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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

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Abstract

University Science Park incubators (USIs) have emerged as a means by which Government, academia and business can develop high technology business firms (spin out HTBFs) from initial conception through to becoming established small firms, which are ready to move beyond the Science Park confines. Although there is considerable literature on how USIs can be improved and developed there is a paucity of studies, which explore how lifecycle development within HTBFs in USIs can affect how they use the unique resources and opportunities of the USI. Moreover, there is a focus on single point in time studies, which do not adequately investigate the longitudinal dynamics of HTBF lifecycle development within USIs. Therefore, the aim of this paper is to explore the longitudinal use of the unique resources of the USI by HTBFs at different lifecycle stages.

The research methodology involved 18 HTBFs within two separate USIs. A series of longitudinal interviews and focus groups were conducted with HTBFs and USI staff over a 36-month period. NUD*IST software was used in developing the coding and analysis of transcripts. The results show that a HTBF's propensity to make effective use of the USI's resources and support increases as the lifecycle stage of the company increases and the small-firm searches for independence and autonomy. Therefore, further research is required to investigate the following two outstanding questions; firstly, which usage pattern is associated with the HTBF's ultimate success or failure in the marketplace? And secondly, are there any services missing from the observed array that the USI could provide to enhance the HTBF's degree of ultimate success?

Keywords: University incubators; High technology firms; Lifecycle; Entrepreneurial growth

1. Introduction

Within the literature the University Science Park incubator (USI) is recognised as an effective support mechanism for new entrepreneurial firms (Smilor and Gill, 1986; Barrow, 2001). This recognition is based on the provision of shared facilities such as offices, administrative staff and access to university research and external grant support from Government and other sources, such as venture capitalists (Albert and Gaynor, 2003; Carayannis et al., 2006). Moreover, the USI has emerged as incorporating and promoting mechanisms that foster partnerships between the University, the incubator firms and other external parties thus, facilitating the transfer of knowledge and expertise from Universities to the business economy (Zucker et al., 2002; Lender, 2003).

Although there is a significant literature on how USIs can be improved and developed (e.g. Safraz, 1997; Lee and Osteryoung, 2004; Rothaermel and Thursby, 2005; Dettwiler et al., 2006) there is a paucity of studies which explore how lifecycle development within the high technology business firms (HTBF) influences the use of the unique USI resources. Moreover, there is a focus on single point in time studies which do not adequately investigate the longitudinal dynamics of HTBF lifecycle development

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within USIs prompting the need for longitudinal studies (Terleckyi, 1999; Rothaermel and Thursby, 2005). Questions arising include, what role does the USI play in supporting the HTBF in its development as represented by the lifecycle model? How do HTBFs utilise the unique resources and support provided by the USI in order to support growth ambitions throughout the lifecycle stages?

If these issues and questions can be addressed then there will be an opportunity to make a twofold contribution to knowledge. Firstly, models and methodologies relating to lifecycle development within USIs will be clarified and developed. Secondly, stakeholders involved in USIs will have a clearer understanding of how to ensure that appropriate support and resources are available for the HTBF at the different stages of its lifecycle development.

Therefore, the aim of this paper is to explore the longitudinal use of the unique resources of the USI by HTBFs at different lifecycle stages. This paper seeks to add to the USI literature by exploring how lifecycle development within HTBFs in USIs can affect how they use the unique resources and opportunities of the USI. Consequently, the authors aim to investigate small-firm lifecycle development in USIs using a longitudinal study. The study is based on longitudinal evidence gathered from eighteen small HTBFs within two separate USIs based in the Republic of Ireland and United Kingdom, respectively. The paper commences by addressing the key issues within the current literature relating to the resource-based perspective (Druilhe and Garnsey, 2004) with particular attention focused upon lifecycle development of HTBFs. Following the presentation of the research questions and research methodology, the longitudinal empirical findings are discussed. Finally, the paper concludes with overall conclusions and recommendations for further study.

2. Resource-based perspective and the USI

The resource-based view (RBV) of the firm is used to investigate how the deployment of key resources in the USI, namely business support and social support changes during the lifecycle development of the small entrepreneurial firm. According to the RBV of the firm (Penrose, 1959; Barney, 1991) organisations are collections of unique resources and capabilities. The RBV refers to financial, physical, human, commercial, technological and organisational resources (Barney, 1991). Lockett and Wright (2005) found that the RBV could be used to conceptualise the both the static (e.g. facilities) and dynamic (e.g. routines such as technology licensing and proof of concept processes) resources associated with USIs. Druilhe and Garnsey (2004) conclude that the RBV and particularly Penrose's work (1995) provides a basis for conceptualising the emergence of entrepreneurial firms and for differentiating between science-based firms (Lofsten and Lindelof, 2005).

From a resource-based perspective, the incubator adds to the stock of resources available to the organisation without incurring substantial cost (Rothaermel and Thursby, 2005b; Carayannis et al., 2006). Proximity to the university coupled with the knowledge, facilities and labour force can be valuable in several ways (Lofsten and Lindelof, 2005; Dettwiler et al., 2006). Co-operation with university staff may provide access to the latest knowledge in the area of interest thus resulting in the development of more innovative products (Lockett and Wright, 2005; Nouira et al., 2005). The university link may also result in reduced development costs (Markman et al., 2005) in addition to providing the customer with a guarantee that products or services are based on the latest knowledge available (Zucker et al., 2002). Another related university resource is the availability of specialist skills-based labour where it may be an advantage to be located close to the university in order to make the firm known to students in specific disciplines (Barrow, 2001).

The resources provided by the incubator include incubator facilities and the clustering effect similar to that of a Community of Practice (Carayannis et al., 2006; McAdam and McAdam, 2006). Incubator facilities include business advice, service and incubator management. Business advice includes that acquired either from the persons employed by the incubator or by consultants recommended by the incubator administration (Lee and Osteryoung, 2004; Rothschild and Darr, 2005). Moreover, the service resource provided by the incubator refers to secretarial services, conference facilities, canteen and car parking which are usually much less costly than individual premises and services (Markman et al., 2005). Effective incubator management can ensure that the firms have access to resources of business advice including specialist programmes and seminars (Safraz, 1997).

