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PRIORITIZING BALANCED SCORECARD PERFORMANCE INDICATORS FOR TECHNOLOGY BUSINESS INCUBATORS IN AN EMERGING ECONOMY: A FUZZY DELPHI STUDY FROM PAKISTAN

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Abstract

Purpose: *Technology business incubators (TBIs) in emerging economies are expanding with substantial public support, yet the indicators used to judge them remain largely activity-based and are seldom grounded in stakeholder consensus. This study identifies, screens and prioritizes performance indicators for TBIs in Pakistan across the four perspectives of the Balanced Scorecard (BSC), as the first stage in developing a performance assessment framework.*

Design/methodology/approach: *Candidate indicators were created by reviewing the incubator performance literature and validated by contextual applicability by surveying TBI managers (n = 28) and conducting 6 stakeholder interviews. This was followed by a two-round Fuzzy Delphi Method (FDM) involving ten experts with triangular fuzzy numbers, to determine consensus and defuzzify importance scores; indicators with a score of less than 0.5 were dropped.*

Findings: *Of 28 candidate indicators, 19 were retained: five financial (led by growth rate of tenant turnover), three customers (led by jobs created), five learning-and-growth (led by research and development budget) and six internal-process indicators (led by marketing budget). Grant income, equity and royalty earnings, space occupancy, space per client, connections with academic institutions, staff qualification and applicant selection measures were dropped. The retained set is biased towards resource-input and innovation indicators as opposed to downstream economic impact.*

Originality/value: *To the authors' knowledge, this is the first application of FDM to construct a BSC indicator set for TBIs and the first expert-consensus indicator set for a developing incubation eco system (Pakistan). Normalized indicator weights and operational definitions are reported for direct use in a composite performance index.*

Practical implications: *The identified indicator set gives the stakeholders and regulators i-e Higher Education Commission (HEC), the Ignite National Technology Fund and incubator managers an evidence-based complement to existing self-assessment scorecards, and highlights where current measurement under-represents outcomes such as survival and post-incubation growth.*

Keywords: Technology Business Incubators; Balanced Scorecard; Fuzzy Delphi Method; Performance Measurement; Emerging Economy; Pakistan.

1. Introduction

Technology business incubators (TBIs) are organizations that help new technology-based firms survive and grow during their most fragile stage by combining workspace, shared services, coaching, networks and access to finance (Hackett & Dilts, 2004; Mian et al., 2016). Over four decades they have

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become one of the most widely used instruments of innovation and entrepreneurship policy. Entrepreneurial support organizations of this kind are now so numerous that recent reviews describe them as ubiquitous, while noting that their effects remain unevenly understood (Bergman & McMullen, 2022; Hausberg & Korreck, 2020). The policy case for incubation rests on two arguments: incubators correct market failures that leave young technology firms short of resources and legitimacy (Phan et al., 2005), and they intermediate the weak networks between start-ups, investors and knowledge institutions that characterize immature entrepreneurial ecosystems (van Rijnsoever, 2020).

Incubation has been embraced by emerging economies. In Pakistan, major funds have been spent on establishment of Business Incubation Centers (BICs). Higher Education Commission (HEC) has focused on the universities for promotion of entrepreneurship and growth of innovation eco system (HEC, 2023), while Ministry of IT sponsored Ignite (National Technology Fund) established a network of National Incubation Centers (NICs) in major cities (Ignite, 2024). However, there have been varying evidence that incubation has a positive impact on venture performance and mentoring, and incubation services were not related to survival in a 25-year local survey (Clayton, 2024). In Pakistan, an independent survey discovered that reported graduation rates were grossly exaggerated and only a minor portion of incubated projects go past the start-up phase (Wahid and Khalid, n.d.). These issues have taken on a greater urgency with venture funding reducing drastically, to approximately USD 355 million in 2022 and USD 37 million in 2024 (Invest2Innovate, 2024). As the government constrained its budgets, sponsors and managers must understand what part of incubator performance is most important, so scarce resources can be allocated appropriately.

