

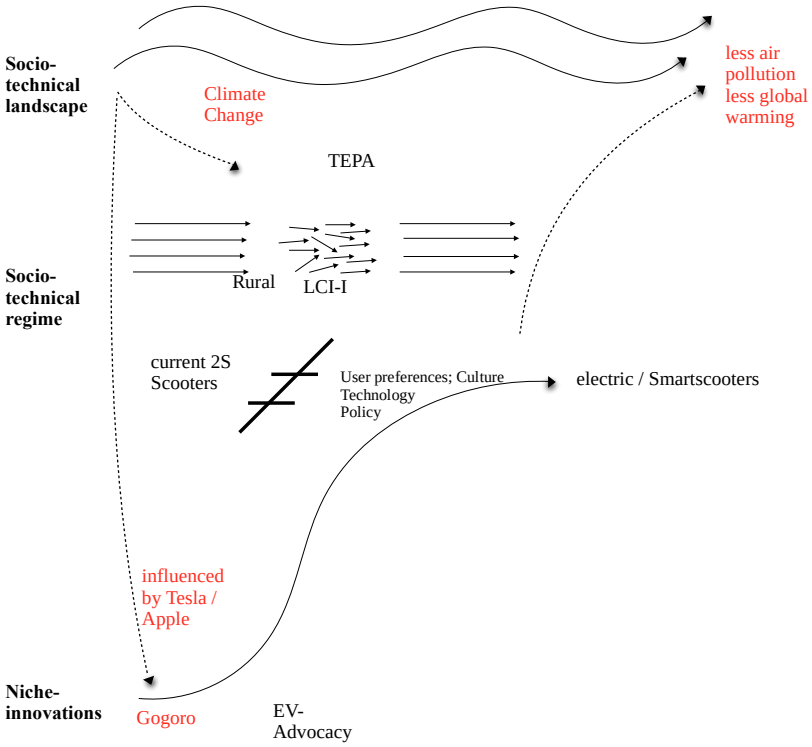

Figure 8. Multi-level perspective, adapted from, (Geels and Schot, 2007)

9.2 Speaking Back to Theory – Overarching RQ

Having answered the sub-RQs by concluding that GT is 1) not part of the current medium-term governance plan 2) the market share and user preferences are still favouring conventional gas scooters. 3) the start-up Gogoro is on its way to be the change maker needed but 4) the rural district Xinshe seems to be not sufficiently included. The two sub-RQs show that Taichung City is not thinking through their initiative in terms of reliance on local capabilities.

9.2.1 Typology of Regional Diversification

Among the four regional diversification trajectories (Boschma et al., 2017) the regional government of Taichung City fits into the *transplantation process*. An analysis was carried out of different regions in the world, which have already applied such a low-carbon initiative. This is a rather risky approach as they do not rely on their own local institutions (Boschma et al., 2017). In other words, they try to bring in globally accepted best case knowledge and experience for their own case. This is a rather top-down and global to regional approach (Boschma et al., 2017), which is for sure very helpful at the beginning.

The start-up Gogoro has developed a product based on local capabilities “And that is the key.” (Interview I). “Innovative clean-tech, eco-smart design that appeals on multiple levels, not just the negation of guilt over carbon intensive approaches – which could only work in a minority of cases, and even less so in Taiwan – is the way forward.” (Interview I). So, they should start thinking of a more bottom-up and regional to global perspective, as the *exaptation trajectory* is described (Boschma et al., 2017). Right now, it is very important to get their electric motor scooters socially accepted by new regulations and social norms. As the *transplantation process* is working on the regime level and the *expectation* one on the niche level. It is safe to say that a closer cooperation between those two levels is necessary and could lead to very positive results. Because Taichung City could work together with Gogoro and thereby relying “on an existing knowledge base and succeeds in entering many sectors by creating new niches” (Boschma et al., 2017, p.39). To sum up, the Taiwanese case tries first an unrelated diversification where new global capabilities are imported. Instead of utilizing their own local/regional knowledge and capability base and support niches that can be scaled up into future global regimes (Boschma et al., 2017). The Taiwanese company Gogoro could be a potential candidate for the latter one, as the German city Berlin is the first abroad customer where citizens of Berlin can rent a Gogoro smart scooter (O’Kane, 2017).