The impact of incubator facilities on the small-firm result in access to new knowledge, expertise, networks and cost effective access to leading edge research (Barrow, 2001). Consequently, such unique resources enable the firms to commence trading quickly without large overheads while also offering credibility to the enterprise and opportunities for networking (Rothschild and Darr, 2005). Clustering effects include access to knowledge resources and the attraction of venture capitalists which is related to the incubator image and the provision of credibility as well as the generation of collective knowledge and learning among its member firms (Hannon and Chaplin, 2003; Hannon, 2005; Rothschild and Darr, 2005). The benefits of clustering effects can also help to minimise the feeling of isolation through the sharing of common values and norms (Smilor and Gill, 1986).

Although the resource-based perspective provides insights into the USI, there appears to be a lack of evidence investigating the impact of such resources as the firm pursues growth strategies and entrepreneurial growth. Moreover, an overly simplified assumption within some studies is that the HTBFs' propensity to make effective use of the USI's resources and support remains linear as the lifecycle stage of the firm increases from the point of

creation of the HTBF to the point of its exit from the USI into the wider Science Park as shown by Zucker et al.'s (2002) study of a USI's bioscience HTBFs. However, this paper suggests that HTBFs' propensity to make effective use of USI's resources and support may be dependent on the lifecycle stage of the HTBF within the USI (Fig. 1). Consequently, the next section of the paper addresses the lifecycle development of the HTBFs in relation to resources.

3. Lifecycle development in small firms

Lifecycle and growth effects can cause marked differentiation within small firms and their ability to make effective use of resources (Churchill and Lewis, 1983; Naffziger et al., 1994, Moy and Luk, 2003). In a review of lifecycle model studies, Beverland and Lockshin (2001) indicate that the lifecycle stage model is a useful and robust representation in terms of being a "roadmap" and "timetable" for SME development and growth. Dettwiler et al. (2006) in a study of USI facility management concluded that phase or lifecycle models could show how facilities can be more effectively used at different stages of HTBF development and that HTBF growth in the USI is a path dependant process consistent with the concept of lifecycle models. Moreover, McAdam et al. (2005) in a study of USI processes conclude that there is a need to represent "progress pathways" for HTBF growth. It is suggested that small firms at the resource maturity stage are likely to have more variety in their customer base and stability in their financial viability than small firms in the early survival stage (Beverland and Lockshin, 2001). Hence, the lifecycle approach suggests that small firms effectively use of resources is likely to have a graded effect throughout the stages of growth and development as outlined by Greiner (1998).

Utilising scarce resources to achieving sustainability and growth is a key challenge for new firms (Miner, 1990; Chan and Lau, 2005). Lifecycle or stage of development models (Greiner, 1972, 1998; Stanworth and Curran, 1976;Deakins and Freel, 2003; Bessant et al., 2005) provide insights into how a small-firm adapts to effectively utilise scarce resources in pursuit of growth. This approach is consistent with that of the resource-based perspective which postulates that small-firm growth depends on the resources available over time to manage growth and maintain current operations (Orser et al., 2000). A recent critique and extensive review of lifecycle by Bessant et al. (2005) cautions against the limitations oversimplifying the possible periodic growth and decline of small firms as opposed to continuous growth through successive lifecycles and being overly prescriptive about the definition of each discrete stage due to the heterogeneity of small firms, but also states that these models provide "significant inputs into providing important insights into understanding organisational behaviour" and that the models are mainly applied to "small, new or rapidly growing firms" as is the case for HTBFs in USIs. The models suggest that at each stage the organisation undergoes changes in management practices and style, organisational structure and degree of informality of systems and strategy (Churchill and Lewis, 1983; Greiner, 1998). The Greiner (1998, 1972) lifecycle model (Fig. 2) is representative of the lifecycle genre (Beverland and Lockshin, 2001) and depicts a continuous relationship between time and growth, consisting of periods of incremental growth (evolution) and explicitly defined crisis-based growth (revolution). Greiner (1998, 1972) suggest that organizations go through five stages of growth and as a result require appropriate strategies and structures in order to achieve entrepreneurial growth.

Therefore, by combining the Greiner Model (Fig. 2) with the resource-based perspective of the firm (Penrose, 1959; Barney, 1991) insights are gained into the resource utilisation of small firms in USIs as they progress to different stages of development. Bigliardi et al. (2006) have used a similar lifecycle analogy for assessing longitudinal Science Park performance using a multiple case analysis, which showed different resource use at different stages of development. The focus of their research was on developing performance or outcome measures based on lifecycle stages, which aligned with the overall mission of the Science Park. The lifecycle approach is also used by Blaydon et al. (1999) used by to probe the different management skills resources in terms of educational

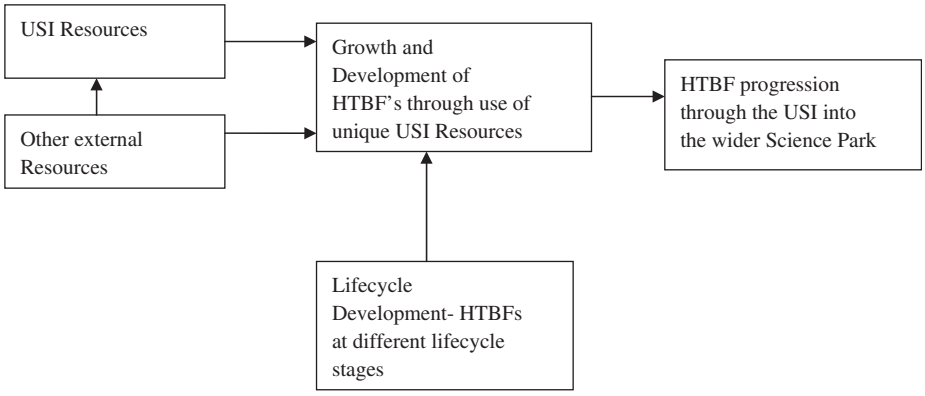

Fig. 1. Relationship between Incubator Resources, HTBFs and Growth (adapted from Lofsten and Lindelof, 2005).

