

ICT policies making toward smart living in Taiwan

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

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Abstract

Taiwan's government has had the goal of adopting smart living enabled by Information and Communication Technology (ICT) infrastructure and applications. Previous Taiwanese government's ICT policies have primarily focused on the development of ICT industries with an emphasis on hardware production. To achieve smart living goals, there was a need to shift the direction of ICT policies to promote the development of an advanced ICT infrastructure and applications to realise these smart living goals. This research analyses policy documents to better understand how Taiwanese ICT policies have supported the development and application of smart living by drawing on concepts from Actor Network Theory to explain the interaction of human and non-human actors in the execution of Taiwan's ICT policies. The results of this research show that the execution of Taiwan's ICT policies has been divided into focusing on different developmental areas in terms of the ICT industry, broadband and wireless infrastructure, the smart living industry and public ICT service. The major finding of this research is that Taiwan's government is the main actor in developing Taiwan's ICT capability and combining existing technologies toward the development of smart living.

Chapter 1. Introduction

Recently, with the ubiquitous distribution of Information and Communication Technology (ICT) into human everyday life, research on the application of ICT has become popular (Weiser, 1991). Recently, smart living, an application of ubiquitous ICT, has received increasing attention among governments (Chen, 2012). Smart living is the combination of ICT and human living requirements, which leads to novel functions, interactions and user experiences with computing (Chi, Chen, Liu & Chu, 2007; Lee et al., 2011). Smart living enables individuals to improve their quality of life (Khalid, 2016). For example, housing is equipped with Bluetooth technology to provide convenience and comfort in terms of remote controlling of air conditioning, lighting and heating (Yan & Shi, 2013); transportation facilities have been improved because of cloud computing and the Internet of Things (IoT), which have resulted in the development of a smart system for improving the safety and efficiency of transportation (Guerrero-Ibanez, Zeadally & Contreras-Castillo, 2015); and healthcare technology includes an automated monitoring system which is designed for taking electrocardiogram measurements and using body surface electrodes (Tamura, Kawarada, Nambu, Tsukada, Sasaki & Yamakoshi, 2007). The blending of ICT with human requirements leads to the emergence of smart living, and the accelerated pace and the formation of smart living applications (Khalid, 2016).

Research shows that smart living is driven by the government in most countries and also by the combination of governmental and non-governmental entities. Various approaches are used to apply smart living in daily life (Chi, Chen, Liu & Chu, 2007). For example, Denmark promotes smart healthcare services, Sweden operates an intelligent transportation system, Russia utilises cloud computing for promoting ubiquitous information access, and Germany deploys RFID-based intelligent logistics in their smart living applications (Chen, 2012). The reason to adopt smart living is because governments around the world face overpopulation. The significant growth of population as it expands outwards and upwards in human living areas results in

overwhelming the natural environment and replacing it with a human-centric living ecosystem (Chen, 2012; United Nations Urbanisation prospect, 2011). This trend is indicated in the emerging living challenges of overcrowded housing, poor sanitation, inadequate transportation systems, and in healthcare and public safety (Chen, 2012). To improve these issues, governments, business and communities have worked together to execute smart living initiatives at a national level as they have increasingly relied on smart technology to improve living conditions (Washburn, Sindhu, Balaouras, Dines, Hayes & Nelson, 2009). For example, South Korea is developing Songdo city with intelligent applications that encompass the principles of sustainable design and technology for assisting residents, from managing their urban life to traffic control, water, energy use and recycling (Angelidou, 2014; Naphade, Banavar, Harrison, Paraszcak & Morris, 2011).

To understand the development of smart living in this context, examining ICT policies is needed because the application of smart living is through the execution of ICT policies which advance and develop the use of ICT for the social benefit of human living requirements (Nam & Pardo, 2011). By examining ICT policies, we can understand how ICT policies help achieve smart living (Angelidou, 2014). However, ICT policies toward smart living are not only for the improvement of the quality of people's lives but also promote the development of other industries that connect with ICT, as many countries around the world have increasingly adopted the idea of using smart living to incorporate the use of ICT in all aspects of human life (Chen, 2012; Lee et al., 2011). In this sense, ICT policies are considered to increase the innovation in other industries. The technologies of other industries may consequently be advanced in their accompanied new products with the support of ICT policies (Chen, 2012). Because of the increase in worldwide governmental attention on the idea of adopting smart living, smart living is interconnected with the development of national strategies. This reveals that effective support from the government is important to develop smart living opportunities. In this study, Taiwan is the country case. Its government effectively supports the development of smart living. In past

decades, Taiwan was a developing and resource-poor country. Through the execution of ICT policies, the government has established the capabilities of ICT and developed the ICT industry in Taiwan, which has brought about the economic growth of this country and led to its leading position as a manufacturer of semiconductors and computer components in the world. In the 2000s, when the ICT service-related industry became the main factor in the growth of the global economy, Taiwan proposed the initiative of smart living technology to develop more human-centric technologies to serve as a paradigm to make sure that Taiwan's ICT industry could innovate its technologies during the transition toward ICT service-related innovation. Currently, Taiwan has been making efforts to stretch the application of smart living into human living requirements and has been incubating the smart living industry as an engine of new economic growth. Taiwan's government has had clear goals for its society, environment and economy. As a latecomer in developing ICT towards smart living, Taiwan's smart living initiatives have been compared to other countries' successful implementations (Lee et al., 2011). To understand Taiwan's ICT policies for developing smart living, this dissertation will investigate how ICT policies support the development of smart living in Taiwan.

To answer the research question, this dissertation draws upon Actor-network theory (ANT) as a theoretical lens to analyse the role of the government, ICT industry, and other private organisations that have interacted with the existing ICTs and ICT infrastructure in making ICT policies toward smart living in Taiwan.

The remainder of this dissertation is organised as follows. Firstly, the literature of past research on smart living is explained, then ICT policy and ANT are reviewed. Secondly, data analysis of this research is outlined. Thirdly, ICT policies that have been made toward smart living are presented, as well as the roles and interactions among the government, ICT industry, other private organisations, ICTs and ICT infrastructure to develop ICT in Taiwan. Finally, this research concludes by discussing the implications of ICT policies supporting the development of smart living.

Chapter 2. Literature Review

2.1 Introduction

The use of ICT to meet human living requirements with regard to housing, education, security, the environment and healthcare is referred to as smart living (Chen & Chang, 2009). The ultimate goal of smart living is to make human life easier by using ICT to improve diverse aspects such as transportation, environmental safety and healthcare by making them more convenient, efficient, coordinated and automated (Chan et al., 2009; Pan et al., 2011).

To discuss relevant literature on the topic of this research, the review will first discuss the concept of smart living. Secondly, ICT policy development for smart living is discussed. Thirdly, the role of government and non-government actors in smart living will be presented. The fourth section will describe Actor-network theory (ANT). The final section will discuss the ANT theory used for the work and justify why it has been selected as the analytical lens for the work.

2.2 The Concept of Smart Living

This section defines smart living and discusses how smart living assists human life and how support for smart living is provided through ICT tools which enhance the quality of human life. Smart living is the use of ICT for enhanced quality of human life. A new generation of integrated ICT hardware, software and network technologies provide ICT systems with real-time information about the real world and advanced analytics to assist people in making intelligent decisions (Chen, 2012). The usage of ICT to upgrade and innovate existing services and systems such as internal lighting (auto on/off), temperature control and more has become the new approach to energy management in order to overcome emerging living challenges and improve the quality of human life (Chen, 2012; Khalid, 2016). The blending of ICT with human requirements leads to the emergence of smart living and accelerates the formation of smart living applications. Smart living is where human life in physical aspects continuously evolves and grows according to conditions and the environment (Chen, 2012). In terms of intellect and

knowledge, scientific innovations and inventions are still happening in all fields of human life. (Khalid, 2016). The outcome of smart living, thus, is developed in the physical and cognitive aspects of human life (Khalid, 2016). The aspects of improvement in the quality of living can be understood with the following examples. Housing equipped with Bluetooth technology provides convenience and comfort in terms of controlling air conditioning, lighting and heating at home remotely (Yan & Shi, 2013). In terms of education, smart living offers connectivity. Even though students attend classes in different locations, their activities are synchronised (Shi et al., 2003). Transportation facilities have been improved because of cloud computing and IoT, which has resulted in the development of a smart system for improving the safety and efficiency of transportation (Guerrero-Ibanez, Zeadally & Contreras-Castillo, 2015). Similarly, environmental issues are addressed with ICTs. ICTs facilitate a deeper understanding of how sustainability can be introduced in businesses and housing (Fang et al., 2014). In healthcare, there is an automated monitoring system for taking electrocardiogram measurements and measurements are done more easily by using surface body electrodes (Tamura et al., 2007). In short, the concept of smart living has been widely applied to support varied human needs.

