Micro Agglomerations of Technology: A Typology of Ownership & Implications of Success

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Executive Summary

Technology agglomeration manifests itself as clusters on national and sub-national (regional) geographical scales and as science and technology parks (STPs) on local geographical scales, (Porter 1996, 1998, Castells and Hall 1994). Whether manifested nationally, regionally or locally, technology agglomeration suffers from a distinct lack of unifying criteria, which hinders conceptual development and new knowledge (Martin and Sunley 2001, Antiroikko 2004, Phan et al, 2005). The literature lacks consensus on definitions and classification and studies lack methodological inventiveness, which frustrates meaning and the development of new knowledge, particularly with regard to what may constitute and drive success in agglomerations. This paper presents a typology of ownership for STPs and argues that ownership models have implications for how STPs are governed, managed and operated, and ultimately for the success of properties. The paper offers a conceptual framework for assessing success and builds a case for a unifying definition for local technology agglomerations.

1.0 Introduction

The success of technology-based property initiatives like STPs has been debated for years (Monck et al 1988, Massey et al 1992, Cabral and Dahab, 1993, Hanson et al 2004). Unfortunately, discussion and speculation have outweighed attempts to produce a means for assessing the antecedent factors that are necessary and sufficient for success. This paper makes three fundamental arguments: first, there is sufficient commonality between technology-based property initiatives to enable a single description; second a clear ownership-based typology of STP exists and third, ownership is directly and strongly associated with STP success.

Recent empirical evidence has identified three dimensions and multiple STP ownership models that have emerged over the half century in which the phenomenon has become institutionalised: level I ownership ('form' or number of shareholder(s)), level II ownership ('type' of shareholder(s)) and level III ownership ('profit orientation' of owner(s)). Ownership dimensions lead to ownership models, which have ramifications for the present, particularly the governance, management and operation of STPs and for the future, since the typology may help to pave the way for clearer analysis of how STPs develop and succeed.

This part-conceptual, research-based paper creates new concepts, extends existing concepts and offers an alternative meaning of STP success, which it defines in terms of a causally complex consequence of managerial, financial and operational decisions and metrics. The research argues that when five factors combine, they are both necessary and sufficient for STP success. The largely subjective set of factors is comprised of three antecedent and two consequential criteria, which require an STP effectively to:

1. Execute a clear vision and strategic intent;
2. Implement a chosen development strategy;
3. Manage conflict on multiple fronts;
4. Generate strong performance (an aggregate of four metrics); and
5. Generate contextual agglomeration (i.e. technological spillovers).

The empirical part of this paper introduces several new concepts and argues that ownership model (form, type and orientation) is strongly associated with the level of STP success. The conceptual part introduces additional concepts and new ways of looking at existing concepts.

1.1 Framing an alternative conceptual basis for STPs

Prominent in the concept base is ownership, by which it is meant 'residual rights of control, or the rights to make any decision concerning an asset's use that is not explicitly assigned by law or contract to another party' (Milgrom & Roberts, 1992:602). STP ownership is a multi-faceted and complex issue involving multiple stakeholders and interests. It is further complicated by the fact that owners can own different assets - land, buildings and improvements - however, this nuance of STP ownership is only superficially explored and 'owner' in this paper includes any of the asset owners.

Four owner-derived concepts are uncovered: ownership levels I, II and III which, together, create ownership models. An ownership model contemplates all three dimensions and has particular knock-on effects for how STPs are governed, managed and operated, including inter alia the format of governance, the strategic direction of the property, including development strategy (how and which sectors are recruited and at which stage of their lifecycles). A new variation of an existing development strategy and a new third option are offered. Multiple owners and institutional interfaces also increase the potential for conflict; the paper introduces

a new way of looking at conflict in STP operations and argues that effective conflict management is a critical success factor. The paper offers new ways of looking at the time over which an STP takes to start (conception to first tenant), redefines services portfolio and provides a conceptual framework for success based on the aforementioned mentioned concepts. The full operationalised list of new and varied concepts appears as Appendix 1.

1.2 Paper Aim & Structure

This paper is based in the economic geography perspective, which 'considers a science park and its surrounding region as an entity consisting of specialized firms with an evolving structure of interfirm linkages and agglomerative effects' (Koh et al, 2005:218). It presents a typology of STPs based on how the properties are financed and owned and examines the implications for success through the lens of selected ownership models. The aims are to:

1. Explain an alternative typology of STP ownership (and elaborate particular models);

2. Assess the implications of ownership for STP success;

3. Offer a definition of STP success and a conceptual framework for assessing current and future STP success; and

4. Provide a unifying concept for local agglomerations, based on the commonalities between STPs in the sample and the criteria for regional agglomerations derived from the literature

The paper is structured as follows: Section 2 presents a summary of the state of the art of knowledge in relation to regional and sub-regional (STPs) technology agglomeration. Section 3 summarises the multi-staged research design, methods and quality issues. Section 4 discusses contextual agglomeration and presents empirical results as summaries of the impact of ownership on key aspects of STPs and vice-versa, including governance and management, public sector support, HEI collaboration, tenant origin, services portfolios, start modes and screening. Based on these associations, the section provides a tabulated summary of selected ownership models. Section 5 focuses on the drivers and consequences of STP success and provides a definition, conceptual framework and twelve attributes of successful STPs. Section 6 discusses the implications, contributions and limitations of the research and section 7 concludes the paper with research directions.

2.0 Survey of the agglomeration literature

This paper is based on research which focused empirically on local agglomerations, particularly STPs, and contextually on regional agglomeration. This paper makes a distinction between the two and applies the twin concepts of macro and micro agglomerations, where the former occurs at the regional level and the latter, at the local level, most clearly manifested by the range of technological property-based initiatives, of which science and technology parks (STPs) are the most established and well-known (Monck et al 1988, Castells and Hall 1994).