9.3 Contribution to Sustainability Science

Sometimes SS is defined as a field that addresses the gap between scientific knowledge and action (Hall, Feldpausch-Parker, Peterson, Stephens, & Wilson, 2017). As an example the authors describe the availability of technologies that allow a sustainability transition but they are not implemented out of political or economic reasons (Hall et al., 2017). The case study region Taichung City is a prime example on that issue. Gogoro as a Taiwanese start-up has the technology to be one of the key pillars in changing Taiwan’s motor scooter industry into a pool of providers that distribute electric motor scooters that are not polluting the immediate environment in their operation mode. But respective governmental bodies that were given the task to implement low-carbon initiatives do not focus on motor scooters. Although they are so much entangled in the Taiwanese daily life. Electric motor scooters or other GT solutions are being cut off. Another debate in the SS field can be linked to my research. It is the debate about sustainability transitions. If one characterises the knowledge-action gap as the first hurdle to overcome. The next one, after having overcome the first one, is the type of pathway we are aiming for. There exist four archetypes of transition narratives: green economy, low-carbon transformation, ecotopian solutions and transition movements (Luederitz, Abson, Audet, & Lang, 2017). The scale for the second narrative is on the city level, where local government functions as implementer of low-carbon initiatives (Luederitz et al., 2017). Specific strategies are being formulated for a sustainability transition within the low-carbon narrative. However, others have

criticised that many in that narrative aim for the low-hanging fruits that do not question the status-quo and thereby perpetuate it (Moloney & Horne, 2015).

Another debate in the SS field is to frame a global sustainability initiative within the SDGs. If we as humanity want to tackle climate change, the list of 193 countries that signed the SDGs, is the community to address. But what about the countries that are not part of the UN and do things voluntarily. Taiwan, as a case example is a double-edged sword. On the one hand, they are not bound to implement certain climate change mitigation strategies due to binding agreements. But they are bound with the global community and developing low-carbon initiatives on a voluntary basis. On the other hand, applying Taichung City's low-carbon initiative as an example, their efforts rather maintain the status-quo than challenging it with radical solutions. The regional government of Taichung City is not developing a shared vision with the surrounding rural districts, which would be necessary for reaching the goal. In their paper, Westley and colleagues highlight with justification that innovation has been supply driven and thereby creating artificial needs based on existing technologies leading us to a technological lock-in. I agree with what has been said, but is not that also an advantage to have corporations and in them experts that develop sustainable innovations? Does not a demand-driven innovation in our current system only reveal products that are aligned with the unsustainable infrastructures in place? So, having a supply driven innovation based on sustainability criteria such as ecological friendly, allow to bring EVs on the market and convince the citizens (who most of the time are no experts and would not have demanded such a product) to use it.

9.4 Relate findings to similar studies

Many peer-reviewed scientific articles had their focus on low-carbon initiatives (see section 3 & 3.2). Hence, I am going to use this section to connect my findings to other studies within the debate about low-carbon initiatives, which either had a similar approach and/or concluded with similar findings. Two researchers evaluated three larger American cities to learn more about their policy plans and to what extend they apply a holistic approach to sustainable development (Finn & McCormick, 2011). They define urban sustainability with metrics including environmental protection, societal, geographical and economic equity as well as economic greening (Finn & McCormick, 2011). I am not going too much into their holistic definition of urban sustainability, which resonates with me, although I miss a metric representing global interconnectivity. They concluded that none of the reports could keep their word and failed to deliver holistic solutions for their cases (Finn & McCormick, 2011). Taichung City's governmental white papers do not claim to apply or aim for a holistic approach to sustainability. However, they claim to develop the whole special municipality of Taichung City into a low-carbon society. As my findings suggest, Xinshe district as rural areas is not actively included via project-based

collaboration. Xinshe is only descriptively mentioned in the reports. A project-based collaboration does not exist. In a sense, my findings correspond to the ones from Finn and McCormick. In both studies, certain aims for a low-carbon initiative are being presented via policy documents but in the end the outcome is different.

