The role of regional contextual factors for science and technology parks: theoretical and practical implications in developing country

Poonjan, Amonpat

Publication date: 2021

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA): Poonjan, A. (2021). The role of regional contextual factors for science and technology parks: theoretical and practical implications in developing country.
The role of regional contextual factors for science and technology parks: theoretical and practical implications in developing country

Amonpat Poonjan

PhD Thesis
March, 2021

DTU Management
Technical University of Denmark
Science and technology parks (STPs) have gained significant academic and political interest for their potential to develop regional economies. Despite their popularity, STPs receive criticism for their inconclusive contributions. Increasing numbers of studies argue that the performance capacity of STPs relies both on STP-internal factors and the regional conditions where the STP is located. While most research focus on STP-internal factors, literature on the linkages between the STP performance and the regional context is still lacking, raising the challenge of designing STP strategies in response to regional specificities. The thesis takes up this call by exploring the role of regional contextual factors in STPs’ performance. The aims of this thesis are threefold. First, the thesis aims to conceptualise the role of regional contextual factors and STP performance by conducting a systematic literature review, the outcome of which is a conceptual framework. Second, the thesis aims to use the framework to provide empirical insight into regional contextual factors and STP development in a developing-country context. Third, the thesis aims to concretise a route from the theoretical to a practical application of STPs’ innovation strategies by integrating STP functions with the concept of smart specialisation strategy (S3) using innovation system foresight.

The overall conceptual framework of the thesis builds on the field of regional innovation systems, innovation systems in developing countries, smart specialisation, foresight studies and the broader perspective of evolutionary economic geography. Thailand is the case study for drawing on empirical experiences. The research approach builds on a systematic review of the literature, empirical investigation of the current practice of regional innovation systems and STPs in the Thai context and a foresight exercise to identify possible ways to improve the current situation. The data collected from semi-structured interviews, secondary data and a Delphi questionnaire provide the basis for the analysis. The secondary data sources cover regional statistical reports, national policy reports, science-park internal reports, government websites and news.

The contributions of this thesis are threefold. First, from the theoretical perspective, the purpose of developing a systematic literature review was to contribute to better understanding the dynamics of STPs in their regional context, which is still lacking in STP studies. The thesis offers a comprehensive framework of regional factors that influence STP performance, providing new insight into the role of regional factors (i.e. degree of urbanisation, industrial structure, regional institutions and culture, university and research institutes and financial resources) for STP development.

Second, from the empirical perspective, the study offers insights into national (NIS) and regional innovation systems (RIS) in the Thai context. The comparative case study from Thailand presents different regions demonstrating different levels of RIS capacity and, thus, STP performance, although the same national innovation system encompasses the establishment of them all. These findings support the idea that the regional level is optimal for analysing innovation policy intervention. However, in Thailand’s context, a national policy formulation to improve supportive conditions and coordinate policy linkages at the regional level is another crucial condition. Moreover, the empirical findings also suggest that regional innovation culture in the form of trust and local collaboration is a foundation for STP development.

Third, from the methodological point of view, the thesis proposes the foresight process as a tool for implementing S3, where STPs align their functions with a regional context. The thesis presents the rationale use of foresight that has greatly contributed to regional policy intervention by enabling a systemic assessment of regional innovation ecosystems and their technological capabilities, then translating it to a policy-priority setting. The suggested approach eases S3 implementation with limited time and resources.

Taken together, this thesis provides a comprehensive framework and proposes a tool for designing STPs that are more specific and sensitive to regional context. The author hopes that this research will contribute to a
deeper understanding of regional innovation policy intervention—more specifically, STPs in the context of developing countries.
Dansk Resume

Forskerparker (Science and Technology Parks - STP) har tiltrukket sig en betydelig forskningsmæssig og politisk interesse på grund af deres potentielle bidrag til udviklingen af økonomien i den region, hvor de er placeret. På trods af deres potentielle er forskerparker blevet kritiseret for at have svært ved at opfylde forventningerne. Den videnskabelige litteratur har antydet, at en af grundene hertil er deres manglende integration i den regionale økonomi. Der mangler en systematisk forståelse af hvordan den regionale kontekst (f.eks. lokale universiteter og forskningsinstitutioner, industriel struktur og normer) påvirker forskerparkers bidrag til den regionale udvikling. Denne manglende systematiske forståelse gør det vanskeligt at designe forskerparkstrategier, der passer til de konkrete regionale udfordringer. Denne afhandling undersøger derfor den rolle, som de regionale kontekstuelle faktorer har for forskerparkers bidrag til den regionale økonomiske udvikling. Det konkrete formål med afhandlingen er tredobbelt.

For det første er det formålet at konceptualisere de regionale kontekstuelle faktorers betydning for forskerparkers mulighed for at bidrage til den regionale udvikling. Det gøres igennem en systematisk litteraturgennemgang. Resultatet af den systematisk litteraturgennemgang er en konceptuel ramme for resten af afhandlingen. Det andet formål er ved hjælp af denne konceptuelle ramme at give en empirisk indsigt i de regionale kontekstuelle faktorers betydning for udvikling af forskerparker i en konkret kontekst; nemlig regioner i et udviklingsland. Konkret drejer det sig om Thailand og især den sydlige Songkhla provins. For det tredje er det målet at anvise konkrete strategier for udvikling af en forskerpark med udgangspunkt i den konceptuelle ramme og indsigten i den konkrete kontekst.

Afhandlingens overordnede konceptuelle udgangspunkt er eksisterende teoridannelser for regionale innovationssystemer, innovationssystemer i udviklingslande, smart specialisering, teknologisk fremrykning samt evolutionær økonomisk geografi generelt.

Metodemæssige bygger afhandlingen på dels en systematisk gennemgang af litteraturen, dels en empirisk undersøgelse af det aktuelle regionale innovationssystem og tilhørende forskerpark, samt dels et teknologisk fremrykning for at identificere mulige måder til at forbedre den aktuelle situation. Analysen er baseret på semistrukturerede interviews, sekundære data samt Delphi-spørgeskemaer. De sekundære datakilder dækker regionale statistiske rapporter, nationale policy rapporter, forskerparkernes interne rapporter samt offentlige hjemmesider og nyheder.


For det andet giver afhandlingen indblik i det regionale og regionale innovationssystem i en thailandsk kontekst. Det sammenlignende casestudie af tre forskerparker i Thailand konkluderer, at de forskellige innovationssystemer i de tre regioner har afgørende betydning for forskerparkernes bidrag til den regionale udvikling, selvom de alle opererer under det samme regionale innovationssystem. Denne konklusion understøtter ideen om, at det regionale niveau er det optimale niveau i analysen af innovationspolitisk intervention. I thailandsk sammenhæng er en national politikformulering til forbedring af støttebetingelser og koordinering af politiske forbindelser på regionalt niveau imidlertid en anden afgørende betingelse. Desuden viser afhandlingen, at den regionale innovationskultur i form af tillid, samarbejde og interaktion er afgørende for forskerparkernes udvikling, da den er grundlaget for innovation i regionen.
Afhandlingens tredje bidrag er metodemæssig. Afhandlingen demonstrerer en fremsynsproces (technology foresight) som et værktøj til implementering af en smart specialiseringsstrategi (S3), hvor forskerparkers strategi tilpasses den regionale kontekst. Afhandlingen konkluderer, at systematisk brug af et teknologisk fremsyn i høj grad kan bidrage til den regionalpolitiske intervention ved at muliggøre en systemisk vurdering af regionale innovationsøkosystemer og deres teknologiske kapaciteter og derefter oversætte den til en politisk (policy) prioritering. Afhandlingen anviser en praktisk fremgangsmåde for implementering af en smart specialiseringsstrategi under begrænset tid og ressourcer.

Samlet giver afhandlingen en omfattende ramme og foreslår innovationspolitiske værktøjer for forskerparker; værktøjer, der er mere specifikke i forhold til en regional kontekst. Håbet er, at resultaterne af denne forskning vil bidrage til en dybere forståelse af regional innovationspolitisk intervention; nærmere bestemt forskerparker i udviklingslande.
Acknowledgements

Growing up in a developing country, I have observed that policies’ impact is often marginal, even though these policies might have been proven successful in other countries. This impression has shaped my interest in doing this research. The questions like how do policy works or how can we make policy more effective are always on my mind. This thesis has allowed me to partly answer the questions within the scope of innovation policy. The journey of doing research has been fun and challenging. I am grateful for the opportunity I have. I would like to thank the Royal Thai government for the funding, DTU for support and Prince of Songkla Science Park, as well as all of my interviewees, for their great cooperation.

My completion of this thesis could not have been accomplished without my supervisors Per Dannemand Andersen and Anne Nygaard Tanner, their continuous support of my PhD study and their patience, motivation and immense knowledge. Their guidance helped me through all the time of researching and writing this thesis. Special thanks to Per for sharing his networks, enabling my participation at conferences and widening my knowledge in foresight study. Also, a special thanks to Anne for always providing helpful input and inspiring me to conduct research and develop my knowledge in the field of economic geography.

My sincere thanks to the members of the PhD committee: Susana Borrás, Toni Ahlqvist, and Ulrich Elmer Hansen - not only for their time but for their constructive feedback to the earlier version of this thesis.

I would like to thank Dr Surachai, Mr Sakkrapong and everyone at APEC centre Thailand for great opportunities in learning the process of science, technology and innovation policy formulation, as well as introducing me to the foresight community in Thailand.

Special thanks to my colleagues at DTU and, in particular, my officemates, Celine, Lena, Meiken, Mariu, Nelda, Tanya, Marie, Wenbo and Guangtao, for stimulating discussions and spiritual support. Thanks to Dorrit and John for weekly jogging companionship. In addition, I would like to thank my friends in Thailand, Kae-Kae, Biw, Nat, Nut, Milk and An-An for supporting me from the beginning of the process. Special thanks to Topaz, Nini, Aff, and Neang, who help me run my errands and give me the necessary distractions from my research.

Finally, I want to express my heartfelt gratitude to my family (parents, brothers, aunts and uncles) for their continuous love and support. I give particular thanks to Thomas for always caring and supporting me in all of my endeavours. You are the best.
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1 Introduction

Recently, interest has grown in place-based innovation policy. The place-based approach aims to provide policy intervention that responds to and engages with regional resources and conditions. The rationale is that regions differ in their economic structure, knowledge resources, supportive institutions and infrastructure. Thus, the chance to modify and develop regional economic structure depends highly on pre-existing conditions (Grillitsch & Asheim, 2018; Isaksen & Trippl, 2016; Todtling & Trippl, 2005). Nevertheless, place-based policies are not straightforward to enforce, and the literature often finds that success remains the exception rather than the rule.

Science and technology parks (STPs) are a type of place-based policy instrument that has received significant attention in the past decades. Despite their popularity, STPs are criticized for their inconclusive contributions. The critiques stem from a lack of integration with regional specificities and the outcomes of the static and linear approach in designing and adjusting STP strategies (e.g. Brooker, 2013; Hansson, Husted, & Vestergaard, 2005; Liberati, Marinucci, & Tanzi, 2016; Shearmur & Doloreux, 2000). Policy supporting STP strategy devotes much attention to such conventional functions as research and development (R&D), technology transfer and the grand infrastructure while insufficiently focusing on the challenges that occur in a specific regional innovation system (Etzkowitz & Zhou, 2018; Tsamis, 2009). Empirical evidence from previous research (e.g. Hansson, Husted, and Vestergaard 2005; Phillimore 1999) shows that the linear approach to STP strategy has overlooked the systemic problems embedded in the regional innovation system. The problem appears to be larger in lagging regions, where the innovation ecosystem is far from ideal (e.g. lack of entrepreneurial and innovation culture, weak firm capabilities). Consequently, STPs become islands of innovation infrastructure that cannot fulfil their role in regional innovation development.

More recent attention has focused on the provision of regional innovation system (RIS). RIS is a conceptual framework that conveys an essential principle of place-specificity in which multiple actors (e.g. firms and universities), supportive infrastructures and institutional environments operate to stimulate collective learning, continuous innovation and entrepreneurial activity (Bjorn T. Asheim, Smith, & Oughton, 2011; Isaksen & Trippl, 2016). RIS views innovation as the result of a collective process influenced by the regions’ endogenous capabilities. This view has been considered a crucial move towards the development of effective regional innovation policies in two senses. On the one hand, it implies that there is no ‘one-size-fits-all’ regional innovation strategy because RIS varies considerably regarding regional innovation capability, industrial base and institutional contexts (Todtling & Trippl, 2005). On the other hand, the concept of RIS has provided a deeper foundation, suggesting that the impact of regional policy intervention depends on the presence of the right infrastructure and institutional configuration for implementation (Flanagan & Uyarra, 2016; Uyarra, 2019). This perspective has been supported by several STP empirical studies (Albahari, Catalano, & Landoni, 2013; Phelps & Dawood, 2014; Shin, 2000; Tsamis, 2009). For example, Albahari, Catalano and Landoni (2013) compare the state of development and highlight the main differences between Spanish and Italian STPs. They find that Spanish STPs perform better than Italian STPs because of the consistent and coherent set of Spanish policies that are specifically designed to support STPs, whereas policies in Italy have had a discontinuous character without particular emphasis on STPs.

Regardless of the theoretical emphasis on context dependency in analysing policy intervention, as well as the illustration of STP empirical results, discussion of the conceptual linkage between context dependency and STP is scarce and scattered. There is limited understanding of how the regional context plays a role in STP performance and how policymakers can adjust and design STP strategies and other supportive policies to enhance regional innovation capacity. Several STP studies partially take into account the level of regional development to explain STP contributions. For instance, Carvalho and Van Winden (2017) and Shin (2000) present the view that metropolitan regions are favourable STP locations. On the contrary, Albahari (2015) finds
that STPs have a higher impact on tenants’ performance in areas with lower levels of technological development. Although these are in-depth studies, discussion of the holistic view of regional dynamics and their heterogeneity in relation to STP performance remains limited. This limitation is accentuated in the recent review of STP literature by Lecluyse, Knockaert and Spithoven (2019). They emphasise the need for more research to provide a deeper understanding of the impact of regional factors and, specifically, the relationship between the region hosting the STP and the contribution the STP can provide.

In the same vein with place-based policy intervention concept, another relevant point is that the EU community has recently highlighted adaptation of regional specificities and regional innovation policy interventions, with the policy concept called smart specialisation strategy (S3). S3 is an innovative approach that aims to boost the regional economy by enabling each region to identify and develop its competitive advantages (Foray, David, & Hall, 2009). Although STPs have long been perceived as important and popular instruments for supporting regional innovation, the development of S3 has underlined their role in regional innovation development. For example, STPs have value in connecting innovative actors (in both regional and extra-regional linkages) and facilitating innovation activities to create a strategy that aligns with the S3 concept. Nauwelaers, Kleibrink and Stancova (2014) pinpoint three key roles in which STPs can make an active contribution to the development and delivery of S3 in the region: (1) providing adequate innovation ecosystem for the development of innovation initiatives (2) forming relevant stakeholders in shaping S3 strategies (3) adding outward looking to S3 development. Nevertheless, in practice, the integration of STP and S3 is still underdeveloped.

Last but not least, while most well-performing STPs are associated with developed countries, little is known about the implementation of STPs in developing countries (Henriques, Sobreiro, & Kimura, 2018). This issue is important for two reasons. First, the concepts of RIS and STP have been initiated and advanced as points of orientations in regional innovation policy intervention by developed countries. The question is how these concepts function in developing countries. Second, governments are the main supporters of STPs in developing countries (A. G. Hu, 2007; Phelps & Dawood, 2014; Vaidyanathan, 2008; W.-T. Yang & Lee, 2000). This implies that innovation policy interventions often originate from the supply side, which might limit the recognition of context dependency and often results in a policy-approach mismatch. However, this also represents an opportunity in that the close connection between the state and STPs can enable national innovation policy to design complementary strategies for STP development.

All these reasons constitute the underlying motivations of this thesis, which aims to explore and explain the role of regional context in regional innovation policy development and, more specifically, STP performance. I believe that a better understanding of context dependency and STP development will provide tools for designing more effective regional innovation policy interventions.

This thesis comprises a synopsis and three journal articles, of which two have been published in European Planning Studies and Asian Journal of Technology Innovation, and the third article is undergoing review in Technological Forecasting and Social Change. The synopsis consists of five chapters and is structured as follows. The first chapter presents the objectives, questions and scope of the research, followed by the research methods. The second chapter introduces the key literature and concepts that this thesis draws on and contribute to. The third chapter describes the empirical context in which the conceptual framework has been applied. The fourth chapter discusses the main implications of the findings from a broader empirical and theoretical perspective. The fifth and final chapter concludes by summarising the contributions of the thesis. The thesis structure is presented in Figure 1.
1.1 Research objectives, research questions and scope

In the broad context depicted by the introduction, the thesis seeks to address the theoretical and practical implications of the connection between regional context and STP performance. Additionally, the thesis aims to address the gap between the importance of contextual factors and STP performance by proposing the use of foresight as part of policy planning. The thesis is built on existing STP studies, combining and discussing the literature with the RIS concept (Bjorn T. Asheim et al., 2011; Cooke & Uranga, 1997; David Doloreux & Porto Gomez, 2017; Isaksen, Tödtling, & Trippl, 2018; Todtling & Trippl, 2005).
To address the overall aim of the thesis, I propose the overall research question:

**How can we conceptualise the importance of regional contextual factors for the performance of STPs? And, how can we use foresight to improve the design of STPs?**

To gather all elements addressing the issues identified above, I rephrase and adapt the overall research aims and questions into the three following sub-research aims and sub-questions:

First, the thesis aims to conceptualise the role of regional contextual factors in relation to STP performance, the outcome of which is a conceptual framework. To do so, this thesis develops a conceptual framework based on a systematic literature review by posing the following research question:

1. **How do regional contextual factors play a role in STP performance?**
   The thesis views regional contextual factors as pre-conditions for STP development. As such, the main focus of the analysis is the causal correlation between regional contextual factors and STP performance. Regional contextual factors here refer to the main structure and functions of regional innovation systems, which are comprised of a set of firms, organisations (e.g. universities) and institutions (e.g. norms and policy) (Isaksen et al., 2018; Todtling & Trippi, 2005). STP performance refers to the broad contribution of STPs at any level. This question is addressed in the first article, titled: the role of regional contextual factors for science and technology parks: a conceptual framework.

Second, this thesis aims to evaluate the usefulness of the new conceptual framework for understanding the differences in STP performance levels and to provide an insight into specific regional contextual factors for the development of STPs in developing countries. To do so, the thesis poses the following research question:

2. **How do regional contextual factors influence STP performance in a developing country context?**
   The conceptual framework is used as a guideline to identify and operationalise the regional contextual factors and STP performance. In broad terms, developing countries are characterised by low income and low levels of industrial-based development. The resulting low productivity indicates a limited capacity to develop new technologies or adopt and enhance existing ones (Altenburg, 2008). In this thesis, I use Thailand, which is characterised as an upper-middle-income country, as a case to represent the developing country context. This question is addressed in the second article, titled: how regional factors influence the performance of science and technology parks: A comparative analysis of regional science parks in Thailand.

Third, to address the gap between the intended STP performance and realised STP achievements, the thesis sets out to include S3 implementation by using foresight as part of the policy planning. The purpose is to integrate the insight on the importance of contextual factors. To do so, it poses the following research question:

3. **How can foresight act as a tool for S3 implementation and align the function of the STP with the regional context?**
   S3 here is framed as a place-based policy concept, more specifically ‘a place-based policy prioritisation framework aimed at helping regions to identify their research and innovation resources in order to build critical mass in areas of comparative advantage’ (Uyarra, 2019). In this sense, STPs are argued to play a key role in S3 policy initiation by aligning their functions and strategies with the prioritisation of S3 policy that builds on regional resources. Foresight here is understood as a process of identification of S3 policy prioritisation, in which STP plays a major role. This question is addressed in the third article, titled: foresight for science and technology parks in a smart specialisation context.
The purpose of this study is to contribute to three fields of research:

- **Regional innovation system:** The theoretical approach of this thesis emanates from the concept of RIS, which views innovation as systemic processes consisting of several key elements, including firms, public research institutions, educational institutions (e.g., universities, polytechnics, vocational training institutions) and, more importantly, innovation policy intervention (STP and S3) (Todtling & Trippl, 2005).

- **STPs in developing countries:** The thesis supplements the literature on STPs in developing countries (e.g., Jongwanich, Kohpaiboon, and Yang 2014; Phelps and Dawood 2014; Rodríguez-Pose and Hardy 2014; Vaidyanathan 2008) by exploring Thailand as a case study.

- **Foresight:** The thesis addresses the gap between policy concept and policy implementation (Carvalho, 2009; Flanagan & Uyarra, 2016) by proposing the use of foresight (A. D. Andersen & Andersen, 2014) for STP in an S3 context.

### 1.2 Research strategy

The thesis addresses the research objectives and research questions in three independent journal articles. Each article builds on different research methods depending on the nature of research objectives, questions and appropriateness within the time and financial constraints. The thesis employs a mixed type of strategies, namely a systematic literature review, a comparative case study and foresight. This section and the following section on research method (section 1.3) incorporate the validity and reliability concepts as they are the key aspects used to discuss research quality. In this section, I first discuss these two concepts and how they are generally used in the thesis. I then discuss the overall research strategy.

Regarding to reliability, Brink (1993) and Riege (2003) argue that the concept concerns the consistency, stability and repeatability of the accounts of the informant, as well as the ability of the researchers to gather and report evidence correctly. Simply put, it refers to the extent to which the research method has consistently obtained the same results more than one time. In this thesis, the overall reliability is achieved through the coordination between the research issues and characteristic of the research design (Yin, 2003) and the transparency and consistency presentation of the data collection and analysis process (Riege, 2003). In term of validity, Leung (2015) argues that the concept concerns the appropriateness of the method, processes, and data. This means that the research design and the choice of methodology are appropriate for addressing the research questions. It also refers to the appropriateness of data and sampling in the research context. To ensure the research validity, this thesis illustrates that the choice of methodology and data collection enables the investigation of findings with proper consideration of the research context. For data collection and analysis, the thesis adopts several methods to enhance validity, including justifying the representativeness of key informant in interviews, using multiple sources of evidence, and describing the specific procedure for coding and analysis (Leung, 2015; Riege, 2003).

The core proposition of the thesis stems from the concept of RIS and the extant STP literature, which demonstrates that context matters for innovation policy instruments, and more specifically STP performance. The main focus of the analysis lies on the causal correlation between regional contextual factors and STP performance. In this sense, the thesis is broadly deductive in nature, as data collection and analysis were guided by the aforementioned theoretical proposition. Its approach aims to provide a conceptual tool as well as enough contextual information for other researchers to transpose this particular case to relevant contexts.

To address the first research question, 'how do regional contextual factors play a role in STP performance?', this thesis starts by constructing the conceptual framework based on a systematic literature review. A conceptual understanding of STP performance, regional contextual factors and how these two elements are linked in the literature was developed through this explorative and systematic process. Two reasons informed the choice of this methodology. First, developing a conceptual framework consists in systematically summarising ideas on a specific topic into a coherent pattern; it also provides key focuses for the research design, method and instruments appropriate for the empirical study (Avant, 1993). Second, a systematic
literature review provides a conclusive assessment of a specific research question in a rigorous, replicable and transparent process (Siddaway, Wood, & Hedges, 2019). Although they can be time consuming, the outcome is substantial in that systematic literature reviews help refine the concept and synthesise the existing knowledge on the relationship between regional contextual factors and STP performance.

To address the second research question, ‘how do regional contextual factors influence STP performance in a developing country context?’, this study applies the conceptual framework to a comparative case study, aiming to assess how regional contextual factors support or hinder STP performance in a developing country context. A comparative case study suits the discussion of this study for two reasons. First, in the theoretical perspective of innovation system, Edquist (2011) argues that innovation policy should be analysed in a comparative innovation system:

> The problems in innovation systems that are to be solved or mitigated by means of innovation policy can only be identified by comparing existing innovation systems with each other—over time and space. The things to be compared are the performance with regard to the intensity of different kinds of innovations in different systems—and the causal explanations for this performance (Edquist 2011, p.1726).

In this specific study, the STPs are treated as part of RIS. Three STPs in three different regions of Thailand are compared. As Edquist argues, a comparative study can concern the same system over time (e.g. T. S. Hu 2008; Liu and White 2001) or different existing systems (e.g. Diez 2002; Lai and Shyu 2005; Morisson and Doussineau 2019; Wonglimpiyarat 2011). This study proposes to compare different regional innovation systems because the development of STPs in Thailand is still in its early stages, and data for the investigation of one system over time is thus limited. Second, in this methodological perspective, case studies respond to ‘how’ questions, which are exploratory and relate to contextual positioning. They provide an in-depth, multifaceted understanding of a complex phenomenon within a real context (Yin, 2003). The present case study helps to understand and explain causal linkages in three different STPs and their differences in terms of regional contextual factors. At the same time, carrying out multiple case studies increases methodological thoroughness by enabling the researcher to analyse data within and across cases, providing the study with important understanding of its differences and similarities (Gustafsson, 2017; Woodside, 2010; Yin, 2003).

In response to the third research question, ‘how can foresight act as a tool for S3 implementation and align the function of the STP with the regional context?’, the conceptual framework was adapted with the concepts of innovation system foresight (ISF) (A. D. Andersen & Andersen, 2014) and S3, providing a tool for designing regional innovation strategies in which STP plays a key role. In this sense, foresight is a process linking the concepts of S3 and STP. The rationale for using it as a method to link theoretical and practical concepts lies in the flexibility and adaptability of the process and the principle of S3. In this context, foresight represents an exploratory approach to identifying regional potential technology development based on regional research and innovation resources and market signals (OECD, 2013a). Further, in the case of Thailand, there is a practical problem of policy mismatch, which stems from limited local engagement in policy planning and design in general (Chaminade, Intarakumnerd, & Sapprasert, 2012). Foresight was proposed to reduce the risk of policy mismatch by allowing local actors to participate in policy and the technological identification process (the discussion of foresight will be further examined in section 2.5).

A summary of the approach adopted by the thesis and the status of the articles is presented in Table 1. The research method, data collection and analysis of each article will be discussed in the next section.
Table 1: Summary of the thesis’s strategy and the status of the articles

<table>
<thead>
<tr>
<th>Article</th>
<th>Research question</th>
<th>Research strategy</th>
<th>Methodology</th>
<th>Status of the articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) The role of regional contextual factors for science and technology parks: A conceptual framework</td>
<td>How do regional contextual factors play a role in STP performance?</td>
<td>Develop a conceptual framework</td>
<td>Systematic literature review</td>
<td>Published in <em>European Planning Studies</em></td>
</tr>
<tr>
<td>(2) How regional factors influence the performance of science and technology parks: A comparative analysis of regional science parks in Thailand</td>
<td>How do regional contextual factors influence STP performance in a developing country context?</td>
<td>Validate the framework</td>
<td>Comparative case study of multiple cases in Thailand. Data collection through desk study and semi-structured interviews</td>
<td>Published in <em>Asian Journal of Technology Innovation</em></td>
</tr>
<tr>
<td>(3) Foresight for science and technology parks in a smart specialisation context</td>
<td>How can foresight act as a tool for S3 implementation and align the function of the STP with the regional context?</td>
<td>Apply the framework to the concept of foresight and S3 for policy recommendation</td>
<td>Single case study in Thailand. Data collection through desk study, semi-structured interviews and Delphi survey</td>
<td>Under review for <em>Technological Forecasting and Social Change</em></td>
</tr>
</tbody>
</table>

1.3 Research methods
To demonstrate the reliability and validity of data collection and data analysis, this section presents a detailed discussion of the research methods for each article.

1.3.1 Developing a conceptual framework: systematic literature review
This thesis develops a conceptual tool to examine the relationship between regional contextual factors and STP performance, by means of a systematic literature review. The process starts with an assessment of the relevance and size of the literature and the establishment of the review’s boundaries (Tranfield, Denyer, & Smart, 2003). Initially, the literature on relevant concepts, including STPs, regional studies, evolutionary economic geography and smart specialization policy were investigated. I examined a broad range of concepts related to STP studies to develop argumentation on place-based policy intervention and regional innovation systems as well as systematise the review protocol to reflect the objective and conceptual discussion (for the review protocol, see the methodology section in article 1). The papers included in the review were identified in the Web of Science (WoS) database based on two selection criteria. First, the papers should discuss STP performance, which refers here to the broad contribution made by STPs (positive, negative or absent) without distinguishing between different levels of performance or its relative importance. Second, the papers should discuss the regional context, that is, the main structure and functions of regional innovation systems (e.g. university and research institutes, industrial structure and institutions) (Todtling & Tripl, 2005). These factors were refined in connection with the STP literature once the framework had been developed.
I analysed and coded 64 articles addressing persistent and relevant themes. The analysis was concept-centric, meaning that the concept dictated the structuring framework (Webster & Watson, 2002). The coding process adopted an exploratory approach using thematic synthesis (Barnett-Page & Thomas, 2009). I followed an open-ended coding protocol, in which every finding pointing to the importance of a regional contextual factor was coded under a suitable label (e.g. university and research institutes, industrial structure and institutions). The codes were initially classified into 11 groups, some of which were subsequently merged based on conceptual similarity (see article 1 appendix 1). The final result of the coding reveals five categories that relate to the regional context (urbanisation, financial support, university and research institutes, industrial structure and institutions) as well as extra-regional networks and the STPs’ internal factors. STP performance results were coded for each paper to ascertain whether it found positive, negative or no effects of the STP on the performance indicator of interest. The process of reviewing and coding selected papers and refining the framework’s structure was iterative. The outcome of this systematic literature review is an analytical framework, RIS-STP, which is used as a theoretical guideline for the rest of the study.

The research validity of using the systematic literature review in developing the new conceptual framework is considered very favourable because all papers are peer-reviewed journal papers – meaning that the study drawn on validated research. However, the research reliability is not as high, given that the study explored an emerging field. There are many cases where only a few studies have looked at a linkage (between context and STP) before, and therefore the understanding of those specific factors’ importance for STPs could change in the future with further studies carried out on this specific matter.

1.3.2 Comparative case study: semi-structured interviews and document analysis

This thesis uses a comparative case study to validate the framework and provide insights into regional contextual factors and STP performance in developing country. The RIS-STP framework is applied to the cases of three STPs in three provinces of Thailand, as an empirical comparison of the regional innovation systems. Regional context analysis here is carried out at the provincial level (below the Thai state and regions and above districts). Thailand comprises seven regions and 76 provinces; the provincial level was chosen as the unit of analysis for two reasons. First, provinces are the primary unit of local government. Second, the provincial level provides the best available comparable statistics at the subnational level. The empirical cases consist of three different science parks in three provinces. Prince of Songkla Science Park in Songkhla is the main case under study and was researched in-depth via a larger number of interviews. 1 Chiangmai Science Park in Chiangmai province and Khonkaen Science Park in Khonkaen province provide two supporting cases, which were reviewed in-depth but rely on fewer interviews due to limited time and resources. The three Thai provinces are similar in both size and level of urbanisation and are regulated by the same national scheme for STP development. This provides a strong analytical basis for examining the impact of various regional contexts when the structure and internal factors of STPs are similar and the national institutional settings are identical but the regional factors (e.g., industrial structure and regional culture) differ.

In this comparative case study, data collection techniques included documentary research (e.g. government reports, international reports, business articles and relevant websites) and semi-structured interviews. Data collection began with a desk study to examine STP performance and the generic description of the regional context of the three cases. Regarding STP performance, I contacted the Ministry of Science and Technology, more specifically the Science Park Promotion Agency (SPA) by email for information about STP development and evaluation. SPA provided the annual reports for STPs and an internal consulting report commissioned by the Ministry of Science and Technology on the long-term impact and operational guidelines of STPs in Thailand (RTI International, 2019). The latter was used as a source for measuring and justifying STP performance. The report provided useful information regarding the STPs’ performance as it captured the economic impact and

1 The name of the university is spelled ‘Songkla’, whereas the province name is spelled ‘Songkhla’.
job creation initiated by STPs in three different regions between 2013 and 2017. Thus, in this study, I used these two metrics as measures of the STPs’ performance (the discussion of the STP performance study is further detailed in section 2.1.4).

While operationalising STP performance is somewhat straightforward, operationalising regional contextual factors is rather complicated because the regional dimensions comprise various factors, each requiring a different assessment. For this reason, data collection consisted of an analysis of different documents as well as semi-structured interviews, which allow for describing, interpreting and gaining in-depth insights into regional dynamics and covering the broad perspective of regional contextual factors. In this process, the RIS-STP framework was used as a broad guideline for the measurement of regional contextual factors, complemented by the relevant literature review and available and accessible data. For example, the literature suggests that the level of regional urbanisation can be understood through the measure of population density, supportive infrastructure and the ratio of employment in high-tech jobs and the agricultural sector (McGranahan & Satterthwaite, 2014; Shearmur, 2012; Shearmur & Doloreux, 2000). Thus, to determine the level of regional urbanisation, I searched for government data that incorporates these indicators (for the detailed operationalisation and measure of regional contextual factors, see article 2).