Agglomeration is defined as 'the association of productive activities in close proximity to one another (which) typically gives rise to external economies associated with the collective use of the infrastructure of transportation, communication facilities and other services' (Dictionary of Human Geography, 2000:7). Agglomeration externalities converge to promote growth in clusters through linkages to large local demand, a plentiful, skilled labour force with specialised skills, specialised inputs and services from supporting industries and inter-firm knowledge spillovers and is not limited to any particular industry or sector (Marshall 1920, Porter 1998). Of particular interest to this paper is localisation externalities, which arise as a consequence of related actors engaged in similar activities in an agglomeration (Verhoef and Nijkamp, 2002).

2.1 National and regional agglomeration

Numerous publications deal with large-scale industrial agglomeration, generally, but relatively few deal specifically with regional agglomeration and even fewer with local agglomerations of technology. Much has been published on national clusters (Porter 1998, Feldman 2001, Krugman 2001, etc) and some on regional (or sub-national) clusters (Cooke 1989, Enright 2001), but attention is dispersed across technologies (Prevezer 1997) and limited to certain externalities (e.g. learning and knowledge spillovers).

Where the sectoral focus is technologies, publications tend to focus on cluster effects, particularly spillovers, knowledge creation and innovation on a systemic level (Bergman and Feser 1999, Malmberg et al 1996, Cooke 1998). Cluster studies tend to be limited to one, two or three regions, at the most: Segal et al (1985) on Cambridge; Saxenian (1984) on Silicon Valley and on Silicon Valley and Route 128 (1988); Garnsey and Longhi (2005) on Cambridge and Sophia Antipolis; Athreye (2001) on Cambridge.

2.2 Sub-regional (local) agglomeration

Like regional studies, local agglomeration studies (particularly, those involving STPs) tend to be limited in scope and expose their limitations in four ways:

- Substantively: quantity of parks studied (Phan et al, 2005, Link and Link 2001),
- Geographically: range of focus (Lai and Shyu 2004),
- Methodologically: unit of analysis and methods (Monck et al 1988)
- Attention span: the range, number and diversity of issues addressed.

Studies tend to focus at a national or regional level, rely on a single unit of analysis (the tenant firm) and focus on individual locations or a basic comparison between two or, exceptionally, three properties (e.g. Simmie et al (2005). Henneberry (1984) compared British and American parks. Link and Link (2001) and Link and Scott (2003) have focused primarily on Research Triangle Park in their work. Park (2001) compared a South Korean park with one from Sweden, Ylinenpää (2001) compared the 'development strategies' of a US (Madison) and a Finnish (Technopolis) science park, Hansson et al (2004) compared a Danish science park

(Symbion) with a UK park (Newcastle's INEX) and Lai and Shyu (2004) compared 'innovation capacity' in a Chinese park (Zhangjiang) and Taiwanese park (Hsinchu).

For the most part, the literature follows the well-trodden strands identified by Castells and Hall (1994) for establishing science parks: 'reindustrialization ('the creation of new jobs in new industries, to replace old jobs in old industries'), regional development ('to concentrate reindustrialization in regions based on need') and synergy creation ('the generation of new and valuable information though human interaction'). The resulting publications form a diverse commentary on regional development (Storey and Tether, 1998), entrepreneurship and innovation (Phillimore 1999, Lai and Shyu 2004) and public-private participation (including university-industry-government collaboration, a.k.a. the 'triple helix' (Etzkowitz 1998, 2001).

Other strands of literature focus on STP determinants and effects (Monck et al 1988, Westhead 1997, Baptista and Swann 1998), definition (Kung 2001), classification (Lafitte 1989), analysis (Cabral and Dahab 1993, 2004, Kung 1997, 2001) and a few on success (Monck et al 1988).

However, the literature is silent with respect to the very influential determinant, ownership, but there have been several attempts to explain STP success (Monck et al 1988, Massey et al, 1992, Cabral and Dahab 1994, 1998, Poulakka 1992, Ylinenpää**,** 2001).

Attempts to reach a common definition have proved elusive, with a confusing progression of more and more exclusive descriptions in their wake (IASP 2002, Castells and Hall 1994, Link and Link 2003, Kung 2001). Castells lumped all science and related parks together as 'technopoles', Link and Link simply adopted the AURP definition and Kung distilled three terms but offered no definition of his own.

Classification attempts have not fared any better and seem to be based either on how properties are labelled, their HEI affiliation or their building occupancy strategies (Kung 1997, Elstrom et al 1997, Lugar 2001, Link and Link 2003, Cortright and Mayer 2001). The classification extracted from the academic literature by Kung is an example of the first and illustrated very clearly the confusion that exists (1997:1). Elstrom et al conclude that the two most prominent European models are the 'incubator-led' (usually smaller parks that support NTBFs) and attraction-led models, larger properties which aim to change 'the entire production system of the area' (Antiroikko 2005:298).

Massey et al (1992) address success impliedly by illuminating the business failure aspect of British science parks but neglect to mention the ownership of properties. Phan et al (2004) conclude that the area lacks a consensus framework. The Cabral-Dahab Science Park Management Paradigm has been one attempt to fill this gap. Proposed initially for a Brazilian biotechnology park and refined 5 years later (Cabral and Dahab 1993, Cabral 2004), the paradigm creates a benchmark for assessing whether 10 measures have been implemented, including R&D personnel, market access, managerial skills and expertise, IP protection, filtering mechanism, clear identity, financial management knowledge, economic and political support, a visionary personality and consultancy firms.

Whilst it cannot be doubted that these factors may be critical to STP success, there is no attempt to discuss the factors in terms of necessity and sufficiency or antecedents and consequences. The framework contemplates the multiple conjunctural causative nature of STP success, but makes no attempt to differentiate the factors according to necessity and sufficiency: are all factors individually necessary or sufficient or are combinations of factors required and if so, which combinations? (Ragin 1987:20). Secondly, the framework does not state how success is achieved or indeed how success is manifested. Finally, the factors are totally subjective, so a valid concern is the objectivity of the assessor. Nonetheless, the framework is a useful starting point because it directs a rare spotlight on STP management.