While I wrote my thesis, a book got published which is worthwhile mentioning. Mathews (2017) claims that the climate change challenge should not be addressed from a moral but from an economic standpoint. His main point is that we are going to witness a global green shift in manufacturing lead by China and India. Both rearrange their industries towards being more sustainable, not because of an intrinsic and moral responsibility for nature but rather because manufacturing REs, etc. helps them to cut costs and makes them less vulnerable from global markets (Mathews, 2017). Though I concede that the economic-manufacturing perspective can be of great help transforming current industries and only as a side-effect minimising climate change effects, I still insist that it might be ineffective in the longer run. Addressing climate change from a SS perspective, sets the whole analysis on a more holistic ground. Various feedback loops on different systems can be recognised. For instance, Mathews (2017) further reports that decoupling and ecomodernization are replicable everywhere. Rethinking this argument not from the same strategic management perspective but from a SS lens, fundamental prerequisites such as education emerge, that Mathews did not address. Hence, applying a manufacturing and resource security lens with climate change as a side effect might be more suitable for the current neoliberal structures. However, with this approach we risk that we rather maintain the overall status-quo in terms of growth-paradigms and neglect other consequences, e.g. inequality.

10 Conclusions

10.1 Key Findings

The results from this study are not surprising, bearing in mind the inconsistency and challenges outlined above. Green transport as a key element for any low-carbon initiative, has been deleted from the latest medium-term governance plan. Without a collaboration between the start-up Gogoro and Taiwan's low-carbon initiatives, a transition towards a low-carbon city seems out of reach. Along the same lines, Xinshe district as a rural area is not primarily included in the low-carbon efforts of Taichung City. Moreover, the rural stakeholder and the LCI-Implementer have different opinions on what to pursue. The implemented flagship programmes are focusing on easily viable low-hanging fruits. Certain governmental stakeholders ensure that motor scooters cannot and are still not being blamed for the urban air pollution, although they hold the biggest share. Moreover, more stringent plans to incorporate renewable energies, e.g. roof-top photovoltaics or on-/offshore wind energy are still

absent in all the low-carbon strategic reports. To really being able to transition to a low-carbon society it is important to have a shared vision and a multi-level governance structure. With the shortcomings found, Taichung City rather maintains the status quo instead of getting onto a low-carbon pathway. The latter one could be only achieved if Taichung City acknowledges its local context, that is the social focus on motor scooters and the sufficient inclusion of its rural areas.

10.2 Future Research

My whole thesis focused on what is happening within the framework of Taichung City's low-carbon initiative. Through my research process, the following future RQs emerged: 1) how are flagship programmes put to practice on the ground, 2) how does the low-carbon office communicates with Xinshe district, and 3) why do most of Taichung City's citizens still prefer a conventional gas scooter. More food for thought from another angle is coming from a political perspective. The current administration under Tsai Ying-Wen is expected to be more prone to leading the country to a more sustainable future. Is this really the case considering it is the second term for the democrats to be in office and might they just not lacking the governmental expertise? Can this ever be the case, if Taiwan's economic transformation while being part of the first generation of Tiger states was growth-oriented. Most of the advocates and supporters were technocrats and laid the groundwork without thinking too much about the environmental impacts. Environmental education in Taiwan is almost non-existent. Do they have the skills and endurance to guide the existing technocratic institutions and infrastructure towards a more ecological-integrative and holistic pathway? Those are further questions that future research from the perspective of a low-carbon transition in Taiwan could address.

