

*Full Length Research Paper*

# Commercialisation of research and technology: A multiple case study of university technology business incubators

Nkosinathi Sithole<sup>1\*</sup> and Robert O. Rugimbana<sup>2</sup>

<sup>1</sup>Business School, Tshwane University of Technology, Pretoria, South Africa.

<sup>2</sup>Faculty of Economics and Finance, Tshwane University of Technology, Pretoria, South Africa.

Received 03 March, 2014; Accepted 24 July, 2014

One of the most important reasons for developing university technology business incubators (UTBIs) is to permit the commercialisation of technology and research by setting up new firms to graduate into fully-fledged businesses, which are normally referred to as new technology-based firms (NTBFs). Relying on the resource-based theory (RBT) and incubation models, the present research is concerned with proposing a theoretical framework for the enabling factors that influence the graduation of new technology-based firms (NTBFs) that result from the commercialisation of research and technology through to becoming established businesses from a university technology business incubator (UTBIs). A pragmatic philosophy informed the researcher's theoretical lens. This involved the use of a multiple case study using mixed methods that entailed the use of both quantitative and qualitative research techniques in the form of semi-structured interviews with the UTBI's management team. The most significant finding of the research is that there are a number of enabling factors that influence the graduation of NTBFs within a UTBI, the most significant of which are stringent selection and admission criteria, the business support services, financial resources, university entrepreneurial network/mediation and organisational resources. Each of these factors is grouped into three stages: the pre incubation stage, the incubation stage and the graduation stage. The unit of analysis for this research consists of the management team within three UTBIs located in one of the University of Technology in Gauteng Province. Owing to the nature of the sample, the results may not be representative of the remaining UoTs in Gauteng. The study attempts to link the development of business ideas to factors that influence their progression into graduated businesses.

**Key words:** Commercialisation, enabling factors, new technology-based firms, University of Technology, university technology business incubators.

## INTRODUCTION

One of the most important reasons for developing university technology business incubators (UTBIs) is to

permit the commercialisation of technology and research by setting up new firms to graduate into fully-fledged

\*Corresponding author. E-mail: [thinankosi@gmail.com](mailto:thinankosi@gmail.com)

businesses, which are normally referred to as new technology-based firms (NTBFs). The latter are considered an integral part of economic growth (Mian, 1996b). Despite the potential contribution of UTBIs to the economy, relatively few studies have investigated and identified the enabling factors that influence the graduation of NTBFs from conception through to becoming established businesses.

This study proposes a theoretical framework of the enabling factors that influence the graduation of NTBFs from UTBIs into established businesses as a result of the commercialisation of research and technology. To achieve this, a multiple case study using mixed methods is employed. The most significant finding of the research is that there are a number of enabling factors that influence the graduation of NTBFs within a UTBI, the most significant of which are stringent selection and admission criteria, the business support services, financial resources, university entrepreneurial network/mediation and organisational resources. Each of these factors is grouped into three stages: the pre incubation stage, the incubation stage and the graduation stage. The rest of the paper is organised as: literature review, followed by research method, analysis and results, discussion and implications, and finally conclusion.

## LITERATURE REVIEW

Previous researchers in university-based incubation focused on assessing the value-added contributions of UTBIs to NTBFs. In his seminal work on United States' (US) universities, Mian (1994) focused on assessing the effectiveness of university technology incubators on the growth of NTBFs. Building on this case study, Mian (1996b) found that UTBIs provide the necessary resource-base and environment conducive to this development and add major values, making the UTBI a viable strategy for nurturing NTBFs (Mian, 1996a).

According to Mian (1996a:330), a UTBI is defined as “a multi-tenant building, in and around university campuses, which provide affordable, flexible space and a variety of typical incubator and university related services for technology based tenant firms”.

The current study derives its conception of the UTBI from these views. In a further study carried out a year later, Mian (1997) developed a conceptual framework for assessing and managing the UTBI as a tool for new venture creation. The framework comprises three performance dimensions: programme sustainability and growth, tenant firm's survival and growth, and contributions to the sponsoring university's mission. According to the framework, the key determinants of the UTBI's effective performance are the facility's expected performance outcomes, the degree of consistency of the management policies with the programme's objectives, the scope of available services and their perceived value-added (Mian, 1997).

More recently, Mian (2011) concluded that a research university's active entrepreneurial involvement provides critical value-added inputs that are essential for the creation and development of innovative ventures and new products. With regard to the growth of NTBFs, a series of important studies have examined the critical success factors of the UTBI in order to evaluate their effective operation. Lee and Osteryoung (2004) compared critical success factors for effective operations of UTBIs in the US and Korea. The study found 14 factors in the areas of goal/operations strategy, physical/human resources, incubator services and networked programme. The goal/operations strategy was perceived to be a more important factor in the US than in Korea. In the South African context, Buys and Mbewana (2007) found eight factors that determine the success of incubators. An important conclusion was that these success factors are strongly correlated with each other (Buys and Mbewana, 2007).

While much of this literature focuses on the critical success factors of NTBFs, one school of the thought has focused on the resource-based theory (RBT), formerly known as the resource-based view (Alvareza and Busenitz, 2001; Löfsten and Lindelöf; 2005; Barney et al., 2011), to improve understanding of the enabling factors that determine the success of UTBI. For instance, in their research, Somsuk et al. (2010; 2012) aimed to improve the understanding of enabling factors that determine the success of the UTBI. Using RBT as the base theory and the Q-sort technique to classify enabling factors, they concluded that resources, capabilities and internal drivers found through the RBT hold the possibility of enabling the success of the UTBI programme (Somsuk et al., 2010). The study suggests that strategic resources and their categories are important to the success and improvement of the competitive advantage of technology-based SMEs (Somsuk et al., 2012).

Furthermore, based on the RBT and the absorptive capacity construct, Rothaermel and Thursby (2005a) hypothesised that knowledge flows enhanced incubator-firm performance. They suggested that the incubator firms' absorptive capacity is an important factor when transforming university knowledge into firm-level competitive advantage. In a follow-up study of incubator graduation, Rothaermel and Thursby (2005b) found that strong ties to the sponsoring university not only reduces the probability of new NTBFs failure but also retards timely graduation. The above line of inquiry puts forth the notion that the success of NTBFs may not be attributed to a single success factor (Kumar and Ravindran, 2012), but to a number of factors.

### What is a business incubator (BIs)?

Business incubator (BIs) has become a ubiquitous phenomenon (Bergek and Norrman, 2008) which has drawn

broad attention from scholars, regional development practitioners and policy makers (Qian et al., 2011). However, there are several sources of ambiguous definitions (Hackett and Dilts, 2004b:59). A precise definition of the phenomenon has been frustrated by the practice of marketing BIs under different terms (Bøllingtoft and Ulhøi, 2005). In fact, there is an on-going debate regarding definitional issues of the concept.

Based on an extended list of definitions, both researchers and practitioners have presented numerous definitions and descriptions of BIs (for a detailed review see Appendix D; Löfsten and Lindelöf, 2002; Peters et al., 2004; Hackett and Dilts, 2004a, b; NBIA, 2007; Markman et al., 2008; Farsi and Nikraftar, 2011). More importantly, the broader trend has been to expand this definition from “*incubator*” (a facility) to “*incubation*” (a process) (Hallam and DeVora, 2009). There are two essential aspects in today’s definitions of BIs: the actual definition (what it is) and the often-implicit impacts (effects) BIs have in firms, communities, science, and technology (Ratinho, 2011).

Pursuing this further and in order to understand incubation one must begin by understanding the term “*incubate*”. According to the literature, to incubate is not only to contain something in a favourable environment for its appropriate development (Branstad, 2010) but also to give form and substance to it (Hisrich, 1988). With regard to incubation, to incubate fledging companies implies an ability or desire to maintain prescribed and controlled conditions favourable to the development of NTBFs (Hisrich, 1988). Hence, a business incubator is a “*producer*” of business assistance programs. While NTBFs are “*consumers*” of those outputs, who operate in an interdependent co-production relationship with the incubator (Rice, 2002).

Accordingly, a business incubator is a shared office space facility that seeks to provide its NTBFs (i.e. “*portfolio*” or “*client*” or “*tenant-companies*”) with a strategic, value-adding intervention system (i.e. business incubation) of monitoring and business assistance (Hackett and Dilts, 2004b). Conversely, practitioners use the term business incubator to embrace technology centres, science park incubators, business and innovation centres, new economy incubators, and a variety of other models (European Commission, 2002). In this study, the above definition of BIs is considered to be the best one that helps understanding this phenomenon and conducting the current study.

### The models of the incubation process

According to Bergek and Norrman (2008), little has been written on incubator models. Other scholars comment that they have yet to encounter such a dynamic model (Phan et al., 2005). Moreira and Carvalho (2012) suggest that the search for models of the business incubation process is on a multifaceted road. It is therefore important

to identify the characteristics of different incubating models, to understand how they work, to assess the value they can add to their particular type of NTBF, and to ascertain the ability of their staff to understand and cater to their clients’ needs (Grandi and Grimaldi, 2004). Bizzotto (2003) defines the incubation process as comprising the following three stages:

**Pre-incubation:** the stage when the focus is on the generation of project ideas that have the potential of being converted into a profitable commercial business, and on identifying future tenants for the incubator.

**Incubation:** the stage during which entrepreneurs are provided with the facilities and the strategic support needed.

**Post-incubation:** the take-off stage when the business is able to continue operations outside the incubator by itself.

The European Commission (2002) presents an incubation model that includes the key processes for generating and developing NTBFs (Figure 1). This model suggests that the way in which business incubators operate can be depicted in terms of a simple input-output model. According to this model the three major elements of incubation are:

**Inputs:** these mainly consist of stakeholder inputs (e.g. the provision of finance), management resources and projects put forward by entrepreneurs.

