This article provides a conceptual framework for assessing and managing the university technology business incubator (UTBI) as a tool for new venture creation. It is widely believed that UTBIs contribute to the nurturing of new technology-based firms (NTBFs). However, they have escaped systematic review in the United States due to a lack of historical data. To fill this gap, a new UTBI performance assessment framework is proposed, which is drawn from a combined survey of the existing body of knowledge in the areas of business incubation, the university's involvement in technology and business development support, and the commonly accepted approaches to organizational assessment that provide the necessary building blocks for the integrative framework. The proposed model is comprised of three performance dimensions: (1) program sustainability and growth; (2) tenant firm's survival and growth; and (3) contributions to the sponsoring university's mission. Further, the scope and effectiveness of the facility management policies, and the provision of services are assessed. The application of this framework is illustrated using four representative UTBI cases selected from a field of 30 five year or older U.S.-based facilities and their 29 tenant firms out of the 84 firms contacted for the survey (35%). A comparative review of these four cases reveals that the framework provides a flexible methodology to assess the performance of UTBIs. The article concludes with a set of elements identified for evaluating UTBIs under the aforementioned three performance dimensions providing measurement indicators. This framework seeks to provide conceptual clarity for those responsible for assessing UTBI performance, directing their operations, or endeavoring to create them. © 1997 Elsevier Science Inc.
INTRODUCTION

Starting in the early 1980s, some U.S. institutions of higher education experienced a transformation by broadening their traditional mission of teaching, research, and public service to include a more active participation in their region’s economic development. During these years, there had been an emerging trend on the part of some entrepreneurial American universities for a more direct involvement in supporting the development of innovative new businesses. This proactive role, though generally motivated by a desire to participate in regional economic development efforts, also serves to develop partnerships with new companies, and reap benefits from the commercialization of the university’s own research (Matkin 1990).

One mechanism used for this purpose is the establishment of technology business incubators in or around university campuses. Interest in university-sponsored business incubator stems from the significant potential of the concept. The concept holds out the possibility of linking talent, technology, capital, and know-how to leverage entrepreneurial talent, accelerate the development of new technology-based firms (NTBFs), and speed the commercialization of technology (Smilor and Gill 1986). Currently, around 50 American universities and 4-year colleges are sponsoring this effort (NBIA 1993a), thus broadening their missions to better serve the economic development needs of their respective constituencies.

Despite a steady growth in the number of UTBIs since the early 1980s, there is no single framework available to assess their working and performance (Mian 1991; NBIA Review 1993). This has placed university administrators in a difficult position. On the one hand, universities and colleges see a wave of activity sweeping the country and feel some pressure to establish similar programs. On the other hand, these institutions are reminded by experts that the jury is still out due to the failure to establish accountability and assessment measures into these programs from the outset (Plosila 1990). Therefore, at present there is a strongly felt need for a viable assessment framework (Allen and McCluskey 1990; Mian 1991). The challenges confronting researchers in developing such a framework include: (1) the emerging nature and relatively short life of the incubator industry to allow longitudinal data; (2) lack of access and enough cases available for in-depth empirical work; (3) lack of consensus on the type of evaluation criteria to be used; and (4) lack of understanding of the incubation process itself. In short, the research on UTBIs performance aspects has been less than comprehensive, and often only a few items are considered. This article is an attempt to fill this gap by enhancing conceptual clarity and providing a viable framework for assessing and managing UTBIs operating in the U.S. environment.

1 TBIs provide qualifying new start-ups with building space in physical proximity to other similar tenant firms. This positioning allows businesses to obtain space often at below market rental rates, share facilities, equipment, and services at low cost. When incubators are associated with universities as is the case with UTBIs the benefits provided to the new firm also include access to university facilities such as libraries, laboratories, etc. again on a per use basis. Tenants have better access to the qualified university personnel and university reputation also adds to the tenants’ marketing potential. In return, universities enjoy several benefits including student employment and training, potential for faculty consulting and entrepreneurship, and image building by participating in regional economic development.

2 These observations are based on the author’s personal communications with several industry experts and practitioners during the past several annual professional conferences. Also, see Allen and Bazan (1990) and Allen and McCluskey (1990).

3 This study is not aimed at passing judgment about the effectiveness of one facility over the other; the purpose is to identify the key components of a cost-benefit model necessary to make such an assessment. The study takes the perspective of university administrators.
base in three areas of relevance (1) business incubation support; (2) the university’s involvement in technology and business development support; and (3) the commonly accepted organizational effectiveness approaches. Further, the use of this framework is illustrated through its application to four representative UTBI cases taken from a national study of 30 five-year and older U.S. facilities. (Mian 1991, 1994a).

LITERATURE REVIEW

A review of the existing body of literature in the three areas of knowledge relevant to the UTBI performance assessment and management, identified earlier, is provided below:

Business Incubation Support

With the growing popularity of the business incubation concept during the 1980s, numerous studies have been conducted to assess the emerging incubator industry across the nation (Temali and Campbell 1984; Allen 1985; Smilor and Gill 1986; Allen and Levine 1986; Hisrich and Smilor 1988; Campbell et al. 1988). During the 1989–90 period, four state-level incubation programs (Ohio, Iowa, Pennsylvania, and Michigan) were systematically evaluated (NBIA 1992). A review of all these 1980s studies show that most of them are primarily descriptive, lacking conceptual and/or methodological grounding (Allen and McCluskey 1990; Mian 1991). Only two of these studies (Smilor and Gill 1986; Allen and Levine 1986) made an effort to address the performance issues and were comprehensive enough to mention the role of universities in providing business incubation support (Mian 1994).

More recently, several researchers have attempted to more specifically address the incubator performance issues (Lichtenstein 1992; Rice 1993; NBIA 1993b). The first two studies review the internal processes in providing incubation support such as networking and managerial intervention at the micro level. In the first study (Lichtenstein 1992), an incubator relationships model was derived from the social sciences perspective, which postulated a flow diagram of the processes by which networking among entrepreneurs and their firms produces economic success. This model was tested on two non-university-related facilities, which however, lacked some degree of generalizability for UTBIs. In the second study (Rice 1993), which hypothesized incubator governance as one of the key components of the performance, a mixture of university-sponsored and economic development entity-sponsored facilities were explored, providing useful insights regarding managerial intervention mechanisms. A third contemporary effort resulted in a workbook type evaluation manual put together primarily for incubator managers’ use (NBIA 1993b). This Economic Development Administration–funded work is a preliminary attempt at developing a “comprehensive” evaluation document for business incubation projects in general. The study reports:

One major conclusion of this effort is that we have been working in virgin territory. Little exists of value in the way of literature, material, framework, methodologies or examples appropriate to the challenge of evaluating business incubation projects or programs.

Unlike the previous two studies that looked at only one key aspect of the business incubation process at a time—networking or managerial intervention, this study, after providing a cumulative account of the incubator performance literature, attempts to de-
velop a broader systemic view in assessing these projects. For the first time this work has extended the treatment from looking at the incubator performance primarily from facility and tenant firm perspectives (Allen and McCluskey 1990) to a host of other stakeholders and including multiple assessment criteria. However, this work too lacks a complete account of the university-related factors, generally understood to provide a resource base necessary for supporting the development of NTBFs. Research that combine UTBIs with other incubator models (as has been the case in these recent efforts along with a few other noted earlier) usually overlooks the specific requirements of developing NTBFs (Roberts 1972, 1991; Bollinger, Hope, and Utterback 1983; Doutriaux 1987, 1992; Boucke, Cantner, Birch and MacCracken 1984, and Hanusch 1994). Such studies tend to extrapolate their general incubator-related analyses to UTBI situations providing less than adequate treatment of issues pertaining to the academic milieu, which is the hallmark of UTBI facilities (Mian 1994b).

An examination of the aforementioned limited research that may be considered the body of knowledge on incubator performance shows that neither of these studies including the more recent efforts specifically focused on developing a viable framework, based on theoretical and/or empirical work that could serve as a model for university administrators in assessing and managing the performance of their UTBI systems. And, in most cases where authors may claim to have addressed UTBIs, an in-depth treatment of the university-related aspects had been lacking. Therefore, it may be concluded that in the absence of a sound body of knowledge on business incubators, there still is no consensus on what makes up the content of success or effectiveness in the area of business incubation and how to measure it (Allen 1985; Smilor and Gill 1986; Campbell et al. 1988; NBIA 1993b). This is even more true in the case of UTBIs (Mian 1991, 1994).

**University's Involvement in Technology and Business Development Support**

Though the idea of the university's organized support for technology and business development is not new in the United States, more recently, during the 1980s, a number of national reports have strongly asserted that academe, through its contribution to technological change, will be a key factor in U.S. economic competitiveness (National Academy of Engineering 1988; Council on Competitiveness 1988). As a result, over the past 15 years, numerous forms of university-based cooperative technology exchange programs have emerged that include: increased faculty-industry consulting activity, industrial associate or liaison programs, technology extension services, cooperative industrial development, industrial parks, and technology business incubators (Business-Higher Education Forum 1988; Battelle 1995). Despite the controversy concerning the type and level of involvement in each of these programs, consensus exists that universities play a central role in advanced technology development, and most commentators agree that the presence of a major university is important, though not sufficient, for the formation of a concentration of technology-oriented enterprises (NSF 1983; Allen and Levine; Miller and Cote 1987; Smilor et al. 1988).

The enthusiasm for partnership between university and industry exists in a range of areas, but particular emphasis is placed on: (1) research-related, technology-based linkage, highest degree of convergence between the university and industry is in high technology research where technology transfer is rapid and requires close proximity
(National Science Board 1982; Doutriaux 1987, 1992); and (2) education’s potential to contribute to economic development through its more traditional training function (Allen and Levine 1986). Additionally, substantial conceptual and theoretical work has focused on structural and organizational factors that might facilitate or hinder university—industry collaboration (Ping 1981; Dill 1990; Lopez-Martinez et al. 1994), and a limited amount of incubator related empirical work has explored whether technology-based firms actually perceive universities to be important beyond the traditional role of providing skilled employees and a source of basic research that can be translated into commercial goods and services (Peters and Fusfeld 1983; Brown 1985; Abetti and Stuart 1985; Allen and Levine 1986; Doutriaux 1987, 1992; Hisrich and Smilor 1988).