The adoption of smart living opportunities can be tracked from a local and a global perspective. From a local perspective, smart living options are embraced because they lead to the construction of ICT-enabled cities. Chen and Chang (2009) and Pellicer, Santa, Bleda, Maestre, Jara and Skarmeta (2013) in describing smart living and smart cities argue that applying ICT into the critical components of infrastructure and services which are related to improving the quality of human life has created more interactive, accessible and effective smart cities. From a global perspective, smart living and smart cities have been recognised as a trend followed by various nations. The reasons for the adoption of this trend are as follows. According to the investigation of the United Nations Urbanisation Prospect (2011), the world population in urban areas has been higher than in rural areas since 2010. It is expected that 60% of people will live in cities in 2050, and the number of people who live in urban areas will reach 6.3 billion in

2050 (Chen, 2012). To address these issues, smart living initiatives have been made by governments, businesses and communities, and they have increasingly relied on smart technology to overcome the issues of population expansion in urban areas (Washburn et al., 2009). With the governments of advanced countries recognizing the importance of smart living in recent years, the move towards smart living has increased (Chen, 2012).

Smart living as understood from the local and global perspective suggests that governments are indeed interested in creating smart cities supported by smart living. Where smart living is considered as the concept of enhanced living with ICT tools, smart cities are an embodiment of all these enhanced living tools and their consequences. ICT is enabled in process associated with cultural services, public services and public safety. The objectives of a smart city are all geared toward enhancing the quality of people's lives (Albino, Berardi & Dangelico, 2015). The formation of smart cities is highly influenced by the government and other factors, which will be discussed here. The government is an important driving factor because it has the power to implement and regulate ICT, which offers smart-living opportunities for its citizens (Albino, Berardi & Dangelico, 2015; Angelidou, 2014; Giffinger, Fertner, Kramar & Meijers, 2007; Pellicer, Santa, Bleda, Maestre, Jara & Skarmeta, 2013). For example, in the USA, the government is implementing a Connected Vehicle Research Program as an intelligent transportation system to improve traffic issues such as car accidents, because the increasing number of people who own vehicles has induced a crowded situation on the roads and a subsequent increase in the number of road accidents (Guerrero-Ibanez, Zeadally & Contreras-Castillo, 2015). Japan has developed Welfare Techno-House as an e-healthcare system to assist its aging population to be capable of living independently using assistive technologies (Chan, Campo, Estève & Fourniols, 2009; Matanle, 2017; Tamura, Kwarada, Nambu, Tsukada, Sasaki & Yamakoshi, 2007). These examples show that governments are actors that drive the formation of smart cities. However, Albino, Berardi and Dangelico (2015) argue that smart city formation are context-dependent on many other factors, too. The other factors as presented by researchers

Albino et al. (2015) and Letaifa (2015) are the demographic diversity of people, capital, labour, infrastructure, economic factors and scientific knowledge about the particular city. These factors can positively influence or deter the formation of smart cities (Weisi & Ping, 2014; Albino, Berardi & Dangelico, 2015; Lu, 2011).

An observation identified in the above literature is that the concept of smart living and the adoption of ICT technology are now becoming a global phenomenon. A growing human population has increased concerns about the need for smart living. The concept of smart cities is one that grew from this demand. Smart cities are where proactive management and planning are done for cities so as to accommodate growing demands for smart living.

2.3 ICT Policy Development for Smart Living

Policy, in general, refers to the direction of action with a specific goal and set of objectives, which is adopted and pursued by a government, a party, and policy-makers and many more interested actors and stakeholders (Nicol, 2003). A policy can be regarded as the direction that must be taken in order to achieve a consolidated set of actions (Torjman, 2005). The term “policy” is related to process and action (Cohen, Salomon & Nijkamp, 2002). Although a policy is often viewed as an action executed by specific people who have power, such as governments or official representatives, a policy can be presented as a series of changes within the decision structure, or just as a declaration (Cohen, Salomon & Nijkamp, 2002).

ICT policies for smart living include actions to advance and promote the development of ICT and the use of ICT for the benefit of society. According to Cohen, Salomon & Nijkamp (2002), there are two basic forms in ICT policy. The first form is the ICT policies and formulations for the application. Here, ICT policy can be formulated in various ways to strengthen the execution of general ICT use in the construction of infrastructure, and educational aspects (Cohen, Salomon & Nijkamp, 2002; McQuaid, 2002). The second form is to understand ICT policy formulations for smart living, where the policy complements the achievement of higher goals

such as smart living or smart city applications (Abgelidou, 2014). These two forms of ICT policy can be regarded as a hierarchy of objective and vehicle (Cohen, Salomon & Nijkamp, 2002). This is because ICT development is a prerequisite for the implementation of any smart living initiative (Nam & Pardo, 2011). The first form of ICT policy has to be presented well, with input from all actors involved in the smart living initiative. When the first form of ICT policy is completed, the second form of ICT policy can then be connected to the previous effort. In the making and execution of ICT policies, there are technical and non-technical aspects to be considered to enhance the development of smart living. For example, assisting in the transformation of local ICT industries, and regulating policy to promote a universal ICT service or to enhance competition among suppliers are all representative of technical and non-technical aspects. Bada and Madon (2006) argue that these actions of making ICT policies will contribute to a country's plan towards smart living and will also serve as a vehicle for long-term benefit, such as the investment in education to improve future human capital in ICT. These actions reveal that ICT policy-making can lead to different results, although ICT policies may be executed in the same ways. Each ICT policy, therefore, has its own approach to developing ICT. Similarly, the results of executing smart living initiatives may also differ.

2.4 Actors/ Stakeholders Influencing Smart Living

Smart living implementation is driven either by the government in most countries or a combination of government and non-government entities. Smart living opportunities can be developed efficiently with government support (Angelidou, 2014; Bria, 2012; Hodgkinson, 2011; Paskaleva, 2011). The government will have the authority to set up the proposal of implementing smart living applications in different areas (Hodgkinson, 2011; Misuraca, Reid & Deakin, 2011). Although there are arguments from the IBM Institute for Business Value (2009), Shi et al. (2003) and Strickland (2011) that the approaches of applying smart living to meet human requirements and to address living challenges can be achieved or provided by

private organisations, the government is still the key actor. This is because the government as an actor might have a much broader view and firmer control over policy implementation for smart living. Governments possess the capabilities to coordinate resources that could aid in the application of smart living in a country or city. Angelidou (2014) argues that top-level authorities are well connected and coordinated when it comes to resource distribution for smart living implementations. They facilitate the mission of having clear roles and responsibilities to enhance the effectiveness of executing national smart living goals (ABB & European House-Ambrosetti, 2012; Nam & Pardo, 2010).

The government as a stakeholder influences smart living policy implementations, and such implementations are rooted in how smart living can be beneficial to the government. Smart living initiatives provide interoperable functions and services, which enable ubiquitous connectivity to transform the process of governmental interaction with its citizens (Nam & Pardo, 2011; Pellicer, Santa, Bleda, Maestre, Jara & Skarmeta, 2013). The operational continuity of all levels in the national smart living strategy can be guaranteed because smart living initiatives are not just the exercise of deploying and utilising ICT (ABB & European House-Ambrosetti, 2012; Nam & Pardo, 2011). They are formed with a broader objective of meeting the evolving needs of mankind (ABB & European House-Ambrosetti, 2012; Nam & Pardo, 2010, 2011). Governmental support of smart living initiatives, thus, provides the process by which smart living initiatives proceed.

The implementation of ICT relating to human needs often comes with some challenges. Because of these challenges, both governmental and non-government actors have to participate and collaborate in smart living implementations. For instance, the application of advanced ICT increases sophistication, but the process of implementation is challenging and to ease the process government intervention is necessary (Hodgkinson, 2011; Nam & Pardo, 2011). The greater the complexity, the greater the need to understand ICT-based opportunities and challenges when executing smart living plans (Nam & Pardo, 2011). The government as a top-

level institutional authority can distribute resources and coordinate with stakeholders, and understand the challenges in terms of the current national situation and how smart living initiatives can be affected by them (Angelidou, 2014). Yigitcanlar and Velibeyoglu (2008) argue that in addition to organised administrative initiatives, the execution of smart living applications requires the support of non-governmental actors too, such as private businesses, and research and development organizations. In this context, other stakeholders are needed, as different opportunities and other action plans for the use of existing ICTs are brought in by these non-governmental actors. Thus, it can be understood that to enable smart living initiatives, it is necessary to have integrated participation, collaboration and networking (Odendaal, 2003). The role of the government is not only confined to making policies but also extends to including partnerships (IBM Institute for Business Value, 2009). The government relates to citizens, society and business to drive growth, innovation and the progression of integrating with technological components (Nam & Pardo, 2011; Nam & Pardo, 2011; Paskaleva-Shapira, Azorin & Chiabai, 2008). Through cooperation with multiple stakeholders, the government is pivotal in the execution of achieving the smart living initiative, and the smart living initiative relies upon the government for its success (Nam & Pardo, 2011).

Different stakeholders such as private organisations become a part of defining ICT policy processes in the context of smart living and thus affect the outcomes of ICT policy execution (Nicol, 2003). The influence of private organisations has grown enormously in the innovation of governmental ICT administrative policies (Chen, 2012; Nicol, 2003). According to Nicol (2003) and Wedel, Shore, Feldman and Lathrop (2005), smart living and ICT policy implementation often involves different actors who are able to guide the development of the vision, goals and principles and plan activities. For example, a policy to promote the development of innovation-based technology in OECD countries involves the participation of various groups such as governments, entrepreneurships and ICT industries (McQuaid, 2002). Policy formulation can help bring together the different actors and stakeholders to achieve

national goals (McQuaid, 2002). The formation of policy through the participation of various actors is also pointed out by Cohen, Salomon and Nijkamp (2002) and Labelle (2005). Policies for smart living are indeed manifested by different actors according to Morestin et al. (2010), who argues that human actors affect the ways of implementing policy and the motivations for promoting policy, and such support will vary between the different human actors. Therefore, ICT policies and their implementation have to be co-created with different stakeholders. The policies are developed in a collaborative and multi-contextual way. Such creation is thus facilitated by the interaction of relevant stakeholders, including government, private organisations, citizens and the material conditions of people's lives when the network of ICT policy actors is formed (Chen, 2012).