I used different types of data sources, from government documents and business articles to government reports, to provide descriptive data for the case (e.g. population density, economic activities, gross provincial product and university research quality). Semi-structured interviews aimed to provide deeper, detailed information about personal experience and critical comments on the influence of regional contextual factors and STP development (e.g. level of provincial collaboration, characteristics of science, technology and innovation (STI)-supportive policies, university knowledge matching local industries and availability of financial resources). Due to time and cost limitations, I conducted face-to-face interviews in Songkhla and phone interviews of key actors from Khonkaen and Chiangmai between February and July 2019. All key interviewees were assessed as credible sources who have experience in the province and fulfil different roles in the science park system, such as science park director, manager and staff, university director and researcher, local entrepreneur and provincial government staff. The diversity of the interviewees’ role in relation to STP-development improves the study validity. Altogether, I conducted 24 interview sessions, two of which were group interviews. The set of pre-determined questions was guided by the RIS-STP framework. The same set of questions was used in each interview, which allows for a close comparison of the interviewees’ responses and increases the research reliability (Young et al., 2018). Notes were taken and reviewed immediately after each interview session. The interviews were recorded with the interviewee’s permission and lasted 45 minutes on average.

Most qualitative studies in this discipline have followed an inductive approach to data analysis, whereby they investigate particular cases and identify patterns from the data. In contrast, this study adopted a deductive approach to data analysis, with the theoretical framework as its departure point informing how the data is collected and interpreted. Data from the interviews was manually and deductively coded by identifying relevant themes from the RIS-STP framework. I reviewed and analysed the data of the three different cases, factor by factor, to locate key points, general consensus and contradictions between the interviewees’ answers. The interview data was complemented and triangulated with government reports, extant literature and business articles. Cases were compared based on their STP performance and regional contextual factors. The analysis focused on exploring how regional contextual factors support or hamper STP performance.

1.3.3 Foresight: document analysis, semi-structured interviews and Delphi survey
This thesis proposes to use foresight to link two policy concepts, S3 and STP. The study started with a meeting with representatives of Prince of Songkla Science Park and regional authorities in May 2019. The objective was to obtain practical information and discuss their expectations regarding the development of the science park to set the objective of the foresight exercise, which is intended to provide results for real use. Prince of Songkla Science Park has selected four focus sectors: rubber, seafood, palm oil and the biomedical science. The rubber
and seafood sectors were chosen based on the existing knowledge base of Prince of Songkla University and the local economic activities, while the palm oil and biomedical sectors were mainly linked to the university's research expertise. Therefore, the foresight exercise aimed to provide a policy recommendation for STP management and regional authorities on these four focus areas. Based on the meeting and discussion, practical research questions were formulated as follows:

- What promising technology developments will be selected as focus sectors in the Songkhla province over the next ten years?
- What global megatrends will have an impact on the development of those sectors over the next ten years?
- What important regional policy and STP management instruments will support the development of promising technology over the next ten years?

The study draws on three sources of data: 1) desk study of relevant reports, web pages and similar sources; 2) semi-structured interviews; and 3) a two-round iterative Delphi survey. In this sense, the information from the desk study and interviews aimed to identify the broader promising technology and business developments of the four focus areas, the current research and economic opportunities and possible global megatrends, which were then used to formulate key statements for the Delphi survey. The latter provided the consensus for defining the specific priorities within each priority area. This method was chosen for two reasons. First, the context of a PhD project carried out in Denmark limited the available resources and my ability to invite the relevant stakeholders to a workshop. Second, the Delphi method provides consensus information from a panel of experts without bringing them together physically, an efficient approach in a context of limited time and resources (Linstone & Turoff, 2002; Rowe & Wright, 1999).

The foresight process was carried out in four steps (see the method section of article 3 for a detailed discussion), starting with mapping and an extensive desk study aimed at acquiring knowledge about science-park focus areas and identifying relevant actors and global megatrends. Subsequently, I interviewed 18 relevant local actors to understand the current situation and trends for each sector in the province. The interview participants were selected based on their particular expertise. The semi-structured interviews were carried out by phone or in-person during visits to the Songkhla province. The interview questions were designed based on the RIS-STP framework and the practical research questions. Similarly to the previous study in section 1.3.2, the same set of questions was used in each interview, enabling for a comparison of the interviewees’ responses and enhancing the research reliability (Young et al., 2018). The insights from the desk study and expert interviews were used to formulate the first-round Delphi survey. The objective of the Delphi survey was to establish a consensus and priorities among four themes according to the practical research questions, namely 1) the most important technologies and business areas in the four sectors, 2) external megatrends affecting the four sectors in Songkhla, 3) possible regional innovation policy instruments and 4) possible STP management instruments to promote industrial development in the four sectors. The same respondents were included in both the interviews and the two rounds of the Delphi survey. The application I used to conduct Delphi was commercially available of Qualtrics software. The software helps improve research reliability because it provided standardised information collection, which is designed to enhance consistency. To improve the validity of the study, the Delphi statements were sent out to the experts’ review before distribution. Moreover, to ensure the effectiveness of the Delphi, I conducted a pilot study at DTU among PhD students. The results of the Delphi surveys were analysed using a simple statistical method, that is, mean and standard deviation were used to provide an overview of the central tendency of the results. However, the use of statistical analysis represents a limitation because of the small sample size. In this regard, the research validity is not that high. To strengthen the result analysis and improve the research validity, I reported and discussed the Delphi result by combining them with the insight from the interviews.
2 Conceptual framing

This chapter takes a look at STP literature and the theoretical concepts that guide this thesis. I start with the definition and broad concept of STP and relevant theories, followed by an overview of the STP literature. I then expand the discussion to STP performance and the challenges faced by STPs in a developing country context. Finally, I introduce the theoretical concepts that underlie the analysis, namely regional innovation system (RIS), smart specialisation strategy (S3) and foresight.

2.1 Science and technology park (STP)

The first conceptualisation of STPs began with the establishment of the Stanford University Science Park in 1951, now known as Silicon Valley. Since then, the concept has inspired policymakers worldwide, with the estimated recorded number of 2,000 STPs (Wainova, 2018). In this thesis, I use the acronym STP, which is common in the research community (Hobbs, Link, & Scott, 2017; Rodríguez-Pose & Hardy, 2014) and denotes the broad concept of science park, research park and technology park, whereas the term ‘science park’ is used in the case study.

2.1.1 Definition and broad concept

I refer to the definition of STP given by the International Association of Science Parks (IASP): A science park is an organisation managed by specialised professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions. To enable these goals to be met, a science park stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; it facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value-added services together with high quality space and facilities.

To summarise, STPs are property-based organisations that aim to promote regional innovation activities through the provision of services. Rodríguez-Pose and Hardy (2014) outline four common features of an STP: i) collaborations with major research centres and universities; ii) a critical mass of knowledge-intensive firms; iii) management support to assist with firm growth, encourage synergies and promote technology transfer; and iv) the incubation of technology-based firms. However, in practice, STP models and strategies are diverse and depend on the host country, sponsors, the park’s objectives and its development stage (Albahari, 2015; Castells & Hall, 1994).

Here, I argue that STP development stages are of particular interest because they have two implications for STP studies and the empirical discussion presented in Chapter 3 of this thesis. First, they suggest that the role of STPs is dynamic and evolves over time. Second, the benefits and impacts of STPs also vary depending on the stage of their development. A study by Castells and Hall (1994), which offers a comprehensive empirical analysis of STPs around the world, indicates that STPs take 10 to 25 years to mature. Drawing from European Commission (2013), Oh and An (2012) and W.-T. Yang and Lee (2000), I have broadly outlined the development of STPs in three stages — the start-up stage, the growth stage and the mature stage:

- **The start-up stage**: STPs focus on building their infrastructure, establishing collaborative relationships and demonstrating the demand for services. At this early stage, support from the public sector is critical for STP development.

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2 This number includes both STPs and incubators.

3 See: https://www.iasp.ws/our-industry/definitions.
• **The growth stage**: the main features of STP development at this stage are stable management, collaborative networks and a clear view of park identity (e.g. the type of anchor tenants and sector expertise). STPs are expected to develop strong links and working relationships with other organisations, particularly in the knowledge base system. Additionally, STPs should be seen as bringing strength to the regional innovation system and integrate well with other regional key players.

• **The mature stage**: STP development at this stage is marked by strong collaboration and linkages with established networks. STPs may have global marketing strategies and attract foreign institutes and foreign investment for themselves and their region.

These development stages highlight the significant diversity of STPs. For example, Stanford University Science Park or Hsinchu Science Park are clearly in the mature stage, whereas the STPs in Thailand are at the beginning of the growth stage, a point to which I will return in Chapter 3.

### 2.1.2 Theories

The agenda for the theoretical development of STP studies has been influenced by several lines of thought in the broad conceptualisation of regional development. In this section, I present theories related to STPs studies. I identify three groups of theoretical foundations in the STP literature: cluster theory, triple helix and regional innovation systems. These three concepts emphasise different perspectives on regional innovation development, resulting in different justifications of STP functions and policy opportunities.

The first group of STP theoretical propositions centres on the concept of cluster, which was inspired by the work of Porter (1990). This concept approaches STPs and their surrounding context as entities consisting of specialised firms and their dynamic linkages among firms, resulting in agglomeration effects (e.g. Athreye 2001; Huang and Fernández-Maldonado 2016; Kulke 2008; D. Y.-R. Yang, Hsu, and Ching 2009). The cluster perspective justifies STP function as an innovation diffusion centre aiming to improve the cluster community by fostering the innovation atmosphere, improving the competitiveness of its related firms and providing knowledge-based infrastructure. Policy, in this view, focuses on industry rather than place. Several empirical studies show that STPs specialise in specific areas — for example, the electronics industry in Hsinchu Taiwan (M. Hu, 2011), the IT industry in India (Vaidyanathan, 2008) and the medical-industrial sector in Linkoping (Hommen, Doloreux, & Larsson, 2006). In this way, STPs aim to promote the growth of key industries and, consequently, help to set up institutions (e.g. by attracting foreign investment and skilled human labour) (Kennedy, 2007; Vaidyanathan, 2008).

The second group of STP theoretical propositions focuses on the concept of triple helix. The key point of this approach is that innovations occur through the interaction of three actors: governments, industries and universities (Etzkowitz & Leydesdorff, 2000). STPs are viewed as an effective tool to support synergy between these three actors. In this context, governments play a role in initiating relevant policies and channelling local resources through STP strategies, while universities and industries contribute by exchanging and diffusing knowledge (Etzkowitz & Zhou, 2018; Malairaja & Zawdie, 2008). Several STP studies stress the role of universities in supporting entrepreneurial and business activities through knowledge transfer, research commercialisation and start-up firm promotion (Albahari, Pérez-Canto, Barge-Gil, & Modrego, 2017; McCarthy, Silvestre, von Nordenflycht, & Breznitz, 2018; Minguillo & Thelwall, 2015b; Yun & Lee, 2013). This perspective comes with an emphasis on the third mission of universities: fostering (regional) economic development (Compagnucci & Spigarelli, 2020; Etzkowitz & Leydesdorff, 2000). For example, Albahari et al. (2017) analyse the relationship between the degree of involvement of a university in the STP and the innovation outputs of its tenants and their links with universities. They find that university involvement is positively related to the number of patent applications, but negatively related to tenants’ innovation sales.

The third group of STP theoretical propositions revolves around the concept of regional innovation system (e.g. Albahari, Catalano, and Landoni 2013; Gkypali et al. 2016; Harper and Georghiou 2005; Tsai and Chang
I use ‘regional innovation system’ as an umbrella term encompassing similar concepts of territory innovation system models used in STP studies, such as regional milieu (Crevoisier, 2004) and learning region (Kevin Morgan, 1997). The concept of regional innovation system highlights the influence of regional factors and their synergies on regional innovation capacity and capability (Comins & Rowe, 2008; Goldstein & Luger, 1990). In this regard, innovative performance is a social phenomenon influenced by social, cultural and institutional factors (Goldstein & Luger, 1990; Rodriguez-Pose & Hardy, 2014). STPs might also have broader functions in the development of the regional innovation system. STPs need to adjust their position within their corresponding regional innovation system, and thus their role might more broadly consist in supporting regional technological strengths instead of focusing on a single field of R&D to bolster particular industries (David Doloreux, 2004; Zhu & Tann, 2005). For example, Gkypali et al. (2016) find that STP performance in western Greece declines along with the decrease in government expenditures on R&D. They suggest that during times of fiscal austerity, STPs should move toward institutional support that aims at boosting entrepreneurial capital and especially at changing society’s perception of entrepreneurship rather than focus primarily on technology transfer mechanisms.

Altogether, the rationale for establishing STPs broadly builds on these three theoretical bases. Although the three concepts are somewhat closely linked, overlapping and incorporated into each other (e.g. Hommen, Doloreux, and Larsson 2006; Jongwanich, Kohpaiboon, and Yang 2014; Steinthorsson, Hilmarsson, and Janusson 2017), the different theoretical standpoints provide different policy opportunities for STP development.

2.1.3 Summary of the literature review
The first STP studies can be traced back to 1986 (Simmie & James, 1986). Since then and for over 30 years, there has been a steady growth in STP studies (Hobbes et al., 2017). In this section, I summarise the subjects that have been discussed in STP studies. To do so, I classify STP literature into two groups based on research approaches (qualitative and quantitative). I first examine the themes found in qualitative studies, followed by those appearing in quantitative studies.

In qualitative studies, four research methods are used, namely interviews, workshops and document analysis including descriptive statistics. Motivations behind these studies vary across four strands of literature, as illustrated below. The first consists of studies focusing on the rationale behind the establishment of STPs and their functions. These studies generally hypothesise that STPs are an efficient innovation policy tool for the development of a regional knowledge-based economy. As discussed in section 2.1.2, the justification for establishing STPs and their functions depends on the theoretical proposition of each study. Several justify establishing STPs as a policy operating within the cluster setting (e.g. Chen, Chien, and Lai 2013; Huang and Fernández-Maldonado 2016; Kennedy 2007; Kulke 2008; Lee and Yang 2000; Vaidyanathan 2008). In this view, STPs aim to develop a high-tech industry in a particular place. For example, Kennedy (2007) and Vaidyanathan (2008) examine STPs in India in a large-scale IT cluster and related activities. They demonstrate that STPs have played a crucial role in the growth of the Indian IT sector. Alternatively, some studies in this group focus on STP functions with regard to university-industry linkages. In this sense, the rationale for establishing STPs is that they contribute to facilitating entrepreneurial growth and network formation within a university context (Fikirkoca & Saritas, 2012; Link, A. N.; Scott, 2007; Steinthorsson et al., 2017; Zou & Zhao, 2013).

The second stream concerns studies discussing the evolution path of STPs, offering information about their development process from the initial stage to more mature stages. These are single case studies or comparative case studies, which primarily adopt an institutional perspective (e.g. Athreye 2001; Biswas 2004; Chen, Chien, and Lai 2013; Druiilhe and Garnsey 2000; Hommen, Doloreux, and Larsson 2006; M. Hu 2011; Shin

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4 The aim of this section is to give an overview of STP studies; thus, the classification of these four streams is not meant to be stringent. Articles could fall into more than one group.
2000; Soenarso, Nugraha, and Listyaningrum 2013; Sofouli and Vonortas 2007; Sutherland 2005). For example, Sutherland (2005) examines the evolution of STP policy strategy in China in the context of the institutional reform of the country’s innovation system. The study finds that STPs are increasingly linked to industrialisation and trade policy instead of encouraging innovation system reform as the initial aim. In another example, a study by Feldman (2007) investigating the political and economic origins of the STP in Linkoping, Sweden, concludes that the development of an STP draws on coalitions and networks that combine innovative, political and financial capital.

The third group encompasses studies analysing best practices and success factors by drawing on the experience of well-performing STPs. Some studies apply the experience of well-performing STPs to different contexts (e.g. Cabral 1998; Comins and Rowe 2008; Echols and Meredith 1998; Guadix et al. 2016; Harper and Georgiou 2005; Hommen, Doloreux, and Larsson 2006; Koh, Koh, and Tschang 2005; Ramasamy, Chakrabarty, and Cheah 2004). For example, Koh, Koh and Tschang (2005) propose an analytical framework that draws on the successful experience of Silicon Valley, Cambridge Science Park and Hsinchu Science Park and apply it to analyse the strategy of Singapore Science Park. Several studies associate the conditions of an STP’s development with its contributions (e.g. Edgington 2008; Kulke 2008; Zou and Zhao 2013). In general, this stream of literature shows that conditions for the success of STPs can be linked to a number of factors related to the surrounding environment and internal characteristics (Cabral & Dahab, 1998; Guadix et al., 2016; Kharabsheh, 2009; Ramasamy et al., 2004; Rowe & Wright, 2011; Wasim, 2014).

The fourth strand is comprised of studies discussing the challenges of STP development. Contrary to the previous group, these studies focus on how STPs are hindered in the achievement of their goals and only make modest contributions. For example, Mae Phillips and Wai-chung Yeung (2003) argue that R&D activities in Singapore Science Park remain scarce due to institutional thinness and local embeddedness. Interestingly, the majority of this research consists of case studies about less developed countries (e.g. Bakouros, Mardas, and Varsakelis 2002; Carvalho 2009; Miao and Hall 2014; Phelps and Dawood 2014; Ratinho and Henriques 2010; Watkins-Mathys and Foster 2006). Even in a European context, Carvalho (2009) shows that to effectively promote the regional innovation system, STP development in Portugal requires a better alignment of universities and regionally based firms as well as the improvement of their unfavourable image concerning the location outside urban areas.

In contrast, the bulk of the quantitative studies concentrates on one broad topic, that is, the examination and evaluation of STP performance. Three methods are used, namely the comparison of on- and off-park firms, the comparison of mean values, surveys and econometric analysis (Albahari, Pérez-Canto, & Landoni, 2010). Several studies use a quantitative approach focusing on measuring differences in performance levels between on- and off-park firms with indicators such as job creation, firm growth, investment in R&D and innovation and patent-related measurements (Ferguson, 2004; Lamperti, Mavilia, & Castellini, 2015; Lofsten & Lindelöf, 2002; Squicciarini, 2009). Other studies investigate the effects of STPs on regional research infrastructure, making STP performance a matter of high-end research metrics — e.g. the number of regional research laboratories and university research collaborations with private firms (Appold, 2004; Bigliardi, Dormio, Nosella, & Petroni, 2006; Minguillo & Thelwall, 2015b).

Based on the summary of the STP literature presented in this section, this thesis falls between the third and fourth stream of qualitative studies. Although the analysis of STP performance is included in the discussion, it is mainly used as a broad term representing contributions explaining the linkages between STPs and regional specificities rather than for the rigorous examination and evaluation of STP performance like several studies in the quantitative approach. The topic of STP performance will be further discussed in the next section.
2.1.4 Science and technology park performance

This section provides a discussion and reflection on studies of STP performance and illustrates this thesis’s view of STP performance.

Although the majority of the STP literature (both qualitative and quantitative) has focused on examining STP performance, the contributions of STPs are often questioned because empirical studies continuously produce inconclusive results. For example, several studies have found a positive impact of STPs on firm growth (Lindelöf & Löfsten, 2003; Lofsten & Lindelöf, 2002), firm survival (Ferguson, 2004) and R&D productivity (C. H. Yang, Motohashi, & Chen, 2009). However, multiple studies have failed to corroborate this positive result and have questioned the effectiveness of STPs (Hansson et al., 2005; Mae Phillips & Wai-chung Yeung, 2003; Phelps & Dawood, 2014; Ratinho & Henriques, 2010; Shearmur & Doloreux, 2000). This inconsistency has prompted the search for mechanisms underlying STP performance presented in the present thesis.

Overall, empirical studies show that the analysis of STP performance focuses on three levels: the park level, the firm level (the tenants located in the park) and the systemic or regional level. It does so by using different indicators, such as intellectual property-related indicators, sales- and profitability-related indicators, firm survival, job creation and economic impact (see Table 2). The literature thus proposes no standard way to measure STP performance because STPs are diverse in size, model, sponsors and development stage. Likewise, the value of STP differs across various dimensions. Lecluyse, Knockaert and Spithoven (2019) suggest that STP assessment should focus on purpose-related measurements to reflect tangible achievements. For instance, assessing an STP using turnover as an indicator is relevant when the STP is fully publicly supported. Further, the diversity of STP performance measurements suggests the variety of STP theoretical standpoints (as discussed in section 2.1.2). For example, studies that measure STP contribution at the regional level using employment and economic growth indicators often ground STP contribution in a regional development perspective, whereas other studies that evaluate STP performance at the level of tenant firms with indicators such as the relationship between the latter and university output often approach STP contributions in a triple helix perspective.

In summary, the level of STP performance and evaluation indicators are multifaceted and depend on purpose-related measurements and the theoretical propositions of each study. The aim of the thesis is not to concretise STP performance evaluation as such but rather to use STP performance to explain a connection between place-based policy intervention and its regional context. Thus, in this thesis, STP performance broadly refers to STP contribution at any level reflecting purpose-related measurements. More precisely, in article 1, which develops a theoretical framework, the term ‘STP performance’ represents STP contribution at any level, reported by the papers in the review as either positive, negative or absent. In this sense, STP performance is used as an umbrella term encompassing other terms such as evaluation, assessment, effect, efficiency, impact, influence, contribution and added value. In article 2, which aims to apply the framework to an empirical case, STP performance analysis and evaluation indicators are guided by the framework and the availability of data that broadly reflects the measurement of the STPs’ purpose. Consequently, in article 2, STP performance is captured at the regional level in the form of economic impact and job creation. These two indicators have been used commonly in measuring STP performance (Table 2).
Table 2: Overview of STP performance indicators with examples of studies

<table>
<thead>
<tr>
<th>Unit of analysis</th>
<th>Indicators used</th>
<th>Studies</th>
</tr>
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<tbody>
<tr>
<td>Regional level</td>
<td>New firm creation, number of spin-off firms, number of firms and high-tech firm distribution</td>
<td>Benneworth and Ratinho 2014; Cheng et al. 2014; Druilhe and Garnezy 2000; Miao and Hall 2014; Salvador 2011</td>
</tr>
<tr>
<td></td>
<td>Job creation and employment growth</td>
<td>Jenkins and Leicht 2006; Ratinho and Henriques 2010; Shearmur and Doloreux 2000</td>
</tr>
<tr>
<td></td>
<td>Number of research institutions and educational activities</td>
<td>Appold 2004; Shin 2000</td>
</tr>
<tr>
<td></td>
<td>Economic impact and development in the form of efficiency and productivity growth, export growth and perception of the economic impact of STPs in the region</td>
<td>Chou 2007; Feldman 2007; Jonsson 2002; Phelps and Dawood 2014; Sun 2011; Vaidyanathan 2008; Walcott 2002</td>
</tr>
<tr>
<td>Park level</td>
<td>Number of tenant firms, number of park employees and sales growth</td>
<td>W.-H. Lee and Yang 2000; Link and Scott 2017; W.-T. Yang and Lee 2000</td>
</tr>
<tr>
<td></td>
<td>Attractiveness to well-known enterprises and R&amp;D networks</td>
<td>Minguillo and Thelwall 2012; Zou and Zhao 2013</td>
</tr>
<tr>
<td>Firm level</td>
<td>Firm development, product innovation, lifecycle progression of start-ups and firm survival</td>
<td>Diez-Vial and Fernández-Olmos 2017; McAdam and McAdam 2008; A. R. Vásquez-Urriago et al. 2014</td>
</tr>
<tr>
<td></td>
<td>R&amp;D activities (e.g. R&amp;D expenditure and firms involved in R&amp;D projects)</td>
<td>Colombo and Delmastro 2002; Fukugawa 2006; Leyden, Link, and Siegel 2008; Mae Phillips and Wai-chung Yeung 2003; Siegel, Westhead, and Wright 2003</td>
</tr>
<tr>
<td></td>
<td>Relationship between tenant firms and university or research institution</td>
<td>Colombo and Delmastro 2002; Fukugawa 2006; Kharabsheh 2009; Malairaja and Zawdie 2008</td>
</tr>
</tbody>
</table>

2.1.5 Science and technology parks in developing countries

As discussed in section 2.1.3, the STP literature broadly suggests that the performance of STPs relies on both internal factors and regional conditions. Inspired by the diverse regional studies, which see regions as an important source of competitive advantage (Isaksen, 2001; Moulaert & Sekia, 2003; Todtling & Tripl, 2005), this thesis argues that the regional conditions of STPs are highly relevant for understanding the performance capacity of STPs. This view implies that regions differ in their economic structure, knowledge resources, supportive institutions and infrastructure. Thus, the chance to modify and develop their economic structure depends highly on their pre-existing conditions, and policy interventions require a deep understanding of the regional context to provide the right response to regionally specific problems (Grillitsch & Asheim, 2018; Isaksen et al., 2018; Morisson & Doussineau, 2019). Given the circumstances, the premise and path for the creation of STPs in less developed countries differ from those of several best practice cases in developed
countries, and the value of STPs in developing countries is often criticised to some degree (Rodríguez-Pose & Hardy, 2014).

The literature suggests two major reasons behind the modest contribution of STPs to economic development in developing countries: the practical implementation of a one-size-fits-all approach and the theoretical perspective of the linear model of innovation. First, the implementation of STPs in most developing countries results from a central decision by the government, which is often inspired by best practices (e.g. Silicon Valley and Cambridge). These best practices stem from spontaneous evolution and cooperation between local actors, as primary driving forces, drawing on an existing dynamic in an innovative milieu. For instance, the Cambridge story goes back to the concentration of scientific resources and the university’s supportive policy towards the commercialisation of research inventions, which naturally led to the creation of the Cambridge Science Park in 1970 (Druilhe & Garnsey, 2000). The two American best-practice cases are anchored in a regional context that includes a well-functioning regional innovation system and therefore offers great opportunities to develop STPs. Meanwhile, in developing countries, in many cases, STPs are established with the aim to create these favourable development conditions. Further, most of the STPs in developing countries have emerged from government intervention and adopt functions and strategies similar to best-practice cases. These government policy interventions often overlook the context and conditions in which STP implementation took place. This implies that copying best practices often proves ineffective and produces highly diverse results in different contexts because of the mismatch with existing regional structures and institutional settings (Carvalho, 2009; Dhewanto, Lantu, & Herliana, 2016; Miao & Hall, 2014; Rodríguez-Pose & Hardy, 2014). For example, Phelps and Dawood (2014) submit that STPs in Malaysia have emerged as a product of competition among regional governments rather than well-planned innovation policy strategies. Many STPs have inadequate supportive strategy to attract and retain investors, resulting in islands of innovation infrastructure that cannot fulfil their role in regional innovation development.

Second, despite increasing arguments over the rise of a systemic approach to innovation policy intervention, the linear and static approach to innovation has remained highly influential in innovation policy interventions, including in the STP proposition (Edquist & Hommen, 1999; Hansson et al., 2005; Marques & Morgan, 2018; Smits & Kuhlmann, 2005). The linear and static innovation policy approach presumes that scientific research can easily be translated into innovation services and products. It adopts a supply-side perspective without considering the particular traits of the demand side (Uyarra, 2019). Consequently, innovation policies, including STP strategies, often focus on the role played by universities, technology transfer functions and financial innovation support for R&D, while underplaying the function of firms and broader supportive institutions (e.g. lack of skilled workforce and network fragmentation) (Intarakumnerd & Chaminade, 2011; Phillimore, 1999; Todtling & Trippl, 2005). This approach is evident in practical cases where STPs cannot respond to regional needs, making them seem insufficient for the promotion of innovation activities (Hansson et al., 2005; Mae Phillips & Wai-chung Yeung, 2003; Phelps & Dawood, 2014). Examples of planned creation of STPs under limited conditions include many state-led STPs in Asia, such as Daedeok Science and Technology Park (South Korea), Tsukuba Science City (Japan) and Hsinchu Technology Park (Taiwan). However, successful cases among these are directly linked to efficient state policies that, in turn, have strongly influenced the development of the regional innovation system and STP strategies (Edgington, 2008; T. S. Hu, Lin, & Chang, 2005; Kim, Lee, & Hwang, 2014). (For instance, the limited initial conditions of Hsinchu Science Park (e.g. few development opportunities, low public investment and population migration outflow, limited industrial development) were slowly offset by a stable and effective national STI policy. The government provided a dedicated research institution (Industrial Technology Research Institute or short for ITRI) to work with on-park firms. ITRI offered not only R&D support but also skilled human labour and networking opportunities for innovation development. The government also expanded the scope of STI policy to the industry policy by proposing measures to encourage the development of corporations in the area surrounding the STP. For instance, manufacturers are exempt from business income taxes for five consecutive years, and their capital
investment in new equipment could offset 50% of the business income tax (Chen et al., 2013). This empirical example suggests that the right policy intervention can help improve regional innovation systems and thus result in better STP performance.

Taken together, STP development in developing countries is challenging because the conditions that support innovation performance are limited. However, these circumstances might be counteracted by appropriate and efficient policy intervention at both the STP level and other levels.

2.2 Regional innovation system (RIS)

This thesis grounds its theoretical discussion in the RIS framework. The RIS concept emerged in the 1990s with the development of the national innovation system (NIS) framework. RIS can be conceptualised as a systemic process carried out by a set of firms, organisations and institutions that influence regional innovation capacities (D. Doloreux, 2002; Isaksen et al., 2018). RIS suggests that the region is a particularly appropriate level for innovation policy intervention because the interactive innovation processes often take place at the subnational level, driven by socio-cultural environments (Cooke and Uranga 1997; Tödtling and Tripl 2005). The theoretical principles of RIS have three implications for this thesis.

First, RIS is of particular relevance to the theoretical discussion in this thesis because the concept is based on the existence of system failures (Edquist, 2011; Edquist & Hommen, 1999). This implies that an innovation policy instrument is embedded in a broader socio-economic context and must deal with system imperfection (Smits & Kuhlmann, 2005). RIS addresses innovation processes as a whole and incorporates all components that are important for regional innovation performance. This formulation suggests that RIS can be applied in different types of region (e.g. peripheral regions, metropolitan regions, regions with a specialised industrial base and organisationally thin regions), which is exemplified in several RIS studies (Isaksen et al., 2018; Todtling & Tripl, 2005; Tripl, Grillitsch, & Isaksen, 2018). In this context, RIS is relevant to this thesis because the empirical case concerns an experience in a developing country that is dominated by SMEs in traditional and resource-based industries and has few higher education and R&D institutions. These characteristics are similar to those of organisationally thin regions as defined by Isaksen, Tödtling, and Tripl (2018).

Second, the concept of RIS suggests that regions differ in their economic structure, knowledge resources, supportive institutions and infrastructure. Thus, the chance to modify and develop regional economic structures depends highly on their pre-existing conditions (Grillitsch & Asheim, 2018; Isaksen & Tripl, 2016; Todtling & Tripl, 2005). This implies that policy interventions aimed at enhancing regional innovation capacity should be more specific and sensitive to the regional context (Isaksen & Tripl, 2016; Todtling & Tripl, 2005; Uyarra, 2009). Thus, STP as a tool for the development of a regional innovation system should be transposed into a regional system and respond to innovation problems in that specific context.

Third, RIS indicates that the impact of regional policy interventions depends on the presence of the right infrastructure and institutional configuration for implementation (Planagan & Uyarra, 2016; Uyarra, 2019). This perspective has been supported by several empirical studies of STPs (Albahari et al., 2013; Phelps & Dawood, 2014; Shin, 2000; Tsamis, 2009). These show that most well-performing STPs are associated with regions with favourable supportive institutions. For example, the literature demonstrates that regions with intensive collaborative linkages may benefit more from the infrastructure provided by an STP (Edgington, 2008; S. J. Lee, Lin, & Hsi, 2017). This suggests that in lagging regions where the institutional configuration is limited, STPs alone might not be sufficient to develop regional innovation capacity.

Consequently, I argue that RIS is an appropriate framework for evaluating regional innovation policy, and more specifically STPs in a developing country context. Although the theoretical argument of RIS and this thesis focus on regional endogenous factors, RIS is not a closed economic and policy system. Regions are embedded in wider national and global systems. These exogenous systems are considered relevant as channels for policy
discussion, knowledge resources and market opportunities (Bjorn T. Asheim et al., 2011; Trippl et al., 2018). For these reasons, this thesis has partly adopted these exogenous factors in the foresight process, when identifying and prioritising STP strategies in an S3 context.

2.2.1 Alternative theories

Even though the thesis approaches the theoretical proposition of STP in light of the RIS concept, there is more than one theoretical framework for the discussion of STP development (as discussed in section 2.1.2). In this section, I address other theories (i.e. cluster and triple helix) and explain why they do not suit the theoretical discussion within this thesis.

