

Formalising the National Innovation System in a Developing Country

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Abstract: Since the introduction of the National Innovation System (NIS) concept, most of the research has focused on innovation capabilities and economic development of developed countries. The paper contributes to the NIS literature for small developing countries that operate largely in low-technology sectors. A case study approach was adopted, detailing the steps for formalising a NIS in a developing country, The Republic of Trinidad and Tobago (T&T). System dynamics is used to examine the policy initiative. For the formalisation of the NIS in T&T, the design of the system must account for all three elements of innovation systems: the actors, the interactions among the actors and the intended innovation output. Policy makers in developing countries must consider their local context when specifying the innovative activity of the NIS. In measuring the success of innovation policies targeting small and medium-sized enterprises (SMEs), financial and non-financial measures should be used.

Keywords: National Innovation System; Developing Country; Economic Diversification; Small Business Innovation

1. Introduction

A nation's competitiveness depends on the capacity of its industry to innovate and upgrade (Porter, 1990). The concept of the National Innovation System (NIS) or National System of Innovation (NSI) has gained prominence as a conceptual framework for analysing technological change, which is viewed as a pillar for the long-term economic development of a nation (Liu, Lu, and Ho, 2014; Lundvall, 2010; Nelson, 1993; Teixeira, 2014). Understanding the linkages amongst institutions and agencies is critical to boosting a country's innovative performance (OECD, 1997). NIS concept benchmarks can be used to measure the innovation capacity and potential of the country (Marx and Brunner, 2013). The NIS concept is highly touted as a mechanism that can enhance a country's overall competitiveness. Not surprisingly, there is burgeoning interest among economists and policy makers in the potential of the NIS to transform the economies of developing countries, with examples of researchers, such as Attia (2015) focussing on African countries and Delvenne and Thoreau (2012) focusing on Latin American countries.

Trinidad and Tobago (T&T) is one such economy, where the establishment of the National Innovation System for Trinidad and Tobago (NISTT) is viewed as a means of achieving economic restructuring. According to the Ministry of Planning and the Economy (2011), the core focus of the NISTT is to facilitate economic

diversification through the promotion of R&D driven innovation. It will support the ideas of individuals and companies. The NISTT will develop and implement a holistic and competitive innovation policy to transform the economy by gradually shifting our economic dependence away from hydrocarbons. This will require the increase in R&D investment to at least 3% of our GDP over the next ten years to generate new products, services and processes. This will improve T&T's Global Competitiveness and Innovation Rank which is a critical indicator of development.

Policy makers, however, face a variety of challenges when they attempt to develop and implement innovation systems. One particular challenge lies in the very conceptualisation of the systems which would be largely informed by examples reported in the NIS literature. But, as researchers such as Varblane, Dyker, and Tamm (2007) warned, attempts to replicate a successful NIS model in another country without making the necessary adaptations for country-specific characteristics would likely lead to failure. A second significant challenge facing policy makers is the identification of the indicators to determine the efficacy of the established national innovation policy (Casanova, Cornelius, and Dutta, 2018). These NIS development and implementation challenges are further pronounced in developing countries. The literature does not offer much guidance, as a review of the literature in this area shows

that research has mainly focused on analysing the NIS in developed countries, with even fewer studies analysing developing countries, such as Korea, Taiwan and Singapore. These developing countries are unique as their policies are relatively aggressive, as they seem to be focussed on catching up with developed countries (Intarakamnerd, Chairatana, and Tangchitpiboon, 2002; Wong, 1999). Even in investigating the appropriateness of a NIS to a developing country, the focus has been on what Intarakamnerd et al. (2002) referred to as ‘learning intensive’, speaking to the country’s ability to not only use and operate technology, but also its ability to acquire and assimilate technology; reverse engineer and upgrade technology; and perform research and technology development. Likewise, Lundvall (2007) notes that research on NIS typically focusses on mature, well-developed innovation systems, largely found in developed countries. There is a dearth of research on developing countries, such as Trinidad and Tobago, that are not learning intensive.

Even further, as highlighted by Golichenko (2016), the NIS literature does not focus explicitly on the entrepreneurs operating as micro or small and medium sized (MSME) enterprises. This limited attention on MSMEs in the NIS literature is a glaring deficit since research has shown that small enterprises innovate differently from large firms. Small enterprises are often plagued by many barriers to innovation; and are less able to dedicate resources to research and development, updating technologies and conducting market research (Todtling and Kaufmann, 2002). As a result of these characteristics, Todtling and Kaufmann (2002) argued that small enterprises can overcome their innovation challenges by relying on external resources and partners, which speaks directly to the interactivity and networks of the NIS concept.

This paper seeks firstly to contribute to our understanding of the nascent stages of the establishment of a NIS in a developing country by exploring T&T as a

case study. Secondly, the paper examines how the interactions among a state agency, a university and a small entrepreneur lead to institutional capacity building as described by Watkins et al. (2015).

The paper proceeds as follows. Section 2 provides an overview of the literature on the NIS approach, and describes specific issues relating to national innovation systems in developing countries. Section 3 presents the research methodology adopted for this study. Section 4 reports on the case study of the formalisation of the NIS in T&T and details a state sponsored innovation promotion initiative. Section 5 presents the results of the innovation promotion initiative. Section 6 discusses the findings. Section 7 concludes the paper.

2. Literature Review

2.1 Overview of National Innovation Systems

The Organisation for Economic Co-operation and Development's (OECD) (1997) report on National Innovation Systems quoted five NIS definitions, shown in Table 1, from early seminal papers on the topic from the 1980s and the 1990s. Even after 20 years since this popular OECD publication, the more recent journal articles often rely on these definitions or on their main premise; which implies that within the research community, there is general acceptance of what is meant by the term ‘national innovation system’.