**Processes:** the various inputs are brought together in the business incubation process through the provision of incubator space and a variety of value-adding services to start-up companies.

**Outputs:** successful companies graduate with positive job and wealth creation impact.

Following this line of thinking, Hackett and Dilts (2004a) propose that NTBFs are selected from a pool of incubation candidates, monitored and assisted, and infused with resources while they undergo early-stage development (Figure 2). According to the model, “*outcomes*” refers to either the survival or failure of an NTBF at the time it exits the incubator, while “*controls*” includes regional differences in economic dynamism, the level of incubator development and the size of incubators. To illustrate the above point, the model is shown as being temporal with arrows in the model indicating the relationships amongst the constructs. The arrows that lie between constructs represent the fact that it is not known whether these constructs overlap; because no one has conducted research using these constructs, the possibility for interaction must be depicted. Arrows going backward from outcomes to the constructs of interest indicate feedback loops that occur over time and through experience, suggesting organisational learning effects (Hackett and Dilts, 2004a).

Other scholars suggest that incubation is very much dependent on the quality of human relationships and occurs via a process of co-production in dyads and triads

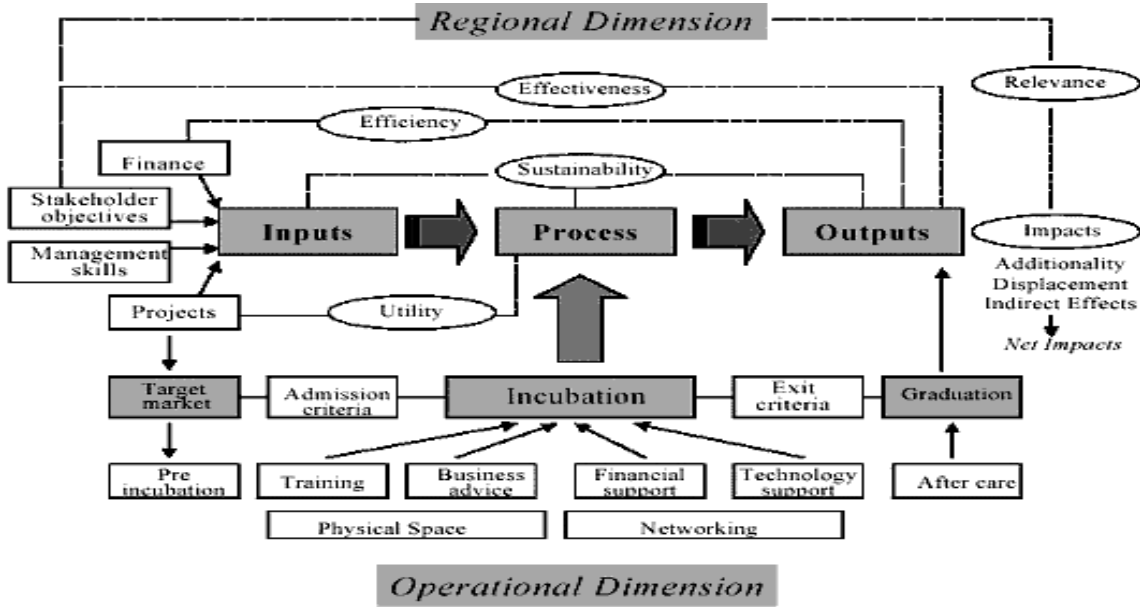


Figure 1. Business incubator model. Source: European Commission (2002).

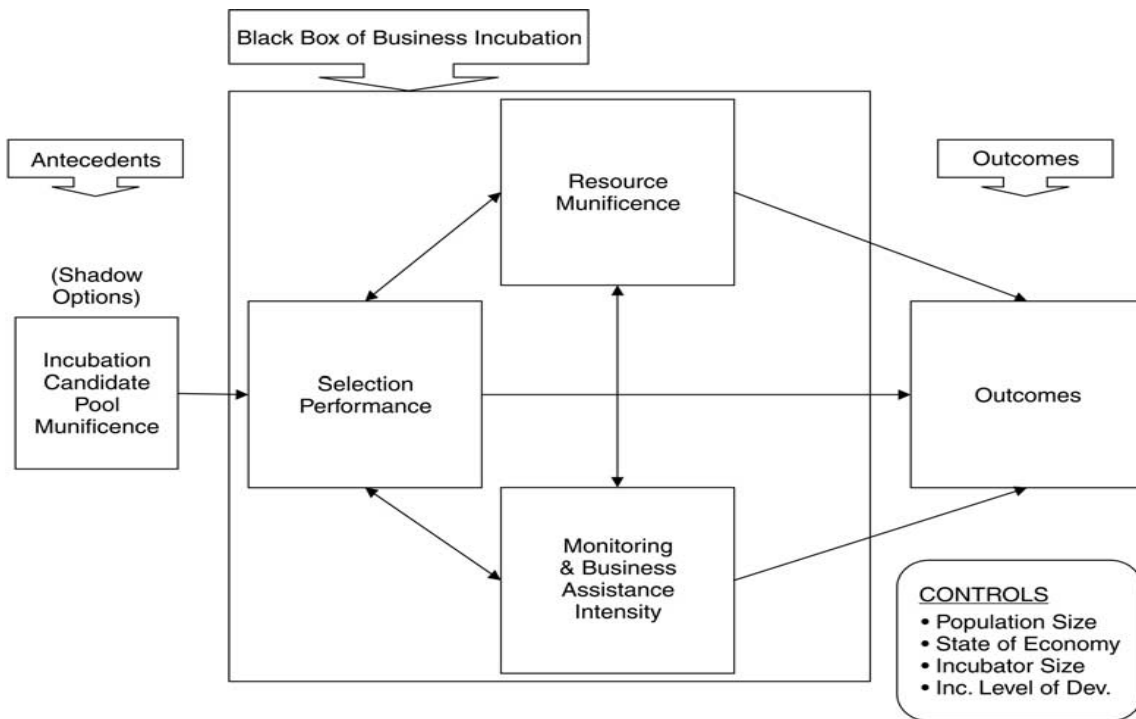


Figure 2. Incubation process model. Source: Hackett and Dilts (2004a).

(Rice, 2002; Ahmad and Ingle, 2011). Without the voluntary and active participation of NTBFs, the mechanisms that facilitate co-production break down (Ahmad and Ingle, 2011). Bergek and Norrman (2008) assert that the three distinguishing factors between different incubation

models are selection, business support and mediation (Table 2). The other factors in their framework include infrastructure and graduation. Selection refers to decisions about which NTBFs to accept for entry and which to reject (Bergek and Norrman, 2008:23).

**Table 1.** Case selection

Case	Yr established	Description	Location
Case A	2006	Case A seeks to nurture and promote the development and involvement of small and medium businesses within the mineral beneficiation sector, particularly platinum group metals (PGMs). It specialises in assisting aspiring jewellers to acquire skills and build careers in designing and manufacturing platinum group metal jewellery. These small jewellery enterprises are housed either physically or virtually at the UTBI.	Based in North West Province, with a satellite station at an UoT in Gauteng
Case B	2007	Case B improves enterprise performance, enhances profitability and growth, and offers technology and management support to South African information and communications technology (ICT) NTBFs and is geared to help early movers maximise the value of their ideas.	Located at an UoT in Gauteng
Case C	2008	Case C is the first South African business incubator that hosts mixed manufacturing technologies under one roof. This model serves as a one-stop solution to solving the problem of entrepreneurs not having the necessary business and technical skills along with a lack of access to supporting resources in the manufacturing sector.	Located at an UoT in Gauteng

**Table 2.** Incubation model components.

Incubator model				
Selection	Business support	Mediation	Infrastructure	Graduation

Source: Bergek and Norrman (2008).

The infrastructure consists of localities, office facilities and “administrative” services. Business support is associated with coaching/training activities undertaken to develop the NTBFs. Mediation refers to how the incubator connects the NTBFs to each other and to the outside world. Finally, graduation is related to exit policies, i.e. decisions concerning the circumstances under which NTBFs should leave the incubator (Bergek and Norrman, 2008:23). This paper adopts Bergek and Norrman incubation-model components to identify enabling factors that might influence the graduation of NTBFs in a UTBI.

## Theories relevant to business incubation

### *Resource-based theory*

Most of the studies in the incubation literature have utilised the RBT to investigate the critical factors for successful business incubation (Somsuk et al., 2010; Todorovic and Moenter, 2010; Somsuk et al., 2012). According to Barney et al. (2011), resource-based

research has reached such a level of precision and sophistication that it resembles a theory rather than a view. According to Barney (1991:105-106), for a firm’s resources to have the potential to be the basis of a competitive advantage, “(a) it must be valuable, in the sense that it exploits opportunities and/or neutralises threats in a firm’s environment, (b) it must be rare among a firm’s current and potential competitors, (c) it must be imperfectly imitable, and (d) there cannot be strategically equivalent substitutes for this resource that are valuable but are neither rare or imperfectly imitable”.