2.5 Actor-network Theory

Actor-network theory (ANT) was proposed by Michel Callon, Bruno Latour and John Law in the 1970s. These scholars argued that before ANT human beings were the centre of most social science studies, and there was a binary classification of nature and human society, and human and non-human elements (Lai & Tan, 2011). However, there are various non-human actors that exist in society. For example, in an ICT policy, apart from the involvement of policy-makers and related stakeholders as necessary factors in driving the execution of the ICT policy, the existence of non-human factors such as ICT infrastructure and legal and regulatory frameworks are needed to form a coalesced national-level initiative for smart living. Murdoch (1997) argues that there are omissions when considering people and technology, and ANT posits that such divisions are in fact artificially formed. The purpose of ANT is to overcome the divide between the social and technological world with symmetry, by observing the actors in the social world and the artefacts in the technological world (Tatnall & Gilding, 1999; Yoo, Lyytinen & Yang, 2005). It provides a concept to interpret a project or a policy which is associated with human beings, technologies, research and development, resources, institutions and regulation (Young,

Borland & Coghill, 2010).

ANT helps correct the omissions introduced in the unnatural divisions between the human/non-human and technology/society. A symmetrical treatment of these different elements is proposed in the ANT theory (Howcroft, Mitev & Wilson, 2004). An actor is always considered based on properties such as behaviours and interests and its social or technological elements (Yoo, Lyytinen & Yang, 2005). The actor-network is structured through the participation of human and non-human elements in collaboration using a process of translation (Murdoch, 1997). Latour (1983) believed that the construction of networks needs to be through the process of translation, that is, the participants must have consistent goals and consensus, and the relationships within the network must be mutually agreed. The success of the translation of the network is derived from the focal point of interest between actants (Murdoch, 1997). This kind of focal point of interest is an obligatory passage point (Lai & Tan, 2011; Law & Callon, 1988; Yoo, Lyytinen & Yang, 2005). The significance of an obligatory passage point (OPP) is that it explains how a society or a network of actors can form a whole mutual relationship. When all actors face the same obstacles which cannot be overcome, this forms an OPP through which the needs of the focal actor must pass, which is the issue of common concern for each actor. The network is built on this OPP. This research makes use of the translation process of four stages as a lens for investigating smart living initiatives in Taiwan, which are problematisation, interessement, enrolment, and mobilisation. The OPP is identified as that feature in the actor-network theory that is associated with the initial problematisation phase in the translation. The OPP is like the narrow end of a funnel where the actors converge on a topic or question.

2.6 Actor-network Theory — Theoretical Lens for Analysing Smart Living Initiatives in Taiwan

ANT was selected for analysing the current state of smart living initiatives and policy development in Taiwan. ANT has been utilised for the analysis of ICT development and implementation in other countries such as South Korea and Sweden. Research works such as

those of Yoo, Lyytinen and Yang (2005) adopted ANT to analyse how South Korea successfully completed a broadband mobile infrastructure initiative by effectively coordinating between different actors including independent developers, manufacturers, mobile service operators and providers, and users of telecommunication technologies. Cho, Mathiassen and Nilsson (2008) applied ANT to explain the difficulties of executing a radiology network system in a Swedish hospital based on the different views of various actors. Heeks and Stanforth (2007) revealed a perspective to provide an insight into the network of actors that encompassed the e-government initiative of Sri Lanka by drawing on ANT. These studies demonstrate that collective achievements and strategies for successful ICT initiatives require all actors to work together, which possibly could provide the theoretical lens to analyse the relationship between society and technology.

In this study, ANT is used as a conceptual level tool to understand ICT policy-making toward smart living in Taiwan. Taiwan's existing programs such as e-Taiwan and M-Taiwan provide an opportunity to use existing frameworks to understand smart living implementations. This is useful for answering the research question of How ICT policies support the development of smart living in Taiwan. ANT basically presents one focal point which synthesises and balances the needs and opinions of different actors. It helps us understand factors affecting smart living, and the actors influenced by smart living, in a holistic way. As Yoo, Lyytinen and Yang (2005, p 324) argue, "in a broadband mobile infrastructure initiative, effective coordination between different actors or agents are necessary. In their case, independent developers, manufacturers or users of telecommunication technologies include manufacturers, operators, service providers and mobile service users". When collating different viewpoints, ANT emphasises the process and meaning of critiques and translation, once again useful for analysing policies. Translation refers to the four processes of problematisation, interessement, enrolment, and mobilisation from the study of Callon (1984). The processes are presented below.

The first stage is problematisation. In this stage, the main actors and related actors and their

goals and problems are defined. The actors have their own obstacles to break through. The obstacles are of common concern to the actors in the network, which requires the focal actor to lead all the other actors to journey through an obligatory passage point (OPP) and serve as a regulatory actor to constrain the mechanism of entering and leaving the network. In the current case study of Taiwan, this is the stage in which the government actors, private institutions and more will be considered.

The second stage is *interessement*, where an entity seeks to strengthen and stabilise the actions of the other actors through methods and means, which means establishing specific explanations, strengthening social associations to consolidate relationships, and forming an alliance mechanism among actors so that an agreed OPP can be passed through by the different actors. Here, the viewpoints, opinions and researched views of the different actants are considered.

Enrolment is the next stage. This refers to the definition and allocation of roles for the series of actors, transforming the problem into a clear narrative and starting multi-party negotiations.

At the mobilisation stage, the actor plays the assigned role and performs their task and continues to coordinate actions and alliances. At this point, translating is the key to the success or failure of the network — through a series of intermediary displacements whether the mediator is representative or not. Each selected intermediary must meet dual requirements: they must obtain a new replacement, and they must treat the other actors equally (Callon, 1984). This is because in order to meet the dual requirements, the development and adoption of ICT policy, for example, requires the integration of multiple elements, including policy-makers, technologies and networks across organisations. The technologies and interests of the actors need to be aligned and coordinated for the successful execution of the ICT policy; if the views held by the different actors of the ICT policy are not consistent in the process of the network, their views will become controversial and the translation may become a betrayal, which will require different actors to reach a common view for attaining a new replacement position. When an actor in the network challenges the OPP because of suspicion or distrust, the actor will

withdraw from the network, and the connection may collapse (Lai & Tan, 2011). Callon (1984) concludes that the notion of translation is focused on the continuity of substitution, and the actors must express the needs and connective ways of others in their own language.

As argued by Young, Borland and Coghill (2010), the adoption of policy requires the integration of multiple elements, which includes human beings, technologies, research and development, institutions and regulation acting together to produce the innovation. Callon's translation model is helpful to assess the Taiwanese situation with respect to ICT smart living. ANT and the translational model together will ensure that the opinions of micro and macro level actors with respect to smart living policy-creation in Taiwan are never treated as a priori, and this will add value to the outcome of the research. The use of ANT for the examination offers visibility in disclosing the interaction among actants transformed simultaneously by recruitment and mobilisation which, in this case, results in the formation of a smart living initiative network.

Chapter 3. Research Methodology

3.1 Research Paradigm

The ontological assumption of this research is relativism, because this research adopts a personal perspective to interpret how Taiwan's ICT policies support the development of smart living. The decision to take this ontological position clarifies that this research regards the formation of reality as needing to be expressed from a personal perspective (Stout, 2012). Therefore, the way of interpreting the process of making ICT policies toward smart living in Taiwan is decided by the researcher. The epistemological assumption of this research is constructivism. According to constructivism, knowledge is created through subjective human interaction with the world (Gray, 2014). Hence, this research examines Taiwan's ICT policies to create knowledge about how ICT policies support the development of smart living in Taiwan. The research paradigm of this research is interpretivism, since the research adopts a personal perspective to create knowledge by examining the data collected from Taiwanese ICT policy documents. Through using a personal perspective to construct knowledge, this study is explained as to integrate human thought with the world to reflect the knowledge (Scotland, 2012; Walsham, 1995). In other words, reality and knowledge are constructed by human subjectivity (Gray, 2014). As such, exploring the process of making ICT policies toward smart living in Taiwan in this research is shaped by personal subjectivity.

3.2 Research Design

This research chooses the case method because it is an appropriate method to collect data that cannot be easily obtained from other researches. Data used in the analysis is published Taiwanese ICT policy documents. Relevant data was collected from the documentation of Taiwan's governmental departments, who issued ICT policies in relation to ICT development and the smart living initiative. Utilising the data from different governmental departments such as the Executive Yuan, Ministry of Economic Affairs and Ministry of Science and Technology

helps this research to identify how Taiwan's government has supported the development of a smart living initiative via the execution of ICT policies. The secondary data of Taiwanese ICT policy documents suits the purpose of this research in terms of understanding the process of making ICT policies toward smart living in Taiwan.