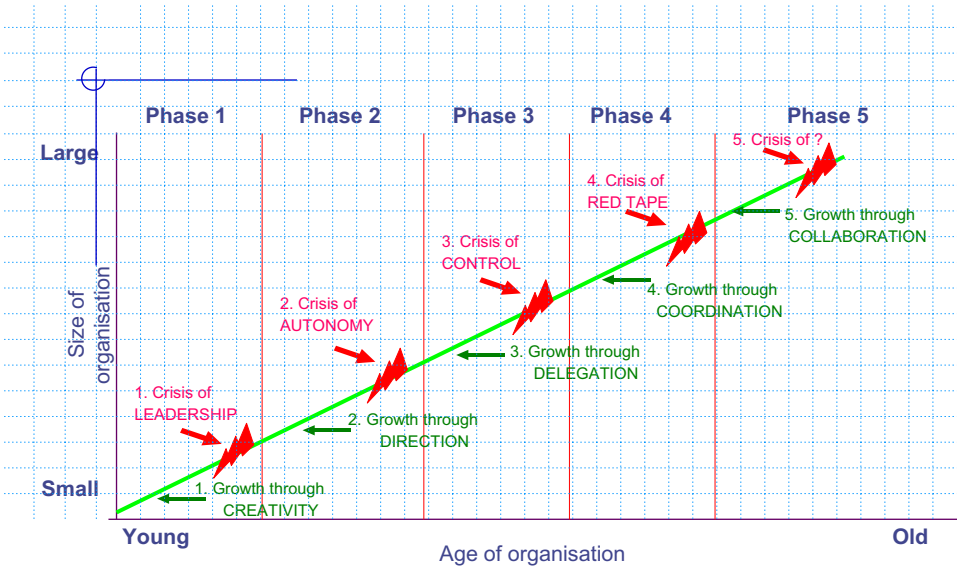

Fig. 2. Characteristics of Greiner's growth model (Greiner, 1972).

programmes needed at each stage of lifecycle development in HTBFs. However, there is a need to look within the HTBFs to question how they effectively use or absorb resources at different lifecycle stages. This paper seeks to build on these studies by adopting the lifecycle approach but with a focus on the support provided by the Science Park at each stage of the lifecycle and by investigating how HTBFs actually use and absorb such resources at these stages.

4. The role of the HTBF management team

To further focus the aim of the study, the role of the HTBF's management team in using unique USI resources at each stage of the lifecycle model is emphasised as a key determinant (Kamm et al., 1990; Birley and Stockley, 2000; Nouira et al., 2005), while at the same time accepting that other factors are important and can be the subject of further research. This approach represents an element of prioritisation and limitation within the study, as other factors will influence growth in this context including motivated employees, marketing and technology development. Carayannis et al. (2006) and Barringer and Jones (2004) show that the HTBF entrepreneur and the entrepreneurial team influence all of these other factors in an overarching manner. The entrepreneur and entrepreneurial team within the USI will be faced with numerous challenges as it progresses through its lifecycle and will require access to different types of resources in order to support its pursuit of growth orientated strategies (Chan and Lau, 2005). Sustaining growth in terms of adequate resource utilisation will be one of the greatest challenges (Timmons, 1994; Deakins and Freel, 2003). In order to overcome this challenge the extant literature refers to the implementation of the entrepreneurial team to lead enterprises which seek to sustain growth by effectively using scarce resources as is the case for HTBFs in the USI context (Dettwiler et al., 2006; McAdam and McAdam, 2006). An emerging theme in the literature is the need for the entrepreneur to share the enterprise if it is to remain entrepreneurial in terms of effectively utilising resources (Cooper and Daily, 1997; Deakins and Freel, 2003). As the firm grows it may well be that the entrepreneur becomes overwhelmed by the sheer volume of the tasks involved in everyday activities and so will need to delegate and share the allocation of appropriate resource with others (Kamm et al., 1990; Neergaard, 2005) There is a need for the entrepreneur to select individuals who possess expertise and contacts, which will aid the growth of the firm, resulting in the formation of an entrepreneurial team (Lessem, 1986; Timmons, 1994; Birley and Stockley, 2000). Once established, it is critical that the correct support and reward structures are established in order to promote the development of this team (Kamm and Nurick, 1993; Neergaard, 2005). It is essential that the team shares the entrepreneurial vision of the entrepreneur and is empowered in such a way that encourages initiative and the adoption of creative and innovative practices based on unique USI resources at each stage of the lifecycle (Safraz, 1997) (Fig. 3).

When an effective entrepreneurial team is in place the entrepreneur is able to resume the position of leader and visionary who not only seizes new opportunities in terms of access to new resources but also encourages the team to be innovative and opportunity focused in resource utilisation (Neergaard, 2005). The maintenance of an entrepreneurial culture is paramount in the encouragement of creativity and innovativeness to employ resources (Timmons, 1994). The entrepreneur must not only provide the team with vision but also with effective systems and structures to support their activities and operations (Kamm et al., 1990; Deakins and Freel, 2003). It is important that the goals set

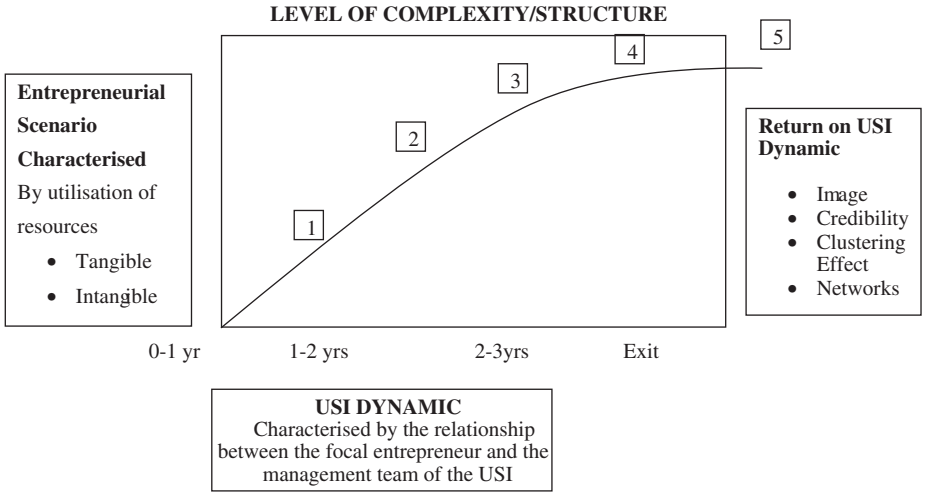

Fig. 3. Lifecycle development within the USI (adapted from Carson et al., 1995).

are achievable and the organisation is working together in order to realise these objectives. In order to achieve these goals it is necessary to have effective team building skills but also networking capabilities in order to access required information and resources (Timmons, 1994; Stevenson et al., 1985; Kamm et al., 1990), where networks of HTBFs and USI stakeholders (both real and virtual) are viewed as a unique USI resource (Lofsten and Lindelof, 2005; Carayannis et al., 2006).