3.0 Research Design, Methods & Quality

This paper draws evidence from research of STPs over a 10-month, cross-sectional, global study, using multiple instruments, data collection methods and an alternative unit of analysis (STP managers). The dataset was drawn from the IASP database and email invitations were sent to all target STPs, which yielded 25 completed e-surveys from established and emerging, large and small STPs from 21 regions in 14 countries on 5 continents. The study is based on a multi-stage, multiple case study design and adopts a strategy of 'converging lines of inquiry' to arrive at a core set of issues as the issues become clearer and the need arises to explore less issues but in greater depth (Yin 1994:92). The study combines quantitative and qualitative methods and employs three research instruments, four sources of evidence and a range of tools.

3.1 Design

The case study design is a synthesis of the works of Blaikie (2001:33) and Yin (1994:20) and specifically, is a variation of the latter's Type 3 holistic multiple case study design, which uses a single unit of analysis and 'examines the global nature of (the STP) organization' (1994:42). The research design consists of three stages of data collection and analysis and starts with an e-survey of all cases, followed by telephone interviews and documentation from half the initial number of cases, before finally focusing on face-to-face interviews with two cases.

Stage	Phase	Orientation of instrument	Analytical tool
1	Data collection	Semi-structured correlational e-survey	MS Excel, SPSS v13
	Analysis	Statistical testing	
2	Data collection	Focused telephone interviews	Analytic induction, Matrix analysis
		Matrix analysis	
	Analysis	Documentation	
		Matrix analysis	
3	Data collection	Semi-structured/focused face-to-face interviews	
	Analysis	Matrix analysis	

Table A: Research design (N = 25)

3.2 Methods

Qualitative research is 'used as a follow-up method to help interpret quantitative results, 'explore selected issues in greater depth' and 'to elaborate and develop analysis, to provide richer detail' (Ragin 1987, Miles and Huberman 1994). The most obvious and noticeable trends (variables) from the initial analysis were used as the defining bases for telephone and face-to-face interviews, which generated a number of accounts of the 'lived experience(s) of' STP managers (1998:61). The fully combined nature of the study is illustrated in Appendix 2.

3.3 Quality

Case study designs are subject to potential breaches of four quality standards: construct validity, internal validity, external validity and reliability (Yin 1994:92). Steps were taken to ensure that these quality standards were either eliminated or mitigated, starting with the choice of multiple data sources, instruments and methods to promote quality using two techniques: data triangulation (sources and collection methods) and 'question triangulation' (the use of key questions in multiple data collection instruments or the restatement of key questions to ensure consistency of response).

Data and question triangulation mitigated the concerns of construct validity and allowed for a 'most important advantage' of developing 'converging lines of inquiry. Internal validity was addressed through pattern matching and explanation building in the matrix analysis phase. External validity, the need for the research to be generalisable beyond the sample to the population of STPs, was mitigated firstly by careful selection of the sampling frame and secondly, by a wide recruitment campaign which was not limited to any particular region or country and gave all STPs meeting the criteria an equal opportunity to participate.

Therefore, it is argued firstly that the study sample is non-random and representative because sampling error was minimalised and secondly, that the research is valid because of the actions taken. Finally, reliability was mitigated by the re-use of the e-survey questionnaire by the IASP for a recent survey, preliminary results of which suggest response consistency. Table C summarises the actions taken to deal with threats to research quality.

Threat to research quality	Action	Result
Internal validity	Statistical testing Pattern matching Explanation-building	Threat eliminated
External validity	Careful selection of the sampling frame	Threat mitigated
Construct validity	Data triangulation 'Question triangulation' Chain of evidence maintained All mini-case reports were reviewed and commented on Detailed case report was reviewed and commented on	Threat eliminated
Reliability	Secondary use of the e-survey	Threat mitigated

Table B: Summary of actions to mitigate threats to research quality (adapted from Yin 1994:33)

4.0 Empirical Results

The qualitative research was grounded by four statistical tests on data from the initial e-survey. The tests produced numerous significant relationships (correlations and associations), which were segmented into common themes and used as the conceptual basis for the two subsequent rounds of interviews and qualitative analysis. Interim deliverables were 12 mini-case reports and the final deliverable was a detailed case report, which confirmed many of the interim findings as well as established new ones. Consequently, empirical findings are the result of a robust, three-stage approach, the key findings of which are owner-related outcomes and the basis for a common labelling of STPs. A case for a single defining label and owner-related outcomes are discussed next.

4.1 An emergent label from STP commonality

A finding unrelated to ownership but relevant to the raison d'être of this paper concerns the labelling of technological property-based initiatives such as STPs to simplify description and understanding. The analysis of STPs revealed at least 10 specific attributes on which the sample demonstrated consistency of commonality around two main aspects:

(a) Physicality and make-up (size: acreage, office space; sectoral make-up: tenant capacity, density of firms and number, type and lifecycle stage of tenant firms) and
(b) Ownership and control (centralised administration and property ownership, limited number of owners - single or a few).

Put simply, technological property-based initiatives are centralised (in the way they are administered, owned and operated) and finite (in terms of size and spatiality between its composite elements). The findings contrast sharply with the attributes of regional or macro agglomerations, which are not centrally administered, decentralised and less precise in their geographical dimensions. These differences provide an empirical basis for the label, 'micro technology agglomeration', which effectively captures the size, industrial and spatial attributes listed above.

4.2 Unpacking STP ownership

4.2.1 Defining ownership

Financing was analysed from the perspective of number and distribution of shareholdings. No evidence of adverse agency practices was discovered, but the analysis produced four clear findings. Fifty-three per cent of e-survey mentions involved multiple ownership, which led to the first dimension of ownership (level I) and a three-way classification: *sole* (50%), *joint* (5%) and *consortium* (45%) owners. Investigating multiple ownership also led to the unsurprising finding that two or more owners create the potential for owner-related conflict and identification of a first level of conflict. The issue of owner-related conflict emanates from any of three sources: owner-owner, owner-investor or owner-developer. The term to describe owner-related conflict is undifferentiated and labelled simply as level 0 conflict.