3.3 Data Collection

The data collection of this research is the Taiwanese ICT policy and smart living initiative documents. Taiwan's ICT policies and smart living initiative are executed by Executive Yuan, Ministry of Economic Affairs, Ministry of Science and Technology and Ministry of Health and Welfare. The smart living initiative and most ICT policies are planned by Executive Yuan, which then collaborates with other ministries to execute the decision of Executive Yuan. Therefore, this research collected data from the websites of these governmental departments as the content of the ICT policies and smart living initiative which mention the above governmental stakeholders as being decision-makers and collaborators. The total number of ICT policy documents collected was 17. The publication date of these documents is from 1973 to 2017. The ICT policy documents from 1973 to 1980 outline the establishment of the Industrial Technology Research Institute, Institute for Information Industry and Science Parks, which were the starting point to establish the capabilities for manufacturing semiconductors and computer components, innovating the capabilities of manufacturing computer components and the ICT industry in Taiwan. Following these ICT policies, documents about the execution of e-Taiwan, M-Taiwan, u-Taiwan, i-236 project, and Intelligent Taiwan, from 2002 to 2009, in relation to the construction of broadband and wireless infrastructure and the development of a public ICT service, were collected. To analyse the effect of these ICT policies, the following data were selected for the research: the Plan of National Information and Communication Development 2007–2016 (assisting to innovate the capabilities of Taiwan's ICT-related private organisations), National Science and Technology Development 2009–2012 (evaluating

Taiwan's ICT capabilities for executing its smart living initiative) and the Promotion of Six Emerging Industries (promoting the application of semiconductor computer components in the development of medical equipment for the biotechnology industry; solar energy and light saving technologies for the green energy industry; and the improvement of hardware and software facilities for the development of excellent agriculture, healthcare, and the cultural and creative industries) and Four Emerging Smart Industries Development (promoting the development of cloud computing, sensor equipment, a smart healthcare cloud and smart green buildings) between 2009 and 2010. Finally, Taiwanese ICT policy documents in relation to smart living were collected to integrate with the previous data collection to analyse how Taiwan's ICT policies have supported the development of smart living. These documents are the Plan of Promoting Smart Living's Application 2010-2013, the Promotion of Big Data 2012, the Plan of Taiwan's Health Cloud 2013 and the Plan of Popularising the Application of Smart Living in Urban and Rural Areas 2017.

3.4 Data Analysis

Taiwanese ICT policy documents are organised chronologically for the purpose of the analysis. The process of making ICT policies toward smart living in Taiwan is analysed first. Various ICT policies will be examined that discuss events which are related to the development of the smart living initiative. To analyse these ICT policy documents, data analysis will utilise ANT as the theoretical lens. This is because ANT offers a perspective for analysing the interaction between human and non-human, and social and technological aspects in the implementation of ICT policies to develop ICT. The execution of Taiwan's ICT policies involves various actors, which are human and non-human, such as governmental stakeholders, private organisations, research institutes, science parks, ICT capabilities and ICT infrastructure. ANT concepts provide the foundation to analyse the association among human beings, technologies, research and development, resources, institutions and regulation in the network. Also, ANT explains the

role of the actors who were involved in the process of forming the network. By applying ANT to this research, the context of how Taiwan's ICT policies have been executed through a process of negotiation between human and non-human actors can be obtained. Therefore, establishing the actor-network from examining the Taiwanese ICT policy documents helps to explain how Taiwan's government has made ICT policies toward smart living, in terms of analysing the relationship between the government, private organisations, research institutes, science parks, ICT infrastructure and ICT capabilities.

Chapter 4. Case Study

4.1 ICT Policies Intending to Develop Smart Living in Taiwan

Fifty years ago, Taiwan was a resource-poor developing country (Dahl & Lopez-Claros, 2005). By executing good policies, such as encouraging foreign direct investment in the past few decades, Taiwan has overcome its shortage of natural resources through the transformation from an agricultural to an industrial economy (Dahl & Lopez-Claros, 2005; Lin, Cheng & Sha, 2003; Zheng & Hu, 2008). Since ICT has contributed to Taiwan's economic growth and its competitiveness with other countries, Taiwan's government has realised the necessity of transforming its economy again from traditional labour-intensive industries to technologically intensive industries (Heeks, 2010; Lin, Cheng & Sha, 2003; Zheng & Hu 2008). The promotion of science and technology as a national priority was thus determined in the late 1960s, which subsequently led to the establishment of the Industrial Technology Research Institute (ITRI) and paved the road toward the development of the ICT industry in Taiwan (Yee, 2013). Commissioned by the government, the ITRI promoted industrial upgrading and exploited domestic and global resources through collaboration with the government, research organisations and industries to build ICT capabilities and to cultivate the capabilities of the ICT industry (Lin, Cheng & Sha, 2003; Yee, 2013). These collaborations sped up the commercialisation of ICT products such as semiconductors in Taiwan and then motivated the development of technology-based industries, which produced leading ICT companies such as the United Microelectronics Company and the Taiwan Semiconductor Manufacturing Company in the 1980s (Yee, 2013). Later on, the emergence of cloud computing changed the ICT industry value chain by introducing global competition based on software and services which negatively affected Taiwan's ICT industry (Wang & Unger, 2013; Yang & Hsu, 2011). The transformation of the ICT industry became the main priority for the government (Yee, 2013).

The Institute for Information Industry (III) established in 1979 was in charge of running a project to develop cloud technology for assisting the transformation of the ICT industry (Yee,

2013). Through the assistance of III, the enhancement of integrating software into ICT hardware, to deliver cloud infrastructure and services, has brought higher value to customers and higher margins for Taiwan's ICT companies and enabled them to be able to reach worldwide markets through cloud technology (Wang & Unger, 2013). The Taiwanese government has succeeded in promoting ICT development and innovation by implementing ICT policies which have contributed to Taiwan's new economic growth in the ICT field. However, Taiwan still has much scope for the creation of a higher value ICT industry that is built on novel services, products and systems (Lee et al., 2011). As many advanced countries have attached more importance to innovating ICT for the purpose of smart living (in various areas such as healthcare, transportation, public service and energy), the Taiwanese government's focus on ICT mass manufacturing has been inadequate to allow Taiwan to maintain continued strong economic growth (Chen, 2012; Lee et al., 2011). In response to this situation, Taiwan's government proposed several ICT policies which focused on the construction of smart living technology infrastructure. These ICT policies assisted Taiwan to push forward national ICT infrastructure and to advance ICT applications, to build ubiquitous wireless broadband to provide a broadband mobile service for the public and to accelerate the introduction of smart technologies (e.g., mobile service) to improve the quality of people's lives, and expand the ICT infrastructure environment for innovative ICT services. Following these ICT policies, the i236 project was proposed as a leading programme to identify how ICT could be applied to smart living. The dimensions of this project for Taiwan were threefold (Lee et al., 2011). The first dimension that related to smart living enabled the cultivation of new industries by connecting workforce professionals across the country. The creation of new industries allowed the leverage of information and awareness to enhance the further application of smart living technologies such as Living Zones or Living Labs. The second dimension aimed to promote business opportunities for local industries and ensure that local industries could be integrated with ICT technology for the execution of a national smart living initiative. Thirdly, the project developed smart living

innovation models based on user needs; for example, two types of living zone (city and town) and three main ICT technologies (wireless broadband network, digital TV network and wireless sensor network) would be combined for the improvement of people's quality of life. In this smart living initiative, a service-driven model gave users an important role as part of the new ICT policy direction. Future ICT policies in Taiwan will be focused on the creation of differentiated services and sectors, from manufacturing to other areas. The smart living initiative will use ICT as a tool in order to enhance Taiwan's global industrial competitiveness and improve the quality of people's lives.

4.2 Actor-network of ICT Policy-making Toward Smart Living in Taiwan

This research utilises ANT as a lens to analyse the process of forming the network, and to understand human and non-human actors in the network, as well as the interaction between the actors in Taiwan's ICT policy-making toward smart living. It analyses how the actors work together toward the development and implementation of the smart living initiative. The actors in the network include the human actors of Executive Yuan, Ministry of Economic Affairs (MOEA), Ministry of Science and Technology (MOST), Ministry of Health and Welfare (MOHW), Ministry of the Interior (MOTI), ITRI, III, the ICT industry, other private organisations, Taiwan's people, and the non-human actors of science parks, semiconductors, computer components, cloud technology, sensor equipment, broadband and wireless infrastructure, and the internet. These actors are derived from the analysis of Taiwanese ICT policy documents. Through analysing each ICT policy event, a deeper understanding regarding the formation process of the network is obtained. This research encodes ICT policies as P1, P2 etc. in a time line as shown in Figure 1. For example, 1973 was when the Industrial Technology Research Institute was established and 1979 was when the Institute for Information Industry was established. These are coded as P1 and P2. In addition, through the analysis of Taiwan's ICT policies, the key actors in the actor-network are shown in Table 1.