10.3 Concluding Remarks

Caught in diversification. This relates to the low-carbon initiative and the many different actions and initiatives heading in opposing directions. Having a plethora of different actions and routines and regimes makes it not only difficult but also necessary to have a shared vision. Caught in diversification – because the development trajectory of Taichung City's effort to become a low-carbon city seems to be stuck in an unrelated regime-prone narrative instead of a related niche-based diversification. While I believe that behind their low-carbon initiative are serious principles to make that transition happen. I also believe that they know how bad the motor scooters are for their own health and the environment, but because of not disrupting the harmony of society it is just tolerated. I conclude by saying that low-carbon initiatives that do not sufficiently acknowledge local context-specific factors rather maintain the status quo.

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Appendices

Appendix 1 – search strings

Taiwan (low-carbon, sustainability, transport)

1. (AF-ID ("National Taichung University Taiwan" 60072398)) AND (low-carbon) → 7 results; 1 match (Yang & Ho, 2016)
2. (AF-ID ("National Taichung University Taiwan" 60072398)) AND (sustainability) → 25 results; 1 match (Yang & Ho, 2016)
3. (AF-ID ("National Taichung University Taiwan" 60072398)) AND (green AND transport) → 15 results; 1 match (Yang & Ho, 2016)
4. (AF-ID ("National Taiwan University" 60005429)) AND (low-carbon) → 188 results, 4 matches (Li et al., 2016; Chen, Liu and Liou, 2016; Chao, Ma and Heijungs, 2013; Li & Yu, 2013)
5. (AF-ID ("National Taiwan University" 60005429)) AND (sustainability) → 456 results, 3 matches (Chen, Zhou and Zhu, 2017; Shih et al., 2016; Wang, 2015)
6. (AF-ID ("National Taiwan University" 60005429)) AND ("green transport") → 1 result, 0 matches
7. (AF-ID ("National Taiwan University" 60005429)) AND (green AND transport) AND (EXCLUDE (DOCTYPE , "cp") OR EXCLUDE (DOCTYPE , "ch") OR EXCLUDE (DOCTYPE , "ed") OR EXCLUDE (DOCTYPE , "bk")) AND (LIMIT-TO (SUBJAREA , "ENVI") OR LIMIT-TO (SUBJAREA , "EART") OR LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "MULT")) → 209 results, 0 matches
8. (AF-ID ("National Tsing Hua University" 60018029)) AND (low-carbon) → 144 results, 4 matches (Shih et al., 2016; Hu et al., 2016a; Hu et al., 2016b, Trappey et al., 2011)
9. (AF-ID ("National Tsing Hua University" 60018029)) AND (sustainability) → 96 results, 3 matches (Shih et al., 2016; Hu et al., 2016a; Wong, Hu and Shiu, 2015)
10. (AF-ID ("National Tsing Hua University" 60018029)) AND (green AND transport) AND (EXCLUDE (DOCTYPE , "cp ") OR EXCLUDE (DOCTYPE , " ch ") OR EXCLUDE (DOCTYPE , " ed ") OR EXCLUDE (DOCTYPE , " bk ")) AND (LIMIT-TO (SUBJAREA , "ENVI ") OR LIMIT-TO (SUBJAREA , " EART ") OR LIMIT-TO (SUBJAREA , " SOCI ") OR LIMIT-TO (SUBJAREA , " MULT ")) → 47 results, 1 match (Hu et al., 2016a)
11. (AF-ID ("National Chengchi University" 60027018)) AND (sustainability) → 128 results, 1 match (Yang, Lee and Hu, 2016)
12. (AF-ID ("National Pingtung University of Science and Technology" 60006082)) AND (low-carbon) → 15 results, 1 match (Tsai, 2014)