Cluster theory proposes a relevant idea for the discussion of STPs. According to Porter (1998), the concept of cluster can be defined as ‘a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities’. However, the literature demonstrates that the definition of ‘cluster’ is not standardised; there is no clear definition regarding the geographical scale and institutional components (Borrás & Tsagdis, 2008; R. Martin & Sunley, 2003). This has led to the differentiation of interpretations of clusters in a real economic phenomenon. For example, clusters can be distinguished by their specialisation in a particular field (despite geographical dispersion) or their focus on a specific geographical area (local grouping of similar firms). The latter interpretation is used in most cases (R. Martin & Sunley, 2003). Further, the rationale of the cluster concept lays in the proximity (both in terms of geography and activities) of firms and associated institutions, which creates favourable location-specific externalities (e.g. knowledge spill-overs and close interaction) (Ketels, 2003; Wolman & Hincapie, 2015). Hence, the concept emphasises the importance of firms and their agglomerative dynamic. This notion has prompted researchers to consider using the concept of cluster in the analysis of STPs in regions with only weakly developed industries or none at all. With this in mind, I argue that the cluster concept has limited the empirical discussion of STP development in regions that have weakly developed industries.

Another theory to consider in the theoretical discussion of STPs is the ‘triple helix’ concept. The rationale behind this concept is that innovation is built on the synergy between university, industry and government (Etzkowitz & Leydesdorff, 2000; Leydesdorff & Meyer, 2003). In general, studies adopting the triple helix approach tend to concentrate on profiling universities, industries and governments and mapping their linkages. Hommen, Doloreux and Larsson (2006) argue that the triple helix is somewhat exemplified by the narrow view of RIS because the concept primarily incorporates the main functions of university, industry and government. They further comment that the concept relies on a top-down and linear model of innovation, in which firms’ strategies are built on a university research base. However, to address this critique, Ranga and Etzkowitz (2013) argue that the concept of triple helix can also be used in an innovation system format guided by systems theory, as a set of components, dynamic relationships and functions. This perspective implies that the triple helix concept is a non-linear approach as it incorporates an innovation system dynamic via the interaction of universities, industries and governments. My impression is that although the triple helix concept might be applicable to this thesis’s theoretical proposition, the RIS concept is more refined, well developed and, thus, better suited to capture all the nuances of regional innovation systems. For example, RIS includes financial institutions in its framework, unlike the triple helix. Moreover, the triple helix concept emphasises the role of university-industry-government linkages, but these linkages have diversified and taken various directions across different regions. For instance, the expertise of universities may not be compatible with the key business of the firms located in the STP or the market dynamics. This formulation has limited the empirical discussion of STP development in regions with weak or non-existent university-industry linkages.

In summary, I argue that RIS is an appropriate framework for the analysis of STPs in the context of this thesis because it addresses innovation processes and capacity as a whole, incorporates all relevant components for regional innovation performance and can be applied in any type of region. The concept of cluster, which emphasises the agglomeration of firms, is less analytically useful in an empirical context with no or only weakly
developed industrial clusters. Similarly, the triple helix concept is arguably limiting if the regions do not have (or have weak) university-industry linkages.

2.3 Smart specialisation strategies (S3)

In this thesis, smart specialisation strategies (S3) are used as a policy concept for STP strategy planning. This section provides a detailed discussion of S3 and its use in the thesis.

S3 is a ‘policy prioritisation framework aimed at helping regions to identify their research and innovation resources in order to build critical mass in areas of comparative advantage’ (Uyarra, 2019). A key novelty of S3 is an identification and prioritisation process involving a wide range of stakeholders, the so-called entrepreneurial discovery process (Barzotto, Carlo, Felicia, Sandrine, & Tomlinson, 2019; Foray et al., 2009). S3, which focuses on particular domains related to pre-existing local resources and on ensuring broad stakeholder involvement, is seen as a complementary strategy for STPs, which are often criticised for their lack of integration with regional specificities. S3 thus gives STPs a great opportunity to shape the future of their region.

In the context of this thesis, I have identified a twofold rationale for linking the concept of S3 and STPs. First, both S3 and STP are place-based policy approaches, developed under the comprehensive concept of evolutionary economic geography and RIS and predicated on the idea that regional innovation policy should build on local strengths and tackle local weaknesses. S3 recognises that regions have very different characteristics, that competitiveness can be based on different types of innovation and knowledge and that different institutional configurations promote different economic activities (Grillitsch 2016). While S3 is a policy concept, STP is a tool for innovation strategies, which argues for supporting S3 implementation (Nauwelaers et al., 2014). Second, in developing countries, where STPs are often publicly managed, there is an opportunity for national and regional policy to integrate S3 with STP policy capacity, complementing other policy dimensions (e.g. industrial and education policy) by taking regional conditions as a potential premise. Given this, linking the S3 concept to STP strategies might help improve STP performance in developing country contexts.

However, researchers and policymakers remark that the practical implementation of S3 remains a significant challenge (Foray, Keller, & Bersier, 2018; Gheorghiu, Andreescu, & Curaj, 2016) For example, S3 assumes that regions have enough resources to build critical mass and that the entrepreneurial discovery process will occur smoothly. This is not always the case, especially in lagging regions that are likely to be ‘hindered by low institutional capacity’ (Marques & Morgan, 2018). Furthermore, the current implementation of S3 is often restricted to the definition of broad priority areas and gives insufficient importance to the identification and development of solid policy instruments (Foray et al., 2018; Uyarra, 2019). In this regard, this thesis partly counters S3 challenges by proposing the use of foresight as a tool to reduce the complexity of its implementation and by aligning STP functions with the regional context, as will be discussed in the next section.

2.4 Foresight

In this study, foresight is proposed as a tool for STP policy initiation in an S3 context and is thus positioned in the context of regional innovation policymaking processes.

The general purpose of foresight is to raise awareness of external changes and enable the adoption of strategies to respond to these changes (Miles, Saritas, & Sokolov, 2016). Foresight is a widespread tool for policy planning at the national, regional and sectoral levels (e.g. A. D. Andersen and Andersen 2014; Chan and Daim 2012; Gómez-Limón, Gómez-Ramos, and Sanchez Fernandez 2009; Martin and Johnston 1999). Given the increasing interest in regional policy intervention in the past decade, a number of studies have widened
its application at the regional level (Fabbri, 2016; Foresight for regional development, 2001; Roveda, Vecchiato, Verganti, & Landoni, 2006; Uotila & Ahlqvist, 2008).

From a policy perspective, foresight thus aims at identifying weak signals, trends and future opportunities in promising areas of technology and business developments. It is also intended to provide policy strategies to respond to changes and support future developments by bringing together a broad range of actors and various sources of knowledge (Havas, Schartinger, & Weber, 2010). Thus, foresight is an appropriate tool for developing S3 as it combines elements of a participatory process with a systematic exploration of the future (Fabbri, 2016; Martinaitis & Reimeris, 2015).

The rationale for using foresight for STP and S3 policy initiation is twofold. First, the foresight process is flexible and feasible enough to be interpreted and customised with ‘various socio-economic constituencies plus a different and highly variable institutional and governance situation from region to region’ (Fabbri, 2016; Gavigan & Scapolo, 2001; Gheorghiu et al., 2016). For example, a priority of regional foresight in core regions may be to identify new demands, critical technology and a new vision, while a priority of regional foresight in lagging regions may be to promote a cooperative culture, encouraging network formation and forging better links between the scientific and business communities (Gavigan & Scapolo, 2001). Second, the foresight process is based on a participatory approach involving a wide range of local stakeholders. This process is also in line with the notion of entrepreneur discovery process in S3 (Gheorghiu et al., 2016). The bottom-up approach, in which policy initiative comes from the demand side, might be a more accurate response to the regional context, reducing the risk of policy mismatch.

However, few studies use the foresight process as a tool for S3 or STP policy initiatives (e.g. Fabbri 2016; Fikirkoca and Saritas 2012; Gheorghiu, Andreescu, and Curaj 2016; Harper and Georgiou 2005; Martinaitis and Reimeris 2015). Those that do are comprehensive but limited to the European context. Very little is known about the role of foresight for developing regional innovation systems in developing countries, although its use in developing countries ‘can be even more crucial as it can help to create a well-functioning innovation ecosystem by organizing systemic foresight sessions aimed at establishing communication platforms between different actors and elaboration of new forms of cooperation and support’ (Kindras, Meissner, & Vishnevskiy, 2015).

With this in mind, this thesis proposes to use foresight as a tool for STP and S3 policy initiation in a developing country context. It uses the innovation system foresight (ISF) framework, which was developed by Andersen and Andersen (2014) on the idea that foresight can accommodate an innovation system by addressing the problems and challenges related to the current context and demands for knowledge. The framework is described in detail in article 3.
3 Empirical context

This chapter aims to present the background conditions of innovation systems in developing countries, which reflects on the empirical case examined by the thesis. It also provides practical information for the case study. The chapter opens with a broad discussion of innovation systems in developing countries, followed by a look at Thailand’s innovation system. I then present a detailed discussion of STPs in Thailand and the three STPs that are used as the case study of this thesis.

3.1 Innovation system in developing countries

It is well known that the characteristics of innovation systems in developing countries are distinct from those of developed countries. Developing countries are less established in terms of institutional configuration, the maturity of science and technology practices and linkages among actors (Egbetokun, Oluwadare, Ajao, & Jegede, 2017; Intarakumnerd, Chairatana, & Tangchitpiboon, 2002). In order to summarise the challenges faced by innovation systems in developing countries, I have outlined the problems in four dimensions: firms, university, government and the wider economic and business environment. These four dimensions were derived from the concept of ‘national innovation system framework’ (Lundvall, 2007; Patel & Pavitt, 1994).

First, firms have limited capabilities to develop new technology and encounter difficulties regarding technology absorption. In developed countries, research and development (R&D) is at the core of new technology development, while in developing countries, adopting and acquiring technology is more important than developing new ones. Thus, technologies are often new to firms but not to the industry (Cirera & Maloney, 2017; Egbetokun et al., 2017; Schiller, 2006). Moreover, Guimon (2013) points out that firms in developing countries have shown little motivation for industry-university collaboration. The reasons are threefold: they do not feel the need to collaborate with universities, do not have the capacity to collaborate or find the process complicated. Second, in developing countries, universities are prominent actors in the innovation system, acting as its main endogenous knowledge source; thus, they take on wider responsibilities in the whole process of innovation development. However, in developing countries, universities face several challenges in promoting innovation—for example, scarce resources in terms of the infrastructure and the number of researchers in order to support knowledge linkages with the industries. This problem also constitute to insufficient labour mobilisation between universities and industries, which results in the lack of knowledge flow (Lundvall, Joseph, Chaminade, & Vang, 2011; Schiller, 2006). Third, governments play a major role in building successful innovation systems in developing countries as they are responsible for infrastructure development and initiate supportive policies (Lai & Shyu, 2005; Rodríguez-Pose & Hardy, 2014; Wonglimpiyarat, 2011). However, Cirera and Maloney (2017) argue that governments in many developing countries lack the human resources and organisational efficiency to formulate and enforce effective policies that could correct market and system failure and thereby encourage innovation. Cirera and Maloney (2017) label this condition as ‘innovation policy dilemma’. Fourth, the wider setting that complements innovation development in developing countries is generally absent or inadequate. This includes outdated developed infrastructure, lack of skilled human labour, lack of financial capital, weak entrepreneur culture, low demand for technology and undervaluing of scientific knowledge and technological innovation (Cirera & Maloney, 2017; Intarakumnerd et al., 2002).

Altogether, the limiting conditions of innovation systems in developing countries suggest that policy analysis aimed at fostering innovation in developing countries should take into account various dimensions. Major investment in infrastructure and financial instruments alone are inadequate for supporting a sustained innovation system.
3.2 Innovation system in Thailand

Like other developing countries, Thailand has faced multiple challenges in developing its innovation capacity. The literature and several reports demonstrate that Thailand’s innovation system is comparatively weaker than those of other countries with an upper-middle income level (Chaminade et al., 2012; OECD, 2013b; World Bank Group, 2018). Political instability poses a problem for the Thai innovation system, especially in the form of policy uncertainty. Thailand’s national innovation system is characterised by the fragmentation of actors and linkages, an ineffective industrial policy and low investment into innovation inputs (e.g. expenditure on R&D, number of researchers involved in R&D and payment for intellectual property) (OECD, 2013b). Before 2001, Thailand’s innovation policy fell within the scope of the science and technology policy, with no explicit mention of an innovation strategy. Policy attention regarding R&D and knowledge production focused strongly on universities and research institutions, while firms were almost absent from the context of science and technology development policy (Intarakumnerd and Chaminade 2011; Patarapong Intarakumnerd and Chaminade 2011). As a result, the university is portrayed as the main actor of the regional innovation system to this day. A major change in innovation policy came in 2001 when a systemic innovation policy approach was first initiated, and the science and technology policy was expanded into a science, technology and innovation policy. The government tried to develop the country’s competitiveness at both the regional and national levels (Chaminade et al., 2012). In 2004, it approved the establishment plan for the regional science parks, the first explicit project to decentralise STI policy at the regional level (Tantanasiriwong, 2016).

3.3 Science and technology parks in Thailand

Regional science parks aim to fill the economic inequality gap between Bangkok and the peripheral areas by using STI policy to enhance capabilities in the agricultural, industrial and manufacturing sectors (Tridech, 2016; Wongpreedee, 2017). Initially, only three science parks existed, embedded in three major universities in different parts of the country. These parks provided only soft services to local firms by means of technological consultancy, training and collaboration. In 2007–2011, the plan to develop science parks was temporarily terminated. It resumed in 2011 with a large budget for the parks to set up new infrastructure, provide full functional services and enhance the regional STI-perception level (Irawati & Rutten, 2013). At present, there are 16 science parks across the country, 14 of which operate in three different regions, one in Bangkok and one (currently in the set-up phase) in the eastern region (Figure 2).

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5 Blue dots in Figure 2 – North: Chiangmai University; North East: Khonkaen University; and South: Prince of Songkla University
The three initial science parks have become the main branches of other science parks in the region. All parks are governed by the same national programme for STP development. Since 2013, the parks are officially organised in a partnership model of local university science parks, occupying two floors of the host university building and adopting a triple helix ecosystem. The director of each park reports directly to the host university. However, funding and budget allocation as well as the overall strategy are managed by the Ministry of Science and Technology. Thus, all three parks have provided similar services, which can be described as four platforms.

The first is the **service platform**, consisting of five sub-platforms:

- **Office space and laboratory spaces**: science parks provide small scale in-wall incubation office space for start-up firms, which can accommodate approximately three small firms only. Thus, most start-up firms have a virtual office or are located elsewhere. Laboratory spaces are provided in collaboration with host universities.
- **Innovation design centre**: the services aim to support product design, packaging design, trademark design, brand design, social media design and advertisement design.
- **Intellectual property (IP) consultancy**: science parks provide several services with regards to intellectual property consultancy, for example, training services for STI-based local firms or guidelines and consultancy for firms and university researchers applying for IP. The IP service also advises university researchers on how to turn their research into a business idea. Moreover, it is a supporting platform.

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6 This service section refers to data from Tridech (2016) complemented by interview data and the science parks’ internal annual reports year.
service for park customers who participated in other platforms, such as start-up firms in business incubation platforms and local SMEs in collaborative research platform.

- Science and Technology infrastructure DataBank (STDB): STDB is a supporting database providing useful information, such as researcher profiles, service laboratories, scientific equipment and academic publications. It is an important tool for science park staff to search for supporting STI information and help park customers find matching researchers and/or book laboratories and scientific equipment. However, the STDB database currently only includes data from the science parks network.
- Office of Industrial Liaison (OIL): OIL is the technical assistant for local SMEs. OIL helps to stimulate STI awareness among local firms and assist them in applying and receiving appropriate services from STPs. This service is offered by contacting and visiting local SMEs.

The second is the **business incubation platform**. The platform seeks to help STI-based start-up businesses during the early stage of their operation as well as support firms entering the market. Each start-up firm can remain in the incubation programme for a maximum of three years. Parks provide support in both technology and business incubation by seeking advice from university and private experts as well as connecting with private venture capital. Start-up firms using this incubation service receive special discounts, including on in-wall office spaces. According to their annual reports, in 2017 and 2018, each park has 6 to 12 start-up firms joining its incubation programme.

The third platform is **the Industrial Research and Technology Capacity Development Program (IRTC)**. The IRTC platform connects firms with researchers from universities that provide technical supports to businesses. The IRTC programme was developed to guide local SMEs in solving industrial problems such as process improvement, process control, product creation, zero-waste management and STI capacity building. Most projects run for 6–12 months. Each firm can join one project per year, for a maximum of three consecutive years. Each project receives funding up to 300,000 THB (approximately 8,192 EUR). Interestingly, the number of firms joining this platform differs greatly between the three parks. According to their annual reports, in 2018, Prince of Songkla Science Park had seven IRTC projects, followed by 10 IRTC projects for Khonkaen Science Park and 65 IRTC projects for Chiangmai Science Park.

The fourth platform is the **Co-research platform**. It allows firms and university researchers (through the means of the science park) to create a joint industrial research project, with 70% of the investment expected to be contributed by the private sector and 30% by the parks. The program aims to engage major local firms as anchor tenants of a park. However, the research content must be closely related to a market issue and mainly stems from industrial requirements. Every year, each park has only two or three firms joining this programme.

Using the terminology of STP development stages (see section 2.1.1), the three main parks have entered the transition period from a start-up state to a growth state, moving from university buildings to new dedicated infrastructure that enables them to provide additional facilities, such as laboratories and rental space. At the beginning of 2019, when I collected the data for this thesis, Khonkaen Science Park and Chiangmai Science Park had just moved into their new buildings; Prince of Songkla Science Park did so the following year. This implies that the analysis is guided by data for which the internal setting of the three parks might differ. However, I argue that the difference in infrastructural setting has only a small or no impact on the results because the STP performance data (article 2) covers the period 2013 to 2017 when all parks were embedded in a university building. However, such a situation might have raised the question whether the results have been different if I had done the research again with the new science park infrastructure setup. As a result of my argument based on the thesis proposition that views regional contextual factors as pre-conditions for STP development, I argue that the findings will not vary significantly with the new setting if the regional contextual factors in each region themselves remain unchanged.
The next section will provide an overview of the three science parks and their regional context. These parks have different focus sectors depending on the strengths of the local universities' research and local economic capabilities.

### 3.3.1 Chiangmai Science Park

Chiangmai Science Park is located on the Chiangmai University campus, in the urban centre of Chiangmai province. According to the park’s internal annual report, in 2018, Chiangmai Science Park had 57 employees (Northern Science Park, 2018). In May 2018, the science park moved from the university building to a new dedicated building (Figure 3), located 7.6 kilometres from the Chiangmai city centre and 13 kilometres from Chiangmai University. The new building’s area size is approximately 22,000 square metres (Chiangmai University, 2020; Tridech, 2016). The province is renowned as a tourist attraction and for its unique arts and crafts tradition. Foreigners identify Chiangmai as one of the best places to stay because of the low cost of living, the stunning and calming atmosphere, the variety of co-working spaces and ease of getting around (Erin, 2020; Hynes, 2016). In 2019, Chiangmai reported 10.8 million visitors (70% were Thai and 30% foreigners) (Bangkok Post, 2020). Firms present in Chiangmai specialise in food processing, IT, tourism, textile and furniture production (Ministry of Industry Chiangmai Province, 2019). According to an interview with the park manager in 2019, they informed that Chiangmai University, the host university of Chiangmai Science Park, puts a strong emphasis on engineering, science, agriculture and medicine. Chiangmai Science Park focuses on the agricultural sector, particularly rice and local herbs, IT, tourism and the biomedical industry (Pisansupong, 2014; Plaeksakul, 2013).

![Figure 3. Chiangmai Science Park, old location (left) and new location (right)](image)

### 3.3.2 Khonkaen Science Park

In the north-eastern region, Khonkaen Science Park was originally located on the university campus, 3 kilometres from the urban centre of Khonkaen province. According to an interview with the director of the park in 2019, Khonkaen Science Park has 41 employees. In September 2018, the park moved to a new dedicated building in the area of the university campus and very close to the centre of the north-eastern economic zone (Figure 4). The new building area consists of 19,000 square metres. The province plays a major role in driving the economy and culture of the north-eastern region. The Thai government nominated Khonkaen as an export centre for the Indo-China trade area. Khonkaen offers a balanced mix between traditional and modern life, as agriculture and textiles are still dominant sectors in the countryside while the urban area is undergoing dramatic growth (Lonely Planet, 2020; Sudhipongpracha & Dahiya, 2019). The majority of local firms in Khonkaen specialise in textiles, distilleries, sugar and paper production (Ministry of Industry Khonkaen Province 2019). Khonkaen University, the host university of Khonkaen Science Park, carries out outstanding research in tropical medicine and agriculture, in both animal and plant science. Khonkaen Science Park focuses on the agricultural sector, particularly rice and local herbs, IT, tourism and the biomedical industry (Pisansupong, 2014; Plaeksakul, 2013).

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7 See: https://www.timeshighereducation.com/world-university-rankings/khon-kaen-university
Science Park focuses on livestock, especially broiler, food processing, health science and bio-materials (Northeastern Science Park 2018; Tridech 2016).

3.3.3 Prince of Songkla Science Park
Prince of Songkla Science Park, in the southern region, is embedded in the university campus, 3 kilometres from the city centre. According to an interview with park manager in 2019, Prince of Songkla University Science Park has 70 employees. In September 2020, the science park moved from the university building to a new dedicated building, 7.6 kilometres from the university campus (Figure 5). The new building area covers approximately 22,000 square metres. Songkhla is a southern hub of communication, trading and transportation as well as a gateway to Malaysia and Singapore. In light of this, the province has gained importance in driving economic growth in the southern region. In Songkhla, the majority of firms operate in the rubber and seafood sectors (Ministry of Industry Songkhla Province, 2019). Prince of Songkla University is the oldest university in southern Thailand. Its research expertise focuses on rubber, palm oil, seafood, nursing and medicine. Accordingly, the science park concentrates on rubber, seafood, palm oil and the biomedical sector.

As discussed in section 3.3, at the time of collecting the data for this thesis, these focus sectors were more likely to be part of a broad plan than a clear strategy. There was no special approach to these flagship sectors (e.g. strategic decisions concerning the types of firms to accept, providing special incentives and the presence of supportive infrastructure). Only the local university’s scientific base, which consists of a pool of specialised researchers, appeared relevant to these focus sectors. A dedicated comprehensive and long-term strategy is expected to be elaborated in the near future, once the parks have settled in their new premises, which will
enable them to accommodate on-park tenant firms and provide supportive laboratories related to their focus sectors. This may also impact the networking opportunities that parks aim to create for tenant firms.\textsuperscript{8}

A look at the innovation system at the regional level shows that STPs in Thailand have a close connection with the local university in their adoption of top-down STI policy from the national government, whereas interactions with other regional actors (e.g. local firms and local government) slowly develop over time. This reflects the strength and persistence, in the Thai system, of the linear view of the innovation model approach, which highlights the role of the university as the main actor in knowledge creation. Compared to other STPs worldwide, STPs in Thailand share common service features as regards collaboration with major research centres and universities, management support to assist with firm growth, encouragement of synergies and promotion of technology transfer and the incubation of technology-based firms. However, according to interviews with science parks directors and managers as well as a report from Pisansupong (2014), at the moment, one major difference between regional STPs in Thailand and other STPs worldwide is that the former have not yet attracted a critical mass of knowledge-intensive firms. This is one of the challenges of STP development in Thailand.

\textsuperscript{8} Interviews with STP directors and managers.
4 Discussion: answering the research questions

In this section, I summarise and discuss key findings from the three articles. These findings reflect the research objectives and questions discussed in section 1.1.

4.1 How do regional contextual factors play a role in STP performance?

Article 1 aims to conduct an exploratory examination of the relationship between STP performance and regional context factors through a systematic literature review. The key findings are presented conceptually in a RIS-STP framework (Figure 6). The framework consists of seven themes: five broad categories of regional factors (university and research institutions, industrial structure, institutions, financial support and urbanisation), extra-regional factors and park-internal factors. However, because the argument of the thesis focuses on regional endogenous dynamics, the analysis of the review concentrates on the five groups of regional factors.

Figure 6. Framework of factors influencing STP performance based on the literature review. Regional contextual factors (1–5), extra-regional connectivity (6) and STPs’ internal factors (7). Source: Poonjan and Tanner 2020

In the following paragraphs, I summarise how each regional factor plays a role in STP performance (see the results and analysis section of article 1 for a more detailed discussion).

The first factor is the importance of university and research institutes. The availability and capacity of universities and research institutes to participate in knowledge networks is a fundamental precondition driving STP performance. The analysis shows that universities and research institutes play three major roles in this regard: they act as a source of knowledge creation and a knowledge network, they provide skilled human labour, and they offer a place to encourage innovation culture and activities. However, the linkage between STPs and universities is multidimensional and can be determined by a university’s profile, innovative attitude and knowledge domains. For instance, Minguillo and Thelwall (2015a) argue that high-ranked universities actively engaging in R&D collaborate better and more dynamic with STP tenants than medium- and low-ranked universities. This suggests that universities and research excellence are important for knowledge transfer between knowledge producers and the private sector. In addition, local universities that offer matching financial sources effectively encourage students to spin off their research or appreciate extra
research activities are often linked to well-performing STPs (Zou & Zhao, 2013). Conversely, local universities that look down on entrepreneurial culture and build on conventional academic goals may hamper STP performance (Etzkowitz & Zhou, 2018; Hansson et al., 2005).

The second factor is the regional **industrial structure**. The review shows that regions with a strong industrial agglomeration and the presence of leading high-tech firms and industries are more likely to exhibit positive STP performance levels. The evidence for this analysis is visible in several studies (e.g. Hommen, Doloreux, and Larsson 2006; Yun and Lee 2013). They suggest that the connection between STPs and a favourable local industrial agglomeration (including the participation of leading high-tech firms) sustains the performance of both local industries and STPs in the form of R&D and the chance to create spin-off companies.

The third factor is **institutions**, which can be classified into three sub-groups. The first consists of **innovation and entrepreneurial culture and norms**. The literature indicates that regions that have intensive collaborative linkages may benefit more from the facilities supported by STPs. The analysis also shows that the effectiveness of STPs often manifests in transaction-intensive linkages between firms and other innovative actors that promote entrepreneurial activities (Edgington, 2008; T. S. Hu, 2008; Zou & Zhao, 2013). The second sub-group, **multi-scalar STI policy**, can be described as an interplay between national and regional policies. The analysis suggests that in the best-performing cases, the relationship between national and regional policies is characterised by coordination, coherence and stability (Albahari et al., 2013; Edgington, 2008; Huang & Fernández-Maldonado, 2016). In this matter, the national government policy framework is particularly important in less-favoured regions because these are less resourceful in terms of finance, skilled labour and scientific knowledge bases (inter alia). As a consequence, less-favoured regions depend to a greater extent on sufficient and stable national framework conditions. On the other hand, an incoherent and uncoordinated policy at the national and regional levels may lead to inefficient STP development (Phelps & Dawood, 2014). The third sub-theme is **the adjustment and integration of STI policy to match the local context**. The analysis shows that regional differences reflect the need to adjust STP strategies and other supportive STI policies to fit the regional context. For example, in regions where the entrepreneurial culture is low, policy initiatives targeting the formation of new firms are more important than massive infrastructure projects (Etzkowitz & Zhou, 2018). The review also reveals that the challenges faced by poor-performing STPs are exacerbated by a lack of integration of the resources of local actors, such as universities, industries and local governments (Brooker, 2013; Shin, 2000).

The fourth factor is the **availability of financial support**, which is understood as both access to financial capital and assistance on how to access and manage funding. The analysis suggests that access to financial resources is essential for STP performance in general because it plays a critical role for entrepreneurs to carry out R&D activities, initiate manufacturing and promote the sale and marketing of products or services (e.g. Watkins-Mathys and Foster 2006; Xiao and North 2018). The literature indicates that STPs based in metropolitan areas often have higher chances of receiving financial support than STPs located in peripheral areas because networking opportunities contribute to better access to financial sources (Salvador, 2011; Watkins-Mathys & Foster, 2006).

The last factor is the level of regional **urbanisation**. The review reveals that in most cases, STPs situated in urbanised areas benefit from access to skilled human labour, financial investment, supporting institutions and face-to-face meetings with other high-tech companies (Comins & Rowe, 2008; Edgington, 2008). On the contrary, STPs that are located in peripheral areas struggle to attract skilled workers and lack social facilities such as restaurants and leisure facilities, which are vital for networking (Watkins-Mathys & Foster, 2006).

Altogether, the results show that regional contextual factors affect STP performance. These findings substantiate previous STP studies that emphasise the importance of context (e.g. Edgington 2008; Etzkowitz and Zhou 2018; Harper and Georgiou 2005; Phelps and Dawood 2014). They are also in line with existing
knowledge on place-based policy intervention, according to which regional policy cannot start from scratch and regional contextual factors should be taken as a departure point for the implementation of place-based policies (Boschma, 2005; McCann & Ortega-Ariglés, 2013; Todtling & Trippl, 2005). These findings also reinforce the idea, articulated through the evaluation of regional policy initiatives, that the impact of regional policy depends on the presence of the right infrastructure and institutional configuration for policy implementation (Flanagan & Uyarra, 2016; Smith, 2000). This indicates that to strengthen STP performance as a whole, supportive policies concerning these regional factors are required, especially in lagging regions with fewer resources. Other types of policy could include: stimulating regional collaboration, supporting entrepreneurial culture in universities and well structuring multi-scalar policy, which is characterised by coordination and coherence between the national and regional levels. In summary, this study examines the regional dynamics of STPs and conceptualises them in a RIS-SP framework. The RIS-SP framework provides a systematic view of the design and/or improvement of STP performance by taking regional contextual factors into account.

4.2 How do regional factors influence the performance of science and technology parks? A comparative analysis of regional science parks in Thailand

The second article focuses on using the RIS-SP framework to examine how regional contextual factors support or hamper STP performance. To do so, the framework is applied to a comparative case study of three STPs in three provinces of Thailand, namely Prince of Songkla Science Park in Songkhla province, Chiangmai Science Park in Chiangmai province and Khonkaen Science Park in Khonkaen province. The analysis is based on the performance of the three STPs and the effects of their differing provincial conditions.

The results obtained from the internal report indicate that Chiangmai Science Park performs the best, followed by Khonkaen Science Park and Prince of Songkla Science Park (RTI International, 2019). This interpretation of performance was corroborated by most of the interviews. A comparative analysis of regional contextual factors for each park shows that the three provinces differ in their industrial structure and levels of trust and collaboration, which generates different regional starting points for the STPs’ activities. However, the three provinces have faced similar challenges in terms of multi-scalar STI policy, university-industry collaboration and financial support (the summary of the comparison is illustrated in article 2, Table 3).

A comparative analysis suggests two possible explanations for Songkhla’s lacking innovation capacity compared to the other two provinces, which results in the lowest STP performance of the three. First, the industrial structure is less diverse in Songkhla than in Chiangmai and Khonkaen. Additionally, most firms are low-tech and situated upstream and midstream in the value chain. Although regional innovation capacity might go beyond the dichotomy of diversified and specialised regions, generally, the outcomes of the local economy depend partly on the capacity of local firms to adopt new technologies and knowledge and apply them productively (Iammarino, 2011; Lester, 2005). Thereby, the low level of firm capacity in Songkhla may also contribute to the limited regional innovation capacity. Second, the level of collaboration and trust among local actors is fairly low in Songkhla compared to Chiangmai. The literature suggests that the local collaboration is an important mechanism for innovation creation as it stimulates the recombination of knowledge across different actors and enhances the knowledge productivity of regions (Trippl & Toedtling, 2008). Several studies (e.g. Aarstad, Kvitastein, and Jakobsen 2019; De Noni, Ganzaroli, and Orsi 2017) have found a link between high levels of regional collaboration and innovation. Thus, insufficient collaboration between local actors reduces the opportunities for knowledge flow and innovation formation and may therefore be the explanation for poorer STP results.

At the same time, the analysis of the results reveals that the three provinces have faced similar challenges in terms of multi-scalar STI policy, university-industry collaboration and financial support. Whereas discontinuous financial support is clearly a disadvantage for building regional innovative capacity, the
importance of incoherent multi-scalar STI policy has emerged as a major problem in Thailand’s innovation system. This study has shown that the challenges of STI policy and government structures at the national level have affected STI policy adjustment at the provincial level. Notably, the centralised, top-down approach reduces horizontal collaboration and creates somewhat redundant functions across different organisations at the provincial level. In addition, the limitation of provincial autonomy results in a policy mismatch between the national government’s policy support and current issues in the provinces. Thus, for the Thai government, there is a need to reduce the inconsistency of policy at the national and provincial levels to better meet the local demand for STI policy.