Secondly, the research uncovered several owner types: *higher education institution* (HEI), *public liability company* (Plc), *private limited company* (Ltd), *state-owned corporation* (SOC) and *State*. Plc owners received the highest proportion of mentions (41%), followed by HEIs (32%), Ltds (27%), State and SOC (18%). Type of owner lay the basis for the second dimension of ownership (level II) and has implications for the triple helix model of regional innovation. Owner type can be characterised as a unilateral (single), bilateral (double) or trilateral (triple) representation of the helix, which 'comprises three basic elements: a more prominent role for universities in innovation, a movement toward collaborative relationships

among the three major institutional spheres (university, industry and government); in addition, each institutional sphere also 'takes the role of the other …' (Etzkowitz, 2005).

Thirty six per cent of mentions concerned *not-for-profit* (NFP) status, which led to the third and final dimension of ownership, profit orientation (level III). When dimensions are cross-referenced, ownership combinations or models result, which are part represented below.

Level II ownership		Level I ownership			For profit or Not for profit	Level III ownership
		Sole	**JV**	**Consortium**		
	Plc	**Sole Plc**	Plc-JV	**Plc-consortium**		
	HEI	**Sole HEI**	**HEI-JV**	**HEI-consortium**		
	Ltd	Sole Ltd	Ltd-JV	Ltd-consortium		
	SOC	**Sole SOC**	SOC-JV	**SOC-consortium**		
	State	Sole State	State-JV	State-consortium		

Figure A: STP ownership models (N = 12)

Theoretically, the framework yields 30 potential ownership models because each of the 15 models can also be either 'for profit' (FP) or 'not-for-profit'. Of the 30 models, 7 were identified in the sample (highlighted) and are the focus of this paper.

4.2.2 Impact of ownership

The initial exploratory quantitative analysis produced multiple additional findings that prompted further investigation. The second and third rounds of qualitative analyses revealed a progressive sharpening of focus, which qualified initial findings and reduced them to a set of eight core issues, all directly associated with ownership.

Governance & Management

The first issue is governance. Respondents were asked to confirm the type and composition of governing group, the former, to record the most popular working arrangement and the latter in order to assess the breadth of stakeholder representation in top level decision making. The most popular working arrangements are a 7 - 9 person-board (73%) and a 2 - 6 person-'steering group' (67%). Sole and consortia owners overwhelmingly are governed by boards, regardless of who the sole owner is or how the consortium is composed. JV owners are inconclusive (steering group and committee). Representation is largely limited to three sets of stakeholders: owners/investors (61%), HEI representatives (56%, where HEIs are owners) and management (47%), with less evidence of tenant involvement (21%). In terms of managing properties, a small team (5 – 10 members) is fully capable of managing a property.

Public sector support

The second issue is public sector support (PSS), which was examined from three perspectives: the type and reason for the support, the type of owner attracting the support and the timing of support. The most popular type and reason for support is a grant for property purchase (33%) and significant additional findings involve the type and form of owners most likely to attract

support and the timing of support. Sole HEI- and Plc-owners attract less public support than multiple owned-STPs (Plc owners tend to attract the least support). The evidence was inconclusive for JVs but consortia tend to attract the highest level of support, possibly related to the high level of involvement by the State in consortia. Consortia-owned STPs also experience the highest level of public-private conflict, followed by JV- and then sole-owned STPs. The timing of support showed a steady decline with the maturity of the property, with STPs reporting less and less support with time (52%, 43%, 39%). While it is inappropriate to draw firm conclusions from this trend, one possible inference is that public support is mis-aligned with needs because as properties mature, their support needs may actually increase, even though the purpose for the support might change.

PSS was acknowledged as 'a hot topic at the moment' by one respondent given the potential for fallout due to a joint venture with a private firm. This exclamation led to confirmation of a second level of potential conflict, namely public-private or level 1 conflict, which arises when public funds are perceived to be supporting a property that has significant private interests.

HEI collaboration

The third issue involves HEIs from two perspectives, collaboration and potential for conflict. An increase in HEI collaboration by STPs is important to most STPs and generally considered to be positive because it 'gives confidence' and credibility to operations, particularly those involving research. The study examined the extent of collaboration and where HEIs are involved, the potential for conflict with commercial reality or interests.

HEI collaboration appears to be more important to sole-owners, which may relate to the fact that sole owners tend to be either HEIs or Plcs (which are keen to seek collaboration to increase their services and credibility to tenants). The evidence suggests increasing and involved HEI relationships by Plcs, which may be actively seeking access to university staff and research. Alternatively, HEIs can proactively seek involvement with sole Plc owners to extend the reach of their academic programmes or gain a 'commercial edge' for their research. One respondent Plc owner was approached by a business school to set up an informal exchange of services. The informal exchange has worked well and will serve as the basis for a formal agreement.

Consortia are also enjoying increasing collaboration with HEIs. This finding is important because even though there is little evidence of initial HEI involvement, consortia seem eventually to come around to the idea of engaging with academia. Finally, the evidence also points to involved collaboration by HEIs in State-owned STPs, which may be more attributable to the number of shareholders (i.e. consortia), rather than the 'type' of owner.

HEI involvement raised the issue of a third level of potential conflict (level 2 conflict), which arises when commercial reality is ignored in favour of academic aspirations or vice versa, when academic research is overridden by commercial aspirations.

Tenant origin

The fourth issue concerns tenant origin, which has implications for development strategy. Research findings indicate that the sectoral composition of an STPs tenancy is a strong indicator of the property's development strategy, which may be attraction-focused (seeks to attract established technology based firms (ETBFs) to the property or incubation-focused, (seeks to attract and grow new technology based firms, NTBFs). The findings also indicate a clear case for a third 'hybrid' (or dual) development strategy and for variations within the incubation strategy. The hybrid version involves both attraction and growth activities, and incubation can be further split between incubation/growth (no specific objective about where

NTBFs locate after they succeed) and incubation/retain (specific objective to keep the firms in the locality). The cross-case analysis exposed five additional findings.