The cooperative exchanges undertaken by entrepreneurs and universities in the form of UTBIs are aimed at facilitating the process of technological innovation. Hence, in specifying the objectives of cooperative programs such as UTBIs, it is useful to consider program activities in relation to the innovation process to help inform and conceptualize innovations. One of the simplest models of innovation, which is also widely used (despite the limitations) is the so called “pipeline” model (Tornatzky and Fleischer 1990). The exchange taking place in a typical UTBI is largely concentrated at the early-middle stages of innovation. Additionally, smaller technology-based firms are more likely to be involved in the application of existing scientific and engineering knowledge found in the institutions of higher education (Doutriaux 1987; Business Higher Education Forum 1988). Unlike large firms, where the consideration of proprietary position becomes paramount to them, as innovation approaches commercialization, small firms may seek to cooperate with a university in these later stages if, for example, there is a gap in the entrepreneur’s knowledge and the university has noted experts on its faculty or sophisticated instrumentation not otherwise available to the firm. Cooper (1986) found that high technology firms are dependent upon current knowledge of technical and market opportunities, and this knowledge is most likely to be acquired in a university or a corporation already active in a given technology. Additionally, the entrepreneur wants to avail the shared business expertise and other services at affordable cost, available through their business incubation support.

One major problem, however, is that American institutions of higher education differ among themselves with respect to the type of relationship with industry they deem appropriate, particularly the extent of the university’s role in developing and marketing innovations. Some of the major old-line research universities have limited their industrial relationships to the support of basic scientific research and have largely preserved control of the direction of the research. More technically oriented institutions—such as the polytechnic institutes—have been more willing to cooperate with industry in applied research. And, another group of universities with specially strong traditions of community service, has been willing to cooperate with entrepreneurs in technology exchange and development as well (Association of American Universities 1986; Abetti et al. 1986; McMullan et al. 1986).

The “pipeline” model of innovation serves to make a final point about objectives of UTBI programs. That model makes it clear that the economic and social benefits associated with innovation do not begin to accrue until after the innovation is introduced

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4 The “pipeline model” depicts the innovation process as a consequence of activities involved in generating new knowledge and moving it from idea to application. Although there is no complete agreement on the stages of activity, a typical representation is given as: basic research→applied research→development→prototype→production→market introduction→market diffusion→economic impact.
to the market and widely diffused. Thus, these benefits must be considered as long-term aspects of the cooperative programs in technology exchange. There are numerous types of the community-related economic impacts and agglomeration effects identified in the case of NTBFs (Bollinger, Hope, and Utterback 1983; Miller and Cote 1987): (1) sales, revenues, and tax dollars—studies have showed that NTBFs have remarkable growth rates when measured in terms of sales, net revenue, and tax dollars; (2) employment generated—NTBFs, because of their tendency toward rapid growth, have a substantial impact in creating new high paying jobs; (3) stimulating R&D and innovation—the presence of NTBFs helps to gain understanding of the characteristics of new products and processes developed by small enterprises and of the frequency and value of these inventions; and (4) export potential—because of the innovative component in NTBFs there is a potential for increase in the level of exports. Clustering suppliers of parts/components, trained employees, and entrepreneurs develops a rich milieu as formal and informal networks through which information will flow easily. As information on the ways and means of NTBF is diffused to venture capitalists, industrial buyers, the financial community, and business executives, the psychological cost of doing transactions is reduced.

In addition to these long-term objectives, there are the medium to near-term objectives as well. These tend to focus on university mission and operational aspects in areas of technology and business development. Because of the difficulty of measuring the regional economic impacts to program activities, it seems appropriate here to focus the UTBI program effectiveness assessments on these medium to near-term objectives. In the early years of a cooperative program such as the UTBI, achievement of proximate objectives can indicate progress toward ultimate objectives (National Academy Press 1987).

Organizational Effectiveness Approaches

In the general organizational assessment literature there are numerous approaches to address the question of effectiveness. Out of these the four most commonly accepted approaches are: (1) the goal approach; (2) the system resource approach; (3) the stakeholder approach; and (4) the internal process approach (Robey 1991; Banner and Gagne 1995). A close scrutiny of the literature shows that apparently there is no consensus on the relative merits and applicability of these often competing approaches (Cameron and Whetten 1981). Despite the growing attention and a prominent place of effectiveness in organizational literature, confusion and ambiguity still characterize scholarly writing on the subject (Cameron 1986). Debates over domains of activity and levels of analysis (individual, group, or systemic) have at times appeared quite bewildering (Cameron and Whetten 1981). Additionally, the life-cycle advocates have argued that most of the literature on organizations is based on static assessments of mature organizations and that the criteria of effectiveness must change over time, and there is a need for longitudinal approach in assessments. Historically, evaluation researchers selected measures of effectiveness opportunistically, and each of these approaches reflects on

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5 The conceptual model depicted in Figure 1 provides linkages of the UTBI with the outside community through the creation of NTBFs. For actual measures of these economic impacts, see U.S. Department of Commerce (1992).

6 According to the goal model, an organization is effective to the extent it accomplishes its stated goals; the systems resources model reviews the acquisition of needed resources; the stakeholder model requires the satisfaction of its constituencies; and the internal process approach looks at the human relationships within the organization.
underlying biases about what is important to the organization (Cameron 1986). And, three areas of conflict are often reported in assessment issues: (1) the effectiveness models and criteria are selected arbitrarily, relying primarily on convenience; (2) the indicators selected are often not well defined; and (3) outcomes are the sole criteria used by the researchers whereas effects are most frequently used in public policy decisions.

DEVELOPING A FRAMEWORK FOR ASSESSMENT

The concept of organizational performance is central to the investigation of UTBIs’ success as technology-based enterprise development tools. However, as depicted in the previous section, with the exception of some anecdotal knowledge accumulated during the limited history of the business incubation industry and the often controversial role of academe in technology and economic development, which has produced some fragmented work, there exists no foundation in the way of literature, conceptual frameworks/methodologies, and examples appropriate to the challenges of assessing UTBIs. Given the highly interdisciplinary and interdependent nature of a typical UTBI project, and the controversial, fragmented, and anecdotal nature of the existing body of knowledge, no single theoretical discipline seems sufficient to offer an adequate conceptual model to assess UTBIs’ performance. To provide a theoretical foundation, this article proposes an integrative approach that draws upon the existing body of knowledge from the aforementioned three areas of interest. The proposed conceptual framework is hypothesized to take the overall system’s perspective combining the salient features of the four program effectiveness approaches, namely: the goal approach; the system resource approach; the stakeholder approach; and the internal process approach. Table 1 outlines some of the salient features of these four approaches operationalized in the UTBI context. The framework also attempts to address the areas of conflict in effectiveness assessment (described in the previous section) by attempting to better define the measurement indicators after combining the outcomes with other organizational performance and value-added dimensions in the university-sponsored technology/business incubation context.

Based on this approach, Figure 1 provides a conceptual model for assessing the UTBI system. As shown, one building block of the model is the motivations of the sponsoring university for establishing a UTBI, which are exogenously defined by the university’s top management (often with inputs from other key stakeholders), resulting in a set of expectations on the relationship with the UTBI and its impact on the university and its surrounding environment as stated in the box. In order to deliver on these expectations, the technology business incubator (labeled as the UTBI program) establishes its own goals and objectives, crafts a strategy to attain a certain level of operational viability with the help of its stakeholders and the surrounding environment, and pursues appropriate growth. The key facility management and service activities are summarized in the upper section of the UTBI box. As shown in the form of a circle in the middle section, the primary service of the UTBI program is to support the creation and growth of its tenant firms during the start-up years through value-added contributions—the incubation process. Qualifying entrepreneurs and new start-up firms are recruited from within and outside the university (shown as a separate box) and the graduate firms move out of the UTBI to the community (shown in another box) adding to the area’s industrial base. As mentioned earlier, the UTBI facility secures needed resources from the sponsoring university and the outside community and other stakeholders to fulfill its organi-
TABLE 1 Operationalization of the Salient Features of the Selected Approaches to UTBI Assessment

Goal Approach—It articulates and accomplishes its stated goals
• Clarity of the UTBI objectives
• Realization of these objectives
• Organizational structure/strategy
• Sustainability/growth

System Resource Approach—It acquires needed resources
• Acquisition of financial resources
• Facility champion/management team
• Securing the entrepreneur tenants
• Securing faculty/student employees
• Securing knowledge/equipment
• Securing institutional support
• Securing prestige/image

Stakeholder Approach—Its constituencies are minimally satisfied
• Satisfaction of the university
• Satisfaction of the facility management
• Satisfaction of the entrepreneur tenant
• Satisfaction of other (govt/private) stakeholders

Internal Process Approach—It has smooth internal functioning
• Effectiveness of managerial support
• Effectiveness of decisionmaking/policies
• Effectiveness of networking among tenants
• Effectiveness of communication/teamwork
• Success in firm creation/growth

As shown in the bottom section of the UTBI box, the UTBI activities result in a set of outcomes that are equated with its objectives in fulfilling the university expectations. The various dynamic interactions are represented by feedback loops, which are numbered and described at the bottom of Figure 1. Using this conceptual approach, a UTBI facility is considered effective to the extent that it accomplishes the stated goals/objectives, acquires and effectively uses the needed financial, labor, and other resources, and satisfies the main strategic constituencies, which in this case are: the sponsors including representatives from the university and other involved public and private entities, the facility management, and the UTBI tenant firms. Clearly, the effectiveness criteria must take into account the realization of each of these interrelated components, which will in the long-run determine the success of the endeavor—an integrative-longitudinal stance.

As depicted, this proposed model for the UTBI performance assessment is based on the following three sets of variables.

1. Performance Outcomes—the facility’s performance outcomes are assessed using four categories: (a) the program sustainability and growth, (b) tenant firm’s survival and growth, and (c) contributions to the sponsoring university’s mission, (d) community-related impacts.