In order to build a strong entrepreneurial team, the entrepreneur will select individuals who not only possess technical and managerial expertise but who also share same values and work ethic (Cooper and Daily, 1997). Hansson et al. (2005) refer to this as building social capital to promote growth and development. The entrepreneur will use this team as a sounding board and decision-making forum through which the direction and focus of the firm will be made. By seeking managers' advice and feedback the entrepreneur will not only promote entrepreneurial and innovative thinking amongst the team but will also gain trust and commitment from the employees (Kaplan, 1984; Kamm and Nurick, 1993). According to Vyakarnam et al. (1996) it is not solely the entrepreneurial team itself which is important to growth orientated strategies but the ability of the entrepreneur to build and manage the team effectively. Moreover, the process of building and developing the entrepreneurial team is not structured and systematic, but more likely to be chaotic spontaneous and unique to the entrepreneur (Freel, 1997; Birley and Stockley, 2000).

5. Research methodology

The main research questions in relation to the aim of the paper are:

- What role does the USI play in supporting the HTBF in its development as represented by the lifecycle model?
- How do HTBFs utilise the unique resources and support provided by the USI in order to support growth ambitions throughout the lifecycle stages?

The research method chosen was that of using case-based research to probe the relationships suggested in the initial conceptual model (Fig. 1) (Yin, 1994; Eisenhardt, 1989; Perren and Ram, 2004). The exploratory multiple case strategy was used as the study focuses on achieving insights based on "*how*" and "*what*" type questions (Yin, 1994; Eisenhardt, 1989). This study recognises that the research questions relate to issues, which are complex and dynamic, consisting of a wide range of influences, which interact thus, forming the realities of the entrepreneur, the entrepreneurial firm and the USI. The first research question is based on the USI level of analysis and the second research question relates to the HTBF level of analysis, consistent with that of Lofsten and Lindelof (2005) who state that HTBF level of analysis studies is needed due to the heterogeneity of HTBFs. Moreover, this study uses longitudinal research as opposed to a cross sectional study to show the dynamics involved. Terleckyi (1999) suggests the need for more longitudinal research in small firms. The research was undertaken over a 3-year period between 2000 and 2003. This longitudinal approach, combined with a qualitative methodology, drawing upon interviewing, non-participant observations and informal discussion with a range of stakeholders associated with the incubator, realised a deep rich data set. The longitudinal multiple perceptions, revealed the complexity and dynamics of the USI and the HTBFs as opposed to the usual "snapshot" approach (Gill and Johnson, 2002). Therefore, it was possible to construct a rich picture of how the entrepreneurs operated within the unit over time and it, in turn, supported their ambitions through access to shared facilities, advisors, technical information, investors and development opportunities.

The context of the research was two USIs, one USI (I) was located in the Republic of Ireland and the other USI

(II) in the United Kingdom. USI (I) was chosen, as it has been in operation for a considerable period of time and hence suitable for observing developments in lifecycle progression. It was established in 1980 and was located within Ireland's first Science and Technology Park. The incubator was Ireland's first digitally networked business incubator. The incubator offers an effective integrated package of new business development support services, facilities and expertise to assist entrepreneurs to plan, research, develop and build new Irish high technology businesses. The aim of the incubator is to incubate small high technology firms for a 3-year period and once incubated successfully, the firms move into the nearby larger science park facilities. USI (II) was established in 1999, to support the growth of small IT firms. The incubator site is a "state-of-the-art" biotechnology research and development centre combining the latest in laboratory facilities with a comprehensive support infrastructure. This combination of an exceptional building resource with a commercially and academically supportive company offers a unique package for biotech start-ups. The site incubates new ventures for a 3-year period and if then successful, the firms move into the nearby larger science park facilities. Tenants of incubator facilities can be "spin-out" firms, which have emerged directly from the university research and knowledge base or "spin-in" firms, keen to take advantage of the facilities and research profile of the university to establish new research and development-based companies. The characteristics of the 18 firms involved in the study are detailed in Table 2.

The entrepreneurs or owner/managers of each firm in each USI were interviewed several times—each upon at least six formally agreed occasions over a 3-year period with other numerous informal meetings, conversations and exchanges (e.g. telephone and email) occurring during the course of the study. The respective USI management team, other support workers and external visitors were also interviewed at some length to gain insights into their perceptions of lifecycle development in the units. The longitudinal multiple perceptions, revealed the complexity of the lifecycle development within the USI. The interviews were tape-recorded, transcribed and then analysed through the NUD*IST software package. The transcripts were coded using the free node facility of the software package. As a result, a number of categories emerged for example, growth strategies, delegation, motivation and the entrepreneurial team. During the process of "coding-on" these categories were re-analysed and categorised into "tree nodes". The tree nodes were then re-analysed and re-categorised into parent and child nodes. Once satisfied with the node system the researcher was able to use the "search and compare" node facility of NUD*IST to ask specific questions about the data collected. Other conversations and observed significant events were outlined and recorded within a research diary from which the research team consisting of two full-time researchers worked to identify common themes, significant events and examples of change over time.

Data triangulation, how quality of data was maintained and other factors (other than entrepreneur and entrepreneurial team effects) were controlled in order to generate confidence in the value of the research (Creswell, 1994; Easterby-Smith et al., 1991; Guba and Lincoln, 1994). These sources included participant observation, semi-structured and unstructured interviews, ethnographic observations, facilitated focus groups, university-organisation meetings, facilitated management discussions at the university, critical action research and review of company documents and archives. Other longitudinal studies, such as those by Shaw (2006) and Fletcher (1997), demonstrate the value of this approach given the richness of the information gathered and advantages to be gained from being immersed in the respondent's world. Yet, it is not only the detailed nature of the data which makes longitudinal studies so valuable but also, the manner in which the findings inform conceptual analysis, given their in-depth and dynamic nature. It is axiomatic that longitudinal studies are time consuming but, this approach does offers the opportunity to become immersed in the context and critically facilitates insights into the dynamics of change and continuity over time.

6. Results and discussion

The results were coded into the key areas relating to lifecycle development within the USI, as shown in Table 1. These areas were used to structure the discussion of the results in the following sections of the paper.

6.1. Utilisation of resources

In Table 2, a longitudinal representation of the utilisation of resources in relation to the firm's lifecycle development is presented.