Another challenge embedded in Thailand’s innovation system is the lack of university-industry collaboration. However, it has been argued that low levels of university-industry collaboration may not be a major issue in developing countries because the industry is better characterised as traditional than science-based (Guimon, 2013; Pittayasophon & Intarakumnerd, 2017; Schiller, 2006). This study confirms the claim that the role of Thai universities differs from the Western experience and that, consequently, in some regions, STPs may not be the most suitable policy instrument (Schiller, 2006). Given that the main goal of STPs is to strengthen knowledge linkages between universities and industries and that the need for university-industry collaboration in developing countries could be lower (due to a different industrial structure from that of developed countries), it might seem paradoxical that STPs continue to be a very influential STI policy instrument in Thailand. In this matter, policies may aim more to strengthen other types of knowledge infrastructure at the regional level. This can be done, for example, by utilising and boosting existing informal channels of knowledge sharing between universities and industries, by building absorptive capacity to adopt and diffuse already existing technologies and by improving the knowledge base of regions through increasing the quality and quantity of traditional university outputs, such as the number of graduates, publications and research projects fitting the regional needs (Guimon, 2013; Lester, 2005; Schiller, 2006).

Taken together, the empirical findings show that despite the existence of a centralised, top-down approach, the three provinces in Thailand possess different types of regional innovation systems and, thus, reflect different levels of STP performance. These results indicate that STP strategies across the country need to be articulated to fit regional specificities. This underlines the rationale for context dependency and policy intervention at the subnational level (Boschma 2004; Tödtling and Trippl 2005). This finding broadly supports the conclusions of other studies in the area of innovation policy and STP in developing countries, which highlight the limitations of innovation system conditions, especially the quality of governance, in exploiting efficient supportive innovation policy (Chaminade et al., 2012; Intarakumnerd et al., 2002; Rodríguez-Pose & Hardy, 2014). The discussion of policy recommendations will be further elaborated in section 5.2.

4.3 How can foresight act as a tool for S3 implementation and align the function of the STP with the regional context?

The third article of this thesis aims to expand the role of STPs to S3 policy initiation by proposing the use of foresight for policy planning. The practical implications draw on the experience of Prince Songkla Science Park, in the Songkhla province of Thailand. In this summary of the discussion, I focus on the use of foresight to align the function of STP with S3 development; the practical results for policy recommendations are described in full in article 3.

The overall foresight process is grounded in the core concept of S3, which highlights the importance of the technological resources available in the region and bottom-up policy formulation. The bottom-up approach emphasises regional actors and regional resources, arguing that policy is undertaken at the regional level, unlike the top-down approach, which only takes into consideration the central decision-makers and fails to capture regional specificities (Cerna, 2013; Sabatier, 1986). This top-down approach is usually dominant in STI policy in Thailand and other Asian countries. However, in the context of regional policy intervention, it has
been argued that to respond to regionally specific challenges, the top-down and bottom-up approaches should be balanced (Crescenzi & Rodríguez-Pose, 2011; Uyarra, 2009). For this reason, this thesis proposes the use of foresight and demonstrates that it allows for the incorporation of bottom-up policymaking without completely disrupting existing top-down policymaking practices.

Regarding regional technological resources, this foresight process covers four focus sectors of Prince of Songkla Science Park, namely the rubber, seafood, palm oil and biomedical sectors. The foresight process is used to examine four topics linked to S3 initiation in the selected sectors: (1) potential technology and business development; (2) global megatrends that will impact these developments; (3) key instruments for regional policy; and (4) STP management strategies. The RIS-STP framework provides guidelines for the formulation of key instruments for regional policies and STP management strategies.

The study shows that the foresight process facilitates the development of STP strategies in an S3 context in three ways. First, it helps to identify the regional technology and business development areas with the highest potential for future development and sufficient knowledge and skill competencies that are ready to be exploited in the region. In addition, foresight helps to pinpoint global megatrends in these areas to anticipate demand opportunities, prospects for R&D and patterns in broad policy planning. Future perspective is important for S3 policy planning because regions cannot excel in all areas and thus need to identify their research and innovation resources based on the opportunities, threats and weaknesses of the future. Thanks to foresight, policy support and potential investment can focus on the appropriate fields to bolster regional economic development (Fabbri, 2016; Gheorghiu et al., 2016). For example, the results of the foresight exercise in Songkhla reveal that the impact of global megatrends in health, wellness and well-being is highly ranked across all three sectors. The respondents anticipate that the trends will influence consumer lifestyles in the future. Therefore, the market for products and services related to healthy lifestyles and well-being would also increase. Along the same line, the respondents from the biomedical sector foresee that the sector will be affected by an ageing society. As a result, demand from both the public (e.g. hospitals) and the private sector would warrant greater funding targeting products and services for health, wellness, well-being and the elderly.

Second, the foresight process promotes the bottom-up approach of the S3 entrepreneurial discovery process and STP strategy design in general. The entrepreneurial discovery process gives local stakeholders a chance to identify the regional strategies that are best for the region; this prospect is important for place-based policy intervention because it helps to reduce the risk of policy mismatch (Grillitsch, 2016). However, it has been argued that the entrepreneurial discovery process may entail some risks, such as the possibility that powerful local stakeholders will take advantage of it and only lobby for their own interests (Kiel, Hassink, & Gong, 2019). In line with European Commission (2015) and Foray, David, and Hall (2011), this thesis argues that foresight can help with such situations, as an evidence-based, transparent process that includes a wide range of relevant stakeholders. Foresight can help prevent the entrepreneurial discovery process from being hijacked by interest groups. With regard to the Songkhla experience, the experts’ consensus is that the province needs policy support related to the promotion of collaboration on both regional policy instruments and STP management instruments. This is in line with the results presented in article 2, which demonstrate that the current regional innovation culture and collaboration among firms and between the universities and firms are generally weak. In this regard, foresight has demonstrated its ability to establish communication platforms between different actors and elaborate new forms of collaboration and support in identifying regional policy strategies.

Third, the proposed foresight model (based on interviews and a Delphi survey) has eased the complexity of S3 initiation in a context of limited time and resources. This perspective is important for S3 initiation in developing

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9 The palm oil sector was ultimately excluded from the analysis because its presence in Songkhla province is weak compared to the other three sectors.
countries (or less-favoured regions) characterised by an insufficient level of institutional development (e.g. fragmentation and weak representation of local stakeholders and/or stakeholders who are not familiar with foresight). This study argues that Delphi-based foresight provides an efficient decision-making approach, gathering consensus information from a panel of experts without bringing them together physically; it also helps dilute the social issues that can hamper effective communication (Linstone & Turoff, 2002; Rowe & Wright, 2011). In this regard, the proposed approach differs from the workshop-based approach suggested for European regions (Foray et al., 2018; Harper & Georghiou, 2005).

In sum, this study submits that the foresight exercise adds a conceptual discussion to the development of STPs and the concept of S3 by enabling a systemic assessment of regional innovation ecosystems and their technological capabilities and then transposing it into a policy priority setting. This study adds to the debate on foresight for regional innovation systems (e.g. Fabbri 2016; Gheorghiu, Andreescu, and Curaj 2016; Kindras, Meissner, and Vishnevskiy 2015; Uotila and Ahlqvist 2008) and the role of STPs in an S3 context (Nauwelaers et al., 2014). The model proposed in this study provides an example that can be replicated elsewhere in similar contexts.

Chapter 4 has summarised and discussed key findings from the three articles. These findings reflect the overall research question and objectives discussed in section 1.1 by addressing the theoretical and practical implications of the connection between regional context and STP performance. Additionally, they illustrate the use of foresight in policy planning. The findings of this study make several contributions to the current literature, which I will elaborate on in the next chapter.
5 Contributions, limitations and avenues for future research

In this chapter, I present the contributions of the thesis, research limitations and opportunities for future studies. The chapter starts with the discussion of the thesis’s contributions to furthering academic knowledge about STPs and RIS. I outline three dimensions: theoretical, empirical and methodological (Table 3). The empirical discussion in article 2 is considered as a two-way analysis for interpreting theoretical and empirical contributions. This means that theories help to describe and explain empirical insights. At the same time, the logic of empirical insight corroborates theories (Ågerfalk, 2014; Presthus & Munkvold, 2016). In this regard, I theorise key findings of the empirical insight and discuss them in the context of the theoretical contribution. In the empirical contribution section, I discuss the general experience of Thailand’s national and regional innovation system. A summary of the thesis’s contributions is presented in Table 3.

Table 3: Summary of the thesis’s contributions

<table>
<thead>
<tr>
<th>Contributions</th>
<th>Theoretical</th>
<th>Empirical (from the Thai context)</th>
<th>Methodological</th>
</tr>
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<tbody>
<tr>
<td>(1)The role of regional contextual factors for science and technology parks: A conceptual framework</td>
<td>Offers a conceptual framework (RIS-STP) of regional contextual factors linked to STP performance</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(2)How do regional contextual factors influence STP performance? A comparative analysis from Thailand</td>
<td>Corroborates the idea that there is ‘no one size fits all’ approach</td>
<td>Provides background context on the national innovation system and empirical insight into the regional innovation system and STP performance in Thailand</td>
<td>Applies the RIS-STP framework for assessing regional contextual factors and STP performance</td>
</tr>
<tr>
<td>(3)Foresight for science and technology parks in a smart specialisation context</td>
<td>Concretises the theoretical discussion of the role of STPs in innovation strategy and S3 by applying innovation system foresight (ISF)</td>
<td>Complements article 2 regarding the empirical findings on Thailand’s national and regional innovation system</td>
<td>Proposes a tool for S3 initiation where STP plays a major role and align their functions with the regional context</td>
</tr>
</tbody>
</table>

5.1 Theoretical contribution

The thesis makes four principal theoretical contributions. First, it proposes a RIS-STP framework, promoting a new way to assess STP performance and design STP strategies. The significance of this framework lies in a systemic linkage between regional contextual factors and STP performance. Generally, the RIS-STP framework provides two levels of analysis for the design of STP strategies. At the STP level, this framework argues that when designing STPs, it is important to assess pre-existing competencies and skills embedded in the industrial
and knowledge infrastructure to create STP strategies that respond to regional needs. At the policy level, this framework also suggests that the impact of STPs is dependent on these regional contextual factors. This perspective provides two implications. First, this means that the relative importance of STP performance-based measures (e.g. patents and number of start-up firms) varies across regions and time. Thus, the impact of an STP may be of greater importance in a less developed region even though the absolute values of STP performance measures are low (Albahari et al., 2017). As a result, STPs can be an important policy tool in less developed regions. Second, this also implies that to promote STP performance as a whole, policy support is required in other dimensions (e.g. stimulation of local collaboration, coherence and coordination of STI policy at the national and regional levels, promotion of skilled labour and quality of university research). This perspective is particularly important in lagging regions, where the regional resources to support innovation are limited. The RIS-STP framework supports the work of other STP studies and the broad concept of regional innovation policy intervention, which paint the development of STPs as context driven, resource dependent and competence based. However, the framework seeks to take stock of this knowledge and provide a new combined approach to understanding STP performance. All in all, the RIS-STP framework offers a comprehensive and systematic approach for assessing the interplay between STP performance and specific regional innovation systems. This framework should help to improve the performance of STPs in developing countries, which have often been criticised for their static and linear approach to designing STP strategies, resulting in modest outcomes.

Second, the empirical findings in article 2 indicate that despite a strong top-down, centralised approach, the three different regions in Thailand manifest a different level of development of their regional innovation system and, thus, different levels of STP performance. This further supports the idea that there is no one-size-fits-all approach and that geography matters in the analysis of innovation policy intervention. Regional studies provide two broad explanations for this argument. First, regions differ in their economic structure, knowledge resources, supportive institutions and infrastructure, and thus in their innovation performance. This suggests that the chance to modify and develop the regional economic structure depends highly on pre-existing conditions (Grillitsch & Asheim, 2018; Todtling & Tripl, 2005). Second, the underlying mechanism of knowledge spill-over has been shown to be spatially bound because learning mechanisms require personal links between actors. These intensive personal linkages are often strong at the regional level thanks to long-lasting direct and personal relationships facilitated by geographical proximity (Bjørn T. Asheim & Coenen, 2005; Lester, 2005; Maskell & Malmberg, 1999; K. Morgan, 2004). It would therefore seem appropriate to analyse innovation policy intervention at the regional level.

Third, the empirical findings presented in article 2 suggests a link between the level of regional collaboration and STP performance. This can be explained by the regional innovation culture in the RIS perspective, which implies that a good interplay between actors within and between the RIS systems is important for knowledge generation and diffusion (Tripl & Toedtling, 2008). This view suggests that regional innovation culture in the form of trust and collaboration is a foundation for knowledge learning and innovation processes and, thus, STP development. This has raised questions for policymakers, for example, regarding how STPs can address this issue and build trust and collaboration. Although the process of building local trust and stimulating regional collaboration is complex, evidence suggests that it is possible (Christopher, Watts, McCormick, & Young, 2008; Guimon, 2013; Henton, Melville, & Walesh, 2002). The main suggestion here for STPs and policymakers is that in regions with low levels of collaboration, investment in STPs alone is insufficient to improve regional innovation capacity; reshaping the informal institutional settings of regions is necessary. Other supportive policies aimed at stimulating regional collaboration should be considered, such as collaborative schemes to support R&D investment in firms, collaboration on the provision of innovation vouchers and prioritised funding conditions to promote joint research (Uyarra, Sörvik, & Midtkandal, 2014).
Fourth, with respect to article 3, this thesis argues that STPs and S3 can complement each other, based on the rational discussion of context dependency and policy intervention. STP can potentially play a major role in S3 initiation, namely by providing an adequate innovation ecosystem, gathering multiple stakeholders and enabling their contributions to shape S3 strategies, and connecting extra-regional actors for the implementation of S3 strategies (Nauwelaers et al., 2014). In this matter, the use of foresight adds a conceptual discussion to the development of STPs and the concept of S3. Moreover, as discussed in section 4.3, the foresight process has proved very useful in a political environment dominated by top-down policymaking. Altogether, the integration of STP, S3 and innovation system foresight assists STPs and regional authorities in responding to policy priorities linked to the development of existing regional economic structures and future perspectives.

5.2 Empirical contribution from Thailand

The thesis’s empirical contributions are listed in three points. First, although I argue that the regional level is appropriate for the analysis of innovation policy intervention, in Thailand, the broader context of the national innovation system is equally important because of the country’s centralised and top-down approach. This means that the broader frame of the national innovation system can play a crucial role in developing the capacity of regional innovation systems. The study outlines two policy implications for the Thai government, based on the findings from article 2 and 3. First, the configuration of STPs should be specifically designed in response to particular regional problems and potentials. As seen in article 2, understanding regional industrial structure is important not just to provide the appropriate technological knowledge, but also to address the issue of collaboration with the right policy instruments. Second, there is a need to curb policy inconsistency at the national and regional levels to properly address local demands for STI policy. Consequently, policies should be formulated to give administrative autonomy locally to stimulate the lateral collaboration of local actors in addressing innovation system failures. Further, while innovation system failures are the same at both the national and regional levels, there is a need to address more systemic problems at the national level. This includes actively promoting university-industry collaboration, providing sustainable financial support and restructuring the bureaucracy at the regional level by allowing regional authorities to respond to regional needs more efficiently (Chaminade et al., 2012; Intarakumnerd & Chaminade, 2007; World Bank Group, 2018).

Second, the question arises of whether a developing country like Thailand can analyse innovation policy intervention using the RIS framework, which was created in the developed world. The theoretical arguments and empirical findings from Thailand demonstrate that RIS can be flexibly applied to analyse regional innovation policy intervention (such as STP and S3) in a developing country context. This is consistent with the conclusion reached by Schiller (2006), which highlights that the RIS framework is still the most suitable approach for analysing the role of regional innovation systems in developing countries because the concept can be used to examine regional disparities in innovative capacities. For instance, article 2 found that the three provinces vary in terms of industrial structure and level of trust and collaboration, thereby providing different regional starting points for STP activities.

Third, empirical insight from three different provinces in Thailand, which manifest different levels of RIS and thus, STP performance, has raised several questions concerning the use of regional innovation policy intervention via STPs — for example, whether STPs are the best policy instrument in regions with little local knowledge exchange due to low levels of collaboration and, at the very least, if STP is capable of addressing these problems on its own. RIS studies suggest that STPs might be pertinent (Isaksen et al., 2018; Isaksen & Trippl, 2016; McCann & Ortega-Argilés, 2013). In this sense, STPs are argued to be a policy tool ‘that compensate for the lack of spontaneously created externalities’ (Isaksen et al., 2018). However, this literature also points out other policy strategies that would complement regional innovation systems, such as building up firms’ R&D competence and recruiting skilled and qualified people from other regions. My observation from this study is that STPs might be applicable in this context because, at the basic level, this form of
intervention contributes to raising awareness among local actors and provides room for regional innovation dialogue — particularly, in most cases, within universities and firms. However, as previously discussed, an STP must be better integrated into its specific regional innovation system and its strategies should respond to regional specifics. What makes sense here is the implementation of STPs through articulate planning rather than political bias that often results in a mismatched strategy. As Boschma (2004) argues, the ‘copying of best practices is almost impossible when it concerns region-specific assets that are soft, tacit and intangible (such as a knowledge and competence base, or an institutional setting), and which are the results of long histories in specific contexts’. Moreover, experience from Thailand shows that the implementation of STPs is not sufficient to solve the problems of regional innovation systems and develop regional innovation capacity. A major lesson here is that the implementation of STPs as a tool for stimulating regional innovation activities must be developed concurrently with other dimensions and supportive policies. For example, in regions with low levels of local collaboration, in addition to STP development, policies should focus on building the capacity of concerned actors and strengthening networks among actors to enhance knowledge flows and encourage favourable collaborative practices (e.g. facilitating access to partners with complementary assets).

This section has discussed challenges specific to regional innovation policy in the Thai context, which are likely to be relevant for other developing countries exhibiting a similar context.

5.3 Methodological contribution

The thesis makes two practical methodological contributions. The first is the application of the RIS-STP framework. Article 2 demonstrates that the framework helps to analyse the regional innovation system, which is important for diagnosing systemic problems to design STP and other supportive innovation policy strategies. The mix of quantitative and qualitative data provides context and enables the dynamic interaction of the case studies. However, there is room for further improvement of quantitative approaches to expand the analysis of the results when using the framework in contexts where the comparative data is sufficiently available (e.g. using bibliometric and patent analysis to examine industrial structure patterns and the level of university-industry collaboration).

The second significant methodological contribution is the use of foresight as a tool for S3 implementation, which aligns the function of STPs with their regional context. The rational use of foresight has greatly contributed to regional policy intervention, more precisely concerning STPs in an S3 context. While foresight generally constitutes an evidence-based, transparent process that engages participants broadly, the integration of the RIS-STP framework and the principle of innovation system foresight represents a step forward for S3 policy initiation. Indeed, it ensures that policies can better respond to the need to increase the regional innovation potential and address regional innovation issues, resulting in projects displaying consistency between policy intervention and regional needs. The thesis argues that an insufficient level of institutional development prevents regional foresight from being applied similarly in developing and developed countries. In the Thai context, Delphi-based foresight is helpful for easing the social issues that can hinder effective communication (Rowe & Wright, 1999). Overall, the process of foresight and the role of STPs in initiating S3 can compensate weak institutions in lagging regions, through the identification and prioritising of policy interventions based on regional conditions and future perspectives in a bottom-up process.

5.4 Limitations and avenues for future research

I list the thesis limitations and potential future research ideas in five points. First, the thesis presents a theoretical and empirical demonstration of the role of regional contextual factors as preconditions for STP performance, putting the focus on regionally endogenous factors and their dynamic linkages. This has created limitations regarding STPs’ internal factors and extra-regional linkages. Although article 3 partly integrates these two perspectives in the formulation of policy instruments, these topics have deliberately not been
discussed in the thesis. Further work linking STP internal management and extra-regional linkages would most likely improve the conceptual model for the implementation and design of STPs.

Second, the arguments related to the evaluation of STP performance are mainly used as a proxy to explain the connection between place-based policy development and regional specificity. Therefore, the thesis does not rigorously explore this topic in detail. Departing from Lecluyse, Knockaert and Spithoven (2019), I suggest that future research could focus on the evaluation of STPs’ performance using purpose-related measurements and/or adding socio-economic measurements to the performance indicators. Rigorous performance evaluations may unpack the unclear contributions of STPs across regions and shed light on the use of STPs in lagging regions.

Third, while the empirical findings from article 2 suggest that regional collaboration and trust are an important starting point to create a robust regional innovation system, RIS studies have rarely discussed this topic in detail (David Doloreux & Porto Gomez, 2017; Flanagan & Uyarra, 2016). This gap calls for more studies on the role of institutions — in particular, soft institutions — and policy to break path dependencies in favouring local innovation culture.

Fourth, concerning article 3, while the literature on regional policy highlights the application of policy integration, a comprehensive theoretical and empirical foundation in this regard are still lacking. This thesis only addresses policy integration between STP and S3. Thus, future research could consider this issue. For example, Oughton, Landabaso, & Morgan, (2002) suggest that there is the need ‘to integrate technology policy and industrial policy by encouraging expenditure on innovation activity within mainstream industrial policy (Structural Funds) programmes’. Moreover, while most foresight studies base their case studies on regional and national projects, this study is built on a PhD project, which has both positive and negative implications. The foresight method produces efficient results in the context of limited resources and time constraints. At the same time, it might lack a dynamic of participant engagement and commitment. The process can thus be complemented by a workshop, as suggested by Foray, Keller and Bersier (2018), to enhance local engagement and commitment to the project.

Finally, this research has only investigated empirical cases in Thailand. This approach can be criticised as forming a weak basis for generalisation. However, I have argued in the previous chapter that these case studies provide an excellent general snapshot of the regional innovation system in a developing country and the regional innovation policy approach. Nonetheless, caution must be exercised when applying this thesis approach in different contexts. With respect to a case study context, further research should conduct a comparative study across different countries, capturing a broader range of national innovation systems and regional heterogeneity, to provide a wider perspective on different NIS approaches that influence different RIS approaches and, thus, STP performance.
Reference


Intarakumnerd, P., Chairatana, P., & Tangchitpiboon, T. (2002). National innovation system in less successful


Ratinho, T., & Henriques, E. (2010). The role of science parks and business incubators in converging


Simmie, J., & James, N. D. (1986). Will science parks generate the fifth wave? Planning Outlook, 29(2), 54–57. https://doi.org/10.1080/00320718608711769


Tsamis, A. (2009). *Science and Technology Parks in the less favoured regions of Europe : an evaluation of their..."


Article 1
The role of regional contextual factors for science and technology parks: a conceptual framework
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To cite this article: Amonpat Poonjan & Anne Nygaard Tanner (2019): The role of regional contextual factors for science and technology parks: a conceptual framework, European Planning Studies, DOI: 10.1080/09654313.2019.1679093

To link to this article: https://doi.org/10.1080/09654313.2019.1679093

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The role of regional contextual factors for science and technology parks: a conceptual framework

Amonpat Poonjan \( ^a \) and Anne Nygaard Tanner \( ^b \)

\( ^a \)Innovation Division, Department of Technology, Management and Economics, Technical University of Denmark, Lyngby, Denmark; \( ^b \)UNEP DTU Partnership, Department of Technology, Management and Economics, Technical University of Denmark, Copenhagen, Denmark

ABSTRACT

Literature on science and technology parks (STPs) lacks a systematic understanding of how regional contextual factors affect the performance of STPs. Most studies focus on park-internal factors and neglect the regional context and connections when evaluating STPs’ performance. This paper provides new insight on the role of regional factors for STPs by combining and discussing existing studies on STP performance with literature on regional innovation systems. We conduct an exploratory, systematic literature review of 64 papers that refer to park-external factors in their studies of STP performance. We identify five regional factors (university and research institutes, industrial structure, institutional settings, financial support and urbanization) and assess how these factors have been shown to play a role for STP performance in previous studies. Based on this review, the paper develops a comprehensive framework of how regional contextual factors influence the performance of STPs, which can be used in designing and/or improving STP-performance while taking regional characteristics and needs into consideration. We believe a dynamic and comprehensive understanding of these regional connections can help improve designs of STPs, and thereby their performance.

ARTICLE HISTORY

Received 28 June 2019
Revised 19 September 2019
Accepted 7 October 2019

KEYWORDS
Science and technology parks; regional context; systematic literature review; regional innovation systems; Multiscalar STI policy

Introduction

Science and technology parks (STPs) have gained significant academic and political interest for their potential to deliver high-tech innovations and entrepreneurial activities benefitting regional economic development. However, the positive impact of STPs is often questioned because empirical studies continuously demonstrate inconsistent results. While some studies have found positive results on firms located in STPs (e.g. Squicciarini, 2008, 2009; Yang, Motohashi, & Chen, 2009), others have not been able to confirm a positive, significant relationship (e.g. Colombo & Delmastro, 2002; Lofsten & Lindelöf, 2002; Siegel, Westhead, & Wright, 2003) and have questioned the effects of STPs on technological development, innovation and regional economic development.

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development (Rodríguez-Pose & Hardy, 2014). The unclear contribution of STPs has led scholars to search for factors and mechanisms that influence the performance capacity of STPs. However, most research has focussed on park-internal factors, such as the science park management, availability of qualified research and development personnel, marketing expertise, financial support as well as the park identity and brand (Cabral & Dahab, 1998; Lindelöf & Löfsten, 2002; McCarthy, Silvestre, von Nordennflycht, & Breznitz, 2018).

More recently, attention has been paid to park-external factors for STPs’ ability to foster regional development (Etzkowitz & Zhou, 2018; Minguillo & Thelwall, 2015b). Minguillo, Tijssen, and Thelwall (2015, p. 712) argue that the external environment of STPs, such as ‘the agglomeration of the critical mass of knowledge and capabilities’ are more relevant for understanding the performance capacity of STPs. Similarly, Tsamis (2009) finds that science and technology parks in less favoured regions in Southern Europe remain primarily real-estate projects, with only marginal contribution to the regional technological development and poor records of creating new technology-based firms (NTBFs). Tsamis argues that the explanations are to be found within regional contextual factors, such as a pre-existing weak local technological base and absence of sophisticated demand for the services of STPs. Also, in the case of successful STPs, Etzkowitz and Zhou (2018) provide an example from the USA and China, highlighting that innovation dynamics did not induce from the park itself but from University-Industry–Government interactions shaped by the regional context. This new interest in including regional contextual factors in explanations of STP performance is inspired by a diverse literature on territorial innovation models (Moulaert & Sekia, 2003), which sees regions as an important source of competitive advantage (Castells & Hall, 1994; Starr & Saxenian, 1995).

However, literature on the linkages between the performance of STPs and the regional context have been scarce and scattered (Goldstein & Luger, 1990; Mora-Valentin, Ortiz-de-Urbina-Criado, & Nájera-Sánchez, 2018). This paper aims to fill this gap by conducting a systematic, exploratory literature review of the relationship between STPs’ performance and the regional context. Although many studies have acknowledged the importance of the regional context for STP performance (Castells & Hall, 1994; Comins & Rowe, 2008; Etzkowitz & Zhou, 2018; Minguillo et al., 2015), this is to the best of the authors’ knowledge the first attempt to carry out a systematic review of how regional contextual factors influence the performance of STPs.

Based on the review and inspired by the regional innovation system literature, we develop a framework consisting of five broad categories of regional factors as well as extra-regional linkages and park–internal factors, all of which influence the dynamics of STP performance. These findings are important for the design and use of STPs in future regional and national science, technology and innovation (STI) policies.

The paper is structured as follows. In the next section we discuss different understandings of STP performance before situating the concept of STPs in the field of regional studies by zooming in on the regional context of STPs. The third section presents the method of the systematic literature review. The fourth section presents the findings of the literature review, while the final section summarizes the main conclusions and draw implications for policy and STP practitioners.
Conceptual Framing

The performance of science and technology parks

The first formal science park was established in 1951 in Silicon Valley at Stanford University (Nahm, 2000) and subsequently ignited a rapid growth of STPs across the world. Despite their popularity, STPs are heterogeneous in terms of size, geographical coverage and the infrastructure and service they provide; therefore, there does not exist a universal definition (Albahari, Pérez-Canto, & Landoni, 2010). However, STPs are often characterized (Hansson, Husted, & Vestergaard, 2005) as property-based organizations that bring together firms in one physical location. The key purpose of the STP management is to support the development of park tenants by providing different infrastructural support, set priorities and facilitate R&D-based technological activities and networks.

The heterogeneity of STPs and lack of standardized evaluation approaches are among the reasons for why it is difficult to measure and explain STP performance (Albahari, Catalano, & Landoni, 2013; Albahari, Pérez-Canto, Barge-Gil, & Modrego, 2017; Chan, Oerlemans, & Pretorius, 2011). The study by Phan, Siegel, and Wright (2005) show that performance analysis of STPs can be categorized into four levels; the individual level (entrepreneurs involved in tenant firms); the park level; the firm level (tenants located in the park), and the systemic or regional level.

In general, however, most empirical studies investigating the performance of STPs focus on the first three levels and assess whether STPs have been successful in promoting innovation, NTBFs, high-skill activities, economic performances among the resident firms and linkages between on-park firms and universities (e.g. Colombo & Delmastro, 2002; Fukugawa, 2006; Link & Scott, 2003; Lofsten & Lindelof, 2001, 2002; Yang, Motohashi et al., 2009). Nevertheless, the results of studies on STP performance are inconclusive. While some studies have found positive results on firms located in STPs (e.g. Squicciarini, 2008, 2009; Yang, Motohashi et al., 2009), others have not been able to confirm a positive, significant relationship (e.g. Colombo & Delmastro, 2002; Lofsten & Lindelöf, 2002; Siegel et al., 2003). This discrepancy has led to critical questioning of the value of STPs (Rodríguez-Pose & Hardy, 2014; Tsamis, 2009) and has initiated a search for explanations of the inconsistency.

Moreover, when it comes to understanding the value of STP performance across different regions it is important to assess STP performance in light of the regional context. We believe that the relative importance of STP outcome-based measures (e.g. patents, start-ups, NTBFs) differ across regions and time. Thus, the impact of an STP may be of greater importance in a less developed region even though the absolute value of STP performance measures are low (Albahari, Barge-Gil, Pérez-Canto, & Modrego, 2018). In consequence, STPs can be an important policy-tool in less developed regions, for example as part of a policy-supported path creation process in peripheral regions (Isaksen & Tripl, 2017). Also when the absolute performance measure look less impressive compared to STPs in economic strong regions. This understanding of performance underline the need to analyse STPs and STP performance in light of the regional context.

Furthermore, since we have seen an increase in papers that refer to park-external factors, we believe the literature lacks a systematic understanding of how regional factors may influence the performance of STPs. In this paper, we therefore aim to bring together insights from the literature on park-contextual factors by conducting a systematic review of research that refers to park-external factors in their explanation of STP performance.
**Why do regional contextual factors matter?**

Since the 1980s, significant attention in economic geography has been given to various types of territorial innovation models (TIM) with the aim to explain the local dynamics for innovative behaviour (Moulaert & Sekia, 2003). A common feature of TIM is to look at regional development as a local or regional endogenous process combining economic, socio-cultural and political dimensions. The framework of regional innovation systems (RIS), one of the TIMs reviewed by Moulaert and Sekia (2003) deals exactly with the link between regional economies and innovation capacities (Asheim & Isaksen, 2002) which is of significant importance for understanding conditions for STP performance. The RIS framework views innovation as a systemic process carried out by a set of actors (e.g., firms, universities and research institutes, regulatory authorities, intermediary organizations such as STPs, policy-makers and financial institutions) who interact with each other (Doloreux & Porto Gomez, 2017).

The regional endogenous development approach resonates with a recent development in the literature on STPs (Etzkowitz & Zhou, 2018; Minguillo et al., 2015). As demonstrated by Tsamis (2009) success factors for STPs can be categorized into two groups: internal factors (i.e., parks’ ownership and organization structure, finance, STP management and infrastructure) and regional contextual factors. As important contextual factors for STPs, Tsamis mentions a supportive institutional framework in relation to technology transfer cooperation and entrepreneurship, the availability of local resources to attract anchor tenants and a home market to support the growth of start-ups. Similarly, Comins and Rowe (2008) argue that STPs are likely to be more successful in regions that have the properties of a large metropolitan, diverse and well-established developed economy, a strong research base, a culture of entrepreneurship, pro-active entrepreneurship management and actively engaged stakeholders including universities and research centres.

In the following, we introduce the regional contextual factors that we identify as important in the literature review. These count university and research institutes, industrial structure, institutional settings, financial support and urbanization and will be discussed in light of extant literature from the field of economic geography.