2. Management Policies and Their Effectiveness—an assessment of the facility’s management practices and operational policies in light of the program objectives provides a review of the effective utilization of resources resulting in the success of the program. The key elements explored include: (a) goals, organizational structure and gov-
The UTBI Program

Management & Services
- Goals, structure and governance
- Financing and capitalization
- Operational policies
- Target markets
- Services provided

Incubation Process
Value added in the creation and growth of tenant firms

Performance Outcomes
- Program growth and sustainability
- Tenant firm’s survival and growth
- Contributions to the university mission
- Community-related impacts

Sponsoring University - Motivations and Environment
- University’s public image in promoting econ development
- Commercialize technology
- Nurture new start-up firms
- Provide entrepreneurship training
- Other

Entrepreneurs and New Start-up Firms
- From university community-professors and alumni
- From outside community

Community and Other Stakeholders
- Public sector: federal agencies state government local government
- Private sector: large companies small and medium firms
- Other: citizens etc.

FIGURE 1 Conceptual model for assessing and managing the performance of UTBIs.

ernance, (b) finance and capitalization (c) operational policies, and (d) target markets.

3. Services and Their Value-Added—a review of the provision and perceived value-added of the facility’s services to the tenant firms in the form of: (a) the typical shared office services including rental space and other business assistance services, and (b) the university-related services such as student employees, faculty consultants, and the university’s institutional support system around the facility.

From a synthesis of the literature cited earlier some broad range of characteristics may be drawn that convey a sense of the UTBI-specific performance aspects that have been
TABLE 2  Summary of the Literature Related to Performance Assessment and Management
Characteristics of UTBIs

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Used By—Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Performance Outcomes</td>
<td></td>
</tr>
<tr>
<td>(b) Tenant firm’s survival and growth</td>
<td>Allen and Levine (1986), Hisrich and Smilor (1988)</td>
</tr>
<tr>
<td>(c) Contributions to sponsoring university’s mission</td>
<td>McMullan et al. (1986)</td>
</tr>
<tr>
<td>(d) Community-related impacts</td>
<td>Bollinger et al. (1983), NBIA (1993b), Miller and Cote (1987), McMullan et al. (1986)</td>
</tr>
<tr>
<td>(a) Program goals</td>
<td>Allen and Levine (1986), Smilor (1987), NBIA (1990)</td>
</tr>
<tr>
<td>(c) Financing and capitalization</td>
<td>Same as above</td>
</tr>
<tr>
<td>(d) Target markets</td>
<td>Same as above</td>
</tr>
<tr>
<td>(f) Tenant performance review policy</td>
<td>Same as above</td>
</tr>
<tr>
<td>3. Services and Their Impact</td>
<td></td>
</tr>
</tbody>
</table>

Empirically found or observed to influence university-based technology business incubation support (Mian 1994a, 1994b). These characteristics are listed under the above three sets of variables (along with the authors who used them) as shown in Table 2.

The three sets of UTBI performance variables (conceptualized in Figure 1) defined by the UTBI characteristics (drawn from the literature, listed in Table 1) provide a framework that captures most of the key UTBI performance dimensions. The framework provides a systematic approach to the UTBI performance assessment and is applicable to the facilities for which the appropriate data are available.

APPLICATION OF THE FRAMEWORK

Methodology and Sample

To verify the validity of the framework the data from a recent national study of 30 UTBI facilities were employed (Mian 1991, 1993, 1994a). To overcome the problem of selective recollection, revisionism, and possible bias, multiple independent sources of information were used in this case study research. Based on these premises, the application

7Several researchers (Campbell et al., 1988; Allen and Bazan 1990) have advocated the use of case study approach for incubator evaluation. Such an approach, they assert, allows us to consider those unique
of the proposed framework used a multiple-case design with an embedded survey (approximating longitudinal characteristics) of the tenant firms (Yin 1984; Babbie 1973).  

One logical way to assess the performance of UTBIs is to compare the performance of their tenants to similar firms not located there. However, previous research has shown this approach has its limitations (Scheirer 1985; Allen and Bazan 1990; Mian 1991): (1) there is no reliable and cost-effective way to identify a comparison group because of poor data sources on small start-up firms; (2) there is no reliable way to identify a comparison group because of a strong selection bias of UTBI tenants—along with the often small number of UTBI firms limiting the validity of statistical comparisons; (3) lack of control on firm variables—such as organizational mission, geographical location, lifecycle aspects, etc.—make direct comparisons of the outcomes misleading due to firm dissimilarities; and most importantly (4) the effects of UTBIs are not limited to their tenant firms.

This study uses a comparative evaluation approach that provides a useful tool for analyzing the comparative characteristics of different programs with similar core objectives, based on the same set of desired outcome measures (Weiss 1972). The approach has been successfully applied and recommended in assessing programs similar to the UTBI (Forrer 1990). To enhance limited generalizability inherent in the case method of inquiry, the sample of cases is selected in such a way that the differences among the cases are maximized. If we find similarities in management policy practices in UTBIs as entirely different as those studied here, there is a reason to believe that the applicability of those practices extends beyond these particular cases (Morone 1993). For data collection, on-site interviews were conducted with the facility managers/directors and their staff, involved university faculty/administrators, and state/local officials represented on the board of directors, which was supplemented by information obtained through mail surveys with the tenant firms of the selected UTBI cases. The UTBIs reviewed were chosen to represent programs which: (1) were sponsored by a “major” university in the United States; (2) represented both public and private university types; (3) were representative of those generally viewed as “successful” as well as “not-so-successful;” and (4) were in the range of 5 and 8 years old. Using this criteria a

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8 In a typical longitudinal survey design, data are collected at different points in time and changes are reported in the form of trend, cohort, and panel studies (Babbie 1973, pp. 63–66). The study process can be approximated by asking the respondents to supply data for the current year and for the previous years as well. There is a need, however, to ascertain information accuracy and to clean the data from other possible life-cycle effects. Nonetheless, in actual applications of the model, true longitudinal data collection is recommended with the comparative data obtained either from the professional association or private sources.

9 Weiss (1973, p. 83) has suggested three conditions that experience suggests particularly recommend the use of comparative evaluations: (1) when the issues are real and policy-makers are faced with vital decisions among alternative strategies for action; (2) when the alternative programs are relatively well defined, with substantially similar aims (having a set of core goals in common) but clearly differentiated strategies for attaining them; (3) when there is preliminary evidence that the programs have the viability and strength to offer some likelihood of success.

10 There is a note of caution here. According to Weiss (1972), a comparative evaluation approach is justifiable only when programs are truly comparable; evaluation of performance or outcomes requires that the alternative programs are relatively well defined, with substantially similar aims but clearly differentiated strategies for attaining them; and probability of some positive outcome.

11 Major university is defined here according to the Carnegie Classification, including research universities and doctoral degree-granting institutions.

12 A vast majority (83%) of the five year or older UTBIs were initiated during the 1983–1986 period and were 5 to 8 years old at the time of data collection (Mian 1994a).
TABLE 3 Diversity of Selected UTBIs: Their Characteristics and the Tenant Firms’ Survey Data

<table>
<thead>
<tr>
<th>Incubator Facility — Year Established</th>
<th>Sponsoring University—Private or State (Research Park Presence)</th>
<th>Rentable Space in Square Feet (Relative Size)</th>
<th>Tenant &amp; Graduate Firms Contacted for Survey # (Current Tenants #)</th>
<th>Total Firms Responded to the Survey #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology Innovation Center (TIC)—1986</td>
<td>Northwestern University—A Private University (Nearby Research Park)</td>
<td>33,000 (Medium)</td>
<td>31 (25)</td>
<td>7</td>
</tr>
<tr>
<td>The Ben Craig Center (BCC)—1986</td>
<td>University of North Carolina at Charlotte—A State University (Nearby Research Park)</td>
<td>87,000 (Large)</td>
<td>17 (14)</td>
<td>8</td>
</tr>
<tr>
<td>Edison Technology Incubator (ETI)—1984</td>
<td>Case Western Reserve University—A Private University (No Research Park)</td>
<td>13,000 (Small)</td>
<td>11 (7)</td>
<td>4</td>
</tr>
<tr>
<td>Technology Advancement Program (TAP)—1984</td>
<td>University of Maryland—A State Land Grants University (No Research Park)</td>
<td>15,700 (Small)</td>
<td>25 (19)</td>
<td>10</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td></td>
<td></td>
<td>84 (35.6%)</td>
<td></td>
</tr>
</tbody>
</table>

sample of the following four UTBI facilities was selected to establish the proposed performance assessment framework:13

- Technology Innovation (TIC)
- The Ben Craig Center (BCC)
- Edison Technology (ETI)
- Technology Advancement Program (TAP)

Table 3 shows the diversity of these UTBIs along with their tenant firms’ survey data.

Each of these facilities was visited by the investigator, during which appropriate documents were obtained and interviews were conducted with the facility manager/director, the faculty, and other governmental and private sector representatives from each facility’s board of directors.14 (A minimum of six individuals was interviewed at each site). As shown in the table, out of a population of 84 tenant firms to whom the survey was mailed only 29 (35%) responded.15

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13Fourteen of the most highly respected experts in the field including academics/researchers, the national professional association’s officers, and some renowned practitioner managers were interviewed personally during the annual national conference (with extended telephone follow-ups, later on). These experts were asked to verify the selection criteria and help identify a representative sample for the case study. Based on a summation of their responses, a total of seven (out of a population of 30) 5-year and older UTBIs were identified and ultimately four facilities conforming to the 5 to 8 year age range, are included in this study.

14The data collection and subsequent verification were carried out during later half of 1991.

15Mail reminders, and in some cases help from the facility management, were sought to obtain the response. It is plausible that a majority of those responding to the survey were successful firms. However, every effort was made to discourage any bias and selectivity. Most of the nonrespondents were relatively newer tenants and were not dissimilar to the responding tenants in terms of industry type and/or size.
The following sections provide performance reviews of each of these four UTBI facilities in a comparative fashion. To account for differences in time spans, the cases are grouped into pairs of cohorts, with each pair having a private university and a state university UTBI and with each established in the same year. Wherever possible, the data are collected for several years, approximating longitudinal approach. The research findings are categorized according to the three sets of variables noted earlier in the assessment framework.