Within the literature the USI is recognised as an effective support mechanism for new entrepreneurial firms (Smilor and Gill, 1986; Barrow, 2001). This recognition is based on the provision of shared facilities such as offices, administrative staff, shared canteen and shared reception. Therefore, at the initial stage of the lifecycle all of the firms discussed within this study avail of such services. In fact, the USI catered for the needs of the firms by providing a support infrastructure including Internet, telephone and fax services. Such facilities meant that the firms were able to organise and commence trading relatively quickly as the incubator minimised many of the challenges associated with the practical side of the new venture creation process. As one respondent, A4 stated, "*For a start-up firm, you don't want to be burdened with overheads because you're trying to add value to your product very quickly*". The speed at which the firm can get up and going was also identified as one of the key benefits of the incubator, "*I know of one Dublin based firm, in a similar position to us, they didn't have*

Table 1
The Relationship between the key themes in the literature and tree nodes identified within empirical research

Key themes identified in the literature	Key nodes identified during data analysis
University incubation literature • Provision of physical infrastructure • Clustering effect • Credibility and image • Access to professional networks (Zucker et al., 2002; Albert and Gaynor, 2003; Lender, 2003; Carayannis et al., 2006)	*Focus of research*: to explore the longitudinal use of the unique resources of the USI by HTBFs at different lifecycle stages • 18 entrepreneurs—2 USIs • 36-month period • HTBF owner/managers • USI staff
Resource based view and USI • Unique resources and capabilities • Static and dynamic resources in the USI • Incubator adds to the stock of resources • Proximity to university (knowledge, labour, and facilities) (Penrose, 1959; Barney, 1991; Druilhe and Garnsey, 2004; Lofsten and Lindelof, 2005; Lockett and Wright, 2005; Rothaermel and Thursby, 2005b; Carayannis et al., 2006; Dettwiler et al., 2006)	*Utilisation of resources* • Provision of infrastructure/ ○ Office space and facilities ○ Canteen ○ Secretarial services • University services • Credibility with customers and suppliers
Lifecycle development • "Roadmap"and"timetable" for SME development and growth. • Lifecycle/growth effect and use of resources • Graded effect • Greiner model and resource-based perspective (Greiner, 1972, 1998; Churchill and Lewis, 1983; Moy and Luk, 2003; Naffziger et al., 1994)	*Entrepreneurial transition* • Recruitment • Negative aspects • Incubator image: bad for business
HTBF management team • The Entrepreneurial Team • Selection of individuals who possess expertise and contacts, which will aid the growth of the firm • Ability of the entrepreneur to build and manage the team effectively (Lessem, 1986; Kamm et al., 1990; Timmons, 1994; Freel, 1997; Birley and Stockley, 2000; Neergaard, 2005)	*Establishment of entrepreneurial team and gaining independence* • A firm under transition a • Challenges • Gaining independence • Delegation • Motivation

Table 2
The longitudinal representation of the utilisation of resources in relation to lifecycle development

USI/ HTBF	Industrial sector	Initial stage on LC model	Utilization of resources	Intensity of use	Final stage on LC model	Utilization of resources	Intensity of use
A1	IT	2	OF	ED	4	OF	ED
			C	ED		EP	OM
			CP	ED		R	TW
			P/I	OW		CP	ED
			R	TW		C	ED
			AS	OM		P/I	OM
						AS	OM
A2	IT	1	OF	ED	3	EA	OM
			C	ED		R	TW
			CP	ED		C	ED
			P/I	TW		CP	ED
			R	TW		OA	OM
			AS	OF		AS	OM
						P/I	OM
A3	SC	1	OF	ED	3	OF	ED
			C	ED		EA	OM
			CP	ED		EP	OM
			R	TW		R	TW
			AS	TW		C	ED
						CP	ED
						AS	OM
A4	ICT	2	OF	ED	4	OF	ED
			C	ED		VC	OM
			CP	ED		EA	OM
			R	TW		EP	OM
			AS	OM		OA	OM
						AS	OM
						R	TW
						C	ED
						CP	ED
						OA	OM
A5	IT	1	OF	ED	3	OF	ED
			C	ED		EA	OM
			CP	ED		EP	OM
			R	TW		R	TW
			AS	OF		C	ED
						CP	ED
						AS	OM
						OS	OM
A6	IT	1	OF	ED	2	OF	ED
			C	ED		AS	OM
			CP	ED		EGS	OM
			R	TW		OA	OM
			AS	OF		R	TW
						C	ED
						CP	ED
A7	IT	1	OF	ED	3	OF	ED
			C	ED		R	TW
			CP	ED		C	ED
			R	TW		CP	ED
			AS	OF		OA	OM
						AS	OM
A8	CON	1	OF	ED	1	OF	ED
			C	ED		FS	OF
			CP	ED		EGS	OF
			R	TW		MGT	OF
			AS	OF		AS	OF
						R	TW

Table 2 (*continued*)

USI/ HTBF	Industrial sector	Initial stage on LC model	Utilization of resources	Intensity of use	Final stage on LC model	Utilization of resources	Intensity of use
						C	ED
						CP	ED
A9	MED	1	OF	ED	1	OF	ED
			C	ED		FS	OF
			CP	ED		EGS	OF
			R	TW		MGT	OF
			AS	OF		AS	OF
						R	TW
						C	ED
						CP	ED
A10	IT	1	OF	ED	2	OF	ED
			C	ED		MGT	OF
			CP	ED		OA	OF
			R	TW		AS	OF
			AS	OF		R	TW
						C	ED
						CP	ED
A11	ICT	1	OF	ED	4	OF	ED
			C	ED		VC	OF
			CP	ED		UR	OF
			R	TW		P/I	OM
			AS	OF		OA	OF
						AS	OF
						R	TW
						C	ED
						CP	ED
A12	CON	1	OF	ED	3	OF	ED
			C	ED		EA	OM
			CP	ED		EP	OM
			R	TW		C	ED
			AS	OF		CP	ED
						AS	OM
A13	BIOTECH	2	OF	ED	4	OF	ED
			C	ED		VC	OF
			CP	ED		US	OF
			R	TW		UR	OF
			AS	OM		MGT	OM
						AS	OM
						R	TW
						C	ED
						CP	ED
A14	BIOTECH	3	OF	ED	2	OF	ED
			C	ED		US	OM
			CP	ED		UR	OM
			R	TW		VC	OM
			AS	OM		MGT	OF
						AS	OF
						R	TW
						C	ED
						CP	ED
						P/I	OF
A15	IT	2	OF	ED	5	OF	ED
			C	ED		VC	OF
			CP	ED		R	TW
			R	TW		C	ED
			AS	OM		CP	ED
						AS	OM
						MGT	OM
A16	IT	1	OF	ED	2	OF	ED
			C	ED		AS	OF
			CP	ED		OA	OM
			R	TW		MGT	OF
			AS	OF		R	TW
						CP	ED
						C	ED
A17	BIOTECH	1	OF	ED	2	OF	ED
			C	ED		US	OF
			CP	ED		UR	OF
			R	TW		VC	OF
			AS	OF		R	TW
						C	ED
						CP	ED
						AS	OF
						MGT	OF
						P/I	OW
A18	IT	3	OF	ED	5	OF	ED
			C	ED		UR	OM
			CP	ED		VC	OF
			R	TW		C	ED
			AS	OM		CP	ED
						R	TW
						AS	OM
						MGT	OM