13. ((AF-ID ("National Pingtung University of Science and Technology" 60006082))) AND (sustainability) → 75 results, 1 match (Tsai, 2014)
14. ((AF-ID ("National Pingtung University of Science and Technology" 60006082))) AND (green AND transport) → 47 results
15. (AF-ID ("National Ilan University Taiwan" 60028478)) AND (low-carbon) → 3 results, 1 match (Fang, Chang and Yu, 2014)
16. (AF-ID ("National Ilan University Taiwan" 60028478)) AND (sustainability) → 26 results, 0 matches
17. (AF-ID ("National Ilan University Taiwan" 60028478)) AND (green AND transport) → 35 results, 1 match (Fang, Chang and Yu, 2014)
18. (AF-ID ("National Taipei University" 60016334)) AND (low-carbon) → 13 results, 1 match (Tsai and Chang, 2015)
19. (AF-ID ("National Taipei University" 60016334)) AND (sustainability) → 106 results, 0 matches
20. (AF-ID ("National Taipei University" 60016334)) AND (green AND transport) → 25 results, o matches

Cities and Climate Change

(TITLE-ABS-KEY (cit*) AND TITLE-ABS-KEY ("climate change") AND TITLE-ABS-KEY ("low-carbon")) → 327 results, 8 matches (Freeman and Yearworth, 2017; Wang et al., 2017; Philp and Taylor, 2017; Mehta, Shankar and Bandopadhyay, 2016; Zhou et al., 2015; Lo, 2014; Khan, 2013; Chen and Shu, 2012)

TITLE-ABS-KEY (rural) AND TITLE-ABS-KEY ("climate change") AND TITLE-ABS-KEY ("low-carbon") → 47 results, 1 match (Phillips and Dickie, 2014)

Appendix 2 – interview guidelines

EV-advocacy group

1. General questions about the interviewee and the related organisation
    - How would you describe your institution?
    - What is the role of it in society (its mission)?
    - What are your responsibilities in that institution?
2. Grand tour questions
    - How is climate change being perceived in Taiwan?
    - What have been the main developments in the EV sector in Taiwan?
    - How would you define Green Transport?

3. Content questions (1/2)
    - In what development stage do you see green transport in Taiwan?
    - To what extent is green transport part of public mainstream discussions?
    - How do you see the role of green transport as a climate change linkage?
4. Content questions (2/2)
    - How do you perceive the 6 low-carbon pilot projects in Taiwan?
    - To what extent are the action items (Figure 1) considering Taichung's context?
    - Which one could be most effective, from your perspective?
5. Challenges
    - Are there challenges for Taiwan's transition to a low-carbon society?
    - What are the challenges?
    - What strategies come to your mind for overcoming those challenges?
6. Public awareness
    - How is climate change being discussed in Taiwan?
    - To what extent are Taiwanese aware of potential consequences/impacts?
    - How could a public debate about climate change be further developed?
7. Closing questions
    - What role could Gogoro play in that transition?
    - For how long have you been in Taiwan?
    - Do you have anything to add?

LCI-Implementer

1. General questions about the interviewee and the related organisation
    - How would you describe your institution?
    - 您會如何描述您的機構？
    - What is the role of it in society (its mission)?
    - 低碳辦公室在社會中的作用是什麼？
    - What are your responsibilities in that institution?
    - 在低碳辦公室，您有什麼責任？
2. Grand tour questions
    - How is climate change being perceived in Taiwan?
    - 台灣如何看待氣候變化？
    - To what extent have you dealt with it in your daily work?
    - 您在您的日常工作中處理了什麼程度？