More sole owners pursue incubation/growth strategies but the evidence is inconclusive as to which strategy is preferred by joint owners. This is not surprising, since a high proportion of sole owners is HEIs, which are generally more closely associated with incubation activities. Consortia tend to implement attraction or hybrid strategies and the presence of the State seems to persuade development efforts in the direction of attracting ETBFs. This is ironic, given that the State arguably should be involved primarily in incubating and growing NTBFs.

Services portfolio

The fifth issue is services portfolio, for which the research sought to establish the breadth and depth of tenant services and any association with ownership. However, findings suggest that portfolios are more complex than initially appear. Services can be categorised according to type, value add and users: (a) low value added basic infrastructural services (e.g. connectivity, facilities, etc) targeted at tenant firms; (b) general business support services (e.g. business planning) also targeted at tenants; (c) higher value added lifestyle and 'town' services (e.g. fitness centres, bank, etc) for employees and finally (d) highest value specialist business services for tenants with 'special' needs (services such as IP advice or onsite VC). Services portfolios can be segmented into comprehensive (includes all types of services), basic plus (basic/infrastructural and lifestyle) and basic.

high-value

low-value

Type of service(s)/users	Firms		Employees/STP staff
	NTBFs	ETBFs	
Specialist	legal advice (IP, contracts) IP agents (patent office) onsite venture capital		
Lifestyle/'Town'			fitness centres, cafes, banking, nurseries, local transport
General business support	business consultancy and advisory (planning, accounting)		
Basic/infrastructural	shared facilities (reception, meeting, connectivity)		

Table D: Types, examples and users of STP services

The comprehensiveness of an STPs services portfolio is associated with sectoral composition generally, stage of lifecycle of tenants specifically and indirectly associated with development strategy. Most respondents report a comprehensive portfolio, but on closer scrutiny and using the above segmentation scheme, this was not found to be the case. Comprehensive portfolios were found in relatively few parks, possibly because they are also strongly associated with the new technologies and an incubation/growth strategy, which are most likely to be deployed by a sole HEI or Plc owner.

Plc-owners seek full portfolios of services, initially starting with basic or basic plus portfolios that then build into comprehensive portfolios. Unsurprisingly, comprehensive portfolios are more likely when properties are filled and owners are resource-rich. There is no evidence to

suggest that a particular level of services is associated with JV-owners and the evidence is inconclusive as to the portfolios of SOC and State-owners. Consortia tend to start with limited portfolios and enhance them depending on which firms are later attracted.

Finally, general business support services, internal and external networking and public relations, are the most popular individual offerings. Wide-ranging agreement on these particular services suggests proactive efforts by STP managers to assist with tenant promotion.

Start Mode

The sixth issue is start mode, defined as the time between conception of a property venture and accommodation of the first tenant, ranging from a few months to more than twelve years. The research identified a range of 'start modes', which prompted a three-way categorisation into 'fixed date', in which an STP starts within a year or 2 of conception; 'rolling start', in which an STP starts within 5 years and a 'staggered start', which takes as little as 5 but as many as 10 years or more. The research sought to link start mode with initial clarity of vision and strategic intent, ceteris paribus.

Solely-owned STPs tend to have a rolling or fixed date start. JVs experience staggered starts but there is no logical reason for this, except that staggered starts tend to occur in HEI-owned parks which may suggest uncertainty in the early years or other intervening factors such as lack of resources. Consortia-owned STPs tend to experience fixed date/rolling starts. Plc owners experience staggered starts, although gain, there is no logical reason for this, given that Plcs are resource-rich and less likely to be buffeted by uncertainty. State-owned STPs start at the fixed date/rolling start end, which may suggest that State STPs are clearer about their vision and purpose initially. While no absolute association could be established between start and clarity of vision, the study did find that successful STPs tend to demonstrate a clear sense of strategic purpose as indicated by start mode.

Screening process

Screening process is the seventh issue and a formal or informal 'filtering mechanism' was reported by all but one of the initial respondents. Further exploration revealed that even formal screening processes are informally applied and the subjective considerations of the management team or Director, frequently over-rule published criteria. Screening in solely-owned STPs appears to implicate an incubation/growth strategy and the need to ensure that NTBFs are 'fully ready when they enter the business world'. In HEI-JVs, screening ensures that new firms seeking accommodation have the potential for HEI-association. On the other hand, consortia screening appears to relate to general desired associations with the STP, rather than with a university. Finally, Plc owners may seek occupancy in preference to a 'tenancy fit', i.e. fill space rather than match prospective tenants with the ideals of the STP or other owner.

Contextual agglomeration

The eighth and final issue explored was the perception of the STP effect on the context of the property. Specifically, the research sought to establish whether STPs had contributed directly to the technological agglomeration of the immediate region, the evidence of which is the specific localisation externality of spillovers of firms and related commercial activity. The research found that certain STPs generate more activity of this type than others.

Two types of contextual agglomeration were identified: STP-specific contextual spillovers (directly related or attributable to the property) and general contextual spillovers (indirectly attributable to STPs). Specific effects occur in several ways, for example, when NTBF tenants outgrow the property and relocate outside of its perimeter but stay in the vicinity, when larger

ETBFs create an 'anchor effect' and attract smaller supplier firms to the area or when other activities in the park result directly in knock-on effects in the immediate vicinity (e.g. a specialist services base of consultants and advisers amasses). General effects indirectly relate to STPs and include other institutions, trade associations or economic activity.
The first STP-specific effect is an ideal outcome of a successful growth or growth/retain strategy, the second, of a successful attraction strategy and the third could be a result of either or none. STP-specific contextual agglomeration appears best served when the STP concerned is able to create, develop and spin out of itself firms into the surrounding vicinity (although clearly, this is a longer term consequence). Five of 6 sole-owned STPs, whether HEI or Plc, showed 'significant evidence' and 1 showed 'some evidence of specific contextual spillovers. JVs are inconclusive (1 showed no evidence and the other is 'too early to tell') and 2 of 4 consortia showed 'significant evidence' (the others showed 'some evidence and 'little evidence'). State-owners are inconclusive.