Office facilities (OF); Administrative staff (AS); Shared canteen (C); Shared reception (R); Car park (CP); Access to university research (UR); Access to external grant support from (EGS); Access to venture capitalists (VC); USI MGT services (MGT); Exchange of advice (EA); Professionalism/image (P/I); University services (US); On site advice (OA); Financial support (FS); Entrepreneurial programmes (EP).
Everyday (ED); Once a fortnight (OF); Once a week (OW); Twice a week (TW); Once a month (OM).

facilities like this and spent a lot of time moving from one inadequate rented premises to another which is a complete distraction from your business (A11). The incubator facilities and resources minimised a lot of the challenges associated with the practical side of establishing networks. For example, A7 commented '*the incubator enabled us to commence trading quickly by not only providing office space but by putting us into contact with key individuals*''.

Moreover, being in close proximity to other HTBFs was also recognised by most of the firm owners as a positive aspect of the incubator as it facilitated networking enabling discussion concerning problems and challenges which, in turn, gave comfort in that it revealed that many difficulties were common to all firms. This was reinforced by A15 who, conscious of the firm's size and limited resources, felt that the incubator provided a network with professional bodies as well as mentors which enabled the entrepreneurs to keep up to date with latest advances and developments, ''*It is very difficult to work in isolation. You need to be in an environment, where you are meeting different people. If you are working for yourself and you are a one man or two man operation, you need to be able to get into the network, at least you know what is going on and you know what is happening out there, you are not isolated*''.

In terms of the USI adding to the HTBF's stock of resources, the university was identified not only as important within the portfolio of relationships but also critical in terms of facilitating and developing networks with other third parties. In fact, the university association proved useful in terms of making contacts at seminars and conferences as well as gaining access to customers and suppliers. The entrepreneurs all agreed that this relationship was an effective means remaining informed regarding the contemporary opportunities and information, allowing them to tap into a network, which in other circumstances, they would have found difficult. This sentiment was expressed by A13, "*It is good because you know about all the lectures which are going on, as an industry person you would not get access to. You can look at the notice boards to find out what's going on*". Another comment came this time from A14, "*also a lot of the staff are from the medical school in the university, so obviously they know what is going on, they have got networks and so-on, so if there is something going on, you get an email, "have you heard about such and such*". University collaboration also provided access to research and technology; according to A17 initially the university played a significant role in the firm in terms of providing facilities and also the provision of space in the incubator. All of the entrepreneurs actually used their links to the university to employ students and recent graduates; this was deemed to be an invaluable opportunity to identify new talent. For example, A13 remarked, "*we recruit from the university. We keep an eye on the recent graduates and do a bit of homework to find out who has the greatest potential*". In summary, referring to the importance of contacts in the university ME stated, "*obviously if you have spent your whole professional life at XXX University the links are not just going to go, you couldn't put a value on them really in terms of how they make this business viable*".

Two predominant industrial sectors featured in the study, namely, Biotechnology and Information Technology. Product development times and their associated costs within these two sectors resulted in the different use of the network/university context. For example, owners/managers within the biotechnology sector are normally scientists with limited business managerial experience. Moreover, the majority of firms are university spin-outs or spin-outs from large pharmaceutical companies. The R&D process is strictly regulated and can take on average up to 15 years with an estimated cost of £600 million (Tollman et al., 2001). Information technology firms on the other hand grow more quickly than their biotechnology counterparts as product development horizons are much shorter (Lowegren, 2003). The aim of the biotechnology industry is to reduce development time and associated costs. It is anticipated that this may be achieved through networking and learning through networks with the university, other firms and research organisations (Brannback and Heinonen, 2003). According to Todtling (1994), the information technology industry relies less on university research than the biotechnology industry. Moreover, research suggests that biotechnology firms use the research found at the university while the information technology use the labour at the university (Lowegren, 2003). In a study carried out on Swedish Science Park, biotechnology firms felt that the image of the park and associated credibility made a great difference to their development while information technology firms felt that the difference on their development by these two factors was minimal (Lowegren, 2003).

Supporting the findings within the extant literature, one of the greatest benefits of incubator placement from the resource-based perspective was the credibility the address gave to a young firm. This was summarised by A2 who stated that, "*one of the advantages, particularly when you are starting up, is the address because if you are dealing with customers, it is a professional address*". This was a key issue as all of the entrepreneurs made some link between credibility, professionalism and firm durability with comments supporting the importance of this association, "*When we were working from home we found that using our home address did not have a lot of credibility with customers. When you were cold calling companies with your idea, giving your home address, it is not very professional*" *(A3)*.

Consequently, the facilities offered by the incubator such as shared meeting rooms and reception areas were all considered to offer distinct advantages, particularly when interacting with customers. Reflecting this view A5 remarked, "*The meeting rooms are brilliant, when I have to bring somebody here and I need to give an image of my firm, it is very useful*" while A7 stated that, "*You have got the shared infrastructure like the receptionist, meeting rooms, presentation rooms, conference rooms, which are a major help especially for meeting people like customers or suppliers, it looks professional*".

While recognising the advantages offered from such shared facilities, a number of respondents drew attention to some of the more negative aspects. This was captured by A4, "*Whatever level you are dealing at, an address is important and an incubator address probably does not portray the best image for a firm in our business at least. It is not a prestige environment to be in for us anymore; it says we are still kind of in diapers*". This feeling was shared by A11 who went to great lengths not to advertise or emphasise the address, '*It does put customers off, we do not stress that it is an incubator, we say the innovation centre, or high technology companies. We do not use the title because oh no! That is an incubator and firms in there are just starting out*". Given that those expressing such comments were the owners of the oldest firms in the incubator at the time at approximately 3-year old, it appears that as the firm grows, the relevance of the incubator adding credibility declines. The entrepreneurs become increasingly conscious of the need to portray a more established image to their clients and the continuing association with the incubator signalled immaturity.