The information presented within the definitions in Table 1 shows at least three critical elements which are highlighted in Table 2. The first four definitions refer specifically to the actors or institutions that comprise the NIS. In the fifth definition as given by Lundvall (2010) instead refers to ‘elements and relationships’. Secondly, four of the five definitions refer to the relationships among the said actors. Thirdly, all five definitions address the issue of the innovative activity, by highlighting the existence of new knowledge, learning or technologies.

Table 1. Seminal NIS Definitions

NIS Definitions
<i>Freeman (1987) - The network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies.”</i>
<i>Lundvall (1992) - The elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state.”</i>
<i>Nelson (1993) - A set of institutions whose interactions determine the innovative performance ... of national firms.”</i>
<i>Patel and Pavitt (1994) - The national institutions, their incentive structures and their competencies that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country.”</i>
<i>Metcalfe (1997) - A system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies.”</i>

Source: Adapted from OECD (1997)

Table 2. Elements of the Seminal NIS Definitions

NIS Definitions	Actors	Relationships among the Actors	Innovative Activity
Freeman (1987) <i>The network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies.”</i>	<i>The network of institutions in the public and private sectors</i>	<i>Activities and interactions</i>	<i>Initiate, import, modify and diffuse new technologies.”</i>
Lundvall (1992) <i>The elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state.”</i>	<i>The elements and relationships</i>	<i>Interact</i>	<i>The production, diffusion and use of new, and economically useful, knowledge</i>
Nelson (1993) <i>A set of institutions whose interactions determine the innovative performance ... of national firms.”</i>	<i>A set of institutions</i>	<i>Interactions</i>	<i>Innovative performance</i>
Patel and Pavitt (1994) <i>The national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country.”</i>	<i>The national institutions</i>	<i>---</i>	<i>The rate and direction of technological learning (or the volume and composition of change generating activities)</i>
Metcalfe (1997) <i>A system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies.”</i>	<i>A system of ... institutions</i>	<i>Interconnected</i>	<i>Create, store and transfer the knowledge, skills and artefacts which define new technologies.”</i>

Source: Adapted from OECD (1997)

2.1.1 The Actors in the NIS

There are varying typologies regarding the actors making up the NIS. In one typology, the university, industry and government make up the three actors of the triple helix model (see Figure 1). They interact with each other, contributing to the innovative activity in knowledge-based societies (Etzkowitz and de Mello, 2003). In this model, the university’s role includes conducting research and commercialising research outputs, and also educating and training people; industry’s role is to convert ideas and inventions; while government’s role is to formalise policies and provide funding (Datta and Saad, 2011).

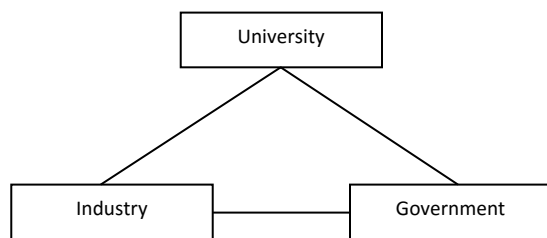


Figure 1. Typology 1 detailing Three NIS Actors

In another typology, authors such as Sakarya (2011) identified six actors comprising the NIS: public and private innovative firms; non-profit public or semi-private research institutions; the scientific system made up of universities and research institutions; supporting and bridge institutions; financing institutions; policy-making, implementing and assessing institutions. The inter-relationship among these factors is shown in Figure 2.

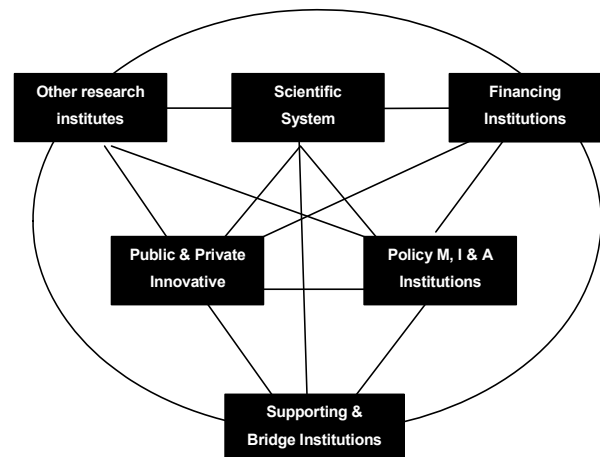


Figure 2. Typology 2 detailing Six (6) NIS Actors

The typology in Figure 2 is also seen in research by Gododze (2016), who described the NIS as a socio-economic system made up of actors, such as companies; research and academic organisations; public administrations; professional mediators; and other formal and informal institutions.

There are both similarities and differences in the narrow and moderate typologies. In terms of the similarities, public and private innovative firms, and the scientific system identified by Sakarya (2011) mirror the industry and university identified in the triple helix model. Likewise, policy making, implementing and assessing institutions identified by Sakarya (2011) bear much similarity to the government actor identified in the triple helix model. With respect to the differences, the research institutions can be viewed as complementary to

the university, whilst recognising that there are several other institutions, not be classified as universities, conducting and disseminating research. The supporting and bridging institutions identified by Sakarya (2011) as institutions that provide services such as laboratory testing and standards setting are important additions, especially as these firms are most often certifying various regulatory dimensions of the innovative products. Lastly in addition to government's financial input in innovation as highlighted in the triple helix model, institutions like venture capital firms also play essential roles in terms of providing the critically required financing for innovation.

A more detailed typology identified by Roos, Fernstrom, and Gupta (2005) reveals 12 NIS 'constituents'. This is shown in Table 3. In this model, the NIS is described as comprising all economic, political and other social institutions involved in innovative activities, specifically universities and research bodies, financial systems, monetary policies and the international organisation of private firms. In the same light, Acs et al. (2017) provided a highly comprehensive view of the actors of the NIS, by identifying scientific and technological institutions, the education, research, apprenticeship, and training system, the financial system, the intellectual property rights system, the tax system, the structure of the industry and labour market, individual and firm level incentives, and other systems.