RBT has been one of the most significant theories in the field of strategic management. However, some researchers have criticised RBT in terms of its theoretical and practical applicability (Priem and Butler, 2001; Akio, 2005; Sheehan and Foss, 2007). According to Priem and Butler, the elemental RBT is not a theoretical structure. Lockett et al. (2009) point out in addition that the RBT is tautological if the firm’s possession of unique capabilities cannot be ascertained independently of their description. Other critics suggest that the RBT’s concepts of “valuable” and “rare” resources do not fulfil the conditions

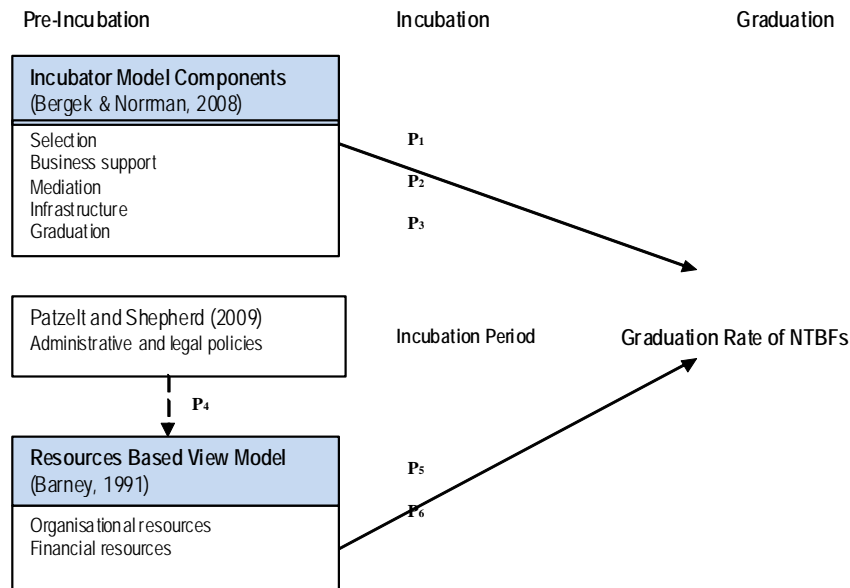


Figure 3. The proposed research model.

for acquiring and realising a competitive advantage (Akio, 2005). Some point out that it lacks the concept of activities and argue that it has not reached its full potential in the field of strategy (Sheehan and Foss, 2007). The RBT model appears well-suited to the present research objectives. It is a compelling theory and can provide insight into the way in which the incubator values and selects NTBFs (Hackett and Dilts, 2004a).

### Real options theory

Hackett and Dilts (2004a) employed real options theoretic reasoning to develop a theory of business incubation. This theory seeks to predict and explain how business incubators and the process of business incubation increase the likelihood that new ventures will survive the early stages of development. A real options perspective would view NTBF-selection as the creation of an option with subsequent resource infusions and monitoring and assistance as option exercises (Hackett and Dilts, 2004a). It conceptualises the incubator as an entrepreneurial firm that sources and macro-manages the innovation process within emerging organisations, infusing these organisations with resources at various developmental stage-gates while containing the cost of their potential failure (Hackett and Dilts, 2004a).

### Other theories applied to incubation

Using the stakeholder theory, Alsos et al. (2011) investigated how technology incubators manage and balance the expectations of stakeholders, and the effect

on the shaping of technology incubators and their chances of success. The study identified three strategies to balance stakeholders' expectations (Alsos et al., 2011). Another theory that is widely used is the network theory, which proposes that the primary value-added feature of incubators is the set of institutionalised processes and norms that carefully structure and channel knowledge throughout the incubator network in order to create conditions that facilitate the development of NTBFs and the commercialisation of their innovations (Hackett and Dilts, 2004a). They do not provide an integrated, theoretically driven explanation of the factors that constitute the incubation process.

### Theoretical framework and propositions

This section will discuss the relevance of all theoretical foundations that constitute the constructs in the theoretical framework. The purpose of this study is to propose a theoretical model of the enabling factors that influence the graduation of NTBFs. The theoretical foundation of this research is based upon the literature, RBT and Bergek and Normman's Incubator model components. Figure 3 shows the research model that proposes RBT and Bergek and Normman's Incubator model components might influence the graduation of NTBFs in a UTBI.

### Stringent selection and admission criteria

Researchers have found that tenant survival rate is positively related to a balanced screening profile (Aerts et al., 2007). The aim of the selection process is to identify

business proposals that have a greater chance of success (Bizzotto, 2003). The ideal candidate is likely to be judged on level of innovativeness and potential for growth (Alsos et al., 2011). One way of minimising the number of tenant failures is to subject potential NTBFs to a severe screening process (Aerts et al., 2007). Having in mind the question raised about the selection criteria Bergek and Norrman (2008) forward a four-field matrix consisting of the following strategies: picking-the-winners and idea, picking-the-winners and entrepreneur, survival-of-the-fittest and idea and survival-of-the-fittest and entrepreneur. In view of this, it is expected that proposition *P1: The stringent selection and admission criteria will significantly and positively influence the graduation of NTBFs in a UTBI*

### **Business support services**

Business support is an integral part of business incubation and arguably its most complex dimension (Ratinho et al., 2010). Business support services such as coaching and training are crucial elements of learning within BIs (Bruneel et al., 2012). Bergek and Norrman (2008) suggest that business support strategies may be positioned on a scale from “*strong intervention*” to “*laissez-faire*”. These dimensions will be incorporated to determine the factors that might influence the graduation of NTBFs. Hence, in view of the above, we may deduce that proposition *P2: Business support services are significantly and positively related to the graduation of NTBFs*

### **University entrepreneurial network/ mediation**

The literature defines networking as the access available to the tenants of the incubator to managers, administrative, management, financial, legal, insurance consultants as well as to scientists, academicians, prospective customers, either for a fee or free of charge (Peters et al., 2004). McAdam and McAdam (2008) opine that university links are useful in terms of facilitating and developing networks with third parties and providing access to research and technology. The UTBI's university linkage plays an important role in providing the infrastructure support and the necessary value-added contributions critical for nurturing such businesses (Mian, 1996b). Mediation strategies vary in terms of the type of innovation system in focus: technological, regional or cluster (Bergek and Norrman 2008). As a result of the above, it is assumed that proposition *P3: University entrepreneurial networks are significantly and positively influence the graduation of NTBFs*

### **Organisational resources**

The purpose of the incubator is to provide

resources in those areas where entrepreneurs have gaps (Rice, 2002). Commonly incubators provide clients with affordable and flexible space (Hallam and DeVora, 2009). The physical infrastructure includes rental spaces, equipment, administrative facilities like fax, phone, internet lines, in certain cases labs, conference facilities and so on (Peters et al., 2004). It is expected that proposition *P4: Organisational resources are significantly and positively related to the graduation of NTBFs.*

Access to administrative support and reduction of early-stage operational costs are typical critical barriers which many “new infants” have difficulty in overcoming (Bøllingtoft and Uihøi, 2005). These administrative burdens consume the academic entrepreneur's scarce time and resources in conforming to such bureaucratic requirements (Patzelt and Shepherd, 2009). Similarly, explicit policy forcing graduation might be counter-productive (Rothaermel and Thursby, 2005b). The authors further suggest that university must not institute iron clad policies, but rather to make graduation decisions on a case-by-case basis. The aspiring and established entrepreneurs must be aware of university policy and procedures and of the consequences for breaching the agreements (Dina, 2013). As a result, it is expected that proposition *P5: University administrative and legal policies will have a negative influence on the graduation of NTBFs.*

### **Access to financial resources**

Access to finance offered by a policy program is central and enhances the entrepreneurs' perceived benefits of other policy measures such as providing access to nonfinancial resources (networks, business knowledge) and reducing administrative burdens, but diminishes the perceived benefits of offering tax incentives for new ventures (Patzelt and Shepherd, 2009). UTBIs do not have financial pressure to return a profit, but they are focused on serving the scientific community at the university (Carayannis and von Zedtwitz, 2005). Therefore, based on the above argument, we may infer that proposition *P6: The possession of financial resources will positively influence the graduation of NTBFs.*

## **METHODOLOGY**

This paper is designed to be a multiple case study using mixed methods that entail the use of both quantitative and qualitative research techniques. Quantitative and qualitative data are collected and analysed appropriately at the same time, but the latter is given more weight than the former. Such a design allows the two types of data to integrate at all stages of the project. For this study, a pragmatic paradigm is preferred because they have the ability to embrace multiple cases, quantitative and qualitative data, and multiple research paradigms (Dooley, 2002). This approach relies on a version of abductive reasoning that moves back and forth

between induction and deduction—first converting observations into theories and then assessing those theories through action (Morgan, 2007). The methodology of multiple case studies will be used within this study because of its ability to combine data collection methods such as documents, archival records, interviews, physical artefacts and observations (Eisenhardt, 1989; Yin, 2009).

Basically, a mixed method approach inquiry combines both ideas from qualitative and quantitative research (Creswell, 2009:4; Johnson et al., 2007; Grafton et al., 2011). More importantly, the rationale for mixing data within one study is grounded in the fact that neither quantitative nor qualitative methods in themselves are sufficient to capture the trends and details of a situation (Creswell et al., 2004; Ivankova et al., 2006). This applies to a complex issue of enabling factors that influence the graduation of NTBFs in a UTBI in particular. The study adopts a multiple case-study approach as applied by Mian (1994, 1996a, b, 1997) to assess the value-added contributions of UTBIs to NTBFs. Furthermore, the embedded case study designs points that such studies represent a form of mixed methods research since other research methods are embedded within the study (Yin, 2009:63). The mixed methods approach mixes the insights of qualitative research with the numerical rigor of quantitative research. Quantitative and qualitative data are collected and analysed concurrently, but more emphases are put on the latter

According to Yin (2009), a multiple case study can be used to either (a) predict similar results (a literal replication), or (b) predict contrasting results but for predictable reasons (a theoretical replication). A literal replication describes the conditions under which a particular phenomenon is likely to be found, while a theoretical replication describes the conditions when it is not likely to be found. In this study, the aim of the multiple case selection strategy is to compare and contrast results or theoretical replication, or to explain the conditions under which the factors that enable graduation will be uniquely associated with a particular type of UTBI model. In sum, mixed-methods design is appropriate for case studies (Sharp et al., 2011). In contrast to the use of case studies alone, mixed-methods research enables a researcher to address more complicated research questions (Yin, 2009:64). From the above discussion, it is clear that mixed methods research is the best way to fulfil research objectives and answer research questions. This research considers a combination of a multiple-case study, archives and semi-structured interview approaches in which both qualitative and quantitative research techniques are used in a semi-structured format.