The first step to answering that question is a TBIs performance measurement problem. Preliminary research evaluated incubators based on individual, typically lagging, measures like survival, graduation rates or employment (Bergek & Norrman, 2008; Hackett and Dilts, 2004). More recent work argues for multidimensional instruments: Messeghem et al. (2018) adapted the Balanced Scorecard (BSC) to nonprofit incubators, and Azadnia et al. (2022) built a fuzzy-inference performance framework for Irish incubation centres. Recent systematic review finds that there is still no evidence to provide clear indicators of intangible resources, knowledge sharing and commercialization readiness (Pattanasak et al., 2022). The majority of the validated instruments are created in European contexts, and most of the studies done in Pakistan have been predominantly descriptive (Hafeez et al., 2021). The HEC's annual self-assessment scorecard for UBIs is an important step, but its key performance heads are dominated by facilitation activities and process compliance, and their weights were not derived from structured expert consensus (HEC, 2023).

Selecting indicators also raises a methodological problem. Indicator choice relies on expert judgement, which is expressed in vague linguistic terms that crisp Likert scores do not capture well. The Fuzzy Delphi Method (FDM) addresses this by representing linguistic ratings as fuzzy numbers, reaching consensus in fewer rounds than the classical Delphi, and screening items against an explicit threshold (Habibi et al., 2015; Ishikawa et al., 1993; Murray et al., 1985). Fuzzy multi-criteria methods have been used to priorities enabling factors of university incubators in Thailand (Somsuk & Laosirihongthong, 2014) and to weight performance criteria for Irish incubation centres (Azadnia et al., 2022), but we are not aware of any study that uses FDM to build a BSC indicator set for TBIs, nor of any expert-consensus indicator set for Pakistan.

Accordingly, this study addresses two research questions:

RQ1: Which performance indicators, organized under the four BSC perspectives, do experts consider relevant for TBIs in Pakistan?

RQ2: How do experts priorities these indicators, and which should be retained for a subsequent performance assessment framework?

The paper makes three contributions. First, it consolidates the dispersed incubator performance literature into a candidate set of 28 indicators mapped to the BSC. Second, it applies a two-round FDM to screen, rank and weight these indicators, yielding 19 consensus indicators with normalized weights and operational definitions. Third, it interprets the resulting set against international evidence and against Pakistan's existing scorecard, identifying where current measurement under-represents outcomes. The remainder of the paper is organized as follows. Section 2 reviews the literature and states the research gaps.

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Section 3 describes the Pakistani context. Section 4 sets out the methodology, Section 5 the results and Section 6 the discussion. Section 7 concludes with limitations and directions for the framework study that follows.

2. Literature review

2.1 Technology business incubators: concept and evolution

Technology Business Incubation emerged in the United States in the late 1950s and spread through Europe in the 1980s under labels such as innovation centers, technopoles and science parks (Aernoudt, 2004; Phan et al., 2005). Their offer has evolved across generations, from subsidized space and shared services, to coaching and business support, and more recently to access to networks and investors (Bruneel et al., 2012). Typologies distinguish public, private, corporate and university incubators, and incubator type shapes the results that can be expected (Barbero et al., 2012; Grimaldi & Grandi, 2005). This study adopts the view of a TBI as an organization, frequently affiliated with a university, that supports nascent technology ventures through tangible and intangible services (Grimaldi & Grandi, 2005; Mian, 1996).

University-linked TBIs are of particular interest because they connect start-ups to laboratories, faculty expertise and student talent, while giving universities a channel to commercialize research (Mian, 1996; Mian et al., 2016). Recent reviews show that the field has moved from describing incubator services toward explaining how incubation works: open innovation and social capital now complement the resource-based view as explanatory lenses (Hausberg & Korreck, 2020), research themes have diversified around performance, ecosystems and start-up support (Deyanova et al., 2022; Leitão et al., 2022), and incubation is increasingly modelled as a process linking context, interventions, mechanisms and outcomes (Sohail et al., 2023). Accelerators have also emerged as a distinct, cohort-based variant (Crișan et al., 2021).