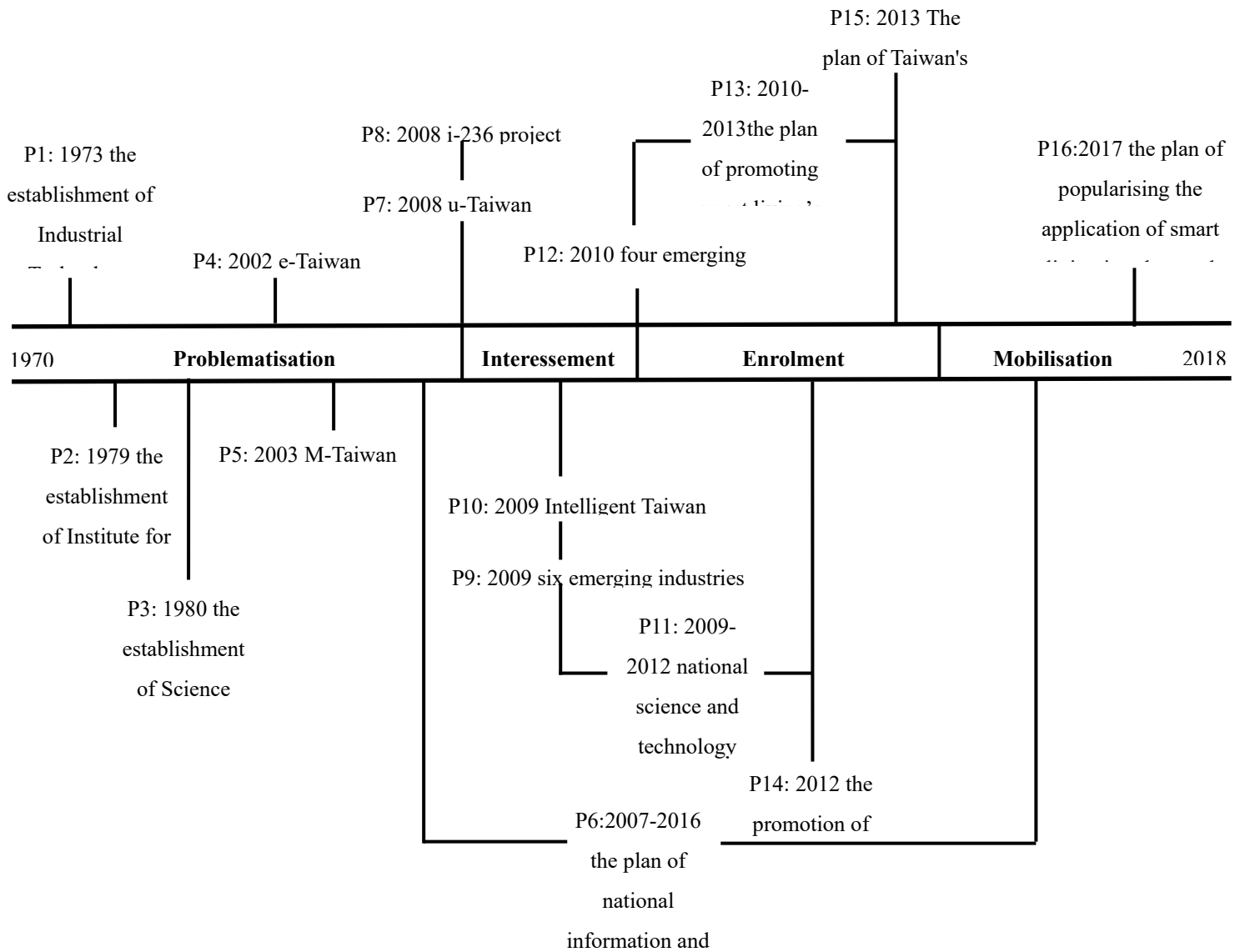


Figure 1: The formation process of ICT policy-making toward smart living in Taiwan

4.3 Actor-network in Taiwan's ICT Policies

4.3.1 Problematisation

This subsection will explain the context of translating the process of problematisation from Taiwanese ICT policy documents. In this stage the focal actor leads all the other actors to journey through an obligatory passage point (OPP) and serves as a regulatory actor to constrain the mechanism of entering and leaving the network. The below table provides an overview of translating the process of problematisation in the interaction of human and non-human actors

in the execution of Taiwan's ICT policies. The complete background of translating the process of problematisation is then discussed.

Table 1: Overview of translating the process of problematisation among the interaction of human and non-human actors in the execution of Taiwan's ICT policies

Analysis	Evidence
MOEA was a focal actor in establishing ITRI and III in the execution of Taiwan's initial ICT policy by identifying the needs of developing ICT capabilities in terms of making semiconductors and computer components and innovating ICT.	Taiwan needed to establish ITRI and III for developing the ICT capabilities of making semiconductors and computer components and innovating ICT to transform Taiwan's economy from the traditional labour-intensive industries to technologically intensive industries. (P1, P2)
MOST interacted with the existing technologies of semiconductors and computer components to establish science parks for supporting the practical applications of the ICT industry, and then facilitated the interaction between the technologies and research institutes for technological innovation.	After the establishment of capabilities for making semiconductors and computer components, the lack of a platform to support the practical application of the ICT industry was identified by MOST as being a potential problem in achieving the planned economic and industrial transformation as well as the innovation of technologies. (P3)
In e-Taiwan, M-Taiwan and u-Taiwan, Executive Yuan interacted with broadband and wireless infrastructure then coordinated each city government and telecommunication company and the companies' capabilities to construct a broadband and wireless infrastructure.	During the execution of e-Taiwan, M-Taiwan and u-Taiwan, Executive Yuan received information about the need for constructing a broadband and wireless infrastructure from each city's government. Based on the information provided from each city government, Executive Yuan invited telecommunication companies to address the need. It required the companies to examine the capabilities of their broadband and wireless technologies as to whether they were capable of participating in the construction of a broadband and wireless infrastructure. (P4, P5, P6, P7)
Taiwan's government interacted with ICT-related private organisations and their capabilities for ICT development and innovation in the national information and	ICT-related private organisations in Taiwan were assisted by the government's investment in ICT development and innovation to develop and innovate their technologies. Through this

communication development plan in order to develop future ICT policies.	development, these organisations could collaborate with the execution of future ICT policies. (P6)
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Taiwan's government had blueprinted the development of the smart living initiative since the first ICT policy was issued by MOEA in 1973. At this time, MOEA was a focal actor in the initial development of the actor-network to form ICT policy. This is because when Taiwan's government was facing the challenge of transforming a labour-intensive industry into a technologically intensive industry, MOEA decided to establish ITRI and III after interacting with the manufacturers of semiconductors and computer components from advanced countries (III, 2018; ITRI, 2018).

“The establishment of ITRI and III by MOEA began the development of Taiwan's capability of manufacturing semiconductors and computer components (P1, P2).”

After the establishment of ITRI and III, the lack of a platform to support the practical applications of the ICT industry was identified as a potential problem in achieving the planned economic and industrial transformation. The involvement of MOST in establishing science parks in the formation process of the network tackled the issue by shaping the environment and conditions for ICT industrial development. This contribution enabled personnel between Taiwanese and foreign research and academic institutes to interact with each other for the purpose of developing and innovating the manufacturing process of semiconductors and computer components. The generation of new and innovative ICT technologies in science parks encouraged ICT firms to develop innovative ICT in the field of semiconductors and computer components. Taiwan's government interacted with the existing semiconductor and computer component technologies to decide the policy for the development of these technologies in terms of the need for economic transformation.

“This facilitated the interaction between governmental units, research institutes, ICT firms, and the technologies of semiconductors and computer components in the establishment of science parks (P3).”

However, with the development of ICT and the ICT industry, ICT-based development for a national ICT infrastructure (in terms of the public service of ICT applications between the government and citizens) became the long-range objective in Taiwan (P6):

“This is because governments around the world had planned forward-looking ICT policies, such as Japan’s e-Japan and u-Japan, and South Korea’s e-Korea, IT839 and u-Korea. A series of actions taken in ICT infrastructure construction and in the legislative environment enabled these governments to develop a convenient electronic service for their people and apply industrial information in order to raise their national competitiveness (P6).”

As a reaction to this trend, Taiwan’s lack of ICT infrastructure was identified. The transformation of worldwide national ICT development drove Executive Yuan to promote e-Taiwan (2002), M-Taiwan (2003) and u-Taiwan (2008). These three ICT policies focused on the construction of broadband and wireless infrastructure, and the innovation of the public service using the internet to construct the Ubiquitous Network Society (UNS). The series of these three ICT policies marked the beginning of forming the network in Taiwan’s ICT policies, pushing Taiwan towards smart living.

“The construction of UNS was to enable people to enjoy food, clothing, housing, travel, education, and so on ubiquitously by accessing an e-service. Combining a ubiquitous network with people’s needs to facilitate socio-economic and technological development is aimed at applying new technology to enhance quality of life in the construction of good environment, industry and living conditions (P4, P5, P7).”

Applying ICT into the broad areas of human activities reveals that these three ICT policies were required to encompass efforts across the actors of Executive Yuan, city governments, telecommunication companies, and broadband and wireless infrastructure. For example:

“Executive Yuan coordinated with each city government and telecommunication company to construct a broadband and wireless infrastructure. To do this, Executive Yuan needed to understand the current broadband and wireless infrastructure situation via a report from each city government. It then clarified the need for the construction of a broadband and wireless infrastructure before executing the ICT policy. Also, Executive Yuan required telecommunication companies to know whether they were capable of participating in the construction of a national ICT infrastructure (P4, P5, P7).”