Comparative Case Study of Technology Innovation Center (TIC) and The Ben Craig Center (BCC)

Table 4 provides an overview of the comparative assessment characteristics of TIC and BCC in three categories: (1) performance outcomes (2) effectiveness of management policies and practices and (3) services and their value added. A detailed comparative analysis of the cases follow:

The performance outcomes were assessed using the three subcategories: (1) program sustainability and growth (2) tenant firm’s survival and growth and (3) contribution to sponsoring university’s mission.

Program Sustainability and Growth

The UTBI’s organizational sustainability primarily stems from the articulation and communication of its goals and their actual realization as perceived by the various stakeholders, specifically the sponsoring university. An ongoing success in accomplishing this task will most probably result in a continued support for its existence and growth. Apparently, the availability of long-term, in-kind support (through subsidized or free use of facilities) or lump-sum donations to cover major capital expenses at the outset would help UTBIs in attaining sustainability. In certain circumstances, the presence of anchor tenants and/or adjoining research parks have also been described as the potential sources of continuity to an incubation project (Mian 1994a). It may be mentioned here that the desirable growth in space/facilities/services is a function of good business forecasting of the actual needs. And, change in sponsors’ and hence the UTBI’s objectives based on market dynamics determines the rate and direction (positive or negative) of this growth on a case by case basis.

Though each UTBI case has its unique origins and characteristics including goals, their program sustainability and growth in facilities such as new buildings, number of staff, additional services, and in developing new projects within the programs they have some elements in common.

The Technology Innovation Center (TIC) at Northwestern University (a private university) started its operation in June 1986, and rents its 33,000 square feet of rentable space at its new facility near the university campus. TIC’s program growth has been...

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16 Direct communications with several incubator/research park directors/managers in the United States. This view is supported by the “competing values model” of organizational assessment (Cameron 1986). This task is generally performed by a project champion (s)—see part (c) contributions to the sponsoring university’s mission.
TABLE 4 Summary of Comparative Assessments for TIC and BCC

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>TIC—Northwestern University (Private University)—Established 1986</th>
<th>BCC—University of North Carolina, Charlotte (State University)—Established 1986</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Performance Outcomes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program growth and sustainability</td>
<td>Rentable space has grown 15 times via new buildings. TIC continues to draw community and university support including 1/3rd to 1/2 of the operational budget.</td>
<td>Rentable space has grown 2 times with additional future capacity of 1 and 1/2 times via new buildings. Continued state support covered around 1/2 of the operational expenses.</td>
</tr>
<tr>
<td>Tenant firm’s survival and growth</td>
<td>Tenants (N=6) reported positive growth in sales (117%) and employment (79%) during 1986-90. With 9 graduates the incubation rate is 7% of average # of tenants per year.</td>
<td>Tenants (N=6) reported positive growth in sales (146%) and employment (45%) during 1986-90. With 4 graduates the incubation rate is 7% of average # of tenants per year.</td>
</tr>
<tr>
<td>Contributions to sponsoring university’s mission</td>
<td>Enhanced public image due to press coverage and large # of visitors. Small but growing # of faculty entrepreneurs/student trainees/employees. No adverse impact on univ environment reported.</td>
<td>Enhanced public image due to press coverage and visitors. Limited #s of faculty entrepreneurs and student trainees/employees. Similarly, no adverse impact on univ environment reported.</td>
</tr>
<tr>
<td>Community-related impacts</td>
<td>Aggregate quantitative data not available. Several conglomeration effects were positive.</td>
<td>Aggregate quantitative data not available. The conglomeration effects were generally not apparent.</td>
</tr>
</tbody>
</table>

**Effectiveness of Management Policies and Practices**

| Goals, structure, and governance | TIC shows considerable progress in achieving goals of NTBF development, providing entrepreneurial lab for students/faculty, and capturing tenants for the research park. Located on NU campus with numerous complementary research facilities such as BIRL lab, TIC is a non-profit entity managed by the for-profit research park and overseen by a private sector dominated board. Lean staff with reported minor to major value-added in management support. | BCC shows some progress in achieving goals of NTBF development, but limited progress in recruiting manufacturing firms, providing entrepreneurial lab for students/faculty, and no progress in capturing tenants for the research park. Located near UNCC campus with some complementary research facilities, BCC is a non-profit corp. governed by a private sector dominated board. Relatively large staff with reported minor to major value-added in management support. |
| Financing and capitalization | Local EBIC has provided early stage VC funds to several tenants. Support for federal SBIR awards is also provided to tenants. Exact # of the recipients is not available. | BCC lacks programs in providing financial support/funding for tenants due to the fact that NC state does not have a strong VC industry. Support for federal SBIR awards is provided to tenants. Exact # of the recipients is not available. |

(continued)
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>TIC—Northwestern University (Private University)—Established 1986</th>
<th>BCC—University of North Carolina, Charlotte (State University)—Established 1986</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational policies</td>
<td>For entry NTBFs with resources fit are emphasized and flexible (2—5 yrs) exit policy enforced by rent increase. Informal tenant progress reviews held, and no written intellectual property safeguard rules provided. Informal contact with alumni firms are kept.</td>
<td>For entry manufacturing/tech firms with mkt potential emphasized, and flexible (3 yrs avg) exit policy enforced by rent increase. Tenant advisory committees drawn from private sector provide performance feedback. No written policy for intellectual property safeguard or for contacts with alumni firms are presently available.</td>
</tr>
<tr>
<td>Target markets</td>
<td>Software, biotech, and electronics firms dominate TIC. In terms of type of tenants univ-related entrepreneurs have been solicited with some degree of success.</td>
<td>Software, biotech, and instrumentation firms dominate BCC. In terms of type of tenants univ-related entrepreneurs have been solicited with limited success.</td>
</tr>
</tbody>
</table>

**Services and Their Perceived Value-Added**

| Shared incubator services | TIC provides most of the shared office and business assistance services. Mainly photocopier, fax, phone, personal computer, business planning, and business connections help were used and had value for the tenants. | BCC also provides most of the shared office and business assistance services. Mainly photocopier, fax, receptionist, conference room use, accounting/marketing/business plan help were being used and had value for the tenants. |
| University-related services | All of these services are available or made available to TIC clients. Student employees, faculty consultants, library, labs/workshops were more frequently used. These services and the university image were assigned major values. | Most of these services are available or made available to BCC clients. Student employees, faculty consultants, library were more frequently used. These services and the university image were assigned major values. |

relatively high;\(^\text{17}\) for example, the recent 1990 expansion has more than doubled its physical facilities and accordingly more services and new programs have been added. In spite of the considerable growth in rentable space, TIC did not seem to have experienced any difficulty in attracting suitable tenants. In terms of program sustainability, there was widespread enthusiasm among the stakeholders including the university and community leaders in terms of the articulated objectives and their degree of realization. The university had initially provided a free/subsidized use of its buildings, labor, and facilities, which helped TIC to sustain its operation in its early years of inception. The success of the program has helped to maintain a continued support from the university and the other state and local stakeholders providing necessary sustainability and growth in

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\(^{17}\)The terms slow, moderate, and high growth are used in a relative sense keeping in view the four facilities being studied. Though difficult to quantify slow growth represents almost no growth in physical facilities and/or services except a marginal growth in the number of tenants. On the other hand high growth represents noticeable growth in all aspects of the facility and its offerings. Moderate growth falls somewhere in the middle. However, to be objective these judgments on growth were also verified during site interviews and discussions with the experts.
TIC's service offerings and programmatic activities which is expected to continue. In terms of operating revenues, TIC was reported as having broken even before moving to the new facility in 1991. After its relocation to the current building, TIC claimed to have received about two-thirds of its budget from rental income and services. The remaining operational subsidy was obtained (at the time of the survey) from the university's research park, which has proved to be another source of sustainability for the incubator project. TIC management, however, seemed committed to a break-even operation.

The Ben Craig Center (BCC) at the University of North Carolina at Charlotte (a state university) was established in March 1986 with 27,000 square feet rentable space near the university campus. Starting in early 1991, an additional 50,000 square feet rentable space was provided at its newly built facility. Due to this recent growth in rentable space, the management has been soliciting tenants to fill the empty space while trying to keep the entry policy guidelines. In terms of program sustainability, BCC also enjoyed a widespread enthusiasm among the stakeholders including the university’s foundation and its faculty and management in terms of BCC’s objectives and its overall direction. Additionally, private business leaders’ direct involvement in providing the necessary financial and in-kind support on a long-term basis is a healthy sign for the project’s sustainability. In fact, BCC has been fortunate in obtaining financial aid for capital investment, which has been used in the construction of new buildings and facilities on which no debt service is required. The presence of the nearby research park also provides a potential source of support in this respect. In terms of operating revenues, BCC’s management also claimed to have received about two-thirds of its budget from rental income and services. The remaining operational subsidy was obtained (at the time of the survey) from the state. The current management, however, did not show any resolve for a break-even operation which goes negatively for BCC’s prospects of financial self-sufficiency.

Tenant Firm’s Survival and Growth:

Figure 2 depicts the responding tenant firms’ data from all the four cases, showing general growth trends in sales (graph A) as well as in employment (graph B) during 1986–90 incubation years. As mentioned earlier, it is plausible that responding tenant firms were generally more established (older and/or larger) than nonrespondents, which may have inflated the actual growth experienced by most of the tenants (a majority of the responding firms, 22 out of 29, provided this data).