2.2 Measuring incubator performance

Measuring incubator performance has proved difficult because incubators serve several stakeholders whose goals differ: sponsors seek regional development, managers seek financial sustainability and tenants seek growth (Messeghem et al., 2017). Early research used counts of outcomes like tenant survival, graduation rates, jobs and revenues (Hackett and Dilts, 2004) whereas best-practice frameworks focused on selection, business support and mediation (Bergek and Norrman, 2008). Subsequent benchmarking studies then pointed out the inexistence of similar metrics across incubators (Torun et al., 2018)

Factor-based research has since been able to determine incubator performance drivers within a particular environment. In Saudi Arabia, knowledge sharing and individual creativity were associated with TBI performance (Binsawad et al., 2019). In Indonesian public universities, entry criteria, mentoring networks, funding and institutional support were linked to performance (Gozali et al., 2020). In China, factors related to people, technology and capital were significantly associated with TBI performance in panel data (Yuan et al., 2022). Evidence on outcomes for tenants is less consistent: incubation was linked to growth but not survival in Italy (Lukeš et al., 2019), and mentoring was associated with better access to finance but not with survival in the United States (Clayton, 2024). Reviews attribute this inconsistency to small and idiosyncratic samples, limited attention to context and a weak understanding of support mechanisms (Ratinho et al., 2020).

The most recent systematic review of incubator performance identified ten critical success factors, with financial resources, networking and marketing studied most often, and six performance-measurement dimensions (Pattanasak et al., 2022). It also concluded that indicators for intangible assets and commercialization readiness are underdeveloped and that factors are rarely linked to coherent strategic actions. These observations motivate a strategy-linked, multidimensional framework such as the BSC.

2.3 The Balanced Scorecard and its adaptation to Technology Business Incubation (TBIs)

The BSC translates strategy into a balanced set of measures across four perspectives: financial, customer, internal business processes, and learning and growth (Kaplan & Norton, 1992, 1996). Its value lies in combining lagging outcome measures with leading driver measures and in making the assumed cause-and-effect links between them explicit. After three decades the BSC remains widely studied and practiced; a bibliometric and systematic review of 1,294 studies documents its extension to public, nonprofit and sustainability settings (Kumar et al., 2024; see also Hoque, 2014).

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Incubators fit this extension well. Messeghem et al. (2018) used the BSC as the basis for a nonprofit incubator performance scale and validated it with data from 121 incubator managers; a companion qualitative study involving policymakers, entrepreneurs and managers argued that the BSC allows all stakeholders' perspectives to be represented in one instrument (Messeghem et al., 2017). Azadnia et al. (2022) combined a Delphi panel, fuzzy analytic hierarchy process and a weighted fuzzy inference system to evaluate Irish incubation centers on six criteria. A related stream uses the resource-based view to classify the enabling resources of incubators into human, technological, financial and organizational categories (Somsuk & Laosirihongthong, 2014). The two lenses are complementary: the resource-based view classifies the inputs an incubator needs, whereas the BSC organizes the performance an incubator should deliver. Because the purpose of this study is performance assessment, the BSC is adopted as the organizing framework.

2.4 The Fuzzy Delphi Method

The Delphi technique elicits structured, anonymous expert judgement over iterative rounds until opinions converge. Classical Delphi studies can be time-consuming and represent judgements as crisp numbers, which may misrepresent the ambiguity of linguistic assessments such as "very important". Murray et al. (1985) proposed combining Delphi with fuzzy set theory, and Ishikawa et al. (1993) formalized the FDM using fuzzy integration. In FDM, each expert's linguistic rating is converted into a triangular fuzzy number, agreement is assessed by the distance between individual and group ratings, and items are accepted or rejected by comparing a defuzzified score with a threshold (Habibi et al., 2015). FDM has been used widely to screen indicators and barriers in management research (e.g., Bui et al., 2020), but, as noted above, not to build a BSC for TBIs.