The model by Roos et al. (2005) offers greater details than the typologies shown in Figures 1 and 2. For instance, the 'government' actor in Typology 1 and the 'policy making, implementing and assessing institutions' in Typology 2 are reflected in constituents 11 and 12, 'Rewards/Incentives' and 'Government Policy, Funding and Procurement Institutions'. Noteworthy distinctions from the Typologies 1 and 2 are the inclusion of the role

of 'People and Culture', 'Public Good' and 'Domestic and International Customers'.

2.1.2 The Relationships among the Actors in the NIS

The relationships among the actors in the NIS concern their interactions with institutions and policies (Liu and White, 2001). These interactions in the NIS have been related to a number of different 'flows' among the actors making up the NIS. These flows include knowledge flows, financial flows, human flows, and regulation flows (Niosi, 2002). Of the four flows identified by Niosi (2002), knowledge flows, referred to as 'the lifeblood of the system' (Golden, Higgins, and Lee, 2003) predominate in the literature. For example, according to OECD (1997), assessing a NIS is based on the measurement of the following types of knowledge flows:

- Joint research activities and other technical collaborations.
- Co-patenting, co-publications and informal linkages.
- Diffusion of knowledge and technologies and diffusion through machinery and equipment.

Financial flows also feature significantly in the NIS literature. For example, Roos et al. (2005) explain Finland's NIS, and detail the range of public and private capital providers that supply funding and financing for research projects, training projects, technology transfer and foreign venture capital funds. Similarly, in describing Sweden's NIS, Roos et al. (2005) identify the agencies and their respective roles in providing seed financing, research and development (R&D) funding, and loans.

Human flows among universities, firms and government laboratories are important in the NIS. Human flows and knowledge flows are highly interrelated, as humans are viewed as the 'bearers of tacit knowledge and know-how' (Niosi, 2002), and knowledge is viewed as being embodied in humans.

Table 3. NIS Constituents Identified by Roos et al. (2005)

	NIS Constituents	Description
1	People and Culture	Education levels; Innovative / Creative; Risk Tolerance; Entrepreneurship; Attitudes to Science and Technology
2	Education	Teaching; Higher Degrees; Tertiary; Workforce Development; Vocational and Educational Training; Primary and Secondary
3	Public and Non-Profit R&D	University, Government R&D; Non-Profit and Private Research
4	Public Good	Health and Medical, Environment; Art and Culture; Defence; Space
5	Linkages	Technology Transfer; Cooperative Research; Incubators; Technology Diffusion; Innovation Awareness; Conferences
6	Clusters	Cluster Networks; MNCs, Large Companies, SMEs; Emerging Exporters; Innovative Companies; R&D Performing Firms; Start-ups / Spinoffs; Industry Bodies; Advisor Services; Investors; Creditors
7	Domestic and International Customers	Leading Customers; Direct Customers; End users / Stakeholders; Government Procurement; International Customers
8	International Links and Infrastructure	R&D and Business Links; Recruit and Retain Companies; Imports / Exports and Infrastructure (Physical and Information)
9	Intellectual Policy	Patents, etc.
10	Risk Finance	Retained Earnings; VC, Debt, Equity, Grants
11	Rewards / Incentives	Tax Rates; R&D breaks; Capital Gain Tax Options
12	Government Policy, Funding and Procurement Institutions	Education Funding Bodies; R&D Funding Bodies; Science, Technology and Innovation Policy Advisory Bodies; Standards; Regulations; Contract Legal System; Fiscal and Tax Policy; Trade / Tariff and Procurement Policies; Federal and Regional Decision-Making Processes

(OECD, 1997). Hence, personnel mobility, where technical personnel move within and between the public and private sector, is one type of flow used to measure and assess NIS (OECD, 1997).

Regulation flows, identified as moving outward from government agencies, typically take the form of policy instruments, and its primary purpose is to stimulate the formation of the innovation system. These policies often relate to factors such as regulations, taxes, financing, competition, and intellectual property that create and enhance innovation opportunities (Metcalfe and Ramlogan, 2008)

2.1.3 Innovative Activity in the NIS

Innovative activity is considered the output of the NIS. There is, however, some debate in the NIS literature relating to how narrowly or how broadly 'innovation' should be defined. As the NIS is viewed as a means of creating and developing a knowledge-based economy, the argument for a narrow definition of innovative activity is based on innovation being the result of 'knowledge-intensive activity', that is 'more science-intensive', 'more technology-intensive' and 'more skills-intensive' (OCED, 1999). According to OCED (1999), innovation in a knowledge-based economy is 'the creative use of various forms of knowledge': technical knowledge, scientific knowledge, and production and engineering knowledge. In this regard, output and input indicators of innovative activity would include metrics such as R&D expenditure, R&D researchers, FDI outflows, high technology exports, technology fees received and registered patents in the US (Singh, 2004).

Those in support of taking a broad view of innovative activity in the NIS often refer to definitions found in mainstream innovation research, where innovation is viewed as the process involved in the search for, discovery, experimentation, development, imitation and adoption of new products, production processes and organisational setups (Dosi, 1988). Whilst acknowledging the inextricable link between the NIS and knowledge-based economy, proponents for the broader view such as Lundvall (2007) note that although there is a bias towards high-technology industries and the science-technology-innovation (STI) mode, there should also be recognition that innovative activity also occurs in low-technology industries and via the doing-using-interacting (DUI) mode of innovation.