This study's scope has been restricted to three incubators based in a university particularly UoT in Gauteng Province. Such Metropolitan environments with diverse and large-scale industrial activities may be helpful to business incubation (Zhang and Sonobe, 2011). The criteria for the selection of case organisations are as follows: First, since the aim was theoretical replication three different types of incubator organisations had to be selected. Second, the sites were to be officially designated as "UTBIs" as defined by Mian (1996a:330) not BICs, IPis, and CPIs. Third, only UTBIs with at least one graduated tenant were included in the study; hence all the incubators had been established for at least three years and more (Peters et al., 2004). A number of university incubator-incubation researchers in the past have used between two cases (Mian, 1996b; McAdam and McAdam, 2008) and six cases (Mian, 1994, 1996a; Grimaldi and Grandi, 2001). The three case studies included in this research (Table 1) should provide sufficient evidence, through theoretical replication, on which to base this study's key findings.

### Sample selection

A sample comprises several "units" and each unit is observed at discrete points in time, comprising "cases" (Gerring, 2004:342). In

the case study method, because the researcher does not use statistical generalisation, but generalises theory, the goal is to obtain replication, not an enumeration (Kohn, 1997). Population, unit, case and observation are nested within each other (Gerring, 2004). A series of case studies might therefore be referred to as a sample (Gerring, 2004). According to Hackett and Dilts (2004b), there are multiple levels of analysis employed in incubator-incubation research which are (a) entrepreneur (individual) level, (b) incubator manager (individual) level, (c) incubatee (group/firm) level, (d) incubator (firm) level, (e) community (local) level, and (f) incubation industry (industry) level. This study will interview the management team (Mian, 1996a, 1997; McAdam and McAdam, 2008) who are directly involved with commercialisation of NTBFs.

A concurrent design utilising identical samples generated through the joint use of probability and purposive techniques was used to sample the UTBI staff who participated in this study. Concurrent mixed-methods sampling involved the selection of units of analysis through the simultaneous use of both probability and purposive sampling (Teddlie and Yu, 2007). Because senior management participated in the study, a clear and accurate picture of the NTBFs was acquired. In this study, quantitative and qualitative data are integrated not only at the stage of results reporting, but also during the processes of data collection and data analysis in order to maximise the integration of two methods. During the data collection stage, semi-structured interviews comprising a survey that contains both Likert-scale questions (quantitative data) and open-ended questions and annual reports (qualitative data) were utilised. The basic data analysis procedure in this study involved conducting separate data analyses for each of the quantitative (STATA) and qualitative data (ATLAS.ti), but the one was related to the other for the purpose of triangulation and embedding. Firstly, data analysis consists mostly of "within-case analysis" and "cross-case analysis". Secondly, data analysis consists of examining, categorising, tabulating, and testing qualitative or quantitative evidence for the initial propositions of the study, as proposed by Yin (2003:104).

## ANALYSIS AND RESULTS

The data analysis consisted mostly of "within-case analysis" and "cross-case analysis", which are: the examination, categorisation, tabulation, and testing of the qualitative or quantitative evidence for the initial propositions of the study, as proposed by Yin (2003:104).

### Within-case analysis

According to Eisenhardt (1989), within-case analysis involves detailed case-study write-ups for each site. This gives the investigator a rich familiarity with each case, which, in turn, accelerates cross-case comparison (Eisenhardt, 1989).

### Case study A

Case A is a non-profit (Section 21) organisation that seeks to nurture and promote the development and involvement of small and medium-sized businesses within the mineral beneficiation sector, particularly the platinum group metals (PGMs) sector.



### **Pre-incubation stage**

The process of selecting and admitting an NTBF is managed by the incubator's management team. During the pre-incubation stage, NTBF applications follow the following three-step process of selection and initiation before approval:

1. They must present the initial business idea
2. They have to start off with the UTBI as a project
3. They must graduate to become a UTBI tenant, when all business systems have been put in place and the business is making an income.

### **Incubation stage**

The main service in Case A is assistance to small and medium enterprises to develop all aspects of their business. During the incubation stage, Case A offers the following services to NTBFs:

1. Access to machinery: state of the art equipment necessary to manufacture jewellery.
2. Platinum loan: assists NTBFs to borrow PGM metals to fulfil their orders.
3. Training centre: Case A has teamed up with the XYZ Further Education and Training (FET) College. The college prepares students for a National NQF Level 3 Certificate in Jewellery Manufacturing in a mass production environment.
4. Organised interactions: Case A has strong links with the South African jewellery manufacturing industry and is able to call on experienced advisors to assist and share information on what works and what does not work in the jewellery manufacturing industry.
5. Marketing of NTBF products: The centre is able to assist NTBFs to reach their clients and distribute platinum jewellery in and around South Africa. Case A also helps NTBFs with information and support to take part in international trade shows that open opportunities for tenants to sell their products internationally and form distribution networks in other countries.
6. Security: Security is very important when dealing with precious metals and expensive materials such as palladium and platinum. NTBFs benefit from high security at a very affordable price, since costs are shared.

The incubation services offered to NTBFs described above was affirmed by the respondent:

*"So if you got the skill...but the skill is not up to standard, then while before you are incubated we sort of direct you, to to.... , I will not say training because you know colleges do the training. Basically direct you towards the qualification, we sometimes campaign for NQF to fund such a qualification. So basically,..... it's linking them with the qualifications to have the necessary*

*qualification to be in the incubator". [P 1: Case A A1.rtf - 1:81 [So if you got the skill...but the skill is not up to..] (19:19) (Super).*

### **Graduation stage**

The duration of stay for NTBFs is three years, after which a tenant should be able to operate without the help of Case A. Case A is linked to two institutions of higher education that continuously enrol potential NTBFs for various courses related to jewellery design. The combination of institutional support and incubation services contributes to the incubator's success, hence the timely and successful graduation of NTBFs.

### **Case study B**

Case B is an ICT business and technology incubator that stimulates, grows and launches early-stage, technology-rich businesses through world-class technology incubation, professional business support services and resources, and a network of expert incubation and coaching professionals. The UTBI commenced its activities in 2007, focusing on the incubation of young IT graduates, professionals and disadvantaged groups, with the intention that these individuals pursue entrepreneurship as an alternative to traditional employment.

#### **Pre-incubation stage**

During the pre-incubation stage, Case B screens NTBFs on the basis of high-growth potential and innovativeness. The potential NTBFs are required to produce a business plan that outlines their growth potential

#### **Incubation stage**

Case B provides an integrated package of workspace, shared office services, access to specialised equipment and value-added services like management assistance, access to finance, marketing and networking support. Businesses within the UTBI fall within various stages of being built, from a concept phase, where a first-cut assessment of the strategic environment is being made, to the development phase, where feasibility and go-to-market strategies are being explored, and, ultimately, the commercial phase, where profitable market opportunities are exploited and the focus is on growing the depth and breadth of the venture. In the words of the Case B manager when asked about the incubation services offered to NTBFs:

*"We only give support to NTBFs such as facilities to use, internet and other resources that the NTBFs might*

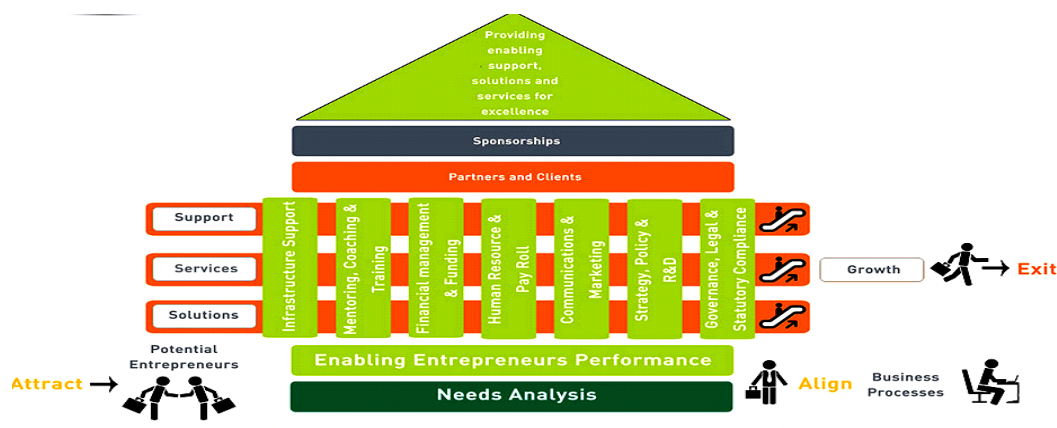


Figure 4. Case B incubation model. Source: Case B website.

require". [P 3: Case B-B1.rtf - 3:4 [We only give support to NTBFs ..] (10:10) (Super)]

### Graduation stage

The graduation committee makes the final decision on the graduation of NTBFs. This committee is made up of the board of directors and the sponsors of the UTBI (Figure 4).

### Case study C

Case C is a unique institution within the STP group of business-support organisations owing to the fact that it is the first South African business incubator that hosts mixed manufacturing technologies under one roof. This model serves as a one-stop solution to solving the problem of entrepreneurs who do not have the necessary business and technical skills, along with a lack of access to supporting resources in the manufacturing sector. The concept was born from talks between STP, the National Small Industries Corporation (NSIC) and the Brazilian Micro and Small Business Support Service (SEBRAE). The establishment of the concept in 2008 was driven by the UTBI manager.

### Pre-incubation stage

Three times each financial year the UTBI pursues a marketing campaign, whereby potential entrepreneurs are invited to apply for the UTBI's programme. Each individual is screened and interviewed and only the most promising individuals are inducted into the programme. The selection of only the best candidates is important to the success of the programme, as a high level of achievement, motivation and determination is necessary to meet the programme's rigorous demands and the post-training demands of an entrepreneurial business.