2.5 Research gaps

Table 1

Research gaps addressed by this study

Gap	Evidence from the literature	How this study responds
G1. Context: validated multidimensional instruments come mainly from Europe	BSC-based and fuzzy frameworks have been developed for French and Irish incubators (Messeghem et al., 2018; Azadnia et al., 2022); evidence from South Asia is limited (Hafeez et al., 2021)	Develops an expert-consensus BSC indicator set for TBIs in Pakistan
G2. Measurement: indicators for intangibles, commercialization and strategy links are underdeveloped	Pattanasak et al. (2022); Ratinho et al. (2020)	Includes innovation, licensing and capability indicators and links each to a BSC perspective
G3. Method: expert judgement is treated as crisp	Fuzzy methods have weighted incubator factors (Somsuk & Laosirihongthong, 2014; Azadnia et al., 2022) but FDM-based BSC indicator screening is absent	Applies two-round FDM with explicit consensus and retention thresholds
G4. Policy: national scorecards are activity-based and unweighted by consensus; reported outputs are contested	HEC (2023) scorecard heads; overstated graduation figures (Wahid & Khalid, n.d.)	Derives weights from expert consensus and proposes measurable definitions

Source: Authors' synthesis.

3. Research context: technology business incubation in Pakistan

Informal efforts to support student entrepreneurship in Pakistani higher education date back to the mid-1980s, when the Institute of Business Administration (IBA) Karachi and the Lahore University of Management Sciences (LUMS) introduced entrepreneurship into their curricula. One of the first informal incubations took place at LUMS in 1999, when an alumni-founded software firm was given subsidized space

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and access to campus facilities. The National University of Sciences and Technology (NUST) launched the first formal university incubator in 2005, initially from rented premises, and opened a dedicated Technology and Innovation Centre of approximately 33,000 square feet in 2012 with a model centered on technology commercialization (Hafeez et al., 2021). In 2010, IBA Karachi's Center for Entrepreneurial Development introduced a different model in which a three- to four-month programs on idea generation, team building, minimum viable product development and sales preceded incubation (Mian et al., 2016).

Public programs subsequently scaled these early initiatives. The HEC sponsored the establishment of BICs, initially in research-intensive public universities with established Offices of Research, Innovation and Commercialization, and its BIC Policy 2021 allows universities to form consortia with other public and private institutions (HEC, 2021).

By 2023 the HEC had established 38 BICs and evaluates them annually through a self-assessment scorecard with six key performance heads: human resources and facilitation, the incubation process adopted, start-up facilitation and support, funding opportunities and linkages, post-incubation strategies, and capacity building and mentoring (HEC, 2023).

The 2022–23 validation report noted that 42% of evaluated BICs lacked a full-time manager and that structured post-incubation programs were largely missing (HEC, 2023). In parallel, the Ministry of Information Technology and Telecommunication, through Ignite, has established NICs in Islamabad, Lahore, Karachi, Peshawar, Quetta and Hyderabad, together with specialized aggrotech and aerospace centers in Faisalabad and Rawalpindi (Ignite, 2024). Provincial bodies such as the Punjab Information Technology Board and private and corporate programs complete the landscape.

Despite this expansion, the evidence on results is contested. A study of 23 Pakistani centers reported that self-reported success rates exceeded 50%, whereas only about 5–7% of incubated ventures reached the start-up stage and 1–3% the scale-up stage, and that graduation figures were overstated (Wahid & Khalid, n.d.). Tenants have reported that the effectiveness of incubation facilities falls short of their perceived importance (Hafeez et al., 2021). The wider innovation environment is also weak: Pakistan ranked 99th of 139 economies in the Global Innovation Index 2025 (WIPO, 2025). Taken together, rapid public investment, contested outcome reporting and a contracting funding environment make a credible, consensus-based indicator set a policy priority.