2.2 NIS in Developing Economies

Since innovation is viewed as one of the main ways through which both firms and countries can achieve and maintain competitiveness, the premise of the NIS is inextricably linked to economic growth and development. The role of the NIS in developed countries is however quite different from its intended role in developing countries (Feinson, 2003). Whereas for developed countries, the NIS allows for continuing to

develop and enhance competitiveness, for developing countries, the NIS's intended role is much urgent, in that its goal is to provide these countries with a means of 'catching up' with the type of economic independence experienced by the developed countries. For developing countries, objectives of NIS have been identified as poverty reduction and improved income distribution (Attia, 2015), and overall economic health (Bartels et al., 2012).

The NIS literature therefore makes a point of distinguishing between the characteristics of developed countries and developing countries. According to Varblane et al. (2007), the concept of the NIS was based on developed economies, which typically have high income levels, strong knowledge bases, well-functioning market systems, and strong institutional and infrastructural support for innovation. Developing countries, on the other hand, are characterised by being just the opposite in terms of income level, knowledge base, market-structure, and support for innovation. In light of these characteristics the study of the role of the NIS in developing economies has centred largely on the need to build up the indigenous science and technology base (OECD, 1999), bearing in mind related issues such as the path-dependent nature of economic development; degree of technological absorptive capacity; geographic and cultural proximity to leading technology countries; underestimation of the role of public policy in the development of an NIS and potential institutional, social and cultural obstacles to innovation (Intarakamnerd et al., 2002; Varblane et al., 2007).

Of the above stated issues critical to NIS in developing countries, perhaps the most referred to as 'the degree of technological absorptive capacity'. For example, Feinson (2003) reported that '...successful economic and industrial development is intimately linked to a nation's capacity to acquire, absorb and disseminate modern technologies'. In this study, Feinson (2003) stresses that far more than simply acquiring technology, there must also be a 'command' of this technology, where there must be an understanding of 'how' and 'why' the technology works. The ability to learn, both in terms of 'passive learning' and 'active learning' therefore has become a focal point for the development of NIS in developing economies.

3. Research Methodology

This research seeks to contribute to the understanding of the formalisation of NIS in developing countries, and to explore the impact of policy initiatives designed to promote innovation in small companies. For the formalisation aspect, the design of the NIS and the steps taken for its implementation are detailed via the reporting of secondary data. For the policy initiative, an inductive approach is adopted, whereby the research utilises a case study design, set in T&T, to study an innovation promotion initiative that involved multiple

NIS actors. The research question posed is: *Can a small business innovate with the assistance of an innovation program in the absence of a NIS?*

Primary data was collected via interviews with the owners of a small manufacturing company, the case company enrolled in the innovation programme initiative, programme facilitators and administrators; and participant observations of the two assigned mentors. Secondary data was collected via documentation from the case company, state agency and state university; and institutional websites.

Data analysis was achieved via a system dynamics approach, as described by Sterman (2000). To represent the NIS, Stock and Flow Diagrams (SFD) are used, where stocks represent accumulations, and flows represent the rate of change of the accumulations. Causal loops are also used to show the relationships among variables, where a positive or reinforcing loop indicates the change of one variable leading to a change in the same direction for the second variable; while a negative or balancing loop indicates the change in one variable leading to a change in the opposite direction for the second variable. Vensim PLE software was used for the creation of the diagram.

4. Case Study

Trinidad and Tobago, a twin-island republic located in the Caribbean with a population of 1.369 million persons, is described by the World Bank as a high-income non-OECD country, with a 2017 GDP figure of 22.08 billion USD (www.worldbank.org). In 2017, the country’s GDP contributions included 19.6% from the mining and quarrying sector, 19.1% from the manufacturing sector, 6.6% from the financial and insurance industry, and 0.4% from the agriculture, forestry and fishing sector (MoF, 2018).

Because of the country’s heavy dependence on its oil and gas sectors, the need for diversification has been long touted (Khadan and Ruprah, 2016). However, diversification efforts have not resulted in positive results. The formalisation of the NIS in the last decade represents yet another attempt at the country’s diversification efforts.

4.1 Formalisation of the NIS in T&T

The formalisation of the NIS in T&T entailed two main iterative steps, namely, the design of the NIS and the implementation of the NIS.

4.1.1 Design of the NIS

A draft National Innovation System of Trinidad and Tobago (NISTT) was established in the fourth quarter of 2010, with the main aim of diversifying the oil and gas driven economy of T&T, through the combination of investment and innovation. The management of the NISTT falls under a Council of Ministers, led by the Prime Minister, and is made up of eight other

government ministers as shown in Figure 3. Further management support is provided by the Economic Development Board (EDB) and the Council for Innovation and Competitiveness (CIC), whose roles include policy identification and advisory support for short-term economic improvement and longer-term economic strategic management; and consultation with stakeholders.

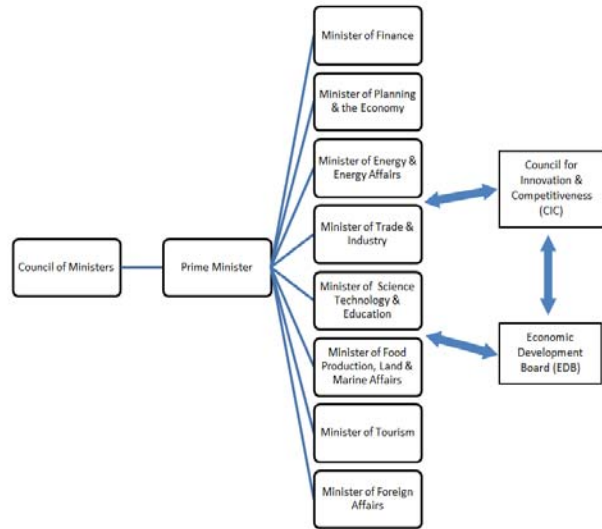


Figure 3. Draft NISTT Management Structure

Moreover, using an Innovation Diamond, the NISTT was designed to comprise 5 main actors (see Figure 4). The learning and R&D systems in the Innovation Diamond include the two state-sponsored universities, The University of Trinidad and Tobago (UTT) and The University of the West Indies (UWI). The planned focus and function of each of the five NISTT actors are detailed below in Table 4.