A more detailed account of each tenant at TIC revealed that five out of six responding firms show a trend in sales growth (year averages: 200%, 100%, 159%, 83%, 172%, and −13%) and four out of six employment growth (yearly averages: 75%, 0%, 175%, 72%, 0%, and 150%) during the incubation periods. This tenant firm–reported data cover all 4 years of the UTBI’s (TIC in this case) operational life (data for the latest year were not yet compiled). According to TIC management, as of late 1991, nine firms graduated from TIC, which yields an average of about 7% (9/5 × 100/25) gradua-

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18 Both Graph A as well as Graph B plot total actual values (sales in dollars and employees in numbers, respectively) of all responding firms in a facility during each incubation year. The number of reporting firms at each facility is given in parentheses.

19 The yearly averages of sales growth as well as in employment growth for each firm are calculated by adding the growth percentage (positive or negative) for the consecutive four periods during 1986-90 incubation years, and then dividing it by four.
tion rate per year.\textsuperscript{20} Out of the nine graduates, all but one are still in operation. No data on discontinuances were available from TIC.

Similarly, a more detailed account of six responding tenant firms at BCC show a general trend in sales growth (yearly averages: 54\%, 210\%, 60\%, 271\%, 130\%, 150\%) and in employment growth (yearly averages: 17\% 100\%, 26\%, 50\%, 0\%, and 33\%) during the incubation periods. Similarly, this tenant firm–reported data cover all 4 years of the UTBI's (BCC in this case) operational life (data for the latest year were not yet compiled). According to the BCC management, as of late 1991, of the known four firms who graduated from the center, all are still in operation. This yields an average of about 7\% (4/4 × 100/14) graduation rate per year. The number of discontinuances during tenancy was not reported by the management.

\textsuperscript{20}The number of total graduates to date divided by the number of years of operation gives the average firm creation rate per year. This rate is further multiplied by 100 and divided by the number of total tenants to give the average percentage of tenants graduate per year defined here as the graduation rate.
Contributions to the Sponsoring University’s Mission

Assessments on direct contributions to the sponsoring university’s mission essentially involved looking at student employment and training opportunities provided; faculty involvement as consultants/entrepreneurs; the extent of community, national, and international interest shown in the project; and any adverse impact on the university’s primary mission of teaching and/or research.

Impact on the university itself in the form of student jobs and faculty consulting at TIC was limited but positive. There is a small number of part-time students and some faculty involved with the program. No adverse impact on the university’s teaching and/or research was reported during the interviews. The press reports, national and foreign visitors’ data, and interviews with the facility management, university administrators, and board members from the local private sector and the in-house state technology development program, proved that TIC was perhaps the most widely visited facility among the 5- to 8-year-old UTBIs. Therefore, the presence of TIC on Northwestern University’s campus seemed to have enhanced the university’s prestige and added to its image inside and outside the state. This was made possible partly because of the joint UTBI-research park integrated project which attracted more attention. The facility has a number of strong advocates led by a vice president of the university, who reportedly worked hard during the early years to sell the project within and outside the campus.

BCC’s impact on the university itself in the form of student jobs and faculty consulting was also limited. In spite of the fact that the center is in close physical proximity to the university and the university research park, there were only a small number of part-time students three to four who worked for the center’s management and a couple of faculty members were involved as entrepreneurs. The number of part-time students employed by the tenant firms were not made available. No adverse impact on the university’s teaching and/or research was reported during the interviews. According to the management, BCC was said to have been perceived as a model of economic development efforts in the region, and its presence was described to have enhanced the university’s prestige, adding to its image in the state and outside. Further, BCC’s international program was considered quite unique and has drawn considerable attention. Interviews with some members of the BCC board of directors representing the areas’ businesses, governmental technology development programs, and various university departments attested to this fact. Though high level support for the center stems from the university chancellor, who is considered an ardent advocate of the program, it was apparent during the interviews that BCC enjoys considerable support both from within and outside the university.

Community-related Impacts

The different types of community-related impacts of UTBIs identified include various quantitative as well as qualitative measures. The major types of quantitative measures used are income and employment related. These include tenant and graduate firms’ sales, revenues, tax and export dollars, and the number and types of jobs created and amount of income attributed to those jobs (Malecki 1983). Among the qualitative measures, various conglomeration effects such as availability of skilled labor, venture capitalists, entrepreneurs with start-up experience, clustering of suppliers of parts/compo-
nents, and services in a specialized technology etc. Prevalence of a rich milieu in information flow networks and technology innovations etc may be linked to the UTBI.

In both TIC and BCC, the only quantitative data made available were the individual tenant firms' employment and sales figures along with the number of firms graduated from these facilities (reported earlier). Because not all of the tenants and graduates responded to the mail survey, this information is incomplete and cannot be used to quantitatively assess this performance dimension. The facility management in both cases did not find it appropriate to share this client-related data. Qualitatively, interviews with various stakeholders revealed that in the case of TIC most of the conglomeration effects listed above were positive. In the case of BCC some of the impacts such as availability of trained manpower, services providers, and an environment of innovativeness in general seemed shaping up slowly and were not as apparent as in the case of TIC. However, despite the measurement challenges, these impacts need to be explored more thoroughly in the future application of this framework.

The management policies and practices were assessed using the four categories: (1) goals, structure, and governance; (2) operational policies; (3) financing and capitalization; and (4) target markets.

Goals, Structure, and Governance

In terms of goals, TIC seeks participation in the state’s economic development activities by supporting the development of NTBFs. In pursuing the economic development objective it aims at providing a laboratory for learning entrepreneurial skills by the Northwestern University students and faculty. Promoting commercialization of university technology and recruiting tenants for the nearby Evanston Research Park have also been the objectives at TIC. A review of TIC's past accomplishment shows that the facility has made considerable progress in achieving all of these goals.

Administratively, the policy guidance for TIC has been provided by a private sector-dominated board including university representatives. The incubator management team comprises a director, assisted by a staff and a few part-time students. The general university environment in the form of complementary research and technology development support activities around TIC was ideal as manifested by the presence of a Small Business Development Center, Evanston Small Business Investment Corporation, University-operated Technology Commercialization Center (TCC), Basic Industrial Research Lab (BIRL) and numerous other university-related research institutes and laboratories. Interviews with the incubator management and involved university officials revealed some degree of interaction by the tenants with these complementary support facilities. However, improved networking and access would have enhanced the effectiveness of these university-related facilities for the tenants. The quality of management support received by the tenant firms in helping to solve their problems ranged from minor to major in value-added terms as reported by the respondents. This was somewhat surprising in light of the gamut of services provided along with the high degree of care shown for the tenants. Apparently, TIC seemed to be on track and no major need for improvements was noticed in this area.

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21 The value-added contributions of the services provided were assessed through tenants' perceptions recorded on a four level scale, with 0 as no value-added, 1 as minor value-added, 2 as moderate value-added, and 3 as major value-added. Similarly, the extent of usage was recorded on a 3 level scale with no, occasional, high usage patterns reported by the tenant firms.
In terms of goals, BCC seeks participation in the state’s economic development activities. In pursuing the economic development objective, BCC aims at supporting the development of manufacturing oriented small firms in particular. BCC also intends to capture tenants from its graduates for the university’s research park. A review of the actual progress toward realizing these goals show that BCC has only a handful of tenant companies that could be categorized as manufacturing and there had been some unsuccessful efforts in trying to relocate their graduates (four firms, so far) to the nearby research park.

BCC is a non-profit corporation supported by the university foundation. Over the years, the state had helped the center by providing funds for capital expenditure. Therefore, both the state and the university through its foundation wield some degree of indirect control on the center’s long-term goals and strategic planning, but the policy guidance has been provided by a private sector-dominated board. The day-to-day management is provided by an executive director with staff of five to six full-time individuals. The presence of research and technology development support facilities around BCC in the form of a Small Business and Technology Development Center, University Technology Transfer Office, University Research Park, and the International Program, provides a conducive environment for nurturing new businesses. The data on actual use of these complementary facilities by the tenants were not available. The quality of management support received by the tenant firms in helping to solve their problems was reported as ranging from minor to major in value-added terms. The analysis shows that BCC needs to strengthen at least two areas: one, recruit more manufacturing firms; two, provide better financial support and venture capital help for the tenant firms.

**Financing and Capitalization**

This is assessed in two ways: one, for the UTBI itself (also included earlier in the analysis of sustainability of the facilities); two, for the tenant firms. As explained earlier in the discussion on sustainability, a lump-sum financial or in-kind donation to own buildings and/or pay salaries of key personnel, etc. usually provided at the time of inception will set a UTBI on a path to financial self-reliance. However, not all UTBIs are found to be fortunate in this respect.

Currently, TIC claims to have received around two-thirds of its operating budget from rental and service incomes. The remaining one-third of the revenue was obtained from the adjoining for-profit research park. The state grants were secured to cover new capital expenditure. The university provided buildings and in-kind support. For its tenant firms, TIC provides help to secure federal SBIR awards, and also helps to obtain funding through private sources such as the local Evanston Business Investment Corporation (EBIC).

In terms of operating revenues BCC also claimed to have received around two-thirds of its operating budget from rental and service incomes. The remaining one-third of the revenue was obtained from the university’s foundation and private sources. Public

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22 This includes in-house consultants and the Small Business Development Center officials who work more closely with the executive director.

23 The Small Business Innovation Research (SBIR) program is a U.S. government initiative intended to address the government’s scientific R&D needs. The program is a three-phase process through which eligible small businesses receive funds on a competitive basis.
Operational Policies

Among the operational policies, the application of a formal entry/selection policy procedure was reported at TIC. The decisions are made by the director in consultation with a special committee formed for this purpose. Generally, technology-based start-ups are encouraged as tenants. In exit/graduation policy, flexibility is maintained and the incubation period varies from 2 to 5 years. Presently, there is no written intellectual property rights protection policy for tenants, and no graduate firm/university linkage policy for TIC alumni firms is available. For graduating tenants, relocational advice is provided on an informal basis. The tenant firm performance reviews are conducted informally by the incubator director, every year, and there are no formal procedures developed in this regard.