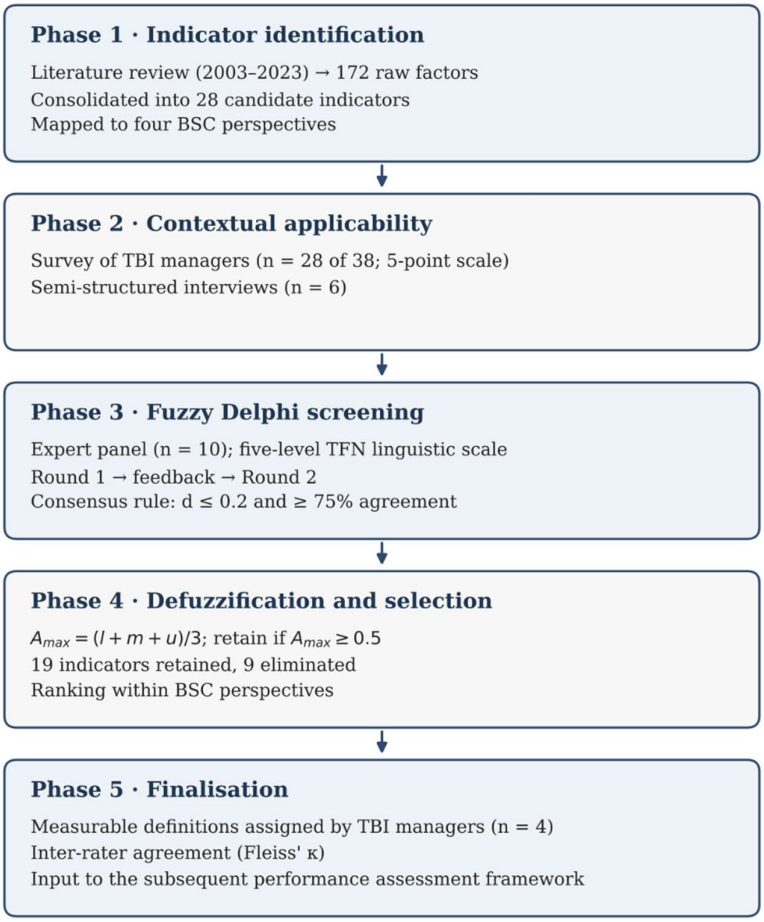
4. Methodology

4.1 Research design

The study followed a sequential, multi-phase design (Figure 1). The literature was used to identify candidate indicators (Phase 1) and the applicability of the indicators to the Pakistani context was verified by a manager survey and interviews (Phase 2). An expert panel screened and ranked them then using the FDM (Phases 3 and 4), and those retained were then operationalized to use in the next framework study (Phase 5).

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Figure 1
Research Design



4.2 Phase 1: identification of candidate indicators

The literature search was structured whereby Semantic Scholar and Google Scholar were searched using query (performance) and factors and technology business incubation using the query (performance) AND (factors) AND (Technology business incubation) in Semantic Scholar and Google Scholar respectively. Peer-reviewed articles in journals were selected; books, conference papers and grey literature including white papers and blogs were not selected. Title, abstract, and key-word screening brought the number down to 46 articles and full-text evaluation on the basis of the inclusion criteria resulted in 11 studies that collectively reported 172 performance factors. Indicators that overlap in meaning were combined and the set thus formed were mapped to the 4 BSC perspectives giving 28 candidate indicators (Table 2). All the indicators are based on the new literature within the incubator, which, in turn, helps to verify its content validity.