### Incubation stage

The training programme runs for four months on a full-time basis. During this time each NTBF is provided with business and entrepreneurial training twice a week, and technical training three times a week. Assessments are conducted after each module of training is completed in order to ensure that NTBFs are competent on machinery and business skills. Once the training period has been completed, successful NTBFs are assisted in completing a quality, bankable business plan, and are linked to financial institutions and supporting organisations. Each NTBF is monitored on a regular basis to identify and solve any problems that may be experienced before such problems can lead to failure. Once an NTBF has been successfully financed, Case C facilitates and assists in the acquisition and installation of machinery. The UTBI further provides mentoring and coaching services combined with incubation services during NTBFs start-up for an agreed time after start-up to help ensure the lowest possible failure rate for NTBFs (Figure 5).

Therefore, the respondent in this case elaborated the incubation model:

*"You see how our model works; we have your skills development program that runs for 3 months. From those 3 months, 120 people are taken to undertake skills development program. From that 120, we know we have 96 that will pass. There are still no NTBFs; they do not have an idea what they want to do as far as the product is concerned. Based on the skills development program they have 9 months to make a decision; that is the pre-incubation, which is right at the establishment phase. Then we have the incubation stage when they register the company, get funding, get a market etc and that is the incubation stage. Then we have what we call post-incubation stage. So, yeah it's different. We work with that we create. That is the primary objective. And then only in April we are opening the existing manufacturing*

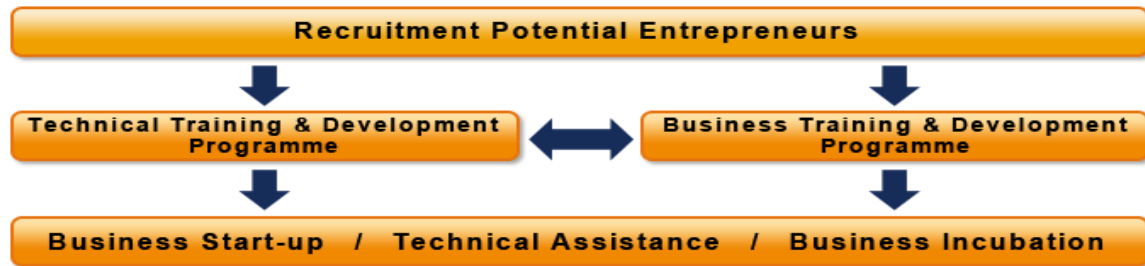


Figure 5. Case C incubation model. Source: Case C website.

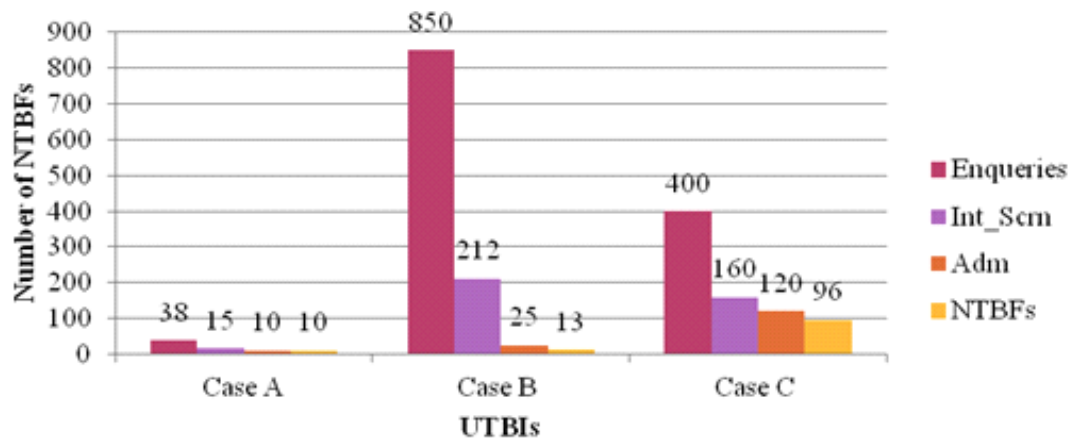


Figure 6. UTBI screening practises.

*businesses*" [P11: Case C C4.rtf - 11:4 [You see how our model works, i..] (16:16) (Super)].

### Graduation stage

The duration period for NTBFs is three years, which is divided into three stages –the pre-incubation stage, incubation stage and post-incubation stage.

### Cross-case comparison

According to Eisenhard (1989), the key to a good cross-case comparison is counteracting these tendencies by looking at the data in many divergent ways.

### Stringent selection and admission criteria (P1)

The analysis of the interviews across the cases found three codes within the selection family, namely selection criteria and screening, selection panel, and incubation contract. Selection criteria and screening were found to be the most important enabling factor amongst the codes identified within the selection family. This suggests that

stringent selection criteria will ensure that the UTBI selects NTBFs that will graduate successfully and on time.

The following quotes demonstrate a range of views and beliefs held by a management team on the significance of selection criteria screen:

*"...We put them through an entrepreneurial test, we give them a questionnaire and ... that qualifies them whether they will be accepted into our programme. We start with the information sections, right! Let me give you a background; we start with information sessions, right! People that are interested we give them information of what we do here and they fill in a questionnaire and from that questionnaire, right, em, em' they get a call for an interview. The interview then determines if they can become part of this intake for students or NTBFs that will attend our classes"* [P 8: Case C C1.rtf - 8:9].

Figure 6 presents the screening factors the UTBIs used to evaluate potential NTBFs graphically.

Company check-sheets or assessment forms have been developed and are used to minimise risk in the selection process (Ascigil, 2006). The stringent selection and admission criteria are a significant factor and positively

influence the graduation of NTBFs in an UTBI. These results are in line with the enabling factors that influence the graduation of NTBFs. Stringent selection criteria thus influence the graduation rate of NTBFs within the UTBI.

### Access to business support services (P2)

The analysis of the interviews found six codes that are associated with the business support family: entrepreneurship education and training, access to markets and marketing, international trade assistance, legal registration and compliance, mentoring/coaching, and product design. These are commented on in greater detail below. Entrepreneurship education and training is provided by the UTBIs, which are mostly affiliated to universities in order to develop a spirit of entrepreneurship in the community (Ghasemizad, 2009). For that reason, this code is directly quoted by the interviewee from the cases analysed:

*“As colleagues, we also need to be mentored or trained on what we do. So it is one thing that the university should look at and also we as facilitators of these entities”* [P 4: Case B2-B2.rtf - 4:3].

The markets in which NTBFs operate are competitive (Löfsten and Lindelöf, 2002), but UTBIs are less “time sensitive” than the private incubators in terms of reducing the time-to-market of NTBFs (Hallam and DeVora, 2009). With regard to access to markets and marketing, comes out to be related to only two cases which are Cases A and B. As corroborated by the respondent in these cases:

*“At the moment we are working with some... jewellers that take on the goods or – products that NTBFs produce on consignment. They take products and keep them in a shop you know and they can sale them on a mark-up. We have a shop in Pretoria, a shop in Johannesburg and locally we still work on some, but other than that we also run initiatives like going to the shopping malls and polishing jewellery and exposing them to other segments .We have such initiatives to expose them to more market segments; not only to be exposed to only one”* [P 1: Case A A1.rtf - 1:92].

The management team highlighted the importance of international trade assistance to NTBFs. In the words of the Case A manager:

*“... We do exhibitions, for example, NTBFs will go to London Fashion Week and obviously they will be able to market their product, but that is through the DTI because on our own and NTBFs on their own its very difficult to actually access such markets. But what we are also doing at the moment, two of our officials within the incubator have gone for international export trade, export*

*markets training last year and they are currently working on different proposals so that our NTBFs will be able to operate in international markets”* [P 1: Case A A1.rtf - 1:93].

The management team pointed out the importance of legal registration of NTBFs among other factors that contribute to the graduation. Legal registration of the company comprises tax-clearance forms, industry regulations and proper registration of the company at the Companies and Intellectual Property Registration Office (CIPRO). As manager A1 remarked:

*“If I am saying industry regulations, I am talking about, you know, compliance issues like with the regulator and am am’ Jewellery Council, and after that we basically channel the person in getting the right requirements over and above the company requirements in the jewellery, you know”* [P 1: Case A A1.rtf - 1:77].

Mentoring can also lead to business opportunities and referrals for the NTBFs (Davies, 2009). On the other hand, coaching is described as involving seminars or programmes offered either for a fee or free of charge to the NTBFs (Peters et al., 2004). The management teams mentioned the need of mentoring and coaching:

*“Case A offers the right equipment combined with correct training and mentorship”* [P 5: Case A Business Concept.rtf - 5:12].

*“Head office provides workshops, training and coaching to NTBFs”* [P 3: Case B-B1.rtf - 3:11].

*“NTBFs are monitored on a regular basis, there is coaching and mentoring done. Okay, when we do coaching and mentoring we have NTBFs coming in every Friday. Therefore, NTBFs are obviously here every Friday. Both in business development and technically we have coaching and mentoring on a regular basis”* [P10: Case C C3.rtf - 10:15].

Better product design leads to a greater possibility of success in the business. As mentioned before, the markets in which NTBFs operate are competitive. As a result, business support of product design will enable NTBFs to graduate on time. As manager C4 stated:

*“We put them in touch with the Technology Innovation amm mm Technology Innovation Agency (TIA) in terms of tooling. For example, SEDA provides a lot of staff like your branding, marketing, amm you know in terms of product prototype development. SEDA is our biggest partner”* [P11: Case C C4.rtf - 11:13].

The above quotes perhaps highlight a number of factors associated with the business support services. Therefore,

these services are significantly and positively related to the graduation of NTBFs.

### **Access to university entrepreneurial network/mediation (P3)**

Networks are perceived to be a critical element in the incubation process (Soetanto and Jack, 2011). Networking may involve linking business together, linking individual entrepreneurs together, or connecting entrepreneurs with providers of crucial resources (Hallam and DeVora, 2009). Within the entrepreneurial network/mediation family, this study found five codes, namely external networks, funding network, internal network, link to strategic partners, and link to the university, as described below.