At BCC, among the operational policies, again the applications of formal entry/selection policy procedure were reported. Typically, technology-based start-ups with high growth potential and existing cash flow were encouraged. In exit/graduation policy, incubation period was negotiated at the time of entry. After the expiry of this period rent was raised at the rate of $2 per square foot per year and tenants were persuaded to graduate. Currently, there is no written intellectual rights protection policy, and no graduate firm-university linkage policy available to the BCC tenants. The graduating tenants are encouraged to stay in the state, and relocational advice is provided on an informal basis. There are no mandatory tenant performance review procedures followed at BCC. For this purpose, tenant advisory committees drawn from the private sector meet quarterly with the tenants and necessary feedback is provided on financial and other business aspects, whereas the incubator director who has more frequent contacts conducts informal reviews.

Target Markets

To study the UTBI target markets, two parameters were used: first, the type of technologies represented and their relevance to the available resources; second, the type of tenants admitted as measured by the representation of the university-related (students, alumni, professors) entrepreneurs.

TIC’s targeted technologies among its tenant firms include: software/information science, biotechnology/medical, electronics/electrical, instrumentation, and telecommunication. Much higher representation of software/information science and biotechnology/medical firms shows a growing trend in TIC’s admittance policy in this area of vital interest to the region. It is also in line with the university's strength in these areas of technology and attests to the fact that entry policies were followed. In terms of the university-related entrepreneurs, it was reported that there were a couple of cases in which Northwestern’s engineering faculty members had been involved in developing funds for capital expenditure were made available through various state agencies. As mentioned earlier, currently the center lacks programs in financial support/funding for its tenants. Some of the tenants reported difficulties in obtaining necessary funds and it becomes important for the center to provide better funding support due to the fact that (1) North Carolina is not known for a developed venture capital industry, and (2) the adjoining Research Triangle Park area is home to a large number of NTBFs.
their technologies, but none of these efforts had resulted in real success stories. Additionally, some of the TIC’s tenants were university alumni. However, at the time of survey, the percentage of university-related entrepreneurs was limited but growing as a result of management’s encouraging policy.

At BCC, from the point of view of technology representation, there is a high percentage of targeted technologies among its tenants as well, which include tenants in software/information science, instrumentation/mechanical, electronics/electrical, robotics/automation and biotechnology/medical. The much higher representation of service and software firms as opposed to technology-based manufacturing businesses showed a drift from BCC’s goals. This also suggested that the entry policy may not have been strictly followed to increase tenancy. Second, the percentage of university-related entrepreneurs (students, alumni, professors) among its tenants was found limited. Currently, only one university-related entrepreneur (a professor) was involved as a tenant. This showed the need for improvement in the implementation of the policy to achieve the goal of developing entrepreneurs from within.

The **provision of services and their value-added** are assessed using two subcategories: (1) incubator services and, (2) university-related services.

**Shared Incubator Services**

TIC provides most of the incubator services. Findings on value-added contributions show that of the incubator services, photocopier, fax, phone, and personal computer were used and had major values for the tenants. The business assistance services such as business plans, business connections, and mail sorting were also used and moderate to major values were assigned to them.

The Ben Craig Center provides most of the incubator services, as well. The findings on value-added contributions show that, the shared office services of photocopier, fax, receptionist, conference room use, and shipping and receiving were used more frequently and had major values for the tenants. In the case of business assistance, accounting, marketing and business plan assistance services were used more frequently, and moderate to major values were assigned to them.

**University-related Services**

At TIC, access to most of the university-related services is either available or made available on request. The findings on value-related services show the use of student employees, faculty consultants, library/information databases, laboratories/workshops with major values assigned to them. The respondents also reported that the university’s image was of major value to their firms.

At BCC, on the university-related services side access to all but labs/workshops and employee education and training services was generally available. Of the services used, student employees, faculty consultants, library services, and university image conveyance were valued by the respondents.

**Comparative Case Study of Edison Technology Incubator and the Technology Advancement Program**

Table 5 provides an overview of the comparative assessment characteristics of ETI and TAP using the same framework, a detailed analysis of which is provided below:
TABLE 5 Summary of Comparative Assessments for ETI and TAP

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>ETI—The Case Western Reserve University (Private University)— Established 1984</th>
<th>TAP—University of Maryland, College Park (State University)— Established 1984</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Performance Outcomes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program growth and sustainability</td>
<td>Rentable space has grown only 14%. ETI continues to draw private &amp; state support (from Edison program) including 2/3rd of its operational budget.</td>
<td>Rentable space has grown more than 100%. TAP's continued state support covered around 1/2 of the operational expenses.</td>
</tr>
<tr>
<td>Tenant firm’s survival &amp; growth</td>
<td>Tenants (N=4) reported positive growth in sales (400%) and employment (77%) during 1986-90. With 4 graduates the incubation rate is 10% of average # of tenants per year.</td>
<td>Tenants (N=6) reported positive growth in sales (45%) and employment (11%) during 1986-90. With 9 graduates the incubation rate is 8% of average # of tenants per year.</td>
</tr>
<tr>
<td>Contributions to sponsoring university’s mission</td>
<td>Enhanced public image due to press coverage and some visitors. Small # of faculty entrepreneurs/student trainees/employees. No adverse impact on university environment reported.</td>
<td>Enhanced public image due to press coverage, visitors—resulting in continued state support. Lack of faculty entrepreneurs &amp; a few student trainees/employees. No adverse impact on university environment reported.</td>
</tr>
<tr>
<td>Community-related impacts</td>
<td>Aggregate quantitative data not available. The conglomeration effects were generally not apparent.</td>
<td>Here too, aggregate quantitative data not available and conglomeration effects were generally not apparent.</td>
</tr>
<tr>
<td><strong>Effectiveness of Management Policies and Practices</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goals, structure, and governance</td>
<td>ETI shows limited progress in achieving goals of focusing biotechnology NTBF development and providing entrepreneurial lab for students/faculty. Located near CWRU campus with numerous complementary medical and other research institutes and labs, ETI is a non-profit wholly owned subsidiary of the university. Policy guidance has been provided by a private sector dominated board. Relatively lean staff with reported moderate to major value-added in management support.</td>
<td>TAP shows progress in achieving goal of NTBF development, but there is no mentionable progress in recruiting university-related entrepreneurs by providing lab for students/faculty. Located in the UM's College Park campus with numerous complementary research facilities, TAP is a part of university’s ERC. TAP’s policies are made by a private sector dominated board. Relatively medium sized staff with reported minor to major value-added in management support.</td>
</tr>
<tr>
<td>Financing and capitalization</td>
<td>ETI has provided support for obtaining money from various private VC and seed funds to its tenants. Support for federal SBIR awards is also provided to tenants. Exact # of recipients is not available.</td>
<td>TAP lacks programs in providing financial support/funding, however, informational sessions are held at its Dingman center. Support for federal SBIR awards is provided to tenants. Exact # of recipients is not available.</td>
</tr>
</tbody>
</table>

The performance outcomes were assessed again using the three categories mentioned earlier:

**Program Sustainability and Growth**

The Edison Technology Incubator (ETI) at Case Western Reserve University (a private university) started working in March 1984. The facility rents 13,000 square feet of its
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>ETI—The Case Western Reserve University (Private University)—Established 1984</th>
<th>TAP—University of Maryland, College Park (State University)—Established 1984</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational policies</td>
<td>For entry NTBFs are emphasized and a 6-month lease is provided. After 2 yrs of tenancy special approvals are required to stay and exit policy is enforced by rent increase. Informal tenant progress reviews held, and no written intellectual property safeguard rules provided. Informal contact with alumni firms are kept.</td>
<td>For entry NTBFs are selected emphasizing 3 criteria (general, technical, business). Flexible (3 yrs avg) exit policy enforced by negotiations. 1-2% equity held in couple cases. Tenant performance reviews are held yearly. No written policies for intellectual property safeguard or for contacts with alumni firms are available.</td>
</tr>
<tr>
<td>Target markets</td>
<td>Instrumentation/mechanical, biotechnology, and software firms dominate ETI. In terms of type of tenants univ-related entrepreneurs have been solicited with limited of success.</td>
<td>Biotech, electronics, food and telecommunications firms dominate TAP. In terms of type of tenants univ-related entrepreneurs have been not been solicited due to various reasons.</td>
</tr>
<tr>
<td>Services and Their Perceived Value-Added</td>
<td>ETI provides most of the shared office and business assistance services. Mainly, photocopier, fax, phone, security and receptionist, business connections help and other business services were used and had value for the tenants.</td>
<td>TAP also provides most of the shared office and business assistance services. Mainly photocopier, fax, telephone, conference room use, business plan, legal help, grants and loans were used and had values for the tenants.</td>
</tr>
<tr>
<td>Shared incubator services</td>
<td>University-related services</td>
<td>Most of these services are available or made available to TAP clients. Student employees, faculty consultants, library, labs/equipment were more frequently used. These services and the university image were assigned major values.</td>
</tr>
<tr>
<td></td>
<td>All of these services are available or made available to ETI clients. Student employees, faculty consultants, library, labs/equipment and technology transfer programs were more frequently used. These services and the university image were assigned major values.</td>
<td>Most of these services are available or made available to TAP clients. Student employees, faculty consultants, library, labs/equipment were more frequently used. These services and the university image were assigned major values.</td>
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</table>

space in its multistory building on the university campus. The ETI program’s growth in facilities and new programs has been relatively slow to moderate during the past 7 years of its history, and therefore, only a handful of select tenants have been served. In terms of program sustainability, ETI has enjoyed considerable support from the state through the Edison Technology Program. The other stakeholders including the university’s management school, which only provided in-kind support and the state’s private sector, which continue to provide funds were positive about the long-term viability of the project. In terms of operating revenues ETI received only one-third of the annual operating budget from its rental and services income and the state with the help of local private sector picked-up the remaining tab. In the long-run the authorities are considering establishing a research park adjacent to ETI which is expected to be a potential source of enhancing the incubator project’s sustainability and growth.