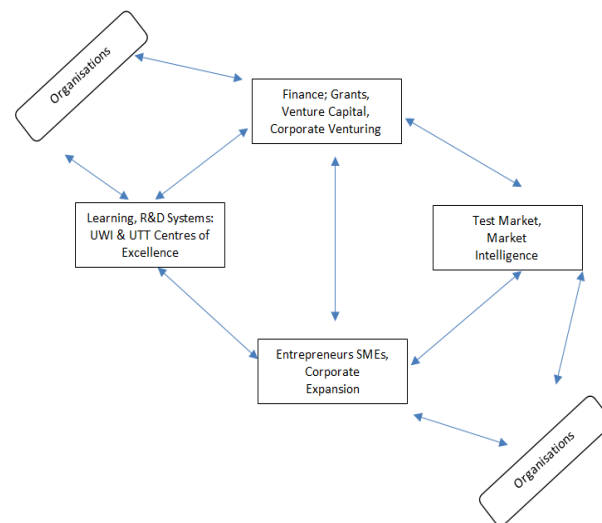


Figure 4. Draft NISTT Innovation Diamond

Table 4. Focus and Function of the NISTT Actors

NISTT Actors	Planned Focus	Function
Learning, R&D Systems: Centre of Excellences	Identification of technologies and sectors for growth and development	<ul style="list-style-type: none"> To create and diffuse knowledge <ul style="list-style-type: none"> To foster technology transfer To incubate new and developing SMEs
Finance; Grants, Venture Capital and Corporate Venturing	Financing for Innovation	<ul style="list-style-type: none"> To provide grants for: <ul style="list-style-type: none"> R&D Proof of concept To provide finance support for innovative SMEs via: <ul style="list-style-type: none"> Venture capital Government Economic Development Bonds
Test Market, Marketing and Market Development	Supporting services	<ul style="list-style-type: none"> To support product / service and process development
Entrepreneurs, SMEs, Corporate Expansion	Cluster formation	<ul style="list-style-type: none"> To provide support for growth of SMEs To facilitate formation of clusters
Organisations	Networking	<ul style="list-style-type: none"> To facilitate overall growth of all actors comprising the NISTT

4.1.2 Implementation of the NISTT

For the implementation of the draft NISTT, two main activities were undertaken. The first activity was a series of five sessions, which was attended by over 800 people. The objective of these sessions was to inform the population of the planned NISTT; to obtain buy-in; to receive feedback about the draft plans for the NISTT; and to brainstorm for economic and social development ideas. The second activity was a foresighting exercise involving experts, who were asked to project 15 to 20 years in the future, to determine the key areas and technologies for potential investment (<http://pesrga.gov.tt/>). The draft NISTT was never implemented. Subsequent to this, a National Innovation Policy was crafted and is currently awaiting governmental approvals.

4.2 Innovation Promotion Initiative for SMEs: A Case Study

4.2.1 Introduction to the Innovation Promotion Initiative: The INSTIL Innovation Programme

In T&T, the Business Development Company (BDC), established in 2002, was formed with the mandate of enterprise development for T&T. Its suite of services included Consultancy Services, Export Certification, Financial Support Services, International Business Promotion Support Services, Trade Assistance, and Training and Business Advisory Services (<http://www.bdc.co.tt>). BDC, alongside contracted innovation management companies, Dolmen, based in Ireland (Dolmen, 2011) and the NEXT Corporation (NEXT Corporation, 2008), designed 'INSTIL Innovation' as a 12-month programme for SMEs, with the intended aims of the SMEs introducing new processes to improve their efficiency and productivity, and creating new products and services for local and export markets (BDC, 2011). The INSTIL Innovation programme's main features included mentorship, workshops, and access to state-supported institutions and programmes. In T&T, companies are defined as in Table 5 (MoEDFA, 2001).

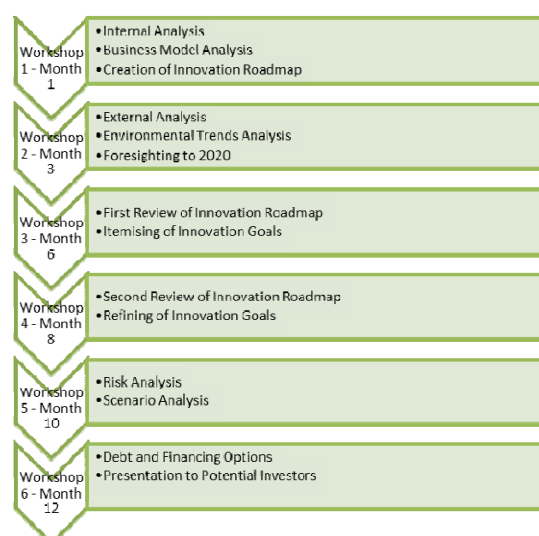
Table 5. Definitions of Firms in T&T

Category	Number of Employees	Assets (TTD) ¹	Sales (TTD)
Micro	< 6	< 250 K	<250 K
Small	6 - 25	250 K – 1,500 K	250 K – 5,000 K
Medium	25 - 50	1,500 K – 5,000 K	5,000 K -10,000 K

¹ \$1TTD = \$0.15 USD

In terms of the mentorship, two mentors were assigned to each SME participating in the programme. Mentors were identified from local universities and other state agencies that provide research and business support. The mentors were required to attend the workshops held by the BDC, NEXT Corporation, and Dolmen; and had the responsibility of guiding and advising the SME's innovation process. The mentors' primary purpose was to ensure that outside of the workshops, continuous communication and feedback were maintained with the SMEs with respect to ensuring that innovation targets were on their way to being met.

The second feature comprised six workshops. The timing and focus of each workshop are given in Figure 5.