Internal networks refer to the relationship among NTBFs (Soetanto and Jack, 2011). By locating NTBFs under one roof, incubators create opportunities and an environment conducive to them interacting and creating synergies (Abduh et al., 2007; Hallam and DeVora, 2009). As noted from the interviewees:

*“We have in-house networking during the incubation process”* [P 3: Case B-B1.rtf - 3:12].

External networks refer to the firm's relationship with other institutions such as a university and/or research centre (Soetanto and Jack, 2011). This external network provides services that are not offered by the incubator and helps incubatees to establish contact with universities, government and future investors (Hallam and DeVora, 2009). Manager A1 talked about the external networks that they provide for NTBFs:

*“...The types of network are basically determined by the skills, expertise and the gaps that the NTBFs come with, and we are then able to say they need this type of engagement, they need this type of network, you know”* [P 1: Case A A1.rtf - 1:90].

Some managers highlighted the importance of linking to strategic partners. They argued that having Memorandums of Understanding (MoUs) with strategic partners have an influence on the graduation of NTBFs:

*“SABS (South African Bureau of Standards) – we are currently working on our International Standard Organisation (ISO) compliance certificate and we have quite strong ties with them through the SEDA provincial office and the national office. We have ties with Productivity South Africa – they engage with our NTBFs on an annual basis. They look into compliance in terms of productivity and participating in their competitions. In addition, yeah ... the types of networks and relationship in terms of their documented, we don't have document types of*

*relationships. We have MoUs with Anglo Platinum, which is the Anglo American Platinum Division where they develop our SMMEs and they have direct impact on SMMEs that are incubated and we have MoUs with North West Province. We have MoUs with the Bojanala district municipality and they also serve on our board. The Local municipality we engaged with them on a regular basis. We have specific relationships. They are sustainable and based on common supply and demand curves with the sector value chain”* [P 1: Case A A1.rtf - 1:97].

The UTBI's university linkage plays an important role in providing the infrastructure support and the necessary value-added contributions critical for nurturing such businesses (Mian, 1996b). Links with universities are underlined in the literature as a decisive factor for success (Tang et al., 2010). Technology stations located at the universities, which have cutting-edge technology, are of major advantage to the graduation of NTBFs. The location of technology stations at UoTs points to the importance of these universities in the development of technology-intensive small firms (Ndabeni, 2008). This was also affirmed by all three cases:

*“... I will be honest, we have worked with TUT, with which we sort of concluded a MoU last year, and we engaged with Central University of Technology (CUT), engaged with Harmony Jewellery School, which is a college within Witbank. We have engaged obviously here with Orbit College and we sent a few request to Cape Town universities, the one that has a jewellery school. I think its Western Cape or something. And Durban University of Technology (DUT) in Kwa Zulu Natal just to sort of have some networks and be able to establish satellite offices that will be able to incubate jewellers that come out of the university or tertiary institution”* [P 1: Case A A1.rtf - 1:94].

Funding networks, another element of entrepreneurial networking, were argued to be influential for NTBFs to access funding. As noted from the interviewees:

*“So, the networking possibilities that we offer at the moment are funding linkages and production linkages in terms of the product accessibility into the market”* [P11: Case C C4.rtf - 11:19].

University entrepreneurial networks thus significantly and positively influence the graduation of NTBFs.

### **Access to organisational resources (P4)**

Most university incubators provide specialised resources, such as technical or other research capabilities that are not otherwise available to NTBFs (Todorovic and Moenter, 2010). Within the organisational resources family this study found three codes – infrastructure,

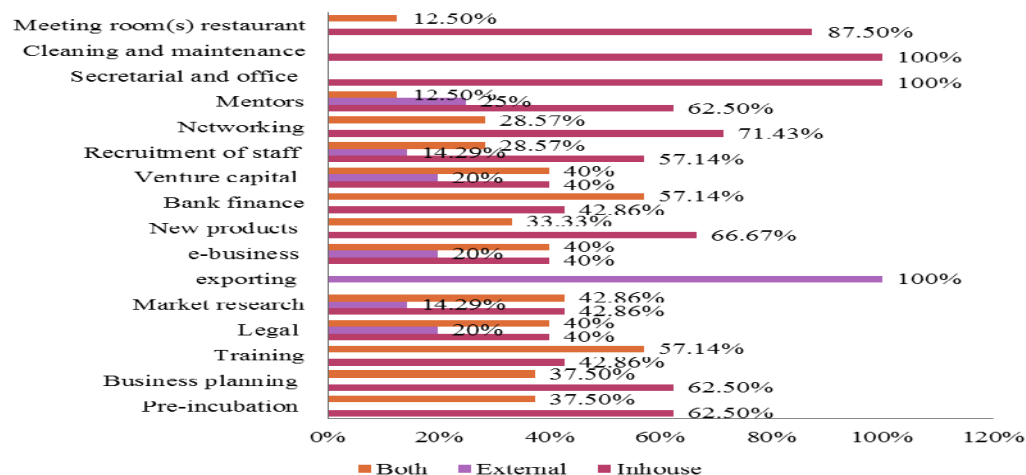


Figure 7. Services offered.

internet and physical resources.

The physical infrastructure includes rental spaces, equipment, administrative facilities like fax, phone and internet lines, and in certain cases labs, conference facilities and so on (Peters et al., 2004). As manager B1 stated:

*"We offer the NTBFs the offices, electricity and a platform to discuss their business. However, sometimes our internet is slow and not working"* [P 3: Case B-B1.rtf - 3:8].

On the other hand, managers interviewed pointed to the importance of the internet. NTBFs use the internet for research purposes. In the words of a management team:

*"They have access to internet services here, am' they free to come in and to speak with us about any problem and, like I said, we are here for mentorship as well all the time"* [P 8: Case C C1.rtf - 8:24].

Physical resources represented the physical characteristics of the UTBI, including the size of the incubator (leasable space), age and shared resources like office equipment and machinery. For example, manager C1 stated:

*"Am' what we do we are up to date in what we offer them here, like roof-sheeting manufacturing, toilet papers, printing, etc. and chemicals, okay"* [P 8: Case C C1.rtf - 8:36].

Figure 7 gives a clear picture of the services offered to NTBFs. NTBFs of the three UTBIs have a wide range of services at their disposal.

For this research, it is assumed that organisational resources are significantly and positively related to the graduation of NTBFs.

### University administrative and legal policies (P5)

Administrative and legal policies, including selection and graduation policies were reported on. In the selection policy, in some cases NTBFs were encouraged to register for a qualification or produce a range of skills. Clear recruitment policies must exist to run this stage effectively so that the incubator eventually supports and funds sustainable long-term profitability (Ascigil, 2006). The graduation policy is generally kept flexible, but has an optimal period of three years. IT-based software may take less time to move from pure ideas to actual commercialised products in comparison to a hardware-based product or an agricultural product (Al-Mubarak and Wong, 2011). During the graduation period, the graduation committee decides which NTBFs will graduate based on set measures. After the expiry of this period the rent was raised. Hence, university administrative and legal policies will have a negative influence on the graduation of NTBFs

### Access to financial resources (P6)

Generally, NTBFs need and require financial support for their businesses. Within the financial resources family, this study found three codes associated with the financial resources, namely financial loans, financial support and financial grants. However, NTBFs do not have records of accomplishment on which banks may base their lending decisions (Zhang and Sonobe, 2011). In these circumstances, the only way to get started is by the founders providing the finance personally (Löfsten and Lindelöf, 2003). Regrettably, none of the cases provides financial support to NTBFs in the pre-incubation and the incubation stage.

*"...For a business to actually take off we don't, we don't"*

*priorities on financial support. Our priority is the ability to run the business” [P 1: Case A A1.rtf - 1:83].*

Access to financial resources will positively influence the graduation of NTBFs.

The nature of incubation changes according to:

1. The varying resource needs of the tenant firm over the duration of the incubation period
2. The tenant firm’s industrial affiliation

As has become clear, the incubation process has three stages. In the pre-incubation stage, the UTBIs provide the following enabling factors: stringent selection and admission, and pre-incubation services. During the incubation stage the UTBIs provide access to business support services, financial resources, organisational resources and university entrepreneurial networking/n mediation. During the graduation stage, UTBIs provides the graduation exit strategy, graduation rate and the incubation period. The present research contributes to the literature on university entrepreneurship, particularly the research stream on new firm creation (Rothaermel et al., 2007). The study attempts to link the development of business ideas to factors that influence their progression into graduated businesses. The findings have provided an insight into the enabling factors that might influence the graduation of NTBFs (Figure 8). This expanded theoretical framework highlights the incubation stages of UTBIs and, most importantly, what each stage constitutes. On examination of Figure 8, it becomes apparent that infrastructure is part of business support and that financial loans are associated with financial and organisational resources. Financial support is in addition, a part of entrepreneurial network/mediation.

The theoretical framework depicts the incubation stages of pre-incubation, incubation and graduation. A pre-incubation stage has also been included in Figure 8 as an enabling factor. The study found that within the pre-incubation stage there are two most important enabling factors that could influence the graduation of NTBFs, namely stringent selection and admission criteria, and pre-incubation services. The figure depicts that incubators have some form of application/screening process, and that service is present during the pre-incubation stage. The pre-incubation service contributes to the graduation of NTBFs and could be a positive motivator for the early growth of NTBFs. Hence, this aspect is also strongly established and all the three research cases supported this enabling factor.