There is ample evidence to suggest that STPs have the ability to generate contextual agglomeration, but this not to suggest that such activity is caused by ownership. However, it is arguably one of the most dramatic and desirable effects of an STP, though unlike other criteria, it is a consequence of and not antecedent to success.

4.2 Summarised impact of selected ownership models

Seven unique ownership models were represented in the sample and in all stages of the research. The table summarises the impact of these ownership models based on the factors examined above (the full table with legend appears as Appendix 3).

STP Ownership Model (n) /Factor	Governance/ management	PSS	HEI collaboration	Tenant origin/ Development strategy	Services portfolio	Start mode	Screening process	Contextual agglomeration
HEI-consortium (3)	Board + small team, Board + small team, Board + large office	High Low High	High High Low	Hybrid Incubation/grow Attraction	Comp Basic + Basic +	Rolling Fixed Staggered	Informal Formal (covenant) N/c	Some Significant Significant
Sole HEI (3)	Board + small team, Board + university office, Board + large office	Limited None Limited	High Low Medium	Incubation/grow, Incubation/grow Incubation/retain	Basic + Basic + Comp	Fixed Rolling Rolling	Formal Informal Formal	Little Some None (too early to tell)
HEI-JV (2)	Steering group + small team, Board + university office	Some None	Medium High	Attraction Hybrid	Basic + Comp	Staggered Staggered	Informal Formal (covenant)	None None (too early to tell)
Sole Plc (1)	Board + small office	None	High	Hybrid	Comp	Staggered	Informal	Significant
State-consortium (1)	Board + SOC subsidiary	High	Low	Attraction	Comp	Rolling/ staggered	Formal (covenant)	Little
Sole SOC (1)	Board + SOC department	Some	Low	Incubation/retain	Basic +	Rolling	Formal	Little (early stages yet)
Plc-consortium (1)	Board + Subsidiary of Plc	Some	Low	Attraction	Basic	Rolling	None	None

Table E: Impact of seven ownership models (N = 12)

5.0 STP success

5.1 Defining and underpinning STP Success

The research considers STP success as a causally complex consequence of several necessary and sufficient factors that result in the improvement of the STP and its immediate environment. Based on the Oxford dictionary definition as 'favourable outcomes' (1996:635), STP success is defined as an aggregate measure of five favourable outcomes, which involve the ability of an STP effectively to:

1. Execute a clear vision and strategic intent (indicator = type of start);
2. Articulate and implement a development strategy (indicators = sectoral composition, occupancy ratio);
3. Manage conflict at three key interfaces (indicators = evidence of owner, public and academic conflict; how each is managed);
4. Generate strong performance (an aggregate 'score' of four indicators: (a) annual revenues (b) annual aggregate revenues (c) aggregate export sales and (d) occupancy ratio (i.e. current occupancy to amount of office space available)); and
5. Generate contextual agglomeration (spillovers of technology firms and 'extra-property' activity; indicator = evidence of spillovers).

N.B. Contextual agglomeration is the only effect included because the concept presumes other effects such as tenant growth and development. It is also important to note that the fifth criterion is equally as important for NFP properties because none of the indicators is profit-related.

5.2 Attributes of successful STPs

When applied to the sample, the framework revealed that 6 of 12 STPs met all the above criteria outright, one STP partially met the criteria and five STPs failed the 'success test'. The examination revealed a number of attributes of successful STPs:

(i) Single shareholders are generally more likely to achieve success than multiple owners.

(ii) Successful STP owners tend to have an HEI in their ownership structure, whether as joint partners, in consortia or standalone.

(iii) Successful STPs effectively manage conflict by maintaining a clear separation between ownership and management, balancing competing interests and expectations and forging innovative ways of doing things between diverse parties (e.g. financing instruments).

(iv) Half of successful STPs had not been the beneficiary of any significant public support, the amount of which appears to have no bearing on success, which suggests that public support is desirable and often necessary but is neither a necessary nor sufficient condition for success.

(v) Successful STPs tend to experience low or non-existent public-private conflict, possibly due to the relatively low amount of PSS.

(vi) HEI involvement is relatively high in successful STPs, however, collaboration does not appear to be a necessary or sufficient condition for success since unsuccessful STPs also enjoy significant collaboration with HEIs.

(vii) Despite the high academic involvement and potential for conflict, actual academic-commercial tensions are low in successful STPs.

(viii) Successful STPs articulate and deploy the full range of development strategies, though the incubation strategy may be most dramatic in its effects (particularly, contextual); development strategy may also directly impact another criterion for success, namely performance.

(ix) Successful STPs create contextual technological spillovers specific to it, i.e. directly from activity within the STP.

(x) Successful STPs maintain comprehensive services portfolios and also appear to adapt their portfolios to sectoral composition and tenant lifecycle stage, when necessary.

(xi) Successful STPs act on a clear vision and strategic intent, one indicator of which may be the mode of start; successful STPs have a 'fixed date' or 'rolling' start within a short period of time.

(xii) Successful STPs enjoy strong and consistent performance in the above metrics over at least a two-year period (the survey requested five years of data but most were unable to provide the full data).

The presence and formality of a screening process is inconclusive; all successful STPs have one and both formal and informal processes are in place. Finally, the research confirmed that individual success-related criteria, vision and strategic clarity, development strategy and conflict management are either necessary or sufficient conditions for STP success and both necessary and sufficient in combination. However, further research is required on performance to confirm the causal status of this metric, which may be either necessary or sufficient because it presumes other important measures such as development strategy and eventually leads to localisation externalities.