**Regional contextual factors**

A key purpose of STPs is to facilitate learning and knowledge transfer between industrial and non-industrial knowledge partners in a region. Therefore the availability and capacity of ‘university and research institutes’ to engage in knowledge networks are important for the innovative capacity of regions as well as for STP performance.

Besides engaging in knowledge networks, universities are perceived as a key knowledge resource for innovation – both in terms of R&D development and in developing skilled human labour forces. When firms raise their technological development level, they often need direct or indirect knowledge input from universities. This knowledge flow has been observed to be strong when the research interests between a university and local industries are matched (Yan, Chien, Hong, & Yang, 2018). In consequence, STPs can play an intermediate role to accelerate the process of knowledge flows between universities and industries when they build on technological domains that are relevant for existing industries.
The fact that regions differ with respect to their ‘industrial structure’ has implications for regional innovativeness in more than one sense. First, industries exhibit different innovative behaviour and patterns (Pavitt, 1984) and therefore the industrial structure of a region implies that regions will differ in the type of innovations on a number of dimensions, such as incremental vs radical, high-tech vs low-tech, user-driven vs technology-driven. Moreover, the industry structure of a region also affects new firm formation rates in regions; for example, new firms more frequently spin-out of business service industries than from mining industries (Bosma, Schutjens, & Stam, 2011).

In the past decade, the evolutionary turn in economic geography has contributed with new perspectives on regional diversification processes. In evolutionary economic geography, regional industrial specialization and diversification patterns are perceived to be shaped by pre-existing resources (Boschma & Frenken, 2011; Neffke, Henning, & Boschma, 2011). Hence, regions are more likely to diversify into industries that are for instance technologically related to pre-existing industries or related through product markets (Tanner, 2014).

Taking the insights from evolutionary economic geography into consideration, it is reasonable to suggest that the process of establishing an STP should consider building it around technological fields that are related to the pre-existing industry in a region. Either upstream, where knowledge bases and scientific principles are cognitively related or downstream, where new technologies can be brought in and applied to renew existing industrial paths. Therefore, if innovation policy instruments such as establishing an STP in a region should contribute to the long-term economic development, and potentially restructuring of a region, it is essential to consider industrial patterns for innovative behaviour and regional diversification potential.

Regional economies are also constituted by the ‘institutional settings’ that guide the behaviour of actors (Todtling & Trippl, 2005). As Lundvall (2007) argues, institutions shape and influence the innovative capacity at different levels – to understand the ‘micro-behaviour’ in the core of innovation processes but also the ‘wider settings’ that the innovative activities are shaped by.

Formal institutions such as policies and regulations express the underlying policy rationales that define the nature of public intervention for innovation support. Innovation policies can both shape incentives for economic actors to engage in innovation processes and at the same time create legitimacy for new path creation processes in the regional economy (Dawley, 2014). In that sense, policy support to demonstration projects or in this case field-specific STPs can create legitimacy for new economic activities in that field. Because legitimacy has been shown to be important for mobilising other resources (e.g. financial or knowledge creation) for new economic activities (Binz, Truffer, & Coenen, 2016), policy support is essential for STP performance.

The normative type of institutions (Scott, 2013) that are embedded in culture, norms and habits for interaction between people have been shown to matter in terms of improving innovation capacity of society (Efrat, 2014; Shane, 1993). Normative type of institutions influence the success of STPs by shaping the attitude and actions of entrepreneurs, venture capitalists, collaborative partners and park managers in all aspects ranging from taking risks, building trustful partnerships and seeing and searching for new information. Hence, some regions may be characterized by high levels of entrepreneurial culture (Beugelsdijk, 2007) and benefit more than others by the specific infrastructure an STP can provide to the entrepreneurial process.
In sum, institutions influence the performance of STPs both through formal institutions such as policy and regulations but not least through the informal institutions that guide behaviour and create trust in a society.

Another critical condition for the development of well-functioning RIS is the availability of ‘financial support’ (Asheim & Isaksen, 2002). Access to finances is a fundamental part of all economic activities, allowing organizations to conduct research, adopt technologies necessary for inventions as well as develop and commercialize innovations. Hence, access to financial support is important at all stages of innovation processes and thereby also to the key goal of STPs, namely supporting innovative activity.

Finally, ‘urbanization’ is perceived as a fundamental factor for favourable innovation systems to develop and grow. Urbanization has been linked to high levels of regional innovative capacity because it represents a strong diversification of economic activities, an environment that encourage face-to-face interactions, well-educated workforce and easy market access (Iammarino, 2011; Shearmur, 2012). As Comin and Rowe (2008) argue, STPs in large metropolitan regions are less likely to be the major drivers of change, but can enhance the process of becoming a more knowledge-intensive economy because the innovative capacity of urban regions are higher than peripheral.

This section has introduced the factors that matters for regional innovative capacity and hereby the success of STPs. Put together, we believe that regions are diverse and evolve along their own characteristics influenced by the capacity of universities and research institutes, industrial structure, institutional settings, availability of financial support and degree of urbanization. The intensity of these factors distinguishes regions into different types, such as metropolitan regions where the degree of urbanization and social interactions are high and peripheral regions where the degree of urbanization is lower, often lack financial resources and are characterized by a less diversified industrial structure (Todtling & Trippl, 2005).

Methodology

To examine the relationship between regional contextual factors and the performance of STPs, we conduct a systematic, exploratory literature review. Systematic reviews are used to improve the evidence base of a field and its subfields through a process of synthesizing research in a systematic, transparent and reproducible manner (Tranfield, Denyer, & Smart, 2003). Inspired by Tranfield et al. (2003), we initiated our review with a scoping study to assess the relevance and size of the literature as well as to delimit the focus of the review. At this stage we studied literature on related and relevant concepts, including STPs, regional studies, evolutionary economic geography and smart specialization policy, all of which identified the need for a review. Subsequently, we compiled a review protocol reflecting the conceptual discussion of the scoping study, the objective of the review and the significance of the problem.

A second step in the review process was to develop comprehensive, unbiased search parameters in order to identify the master sample of papers by using search parameters to include papers on STPs and performance. In the selection of papers we do not distinguish between different levels of performance or the relative importance of performance (for discussion of how to understand STP performance, see Section 2) but only capture STPs’ performance as the papers report as either being positive, negative or absent.
We limited our search to the WoS, using the Social Science Citation Index (SSCI) and Science Citation Index (SCI) database for similar reasons as put forward by Mora-Valentín et al. (2018). We included only articles and reviews and left out book chapters and conference proceedings.

As illustrated in Figure 1, in Step 1 we identified the population of articles on STPs by using search terms. In Step 2, we identified the top 100 most cited articles in order to identify which terms are used in studies of STPs’ performance. We found several search terms that was included in Step 2 to identify the population of journal articles that deal with STPs and performance.

**Figure 1.** Literature search and process of selecting papers.
Because we identified in the scoping study that the linkage between STPs and the regional context is rather under-investigated, we decided to qualitatively assess (in Step 3) whether a paper includes regional contextual factors or not, rather than attempting to include this limitation of the sample through search parameters. We reduced the population of articles to 71 by screening Title and Abstract using a 3-step checklist. In the subsequent full text reading of the articles, a further seven studies were dropped, leaving the sample size of relevant articles to 64.

**Synthesis method**

Because the aim of this study is to shed light on a relationship which has not received pronounced attention in prior research, we follow an exploratory approach in synthesizing the literature. We use thematic synthesis because most studies in our sample only relate partially to the regional context. Thematic synthesis is useful for understanding how different themes relate to a specific analytical unit and to handle contradictory findings on the relationship between concepts (Barnett-Page & Thomas, 2009). We follow an open-ended coding process where we initially coded every finding that points to the importance of a regional contextual factor under a label suitable for the given factor. The codes were initially organized into 11 categories that were subsequently grouped and regrouped by merging and splitting them. The coding process is shown in Appendix A and illustrates how two factors ‘central government’ and ‘innovation culture’ were grouped together as ‘Institutions’ and ‘Regional specialisation’ was merged with ‘Industrial structure’, while the initial groupings of ‘local collaboration’ and ‘human labour’ were recoded based on the respective actor types (institutions, university and industrial structure), in order to capture more nuances. The result of the coding reveals five categories that relate to the regional context (urbanization, financial support, university and research institutes, industrial structure and institutions) as well as extra-regional networks and STPs’ internal factors.

Concurrently, the findings on performance were coded for each paper to determine whether each specific study finds that the STPs have a positive or negative impact on the specific performance measure that particular paper had in focus. Subsequently, we extracted reports that demonstrate how the different themes relate to the STPs’ performance. These reports create the foundation for the next section, where we present the results of the literature review.

**Results and analysis**

The 64 selected papers are distributed across 40 journals, which indicates that the field of STP study is interdisciplinary by nature and relates to a number of subjects. The top three journals are Technovation (20%), European Planning Studies (12.5%) and Environment and Planning C-Government and Policy (10%).

Figure 2 summarizes the findings of the literature review of regional factors and their influence on the performance of STPs. A more detailed exposition of the review with a distribution of the papers across each of the seven factors is available in Appendix B. In the following section, we will elaborate on what the literature has reported with respect to the five regional contextual factors (left side in Figure 2) and their relationship to STP performance.
This review confirms that STPs that have successfully established strong collaborative ties to university scholars have higher levels of performance (e.g., higher patent application and number of firms on park) (Albahari et al., 2017; Diez-Vial & Montoro-Sánchez, 2016; Link & Scott, 2003; Mingiuillo & Thelwall, 2015). We have identified three roles universities and research institutes play for STP performance: a source of knowledge creation and knowledge network; skilled human labour provider; and a place to encourage innovation culture and activities.

One of the fundamental premises of STPs is to strengthen the tie to university-based knowledge, where universities become a source of knowledge creation that links directly to R&D development in park tenant firms (Hu, 2011; Hu, Lin, & Chang, 2005; Jongwannich, Kohpaiboon, & Yang, 2014; Malairaja & Zawdie, 2008; Yan et al., 2018). High-quality and active R&D universities present more active and better quality collaboration with park tenants than medium- and low-ranked universities, which implies that university and research excellence is important for knowledge transfer between knowledge producers and private sectors (Mingiuillo & Thelwall, 2015).

Furthermore, one important factor is the knowledge match between university research and firm requirements (Hu, 2011; Malairaja & Zawdie, 2008; Yan et al., 2018). A cognitive mismatch between university research and firm-specific knowledge requirements could hinder STPs performance, as shown in Lin and Tzeng (2009). Hence, it is important for university and/or research institutes to consider local capabilities in their research strategy in order to enhance local synergy, which potentially can lead to higher local economic impact through STP collaboration. To exemplify, the early development stage of Daeduck Science Park showed that little synergy between research institutes and local industries resulted in insufficient local economic impact (Shin, 2000).

Knowledge networks with universities through both formal and informal interactions also lead to the ability of identifying common research interests between universities and firms (Padilla-Meléndez, Del Aguila-Obra, & Lockett, 2013), access to human labour (Motohashi, 2013) or even venture capital and worldwide connections. For example, the well-performing Tuspark in China has built an active informal network through its alumni group, helping firms expand connections worldwide (Zou & Zhao, 2013).
Similar to knowledge input, firms require specific skilled human labour that match their need. Hence, a university that provides matching skilled labour reflects good synergy between the university and park firms (Pilar Latorre, Hermoso, & Rubio, 2017); if not, it could hinder park development, as in the case of IDEON science park, where tenant firms highlight that the local university could not supply relevant qualified labour (Jonsson, 2002).

Finally, universities are places to bring up and encourage entrepreneurial behaviour by internal academic staff and students, an approach which will reflect directly in STPs’ performance measures. Universities that support entrepreneurial culture by encouraging students to spin off their research or appreciate extra research activities often link to well-performing STPs (Zou & Zhao, 2013). On the other hand, local universities that view entrepreneurial culture as low status and build on traditional academic goals hamper STPs’ performance (Etzkowitz & Zhou, 2018; Hansson et al., 2005; Padilla-Meléndez et al., 2013). Newcastle Science City is an example of a stagnated STP, which partly occurred because of the local university’s narrow view on entrepreneurial culture, where academics lacked provision for leave of absence or reduction in academic duties in order to explore entrepreneurial opportunities (Etzkowitz & Zhou, 2018).

Altogether, although it is a fundamental premise of STPs to strengthen the tie to university-based knowledge the literature reveal that the relationship is multifaceted and depends on the ranking, attitude and knowledge domains of the university. Local universities that provide matching research activities and skilled human labour are more likely to produce synergetic relationships to tenant firms. Similarly, the attitude of academics (e.g. internal entrepreneurial culture) and the cultural norms at the university towards firm collaboration link to the performance of STPs.

**Industrial structure**

The pre-existing regional industrial structure is a frequently occurring theme in the papers reviewed. Several studies confirm that in regions with strong industrial agglomeration or the presence of large high-tech firms, STPs tend to perform well, particularly if the STP’s strategy relates technologically to the local industry (Hommen, Doloreux, & Larsson, 2006; Hu, 2008, 2011; Yun & Lee, 2013). Eindhoven high-tech development is an example of an STP that was initiated by local leading firms with the aim to sustain the performance of the high-tech industry by focusing on R&D related to the industry (Huang & Fernández-Maldonado, 2016). Specialized STPs allow parks to leverage their resources by providing common facilities and encourage collaboration among tenants with off-park firms (Vásquez-Urriago, Barge-Gil, Rico, & Paraskevopoulou, 2014). Hsinchu Science Park is a particularly good example of a park that connects to a favourable local industrial agglomeration, providing a competitive production network in the semiconductor sector (Hu et al., 2005; Lee, Lin, & Hsi, 2017).

However, in regions where there is no industrial agglomeration, and/or no high-technology leading firms, STPs show constrained performance levels in R&D (e.g. the case of Newcastle science park and Tsinghua Science Park (Etzkowitz & Zhou, 2018; Phelps & Dawood, 2014; Zou & Zhao, 2013)).

The regional industrial sector also influences STP performance with regard to number of spin-off firms because some sectors, such as information and technology or biopharmaceutical, may have a higher chance to create spin offs than other sectors, such as tourism.
and service (Salvador & Rolfo, 2011). Hence, STPs located in a region where there is a presence of high-tech industries or STPs that host high-tech sector-firms will have a higher chance to create spin-offs.

In sum, regions that have strong industrial agglomeration, presence of high-tech leading firms and high-tech industry sectors are more likely to produce positive STP performance levels.

Institutions

Institutional contextual factors that together guide the behaviour of actors is a particularly broad category covering three sub-groups: the innovation and entrepreneurial culture and norms (3.b. in Figure 2) that characterize the region; the interplay between national and regional policies, namely multi-scalar science, technology and innovation (STI) policy; and the adjustment and integration of STI policy to match local context.

Innovation and entrepreneurial culture

The review reveals that the best practice STPs (e.g. Hsinchu, Kyoto and Mjardevi Science Park) are embedded in a favourable entrepreneurial culture which promotes trust and dense collaborative networks. The literature proposes that successful parks exhibit transaction-intensive linkages between on- and off-park firms and non-firms actors which support entrepreneurial activity (Edgington, 2008). Several studies point towards a particular culture that characterize the regions where STPs perform well, resulting in such dense network activity. This culture is often a starting point for innovation because it acts as an engine to create informal networks between firms that lead to knowledge exchange, access to funding and higher degrees of labour mobility (Edgington, 2008; Hu, 2008; Lee et al., 2017; Zou & Zhao, 2013). A weak entrepreneurial culture, on the contrary, reflects lack of trust and low levels of collaboration in the region (Miao & Hall, 2014; Zeng, Xie, & Tam, 2010), resulting in poorly performing STPs.

In sum, the normative type of institutions embedded in culture, norms and habits for interaction between people shape the attitude and actions of entrepreneurs, venture capitalists, collaborative partners, park managers etc. The review confirms that regions that exhibit transaction-intensive linkages may therefore also benefit more from the infrastructure provided by the STP.

Multiscalar STI policy

For most of the reviewed papers, the regional initiatives related to STPs have been enabled by a national policy framework which assists with respect to funding, supporting infrastructure and building knowledge networks. These broader frames are complemented by decentralized regional policy initiatives that aim at building clusters, networks and partnerships in connection to the STP initiative (Edgington, 2008).

A comparative study by Huang and Fernández-Maldonado (2016) illustrates how the configuration and balance between national and regional policies differ tremendously across countries, resulting in highly different institutional settings for STPs to develop in. They compare the Netherlands, a flexible decentralized welfare society with the more hierarchical and centralized governed Taiwan, and their respective high-tech
policy approaches (Huang & Fernández-Maldonado, 2016). The flexibility of STPs as a policy instrument means that both types of institutional environments can be associated with well-performing STPs.

The Hsinchu science park in Taiwan illustrates how national policies play a major driving force for its success, when the government established the dedicated agency (MOST) to take care of STI policy and give STP development a privileged position compared to other policy areas (Huang & Fernández-Maldonado, 2016; Yan et al., 2018). Similarly, for the Daedeok science park, South Korea, coordination between national and regional interests was decisive for a regionally well-performing STP (Kim, Lee, & Hwang, 2014). On the other hand, an incoherent and uncoordinated policy at national and regional levels may lead to an inefficient STP development, as shown in the case of the Kulim Hi-Tech Park, Malaysia (Phelps & Dawood, 2014).

Besides coordination and coherence between national and regional policies, stability is another important characteristic. Albahari et al. (2013) underline the importance of stable government policy in their comparative analysis of STPs in Spain and Italy. They find that Spanish STPs outperform Italian because of the coherent and steady set of Spanish policies that are specifically designed to support STPs, whereas policies in Italy have had a discontinuous character without a strong focus on STPs.

In sum, the relationship between national and regional policies is important for the development of STPs. In the best performing cases, the relationship is characterized by coordination, coherence and stability.

Integration and adjustment of STI to regional context

A final institutional sub-theme we identify in the review is requirement need to integrate and adjust infrastructure and entrepreneurial policy instruments to fit the local context. As Jenkins and Leicht (2018) puts it, high technology policies have to be adapted to fit existing high-tech resources and unique local strengths and weaknesses. Other studies propose that the problems of poor-performing STPs are caused by a lack of integration of resources from local actors, such as universities, industries and local government (Brooker, 2013; Kim et al., 2014; Shin, 2000).

The review supports that a strong commitment and active involvement from local government reflect a positive outcome for the park (Cheng, van Oort, Geertman, & Hooimeijer, 2014; Hommen et al., 2006; Zou & Zhao, 2013). To illustrate, the Daedoek Science Park was initiated by central government and lacked involvement of the local government in the early stages, thus hindering smooth park development. After the state took an active role to stimulate the link between the park and the local government, the performance of Daedok Science Park improved significantly and became better integrated in the regional economy (Kim et al., 2014; Shin, 2000).

However, studies also point out that different types of regions require varying levels of support depending on pre-existing regional assets and characteristics. In other words. Etzkowitz and Zhou (2018) argue that before STPs can become self-sustainable, they go through a development process in which the allocation of resources is crucial. In peripheral regions, such resource allocation depends on support from both central government and an active regional government. Likewise, the type of policies need to be adjusted, for example for regions where the entrepreneurial culture is low, policy initiatives targeting
new firm formation are more important than a massive infrastructure project (Etzkowitz & Zhou, 2018).

For regions where the innovative intensity is high, infrastructural support needs to be adjusted to an expressed need by potential park customers (local firms/entrepreneurs) rather than being offered blindly at excessively high costs (Tsai & Chang, 2016; Xiao & North, 2018). Other studies show how regions where industrial agglomeration and specialization are strong, policy support aiming at specific sectors is considered to be more important (Kennedy, 2007).

Similarly, the empirical study by Yang, Hsu, and Ching (2009) presents three different strategic coupling processes where local firms, state government and societal forces configure geographically varied patterns of science park-driven regional development. The role of the state differs depending on the regional characteristics. When there is a lack of strong local industry, the actions of the state become critical. On the contrary, in regions where the state has fewer resources and abilities to support the science park, the role of local firms is decisive for the STP development. In sum, regional differences reflect the need to adjust policy to fit the regional context.

**Financial support**

The literature review confirms that availability of financial support, understood as both access to financial capital and guidance on how to access and manage funding, is important for STPs’ performance. The review corroborates that access to financial resources plays a crucial role for entrepreneurs to start a new firm, perform R&D activities, initiate manufacturing, sale and marketing of products or services (Löfsten & Lindelöf, 2003; Mukkala, 2010; Watkins-Mathys & Foster, 2006; Xiao & North, 2018). Similarly, a large number of papers also show that on-park firms face difficulties in accessing financial support (Löfsten & Lindelöf, 2003; Mukkala, 2010; Salvador, 2011; Watkins-Mathys & Foster, 2006) mainly due to generic issues such as uncertainty and the ability of inexperienced entrepreneurs to start a business (Löfsten & Lindelöf, 2003; Mukkala, 2010). Similarly, the cost of financing relatively small amounts can be high due to a lack of economies of scale (Mukkala, 2010).

Literature demonstrating the role of the regional context for the availability of financial support is less clear. The study by Watkins-Mathys and Foster (2006) shows that STPs that are located in industry-dense regions, such as metropolitan areas, benefit from networking opportunities that lead to easier access to financial sources. Similarly, Salvador (2011) argues that the lack of information and collaboration in a region can cause firms to be unaware of opportunities for financial support.

In metropolitan regions, sources of finances are often much richer and more diverse, and the review confirms such regions to have an advantage over less developed regions regarding financial support. However, the literature also shows that information, communication and guidance on how to communicate with venture capitalists is equally important (Löfsten & Lindelöf, 2003; McAdam & McAdam, 2008). In this regard, it is interesting that in less developed regions, the financial support provided by STPs had a more significant impact on firms, whereas the effect of STP support is more limited in urban regions due to the diverse availability of external venture capitals (Xiao & North, 2018).
Urbanization

Although Comins and Rowe (2008) argue that large, diverse, metropolitan regions in well-established developed economies are one of the key factors that influence the success of STPs, we find in our review that the degree of urbanization is rarely mentioned as an explanatory factor for STP performance, despite the fact that the majority of STPs are located in highly urbanized areas. For example, the study of Shearmur and Doloreux (2000) demonstrates that most of the Canadian STPs are located in large cities. Nonetheless, the review supports that in most cases, location in urbanized areas is an advantage because of access to skilled human labour, financial investment, supporting institutions and easier face-to-face meetings with other high-tech companies (Edgington, 2008; Watkins-Mathys & Foster, 2006). Parks that are located in peripheral areas struggle to attract staff (Phelps & Dawood, 2014; Shin, 2000) and lack social facilities such as restaurant and leisure facilities, which are important for networking opportunities as in the case of KHTP in Malaysia (Phelps & Dawood, 2014) and the initial stage of Daeduck Science Park in Korea (Shin, 2000). However, urban density can also have a negative effect on STPs’ performance if a plan and sufficient space for firm expansion are lacking (Edgington, 2008).

Discussion and conclusion

As an initial contribution to understanding the dynamics of STPs in their regional context we developed a comprehensive framework of regional factors that influence STP performance (Figure 2). The review of these factors draws lessons across all types of regions to better understand the key regional dynamics that influence STPs. Keeping in mind that the relative importance of STPs in less developed regions often is higher than in core regions, we believe understanding these dynamic connections can help improve designs of STPs, and hereby their performance.

The review finds some general tendencies about the relationship between type of regions and the performance of STPs. In general, the review indicates that metropolitan regions are better equipped with regard to the benefits that come from an urbanized economy; better opportunities to receive financial support, to enter networks or partnerships, to attract skilled labour and access to related industries, whereas peripheral regions are on the contrary worse off when it comes to all of these parameters.

However, the review also pointed towards other regional contextual differences, which may not be ascribed to a metropolitan-peripheral dichotomy. For example, informal institutional settings, such as entrepreneurial culture, and inducing norms and practices for collaboration between universities and the private sector is generating dense network activity, which benefits STPs’ performance.

Similarly, the characteristics of actors present in a region are important. Universities, research institutes and the local industry influence the possibilities of STPs to develop. The review confirms that STPs tend to perform well in regions where there is a strong link between universities and local companies, through skilled human labour flows, actively networking, spinoffs and start-up activities. Moreover, collaboration between universities and STP tenants is stronger if universities provide cognitively related research activities. Likewise, the review also indicates that the local industry also seems to better
fuel the development of STPs when the firms’ knowledge bases are technologically related to STP tenant firms. Consequently, when designing STPs, it is important to assess pre-existing competences and skills embedded in industry and knowledge infrastructure to create STPs that can thrive on already existing related competences and networks.

These findings correspond with the EU Smart Specialization policy (Piirainen, Tanner, & Alkærsig, 2017) and also to the broad thinking of evolutionary economic geography on path-dependent development. STPs can be integrated in the smart specialization strategy development, as suggested by Nauwelaers, Kleibrink, and Stancova (2014), and by building on pre-existing strengths in the region, contributing to a knowledge-intensive diversification of regional economies. In particular in peripheral areas, STPs may play an important role in the entrepreneurial discovery processes in smart specialization strategies (Fröhlich & Hassink, 2018).

A final dimension of regional endogenous factors with importance for STP development that we have identified in the review is the political decision-making at regional and national levels. In particular, two sub-themes appeared from reviewing the literature; the interplay between national and regional STI policy and regional policies targeting the adjustment and integration of the STP tool into the regional context.

We found that coordinated and coherent interplay between national and regional STI policy reinforces the conditions for STP development. Particularly in less favoured regions, national government policy is important in supporting the regional policy levels because these regions are less resourceful in terms of finance, scientific knowledge bases, skilled labour etc. Consequently, they depend to a larger degree on sufficient and stable framework conditions provided at the national level.

For regional STI policies, we find that they depend on the region’s innovative capacity. The review suggests that when using STP as a policy tool in peripheral regions, it is then all the more important to be aware of all the different points of park-external couplings, such as access to funding, skilled labour, networking, quality of university research and scope and to university research to park identity. Similarly, in less favoured regions, policy should aim to encourage and induce collaboration with local firms as well as entrepreneurial behaviour.

We agree with Etzkowitz and Zhou (2018) that STPs are an adaptable empty box that can be adjusted to achieve various objectives in accordance with local situations at different stages of their development. This suggestion is also in line with Harper and Georgiou (2005), who argue that the development of STPs is context driven, resource dependent and competence based. Regional factors are preconditions that policy makers need to take into account when initiating STP development. Design and implementation of STPs therefore need to be adjusted to the specificities of the industrial context, innovation culture and governance structure of the region.

To the process of adapting STPs to its context the proposed framework can function as a guideline in future policy-making in order to improve the performance of STPs. In particular in less developed regions, where conditions are often poorer but the benefits can be relative more important, regional contextual factors should be assessed and fully understood before designing and establishing new parks. In this process it is important to be aware of how STP systems can benefit from and link to existing knowledge bases (both academic and industrial), how the regional innovative and entrepreneurial culture will reinforce or hinder the work of STPs, and finally how the interplay between national and regional policy can ensure a stable and supportive environment for the STP.
In case of existing STPs that seek to improve their performance, we believe the framework can contribute with a structured evaluation of park-external factors that act as obstacles to the park’s development. This work can be centred on improving the commitment from local government, the entrepreneurial culture and the match between STP’s strategic areas and the knowledge bases of industry, universities and research institutes. For the latter, work on improving and sharpening the technological match can be carried out through participatory foresight exercises combined with bibliometric mapping.

To conclude, the aim of this paper has been to zoom in on the regional dynamics of STPs and on how different contexts results in different conditions for STP performance. In future work, it would be beneficial to carry out empirical studies of STPs following the proposed framework, in order to test its explanatory force and translate findings into a strategic tool for policy makers.

Note

1. Terms such as science park, research park, technology park, science and technology park, business park, innovation centre and technopoles are used interchangeably across the world — in Asia and continental Europe, the term ‘Science parks’ is more commonly used, in the USA and UK it is more common to use ‘Research parks’ and in Latin America ‘Technology park’ is a more commonly used term. In this paper we use the term STP to cover all the above variations.

Acknowledgements

The authors would like to thank Alberto Albahari for advice and Michaela Trippl, for her comments on an earlier version of this paper at the International PhD course on Economic Geography in Utrecht, 2018. The constructive comments from the anonymous reviewer on an earlier version of this paper were also most useful. The authors are listed alphabetically. All errors and shortcomings are of course our own.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This research is funded by the Royal Thai government scholarship.