However, the study also found that during the pre-incubation stage UTBIs do not provide financial assistance to NTBFs:

*“In the pre-incubation stage, we do not have financial support. It’s just administrative support that we offer. Apart from linking them to our sponsor, we have got*

*agencies that would finance pre-incubation processes of good ideas” [P 4: Case B2-B2.rtf - 4:30].*

With regard to the incubation stage demonstrated in the Figure 8, the study found four main enabling factors that might influence the graduation of NTBFs, namely business support, university entrepreneurial network/mediation, and financial and organisational resources. Within the graduation stage, as shown in Figure 8, the study found the following enabling factors that are important to the graduation of NTBFs: graduation exit strategy, graduation rate and graduation incubation period. The graduation rate of an incubator is related to the question of how many UTBI client firms have used the services offered over the years, and have continued their operations after ceasing the use these services (Science Alliance, 2007). Graduation policies should include time limits and the type/amount/value of services that would be provided by the incubator during the incubation process (Scaramuzzi, 2002). However, some incubators do not formulate their graduation policy clearly – the NTBF has a say in choosing the moment of graduation, or the graduation is related to the question whether or not private equity has been obtained (Science Alliance, 2007). Most university incubators have only two processes, pre- incubation and incubation (Farsi and Nikraftar, 2011).

This study also contributes to the literature on the incubator-incubation discourse, specifically within the context of developing countries like South Africa. Most studies that have investigated the factors influencing the success of incubators to date have been conducted in developed countries such as the US, Germany and Italy.

## DISCUSSION AND IMPLICATION

This research has implications for both industry and government strategies. Managers should promote the efficiency of the triple-helix model of academic-industry-government relations, as suggested by Etzkowitz et al. (2000), which enhance the role of technological innovation. For instance, university incubators should have connections with agencies outside the university for finding financial support or for introducing the businesses to related agencies after the incubation period that could provide additional support. Further, by understanding the individual components of the theoretical framework, managers will be in a better position to make decisions concerning NTBFs and thus positively influence the timely and successful graduation of NTBFs. University incubators should operate independently from their institutional administrative and legal policies. In conclusion, management teams need to be specific in their selection policy, the incubation contract and the exit strategy in order to graduate NTBFs on time and successfully. On the other hand, NTBFs should pursue strategies that

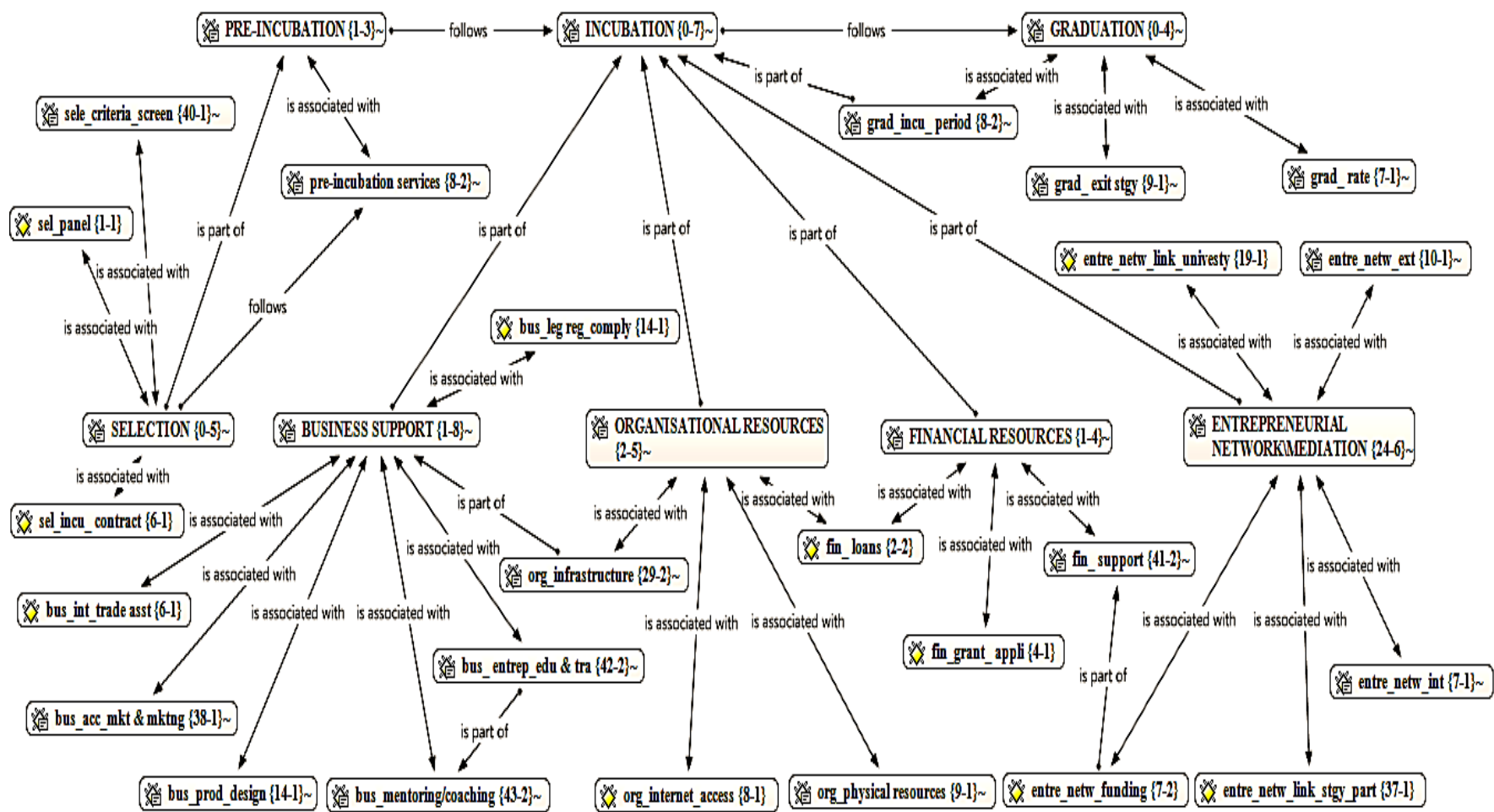


Figure 8. Proposed theoretical framework of factors that influence the graduation of NTBFs.



networks with external resource holders (such as the universities but also other firms etc) in order to succeed (Löfsten and Lindelöf, 2005). Government may be able to improve on efforts to access financial resources. For instance, they could be in a position to offer either a raw-material loan, such as metals, fabrics, etc., for the production requirements of NTBFs, or very low interest rates with a very long period of return as a means of sharing the risks of investing in NTBFs. The final managerial contribution of this study is that the study could serve as a guide for business managers and policy-makers in South Africa when creating policies relating to incubation in general.

## CONCLUSION AND FUTURE RESEARCH

South Africa is characterised by having two incubation movements, namely technology stations and business incubators (Ndabeni, 2008). The technology stations programme was developed by the Department of Science and Technology to strengthen and accelerate the interaction between technikons and SMMEs (Ndabeni, 2008). All the technology stations are located at UoTs. XXX UoT hosts three of them (Ndabeni, 2008).

This study found five enabling factors that might influence the graduation of NTBFs. The enabling factors such as selection and pre-incubation services are related to the pre-incubation stage. Business support services, university entrepreneurial networks/mediation, and financial and organisational resources are part of the incubation stage. Within the graduation stage the study found the following enabling factors important to the graduation of NTBFs: graduation exit strategy, graduation rate and graduation incubation period.

The findings of this study provide a theoretical framework for UTBI managers to be successful in establishing high-growth businesses. Each research issue tested was discussed in terms of its connection to past research and its advances from that research. The limitations and implications of the research were addressed, and suggestions were made for future research. The study has highlighted the enabling factors that could influence the graduation of NTBFs within an UTBI. The study has concluded that a number of factors are a pertinent to the graduation of NTBFs. Firstly, the study's limitations could be addressed to further the capacities and the accuracy of the study. Specifically, it would have been optimal to include the perspectives of NTBFs in order to validate the responses given by UTBIs. The sampling additional UTBIs would also have been preferable to allow for a larger and more diverse sample. Second, future research could adopt longitudinal study surveys conducted in multiple incubators, preferably in both traditional and UoT NTBFs. This would have made it possible to gain greater insight into the incubation process and would also have given valuable insight into the development of NTBFs.

Third, it would be useful to investigate incubation

stages and resources to a greater extent since the nature of incubation changes according to the varying resource needs of NTBFs over the duration of the incubation period and according to the NTBFs industrial affiliation (Ahmad and Ingle, 2011). Hallam and DeVora (2009) have commented that the services required by incubatees will change over time as a consequence of the firm's development phase. Interestingly, a mixed method utilising a longitudinal study would look at resource allocation in terms of the incubation stage and how it influences the graduation of NTBFs.

Fourth, successful and timely graduation does not guarantee long-term success (Rothaermel and Thursby, 2005b). The incubator's responsibility and role in achieving sustainability should not end with graduation (Ascigil, 2006). For this reason, future involvement by UTBIs should go beyond graduation, which is clearly an important milestone in the development of a new venture, but investigate the performance of these ventures post-graduation (Rothaermel and Thursby, 2005b). An important question concerns the extent to which UTBIs provide for graduated firms. A similar analysis can be enlightening for technology stations. Another research area for future development could be the conduct of a meta-analysis to identify and rank the enabling factors that influence the graduation of NTBFs within the UTBI. Finally, further research could also be conducted to provide academic evidence as to whether the commercialisation of NTBF products could influence their graduation. It would be interesting to understand the diffusion of university products and how these are adopted in the market using Rogers' (2003) diffusion of innovations model.

## Conflict of interest

The authors has not declared any conflict of interest.