- How would you define Sustainability?
- 您如何定義可持續發展？

3. Content questions (1/2)
    - Is your low-carbon initiative being a strategy plan or a project plan?
    - 您提倡的低碳是戰略計劃或是項目計劃嗎？
    - On your website, you show those pie charts. How are they calculated?
    - 在您的網站上，您會顯示這些圓餅圖。他們怎麼計算的？
    - Which part of your climate change plan had been most successful?
    - 低碳城市計畫的哪一部分是最成功的？
4. Content questions (2/2)
    - Which efforts had been least successful?
    - 哪些成果最不成功？
    - How did you prepare your climate change plan?
    - 您如何準備氣候變遷計畫？
    - Have you applied any international guidelines, e.g. 5-step process from ICLEI?
    - 您有沒有應用任何國際準則？
5. Challenges
    - Are there challenges for Taiwan's transition to a low-carbon society?
    - 台灣向低碳社會轉型有挑戰嗎？
    - What are the challenges?
    - 有什麼挑戰？
    - What strategies come to your mind for overcoming those challenges?
    - 您認為克服這些挑戰有什麼策略？
6. Public awareness
    - How is climate change being discussed in Taiwan?
    - 氣候變化如何在台灣討論？
    - To what extent are Taiwanese aware of potential consequences/impacts?
    - 台灣人在多大程度上意識到潛在後果？
    - How could a public debate about climate change be further developed?
    - 如何進一步發展關於氣候變化的公開辯論？
7. Closing questions
    - What role does your institution play in that transition?
    - 在這個轉變中低碳辦公室能扮演什麼角色？
    - For how long have you been working in this institution?
    - 您在低碳辦公室工作多久了？
    - Do you have anything to add?
    - 您有什麼要補充嗎？

Rural stakeholder

1. General questions about the interviewee and the related organisation
    - How would you describe your institution?
    - 您會如何描述您的機構？
    - What is the role of it in society (its mission)?
    - 新社區公所在社會中的作用是什麼？
    - What are your responsibilities in that institution?
    - 在新社區公所，您有什麼責任？
2. Grand tour questions
    - How is climate change being perceived in Taiwan?
    - 台灣如何看待氣候變化？
    - To what extent have you dealt with it in your daily work?
    - 您在您的日常工作中處理了什麼程度？
    - How would you define Sustainability?
    - 您如何定義可持續發展？
3. Content questions (1/2)
    - Have you heard from the low-carbon initiative by the Taichung City government?
    - 您聽說過台中市政府的低碳倡議嗎？
    - If not, have you heard about from the national government's initiatives?
    - 如果沒有，您聽說過國家政府的倡議嗎？
    - Are you part of a working group on low-carbon issues?
    - 您是低碳問題工作組的成員嗎？
4. Content questions (2/2)
    - How do you perceive the 6 low-carbon pilot projects/locations in Taiwan?
    - 您如何看待台灣的6個低碳試點項目？
    - To what extent are the action items (Figure 1) considering the Taiwanese context?
    - 考慮台灣情況的行動項目（圖1）在多大程度上？
    - Which one could be most effective, from your perspective?
    - 從您的角度來說，哪一個是最有效的？
5. Challenges
    - Are there challenges for Taiwan's transition to a low-carbon society?
    - 台灣向低碳社會轉型有挑戰嗎？
    - What are the challenges?
    - 有什麼挑戰？
    - What strategies come to your mind for overcoming those challenges?
    - 您認為克服這些挑戰有什麼策略？
6. Public awareness
    - How is climate change being discussed in Taiwan?
    - 台灣如何討論氣候變化？
    - To what extent are Taiwanese aware of potential consequences/impacts?
    - 台灣人在多大程度上意識到潛在後果？
    - How could a public debate about climate change be further developed?
    - 如何進一步發展關於氣候變化的公開辯論？

7. Closing questions
    - What role could your institution play in that transition?
    - 在這個轉變中新社區能扮演什麼角色？
    - For how long have you been working in this institution?
    - 您是市長多久了？
    - Do you have anything to add?
    - 您有什麼要補充嗎？

Appendix 3 – letter of consent

Letter of consent to participate in research interview

1. I understand that the interview procedure contains several email exchanges (asynchronous in-depth interviewing conducted via email).
2. I understand that the data collected via the interview will be analysed by Lars Holländer.
3. My written responses are my own, which I agree to share them for this research, but of course reserve the right to reuse my words/any responses generated.
4. The analysed data and results will be public, as Lars Holländer's master thesis will be published at Lund University.
5. All opinions and values stated during the interview will be collected anonymously.