ORCID

Amonpat Poonjan https://orcid.org/0000-0002-0657-5409
Anne Nygaard Tanner https://orcid.org/0000-0002-3145-908X

References


Rodríguez-Pose, A., & Hardy, D. (2014). *Technology and industrial parks in emerging countries*. Cham: Springer International Publishing. doi:10.1007/978-3-319-07992-9


Appendix A: Coding process

**Initial coding result,**
(1) Urbanisation
(2) Financial support
(3) Central government
(4) Innovation and entrepreneur culture
(5) Local collaboration
(6) Human labour
(7) Regional Specialisation
(8) Industrial structure
(9) University and research institution
(10) Extra region network
(11) STPs’ internal factors

**Regional actors**

**Institutions**
- Institutions (local governance)
- University and research institution
- Industrial structure (local companies)

**Industrial structure**
- University and research institution
Appendix B: Result table of literature review

The result table shows positive and negative connections between regional contextual factors and STP performance. Last column list articles in the review that discuss the relevant topic.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Positive</th>
<th>Negative</th>
<th>Articles</th>
</tr>
</thead>
</table>
| Urbanisation     | • Developed urbanised regions are characterised by higher degrees of investments, human labour accumulation and increase networking opportunity. | • Economically peripheral regions struggle to attract qualified human labour, financial support.  
• High urbanisation levels have consequences for high population density, congestions and insufficient space for company expansion. | Shearmur & Doloreux, 2000  
Edgington, 2008  
Phelps & Dawood, 2014  
Shin, 2000  
Watkins-Mathys & Foster, 2006 |
| Financial support| • Access to funding influences the innovation outcomes of STPs.           | • Newer and smaller firms find it difficult to obtain financial support and the lack of financial aid can hamper technological commercialisation. | McAdam & McAdam, 2008  
Mukkala, 2010b  
Löfsten & Lindelöf, 2003  
Salvador & Rolfo, 2011  
Watkins-Mathys & Foster, 2006  
Xiao & North, 2018 |
<table>
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<tr>
<th>Factors</th>
<th>Positive</th>
<th>Negative</th>
<th>Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Institutional</strong></td>
<td>• A strong entrepreneurial culture is favourable for innovation performance of STPs and generates informal networks that lead to knowledge exchange and/or labour mobility</td>
<td>• Weak innovation culture is related to the lack of trust and interaction between various components in the innovation system and hence leads to poor STP performance.</td>
<td>Edgington, 2008 Hu, 2008 Lee, Lin, &amp; Hsi, 2017 Miao &amp; Hall, 2014 Zeng, Xie, &amp; Tam, 2010 Zou &amp; Zhao, 2013</td>
</tr>
<tr>
<td>• Innovation culture and norm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factors</td>
<td>Positive</td>
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<td>--------------------------------------------------------------------------</td>
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</tr>
</tbody>
</table>
| Industrial Structure    | • Strong industrial clustering mechanism can improve innovation outcome and strengthen knowledge network.  
   - High degree of specialisation relates to the efficiencies of providing resources to tenant firms and could attract firms in the specific specialised field. Strong cluster creates a favourable innovation ecosystem by providing a sufficient specialised labour pool. | • Scattered industrial structure leads to a lack of core technology and R&D development focus.  
   - Regions with poor industrial focus often also have unfocused and scattered university research competence. Too narrow technological focus of STP eliminates potential tenants from other regions’ industrial sectors. | Appold, 2004  
Etzkowitz & Zhou, 2018  
Guadix, Carrillo-Castrillo, Onieva, & Navascués, 2016  
Hansson, Husted, & Vestergaard, 2005  
Hommen et al., 2006  
Hu, 2008  
Huang & Fernández-Maldonado, 2016  
Jenkins & Leicht, 2018  
Jonsson, 2002  
K. Liu, & Hsing, 2005  
Kulke, 2008  
Lee et al., 2017  
McCarthy, Silvestre, von Nordenflycht, & Breznitz, 2018  
Miao & Hall, 2014  
Minguillo & Thelwall, 2015a  
Minguillo, Tijssen, & Thelwall, 2015  
Mukkala, 2010b  
Padilla-Meléndez, Del Aguila-Obra, & Lockett, 2013  
Park & Hu, 2011  
Phelps & Dawood, 2014  
Romijn & Albu, 2002  
Shearmur & Doloreux, 2000  
Staudt, Bock, & Muhlemeyer, 1994  
Tamásy, 2007  
Tsai & Chang, 2016  
Vásquez-Urríago, Barge-Gil, & Modrego Rico, 2016  
M.-R. Yan & Chien, 2013  
Yang et al., 2009  
Yun & Lee, 2013  
Zeng et al., 2010  
Zou & Zhao, 2013 |
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<tr>
<th>Factors</th>
<th>Positive</th>
<th>Negative</th>
<th>Articles</th>
</tr>
</thead>
</table>
| University, HEI, research institution and laboratory                    | • Proximity nearby university has an impact on the success of STPs, it increases the growth of network (informal connection with academic staff and students)  
  • Universities were mentioned as a resource for human capital  
  • University policy should support innovation outcome e.g. encourage patent application and academic entrepreneur creation  
  • Matching research interested between HEI and local industries leads to positive linkage and R&D collaboration | • Lack of integration between HEIs and property and facilities offered at technology parks resulting in weaknesses in getting ideas to market or patent to product.  
  • Chance of knowledge transfer is low, if the level of research excellence is neglected.  
  • University research needs to be integrated with local resources  
  • University views entrepreneur as a low status.  
  • Local universities cannot support qualified labour and scarcely provide the information about their research expertise | Albahari, Pérez-Canto, Barge-Gil, & Modrego, 2017  
  Appold, 2004  
  Bakouros, Mardas, & Varsakelis, 2002  
  Diez-Vial & Montoro-Sánchez, 2016  
  Etzkowitz & Zhou, 2018  
  Hansson et al., 2005  
  Hommen et al., 2006  
  Jongwanich, Kohpaiboon, & Yang, 2014  
  Jonsson, 2002  
  Kulke, 2008  
  Lee et al., 2017; Lin & Tzeng, 2009; Link & Scott, 2003; Löfsten & Lindelöf, 2003; Malairaja & Zawdie, 2008; Minguillo & Thelwall, 2015b, 2015a; Motohashi, 2013  
  Padilla-Meléndez et al., 2013  
  Park & Hu, 2011  
  Phelps & Dawood, 2014  
  Pilar Latorre, Hermoso, & Rubio, 2017  
  Ricardo Martínez-Cañas, 2011  
  Romijn & Albu, 2002  
  Shin, 2000  
  Watkins-Mathys & Foster, 2006  
  M. Yan, Chien, Hong, & Yang, 2018  
  Yun & Lee, 2013  
  Zou & Zhao, 2013 |
## Additional factors

<table>
<thead>
<tr>
<th>Factors</th>
<th>Positive</th>
<th>Negative</th>
<th>Articles</th>
</tr>
</thead>
</table>
| Extra-regional connections | - Firms that have connections outside a region have greater opportunities in conducting research, new knowledge creation, human labour development and wider market distribution.  
- Lack of outside regional connection means lack of market opportunity and may lead to decline of start-up firms  
- Lack of access to resources to upgrade cutting-edge knowledge  
- Lack of management experience and not being familiar with small firms in local area.  
- Outdated infrastructure and inefficient administration system | | Edgington, 2008  
Jonsson, 2002  
Koh, Koh, & Tschang, 2005  
Ku et al., 2005  
Löfsten & Lindelöf, 2003  
Milius, 2008  
Park & Hu, 2011  
Watkins-Mathys & Foster, 2006  
Yang et al., 2009  
Yun & Lee, 2013  
Albahari et al., 2013  
Bakouros et al., 2002  
Lee et al., 2017  
Malairaja & Zawdie, 2008  
Milius, 2008  
Minguillo & Thelwall, 2015b  
Phelps & Dawood, 2014  
Staudt et al., 1994  
Tamásy, 2007  
Watkins-Mathys & Foster, 2006  
Zou & Zhao, 2013 |
| Internal factors         | - Park infrastructure and services that provide what firms require  
- Park management should have the ability to link industry and university, also other regional and national organisations that could support innovation | | |
Article 2
How regional factors influence the performance of science and technology parks: a comparative analysis of regional science parks in Thailand
How regional factors influence the performance of science and technology parks: a comparative analysis of regional science parks in Thailand

Amonpat Poonjan, Anne Nygaard Tanner & Per Dannemand Andersen

To cite this article: Amonpat Poonjan, Anne Nygaard Tanner & Per Dannemand Andersen (2020): How regional factors influence the performance of science and technology parks: a comparative analysis of regional science parks in Thailand, Asian Journal of Technology Innovation, DOI: 10.1080/19761597.2020.1858718

To link to this article: https://doi.org/10.1080/19761597.2020.1858718
How regional factors influence the performance of science and technology parks: a comparative analysis of regional science parks in Thailand

Amonpat Poonjan a, Anne Nygaard Tanner b and Per Dannemand Andersen a

aDepartment of Technology, Management and Economics, Technical University of Denmark, Kongens Lyngby, Denmark; bDepartment of Technology, Management and Economics, UNEP DTU Partnership, Technical University of Denmark, Copenhagen, Denmark

ABSTRACT
Recent research on science and technology parks (STPs) has called for including regional contextual factors in studies of STP performance. However, no study has yet systematically assessed how regional contextual factors support or hinder STP performance. We apply a systematic framework to a comparative case study of three regional STPs in Thailand and analyse the effects of varying conditions along five dimensions: urbanisation, industrial structure, regional institutions and culture, university and research institutes, and financial resources in relation to the performance of each STP. The three Thai regions are similar in both size and levels of urbanisation and are governed by the same national programme for STP development, which provides a good methodological set-up for analysing the effects of varying regional contexts. Findings reveal that positive STP development is grounded in the presence of an innovative culture in regions driven by an active collaboration among local actors. Moreover, despite STPs being located in the same national innovation system, different regional contextual factors result in different levels of STP performance. A holistic understanding of these regional connections can help improve designs of STPs, and other supportive policies that are important for regional innovation development.

KEYWORDS
Science and technology parks; regional context; regional innovation systems; developing countries; science; technology and innovation policy

Introduction
The inconsistency of science and technology parks’ (STPs) economic contribution has led to a strong research focus on understanding both the factors and mechanisms favouring STP performance (Lecluyse et al., 2019). An increasing number of studies argue that the performance of STPs relies both on STP-internal factors and the regional conditions where the STP is located (e.g. supportive infrastructure, local university, industrial systems, and their level of collaboration) (Castells & Hall, 1994; Poonjan & Tanner, 2020; Shin, 2000). Nevertheless, regional conditions are often neglected in STP studies, especially in linking their strategy and evaluating their performance. This paper argues
that one cannot explain differences in STP performance without first understanding the social and institutional context of the regional economy in which a specific STP is placed.

While the importance of context-dependency has been evident in regional innovation policy studies, context-dependency has rarely been discussed and integrated in STP literature. Some scholars apply a qualitative, in-depth approach to understanding the connectedness between STPs and the regional context and how these linkages (or their absence) affect STP performance (e.g. Chen & Choi, 2004; Edgington, 2008; Kulke, 2008). Nevertheless, these studies tend to be single-case studies following different methodological and theoretical approaches, making generalisation difficult. This difficulty likely results from the absence of an underlying methodological framework that would allow researchers to analyse STP performance in the context of a specific regional innovation system.

To overcome the particularities of single-case studies we apply a recently developed systematic framework (i.e. the regional innovation system-STP (RIS-STP) framework) (Poonjan & Tanner’s, 2020) to a comparative case study of STPs in three regions of Thailand: Songkhla, Chiangmai, and Khonkaen. We analyse the effects of varying regional conditions and the performance of the STPs.

The RIS-STP framework identifies five regional dimensions important for STP performance levels: the degree of urbanisation, industrial structure, regional institutions and culture, university and research institutes, and financial resources. The three Thai regions are similar in both size and levels of urbanisation and are governed by the same national programme for STP development. This similarity provides a good methodological set-up for analysing the effects of varying regional contexts across regions where, on one hand, the structure and internal factors of each STP are similar and the national institutional settings are the same but, on the other hand, the regional factors (e.g. industrial structure and regional culture) differ.

The aim of this paper is twofold: (i) to evaluate the usefulness of the RIS-STP framework for understanding differences in STP performance levels and (ii) to provide an insight into specific regional contextual factors for the development of STPs in developing countries. We use the empirical findings to develop recommendations for policymakers to use for strengthening the innovative capacity of the three provinces.

This paper proceeds as follows. The second section presents the RIS-STP framework and theoretical background for operationalising the five dimensions of the regional context. The third section outlines the methodological considerations and approaches. The fourth section describes the STP performance indicators, presents the comparative case study, and sets out its findings. The fifth section discusses the findings in a broader empirical and theoretical perspective. The sixth section concludes by summarising the paper’s theoretical contribution and policy implications.

**Regional contextual factors and STP performance**

As this paper aims to insight into regional contextual factors’ importance for STP performance, the theoretical underpinning of such place-based approach is inspired by the regional innovation system (RIS) framework (Asheim et al., 2011). The RIS framework is used for designing and assessing innovation policy at the regional level (Coenen et al., 2017). The RIS framework views innovation as a systemic process that
involves various regional and non-regional actors (e.g. firms, university, intermediary organisations such as STPs, policy-makers and financial institutions) that interact with each other. The variety of actors and their level of interaction vary across different types of regions (e.g. metropolitan region, lagging region, old industrial region and cross-border regions). The particular regional type corresponds with different levels of innovative capacity (Isaksen & Trippl, 2016; Todtling & Trippl, 2005). Consequently, policy interventions require a deep understanding of the regional context in order to provide the right response for regional specific problems.

Although the theoretical grounding of context-dependency explicitly links to regional innovation policy interventions including STPs, there is still very little understanding of the effects of regional context on STP performance. A few researchers (Etzkowitz & Zhou, 2018; Phelps & Dawood, 2014; Tsamis, 2009) have argued and empirically shown that the success or ineffectiveness of STPs is a result of the regional context. For example, many successful STP-cases are located in large, diverse metropolitan regions characterised by high levels of venture capital, competitive firms, strong research bases and actively engaged local stakeholders (Castells & Hall, 1994; Comins & Rowe, 2008). In contrast, more modest or ineffective STP-cases are often located in peripheral regions where the innovation actors are scattered, there is a lack of prominent research institutions and the presence of weak supportive institutions (Rodríguez-Pose & Hardy, 2014; Tsamis, 2009). Associated with this observation, we argue that there is a need to undertake a more comprehensive understanding of how regional context plays a role in STPs development (Poonjan & Tanner, 2020). To this end, we use the RIS-STP framework as a systemic guideline to assess regional contextual factors and their influence on STPs performance.

The RIS-STP framework consists of five categories of regional factors: urbanisation, industrial structure, university and research institutes, institutions, and financial support, as well as extra-regional linkages and park–internal factors (see Figure 1). The following section outlines our operationalisation of each factor in order to understand the relationship between the regional factors and STP performance as well as its empirical measurability.

![Figure 1. Framework for factors influencing STP performance: Regional contextual factors (1–5), extra-regional connectivity (6) and STP internal factors (7), adapted from Poonjan and Tanner (2020).](image-url)
The first factor is *urbanisation*. Urbanisation is recognised as a fundamental factor that links to the innovation capacity in the region, since it is often reflected in the diversity of economic activities (Jacobs, 1969), better venture capital support and proximity to supportive infrastructure and institutions (Shearmur, 2012). Nevertheless, the degree of urbanisation is often neglected in STPs studies, although some studies suggest that successful cases are often located in urbanised areas, and more moderate cases are often found in less urbanised areas (Lecluyse et al., 2019). The degree of urbanisation can be understood through the measure of population density, supportive infrastructure (McGranahan & Satterthwaite, 2014), the ratio of employment in high-tech jobs (Shearmur and Doloreux 2000) and/or in the agricultural sector (Hofmann & Wan, 2013).

The second factor is regional *industrial structure*. In relation to STP development, the industrial structure refers to the existing local knowledge base that links to regional economic activities. STPs tend to perform well in regions with strong industrial agglomeration or large high-tech firms, especially if the STP strategy relates to local industries (Hommen et al., 2006; Yun & Lee, 2013). Moreover, the type of local industry is also associated with STP performance (in the form of number of spin-off firms and patents). For example, an intensive knowledge-based industry such as the biomedical industry might have higher numbers of spin-off firms than a service-based sector (Salvador & Rolfo, 2011). Another important aspect is the collaboration patterns among local firms. High levels of collaboration encourage the flow of knowledge and skilled human labour, which positively influence STP performance (Saxenian, 1996). Altogether, the industrial structure is broadly characterised by the dominant local industry (e.g. number and size of local firms and the presence of major local firms) and by collaboration patterns between a local firm. Such industrial dynamics can be captured through company and employments statistics as well as interviews.

The third factor is the *presence and quality of local universities and research institutes*. Literature has shown that well-performing STPs are associated with local universities that have high academic quality and provide cognitively matching research activities and skilled human labour with local industrial needs (Malairaja & Zawdie, 2008; Minguillo et al., 2015). In addition, the attitude of university innovation culture (e.g. supporting university-industry collaboration and encouraging students to spin off their research) directly links to high STP performance (Etzkowitz & Zhou, 2018; Hansson et al., 2005; Zou & Zhao, 2013). Universities’ scientific performance can be obtained by bibliometric indicators, for example, the one provided by Leiden ranking (Leiden University, 2019). The extent to which cognitive knowledge matching between the university and local firms, university innovation as well as university entrepreneurial and innovation cultured mindset (e.g. provide student entrepreneur course and encourage internal and external collaboration) can be gleaned through interviews.

The fourth factor is the *institutions*, which is classified in three sub-groups: the multi-scalar science, technology and innovation (STI) policy; the adjustment and integration of STI policy to the local context; and the innovation and entrepreneurial culture in the region.

The first subgroup is the multi-scalar STI policy. As operating at the regional level under the broad national framework, well-performing STPs are often associated with coherent policy between the national and subnational level (Albahari et al., 2013;
Edgington, 2008), despite the nation having a centralised or decentralised approach (Huang & Fernández-Maldonado, 2016). On this issue, the multi-scalar STI policy is represented by the quality of governance as well as adequate and coherent policy support between the national and subnational level.

The second sub-group is how well the STI policy is adjusted and integrated into the regional context. In relation to STP development, a strong commitment and active local government concerning innovation support, and a great match between national STI policy and local problems, often reflect in a good STP performance (Kim et al., 2014; Shin, 2000). In this respect, this subgroup is represented by the level of local government engagement and the matching between policy support and local issues.

The third sub-group of the institutional factors is the innovation and entrepreneurial culture. The majority of relevant STP literature points toward the importance of trust and interactive collaboration among local actors as a fundamental element of innovation processes (Edgington, 2008; Hu, 2008; Zou & Zhao, 2013). In this regard, the measurement of the cultural dimension can be characterised by local business mindset, the awareness of adopting STI into the business, and the level of local collaboration.

The last factor included in the RIS-STP framework is the financial support, which is defined as access to financial capital and guidance on how to access funding and capital. The literature points out that the opportunity to access venture capital is more extensive in metropolitan regions (Watkins-Mathys & John Foster, 2006). In contrast, in less-developed regions (also in the case of developing countries: Wonglimpiyarat, 2011), the primary financial support is from government and extra-regional funding (Xiao & North, 2018). The availability of regional financial support can be identified by a number of financial aid resources related to innovation activities, e.g. financial aid programmes provided by financial institutions, funding support from both public and private organisations, the availability of venture capital firms, angel groups and financial aid information.

Above, we have presented an analytical framework to assess the regional context of STPs in order to explain how these conditions influence STP performance. Another point to discuss is the operationalisation of STP performance. Research suggests that STP performance can be assessed at different levels (e.g. at the STP level and regional level) by different indicators (e.g. number of patents and number of job creation), and importantly under different conditions (e.g. their stage of development and different regional characteristics) (Lecluyse et al., 2019; Poonjan & Tanner, 2020). However, as our aim is to compare three STPs to explore the influence of regional context on STP performance, we use economic and employment impact of the STPs as available in existing government reports.

Whilst, we ground the arguments on the importance of regional context in affecting STP performance, we do not neglect the importance of STP extra-regional linkages and STPs’ internal factors as both factors can have an impact to STP performance. However, in this study, we focus on exploring the linkage between context-dependency and STP performance, because regional characteristics in innovation performance tend to be prominent and persistent (McCann & Ortega-Argilés, 2013; Todtling & Tripl, 2005). Thus, the discussion of STP extra-regional linkages and STPs’ internal factors are not included in the scope of this paper.
**Research method**

We use a multiple case study approach as an empirical comparison among the regional innovation systems (Edquist, 2011). Our level of regional context analysis is at the provincial level (below Thai state and regions and above districts). There are 7 regions and 76 provinces in Thailand. We chose the provincial level for our regional analysis because these are the primary local government unit. In addition, the provincial level also provides the best available comparable statistics at the sub-national level. However, due to lack of consistent measures for STP performance at the STP or provincial level, we rely on the RTI International (2019) report for comparable indicators. The RTI International report measures STP performance as the economic effect of STPs at the regional level comprising several provinces for each of the following regions: northern, north-eastern and southern. Although the RTI International report draws together the result of all parks in the regions (northern, north-eastern and southern region), this disadvantage is surmountable, because most of the regional STP performance contribution came from the main branches, since the main branches are the only parks in growth state who provide full services (see section ‘Science Parks in Thailand’ for description of main STP-branches).

The empirical cases consist of three different science parks in three different provinces. The Prince of Songkla Science Park in Songkhla province is our main case study, which has been examined in-depth with a greater number of interviews. Chiangmai Science Park in Chiangmai province and Khonkean Science Park in Khonkean province are supporting cases, and they have been reviewed in-depth with fewer interviews due to limited time and resources. We used government reports, international reports, and business articles to provide data for the cases. Further, we undertook semi-structured interviews to gain the necessary understanding of how these regional contextual factors influence the development and performance of the STPs. We conducted face-to-face and phone interviews of key interviewees from Songkhla, Khonkaen and Chiangmai provinces during February to July 2019. All the key interviewees were assessed to be credible sources who have experience from working in the province and fulfill different roles in the science park system, such as science park director, manager and staff, university director and researcher, local entrepreneurs and provincial government. The interview questions were derived from the RIS-STP framework. We deductively coded the interview data by identifying relevant themes from the RIS-STP framework. A list of interviewees are shown in Table 1. The analysis focused on exploring how the regional contextual factors support or hamper STP performance.

**Findings**

This section begins with the background development of STPs in Thailand and compares the performance of three different STPs. Then we describe each of the regional contextual factors of the three provinces. These factors are guided by the RIS-STP framework, starting with urbanisation, then moving to industrial structure, university, institutions and financial support.
Science Parks in Thailand

In 2004, the Thai government executed the plan for regional science park establishment with the aim of stimulating economic activity in peripheral areas by combining STI with local knowledge. At the beginning, there were just three science parks embedded in three major local universities in different parts of Thailand (north: Chiangmai university, northeast: Khonkaen university, and south: Prince of Songkla university). These parks provided only soft services to local firms by means of technological consultancy, training and collaboration. During 2007–2011, the plan to develop science parks was temporary terminated. In 2011, the plan was resumed together with a large budget for the parks to set up new infrastructure in order to provide full functional services and enhance the regional STI perception level (Irawati & Rutten, 2013). Now, there are 16 science parks across the country, 14 of them are operated in three different regions, one of the parks is in Bangkok and one is in the set-up phase in the eastern region (Figure 2). The three formerly established science parks have become the main branches of other science parks in the region. The three main parks are in transition from a start-up state to a growth state (European Commission, 2013), moving from university buildings to the new dedicated infrastructure that enables them to provide additional facilities such as rental space and laboratories. Our empirical study will draw on the three main branches of Thai science parks: Prince of Songkla, Chiangmai, and Khonkaen University science parks.

Performance of science parks in Thailand

We use the internal report of the long-term impact and operational guidelines of regional science parks commissioned by the Ministry of Science and Technology (RTI
As we see from the graphs, in 2013, the impact created by science parks was small, and it rose gradually until 2015. From 2015 onward, the trend dramatically increased. This was due to the expansion of park services. The northern science parks showed the best performance, followed by the north-eastern and southern science parks. In consequence, these data indicate that the science park in Chiangmai performs the best, followed by Khonkaen and Prince of Songkla science parks, which is an interpretation that the
majority of our interviews have confirmed. In the following section, we portray the regional context of each science park.

**Regional contextual factors: Songkhla, Chiangmai and Khonkean**

**Urbanisation**

Songkhla, Chiangmai and Khonkaen are the major secondary provinces in Thailand after Bangkok metropolitan area. These provinces' function as regional hubs for transportation, education and business (Bangkok Post, 2020). Table 2 provides the basic socio-economic statistical data of the three provinces. The population figures show that Khonkean and Chiangmai are slightly larger than Songkhla, whereas Chiangmai is the largest province in terms of area. The large area of Chiangmai results in low numbers of total

![Figure 3. Economic impact of regional science parks in Thailand from 2013 to 2017. The chart was created by the authors using data from RTI International (2019).](image)

![Figure 4. Employment impact of regional science parks in Thailand from 2013 to 2017. The chart was created by the authors using data from RTI International (2019).](image)
population density, while looking at the population density in urban areas Chiangmai city turns out to be the most densely populated area. The Chiangmai province also has the highest number of higher education institutions.

Moving into gross provincial product (GPP) data, Songkhla province has the highest GPP per capita, followed by Chiangmai and Khonkean. However, when comparing the ratio of labour force in the agricultural sector to their GPP contribution, Chiangmai has the lowest share of agricultural workers with the highest GPP contribution followed by Songkhla and Khonkean. Khonkaen has the highest GPP contribution from manufacturing sectors, while Chiangmai and Songkhla have relatively higher contribution shares from other sectors such as service sector (in Chiangmai) and oil and gas extraction (in Songkhla). Altogether, these data suggest that Chiangmai has slightly higher levels of urbanisation than the other two provinces.

Nevertheless, each province has its own characteristics (Table 3) that may influence its economic activities and local innovation performance. Songkhla has the advantage of being the border province to Malaysia and was promoted as one of the Special Economic Zones (SEZ) targeted to stimulate trade and investment opportunities (The Board of Investment of Thailand, 2017). Chiangmai is, on the other hand, characterised as being one of the most prominent tourist destinations in Thailand (Table 2) and is famous for its unique arts and crafts culture. Foreigners describe Chiangmai as one of the best places to stay because of the cheap cost of living, beautiful and relaxing atmosphere, several co-working spaces and a strong community of digital nomads (Hynes, 2016). The combination of its appeal as a tourist destination and supportive infrastructure has attracted foreigners to stay in Chiangmai, which increases the cultural diversity in the province. Unlike the two provinces, Khonkaen’s special trait comes from the synergy among local actors, especially local businessmen (Khonkaen Think Thank Group, KKTT) who initiated the smart city project in 2013. The project reflects a better culture for collaboration, citizen participation approach that rarely occurs in Thailand (Smart Growth Thailand, 2017; Taweesaengsakulthai et al., 2019). To sum up, all three provinces have a similar level of urbanisation, but their comparative advantages

| Table 2: Basic socio-economic indicators of each province. |
|-----------------|-----------------|-----------------|
| Factor/Province  | Songkhla        | Chiangmai       | Khonkaen       |
| Population      | 1,417,440       | 1,735,672       | 1,801,753      |
| Area (km²)      | 7394            | 20,107          | 10,886         |
| Population density (per km²) | 192            | 86              | 160            |
| Population density in urban area (per km²) | 862            | 1541            | 434            |
| GPP per capita (THB) | 153,505       | 126,976         | 107,607        |
| Number of higher education institutions | 5             | 7               | 2              |
| The ratio of labour force in the agricultural sector to overall labour | 33.30%         | 32.92%          | 47.30%         |
| GPP from agricultural | 13.46%         | 22.5%           | 11.00%         |
| GPP from the manufacturing sector | 19.35%         | 7.70%           | 36.60%         |
| GPP from other sectors | 67.18%         | 77.50%          | 52.40%         |
| Dominant manufacturing sectors | Seafood, rubber and rubber wood | Plant-based and food processing | Non-metal, metal and food processing |
| Number of tourists (million) | 5.5            | 7.7             | 2.9            |

Notes: GPP = Gross provincial product. All data apart from number of higher education institutions and dominant manufacturing sectors are from the year 2016. The data on number of higher education institutions and dominant manufacturing sectors are from the year 2020.

Source: Chiangmai Provincial Statistical Office (2017); Khonkaen Provincial Statistical Report (2017); Songkhla Provincial Statistical Office (2017); MOI Chiangmai (2019); MOI Khonkean (2019); MOI Songkhla (2019); UniRank, 2020.
of location and local dynamic characteristics vary, making the three provinces useful for explaining how the local context can influence STP performance.

**Industrial structure**

Most of the economic activity in the three provinces is due to small- and medium-sized business (SMEs). The agricultural sector is still essential for the provincial areas in Thailand because it is a foundation for the other local industries, especially for food processing, in the form of raw materials and intermediate goods. Further, the number of labourers in the agricultural sector is noticeably high compared to their GPP contribution, especially in Khonkaen (Table 2).

The presence of firms shows that Songkhla is a specialised province in the rubber and seafood sector, unlike Chiangmai and Khonkaen, where the industrial structure is considerably more diverse. In Chiangmai, the major firms are in food processing, IT, tourism, textile, and furniture production. In Khonkaen, the major firms are in textiles, distilleries, sugar and paper production (MOI Chiangmai Province, 2019; MOI

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**Table 3. Summary of regional contextual factors in each province.**

<table>
<thead>
<tr>
<th>Factor/Province</th>
<th>Songkhla</th>
<th>Chiangmai</th>
<th>Khonkaen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urbanisation</td>
<td>Border region to Malaysia and special economic zone</td>
<td>Cultural diversity</td>
<td>Network-based, citizen participation</td>
</tr>
<tr>
<td>Industrial structure</td>
<td>Specialised Rubber, seafood processing and rubber wood products</td>
<td>Diversified Plant-based, food processing and tourism</td>
<td>Diversified Plant-based, food processing (e.g. sugar), and non-metal manufacturing (e.g. glass producing)</td>
</tr>
<tr>
<td>University</td>
<td>Prince of Songkla University</td>
<td>Chiangmai University</td>
<td>Khonkaen University</td>
</tr>
<tr>
<td>Proportion of top 10% publications (Leiden University, 2019)</td>
<td>4.30%</td>
<td>4.20%</td>
<td>4.80%</td>
</tr>
<tr>
<td>Proportion of collaborative publication with industry (Leiden University, 2019)</td>
<td>2.70%</td>
<td>4.30%</td>
<td>3.20%</td>
</tr>
<tr>
<td>Cognitive matching between university research expertise and local industries</td>
<td>University research expertise broadly matched with local industries but linkages between academics and firms are weak.</td>
<td>Promoted entrepreneurial culture in students and slowly adopted innovation oriented for staffs management</td>
<td></td>
</tr>
<tr>
<td>Institutions</td>
<td>Multi-scalar policy balance</td>
<td>The top-down approach, government and policy instability, mismatch between innovation policy and problems at national and regional levels</td>
<td>The top-down approach, government and policy instability, mismatch between innovation policy and problems at national and regional levels</td>
</tr>
<tr>
<td>Integration and adjustment of STI to regional context</td>
<td>Rarely engage with local/provincial government</td>
<td>Actively engage with local/provincial government</td>
<td>Occasionally engage with local/provincial government</td>
</tr>
<tr>
<td>Norm and entrepreneurial culture</td>
<td>Low collaboration among local actors</td>
<td>Strong collaboration among local actors</td>
<td>Moderate collaboration among local actors</td>
</tr>
<tr>
<td>Financial support</td>
<td>The availability of financing in the province</td>
<td>Local banks provide loan programmes for start-up and SME businesses. Funds and grants for start-up, SMEs and university research activities mainly come from organisations outside the province.</td>
<td>Local banks provide loan programmes for start-up and SME businesses. Funds and grants for start-up, SMEs and university research activities mainly come from organisations outside the province.</td>
</tr>
</tbody>
</table>
The problem of local firms lacking innovative capacity exists in all three provinces, but the problem seems to be larger in Songkhla where most of the interviewees expressed their concerns in this regard. Moreover, the collaboration among local firms seems to be limited in Songkhla. The rubber firm business owner illustrates this:

… there is lack of trust among firms, for example, among mid-stream raw producers and down-stream manufacturer firms. Firms don’t want to share any knowledge because the rubber production formula are similar. Other firms might be able to replicate … (ENT-S2)

Further, the data from the Department of Industrial Works (n.d.) and interviews (SPM-S2, SPS-S3, SPS-S5, and LOC-S1) illustrates that firms in Songkhla are SMEs and operate upstream or midstream in the value chain. They use low-level technology. The revenue is the biggest concern while the application of new technology is perceived as a complicated and unnecessary process. On the other hand, in Songkhla, the participants (ENT-S1, UNI-S2 and FIRM-S1) expressed that the downstream industries that apply advanced technology do not actively engage in knowledge sharing or technology transferring. In sum, Songkhla’s industrial structure is less diverse compared to Chiangmai and Khonkaen. At the same time, the level of collaboration among firms in the Songkhla province is weak.

**University**

In a university-based science park model, the university possesses a major role in STP development. We assessed three STP host universities along three dimensions: university research quality, knowledge matching with local industries, and university innovation and entrepreneurial policy.

We used the Leiden ranking 2019 (Leiden University, 2019) covering the period 2014–2017 to measure university research quality of top 10% journal publications and number of industrial collaboration publications (Table 3). The data indicate that the three universities have a similar research quality, although Chiangmai University has the highest numbers of publications published in collaboration with industry.

We asked the participants about their opinions on the university’s cognitive matching with local industry. The majority of participants from all three provinces agreed that university research knowledge broadly matched the existing local sectors (15 out of 20 participants who answered this question). They (SPM-K1, SPS-S3, UNI-S1 and FIRM-S1) further suggested that the local firms do not require higher levels of technology; in this sense, the university knowledge seems to be sufficient for firms’ current capacity building. Nevertheless, most of the participants in Songkhla gave the impression that the level of collaboration between the university and firms is still limited. The arguments ranged from an insufficient number of researchers, lack of communication channels, to a critical attitude towards academic-industry collaboration. Several interviewees (i.e. SPM-S1, SPM-S3, ENT-S2 and UNI-S1) added that the university researchers and professors do not have business and entrepreneurial mindsets as described:

University research expertise broadly matches with local industries but the communication mechanism with private firms are the problems. University researchers do not have business
mind-set, they just want to do research while firms want an immediate solution. Further, university documentation processes are time consuming. (UNI-S1)

At the same time, the interviewees who disagree on the level of university cognitive matching with local industry argue that there is a need to better link university research and local demand. The interviewees ENT-S1 and SP-ENT-C1 noted that all three regions lack skilled labour in specific areas, such as design and programming. They further commented that there is no channel or platform to connect with the university. This argument is also in line with SPS-S2, SPS-S3 and UNI-S2, who expressed that many university–industry collaborations occurred by informal or alumni connections.

Finally, we assessed if the universities encourage innovation and entrepreneurial culture through their students and staff. In collaboration with the science park, the interviewees described that the three universities provide several platforms for student entrepreneurial activities. For example, the research to market project, which encourages students to use the research outcome and propose a market opportunity. Moreover, the interviewees (i.e. UNI-S1, SPM-K1 and SPM-C1) also indicated that in the past few years, there has been a shift in University evaluation process from traditional perspectives to an innovative approach. For example, the university has an intention to address innovation related to the new measures by integrating private research collaboration and research commercialisation as one of the staff performance indicators.

In conclusion, the three universities have similar prospective in term of research quality, knowledge matching with local industries, and university innovation and entrepreneurial policy. At the same time, they also have common problems in linking between academics and firms.

**Institutions**

**Multi-scalar policy and the integration and adjustment of STI to the regional context.**

Thailand has a centralised top-down approach. Thus, the three provinces share similar characteristics of policy and government support. Innovation policies was integrated as a part of Thailand’s science and technology policy (STI) since 2001, yet the country still faces several challenges linking policy concepts into practice (Intarakumnerd & Chaminade, 2007). The challenges come from the fragmentation of the innovation system, inefficient government bureaucracy, and government and policy instability (OECD, 2013). Further, as argued by Chaminade et al. (2012) systemic problems such as redundant policy structure and promoting innovation culture have rarely been mentioned in Thailand’s STI policy approach.

The challenges of STI policy and government structure at the national level have affected STI policy adjustment at the provincial level twofold. First, the centralised top-down approach limits local engagement and creates redundant functions among different organisations at the provincial level. This problem is rooted in Thailand’s administrative structure. The provincial administrative structure is a dual system comprising two parallel government systems for the same geographical area: a provincial government is appointed and supervised by the central government and a local administrative government which elected by local people. The terms ‘provincial’ and ‘local’ are frequently used in literature and reflect the two different administrative systems for the same geographical area. The provincial government agencies consist of
several ministry organisations (e.g. Ministry of Interior, the Ministry of Agriculture and Cooperatives, the Ministry of Education, and the Ministry of Public Health) (Nagai et al., 2008). These organisations operate at the provincial level as branch offices of central ministries which sometimes create service redundancy and difficulty to collaborate among organisations (Nelson, 2001). As expressed by an interviewee:

Our system has a long vertical line; it slows the working process. At the provincial scale, each ministry organisation is independently busy with their own work that fits with the top-down orders. Thus, it is difficult to have horizontal collaboration at the provincial scale. I worked at the regional science ministry for many years; I have only just learnt in the last few years that the science park exists. (LOC-S1)

This comment indicates that the system poorly recognises the collaboration process at the provincial level.