6.0 Discussion

6.1 Implications

Research findings produce implications related to type (theoretical/conceptual, practical or policy-oriented) and time (currently or potentially future applicable):

Dimension	Implications & contributions
Type	√ Practical √ Conceptual √ Policy-oriented
Time	√ Currently applicable √ Future applicable

Table 6.1: Research implications

Type concerns the effect of implications and time refers to whether implications and contributions are immediately applicable or futuristically so. Practical implications are immediately applicable by STP practitioners (owners, investors, managers and policy makers and planners). Conceptual implications arise for agglomeration researchers generally and STP researchers specifically and can be tested immediately or in future. Policy implications affect planning policy and can be applied at any time by regional policy makers, generally and public and private STP policy planners, specifically.

Implications of the empirical results include a number of specific findings and a conceptual framework, which is used as the basis for a framework of STP success. Results have implications for STPs, STP-based firms, NTBFs in general, cluster initiatives (Porter 2003), and regional policy makers. Methodological implications relate to the alternative unit of analysis, expanded number of cases and approach used to converge systematically upon the issues. The mix of sizes, ages, locations and degrees of success of STPs enabled a diverse and unique dataset. Finally, the study employs a 'bottom-up' approach and shines a rare spotlight on financing, ownership, management and control issues.

6.2 Contributions

The results make several contributions to the current knowledge on STPs and to future research. First, a typology of STP ownership, a clear and simple basis for classifying STPs is provided. Secondly, the paper explicitly defines STP success and provides a ready-to-use conceptual framework for assessing STP success. Thirdly, the paper introduces several new concepts and new takes on existing concepts, including ownership dimension, ownership model, levels of conflict, start modes and contextual agglomeration. Two established 'critical success factors', 'public support' and 'filtering mechanism', are rejected as neither necessary or sufficient for success, so the findings cast doubt on the Cabral-Dahab paradigm, which claims to have 'been validated in Europe, Americas, Arab Countries, Asia and Australia' (Cabral 2004).

Finally, the paper offers a unifying definition for sub-regional (local) agglomerations, based on STPs and the known criteria of regional agglomerations. The definitional and conceptual contributions are important to a field that has suffered from lack of conceptual clarity and development in the past. The analytical framework is a practical contribution to the field and is available for immediate application and testing. Together, these contributions provide an opportunity to improve current operating practices, whilst providing a basis to extend knowledge through future research.

6.3 Limitations

The research that underpins this paper is constrained by one and possibly two limitations, the first of which concerns the bases for operationalising STP success. Arguably, the study is right to treat STP success as a causally complex consequence and combine subjective and objective measures. However, it is debatable whether the chosen metrics are the best for the task. The study would benefit from a wider test basis and a more sophisticated measurement for performance success (i.e. to express performance rating).

The second possible drawback concerns the sample size, though the use of the comparative method may preclude this as a limitation. Whilst the sample size stacks up against most STP studies and cross-sectional research has its advantages on the one hand, a larger N studied over a longer period of time would have provided the basis for a higher level of determinism in the results and a firmer basis for explaining causal flows, on the other. A larger N also presumably would produce a larger number and variety of ownership models, as clearly, a study of this type would want to examine all 30 models, if possible.

7.0 Conclusion

This paper is based on three broad areas of research (local technology agglomerations, STP ownership and STP success) and the nexus of issues between them. There is a clear basis for a single defining label and ownership yielded several discoveries, including:

(a) Financing and ownership are a multi-faceted and complex aspect of STPs;

(b) An alternative way to view STP ownership is via a three-dimensional model, composed of: number, type and profit orientation of shareholder(s); and

(c) The need to consider STP ownership in terms of the complexity inherent in the concept.

Numerous significant relationships were confirmed between owner types and different aspects of STP operations and created the basis for exploring linkages with success. The research confirmed strong and direct associations between ownership and the success of STPs, as defined in this research. When explored further, the nexus of issues revealed:

(a) STP success, like ownership, is a multi-faceted and complex consequence of STP management and operations;

(b) Success of STPs requires multiple contributing factors (in this case, five, of which three are antecedent and two are consequent); together, these factors constitute a necessary and sufficient causal success mechanism;

(c) The antecedent factors for STP success include the execution of a clear strategic intent, the ability to implement effectively a development strategy and the ability to manage conflict on three key fronts;

(d) Consequences of STP success include strong and consistent performance and the generation of contextual spillovers;

(e) If the STP is capable of the factors listed in (c), then it will be in a position to perform well operationally and financially and secondly, to generate contextual spillovers and contribute to the improvement of the immediate region.

To enlarge the study would be an obvious next step. It would be beneficial to extend the study over a much longer period of time to establish statistical causation as well. Finally, a more rigorous testing of success could be conducted by varying the metrics and strengthening the process for arriving at an aggregate rating of performance and a rigorous fit-for-purpose tool.