**Figure 5.** INSTIL Innovation Workshops Timing and Focus

In terms of access to state supported institutions and programmes, the BDC facilitated access to a number of state institutions and programmes aimed at providing the SMEs participating in the INSTIL programme technical, financial, and business support. For example, the University of Trinidad and Tobago (UTT) was poised to provide technical support. The Metal Industry Company Ltd (MIC) was engaged to provide engineering services (MIC, 2011). The Research and Development Facility (RDF) administered by the BDC, offered research and development funding, via a grant, where the maximum funding for a single company project is TT\$500,000 (BDC, 2008).

4.2.2 Introduction to the Case Company – Alpha Manufacturing Limited

Alpha Manufacturing Limited (name changed for anonymity purposes) is a small manufacturing business, with fewer than 15 employees, that makes soft-case products for the musical instrument industry. Alpha was very successful for the first 12 years of operation in terms of sales, both locally and internationally. However, with the global financial downturn in 2008, revenues dropped sharply and the company struggled to maintain its financial commitments and obligations. The owners had very little formal business training but they had innovative ideas for the storage, transport and protection of musical instruments. Their competitive advantage was identified as quality and responsiveness. In their 14th year of operation Alpha joined the INSTIL Innovation program.

4.2.3 Alpha Manufacturing Limited and the INSTIL Innovation Programme

1) The Mentors

The two mentors assigned to Alpha Manufacturing Limited were two faculty members of the Design and Manufacturing section of a state-funded university, The University of Trinidad and Tobago (UTT, 2011a). Of major relevance to the INSTIL Innovation programme was The Industrial Innovation, Entrepreneurship, and Management (IEM) 1-year Master of Science (MSc) programme. The IEM programme was developed through a partnership established with the Institute for Manufacturing at The University of Cambridge. Students in this programme undertake a series of interconnected modules. Modules comprise a two-week teaching period followed by a project for which students are located in an industry/manufacturing plant to solve a real problem (UTT, 2011b). The intent was for the IEM students to be assigned to Alpha during the relevant modules during the course of the INSTIL programme.

2) The Workshops

At the launch of the INSTIL Innovation programme, an innovation scorecard evaluation was done for Alpha. This scorecard rated Alpha and its owners with regards

to awareness and practice of innovation and associated strategies.

Workshop 1: Alpha's vision was to be the largest manufacturer of cases for a particular musical instrument, by providing high quality products through efficient production processes. Objectives were to actively pursue and capture new markets, to extend the company product line and quality, and to put in place adequate and reliable machinery. Alpha expected to achieve goals that were spread over a 12-month time frame. These goals included:

- Three new products which could be brought to market in three, six, and nine months, respectively.
- A new manufacturing process in 12 months.
- A new brand in two months.
- Communications improvement including promotions, advertisements, and website restructuring.

Workshop 2: The external analysis considered trends that would impact Alpha's business, which included rising energy prices, a global aging population and on-line shopping. Based on these trends, Alpha was challenged to think about the trends leading up to the year 2020 and the changes that would be required to their existing business model and value chain.

Workshop 3: The first review of the innovation roadmap identified a number of challenges to Alpha's innovation roadmap, where the major concern was the company's limited resources to simultaneously run the business and execute the innovation goals. The itemised innovation goals were:

- An increase in one-to-one marketing with two to three days a week dedicated to this activity. To achieve this goal, expedited training and restructuring of staff and Alpha, respectively, were required.
- A new layout plan for Alpha's premises as the existing one was not optimised for production and customer walk-ins.
- Sourcing of items for new product development, name and product rebranding, and website revamping.

Workshop 4: Alpha's progress was discussed and documented as follows:

- The one-to-one marketing of two to three days per week was not achieved due to time constraints. However, due to expedited training of staff, a one-to-one marketing push of two days per week was achieved.
- The new layout plan for Alpha's premises was still in the brainstorming stages. However, workflow processes were formally documented to aid in the new layout plan.

- Product rebranding was achieved with Alpha placing labels on their products for the first time.
- A new product name was established that was short and memorable.
- Marketing brochures were developed.
- Discussions were initiated with website developers for website rebranding. For on-line sale transactions, the intent was to utilise the BDC's website portal as the BDC have developed a facility to assist with this.
- New product development was also achieved with Alpha sourcing new materials for their cases and formally establishing different product lines that relate to different pricing strategies.

The roadmap to Month 12 was refined as follows:

- Continuing the training of staff to allow the leadership to focus on one-to-one marketing.
- Increasing manufacturing capabilities by considering outsourcing of certain aspects of manufacture, and also identifying bottlenecks in production with the aim of improvements.
- Finalising prices of new product lines.
- Finishing website development so that the new one is clear in communication, usable, and supports customer customisation of case components.

Workshop 5: The Business as Usual (BAU) scenario was determined to be a risk in itself as the wants and needs of a customer continue to change with time. The risk in innovation for Alpha was identified as:

- Customer/market (determining the unmet needs),
- Financial (loans required to support the innovation process),
- Opportunity (which product/service ideas to focus on),
- Income (loss of income during the innovation process),
- Country (security, stability, cultural stigma with respect to innovation),
- People (trusting others), and
- Event (predictable and unpredictable changes in the business playing field).

The BAU and Innovative Business Financial scenarios were identified for Alpha. From this, a risk management plan for Alpha's new products was generated.

Workshop 6: This workshop brought an end to the programme and discussed funding issues and the presentation of business innovation plans to potential financiers. Additionally, goals for Yr. 4 were established as was done in the first workshop. Alpha's new goals included:

- Hard case commissioning and production.
- Increase in sales of existing products by 15%.

- Introduction of outsourced accessories with the overall intent of becoming a 'one-stop shop' for the musical instrument.
- Continued R&D into new products that can satisfy unmet needs in the musical industry.