Technology Advancement Program (TAP) at University of Maryland, College Park (a state university) was established in September 1984. TAP rents its 15,700 square
feet space to a select group of technology-based start-ups. TAP's program growth and facilities such as new buildings, number of staff, additional services, and new programs have been moderate during the past 7 years. Accordingly, it received an enhanced state grant resulting in increased operational budget and more tenants served. It may be noted here that TAP accommodates almost three times the number of tenants served by ETI with only 20% more rentable space. In terms of program sustainability, TAP has enjoyed considerable support from the state as part of the University's Engineering Research Center, which essentially underwrites the incubator's financial sustainability. In the presence of other ERC operations considered as complementary to TAP (at the time of survey), no consideration had been given to add a research park facility on or near the campus. The extent of support in the form of TAP's actual involvement with other stakeholders including the university community and the local private sector was considerable. Through its annual budget appropriations (to the ERC), the state contributed around half of TAP's operating budget, while the remaining portion was obtained from rental income and services.

Tenant Firm's Survival and Growth

As stated previously, Figure 2 depicts the responding tenant firms' data from all the four cases, showing general trends in sales (graph A) and in employment (graph B) during 1986–90 incubation years. (As noted earlier, a majority of the responding firms, 22 out of 29, provided this data).

A more detailed account of each tenant at ETI reveals that three out of four responding firms show a trend in sales growth (yearly averages: 56%, 0%, 267%, and 12%) and in employment growth (yearly averages: 27%, 140%, 0%, and 38%) during the incubation period. This tenant firm reported data covers the last four time periods (data for the last year were not yet compiled) out of the total of six time periods of ETI's operational life. According to the management, as of late 1991, four firms have graduated from ETI, all of which are still in operation. This yields an average of about 10% (4/6 x 100/7) gradation rate per year. The number of discontinuances during tenancy was not made available by the management.

Finally, of TAP's six responding firms (with complete sales/employment data), four firms show trends in sales growth, one firm shows negative growth, and another no growth (yearly averages: 51%, 70%, 155%, 45%, −50%, and 0%) and in employment three out of six show growth trends, whereas two show negative growth and one no growth (yearly averages: 42%, 61%, 50%, −40%, −50%, and 0%) during the incubation period. This tenant firm reported data covers the last four time periods (data for the latest year was not yet compiled) out of the total six time periods of TAP's operational life. This shows a higher frequency of tenants with positive growth both in sales and in employment than tenants with negative growth or no growth. According to the management, as of late 1991, nine firms had graduated from TAP, which yields an average of about 8% (9/6 x 100/19) graduation rate per year. Out of the nine graduate firms, all but one are still in operation. The data on number of discontinuances during tenancy were not available.

Contributions to the Sponsoring University's Mission

ETI's impact on the university itself in the form of student jobs and faculty consulting was limited (the exact numbers were not made available). In spite of the fact that ETI
has a close contact with the university’s management school, there is a small number of part-time students (two to four) and a couple of faculty involved with the program. No adverse impact on the university’s teaching and/or research was reported by the ETI management and the involved faculty alike. Interviews with the members of the board of trustees representing the University’s Weatherhead School of Management, local private sector, and the state’s Edison technology development program proved that ETI’s activities enjoy widespread support and its presence on the Case Western Reserve University campus was said to have enhanced the university’s prestige, prompting the Weatherhead School to establish the Center for Management of Science and Technology for which ETI serves as a laboratory. No information on facility visits by the interested parties was provided by the ETI management; however, there were frequent local press reports highlighting ETI activities.

TAP’s impact on the university itself in the form of student jobs and faculty consulting was limited to only a small number of part-time students, and at the time of data collection, no faculty were involved with the program (exact numbers were not reported). No adverse impact on the university’s teaching and/or research was reported during the interviews. Because the facility was perceived as providing jobs and helping to create new businesses, it qualified TAP for honorable mention by the state legislators and for obtaining funds from state and private sources. Additionally, a large number of inquiries and visits by the local, national, and even international parties interested in setting up such facilities were reported. Therefore, the management’s claim that the presence of TAP on the University of Maryland’s campus has enhanced its prestige and added to its image in the state and outside seems plausible. During interviews with the university administrators, it appeared that the TAP program also enjoyed considerable support from within. As stated earlier, most state legislators held favorable opinions about the facility’s mission; however, efforts to interview some of the business representatives from the board of advisors list did not succeed.

Community-related Impacts

As stated in the previous two cases, the different types of community-related impacts of UTBIs identified include various quantitative as well as qualitative measures. The major types of quantitative measures used are income and employment related, which include tenant and graduate firms’ sales, revenues, tax and export dollars, and the number and types of jobs created and amount of income attributed to those jobs. Among the qualitative measures, various conglomeration effects such as availability of skilled labor, venture capitalists, entrepreneurs with start-up experience, clustering of suppliers of parts/components, and services in a specialized technology, etc., and the prevalence of a rich milieu in information flow networks and technology innovations may be linked to the UTBI.

Like the previous cases, during the survey of both ETI and TAP the only quantitative data made available were the individual tenant firms’ employment and sales figures along with the number of firms graduated from these facilities (reported earlier). Since not all of the tenants and graduates responded to the mail survey, this information is incomplete and cannot be used to quantitatively assess this performance dimension. Qualitatively, interviews with various stakeholders revealed that in both ETI and TAP, not all of the conglomeration effects listed above were present and like BCC these effects seemed shaping up slowly and were not as apparent as in the case of TIC. Nonethe-
less, these aspects will be explored more thoroughly in the future application of this framework.

The management policies and practices were assessed using the four subcategories stated earlier.

**Goals, Structure, and Governance**

In terms of goals, ETI seeks participation in the state’s economic development activities by supporting the development of NTBFs. In pursuing the economic development objective ETI also aims at providing a laboratory for learning entrepreneurial skills by the Case Western Reserve University students and faculty. Promoting commercialization of university technology (especially in biotechnology) has been one of the primary objectives at ETI. Assessment of the actual realization of these goals shows that there had been limited success in involving faculty and students, and only one major example of spinning off a biotechnology firm based on university technology was reported.

ETI is a non-profit wholly owned subsidiary of the Case Western Reserve University. Over the years the state and private corporations had helped the incubator by providing funds for capital expenditure. Therefore, both the state and the university influence ETI’s long-term planning, but the policy guidance has been provided by a private sector-dominated board, including university representatives. The incubator management team consists of an executive director and an incubator manager, assisted by a staff. The general university environment in research and technology development around ETI is rich in the form of institutional support from various university departments, institutes, and other regional technology and business development centers. Site interviews with the incubator manager and involved university officials provided no evidence as to the extent of support actually tapped from these complementary facilities by the tenant firms. The quality of management support received by the tenant firms in helping to solve their problems (mainly in accessing outside financial support, inside and outside business connections) was reported as ranging from moderate to major in value-added terms. This analysis shows that ETI needs to emphasize its goals of involving university-related entrepreneurs and provide more networking opportunities for tenant firms to take advantage of the complementary R&D activities around ETI.

In terms of its goals, TAP seeks participation in the state’s economic development activities by supporting the development of high technology firms. In pursuing the economic development objective, TAP also aims at providing a laboratory for learning entrepreneurial skills, particularly for aspiring students and faculty. The implementation record shows that whereas TAP has been successful in admitting high technology firms, there was no mentionable progress in developing entrepreneurs from within the university, as stated earlier.

Organizationally, TAP is a part of the University’s Engineering Research Center (ERC) and the university owns and operates the facility. TAP’s policies are made by a 15-member private industry-dominated board of advisors. The facility is staffed by a director, an incubator manager, a program coordinator, and two secretaries. The presence of complementary research and technology development support facilities around TAP in the form of Maryland Industrial Partnerships, Technology Initiatives Program, Technology Extension Service, and the Dingman Center for Entrepreneurship provide an enabling environment for nurturing NTBFs. According to the management, tenants are encouraged to use this university-related institutional support; however, there are
no data to verify that this is actually happening. The quality of management support at TAP, received by the tenant firms in helping to solve their problems ranges from moderate to major in value-added terms, and in accessing outside financial support it was termed of no value to a minor value by the respondents. This means that TAP needs to strengthen at least two areas: (1) encourage more university-related entrepreneurs; (2) provide better financial support and venture capital help to tenant firms.

**Financing and Capitalization**

As stated above in the analysis on sustainability of the facility, state grants through the Edison Technology Program along with other local financial support have been the major sources of capital funds and operational grants providing around two-thirds of ETI's annual operational budget, whereas the remaining operational budget is supported through rental income and services. Private sector support has also been tapped occasionally, but the university does not provide any operational funds. Various private funding arrangements and the federal SBIR awards are available for the tenant firms to seek, and ETI management provides necessary help in obtaining these funds.

Similarly, as mentioned earlier, the state through its annual budget appropriations (to the University's Engineering Research Center) contributes around half of TAP's operating budget, and the remaining operational funds come from rental income and services. The provision of financial support and related services is not a primary objective of TAP, yet the management is increasingly involved in helping its tenant entrepreneurs to obtain private venture capital financing, and in federal SBIR award applications.

**Operational Policies**

At ETI, among the operational policies, the application of formal entry/selection policy procedures was reported by the management. Similarly, technology-based start-ups were encouraged and a 6-month lease was provided in the beginning. In exit/graduation policy, after 2 years of tenancy, the incubation committee's approval was required for further stay. Currently, there is no written intellectual rights protection policy, and no formal graduate firm-UTBI linkage policy available to ETI tenants. Graduating tenants are provided relocation advice on an informal basis. There were no formal procedures installed for the tenant performance review. However, every year informal tenant evaluations are conducted on a voluntary basis in which financial and other performance feedback is provided by the management.

A systematic application of the entry/selection policy was reported at TAP. Equity holdings (ranging from 1% to 2%) were also reported in a couple of tenant firms, but it was not made a practice. Three types of criteria (general, technical, and business) were used to select the technology-based firms. In the exit/graduation area there was no explicit policy; however, a 3-year incubation period was generally allowed with some flexibility based on individual needs. At the time of survey, there was no formal written intellectual property rights protection policy, and no formal graduate firm-UTBI linkage policy was available to the TAP alumni firms. Again, there were no formal procedures regarding relocation advice for the graduating firms. Formal tenant performance reviews were held each year with the incubator manager.
Target Markets
At ETI, from the point of view of technology representation, there was a high percentage of targeted technologies among its tenants, which include: instrumentation/mechanical, biotechnology/medical, electronics/electrical, software/information science, and telecommunications. Much higher representation of instrumentation/mechanical and biotechnology/medical firms shows a growing trend in ETI's admittance policy in this area of vital interest to the state. The development of these technologies was also in line with the university's strength in the chosen areas of technology. This showed that the entry policies were strictly followed. Second, in terms of the university-related entrepreneurs (students, alumni, professors) among its tenants, during ETI's past 7 years history only one major case of a science professor involved in developing a new technology was reported, which shows very limited success in this area.