6.2. The entrepreneurial firm—a firm under transition

Even the largest and most mature of these ventures, at 3-year old, were still in the relatively early stages of growth so it was interesting to consider how the incubator environment impacted upon specific managerial challenges associated with change and expansion. From the interviews, conversations and observations, it emerged that funding; marketing and increasing sales revenues were the greatest challenges for the entrepreneur when managing growth. It was felt that the incubator management could assist more in addressing such problems by, for example, organising more funding seminars or as A6 remarked, "*if the landlord wants to help they should assist in the selecting and recruiting of sales people. We've been through five sales reps and as yet, have been unable to find anyone who is suitable. I have advertised in the papers, we've used agencies. We've tried every possible angle, even consultants*". However, when asked to comment, the management team identified this as a common complaint amongst tenant firms yet, when they introduced mechanisms aimed at promoting greater interaction, such as breakfasts meetings, only a very few were willing to participate. What did emerge from the findings however, was a change in emphasis regarding incubator managerial responsibilities as the firms became more mature. So, when the firms were very young—usually less than one year old—it was noticeable that they had high expectations of the incubator to fulfil a range of managerial functions on their behalf such as identifying appropriate funding sources, arranging meetings with business advisors and the employment of staff. This is reflected in Table 2, which illustrates a decline in the use of the administrative services provided by the Incubator as the HTBF progresses through its lifecycle development.

6.3. Establishment of the entrepreneurial team and gaining independence

As the firms became more mature and the entrepreneur began to assemble a management team, there was a shift in emphasis from looking to incubator management for assistance to developing expertise within the firm, but this was not always an easy transition. For example, since establishing an entrepreneurial team A12 felt that he interacted less with the management team in the incubator and utilised the resources within the firm to a greater degree, "*we're trying to interact less with the landlord, we're now fit to deal with most things ourselves but it's still difficult to have the confidence to go it alone*". The difficulty of letting go, as it were, was echoed by, A7 stating, "*we need to stand on our own two feet more now, I get rather irritated being 'nursed along' but there's a voice in my head which still advises caution, am I ready to make big decisions on my own? I would only have myself to blame then if it went wrong*".

A1 however, the owner of one of the most established firms had moved on from this, "*We have very little dealings with the management team here now. If we have a problem, we sort it out ourselves*". As such, there was a tendency for the entrepreneurs to move away from the administrative services and support once offered by the incubator towards an internal focus. In the initial stages of development and growth, the incubator represents a pseudo entrepreneurial firm, which was eventually replaced by an internal entrepreneurial team. It was during this transition stage, from inception to durability and growth that the entrepreneurs became more sensitive to the possible problems that proximity might present to the firm. This is neatly summarised by an extract from comments made by A5 who, when asked to describe his perception of some of the key changes which had occurred in the firm during its three years of existence said, "*well, when you start you are always looking out side for reassurance; when you are in the incubator, sure you have your own name and the company is yours but it's sometimes almost like it's a communal project before you do anything you worry about asking everyone else, what they think, what it was like for them. When you are further along the line, you can do it yourself, you don't need the others and to be honest, you are not that interested in what they're doing and certainly less willing to share, they must find their own ideas, we need all of ours!*" When asked to comment on this transition, the incubator management team referred to a natural progression whereby the firms relied less on them for advice and support. However, they did feel that this transition was unique to each business with some firms maturing much faster than others; some were very reluctant to leave the incubator and had to be strongly encouraged to accept their growing independence.

6.4. Delegation: a necessary evil

The general impression to emerge from the research was that delegation was another challenge faced by the entrepreneur during the lifecycle development of the firm (Cooper and Daily, 1997). This was encapsulated in the following statement by A1 who remarked, "*we would not be an exemplar for that*". The primary emphasis that appeared to be placed by those involved in the research was that delegation was a necessary evil. Although they still found it challenging in terms of allocating time and effort, all those interviewed were aware of its importance in terms of lifecycle progression. Furthermore, the entrepreneurs found the relinquishing of certain tasks and relying on others to complete tasks difficult. It appeared that delegation was the last resort in terms of progressing to the next stage within the firm's lifecycle. Reflecting on the issue of delegation A15 commented, "*I resisted it for quite a long time especially on the sales side, if you have been involved right from the beginning you want to see it through. But it has reached the point when there is only so much that you can do. So you have to delegate and basically you just have to trust people to do their jobs and I do not see any part of that but I just assume that the thing that I am going to get at the end is right, you just have to run with it because you*

can not do it all''. While A5 remarked, ''*there have not been any major problems, there are always problems with delegation but they are solvable problems*''. However, when asked whether they thought delegation had got any easier with time the common sentiment was summed up by A16, ''*Yeah but its only because I have learnt to do it, it has become more of a necessity. You cannot do everything and you just have to share out the duties*''.

It interesting to note that the majority of the entrepreneurs interviewed felt that delegation was something that they not only disliked but an area where they lacked confidence in their own ability. For example, A13 remarked, ''*Everybody we have recruited has been very good; in that they have been proactive in taking things off me. But in terms of actual delegation, I personally have not been very good at it*''. While A1 remarked ''*you probably could delegate a lot more*''. A12 was the only example of an entrepreneur who appeared to be comfortable with the process of delegation stating, ''*From a technical point of view I have delegated everything. I do not do any of the development. I would be involved in the design of it; I try not to get involved in the day to day support. I would like to delegate everything and just do lunch*''.