## REFERENCES

- Aerts K, Matthyssens P, Vandenbempt K (2007). Critical role and screening practices of European business incubators. *Technovation* 27:254-267.
- Ahmad AJ, Ingle S (2011). Relationships matter: case study of a university campus incubator. *Int. J. Entrepreneurial Behav. Res.* 17(6):626-644.
- Akio T (2005). The critical assessment of the resource-based view of strategic management: the source of heterogeneity of the firm. *Ritsumeikan Int. Affairs* 3:125-150.
- Alsos GA, Hytti U, Ljunggren E (2011). Stakeholder theory approach to technology incubators. *Int. J. Entrepreneurial Behav. Res.* 17(6):607-625.
- Alvarez SA, Busenitz LW (2001). The entrepreneurship of resource-based theory. *J. Manage.* 27:755-775.
- Ascigil S (2006). Fostering entrepreneurship through incubators: challenges in management. United States association for small business and entrepreneurship (USASBE) and the small business institute (SBI), annual conference on "The changing entrepreneurial landscape". Tucson: Arizona.
- Barney JB (1991). Firm resources and sustained competitive. *J. Manage.* 17:99-120.

- Barney JB (2001). Resource-based theories of competitive advantage: a ten year retrospective on the resource-based view. *J. Manage.* 27:643-650.
- Barne JB (2012). Purchasing, supply chain management and sustained competitive advantage: the relevance of resource-based theory. *J. Supply Chain Manage.* 48(2):3-6.
- Barney JB, Ketchen DJ, Wright M (2011). The future of resource-based theory: revitalization or decline? *J. Manage.* P. 37.
- Barney JB, Wright M, Ketchen DJ (2001). The resource-based view of the firm: ten years after 1991. *J. Manage.* 27:625-641.
- Bergek A, Norrman C (2008). Incubator best practice: a framework. *Technovation* 28: 20-28.
- Bizzotto C (2003). The incubation process. Santa Catarina: infoDev Incubator Support Center (iDISC).
- Bøllingtoft A, Uihøi JP (2005). The networked business incubator—leveraging entrepreneurial agency? *J. Bus. Venturing.* 20:265-290.
- Bruneel, J, Ratinho T, Clarysse B, Groen A (2012). The evolution of business incubators: comparing demand and supply of business incubation services across different incubator generations. *Technovation* 32:110-121.
- Buys AJ, Mbewana PN (2007). Key success factors for business incubation in South Africa: the Godisa case study. *South Afr. J. Sci.* 103:356-358.
- Carayannis EG, Von Zedtwitz M (2005). Architecting gloCal (global-local), real-virtual incubator networks (G-RVINs) as catalysts and accelerators of entrepreneurship in transitioning and developing economies: lessons learned and best practices from current development and business incubation. *Technovation* 25:95-110.
- Dooley L (2002). Case study research and theory building. *Adv. Dev. Human Resour.* 4(3):335-354.
- Eisenhardt K (1989). Building theories from case study research. *Acad. Manage. Rev.* 14(4):532-550.
- Etzkowitz H, Webster A, Gebhardt, C (2000). The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm. *Res. Policy* 29:313-330.
- Etzkowitz H, Dzisah J, Ranga M, Zhou C (2007). The triple helix model of innovation University-industry-government interaction. *Technol. Monitor* pp.14-23.
- European Commission (2002). Final report: benchmarking of business incubators. centre for strategy & evaluation services. Kent: European Commission Enterprise Directorate-General.
- Farsi JY, Nikrafta, T (2011). Contextual dimension of university incubator organizations in Iran. *Eur. J. Sci. Res.* 48(3):341-351.
- Grandi A, Grimaldi R (2004). Evolution of incubation models evidence from the Italian incubation industry. *Ind. Higher Edu.* pp. 23-31.
- Hackett SM, Dilts DM (2004a). A real options-driven theory of business incubation. *J. Technol. Transfer.* 29:41-54.
- Hackett SM, Dilts DM (2004b). A systematic review of business incubation research. *J. Technol. Transfer.* 29:55-82.
- Hallam CRA, Devora N (2009). Technology-based business incubation: a study of the differences and similarities between private, university, and government incubation. Portland, Oregon USA: PICMET. 1875-1887).
- Kohn LT (1997). Methods in case study analysis. The center for studying health system change technical publication p.2.
- Kumar KS, Ravindran DSR (2012). A study on elements of key success factors determining the performance of incubators. *Eur. J. Soc. Sci.* 28(1):13-23.
- Lee SS, Osteryoung JS (2004). A comparison of critical success factors for effective operations of university business incubators in the United States and Korea. *J. Small Bus. Manage.* 42(4):418-426.
- Lockett A, Thompson S, Morgenstern U (2009). The development of the resource-based view of the firm: a critical appraisal. *Int. J. Manage. Rev.* 11(1):9-28.
- Löfsten H, Lindelöf P (2002). Science parks and the growth of new technology-based firms-academic industry links, innovation and markets. *Res. Policy* 31: 859-876.
- Löfsten H, Lindelöf P (2003). Determinants for an entrepreneurial milieu: science parks and business policy in growing firms. *Technovation* 23: 51-64.
- Löfsten H, Lindelöf P (2005). R&D networks and product innovation patterns-academic and non-academic new technology-based firms on science parks. *Technovation* 25:1025-1037.
- Mcadam M, Mcadam R (2008). High tech start-ups in university science park incubators: the relationship between the start-up's lifecycle progression and use of the incubator's resources. *Technovation* 28:277-290.
- Mian S (1994). US university-sponsored technology incubators: an overview of management, policies and performance. *Technovation* 14(8):515-528.
- Mian S (1996a). Assessing value-added contributions of university technology business incubators to tenant firms. *Res. Policy* 25:325-335.
- Mian S (1996b). The university business Incubator: a strategy for developing new research/technology-based firms. *J. High Technol. Manage. Res.* 7(2):191-208.
- Mian S (1997). Assessing and managing the university technology business incubator: an integrative framework. *J. Bus. Venturing* 12:251-285.
- Mian S (2011). University's involvement in technology business incubation: what theory and practice tell us? *Int. J. Entrepreneurship Innov. Manage.* 13(2):113-121.
- Moreira AC, Carvalho MFS (2012). Incubation of new ideas: extending incubation models to less-favored regions. *Entrepreneurship-Creativity Innovative Bus. Models* pp.41-58.
- Morgan D (2007). Paradigms lost and pragmatism regained-methodological implications of combining qualitative and quantitative methods. *J. Mixed methods Res.* 1(1):48-76.
- Ndabeni L (2008). The contribution of business incubators and technology stations to small enterprise development in South Africa. *Dev. Southern Afr.* 25(3):259-268.
- Nosella A, Grimaldi R (2009). University-level mechanisms supporting the creation of new companies: an analysis of Italian academic spin-offs. *Technol. Anal. Strategic Manage.* 21(6):679-698.
- Patzelt H, Shepherd DA (2009). Strategic entrepreneurship at universities: academic entrepreneurs' assessment of policy programmes. *Entrepreneurship Theory Pract.* 33(1):319-340.
- Peters L, Rice M, Sundararajan M (2004). The role of incubators in the entrepreneurial process. *J. Technol. Transfer* 29:83-91.
- Phan PH, Siegel DS, Wright M (2005). Science parks and incubators: observations, synthesis and future research. *J. Bus. Venturing* 20:165-182.
- Priem RL, Butler JE (2001). Is the resource-based "view" a useful perspective for strategic management research? *Acad. Manage. Rev.* 26(1):22-40.
- Ratinho T, Harms R, Groen A (2010). Towards a distinction between technology incubators and non-technology incubators: can they contribute to economic growth? *Eur. Council Small Bus. Entrepreneurship* pp.1-26.
- Ratinho T (2011). Are they helping? an examination of business incubators' impact on tenant firms. PHD dissertation. University of Twente.
- Rice M (2002). Co-production of business assistance in business incubators: an exploratory study. *J. Bus. Venturing.* 17:163-187.
- Rothaermel FT, Agung SD, Jiang L (2007). University entrepreneurship: a taxonomy of the literature. *Ind. Corporate Change* 16(4):691-791.
- Rothaermel FT, Thursby M (2005a). University-incubator firm knowledge flows: assessing their impact on incubator firm performance. *Res. Policy* 34:305-320.
- Rothaermel FT, Thursby M (2005b). Incubator firm failure or graduation? the role of university linkages. *Res. Policy* 34:1076-1090. <http://scheller.gatech.edu/directory/faculty/rothaermel/pubs/05bRP.pdf>
- Scaramuzzi E (2002). Incubators in developing countries: status and development perspectives. Washington DC: The World Bank, Information Development Programme.
- Science Alliance (2007). Final report: exploring best practices in incubation in Europe and Israel. [Online]. Google.com. Available from: <http://fivu.dk/en/publications/2007/exploring-best-practises-in-incubation-in-europe-and-israel>. [Accessed: 3/3/2012].
- Sheehan NT, Foss NJ (2007). Enhancing the prescriptiveness of the resource-based view through Porterian activity analysis. *Manage. Decis.* 45(3):450-461.
- Somsuk N, Punnakitikashem P, Laosirihongthong T (2010).

- Determining enabling factors of university technology business incubation programme: resource-based view theory. The IEEE International Conference on Industrial Engineering and Engineering Management (IEEM). pp. 1032-1037.
- Somsuk N, Wonglimpiyarat J, Laosirihongthong T (2012). Technology business incubators and industrial development: resource-based view. *Ind. Manage. Data Syst.* 112(2):245-267.
- Tang M, Baskaran A, Pancholi J (2010). Technology business incubators in China and in India: a comparative analysis. *Inst. Econ. Research and Innovation Working Paper.*
- Todorovic ZW, Moenter KM (2010). Tenant firm progression within an incubator: progression toward an optimal point of resource utilization. *Acad. Entrepreneurship J.* 16(1):23-40.
- Yin RK (2003). *Case study research design and methods.* 3<sup>rd</sup> ed. Thousand Oaks: Sage.
- Yin RK (2009). *Case study research-design and methods.* 4th ed. Los Angeles: Sage.
- Zhang H, Sonobe T (2011). Business incubators in China: Inquiries into the variables associated with incubate success. *Economics: the open-access, open-assessment e-journal.* 5:1-26.