I agree that the interview will be transcribed for further analysis. ☐

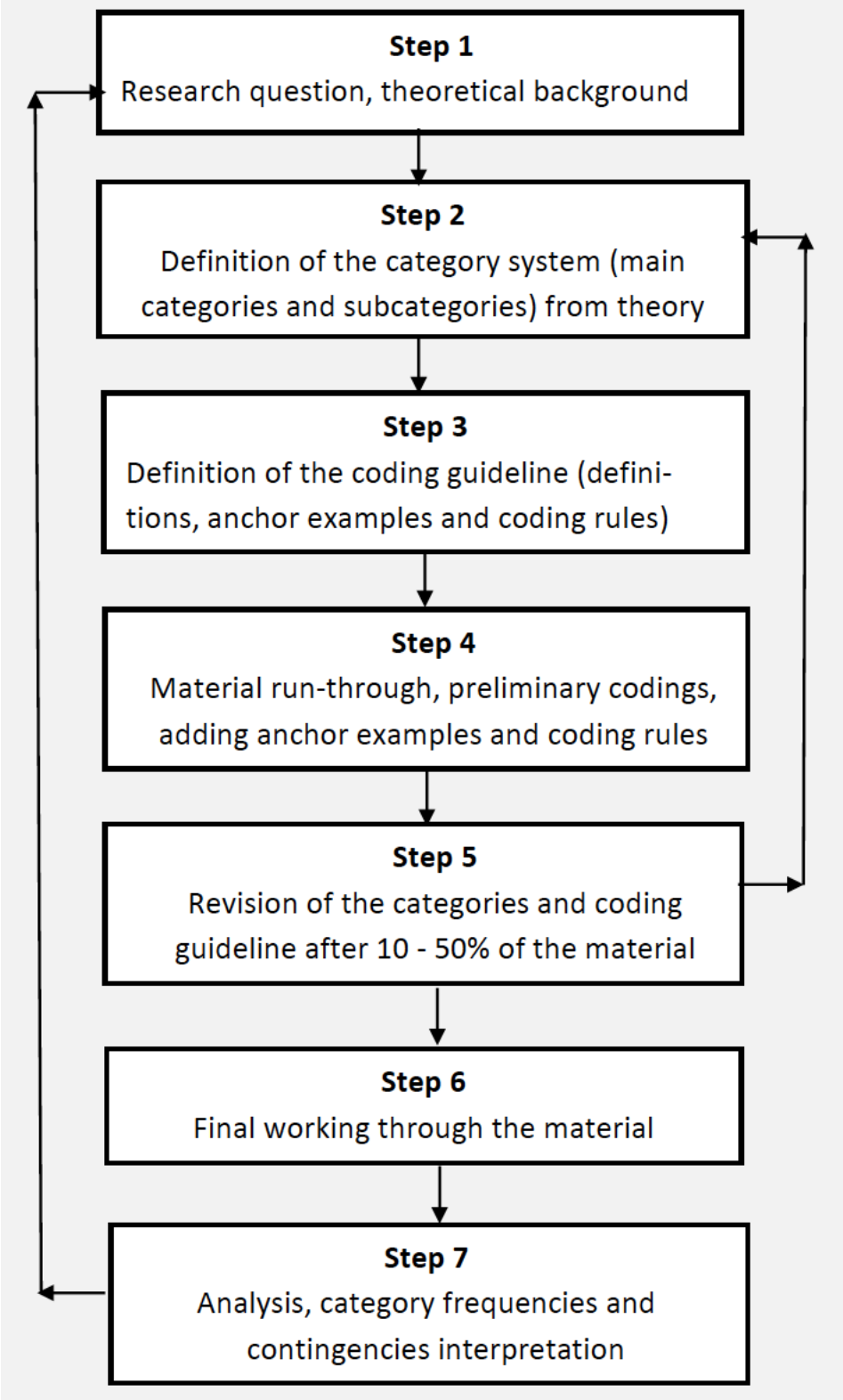
I agree that my answers can be quoted in text (anonymously). ☐

I hereby confirm that I have read, understood and agreed to the criteria above.