Finally, in the case of TAP, from the point of view of technology representation, there was also a high percentage of targeted technologies among its tenants, which include biotechnology/medical, electronics/electrical and food/nutrition, and telecommunications/photonics firms. This shows that the development of these technologies was quite in line with the university's strength in its chosen areas of technology. This also proved that entry policies were strictly followed. Second, from the standpoint of the representation of university-related entrepreneurs (students, alumni, professors) among its tenants, it was found that none of the current tenants were university-related, and no past efforts in recruiting such tenants were shared, which showed some degree of lack of interest in developing entrepreneurs from within.

The provision of services and their value added are assessed using the two categories as before.

Shared Incubator Services
ETI provides most of the incubator services. The findings on value-added contributions show that among the incubator services, photocopier, fax, security, and receptionist services were used and valued highly. Most of the business assistance services were used less frequently though some, including business planning, legal support, helping to obtain grant/loans were reported as adding major values. Rent breaks of up to 30% less than the market rate were also reported as providing a major value for the tenants.

Similarly, TAP provides most of the typical incubator services to its tenant firms. The findings on value-added contributions show that among the various shared office services, photocopiers, fax, telephone, conference room, and personal computer were used more frequently and had major value for the tenants. In the case of business assistance, business plan, legal/government regulation, assessing outside capital, and personnel recruiting services were used at the time of inception or at least once a year. The respondents assigned major values to business planning, government grants and loans, and legal/government regulation support.

University-related Services
ETI provides access to most of the university-related services. Notably, employee education and training seminars were conducted regularly where tenant firm personnel were encouraged to participate. Of the remaining university-related services, student
employees, faculty consultants, library and laboratory services, and technology transfer programs were reported used and were valued highly by the respondents. The respondents also mentioned that university image was of major value to their firms.

Finally, at TAP, among the university-related services, both frequent use of and the value-added were reported in the case of student employees, faculty consultants, library/information data bases, labs/workshops, and sophisticated equipment. Similarly, the respondents also reported that the university image added major value to their firms.

**SUMMARY AND CONCLUSIONS**

Table 6 provides an overview of the assessment framework developed in this study. As shown, three UTBI performance dimensions, each defined by their own sets of variables drawn from the literature and verified through their application to four representative cases formed the basis for the proposed assessment framework. The conceptual model (shown earlier in Figure 1) served as the integrative framework for analysis. During the application of the framework, a combination of expert interviews, site visits entailing record review, management and other stakeholder interviews, and mail surveys with the tenant firms provided an opportunity for synthesizing information from different sources and enabled the researcher to better understand the UTBI performance in its context. This helped to refine the initially conceptualized model and to develop measurement indicators as shown in Table 6.24

The case discussions provided in the previous section illustrate how the proposed framework can be used to analyze the four UTBI projects. The framework takes into consideration both quantitative as well as qualitative performance assessment measures providing a flexible and easy-to-use methodology to assess and manage the performance of UTBIs. It combines the outcome measures with the other value-added aspects of the UTBI system providing an integrative model of assessment. Although the data presented in the case analyses are mainly self-reported estimates with the possibility of reporting biases and selectivity, their relevance and measurability suggests that our conclusions about the usefulness of the framework will remain the same.

It is interesting to note that there appear to be no significant differences in the university-state-private partnerships in the four cases studied, which appears to suggest that UTBIs are drawing equally from these sectors irrespective of who takes the initiative. It seems that across-the-board state or local government funds along with the university resources were being used to leverage private funds and involvement, creating a sense of partnership among these sectors (Mian 1994a). This makes the framework applicable to both of these UTBI sponsorship types—state and private.

Whereas this article provided a viable framework for assessing the UTBI for which appropriate data are available, some questions remain. The research draws from the previous multidisciplinary literature—some of which is anecdotal and the other controversial in nature. Additionally, the framework did not fully account for the micro-level internal NTBF creation processes such as good communication, level of motivation, teamwork, sound decision-making, etc., along with all of the possible macro-level multiplier economic and other

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24 The various elements included under each of the assessment subcategory and their measurement indicators are derived from the literature with additions and adjustments made through insights gained during the survey, but the list is in no way claimed to be exhaustive. It is, therefore, suggested that the users may add new variables and use different or additional measures important to their institutions that are not reflected in Table 6.
### TABLE 6 Components Identified for Assessing and Managing UTBIs

1. **Performance Outcomes**

   **Program Growth and Sustainability**
   - Program profile (growth in budget, space, facilities, services, tenants and staff)
   - Presence of a complementing research park facility (yes/no)
   - Presence of a recognized advocate(s)/champion(s) (yes/no)
   - Share of operational budget supported through internal sources (% share)
   - Level of funding received from key donors including state, industry, university ($)

   **Tenant Firm's Survival and Growth**
   - New firms created (graduation rate)
   - Tenant firms' survivability (ratio of survivors to discontinuances)
   - Tenant firms' sales growth (% annual growth during incubation)
   - Tenant firms' employment growth (% annual growth during incubation)

   **Contributions to Sponsoring-University’s Mission**
   - Salience of technology-based clientele (percent NTBFs)
   - Impact on university's teaching and research (negative or positive)
   - Training in entrepreneurial skills—students, faculty (number)
   - Students/graduates hired by tenants as employees (#, nature)
   - Consulting relationships between university faculty and tenants (#, nature)
   - Impact on university's prestige/public image (media coverage, visitors)
   - Entrepreneurs originating from the university community (number)
   - Tenant employees enrolled in courses/seminars at the university (number)
   - Entrepreneurs serving as adjunct faculty/researchers (#, nature)
   - Other: relationships with public econ dev agencies/business leaders, etc (qualitative)

   **Community-Related Impacts**
   - Tenants' and graduates' sales, revenues, taxes, export ($ value)
   - Tenants' and graduate's employment (number, nature)
   - Other: conglomeration effects, innovation environment etc. (qualitative)

2. **Effectiveness of Management Policies and Practices**

   **Goals, Structure, and Governance**
   - A technology/small business development center is operational (yes/no)
   - Presence of complementary R&D institutions nearby (yes/no, type & interaction)
   - Extent of realization of the stated goals (direction & degree of accomplishment)
   - Organizational structure (type, stakeholder diversity & degree of involvement)
   - Management team and staff (leaness, perceptions about the quality of support)

   **Financing and Capitalization**
   - Level of funding received from key donors—state, industry, university ($)
   - Funding sources and support made available to tenants ($, sources, recipients)

   **Operational Policies**
   - Entry/selection policy (stipulation, enforcement)
   - Exit/graduation policy (stipulation, enforcement)
   -Tenant performance review (formal/informal, frequency, parties involved)
   - Favorable patent/intellectual property policies developed by university (yes/no)
   - A formal/written policy for graduate firm-UTBI linkage (yes/no)
   - A formal/written policy to provide relocation advice to graduate firms (yes/no)

   **Target Markets**
   - Technologies targeted for development (technology representation among tenants)
   - Type of entrepreneurs involved (# of professors, alumni, & others as tenants)

(continued)
TABLE 6 Continued

3. Services and Their Value Added

Shared Incubator Services
- Type of the incubator services provided (names of services, accessibility)
- Tenants’ use and value-added perceptions (frequency of use, degree of usefulness)

University-Related Services
- Type of the university-related services provided (names of services, accessibility)
- Tenants’ use and value-added perceptions (frequency of use, degree of usefulness)

social impacts on the community. In the case of internal processes: first, the proposed model
takes the broader system’s perspective and was not intended to provide a detailed account
of the complex behaviorally oriented internal processes taking place within the UTBI “black
box.” Second, before attempting to factor in this element into the integrative model, per-
haps at this juncture, there is a need for better understanding of the NTBF development
process (and more generically the entrepreneurial/innovation process) itself before making
an assessment of how the incubation function can be made more responsive to the process.
Some authors (Venkataraman et al. 1990) have already pointed out that venture creation
stages, though identifiable at a simplistic and intuitive level, have rarely been substantiated
by empirical testing due to various reasons. As mentioned earlier, recent efforts by some
researchers provide preliminary efforts in areas such as managerial intervention (Rice 1993)
and in internal networking (Litchenstein 1992) in general and university environments in
particular (Boucke, Canter, and Hanusch 1994), but there is a need for further research in
this area. In the case of economic and other social impacts: first, UTBI is a relatively new
phenomenon and it is still premature to talk about its long-term socioeconomic impacts be-
ond what has already been considered in the framework. Second, the UTBI’s economic
multiplier impacts in the form of demand multipliers and direct-effect multipliers have been
suggested through the use of some evolving tools such as Department of Commerce’s RIMS
model (NBIA 1993b) that, given the limited application, also require further probing.

In conclusion, despite the limitations, the study combines the prior fragmented investi-
gations from multiple related disciplines (Low and MacMillan 1988) in an effort to develop
an integrative framework to assess the performance of UTBIs. The framework is substanti-
ated with four exploratory case applications, providing insight into ways of assessing and
effectively directing the UTBI projects. According to the framework, the facility’s expected
performance outcomes, in conjunction with the degree of consistency of the management
policies with the program objectives, and scope of the available services and their perceived
value-added are the key determinants of the UTBI’s effective performance. It is hoped that
the outlined approach provides university administrators and policy analysts alike a state-
of-the-art conceptual and utilization focused robust framework for assessing their UTBI
systems.

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\[^25\] Attempts have been made to capture some of the process-related aspects by including the quality of
management support and the provision of networking opportunities, etc.