In the execution of these three ICT policies, the role of Executive Yuan in explicitly planning the contents of the ICT policies became an OPP for making ICT policies toward smart living in Taiwan. This is because Executive Yuan involved various actors in converging on the topic of building UNS as the narrow end of the funnel. The construction of collaborative relationships among city governments, telecommunication companies, their broadband and wireless network capabilities and broadband and wireless infrastructure shows that Executive Yuan was a necessary element in the formation of the network for these ICT policies. Executive Yuan mediated the interaction across each city government and telecommunication company so that it could subsequently decide the construction of the broadband and wireless infrastructure (P4, P5). The involvement of Executive Yuan in negotiating with city governments and telecommunication companies allowed these actors a degree of autonomy in terms of investigating the current situation regarding the national ICT infrastructure and the capabilities of the broadband and wireless network (P7). Therefore, Executive Yuan defined its position as a mediator which filtered and reformatted the information received from city governments, ICT infrastructure, telecommunication companies and their broadband and wireless network capabilities. It also selectively distributed the information for the purpose of executing the ICT policies.

4.3.2 *Interessement*

This subsection will explain the context of translating the process of interessement from the Taiwanese ICT policy's documents. Interessement is how an entity seeks to strengthen and stabilise the actions of other actors through methods and means, such as establishing specific explanations, strengthening social associations to consolidate relationships, and forming an alliance mechanism among the actors so that an agreed OPP can be achieved by the different actors. The table below provides an overview of translating the process of interessement in the interaction of human and non-human actors in the execution of Taiwan's ICT policies. The complete background of translating the process of interessement is then discussed.

Table 2: Overview of translating the process of interessement among the interaction of human and non-human actors in the execution of Taiwan's ICT policies

Analysis	Evidence
Taiwan's government interacted with ICT-related private organisations and their capabilities for ICT development and innovation in the national information and communication development plan in order to develop future ICT policies.	ICT-related private organisations in Taiwan have been assisted by the government's investment in ICT development and innovation to develop and innovate their technologies. Through this development, these organisations could collaborate with the execution of future ICT policies. (P6)
ITRI and III interacted with the technologies of ICT and six emerging industries to establish the living lab for smart living applications in the i-236 project.	In the execution of the i-236 project to introduce ICT innovative applications in public services, ITRI and III were responsible for working with key industries to establish the living lab for smart living applications. In this collaboration, the innovative technologies of ICT and six emerging industries were transferred to ITRI and III in order to establish the living lab. (P8)
Taiwan's government interacted with the tourism, green energy, healthcare, biotechnology, cultural and creative and agriculture industries, the technologies of these industries, semiconductors and computer components in the policy of	In the development of six emerging industries, semiconductors and computer components were utilised to develop medical equipment for the biotechnology industry, solar energy and light saving technologies for the green energy industry, and to improve hardware and software

developing six emerging industries.	facilities for the development of the excellent agriculture, healthcare, cultural and creative industries. (P9)
ICT applications, broadband and wireless Interacted with the needs of people in terms of their educational, economic, regional, physical and mental differences in the execution of Intelligent Taiwan.	The construction of innovative ICT applications for people was the purpose of Intelligent Taiwan. It would directly contribute to people having more ways to access ICT in terms of their educational, economic, regional and physical and mental differences. Broadband and wireless convergence was the contribution to address these barriers. (P10)

Following the identification of ICT policies to be implemented for smart living in Taiwan, Executive Yuan developed a smart living initiative by engaging with other actors, such as private organisations and research institutes.

First, ICT firms in Taiwan have been assisted by the government's investment in terms of the development of cloud computing.

“Through this development of their technologies, these ICT organisations could collaborate with the execution of future ICT policies (P6).”

Through governmental assistance, other private organisations have had opportunities to expand their business range based on Taiwan's existing ICT advantages. For example,

“in the development of Taiwan's six emerging industries, ie tourism, green energy, healthcare, biotechnology, cultural and creative industries and agriculture, semiconductors and computer components have been utilised to develop medical equipment for the biotechnology industry; solar energy and light saving technologies for the green energy

industry; and to improve hardware and software facilities for the development of the excellent agriculture, healthcare, and cultural and creative industries (P9).”

ICT-related and other private organisations undoubtedly obtain benefits as they can cooperate with each other. Innovative technologies have also been advanced by the innovation of ICT firms and other private organisations’ technologies.

Secondly, ITRI and III are defined as having the role of collaborating with ICT and the six emerging industries in the execution of innovative ICT applications for smart living:

“ITRI and III are in charge of working with key industries to establish the living lab of smart living applications and to introduce innovative applications and services (P8).”

On the other hand, obtaining innovative technologies was an interest of ITRI and III because facilitating integration across different areas of technology enabled transfer of new technology to ITRI and III while they were collaborating with ICT and the six emerging industries. Therefore, ITRI and III were incorporated as additional beneficiaries in the execution of innovative ICT applications for smart living.

Finally, the intention of involving multiple parties to ensure the successful execution of innovative ICT applications reveals one facet of scalability: that people are the would-be beneficiaries. The indication from Intelligent Taiwan (2009) was that:

“the policy is focused on the integration of technology and culture. It is to establish a smart living environment which works together with innovative technological services to promote the concept of smart living in order to provide people with a good living environment. By expanding the application of ICT, people are able to enjoy e-life through multiple channels despite their educational, economic, regional and physical differences (P10).”

The construction of innovative ICT applications for people is revealed as being the purpose of this ICT policy. It directly contributes to people having more ways to access ICT. In addition, wireless and broadband convergence is a beneficiary in this ICT policy, as people could access

ICT through the internet despite regional differences. The construction of a ubiquitous network environment enabled a ubiquitous network computing technology to be built, such as a function for connecting different types of network system, including wired and wireless sensor networks. Therefore, the expansion of wireless and broadband convergence combined with IoT contributed to the technology being further utilised (P10).

4.3.3 Enrolment

The third subsection will explain the context of translating the process of enrolment from the Taiwanese ICT policy's documents. Enrolment is how the definition and allocation of a series of actors transforms the problem into a clear narrative to start multi-party negotiation. The table below provides an overview of translating the process of enrolment in the interaction of human and non-human actors in the execution of Taiwan's ICT policies. The complete background of translating the process of enrolment is then discussed.

Table 3: Overview of translating the process of enrolment among the interaction of human and non-human actors in the execution of Taiwan's ICT policies

Analysis	Evidence
Executive Yuan continuously interacted with semiconductors and computer components for the development of four future emerging smart industries in the national information and communication development plan.	Executive Yuan took advantage of the existing capabilities in making semiconductors and computer components to execute the development of six emerging industries. However, the emerging ICT of cloud computing drove Executive Yuan to prepare for the development of only four emerging smart industries in the national information and communication development plan. (P6)
Executive Yuan interacted with each city government, MOEA, MOTI, MOHW, semiconductors and computer components to decide how to meet the need for smart living applications in the national science and technology development plan.	Executive Yuan evaluated the ways of executing smart living applications based on the situation of city governments, MOEA, MOTI, MOHW, as well as the development of semiconductors and computer components, in the national science and technology development plan. (P11)

MOEA and MOTI, assigned by Executive Yuan, interacted with cloud computing and sensor equipment in preparing to promote a smart healthcare cloud and smart green buildings in the development of four smart emerging industries.	To bring the existing advantages of Taiwan's ICT industry into full play, Executive Yuan assigned MOEA and MOTI to propose cloud computing and sensor equipment as a part of developing four smart emerging industries. Through this development, these technologies were applied for the promotion of a smart healthcare cloud and smart green buildings. (P12)
MOEA interacted with e-books, internet TV and living computers to promote smart living applications in the areas of schools, housing and outdoor places after Executive Yuan interacted with big data to construct the service platform for governmental big data.	e-books, internet TV and living computers were utilised by MOEA to allow students to download textbooks in each city, to combine with human needs to apply into video and security and to increase ICT services to connect with any type of ICT facilities as Executive Yuan promoted big data in the switch from user-centric requirements to the introduction of a human-machine interface for designing smart living applications (P13)
The Executive Yuan interacted with Big data to enable epidemic prevention, disaster prevention, healthcare and environmental protection.	Big data was enrolled in the network and promoted by the Executive Yuan, as governments around the world have utilised big data to advance their applications for epidemic prevention, disaster prevention, healthcare and environmental protection. Therefore, Executive Yuan announced an open data policy by utilising big data to construct its service platform and to encourage research and academic institutes to utilise governmental big data to do research in the areas of epidemic prevention, disaster prevention, smart transportation, and so on. (P14)
Cloud computing and the sensor equipment interacted with MOHW in the innovative cloud remote healthcare service in Taiwan's healthcare plan.	As sensor equipment has been widely used in mobile devices and cloud computing has been emphasised in the development of the six emerging industries and four smart emerging industries, MOHW took these trends to apply these technologies into the innovative cloud

	remote healthcare service (P15).
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In an attempt to build a solid network for the Taiwanese smart living initiative, various actors were organised in preparation for its execution. MOEA, MOTI and MOHW were first enrolled to the network by Executive Yuan (P11). The requirements of the different ministries for preparing the smart living initiative subsequently necessitated the enrolment of private organisations, as preparing for the smart living initiative required the capabilities of private organisations. By involving the capabilities of private organisations, semiconductors, computer components, cloud computing and sensor equipment the smart living initiatives of the different ministries could be carried out. For example,

“MOEA and MOTI followed the strategy of Executive Yuan in the continuous development of semiconductor and computer components to propose cloud computing and sensor equipment as the development strategy for four smart emerging industries, including a smart healthcare cloud and smart green buildings (P6, P12); MOHW interacted with cloud computing and sensor equipment to apply cloud innovative services (P15).”