Moreover, most of the interviewees from the three provinces suggested that the involvement of provincial and local governments could benefit science park development, as they are the best channels to reach local people and public organisations. However, several studies (Haque, 2010; Nelson, 2001; The World Bank, 2012) found that the dual system of appointed provincial government officials and elected local government representatives lacks effective mechanisms to coordinate works and functions. The local government which is elected by people in the province lacks autonomy both in making decision and accessing the financing and human resources (The World Bank, 2012; UNDP, 2009). This problem is confirmed in the interviews (SPM-S1, SP-ENT-C1 and SPM-K1). The interviewees expressed that the local government has inadequate capacity in integrating STI development in their role. Practically, their main function concerns infrastructure development and peoples’ quality of life in general, and engaging in innovation activities is not their top priority. However, the level of local government engagement with STP activities vary across the three provinces and it seems to be weakest in Songkhla, where the interviewees (LOC-1, LOC-2 and SPM-S1) stated that collaboration between local and provincial governments has rarely occurred. In contrast, the Chiangmai and Khonkaen interviewees (SPM-C1 and SPM-K1) expressed that the collaboration with local and provincial governments is more common.

Second, the limitation of autonomy and challenges of STI policy at the national level addressing low levels of collaboration at province level results in policy mismatch between national government policy support and current issues in the provinces. This is best illustrated by the Songkhla rubber city project launched in 2016. The national government established the rubber city as a plan to leverage the rubber cluster from primarily a midstream towards a downstream dominated industry. However, the project has been criticised by the press as unpopular and suffering from a lack of interested investors (Bangkok Post, 2018). This argument is confirmed by our interviews:

The advertisement of the rubber city was really huge at the beginning, like a mega project. The ideal concept would benefit SMEs in the rubber industry. However, in reality the situation is totally different. The infrastructure provided and management process are disorganised. There are just 5–6 firms from the downstream rubber sector situated there, and some have already moved out. (SPS-S5)

This quote confirms that there is a mismatch between the policy support launched by the national government and the local needs at the provincial level, hence resulting in
inefficient investment that is not meaningful to local development. In conclusion, the top-down approach, inefficient system at the national and provincial level has resulted in incoherent multi-scalar policy and restricted the integration and adjustment of STI to the regional context.

**Norms.** We observed regional innovation and entrepreneurial culture in the form of the local business mindset, the awareness of adopting STI into the business, and the level of local collaboration. The interviewees confirmed that all three provinces have a vibrant business environment in the sense that local people are familiar with doing business. However, most of the business activities are simple trade and/or have a low level of technology involved.

Moreover, interviews in all three provinces indicate that in the past few years, local people have increased their awareness of innovation. However, the situation is clearly different between Chiangmai and Songkhla. Interviewees from Chiangmai (ENT-C2) explained that the private sector and local people are very active in undertaking innovative activities and, together with the number of foreigners and people who move from big cities to live in Chiangmai, this has improved the local innovation ecosystem. Contrary the situation in Songkhla, where most of the interviewees expressed concern that local people still lack innovation awareness:

On a scale of one to ten, our provincial innovation culture scores five … (SPM-S2)

Local entrepreneurs have been aware of innovation/technology for a while but they don’t know where to start. (SP-ENT-K2)

The local awareness and understanding of innovation reflect the dynamic and collaboration mechanism between local actors. In Songkhla, collaboration among local actors is limited by the lack of trust, especially among firms. Most of the interviewees noted that local firms exhibit a less innovative mindset of owning the business and technology rather than collaborating. ENT-S2 illustrated that firms see each other as competitors. Even though the province has many firms in the dominant sectors of rubber and seafood, there has been scarce to no collaboration among local firms.

On the other hand, all of the interviewees in Chiangmai expressed positive opinions on the level of collaboration in their province. SPM-C1 described that the culture for collaboration was inherited from family-owned businesses that had built long-term relationships and networks, which younger generations of managers and staffs benefitted from. Level of collaboration had even better conditions now due to communication technology. All interviewees agreed that Chiangmai has strong and active local communities. SPM-C1 further highlighted that the vibrant collaboration in the Chiangmai province has made the support from the government more meaningful. All-in-all, a high level of collaboration and trust among local actors in Chiangmai has encouraged the ease of doing business and knowledge spreading, in contrast to the low level of collaboration and trust among local actors in Songkhla.

**The availability of financing**

The interviews revealed that the availability of financing in the three provinces mainly comes from two sources. First, local banks provide loan programs for start-ups and
SMEs. Second, organisations – both public and private – provide funding and grants for start-ups, SMEs, and university research activities.

The encouragement of government innovation policy has recently prompted financial institutions and investment firms to become more active in investing in start-ups and technology-based companies. Yet, access to capital is a common challenge in all three regions. Entrepreneurs (SP-ENT-S2, SP-ENT-K1, 2 and SP-ENT-C1) highlighted that at the outset they used self-financing and/or borrowing from their family due to the complicated regulations of banks and the difficulty in obtaining financial support at the early stage. Besides, most of the funding for new firm formation targets high-performing start-up firms, of which only a few exist. Furthermore, interviewees from local firms and public officers agreed that the funding support from the government is inconsistent due to the fiscal year budget and slow processes, which hinder long-term finances. In general, the financial situations of all three provinces are similar. They all share the problems in accessing capital.

**Discussion**

In this section, we discuss the findings on how regional factors influence the performance of science and technology parks. The comparative analysis has shown that all three provinces are challenged in terms of incoherent multi-scalar STI policy, lack of university–industry collaboration and lack of capital and funding support. At the same time, we found that the three provinces differ on other factors, such as industrial structure and levels of trust and collaboration, which hence create different regional starting points for the STP activities.

The findings corroborate previous research on innovation system dynamics in Thailand (Chaminade et al., 2012; Schiller, 2006). For example, Chaminade et al. (2012) identify several innovation system failures, which hinder innovation capacity building at a national level. The innovation system failures count network; capability; institutional; and infrastructural failures, which in turn require different types of policy responses (Klein Woolthuis et al., 2005; Smith, 2000). Our study supports that these system failures at the national level also hinder innovation capacity building at the regional level, and thereby STP performance as a whole. Moreover, our analysis also shows how some of these system failures manifest differently across the three regions and in consequence require STI policy that is adapted or at least adjusted to fit the specific regional conditions. In the following, we discuss these findings.

To exemplify regional differences, network and capability failures seem to be larger in Songkhla province than in the other provinces. Especially in terms of industrial structure and norms, Songkhla’s industrial structure is less diverse and firms have a lower level of innovative capacity than in Chiangmai and Khonkaen. The latter leads to capability problems being more severe for Songkhla province with low-tech firms upstream and midstream in the value chain.

On network failures, the level of collaboration and trust among local actors in Songkhla is fairly low compared to the active local collaboration levels in Chiangmai. This lower network capacity of regional actors in Songkhla may have resulted in lower STP performance level. Our findings on varying levels of collaboration confirm the
importance of a strong collaboration culture as a solid starting point for innovation creation (Trippl & Toedtling, 2008). Even though Songkhla benefits from being a border region and from a supportive national policy aimed at the specialised rubber sectors, insufficient collaboration among local actors has limited the opportunities for knowledge flow and innovation creation and may therefore be the reason behind lower STP performance. One of the reasons may be that Songkhla’s industrial structure is dominated by large foreign rubber companies with little incentive or need to collaborate with local firms or universities.

The findings reflect that despite being located in the same national innovation system, different regional contextual factors result in different levels of regional innovation system outputs and thus STP performance levels. This also stresses the importance of understanding the specific industry structure and dynamics in a given region, in order to discover possibilities for improving networking and knowledge sharing, which is the key aim of STPs. On this matter, our study corroborates that best practices often emerge in favourable entrepreneurial and innovation culture that supports local collaboration for learning and knowledge creation (Edgington, 2008; Hommen et al., 2006; Hu et al., 2005). These findings suggest that despite the similar context of national institutions, STP strategies across the country need to be articulated to fit with regional specificity. In regions with low levels of local collaboration, the focus should be on capability-building of concerned actors and strengthening networks among actors to enhance knowledge flows and encourage favourable collaboration practices (e.g. facilitating access to partners with complementary assets). The question is if STP is the best policy response to network and capability failure in all regions and at least whether STP can stand alone in addressing these issues.

On the other hand, some problems seem to be similar to all three provinces, for example, discontinuous financial support, incoherency in policy at the national and provincial level, and infrastructural problems, such as low levels of university-industry collaboration. Whereas the discontinuous financial support is indisputable a disadvantage for building innovative capacity, the importance of low levels of university-industry collaboration in developing countries has in the IS literature been questioned (Chaminade et al., 2012). It has been argued, that low levels of university-industry collaboration may not be a huge problem in developing countries because the industry is better characterised as traditional than science-based. In continuation hereof, our study also confirms that the role of universities still differs from the Western experience and that in some regions STPs may not be the most suitable policy instrument due to the institutional context of developing countries (Schiller, 2006). Since the key task of STPs is to improve the knowledge linkages between university and industry and because the need for university-industry collaboration may be lower due to a different industrial composition than in developed countries it may seem paradoxical that STP continuously is a highly prominent and STI policy instrument in Thailand. Instead, policies may aim more on strengthening other types of knowledge infrastructure at the regional level. For example, by utilising and boosting existing informal channels of knowledge sharing between university and industry (Schiller, 2006) and by improving the knowledge base of regions through increasing the quality and quantity of traditional university outputs such as a number of graduates, publications and research projects fitting the regional needs.
Conclusion

This study set out with the dual aims of evaluating the usefulness of the RIS-STP framework in understanding differences in STP performance levels and providing an insight into specific regional contextual factors for the development of STPs in Thailand.

The theoretical contribution of this paper relates to how STP performance is influenced by regional contextual factors. We contribute to an emerging literature that calls for a better understanding of the effects of regional context on STP performance. By applying a systematic framework, this study expands the explanatory framework for understanding STP performance and confirms that despite being located in the same national innovation system, different regional contextual factors result in different levels of regional innovation system outputs and thus STP performance levels. While the importance of context-dependency has been evident in regional innovation policy studies for a long time (e.g. Asheim et al., 2011; Grillitsch & Asheim, 2018; Isaksen & Tripl, 2016; Todtling & Tripl, 2005) regional conditions for STP performance has rarely been discussed and integrated in STP literature. In particular, the RIS-STP framework (Poonjan & Tanner, 2020) provides researchers with an underlying methodological framework that is comprehensive and systematic in assessing the mutual interplay between STP performance capacities and specific regional innovation systems. In consequence, this perspective supports the idea that one cannot understand STP performance levels disconnected from the regional context.

We have also shown that the RIS-STP framework can provide a better understanding of specific STP development, for example in the case of the three Thai provinces as shown in this paper. Thus, the framework can also be used as a guideline assessment tool to design and adjust the STP strategy as well as other supportive innovation policies that fit the regional innovation situation.

In this particular case, the empirical findings show that despite a strong top-down, centralised approach, the three different provinces in Thailand configure different types of regional innovation systems and, thus, represent different levels of STP performance. However, in the Thai case, the national level plays an important role in improving regional innovation system capacity. Therefore, we draw two major policy implications for Thai government based on our findings.

First, STP’s design and strategies should be carefully planned in response to regional specific problems. As seen in this study, understanding regional industrial structures are important, not only for providing the right technological knowledge input but also for addressing any potential network failures with the best type of policy instruments.

Second, there is a need to reduce the inconsistency in policy at national and provincial level in order to better meet the local demand for STI policy. It will be beneficial if the policy is formulated to give administrative autonomy locally to stimulate horizontal integration of local actors in addressing innovation system failures. Where innovation system failures are the same in the national and regional innovation system there is a need to tackle more systemic innovation issues at the national level, however, this does not diminish the need for greater decentralisation and reform of the bureaucracy allowing regional authorities to respond to regional needs more efficiently; actively promoting university-industry collaboration and providing sustainable financial support (Intarakumnerd et al., 2002; Intarakumnerd & Chaminade, 2007; World Bank Group, 2018).
This paper is limited in the insufficiency of available data that would have permitted a deeper quantitative investigation of the issue. Future research can take note of this problem and examine more in-depth the character of different types of innovation system failures across regions where STPs are prioritised as an instrument to solve the specific failure. Moreover, the main focus of this paper has been on regional contextual factors for STP performance and an obvious next step would be to integrate extra-regional linkages and STPs’ internal factors into a deeper understanding of STP dynamics. Further work on the internal management of STPs and their extra-regional linkages would most likely improve the conceptual model in designing and implementing STPs.

Note
1. The name of the university is spelled ‘Songkla’, whereas the province name is spelled ‘Songkhla’.

Disclosure statement
No potential conflict of interest was reported by the author(s).

Funding
This work was supported by Royal Thai Government Scholarships.

Notes on contributors
Amonpat Poonjan is a PhD student at the Department of Technology, Management and Economics, Technical University of Denmark. Her PhD thesis focuses on the importance of context-dependency for innovation policy approaches. Her research interests include innovation policy, economic geography, innovation systems in developing countries and technology foresight. Anne Nygaard Tanner is an Associate Professor at the UNEP DTU partnership. Her research focuses on innovation processes, sustainability transition of industries, the emergence of new industries and firms’ knowledge sourcing strategies. Per Dannemand Andersen is professor at the Department of Technology, Management and Economics at the Technical University of Denmark. His research interests focus on Technology foresight and on Research and innovation strategies in industrial sectors.

ORCID
Amonpat Poonjan https://orcid.org/0000-0002-0657-5409
Anne Nygaard Tanner https://orcid.org/0000-0002-3145-908X
Per Dannemand Andersen https://orcid.org/0000-0001-8997-1089

References


McGranahan, Gordon, and David Satterthwaite. 2014. IIED working paper urbanisation concepts and trends.


OECD. (2013). Innovation in Southeast Asia: Thailand innovation profile. https://www.innovationpolicyplatform.org/content/thailand#.


Tridech, C. (2016). *Regional science parks: A step forward to innovation ecosystem in Thailand regional science parks*. 33rd IASP World Conference on science parks and areas of innovation, Moscow (pp. 359–376).


Article 3
Foresight for science and technology parks in a smart specialisation context
Foresight for science and technology parks in a smart specialisation context

By Amonpat Poonjan, Per Dannemand Andersen and Anne Nygaard Tanner

Article submitted to Technological Forecasting and Social Change

Abstract:

The concept of smart specialisation strategies (S3) builds on related activities in regional specialised sectors and the bottom-up entrepreneurial discovery processes to identify and prioritise promising technologies and supportive policies. However, the process of identifying and prioritising promising technologies and supportive policies is challenging, especially in lagging regions, where the innovation ecosystem is deficient. In this regard, science and technology parks (STPs) can play a role in innovation strategies for S3. Nevertheless, theoretical and practical concepts that link STPs and S3 have not yet been well established in the literature. This paper fills the gap by concretising the theoretical and practical route that links the innovation strategy role of STPs and S3. To do so, we propose and apply innovation system foresight (ISF) in the Prince of Songkla science park in Songkla province, Thailand. The practical outcome is a policy recommendation for STP management and regional authorities. The theoretical contribution lies in a new approach for S3 initiation in which STPs play a crucial role.

Keywords: Foresight, Smart specialisation, Science and technology parks, Regional context, Developing countries

1 Introduction

It has been argued that science and technology parks (STPs)\(^1\) play a key role in policies that support regional innovation ecosystems because they can act as technology and innovation hubs for entrepreneurial activity in a region (Nauwelaers, Kleibrink, and Stancova 2014). However, several research studies (e.g. Shearmur and Doloreux, 2000; Phelps and Dawood, 2014) have also criticised STPs for not fulfilling their potential. A reason given for this is that they are weakly linked to regional precondition activities. To exemplify, STPs’ strategies do not respond to regional innovation problems and opportunities, thus resulting in mismatched functioning between STP strategies and local needs.

The challenges of such place-based innovation policy for regional innovation development is acknowledged for other regions of the world and approached in the

\(^1\) The acronym STP covers the broad concept of ‘technology park’, ‘technopole’, ‘research park’ and ‘science park’, and is commonly used in the research community, whereas the term ‘science park’ is more common in our case study. For simplicity, we use only STP in this paper.
European Commission’s Smart Specialization Strategies (S3). S3 aims to shape policies for revitalising regional economies based on the local strength of and stakeholders’ involvement in the strategy formation. The rationale behind S3 highlights the importance for regions to focus on particular domains related to pre-existing economic activities in order to develop distinctive areas of future regional specialisation (Foray 2016). By building on pre-existing local resources and ensuring broad stakeholder involvement, regional innovation policy interventions could capitalise on the actual strengths and potentials of regional economies and the value of participatory processes.

While S3 addresses the process used to restructure regional economies, Nauwelaers et al. (2014) discuss the role of STPs in the context of S3. They argue that STPs can potentially provide an adequate innovation ecosystem for initiating innovation activities at a regional level. They further suggest that STPs can become key actors in gathering multiple stakeholders and enabling their contributions to shape S3 strategies. Likewise, STPs may also become extra-regional connectors for implementing S3 strategies. However, in practice, the process of developing STPs to leverage regional capacities and potentials in accordance with S3 strategising remains complex.

This paper aims to concretise a practical route for regional S3 strategy processes in which STPs play a central role. We propose and apply a novel approach to the identification and selection of ‘transformative activities’ as an alternative to the one suggested by Foray, Keller and Bersier (2018). For that purpose, we depart from a recently developed conceptual framework that highlights the importance of regional innovation system (RIS) and STP performance (Poonjan and Tanner 2020). This RIS–STP framework draws on experiences described in extant STP literature and outlines how STP designs need to be reshaped and planned to align with regional contexts and challenges. To add a future perspective to our analysis, this contribution combines the initial RIS–STP framework with the innovation system foresight (ISF) framework by Andersen and Andersen, (2014). The ISF framework was developed from the rationale that foresight can accommodate an innovation system by addressing the problems and challenges related to the current context and demands for knowledge (Andersen and Andersen, 2014). The framework is described in more details in the following section. While Andersen and Andersen focus on foresight for national innovation systems, others have focused on foresight for regional innovation systems (Battistella and Pillon 2016; Fikirkoca and Saritas 2016; Harper and Georghiou 2005; Piriäinen, Tanner, and Alkærsig 2017).

Despite the growing focus on regional innovation systems and innovation policy design through foresight, there is a lack of studies that have applied a perspective as comprehensive as that which the RIS–STP framework presents, while zooming in on the role of STPs in developing regional innovation ecosystems. The theoretical contribution of this paper relates to the implementation of S3 and how the integration of the two frameworks, ISF and RIS–STP, can contribute to it through a novel alternative approach to the identification and selection of ‘transformative activities’ framed by Foray et al. (2018). Thus, this paper contributes to the literature on foresight for STPs and regional innovations systems (Battistella and Pillon 2016; Fikirkoca and Saritas 2016; Harper and Georghiou 2005) by adopting a novel conceptual and methodological approach.

The study behind this paper departs from the practical problem that Thailand’s innovation performance has a low ranking compared to other middle-income countries in Southeast Asia. Following the contemporary understanding of national innovation systems (NISs), Iamratanakul (2014) argues that Thailand’s NIS faces a range of challenges. For example, there is no coherent innovation policy, and industrial
technology policy is treated as a low priority. Moreover, the links between firms and universities are weak, and the country allocates limited expenditure for research and development (OECD 2013).

From 2004 to 2007, regional STPs were established in Thailand to fill the economic inequality gaps between Bangkok and peripheral areas by combining science, technology and innovation policy with regional know-how to assist the private sector in developing innovation-based and sustainable businesses (Tridech 2016). The STPs were planned in affiliation with three major universities in different parts of Thailand (in the north: Chiangmai University, northeast: Khonkaen University, and south: Prince of Songkla University).

In 2015, the Thai government officially released Thailand 4.0, a policy agenda to promote and support innovation, creativity, research and development. In light of this agenda, the role of STPs – among other policy initiatives – received more attention. Although the policy initiative is inspiring and ambitious, the practical implementation is still vague and unclear (Jones and Pimdee 2017).

To explore the Thai innovation system further, this paper’s analysis focuses on practical contributions related to the Prince of Songkla science park in the Songkhla province of Thailand. The aim is to suggest policies for the science park management and regional authorities. Based on dialogue with representatives of the Prince of Songkla science park and Songkhla regional authorities, the practical research questions are formulated as follows:

• What promising technology developments will be selected as focus sectors in the Songkhla province over the next ten years?
• What global megatrends will have an impact on the development of those sectors over the next ten years?
• What important regional policy and STPs management instruments will support the development of promising technology over the next ten years?

2 Theoretical Framework

The following section presents the theoretical foundation of our study. We integrate the three theoretical frameworks of smart specialisation strategies (S3), innovation system foresight (ISF), and regional innovation system for science and technology parks (RIS–STP).

2.1 Smart specialisation strategies (S3)

As mentioned in the introduction, the overall theoretical research question of this paper relates to the role of STP management and policies in the context of S3 implementation.

The concept of smart specialisation strategies emerged in 2008 from a group of academic experts as a policy tool to enhance research and development (R&D) activities in EU economies. The core process views innovation as a critical driver for regional economic restructuring and involves local stakeholders to identify and develop local innovation capacity. Local stakeholder involvement is a crucial mechanism in the policy’s so-called entrepreneurial discovery process (EDP). The EDP advocates a bottom-up procedure conducted by relevant regional actors to identify new related activities that can potentially revitalise local economic activities (Asheim 2019; Foray 2016). McCann and Ortega-Argilés (2016) summarise the pragmatic approach of S3 as
‘carefully choosing priorities which are best suited to moving the region from its current development trajectory to a stronger trajectory via the enhancement of the local entrepreneurial climate’.

New potential growth or transformative activities often emerge from related activities in sectors or technologies that are similar to the region’s existing specialisations. This notion aligns with evidence from empirical studies (e.g. Boschma and Iammarino, 2009; Frenken, Van Oort, and Verburg, 2007). These studies suggest that regional growth is more sustainable in cases where regions diversify into new technologies and skills that build on their existing capabilities. Incremental adjustments to existing core capabilities are especially relevant in lagging regions where the resources to create profound innovation are scarce. S3 works by prioritising regional development spending on each region’s distinct competitive advantages, thus enabling regions to transition into more dynamic and higher value-added sectors. The transition process is expected to occur through regional industry upgrades, diversification or emergence (Asheim 2019; Barzotto et al. 2019; Foray, Keller, and Bersier 2018).

The implementation of S3 is challenging for several reasons, especially in lagging regions. For example, it is difficult to identify local technological domains and develop collective learning in regions where the local precondition for innovation is weak, namely lack of connectedness and entrepreneurial culture, limited size in terms of market potential and industrial diversity and, more importantly, low-quality local governance. Furthermore, it is challenging to identify new related activities in lock-in regions where the local industrial structure is dominated by traditional industries (e.g. agriculture or textiles) (Barzotto et al. 2019; Capello and Kroll 2016; Marques and Morgan 2018).

We argue that the challenges of S3 implementation can be minimised by adequately analysing the functions of STPs. We perceive S3 as a policy approach process, while STPs provide a complementary instrument to initiate the process. Inspired by Nauwelaers, Kleibrink and Stancova (2014) and Barzotto et al. (2019), we suggest that STPs can mitigate S3 challenges in two aspects. First, in regions that lack local preconditions for innovation, STPs can provide adequate innovation ecosystem activities and attract relevant local stakeholders for the entrepreneurial discovery process. Second, in lock-in regions and/or regions that have limited absorptive capacities regarding local small and medium enterprise (SME) firms, STPs can compensate by providing extra-regional outlook.

2.2 Innovation system foresight for smart specialisation

As mentioned above, the EDP promotes a bottom-up process conducted by relevant regional stakeholders to identify activities that have the potential to revitalise the local economy. Such processes were also the key feature of the concept of technology foresight that emerged during the 1980s and 1990s as a tool for boosting innovation systems (Irvine and Martin 1984; Martin and Johnston 1999). Foresight allows policymakers to identify how trends can influence a system, which helps them prepare the strategies needed to cope with the future (Battistella and Pillon 2016). Foresight has been utilised on different scales; there is national, regional and corporate foresight. Observations from extant literature suggest that national and corporate foresight primarily focus on emerging technological issues, while regional foresight more often takes institutions of the region into account (Kindras et al. 2014; Uotila and Ahlqvist 2008). Regional foresight aims to provide valuable input into strategy and policy planning in regions, while also mobilising collective strategic actions (Gavigan et al.
Several studies have linked regional foresight with the concept of RIS (e.g. Fabbri, 2016; Uotila and Ahlqvist, 2008; Vecchiato and Roveda, 2014). The emergence of S3 has focused attention on foresight at the regional scale.

The concept of foresight has developed since it emerged in the 1980s. As the understanding of innovation and innovation policy has developed, foresight has taken a more systemic turn, leading to the coinage of ‘innovation system foresight’ (Andersen and Andersen 2014). ISF is defined as a ‘systemic, systematic, participatory, future-intelligence-gathering and medium-to-long-term vision-building process aimed at present-day decisions and mobilising joint actions to improve innovation system performance with the ultimate goal of improving desirable socio-economic performance’ (Andersen and Andersen, 2014). Based on this definition, the ISF framework can complement S3 in three ways. First, ISF operates in a systemic context dependency. ISF takes not only the emergence of technology foresight into account but also the relevant socio-economic factors in a specific context. Moreover, ISF views the innovation process in an evolutionary sense, meaning that there are actors and institutions involved in the system, and the system is dynamic. The ISF framework emphasises the need to map the innovation system context and, as such, includes reflections on regional strengths and weaknesses. This argument aligns with the core concept of the S3 framework, which highlights the heterogeneity of regions and the need for innovation policy to be adjusted based on the specific context.

Second, S3 aims to identify the promising economic diversification of industrial path development that creates regional structural change. In this sense, ISF complements S3 by providing an evidence-based approach to identifying new related activities and diversifying technological domains surrounding local specialised industries, as well as revealing how to prioritise among policies. In other words, ISF identifies promising areas for economic diversification based on the ideas in existing specialised areas and new market opportunities (Gheorghiu, Andreescu, and Curaj 2016).

Third, foresight activities accelerate the process of regional innovation networking by directly involving relevant local stakeholders in the process. Involving relevant stakeholders is key to the entrepreneurial discovery process of S3. The process helps stakeholders acquire regional assets and casual promise contracts to push new innovations (Fabbri 2016; Uotila and Ahlqvist 2008).

2.3 Regional contextual factors and STP development

Both the concepts of S3 and ISF concern the identification of regional preconditions, local specialisation and stakeholder involvement. For STPs to play a role in S3, their strategies should align and coordinate with the regional preconditions because STP is not a self-sustaining function but is embedded in RIS and a broader set of national innovation systems (NISs). Thus, the characteristics and dynamics of the RIS and NIS are vital for adjusting STP strategy when designing S3, especially at the regional level. The underpinning explanation is that the regions are diverse and evolve, and their characteristics are influenced by the capacity of regional dimensions, namely the degree of urbanisation, availability of financial support, universities and research institutes, industrial structure and institutional settings (Poonjan and Tanner 2020; Todtling and Trippl 2005).

Given the argument regarding regional preconditions for STP development, we use the RIS–STP framework (Poonjan and Tanner 2020) as a primary guideline for designing regional policies and STP management instruments for S3 implementation. We argue that
the policy instruments need to be further elaborated in congruence with the real practical context. The RIS–STP framework captures the contextualised view of empirical studies on the regional conditions that can influence STP performance. The framework comprises five regional factors (see Figure 1), namely urbanisation, availability of financial support, universities and research institutes, industrial structure and institutional settings together with extra-regional networks and STPs’ internal factors. In the following paragraphs, we elaborate on the potential policy recommendations concerning the mentioned contextual factors that arise from the framework analysis.

The first factor is urbanisation, which is considered the fundamental factor for regional innovation activities. Urbanisation is the most basic requirement that links to other supportive factors (e.g. skilled human labour and financial investment) that aid the development of STPs. Thus, the basic requirement for the region is to have well-developed transportation and communication infrastructure.

Similar to urbanisation, the second factor is the availability of financial resources, which is the root of innovation activities (e.g. new firm formation, R&D activities and marketing). The supportive policy should ensure that the availability of funding for the development of new products or the implementation of new process technologies is sufficient and sustainably distributed. At the same time, STPs should also provide assistance and guidance on how to apply for and access funding.

The next factor is the presence of universities and research institutes in the region. The framework indicates the need for excellent university research; cognitive matching between university research experts, highly skilled graduates and local industries and an innovation culture mindset. In this vein, the policy should aim to enhance university research in local core sectors and related knowledge fields, educate highly skilled graduates regarding competences and skills relevant to the industry and promote collaboration between private companies and university researchers. Similarly, STP strategy should also support university–industry relationships and promote and improve the quality of university research.

The fourth factor is the local industrial structure. The framework suggests that regions with strong industrial agglomeration and high-tech leading firms are often associated with better R&D core knowledge and a higher capacity to innovate, which is linked to better STP performance. Such conditions require a policy that upgrades local technological capacities by developing competences and skills in regional core and related industries, as well as promoting collaboration among firms in the region.

The fifth factor is the institutions, which consists of three sub-groups: multi-scalar policy, the adjustment and integration of science, technology and innovation (STI) policy based on the local context and innovation and entrepreneurial culture. The framework demonstrates that stability, coordination, and coherence between national and regional policies accommodate STP development. The second subgroup is the integration and adjustment of STI policy to match the local context. The conditions of this subgroup that favour STP development relate to positive engagement from local government and congruence between STI policy and local problems. It is important to emphasise that initiative and coherence policy from the national government are vital in order to encourage the integration of local government and adjustment of STI policy at the local level. The last element in this subgroup is the innovation and entrepreneurial culture. The framework suggests that transaction-intensive regions with high levels of trust often produce strong collaboration among local actors and have a positive influence on STP development. Potential policy recommendations should aim to enhance local innovation culture and stimulate local collaboration.
Although the framework has accentuated the importance of regional internal dynamics, the context of designing STP strategy for S3 requires an extra-regional linkage, as it is important for knowledge collaboration (Barzotto et al. 2019) and new market opportunities (Paliokaite, Martinaitis, and Reimeris 2015). Furthermore, the STP internal management system should be adjusted and adapted based on the regional preconditions, as we previously discussed. In general, STP services focus on the development of facilities (e.g. laboratories and co-working spaces), new businesses through incubation programme facilitation and intellectual property rights services (e.g. patent lawyers), but the roles and functions of STPs vary from region to region based on the regional preconditions that STPs should support. In some cases, the specialisation of STPs in specific technologies and knowledge fields related to local industries exhibits good performance.

This section has provided a theoretical analysis of the conceptual framework of our study. The overview of the model framework is depicted in Figure 1.

**Figure 1**: The RIS–STP and ISF framework for S3.

The model illustrates that STP is closely linked to the regional system but is shaped by the broader context of the national and global system. The use of the ISF will reveal
information about the potential future development of certain technologies based on regional competence. The integration of the theoretical frameworks guides the three practical research questions and the detailed layout of the foresight process.

The first research question regarding promising technology developments for the selected sectors in Songkhla over the next ten years reflects the S3 framework’s focus on identifying new related activities that have the potential to revitalise local economic activities. This coincides with the regional industrial structure and universities and research institutions competences, as well as the selected sector of the STP. The second question addresses the most important global megatrends that will impact the development of the selected sectors over the next ten years and relates to the global level of foresight regarding S3 as supportive evidence to prioritise promising technology and policy strategies. Finally, the third research question is split into two parts, addressing both the regional policy and STP management instruments that will support the development of promising technologies over the next ten years. This links with the regional contextual factors of urbanisation, financial support, institutions (including the subgroups of multi-scalar policy, integrating STI policy and entrepreneurial culture) and extra-regional linkages. The concept of the mentioned regional contextual factors and evidence from our case will determine the implementable regional policy and STP management instruments.

3 Method
Methodologically, this study is based on a generic innovation system foresight approach (Andersen and Andersen 2014; Andersen, Andersen, and Jensen 2014). The context of the research behind this article is a PhD scholarship granted by the Royal Thai Government and carried out at the Technical University of Denmark. The grant and the geographical distance between the university and the Songkhla province determined to some extent the selection of the detailed foresight methods. Apart from the academic audience, the primary target groups of the foresight exercise were the management of the Prince of Songkla University science park and the policymakers of the Songkhla province. As mentioned in the introduction, the practical aims of the foresight exercise were formulated in dialogue with representatives of the Prince of Songkla University science park and Songkhla regional authorities. The Prince of Songkla University science park has previously selected four focus areas of industry sectors and technology: rubber, seafood, palm oil and biomedical. Therefore, the foresight exercise also focused on these four areas. A time horizon of ten years was chosen. The analytical level of the study was multi-scalar and focused on policy instruments at both the regional/province level and the STP level.