Alpha accessed the following institutions and programmes:

- Technical support of the UTT through the IIEM programme for product development, name and product rebranding, and website revamping.
- Research and development grant funding through the RDF of the BDC for product development, where as a small business, Alpha contributed 30% and the RDF contributed 70%.
- Engineering services of MIC for new product development to determine a new material and novel fabrication techniques for manufacture of hard carry cases.

5. Results of the INSTIL Innovation Programme

The analysis centres on the development of a simulation model, as described by Sterman (2000). The model is represented by the conceptual design of the INSTIL programme. The programme was designed to facilitate product and process innovation training for SMEs, to be achieved via the six innovation workshops and the mentorship programme, and, by extension, access to state agencies and programmes. This combination was expected to encourage a culture of innovation in the INSTIL participant companies, evidenced by the introduction of new products and new processes, that would ultimately lead to increased company performance, and overall improved SME performance.

INSTIL Innovation was an initiative of the BDC, a state agency financed by public funds. The workshops provided formal training for both product and process innovation, which was expected to lead to increased rates of innovation by the INSTIL company participants. The mentorship element, evidenced by the mentorship meetings, provided business support, where the frequency of meetings depended on the INSTIL participant's need for support. The business support provided by the mentor was expected to contribute to the decisions and actions by the INSTIL participant, which were then expected to lead to increased rates of innovation. The mentors were selected from a wide pool of candidates, inclusive of university faculty. The university faculty members were expected to not only lend business and technical expertise, but also to facilitate the INSTIL company participants' usage of and access to university facilities.

Product innovation was expected to lead to increased product offerings to the customers, increasing overall product attractiveness, therefore leading to increased sales. Similarly, process innovation was

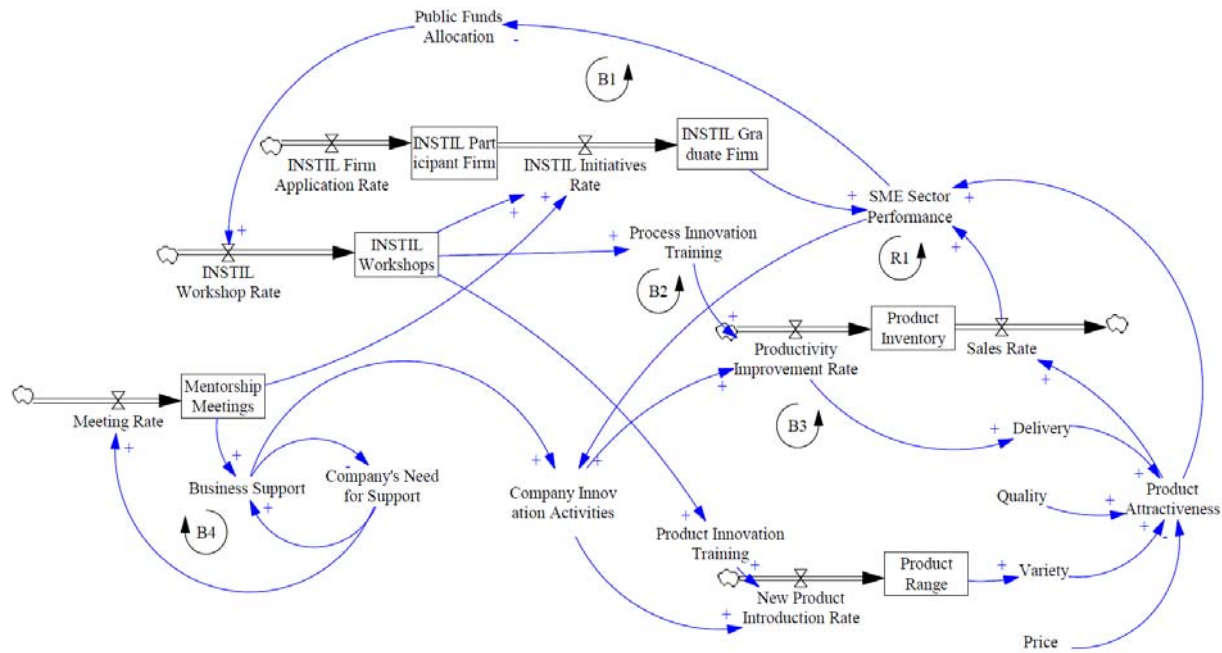


Figure 6. Conceptual System Dynamics Model of the INSTIL Programme

Table 6. Description of Selected Feedback Loops

Feedback Loop	Description
B1	This balancing loop shows the premise of the INSTIL programme, where public funds are utilised to run the INSTIL workshops, to produce INSTIL graduate firms. These graduate firms will increase overall SME performance, and hence, public funds allocated to this INSTIL programme will be reduced.
B2	This balancing loop focuses on the process innovation training. This training leads to increased product attractiveness, which positively impacts sales rate and SME performance. The higher SME performance will lead to a reduction in public funds allocated to the programme.
B3	This balancing loop is similar to the B2 loop, but with the the focus being on product innovation training. This training leads to increased product attractiveness, which positively impacts sales rate and SME performance. The higher SME performance will lead to a reduction in public funds allocated to the programme.
B4	This balancing loop considers the role of the mentors in providing business support. As the need for business support increases, the meeting rate increases, and provides increased business support, which in turn decreases the need for business support.
R1	This reinforcing loop considers the company’s innovation activities, which have a positive impact on product attractiveness and sales rate and SME performance. Increased SME performance will have a positive impact on the company’s innovation activities

expected to lead to increased productivity, and then increase product inventory. Increased product inventory should have led to the company’s ability to better meet delivery requirements, thus, increasing product attractiveness, and increased sales rate. Figure 6 shows the resultant model for the INSTIL programme, and Table 6 provides a description of selected feedback loops.