Furthermore, big data was promoted by the Executive Yuan to be enrolled in the network, as governments around the world have utilised big data to advance their smart living applications in terms of epidemic prevention, disaster prevention, healthcare and environmental protection.

“Executive Yuan thus announced an open data policy by using big data to construct its service platform and encouraging research and academic institutes to utilise governmental big data for research in areas of epidemic prevention, disaster prevention, smart transportation, and so on (P14).”

Through the Promotion of Big Data (2012), big data was utilised for designing smart living applications in terms of human-centric requirements. Because of this, more ICT innovations such as e-books, internet TV and living computers were enrolled in Executive Yuan’s Plan of Promoting Smart Living’s Application (2010-2013) by assigning the mission to MOEA. e-

books, internet TV and living computers subsequently interacted with by MOEA to be utilised in the areas of schools, housing and the outdoors. For example,

“MOEA facilitated students to download textbooks in each city by collaborating with private organisations to integrate the contents of textbooks with big data on a cloud service; MOEA combined internet video and security features with the user interface of private organisations’ big data to meet human needs; MOEA enabled ICT services to be connected with any types of ICT facility by constructing a big data network with private organisations (P13).”

The Plan of Promoting Smart Living’s Application revealed that people’s needs regarding education, internet video and security and ICT services were met by the construction of a big data collaboration between MOEA and private organisations. Through this plan, Executive Yuan also provided the sequence of how it would enrol the actors from the Promotion of Big Data into the Plan of Promoting Smart Living’s Application to execute the Taiwanese smart living initiative. Through the successful enrolment of actors by Executive Yuan to the network, the relationship between private organisations, MOEA, MOTI, MOHW, semiconductors, computer components, cloud computing, sensor equipment, big data, e-books, internet TV and living computers created a dynamic and mutually beneficial outcome. Although there was uncertainty because actors such as big data demonstrated that they had the power to enrol and dominate the network, or, by contrast, they were allowed to enrol in the network because they would bring additional advantages, the establishment of this actor-network provided benefits for Taiwan’s people in accessing smart living services, ICT technologies could be upgraded and the government could innovate public services. Therefore, the actor-network was solid, as the actual ICT policy benefits for people, governmental stakeholders, ICT technologies and private organisations were mutual.

4.3.4 Mobilisation

The final subsection will explain the context of translating the process of mobilisation from Taiwanese ICT policy documents. Mobilisation is how the actor plays the assigned role, performs the task and continues to coordinate actions and alliances. The table below provides an overview of translating the process of mobilisation in the interactions of human and non-human actors in the execution of Taiwan's ICT policies. The complete background of translating the process of mobilisation is then discussed.

Table 4: Overview of translating the process of mobilisation among the interaction of human and non-human actors in the execution of Taiwan's ICT policies

Analysis	Evidence
Executive Yuan interacted with the ICT industry in relation to cloud computing and sensor equipment and its technologies to introduce sensor and cloud technology in traffic management in the plan to popularise the application of smart living in urban and rural areas.	The ICT industry, in relation to cloud computing and IoT, was invited to help launch the Taiwanese cloud healthcare plan. Cloud computing and IoT were also continuously involved in the smart living initiative in terms of introducing sensor and cloud technology into traffic management. (P16)
Executive Yuan interacted with local governments, ministries and their ICT public services in the execution of smart living applications to popularise smart living in urban and rural areas.	Executive Yuan collected issues from the local governments and ministries to facilitate the development of smart living applications in terms of public services. The information provided by local governments and ministries therefore assisted central government in improving the application of ICT in public services. (P16)

During the mobilisation stage, a focal actor, ie Executive Yuan, with the cooperation of ICT industry/private organisations, local governments and different ministries, and interacting with semiconductors, computer components, science parks, cloud computing, big data, broadband and wireless infrastructure, e-books, internet TV and living computers, confirmed the preparatory work for the smart living initiative. As discussed, the development of Taiwan's

smart living initiative began from the execution of the first ICT policy in 1973, which focused on the capability of manufacturing semiconductors and computer components. The execution of other ICT policies between 1979 and 2016 focused on different developmental areas in terms of the ICT industry: broadband and wireless infrastructure, the smart living industry and public ICT service. These and the first ICT policies show that the aims were different from each other. Despite this, these ICT policies were still related to the development of smart living. For example, Executive Yuan collaborated with each city's government and with telecommunication companies in executing e-Taiwan and M-Taiwan to construct broadband and wireless infrastructure. The construction of broadband and wireless infrastructure subsequently contributed to semiconductors and computer components being able to connect with the internet, and then to be applied into cloud computing for the innovative remote healthcare service of the MOHW in the Plan of Taiwan's Health Cloud (2016). The actions of Executive Yuan show that it ensured the actors developing the smart living initiative acted according to the process of developing the smart living initiative through the execution of Taiwan's ICT policies. However, the execution of Taiwan's smart living initiative began in 2017 as the Plan of Popularising the Application of Smart Living in Urban and Rural Areas (P16). With the development of this initiative, the network kept repeating the stages of enrolment and mobilisation. For example, before the announcement of the plan to popularise the application of smart living in urban and rural areas, the ICT industry, in relation to cloud computing and IoT, was invited to join the Taiwanese Healthcare Cloud's Plan at the enrolment stage. In the mobilisation stage, these areas of the ICT industry were continuously involved in the smart living initiative in terms of introducing sensor and cloud technology in traffic management. Similarly, sensor and cloud technology also existed in these two stages as technologies of the ICT industry were applied into the smart living initiative. The network also met regularly at conventions, which enriched the exposure of the actors to information about this smart living initiative. The meetings gave the actors regular opportunities to communicate, coordinate and

review the progress of executing the smart living initiative. The results of the meetings were utilised to coordinate, with the guidance of Executive Yuan, the establishment of a feasible model for local government inter-office integration, industry introduction, equipment maintenance, procurement and data opening, so as to facilitate the sustainable operation of related application services (P16). The involvement of multiple parties in this initiative is revealed in the mobilisation of all the available resources around the network as actors supporting each other when obstacles occurred for the different actors. For example, through the execution of this smart living initiative issues could be collected from local governments and ministries to facilitate the development of smart living applications in order to meet the needs in terms of their area and public services. The information provided from local governments and ministries assisted the central government to improve public service ICT applications among the government and the people, which could not previously connect with each other effectively. This is because, in the past, the model of executing ICT policies was “top down” through the centralised management of central government. The smart living initiative in terms of smart transportation, smart healthcare, smart security, smart learning and smart agriculture developed through mutual assistance between the Executive Yuan, local governments and ministries (P16).

Following the initial ICT policy of developing ICT capabilities and industry for the smart living initiative, coherent ICT policies had made the development of smart living initiative sustainable. Executive Yuan unambiguously assigned MOEA, MOST, MOHW, MOTI, ITRI, III, the ICT industry and other private organisations independence in interacting with semiconductors, computer components, broadband and wireless infrastructure, the internet, cloud technology, sensor equipment, big data, e-books, internet TV and living computers to implement the missions when ICT policies and the smart living initiative were launched. The results show that Taiwan’s ICT policies reached self-sustainability for the governmental units, research institutes

and ICT industry, which had contributed to the development of smart living initiatives as Executive Yuan had planned (P16).

Chapter 5. Discussion and Conclusion

This research examines the development of making ICT policies toward smart living in Taiwan since Taiwan's government announced its first ICT policy in the early 1970s. The purpose of this research is to understand the role of ICT policies in the development of the smart living initiative in Taiwan. Drawing on ANT, this research investigates how the interaction of human and non-human actors generates the application of smart living under the support and guidance of ICT policies in Taiwan.

This research found Taiwan's government had two roles in supporting the development of the smart living initiative. First, the government enabled different actors to form the purpose of developing ICT and to align their interests so that they could build an effective actor-network, which allowed them to shape the context where they could support the development of the smart living initiative. The analysis shows that in the series of e-Taiwan, M-Taiwan and u-Taiwan ICT policies, which were the beginning of making ICT policies toward smart living in Taiwan, Executive Yuan played a significant role in the successful translation and enrolment of key actors in two realms: 1) it enabled the interaction between private organisations and their own capabilities to assist other private organisations to understand their capabilities in the construction of broadband and wireless infrastructure; 2) it facilitated collaboration with other governmental units to meet people's demands for an innovative public service by interacting with the existing broadband and wireless infrastructure. Therefore, Executive Yuan defined a set of OPPs in the process of forming the smart living initiative, which were successfully passed through when the actor-network that was necessary to build the broadband and wireless infrastructure for smart living in Taiwan required the participation of various human and non-human actors.

Similar to the findings on the role of government and ICT policy in ICT and smart living development (Angelidou, 2014; Bria, 2012; Cohen, Salomon & Nijkamp, 2002; Hodgkinson, 2011; Paskaleva, 2011), this research shows that individual actors passively shape the socio-

technical contexts through the execution of ICT policies as much as these contexts limit and drive the national strategies. This then reveals that the strategic choices and options of government for the development of ICT and smart living have to be evaluated with the consideration of how government shapes the context of its ICT policies.