6.5. Motivation of employees

One of the greatest difficulties cited in the literature regarding entrepreneurial growth and lifecycle development was motivation (Deakins and Freel, 2003; Piercy, 1992). Both A1 and A15 felt this was difficult due to the high expectations they had of their staff. However, both entrepreneurs felt that a small firm had a sense of community, as the end product was highly visible to all those involved. A1 remarked, ''*they can also see the failures too as they would have worked with the product right through from development to the final product*''. A14 agreed that a small firm provided an environment whereby employees felt part of the decision-making thus keeping them motivated. Another factor relating to motivation was internal communication channels with A5 commenting, ''*If all employees are keep informed and where appropriate involved to some degree in the decision making process that all adds to morale and enthusiasm of the team*''. A5 also believed that an open culture within the firm added to the general buzz and excitement of being in a new venture, ''*We are very open; everyone comes to the same meetings, no secrets. Obviously some negotiations are confidential, although they know the gist of what is going on, they do not know the details*''. A4 remarked, ''*I believe everyone is motivated and excited in a small business doing something new, doing something that they think is useful and meaningful*''. Two of the entrepreneurs A14 and A13 also used share options as a means of motivating and maintaining morale, ''*they can see that if things go well they can make something out of it*'' (A14). While, A13 stated, ''*They get a stake in the company, everybody is entitled to a stake in the company some of that as a right, and some of that is performance related. It is not a huge stake but its better than kick in the eye*''.

A12 referring to the implementation of structures and systems as a natural progression within the lifecycle development of the firm remarked, ''*adjusting to an answerable or quantifiable control and evaluation of what you are doing is challenging initially*''. This was a common problem for small firms undergoing a period of transition and supports the current literature which refers to the challenges of maintaining control while pursuing growth orientated strategies (Deakins and Freel, 2003) However, all the entrepreneurs agreed that the implementation of systems and structure were often the most effective way to overcome such challenges. A18 stated, ''*in the past there was only four of us, you could write down on a piece of a paper and put it on an excel spread sheet but now it is all scientific projects or jobs. Everything we buy or the time we spend we assign to a certain contract, or a certain piece of R&D work, so we know how much everything is costing. It is not difficult but it is a pain in the ass and you have to allow time to do it*''.

The implementation of structures and systems reflects a shift from a personalised, in formalised, managerial style to a highly structured system (Wright et al., 2004; Beverland and Lockshin, 2001). However, such a shift was necessary in order for the firm to progress to the next stage in its lifecycle development, with A15 stating ''*as you get bigger I think that you have got to do it and it becomes more and more automated as you get bigger*''. However, another entrepreneur A5 remarked, ''*At the moment the problem is we have not taken on enough admin support staff so the people who are doing the lab work are filling it in as they go along. It is only a matter of time that we take someone on to do the admin and take it out of their hands*''. However, A7 stated benefits associated with such systematic procedures, ''*So now we have systems in place to analyse how much time we are spending on particular jobs. We have systems in place for purchases for ordering etc. All the accountancy type things*''.

6.6. Securing venture capital

In terms of growth ambitions and the achievement of sustainability the securing of venture capital was identified as crucial, as was the role of the USI's management team in aiding this process. Not only was the USI management role identified as facilitating access to VC companies but also in terms of providing advice and guidance. In fact, there appeared to be a requirement regarding training; as to how to approach this matter and how to present the firm appropriately to venture capitalists. So in the area of venture capital the entrepreneurs turned to the management team for assistance with A11 noting ''*The management team set up a meeting with X which was great as this is all new to us and we have heard some scary stories, they helped us prepare for the meeting and kept us right on all the legal jargon*''. The importance of Venture Capital to the

sustainability of the HTBF is demonstrated by A14, who while during the period of the study failed to secure second round funding and a result experienced job losses, "*raising capital in this current climate is extremely high, failure to secure second round funding has out us back considerably, and morale is at an all time low*". However, what is interesting to observe in relation to this firm is the role of the USI's management in helping the firm regain its position, with A14 commenting "*We turned to the MGT team who have been great in helping us during this awful time*". The USI's management appears to have a definite role in providing access to venture capitalists and more importantly all of the entrepreneurs appreciated their help in facilitating this process. New high tech firms require considerable levels of investment if they are to realise their potential but the uncertainty surrounding such firms ensure that return upon investment is by no means secure. Hence, the technology risk interface between entrepreneur and investor is uncertain and tenuous. Placement in the USI and access to its networks ensures that the firm is well placed to benefit from support and information sources, which can effectively contribute to investment readiness.

7. Conclusions and recommendations for further research

The aim of this paper was to explore the longitudinal use of the unique resources of the USI by HTBFs at different lifecycle stages. Consequently, a number of questions of interest were identified such as, what role does the USI play in supporting the HTBF in its development as represented by the lifecycle model? How do HTBFs utilise the unique resources and support provided by the USI in order to support growth ambitions throughout the lifecycle stages? In recognition of this, this paper has explored a number of such issues, which suggest that the policies and practices surrounding the management of incubators should be more sensitive to these aspects.

The benefits of the tangible of the incubator are well documented within the literature (Smilor and Gill, 1986; Barrow, 2001). At the initial stage of the lifecycle models the USI adds to the HTBF's stock of resources through the provision of office facilities, canteen, car park and shared secretarial services. All of the entrepreneurs agreed that the ability to commence trading quickly at start up had been enhanced by access to practical support such as telephones lines and Internet access. These may appear to be trivial issues; however, as the firm owners commented, arranging practicalities is immensely helpful as it enabled them to focus entirely upon business activities during the early stages of growth. However, as the firms matured and as awareness of the nature of the competitive environment grew, so did a reluctance to share ideas, problems or solutions in the wider sense.

Moreover, as the HTBF progressed through its lifecycle it faced specific challenges such as the achievement of a balanced team, the ability to delegate and the implementation of appropriate management systems. However, such changes prompted further challenges in trying to strike a balance between innovative, creative thinking and the need for structure and formalisation. Having the confidence to achieve independence by no longer relying upon the managerial support within the incubator was a difficult transition. Allied to this notion of growing confidence and independence over time was the issue of credibility. It emerged quite clearly that the younger firms really valued the credibility afforded to their firms through the acceptance into the incubator but, again as the firms matured was perceived as less helpful as the association was also tied into newness, vulnerability and inexperience.

The results show that a HTBF's propensity to make use of the USI's resources and support increases as the lifecycle stage of the company increases and the small firm searches for independence and autonomy. The findings cited within the paper contribute to the current body of literature by demonstrating the variations in the intensity of resource utilisation as the HTBF progresses through its lifecycle. Therefore, USI provision should be sensitive and flexible in relation to these variations. Consequently, there is a great deal of scope here for further research. For example, further research is required to investigate the following two outstanding questions; firstly, which usage pattern is associated with the HTBF's ultimate success or failure in the marketplace? And secondly, are there any services missing from the observed array that the USI could provide to enhance the HTBF's degree of ultimate success?

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