6. Discussion

The discussion firstly explores the issue of the formalisation of the NISTT, and then considers Alpha in the INSTIL Innovation programme. The nascent stages of the NISTT indicated that the main actors found in mature NISs are present in T&T. However, the existence of the individual actors does not automatically lead to a

functioning NIS. In examining the implementation of the NISTT, there was no evidence of measures put in place to develop and strengthen the relationships among the NIS actors. With the literature identifying these interactions as ‘flows’, with ‘knowledge flows’ described as ‘the lifeblood of the NIS’ (Golden, Higgins, and Lee, 2003), the absence of concrete steps to develop these relationships could be viewed as a major shortcoming in the implementation of the NISTT.

Similarly, the implementation of NISTT never specified the type of NIS innovative activity that would be the desired output. So, while the NISTT specifies the Centres of Excellence with a planned focus of identifying technologies and sectors for growth and development, the business landscape of T&T is characterised by low-technology industries. Moreover,

the indigenous science and technology base, degree of technological absorptive capacity, and potential institutional, social and cultural obstacles to innovation needed to be carefully considered to implement a well-functioning NIS.

These observations about the NISTT reflect the findings of the study conducted by Guinet (2014) who analysed T&T's National Innovation Ecosystem. It was found that the main types of institutions and actors typically found in more mature systems are present, but they are too small, lack maturity and engagement and are incoherent with respect to the strong inner dynamics of a functioning innovation system. Moreover, Guinet (2014) found that the local National Innovation Ecosystem lacks sufficient public and private investment in research and development and innovation, collaboration between academia and industry, governance arrangements, innovation readiness of the private sector firms.

The INSTIL Innovation programme brought together the main elements of the NIS. The actors included private SMEs, universities, supporting institutions, financing institutions, and the policy-making, implementing and assessing institutions. In addition to the actors, the INSTIL Innovation programme was designed to facilitate and encourage the interactions of the actors via knowledge flows, financial flows and regulation flows. Lastly, the INSTIL Innovation programme clearly specified the innovative activity that was the expected output. In essence, therefore, the INSTIL Innovation programme is a microcosm of an innovation system in terms of its design and intent.

The success of the INSTIL Innovation programme, however, was not easily discerned. On the one hand, Alpha, a small manufacturing company with a desire to innovate, was able to benefit from formalised training, which resulted in new production processes, new products, and new marketing strategies. Alpha was able to access services from the UTT, MIC, and the BDC for these innovations. However, on the other hand, the financial impact of the programme, in the case of Alpha, was not overwhelming.

Alpha's revenue compared to T&T's manufacturing GDP is given in Figure 7, noting that the company's entry into the INSTIL Innovation Programme began in Year 2. The company's revenue appears to track GDP, with both peaking in Year 5. With respect to Alpha's profit compared to revenue, Figure 8 reveals a higher profit margin on Year 4 and the years prior. Part of the reason for Alpha's reduction in profit outlays was due to investment in the innovation process and some of the outlays in meeting the INSTIL Innovation programme goals.

Again, the results of the case study mirror the existing literature. As a small enterprise Alpha does not have the resources to commit to a well-defined innovation strategy. The resource limitations include human resource as the management of the company is heavily involved in day-to-day operations, as well as

financial resources to pursue research and development and market research, as described by Todtling and Kaufmann (2002). Without the external resources provided by the INSTIL programme, Alpha would not have been able to overcome many of the challenges of new product development, process and market innovation.

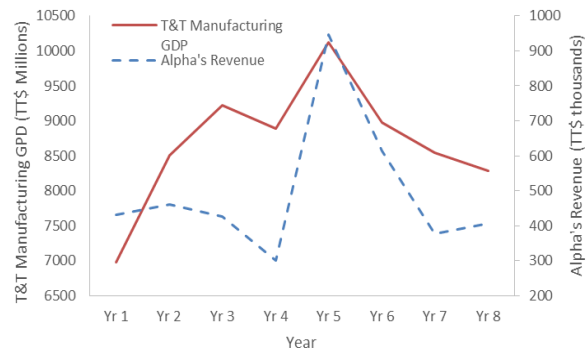


Figure 7. T&T's Manufacturing GDP compared to Alpha's revenue

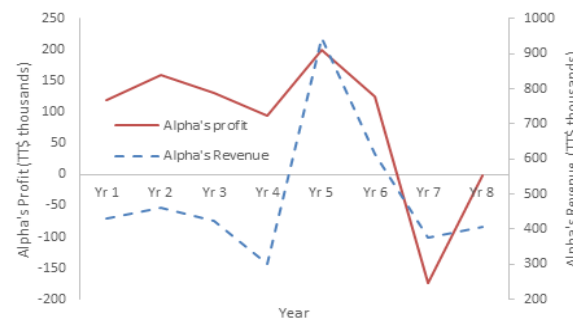


Figure 8. Alpha's profit compared to revenue

7. Conclusions

The paper examines the formalisation of the National Innovation System of T&T and efficacy of a state-led innovation promotion initiative. The examination of the NISTT showed that in designing a National Innovation System, policy makers must not only consider the actors making up the system, but they must also carefully craft mechanisms for the interactions among the actors to ensure there are knowledge, financial, human and regulation flows. Without these interactions, the NIS will not be a well-functioning system. Additionally, policy makers need also consider the historical, current and future contexts of a country in specifying the intended outcomes of the NIS. Without considering a country's context, despite efforts of pulling together the necessary NIS actors, the system will be unable to produce the intended output.

The examination of the INSTIL Innovation programme showed that even when programmes are well-designed, reflecting all elements of a NIS, success,

at least in the short term, and measured in financial terms, is not guaranteed. For SMEs operating in developing countries (such as T&T) that engage in low-technology sectors, external support is invaluable. While financial measures of success would be a key indicator of the efficacy of innovation policy, payback periods may be lengthy, and so, non-financial measures of success could be useful in the short-term.

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