Secondly, Executive Yuan played a pivotal role in shaping the configuration of the actor-network by mediating a consolidated set of actions for the actors. In the ICT policy literature, consolidating a set of actions is used to explain the process by which ICT policies proceed (ABB & European House-Ambrosetti, 2012; Nam & Pardo, 2010, 2011). In the parlance of ANT, actors are structured under the limitation of their choices in any realms of governmental decision. In other words, they are not free actors in the existing actor-network and its connections. While past research on ICT policy has emphasised the significance of understanding the process of a consolidated set of actions in the execution of ICT policies, the results of this research show a consolidated set of actions also in the relationship between different realms. During the development of the smart living initiative, Taiwan's actors built specific connections between the government, private organisations and technologies that were dependent on earlier connections created during the promotion of big data in 2012. This historical event played an important role in the enrolment of the critical actors to the new network that was built around the smart living applications plan and the plan to popularise the application of smart living in urban and rural areas in Taiwan (for example, Executive Yuan enrolled big data to construct an innovative public service. Big data subsequently was utilised by private organisations in the switch from user-centric requirements to the introduction of a human-machine interface for designing the applications for smart living). Here, the Executive Yuan played an important role in sustaining a consolidated set of actions in relationships because it assisted in mediating and shaping the critical relationships among key actors.

Furthermore, Executive Yuan continued the innovation around broadband and wireless infrastructure through its specific mediating role. As noted, the construction of broadband and

wireless infrastructure in e-Taiwan and M-Taiwan contributed to the foundation for accessing the internet in Taiwan. The innovation of public services through the combination of using the internet to construct UNS in u-Taiwan enabled Taiwan's people to enjoy food, clothing, housing, travel, education, and so on ubiquitously by accessing e-services. In this regard, the actor-network in these three ICT policies was more constructive than the actor-network for ICT policies in the 1970s and the beginning of the 1980s, as these three ICT policies drove the execution of Taiwan's ICT policies toward smart living.

As a result, the interaction between Executive Yuan, city governments, telecommunication companies and their broadband and wireless capabilities successfully provided the construction of broadband and wireless infrastructure for ICT policies and innovations, and in turn yielded effective cooperation in the preparation for and execution of ICT policies toward smart living. This interaction, in turn, yielded effective cooperation to the participants of Executive Yuan, city governments, telecommunication companies and their broadband and wireless capabilities which became important actors in the execution of ICT policies toward smart living and the preparation of smart living initiative's execution.

The execution of the smart living initiative offers an interesting insight with respect to a consolidated set of actions for the participants of ICT-related and other private organisations in that the capabilities of the organisations' technologies for supporting the execution of governmental ICT policies were mostly enabled by the government. This support enabled them to expand their business range more broadly using Taiwan's existing ICT advantages while making ICT policies toward smart living in Taiwan. The result suggests that in researching the governmental role in ICT development, a researcher needs to study different types of ICT policies. This is because the constitution of the various activities in an ICT policy has its own decision-making body (Nicol, 2003). Therefore, it is necessary to examine different ICT policies for ICT development in terms of their national context (Hobday, 1997).

This research also provides several significant insights into ICT innovation. First, innovations in ICT applications such as cloud computing and sensor equipment require the successful enrolment of different actors who can bring essential technological and knowledge resources. The enrolment process involves political as well as cognitive and technical skills. As noted by Yoo, Lyytinen and Yang (2005), such a process is like a social network. In such a process, human actors collaborate with non-human actors. Innovation in ICT applications, then, depends on those who can provide a broad coalition foundation and, thus, successfully mobilise innovative approaches. During the preparation for the execution of the smart living initiative, the key actors were able to mobilise under the organisational direction of Executive Yuan. During this stage, the innovation of ICT applications was allocated by Executive Yuan between the camps of private organisations' cloud computing, sensor equipment, e-books, internet TV and living computers, and non-private organisations' big data. Nam and Pardo (2011) suggested that a governmental role is a key element in the success of ICT innovation at national level. This research proves the perspective of these authors by identifying the significance of Executive Yuan in the context of shaping the actor-network in terms of the provision of innovative approaches.

Secondly, with technological development, the actor-network continues to evolve with new actors being enrolled. Through this continuous enrolment, ICT applications were diffused through Taiwan's ICT policies to form a continuous innovative process whereby the actor-network was transformed and reconfigured over time. This reflects not only the development of ICT itself but also how the actor-network changes over time as the importance of ICT is changed for key actors. For example, by recognising the need to execute ICT policies, actors in the network diffused designing the applications for smart living over time following the announcement of big data by Executive Yuan. This invited other actors to be incorporated into terminal services such as e-books, internet TV and the living computers. However, such

constant expansion of ICT capabilities cannot be achieved without the active enrolment of other, new actors in the network.

Furthermore, the constant expansion of the actor-network through the enrolment of new actors to align with the existing network meant mobilisation could be achieved. For example, the continuous involvement of the ICT industry with respect to cloud computing and sensor equipment was introduced into the Taiwanese cloud healthcare plan, and subsequently into traffic management (smart transportation) in the smart living initiative. Cloud computing and sensor equipment allowed Taiwan's government to apply smart living in terms of transportation. The continuous involvement of the enrolled actors in establishing successful ICT policies for smart living in Taiwan demonstrates how through mobilisation this expansion is viable. The result is the identical to the traditional view of ICT innovation and diffusion, which depicts an innovation as an expanded object that needs to be diffused by human interaction.

Finally, ICT development and capability are not just technical decisions made by ICT-related private organisations alone. These decisions are related to the political decisions behind making the policies (Nam & Pardo, 2011). In the analysis of Taiwan's ICT policies, the results show that Taiwan's government purposefully chose to develop ICT not only with the cooperation of ITRI and III but also with ICT-related private organisations. In doing so, Taiwan's government was able to create an actor-network that broke the limitations of its initial ability to develop its ICT capabilities and industry. Other actors such as governmental units, research institutes and ICT-related private organisations in the network introduced ICT into their public services, R&D and innovation in the same way that Executive Yuan did when it interacted with non-human actors. For example, Executive Yuan had to compromise on some of the more novel technical ideas in order to form the necessary alliances, and the other actors might also be required to make similar compromises in their approaches and technologies. Therefore, making ICT policies toward smart living in Taiwan was a technical design issue, not only for the sake of technology, but for the sake of political advantage.

Chapter 6. Contribution

This dissertation examines the formation process of the actor-network in Taiwanese ICT policy, which underlies how Taiwan's government facilitated and strengthened the process of implementing a smart living initiative. In general, this research contributes novel insights into the ICT policy-making process aimed toward ICT-enabled social progress and methodology in ICT policy research by utilising a qualitative method (ie ANT and a case study) that draws on ICT policy-making toward smart living in Taiwan as a case for analysis to explore the interaction between human and non-human actors. The contribution is made to the practice of ICT development toward smart living at a national level with a focus on the execution of ICT policies. In particular, the process involved cooperation between Taiwan's government and the ICT industry/other private organisations; non-governmental units and the ICT industry/other private organisations; and the interaction between Taiwan's government and ICTs/ICT capabilities to form the actor-network. Furthermore, this research adds to the available literature on the application of ANT in the analysis of Taiwan's ICT policies, as researchers have not focused on this topic. By providing an understanding of the impact of how Taiwan's government has executed ICT policies for the development of ICT and the smart living initiative, researchers will benefit if they want to investigate the process of executing ICT policies in Taiwan and to understand the role of the interaction between human and non-human actors in this context.

Chapter 7. Limitations

This research has two limitations. First, only one country is focused on, which is Taiwan. Given each country has its own historical and economic history, and political structure, applying the results of this research to other countries should be done with care. For example, the success of Taiwan's government in executing ICT policies for developing ICT and its smart living initiative cannot be exactly replicated by governments in other countries. However, this does not mean that analysing the network of Taiwan's ICT policies across two different realms as proposed in this research is not important. Secondly, from the point of view of ANT, this research examines the process of making ICT policies toward smart living. Each stage of making ICT policy focuses only on examining the critical turning points in how Taiwan's government interacted with ICT toward the development of the smart living initiative. Therefore, tracing the evolution of ITC after that is lacking.

Chapter 8. Implications

There are two implications for future research from this study. First, this research only investigated one country. Investigating the different contexts of executing ICT policies in different countries is recommended, as different evolutionary paths need to be followed to comprehend how the actor networks are different and how different actors interact in the networks in the situation of developing ICT toward smart living. Such comparative analyses will offer perspectives on how dynamic interactions among social and technological elements form and are formed by the development of socio-technical systems. Secondly, the rapid success of ICT development in Taiwan cannot be explained only in the role of Executive Yuan. Several published journals attribute the success of ICT development in Taiwan either to Taiwan's unique national context, the development of the ICT industry by Taiwan's government, or the effort of other governmental units such as ITRI, III and MOEA. The result of this research suggests that although the above factors were significant in explaining the success, it is more important to understand how over time different stages of executing ICT policies become connected and interrelated and how various factors (such as technical components and competencies) affect the successful or unsuccessful connections in the actor-network. Therefore, this researcher believes that such systemic analysis of the development of each ICT policy's execution can contribute to research on innovations in ICT policy.

Chapter 9. References

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