END

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APPENDICES

Appendix 1: Conceptual & Operational Framework

Construct/concept	Measure	Operational (working) definition
Level I ownership (form)	Number of owners/distribution of ownership	Single (sole), Joint (JV, 2 owners) or Consortia (3 or more owners)
Level II ownership (type)	Type of owner	HEI, Plcs, Ltd, State, SOC
Level III ownership (profit orientation)	Profit orientation of owner	FP or NFP
Micro agglomeration	Commonality in range of STPs and related property phenomena	Agglomerations of technology firms and support institutions that exist usually within the confines of specially designed properties such as STPs, which feature, inter alia, centralised ownership and control, a dedicated management team and a defined area of property.
Macro agglomeration	Perception/attitudes of management	Agglomerations of technology firms and related institutions that exist in the vicinity of an STP, which feature, inter alia, no centralised ownership and control, dedicated management team or a defined area of property.
Ownership model	Type of ownership, Distribution of owners, Number of owners	Derived from the three dimensions of ownership: type, number and profit orientation of owner(s)
Contextual agglomeration	Contextual spillovers and other effects that arise as a result of the STP, either directly (STP-specific) or generally.	Contextual spillovers include technology firms that outgrow the property and leave but stay in the local vicinity and other effects include technological activities that result from the STP (e.g. suppliers and institutions that may locate near the STP to service/supply tenants).
Conflict	State of disagreement (Oxford, p.120)	The state of disagreement that arises naturally when public meets private, academic meets commercial and owner meets owner, investor, developer.
Level 0 Conflict	The potential for 'intra-owner' conflict	Owner-owner, owner-investor, owner-developer
Level 1 Conflict	The potential for public-private tension based on public support for private ventures	Public-private
Level 2 Conflict	The potential for academic-commercial conflict based on academic aspirations and commercial reality	Academic-commercial
Performance	An aggregate measure of four metrics: annual revenues, annual aggregate revenues, annual export revenues, occupancy ratio	Financial measures are measured in $US and occupancy rate is measured as below. The rating is calculated by adding whole numbers for each metric and totalling the score.
Occupancy ratio		Occupancy rate: capacity
Sector composition **Tenant origin**	Sectoral makeup Origin of tenants	The constitution of the property in terms of technology sectors represented and in which proportions and firm origin (local, regional national or international).
Services portfolio	The set of services offered	The set of services offered by an STP to its tenant firms
Services (basic)	Basic infrastructural and general business support services, targeted at tenant businesses.	Low tenant value added, basic infrastructural services that are a part of the facilities makeup of the building(s) and general business support.
Services (basic plus)	Basic services plus lifestyle and 'town' services, targeted at the employees of tenant businesses .	Employee value added services which include fitness centres, café's and possibly town services such as banks, local transport, etc.
Services (comprehensive)	Basic services, lifestyle services and specialist services, targeted at	High tenant value added services which include specialist services and advice such as venture

	both employees and businesses.	capital services and legal advice on intellectual property issues.
Start mode	Time between conception and first tenant (1 – 2 years, 5 years and > 5 – 10 years)	The time between conception and first tenant being accommodated; three modes, fixed, rolling or staggered start.
STP success	Favourable outcomes in five areas: strategic clarity, development strategy, conflict management, performance and contextual effects	A composite score based on several financial and operational considerations (discussed fully in section 5). Revenues (annual, aggregate, export), occupancy ratio, agglomerative effect.

Appendix 2: Combination of Research Methods

Method/Technique	Instrument/Method	Purpose/phase of research	Method orientation
Pilot questionnaire	e-Questionnaire, statistical analysis	Pre-data collection	Qualitative
e-Survey	Interview (telephone), matrix analysis	Data collection	Quantitative, Qualitative
Telephone interview	Documents, matrix analysis	Data collection	Qualitative
Documents	Interview (F2F), matrix analysis	Data collection	Qualitative
Face-to-face interviews		Data collection	Qualitative
Coding		Data reduction	Qualitative
Scaling		Data reduction	Quantitative
Spreadsheet analysis		Data analysis	Quantitative
Univariate analysis (SPSS)		Data analysis	Quantitative
Bivariate analysis (SPSS)		Data analysis	Quantitative
Multivariate analysis (SPSS)		Data analysis	Quantitative
Analytic induction		Data analysis	Qualitative
Matrix analysis		Data analysis	Qualitative

Appendix 3 **Selected ownership models with legend**

STP Ownership Model/Factor	Governance/ management	PSS	HEI collaboration	Tenant origin/ Development strategy	Services portfolio	Start mode/	Screening	Contextual agglomeration
HEI-consortium (3)	Board + small team, Board + small team, Board + large office	High Low High	High High Low	Hybrid Incubation/grow Attraction	Comprehensive Basic plus Basic plus	Rolling Fixed Staggered	Informal Formal (covenant) N/c	Some Significant Significant
Sole HEI (3)	Board + small team, Board + university office, Board + large office	Limited None Limited	High Low Medium	Incubation/grow, Incubation/grow Incubation/retain	Basic plus Basic plus Comprehensive	Fixed Rolling Rolling	Formal Informal Formal	Little Some None (too early to tell)
HEI-JV (2)	Steering group + small team, Board + university office	Some None	Medium High	Attraction Hybrid	Basic plus Comprehensive	Staggered Staggered	Informal Formal (covenant)	None None (too early to tell)
Sole Plc (1)	Board + small office	None	High	Hybrid	Comprehensive	Staggered	Informal	Significant
State-consortium (1)	Board + SOC subsidiary	High	Low	Attraction	Comprehensive	Rolling/ staggered	Formal (covenant)	Little
Sole SOC (1)	Board + SOC department	Some	Low	Incubation/retain	Basic plus	Rolling	Formal	Little (early stages yet)
Plc-consortium (1)	Board + Subsidiary of Plc	Some	Low	Attraction	Basic	Rolling	None	None
	Governing group/management: Board, STG, committee Small team, office, University office, department, Corporation department, subsidiary, etc	Amount of PSS: none, low, limited, some, high	Amount of HEI collaboration: low, medium, high	Development strategy: attraction, incubation (incubation/grow/retain or incubation/grow), hybrid	Portfolio: basic, basic plus, comprehensive	Start: fixed, rolling, staggered	Evidence: none, informal, formal, formal (covenant-based)	Evidence: none, little, some, significant

N.B. Performance – All revenue figures are expressed in $US; the ratio is expressed as a percentage.

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Acronyms/Glossary

STP: science and technology park (includes all related terms, such as research parks and innovation centres)
HEI: higher educational institution
PSS: public sector support
JV: joint venture
Ltd: private limited company
Plc: public liability company
STG: steering group
ETBF: established technology-based firm
NTBF: new technology-based firm
Ownership is defined as "residual rights of control," or the rights to make any decision concerning an asset's use that is not explicitly assigned by law or contract to another party (Milgrom & Roberts, 1992:602) quoted in: Beamish and Makino (1998) Performance and Survival of Joint Ventures with Non-Conventional Ownership Structures, Journal of International Business Studies, Vol. 29.
Ownership model – consists of three considerations, level I ownership, which represents the 'form' of ownership, level II ('type' of owner(s)) and level III (profit orientation of owner(s)) – and there are 30 variations..

END