_____ _____

Signature of interviewee Location, date

Appendix 4 – procedural model of Structuring (deductive category assignment)



source: (Mayring, 2014)

Appendix 5 – Summary of medium-term governance plan 2011-2014 (full table)

Strategic Performance Objectives	Measurement	Actions
1. business-oriented • promote environmental education • volunteer-service	Count certification of excellent environmental education facilities	Environmental literacy, database, grassroots activity, sustainable development of Taichung City
2. clean air trio • improve air quality by controlling • industry, power plants • promoting green transport (GT) • tighten construction site pollution	Number of days with a PSI value >100 Measure O3, PM10 concentration Number of vehicles at the scrap yard	Air quality monitoring, formulate new regulations for industries and power plant operators, EVs for police patrol, more vehicle charging stations, regular inspection, tree planting
3. low-carbon city / GT • become a sustainable life environment • government regulations for EVs • incorporate low-carbon thinking in all bureaus	Number of GT demonstration communities Number of electric vehicles Number of bicycles used	National low-carbon demonstration city, participate in international meetings, switch to EVs, cooperate with public transport,
4. waste reduction & resource recycling • through new technologies	Calculate resource recovery rate, reduction rate of garbage removal	Implementation of garbage collecting fee,
5. clean-up public and private lands • public environmental hygiene • promote environmental awareness	Report dirty spots Check tap water quality	Maintenance of green spaces, urban landscape beautification,
6. on-site inspection of toxic chemicals	Inspection failure rate of less than 10%	Control of toxic chemical substances

• through inspectors		
7. public information • enhance environmental protection	Number of punctual arrivals of garbage trucks	Promote information services to citizens
8. public information • enhance environmental protection	Number of new vehicles	Sort old vehicles out, get new ones
9. recycling of waste furniture • environmental education	Waste recycling rate Create a new website, number of people online	Environmental park for education and learning,
10. waste disposal policy • reduce landfill rate	Proper waste disposal rate and raw landfill ratio	Unite processing capacity of 3 resource recovery plants
11. water quality / soil protection • promote river quality • public drinking water safety • control contaminated soil • sustainable use of land	Measure severe river pollution Area of remediation of contaminated soil Assessment of major pollution sources	Formulate improvement plans, groundwater monitoring work, investigate and control key target zones

source: (TEPA, 2014b)

Appendix 6 – Summary of medium-term governance plan (2015-2018)

Strategic Performance Objectives	Measurement	Actions
1. business-oriented • environmental education / literacy	Measure the total amount of distributed learning passports at schools	Implement a lifelong learning passport
2. improve water and soil quality • maintain / improve river basins	Measure River Pollution Index (RPI)	Improve of river basins, reduce river pollution, manage contaminated farmland
3. cleaning vehicles • increase number of cleaning vehicles • additional manpower	Number of new vehicles Number of new employees	Sort old vehicles out, get new ones
4. maintenance of air quality • health risk assessment	Measure reductions in PM 2.5, NOx,	Investigate air pollution at Taichung harbour, health risk assessment at port
5. green beautification • more green areas	Number of new green areas Measure new planting areas	More green spaces, provision of environmentally friendly farming areas,
6. toxic chemicals / drinking water • inspection / sampling	Number of harmful products Number of water samples	Investigate harmful products, test household drinking water annually,
7. waste disposal / low-carbon energy • reduce landfill rate	Landfill rate Calculation of bioenergy generation	Reduce CO2 emissions by landfill gas recovery and renewable energy generation

source: (TEPA, 2015c)