Empirically, the study draws on three sources: 1) desk studies of relevant reports, web pages and similar sources, 2) interviews and 3) a two-round iterative Delphi method. The structured interviews were carried out either as phone interviews or during visits to the Songkhla province. The interview questions were designed based on the RIS–STP framework. As an alternative to workshops, a Delphi method was selected for two reasons. First, the context as a PhD project carried out in Denmark limited the available resources and ability to invite the relevant stakeholders to a workshop. Second, the process provides an efficient decision-making approach in a limited time and cost situation. The Delphi method provides consensus information from a panel of experts,
without bringing them together physically (Linstone and Turoff 2002; Rowe and Wright 2011).

In an iterative process, we developed key statements regarding issues within each of the four areas of technology and business, as well as key questions regarding regional innovation policy and STP management (see Figure 1). The first step was a comprehensive desk study to gain knowledge about each sector and identify relevant actors. In the next step, we interviewed 18 relevant local actors to understand the current situation and trends for each specific sector in the province. We used the insight from the desk studies and expert interviews to formulate the first round of the Delphi survey, which aimed to establish an overview and prioritise among four themes, namely 1) the most important technologies and business areas in the four focused sectors, 2) external megatrends that affect the four sectors in Songkhla, 3) possible regional innovation policy instruments and 4) possible STP management instruments to promote industrial development in the four sectors. In the second round of the Delphi survey, we combined the selected statements with the selected questions on megatrends, management instruments and regional policy instruments. As far as possible, we included the same respondents in both the interview and the two rounds of the Delphi survey (see Table 1).

The results from the Delphi surveys were analysed using a simple statistical method, i.e. mean and standard deviation were used to provide an overview of the central tendency of the results. However, the use of statistical analysis represents a limitation because of the small sample size (see Table 1).

After the interviews, we found that the palm oil sector was only weakly present in the region compared to the other three sectors. We identified only four regional actors, and only one of them completed the survey. Thus, we excluded the palm oil sector from the analysis of our findings and the final round of the Delphi survey.

![Figure 2](image)

**Figure 2**: The foresight process in Songkhla province.

| Table 1. Number of informants from interviews and Delphi surveys. |
|-------------------------|------------------|------------------|------------------|
| **Sectors** | **Number of interviewees** | **Respondents contacted in first round Delphi** | **Completed responses in first round Delphi** | **Completed responses in final round Delphi** |
| Biomedical | 5 | 13 | 9 | 6 |
| Palm oil | 3 | 4 | 1 | - |
| Rubber | 5 | 14 | 7 | 7 |
| Seafood | 5 | 11 | 4 | 2 |
4 Findings

The findings section begins with background information regarding Songkhla, followed by the results of the foresight exercise and the discussion on the integration of innovation foresight and RIS–STP framework to design and implement S3.

4.1 Background information and data

Songkhla is a major province in the southern region of Thailand and borders Malaysia. The population of Songkhla is 1.43 million. The province’s gross provincial product (GPP) per capita is 35% lower than the national average. The leading university in the southern region, Prince of Songkla University, is in Songkhla and hosts the region’s STP. As it is situated in the border region, Songkhla is a part of a special economic zone (SEZ). The SEZ is a government plan to develop industrial real estate in the border regions by offering both tax and non-tax incentives for investors. It is expected that the SEZ project plan will be complete in 2021 (Songkla Provincial Statistical Office 2019; The Board of Investment of Thailand 2017).

Most economic activities in Songkhla are run by small and medium enterprises (SMEs) and shared among four sectors: agriculture and fishing, mining, services and manufacturing. The manufacturing sector concentrates on rubber, seafood and wood production. The labour force in the agricultural sector accounts for 33.3% of the overall labour force in the province, while the GPP from the agricultural sector is just 14.3% of the overall GPP. A higher level of education accounts for only 23% of all employed workers (Songkhla Industry Organisation 2019; Songkla Provincial Statistical Office 2019).

The Prince of Songkla science park focuses on four sectors as part of a strategic plan to promote local innovative activities. Those sectors are rubber, seafood, palm oil and biomedical. The rubber and seafood sectors were selected based on the existing knowledge base from the university and industry, while the palm oil and biomedical sectors were mainly linked to university research expertise.

The rubber and seafood sectors are the dominant sectors in Songkhla. These two sectors have complete value chain systems in the province and several big local firms, yet the collaboration among local actors is not yet well established. In 2016, the government established Rubber City in Songkhla with an innovation-based plan to develop the rubber cluster from midstream to downstream industries. However, it has been criticised by the press as unpopular and lacking interest from investors (Bangkok Post, 2018). The development of the cluster concept is still weak in the province.²

Although the palm oil sector in Songkhla is relatively weak (the industry value chain is incomplete and there are no big firms) compared to other provinces (e.g. Chumphon and Surat Thani), the STP selected the palm oil sector because the university knowledge base is well established, having first been developed in 1993. Therefore, the university researchers and a small group of local farmers are the only main actors in this sector and most of the collaborations have occurred outside the province.

The last STP focus sector is the biomedical sector. The development of the biomedical sector in Songkhla is linked to the presence of university research expertise and supportive infrastructure (e.g. faculty of medicine at the university hospital and related research institutions). The STP internal report on their intellectual property from 2007 to 2019 demonstrated that the development of the biomedical sector is cross-linked

² Interview with local firms and STP staff in February 2019
with the rubber and the seafood sectors. To exemplify, 40% and 47% of the intellectual portfolio in the rubber and seafood sectors relate to the biomedical field, respectively. However, the development of the sector is rather confined in academic groups (some of them become entrepreneurs). The interviews of university researchers revealed that international collaboration in the biomedical field (and possibly other fields as well) is limited because Songkhla is in a high-risk area under travel warnings from foreign governments. Hence, they rarely attract researchers from abroad even though the situation is relatively safe.

In summary, Songkhla has four potential sectors of particular interest: rubber, seafood, palm oil and biomedical. The province’s key strengths are its location next to Malaysia, the presence of the major university, and the agglomeration of seafood and rubber clusters. However, Songkhla shows typical challenges like other lagging regions. The interviews with local stakeholders revealed that the province has a low level of firm innovation capacity because most firms are SMEs and their priorities concern cost reduction rather than technology upgrades. Furthermore, the dominant sector of agriculture and fishing is labour intensive and their technological capability rarely improves. Lastly, the collaboration among local actors is weak and the industrial policy is inefficient in the case of the rubber city.

4.2 Promising areas of technology and business

In an iterative process based on the desk studies, interviews with key actors and two rounds of Delphi surveys, four sets of statements on promising areas of technologies and business were developed. The intention was to formulate approximately ten statements for each focus area. However, the iterative process led to a variety of 14 statements for the biomedical sector, eight statements for the palm oil sector, 16 statements for the rubber sector and 13 statements for the seafood sector. The statements were selected on two criteria of relevance: first, whether each area of technology or business was of interest to existing firms in Songkhla and second, whether there were existing capabilities in core or related knowledge fields in Songkhla. The statements are shown in Table 2.

Table 2. Statements on promising areas of technology and knowledge in the four selected sectors over the next ten years.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomedical</td>
<td>B1 Biosensors for external medical examination equipment and point-of-care applications</td>
</tr>
<tr>
<td></td>
<td>B2 Biodegradable nanoparticles for drug delivery system</td>
</tr>
<tr>
<td></td>
<td>B3 Biomedical management software (e.g. cloud database for one-stop diagnostic solutions, web-based software for biomedical equipment inspection and management)</td>
</tr>
<tr>
<td></td>
<td>B4 Smart devices for ageing population (e.g. voice or wearable technology for monitoring blood pressure or glucose levels)</td>
</tr>
<tr>
<td></td>
<td>B5 Medical data diagnosis using image processing technology (e.g. x-ray, MRI and microscope)</td>
</tr>
<tr>
<td></td>
<td>B6 Medical data analysis using DNA database diagnosis for personalised and precision medicine</td>
</tr>
<tr>
<td></td>
<td>B7 Medical robotics for surgery and rehabilitation</td>
</tr>
<tr>
<td></td>
<td>B8 Bionic hands and legs using EMG signal controls</td>
</tr>
<tr>
<td></td>
<td>B9 Telemedicine using application on smart device (direct to consumer visit)</td>
</tr>
<tr>
<td></td>
<td>B10 Senior home services</td>
</tr>
<tr>
<td></td>
<td>B11 Obtain biomedical product certification from international organisation such as FDA</td>
</tr>
</tbody>
</table>

3 The respondents from the first round Delphi survey suggested three additional statements, B12–B14 (Table 2).
4 The respondents from the first round Delphi survey suggested two additional statements, R15 and R16 (Table 2).
Regarding both criteria: 1) of interest to existing firms in Songkhla and 2) existing oil sector from the Delphi survey.

As mentioned before, we omitted the palm Seafood
Rubber
Palm oil

<table>
<thead>
<tr>
<th>Palm oil</th>
<th>P1 Develop new high-yielding and drought-resistant oil palm type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P2 Smart farming using automation technology for fertilisation</td>
</tr>
<tr>
<td></td>
<td>P3 Reduce oil loss in non-streaming extraction process</td>
</tr>
<tr>
<td></td>
<td>P4 Oleochemicals technology (e.g. fatty acid, fatty alcohol, methyl esters and glycerin) and palm-based constituents (e.g. tocotrienols and carotene) for new value-added products (e.g. vitamin E supplements and palm oil cosmetics)</td>
</tr>
<tr>
<td></td>
<td>P5 Carotenoid and/or tocotrienols extraction from crude palm oil processing</td>
</tr>
<tr>
<td></td>
<td>P6 Enhance biodiesel standards using H-FAME technology</td>
</tr>
<tr>
<td></td>
<td>P7 Obtain sustainable palm oil production certification (RSPO)</td>
</tr>
<tr>
<td></td>
<td>P8 Agricultural machinery rental businesses</td>
</tr>
<tr>
<td>Rubber</td>
<td>R1 Mechanisation and automation in rubber tapping</td>
</tr>
<tr>
<td></td>
<td>R2 Precision farming (e.g. using sensor data to observe, measure and analyse the needs of rubber)</td>
</tr>
<tr>
<td></td>
<td>R3 Process innovation to reduce costs in rubber processing (e.g. new chemical process)</td>
</tr>
<tr>
<td></td>
<td>R4 Economically feasible technologies to reduce or remove protein from natural rubber</td>
</tr>
<tr>
<td></td>
<td>R5 Use bioprocessing technology to produce natural rubber serum products with commercial applications (e.g. Quebrachitol or Serum Protein)</td>
</tr>
<tr>
<td></td>
<td>R6 Protein-free rubber-based products (e.g. gloves) for allergic consumers</td>
</tr>
<tr>
<td></td>
<td>R7 Technology for rubberised roads: cup lump modified asphalt for road construction</td>
</tr>
<tr>
<td></td>
<td>R8 Rubber in automotive applications (e.g. green tyres or rolling resistance tyre compounds)</td>
</tr>
<tr>
<td></td>
<td>R9 Rubber technology for railway systems (e.g. rubber railway pads)</td>
</tr>
<tr>
<td></td>
<td>R10 Integrated rubber and material technology (e.g. dielectric material or flexible sensors)</td>
</tr>
<tr>
<td></td>
<td>R11 Use rubber for soft robot medical surgery</td>
</tr>
<tr>
<td></td>
<td>R12 Rubber wood: natural bio-based products for wood coating and protection against degradation</td>
</tr>
<tr>
<td></td>
<td>R13 Rubber wood: develop unique product designs (e.g. toys or furniture)</td>
</tr>
<tr>
<td></td>
<td>R14 Obtain sustainability standards and certification for products, processes or management related to rubber</td>
</tr>
<tr>
<td></td>
<td>R15 Membrane process that can replace the centrifugal system in latex concentrate manufacturing</td>
</tr>
<tr>
<td></td>
<td>R16 Rubber product development technology (e.g. dyes and moulds)</td>
</tr>
<tr>
<td>Seafood</td>
<td>S1 Use biotechnology in seafood farming (e.g. using Gonadotropin-releasing hormone [GnRHa] for fish breeding, fish feed biotechnology and bioremediation)</td>
</tr>
<tr>
<td></td>
<td>S2 Precision fish farming using automated feeding strategies and control</td>
</tr>
<tr>
<td></td>
<td>S3 Freezing technology (e.g. liquid nitrogen freezer or air blast freezer)</td>
</tr>
<tr>
<td></td>
<td>S4 Traceability and H2O enabling food logistics</td>
</tr>
<tr>
<td></td>
<td>S5 Substitute raw materials from seafood with other bio-based raw materials (e.g. seasonal vegetables and fruits) that are compatible with existing production system</td>
</tr>
<tr>
<td></td>
<td>S6 Extract bioactive compounds from seafood waste using ultrasound technology to create new value-added products</td>
</tr>
<tr>
<td></td>
<td>S7 High-pressure processing, pulsed electric field and cold plasma technology for food preservation to minimise nutrition lost</td>
</tr>
<tr>
<td></td>
<td>S8 Develop new products that are easy to cook and rich in taste by involving culinary and nutritional expertise</td>
</tr>
<tr>
<td></td>
<td>S9 Develop new packages using biodegradable packaging, smart packaging and new packaging designs</td>
</tr>
<tr>
<td></td>
<td>S10 Develop new value-added products for senior people (e.g. bio-calcium enriched tuna)</td>
</tr>
<tr>
<td></td>
<td>S11 Develop new value-added products for health and beauty market (e.g. high protein, low carbohydrate snacks)</td>
</tr>
<tr>
<td></td>
<td>S12 Obtain sustainability standards and certification for products, processes or management related to seafood</td>
</tr>
<tr>
<td></td>
<td>S13 Obtain standards and certifications for food-safety and health concerns from international organisations</td>
</tr>
</tbody>
</table>

In the two rounds of Delphi surveys, the respondents assessed each statement concerning the two criteria mentioned above. As mentioned before, we omitted the palm oil sector from the Delphi survey.

A first observation of the responses is that all statements have a relatively high score regarding both criteria: 1) of interest to existing firms in Songkhla and 2) existing
capabilities in core or related knowledge fields in Songkhla (see Figure 3). Only three statements have an average score below 3 (moderate) for the criteria ‘existing capabilities in core or related knowledge fields in Songkhla province’. These include one biomedical and two rubber statements:

- **B1** Biosensors for external medical examination equipment and point-of-care applications
- **R7** Technology for rubberised roads: cup lump modified asphalt for road construction
- **R15** Membrane process that can replace the centrifugal system in latex concentrate manufacturing

The second observation is that the scores for the criteria ‘of interest to existing firms in Songkhla’ are higher on average than the scores for the criteria ‘existing capabilities in core or related knowledge fields in Songkhla’. This indicates that the province has limited knowledge bases and lacks critical mass in terms of research and industrial innovation capabilities.

Figure 3: The statements that are of interest to existing firms and represent existing capabilities in core or related knowledge fields in Songkhla.

In general, the responses in the biomedical sector demonstrate a higher degree of consensus than the rubber and the seafood sectors. The reason for this could arise from the variety of respondents in the seafood and rubber sectors. The biomedical sector is a new sector that emerged from university researchers. Thus, the respondents are primarily limited to researchers, entrepreneurs and firms that have a close connection with the university, while the seafood and rubber sectors are already at more mature stages and much larger. Hence, the respondents from those sectors are much more diverse. The statements that display the greatest variance in rubber and seafood sectors are **R9 Rubber**
technology for railway systems (e.g. rubber railway pads) and S7 High-pressure processing, pulsed electric field and cold plasma technology for food preservation to minimise nutrition lost. The top three highest-scoring promising technologies statements related to the importance for firms’ development in Songkhla over the next ten years and existing competences and skills in Songkhla (both at firms and universities) from each sector are displayed in Table 3.

**Table 3.** The highest scoring promising technologies statements.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomedical</td>
<td>B9 Telemedicine using application on smart device (direct to consumer visit)</td>
</tr>
<tr>
<td></td>
<td>B10 Senior home services</td>
</tr>
<tr>
<td></td>
<td>B4 Smart devices for ageing population (e.g. voice or wearable technology for monitoring blood pressure or glucose levels)</td>
</tr>
<tr>
<td>Rubber</td>
<td>R3 Process innovation to reduce costs in rubber processing (e.g. new chemical process)</td>
</tr>
<tr>
<td></td>
<td>R8 Rubber in automotive applications (e.g. green tyres or rolling resistance tyre compounds)</td>
</tr>
<tr>
<td></td>
<td>R14 Rubber wood: develop unique product designs (e.g. toys or furniture)</td>
</tr>
<tr>
<td>Seafood</td>
<td>S5 Substitute raw materials from seafood with other bio-based raw materials (e.g. seasonal vegetables and fruits) that are compatible with existing production system</td>
</tr>
<tr>
<td></td>
<td>S10 Develop new value-added products for senior people (e.g. bio-calcium enriched tuna)</td>
</tr>
<tr>
<td></td>
<td>S11 Develop new value-added products for health and beauty market (e.g. high protein, low carbohydrate snacks)</td>
</tr>
</tbody>
</table>

**4.3 Global megatrends**

A set of 13 global megatrends (see Table 4) was developed based on the desk study, interviews and two rounds of Delphi surveys. In the first round of the Delphi surveys, all three sectors were presented the same list of 12 megatrends (MT1–MT12). The additional MT13 was suggested by the first-round biomedical sector respondents. In the second round, we adjusted the number of global megatrends based on the results of the first round. Consequently, in the second round, each sector was presented with different lists of five to six high-impact megatrends. For each sector, we summarised the three global megatrends assessed to have the highest impact on the development of each of the three sectors in Songkhla (see Table 4).

**Table 4.** List of global megatrends.

<table>
<thead>
<tr>
<th>Megatrend</th>
<th>Biomedical</th>
<th>Seafood</th>
<th>Rubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT1 Global warming and climate change</td>
<td>o</td>
<td>o</td>
<td>0</td>
</tr>
<tr>
<td>MT2 Environmental sustainability</td>
<td>o</td>
<td>o</td>
<td>H</td>
</tr>
<tr>
<td>MT3 Expansion of China’s global influence</td>
<td>o</td>
<td>o</td>
<td>0</td>
</tr>
<tr>
<td>MT4 Emerging competition in Southeast Asia (e.g. Laos, Cambodia and Myanmar)</td>
<td>o</td>
<td>H</td>
<td>0</td>
</tr>
<tr>
<td>MT5 Increased urbanisation</td>
<td>o</td>
<td>o</td>
<td>0</td>
</tr>
<tr>
<td>MT6 Ageing society</td>
<td>H</td>
<td>o</td>
<td>0</td>
</tr>
<tr>
<td>MT7 Automation and artificial intelligence</td>
<td>H</td>
<td>o</td>
<td>H</td>
</tr>
<tr>
<td>MT8 Increased interest in health, wellness and well-being lifestyle</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>MT9 Increased digitalisation</td>
<td>o</td>
<td>H</td>
<td>0</td>
</tr>
<tr>
<td>MT10 Sharing economy</td>
<td>o</td>
<td>o</td>
<td>0</td>
</tr>
<tr>
<td>MT11 Blockchain technology</td>
<td>o</td>
<td>o</td>
<td>0</td>
</tr>
<tr>
<td>MT12 Rising demand for customisation and personalisation of goods</td>
<td>o</td>
<td>o</td>
<td>0</td>
</tr>
<tr>
<td>MT13 Increased quality of education</td>
<td>o</td>
<td>o</td>
<td>0</td>
</tr>
</tbody>
</table>

H: high importance, o: medium to low importance
In hindsight, MT7 and MT9 may reflect the same overall megatrend but are phrased in different ways. This leaves the combined ‘digitalisation and automatisation’ megatrend, together with the MT8 ‘lifestyle’ megatrend, as the most important across the three sectors. The three sectors each have a third megatrend of high importance that reflects specific challenges for each of the sectors.

While the Delphi survey indicated the most important megatrends, the interviews provided insights into how each megatrend will impact development in these sectors. The impact of MT8 (increased interest in health, wellness and well-being lifestyle) is highly ranked across all three sectors. The respondents emphasised that the trend will shape consumer lifestyles in the future. Therefore, the demand for products and services related to health and well-being lifestyles will increase. Additionally, the biomedical sector will be affected by ageing. Thus, the demand from both the public (e.g. hospitals) and private sectors will require more support concerning products and services for the elderly.

As for the combined megatrend (MT7 and MT9), the respondents noted that the rapid global technological developments in digitalisation, automatisation and artificial intelligence will require firms and university to enhance their competences to align and catch up with the global developments. Concerning the biomedical and rubber sectors, the respondents gave the example that the global development of artificial intelligence calls for new competences and research in soft robot technology. A respondent from the seafood sector noted that the increased digitalisation might impact their product development in that sector. For example, packaging might have a QR code so the customer can look for a variety of cooking ideas. Furthermore, the respondents from the rubber sector highlighted the need for technology development that aligns with environmental concerns, namely rubber recycling and waste reduction in the production process. Lastly, the respondents from the seafood sector emphasised that the emerging competition from Southeast Asia will have a significant impact on the seafood sector because the seafood production base will likely move from Thailand to Cambodia or Vietnam due to cheaper labour and fruitful natural resources.

4.4 Regional policy instruments and STP management instruments

The list of policy instruments was derived from the desk study and the semi-structured interviews guided by the RIS–STP framework, which led to 12 suggestions for regional policy instruments (RP1–RP12) and nine suggestions for STP management instruments (Tables 5 and 6). The purpose was to tailor the possible policy instruments to regional preconditions and link them to the promising area of technology. In the second round of Delphi surveys, to keep the list simple and easy to read, we adjusted and reduced the list of regional policy instruments from 12 to seven based on the lowest-scoring items among the three sectors. We merged the policy statements related to promoting collaboration (RP6–RP8) into one group (RP13), and we removed RP9–RP11 due to their low scores. The list of STP management instruments was kept the same because the experts’ opinions were dispersed. Thus, in the second round, the respondents from all three sectors were presented with seven statements of regional policy instruments and nine statements of STP management instruments. The results regarding the importance of regional policy and STP management instruments statements are shown in Table 5.
Table 5. List of regional policy instruments.

<table>
<thead>
<tr>
<th>RP</th>
<th>Description</th>
<th>Biomedical</th>
<th>Seafood</th>
<th>Rubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP1</td>
<td>Improve transportation and communication infrastructure in Songkhla province</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>RP2</td>
<td>Increase research in biomedical/seafood/rubber and related knowledge fields at universities in Songkhla province</td>
<td>o</td>
<td>o</td>
<td>H</td>
</tr>
<tr>
<td>RP3</td>
<td>Educate highly skilled graduates with competences and skills relevant to the industry</td>
<td>o</td>
<td>o</td>
<td>H</td>
</tr>
<tr>
<td>RP4</td>
<td>Promote a culture of entrepreneurship and innovation in Songkhla province</td>
<td>o</td>
<td>H</td>
<td>o</td>
</tr>
<tr>
<td>RP5</td>
<td>Develop competences and skills in biomedical/rubber/seafood and related industries in Songkhla province</td>
<td>H</td>
<td>H</td>
<td>o</td>
</tr>
<tr>
<td>RP6</td>
<td>Promote collaboration among companies in Songkhla province, for example between suppliers, customers, users, technology developers and providers</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>RP7</td>
<td>Promote collaboration between private companies and researchers from the Prince of Songkla University</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>RP8</td>
<td>Promote collaboration with actors outside the Songkhla province, for example between suppliers, customers, users, technology developers, providers and university researchers</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>RP9</td>
<td>Increase availability of funding for developing new products or implementing new process technologies</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>RP10</td>
<td>Public procurement to stimulate regional demand and market opportunities in the biomedical/rubber/seafood industry</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>RP11</td>
<td>Local government initiatives to integrate and adjust national STI policy in Songkhla province</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>RP12</td>
<td>National government initiatives to translate and adjust national science, technology and innovation policy in Songkhla province</td>
<td>H</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>RP13</td>
<td>Promote collaboration among innovative actors both inside and outside Songkhla province</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

H: high importance, o: medium importance

The Delphi results regarding regional policy instruments reflect two key observations. First, in general, the experts considered all the regional policy instruments important. They especially emphasised the policies related to collaboration promotion. The interview data demonstrated that the current situation of the regional innovation culture and the collaboration among firms and between the university and firms are generally weak. Second, the respondents from the biomedical sector ranked the RP12 (national government initiatives to translate and adjust national science, technology and innovation policy in Songkhla province) the highest. The explanation is that the biomedical sector is an emerging field and has interdisciplinary characteristics, so the community and policy

Table 6. List of STP management instruments.

<table>
<thead>
<tr>
<th>SP</th>
<th>Description</th>
<th>Biomedical</th>
<th>Seafood</th>
<th>Rubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP1</td>
<td>Support university–industry relationships</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>SP2</td>
<td>Support and develop science park facilities (e.g. laboratories and co-working spaces)</td>
<td>H</td>
<td>H</td>
<td>o</td>
</tr>
<tr>
<td>SP3</td>
<td>Facilitate the creation of new businesses through incubation programmes</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>SP4</td>
<td>Support networking and collaboration with actors outside Songkhla province (both nationally and internationally)</td>
<td>H</td>
<td>o</td>
<td>H</td>
</tr>
<tr>
<td>SP5</td>
<td>Specialise and prioritise specific technologies and knowledge fields related to local industries</td>
<td>o</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>SP6</td>
<td>Promote and improve the quality of university research</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>SP7</td>
<td>Provide intellectual property rights services (e.g. patent lawyers)</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>SP8</td>
<td>Stimulate innovative behaviour among local companies</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>SP9</td>
<td>Provide assistance and guidance on how to apply for and access funding</td>
<td>o</td>
<td>o</td>
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</tr>
</tbody>
</table>

H: high importance, o: medium importance

The Delphi results regarding regional policy instruments reflect two key observations. First, in general, the experts considered all the regional policy instruments important. They especially emphasised the policies related to collaboration promotion. The interview data demonstrated that the current situation of the regional innovation culture and the collaboration among firms and between the university and firms are generally weak. Second, the respondents from the biomedical sector ranked the RP12 (national government initiatives to translate and adjust national science, technology and innovation policy in Songkhla province) the highest. The explanation is that the biomedical sector is an emerging field and has interdisciplinary characteristics, so the community and policy
has not been formalised or well framed compared to the traditional sectors of rubber and seafood (Gerdsri, Kongthon, and Puengrusme 2017). Besides, as we discussed earlier, the situation of unrest in the southern border provinces has limited international collaboration. This kind of problem requires action from the national government.

As with the regional policy instruments, the experts emphasised the STP management instruments concerning collaboration promotion for university–industry relationships (SP1) and support for networking and collaboration with actors outside Songkhla province (both nationally and internationally) (SP4). Additionally, the respondents also emphasised the support and development of STP facilities (e.g. laboratories and co-working spaces) (SP2) and the specialisation and prioritisation of specific technologies and knowledge fields related to local industries (SP5). In the context of provincial regions where firms do not prioritise their R&D activities or have R&D departments, supportive facilities (e.g. laboratories and co-working spaces) are important for assisting and stimulating innovation. Moreover, for STPs, specialisation in a focused area can act as a guideline for funding investment and help leverage existing resources (e.g. university expertise, laboratories and capabilities within the province).

5 Conclusion and Discussion

As mentioned in the introduction, the theoretical contribution of this paper relates to how the integration of the frameworks of innovation systems foresight and RIS–STP can contribute to the implementation of S3. We have demonstrated that the foresight exercise adds a conceptual discussion to the development of STPs and the concept of S3 by enabling a systemic assessment of regional innovation ecosystems and their technological capabilities and then translating it to a policy priority setting. The suggested approach eases S3 implementation under limited time and resources. Although the practical approach of the study is limited by modest participation and representation of innovative local actors due to the general weakness of the regional innovation ecosystem, we argue that the Delphi-based foresight approach is useful, especially in the context of Thailand, where hierarchical and social pressures can hinder opportunities for relevant actors to express their opinions. The Delphi method helps dilute the social issues that can hamper effective communication (Rowe and Wright 1999). In this respect, the suggested approach distinguishes itself from the workshop-based approach suggested for regions in Europe (Foray, Keller, and Bersier 2018). The practical approach of the Delphi method can be complemented with workshops or other activities that enhance the dynamic of local engagement, which increases commitment to the project (as has been done in two other cases of foresight in an STP context: Harper and Georgiou, 2005; Fikirkoca and Saritas, 2016). All in all, the process of foresight and the role of STP in initiating S3 can compensate weak institutions in lagging regions by enabling a local strategy to be shaped through a bottom-up process (e.g. bridging public–private and/or private–private collaboration) and adequately analysing the functions of STPs. Our study also contributes to the literature on foresight and regional innovation policy by integrating the future perspective, regional context and role of STPs to initiate S3 in a developing country.

The practical aim of this study is to suggest policies for STP management and regional authorities to support a smart specialisation strategy. We have demonstrated a process to identify promising developments within technology and business on which the implementation of S3 in the Songkhla province can be based. Additionally, we have identified some key global megatrends that will impact these developments. Furthermore, and perhaps most importantly, we have identified some key instruments for regional
policy and STP management to support the developments. This case provides an example and can be replicated in other lagging regions that have a similar context.

The promising areas of technology and businesses (formulated as statements) were developed through incremental adjustments and adaptation regarding core and related technology that is resonant with the rationale of S3 implementation (Barzotto et al. 2019). The results from the foresight exercise have enabled us to identify and provide input regarding the prioritisation of technologies that have the most potential for future development, as well as sufficient knowledge and skill competences that are ready to be exploited. These results should be used to stimulate strategic discussions that focus on how this potential development should be taken into account in research and business development in the Songkhla province (Uotila and Ahlqvist 2008). Furthermore, the identified global megatrends can be exploited in combination with the potential technology developments in a prioritisation analysis to identify the demand market and R&D opportunities and trends for broad policy planning.

A key finding regarding regional policy and STP management instruments in the Songkhla region is the need for better coordination between the actors. That includes the promotion of collaboration between innovative actors inside and outside the region and the support of university–industry relationships. This is congruent with conclusions in the literature. The need for collaboration is similar when the S3 implementation results are compared with those from other regions, especially within lagging regions (e.g. Northeast Romania, several regions in Poland and Basilicata in Italy) (Barzotto et al. 2019; Marques and Morgan 2018; Trippl, Zukauskaite, and Healy 2019). The limited level of collaboration has been shown to be a common feature in less-developed regions characterised by weak regional innovation systems (e.g. scattered innovation actors, weak innovation capacity in SME firms, mutual mistrust and a weak cooperation culture) and broad policy structures (e.g. highly centralised governance and/or regional governance with weak innovation development capacity) (Barzotto et al. 2019; Marques and Morgan 2018; Trippl, Zukauskaite, and Healy 2019). In this sense, we conclude that STP can play an active role in compensating for weak institutions.

Additionally, in the case of Songkhla, our study indicates a need for coordination of policies at regional and national levels to stimulate local innovation. This coordination also seems necessary for policies to better impact longer-term development. Another main conclusion regarding regional policy is that competences and skills need to be developed in the sectors focused on in this study (in particular, the biomedical and seafood sectors) and the related industries. This is mirrored by a similar need for STP management to specialise in and prioritise resources for specific technologies and knowledge fields related to local industries, and the need to develop matching STP facilities. This conclusion is congruent with recommendations for STPs in Europe (Nauwelaers, Kleibrink, and Stancova 2014). A broader implication of the findings of this study is that STPs can play two significant roles in S3 implementation. First, STPs should strengthen fragmented local networks, foster linkages and related variety between sectors where a critical mass already exists and activate their extra-regional linkages to counteract the local outdated specialisations. Second, STPs should synergise their internal assets with the existing regional resources (e.g. develop STP facilities to complement local specialised and related areas).

This study has contributed to the body of knowledge on the use of foresight studies in regional innovation policy and, specifically, the initiation of S3, in which STP plays a vital role. Future studies can apply the framework to a different context and/or readjust the process by adding other foresight tools such as scenario planning and road mapping.
to substantiate the process. Finally, we hope that our study will stimulate more research and discussion regarding the flexible and robust tool for initiating and implementing S3 that works under limited resources and time.

Acknowledgements

This research is funded by a Royal Thai Government Scholarship. An earlier version of the paper was presented at the ISPIM Connects Bangkok 2020 event, and the authors appreciate comments from the anonymous reviewers related to this event.
References


OECD. 2013. Innovation in Southeast Asia: Thailand Innovation Profile. https://www.innovationpolicyplatform.org/content/thailand#.