Table 2. Candidate indicators and representative supporting literature

BSC perspective / candidate indicator	Representative sources
Financial (9)	
Growth rate of tenant turnover	Lukeš et al. (2019); Messeghem et al. (2018)
Venture capital (VC) funds secured	van Rijnsoever (2020); Clayton (2024)
Sales	Lukeš et al. (2019); Azadnia et al. (2022)
Grant income	Messeghem et al. (2018); Torun et al. (2018)
External funding raised	Hackett & Dilts (2004); Clayton (2024)
Royalties from patents and licences	Mian (1996); Yuan et al. (2022)

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Capital investments	Yuan et al. (2022); Pattanasak et al. (2022)
Percentage of occupied space	Hackett & Dilts (2004); Torun et al. (2018)
Projected earnings from equity holdings	Bergek & Norrman (2008); Torun et al. (2018)
Customer (5)	
Space available per client	Torun et al. (2018); Gozali et al. (2020)
Links to other and academic institutions	Mian (1996); van Rijnsoever (2020); Pattanasak et al. (2022)
Survival of tenants	Mas-Verdú et al. (2015); Lukeš et al. (2019); Clayton (2024)
Number of jobs created	Hackett & Dilts (2004); Lukeš et al. (2019); Azadnia et al. (2022)
Number of spin-offs / spin-outs created	Mian (1996); Clarysse et al. (2005)
Learning and growth (6)	
Research and development budget	Binsawad et al. (2019); Yuan et al. (2022)
Number of products licensed out	Mian (1996); Leitão et al. (2022)
Number of innovative products	Binsawad et al. (2019); Leitão et al. (2022)
Number of patents	Mian et al. (2016); Yuan et al. (2022)
Reducing risk of failure	Aernoudt (2004); Deyanova et al. (2022)
Qualification index of staff/tenants	Gozali et al. (2020); Pattanasak et al. (2022)
Internal processes (8)	
Access to funds	Gozali et al. (2020); Pattanasak et al. (2022)
Marketing budget	Pattanasak et al. (2022)
Number of virtual cohorts	Bergman & McMullen (2022); HEC (2023)
Coaches/mentors per start-up	Eveleens et al. (2017); Gozali et al. (2020); Clayton (2024)
Number of training hours	Ratinho et al. (2020); Sohail et al. (2023)
Length of engagement	Hackett & Dilts (2004); Bergek & Norrman (2008)
Percentage of applicants accepted	Bergek & Norrman (2008); Pattanasak et al. (2022)
Number of applicants	Bergek & Norrman (2008); Gozali et al. (2020)

4.3 Phase 2: contextual applicability

To confirm that the candidate indicators were meaningful for Pakistani TBIs, a questionnaire was emailed to the managers of 38 incubators drawn from the HEC list. Respondents rated the applicability of each indicator on a five-point scale from 1 (not applicable) to 5 (completely applicable). Reminders were sent after two weeks and non-respondents were contacted by telephone. Within four weeks, 28 valid responses were received, a response rate of 73.7%. Semi-structured face-to-face and telephone interviews were then held with six stakeholders (four current managers, one former manager and one director), selected for their practical experience. The interviews followed a standard protocol, corroborated the survey results and invited participants to propose additional indicators. However, the survey preceded Fuzzy Delphi rounds covering all 28 indicators, and no new indicator was added through the interviews.

4.4 Phase 3: Fuzzy Delphi screening

4.4.1 Expert panel and instrument. A panel of ten experts was purposively selected, comprising academics, industry professionals and incubator managers with a mean of 20.1 years of relevant experience (SD = 1.2). Panels of ten or more are considered adequate for homogeneous Delphi groups (Adler & Ziglio, 1996), and all ten experts completed both rounds. The questionnaire (Appendix A) asked experts to rate the importance of each indicator using five linguistic terms, which were converted into triangular fuzzy numbers (TFNs) as shown in Table 3 (Habibi et al., 2015).

Table 3

Linguistic variables and corresponding triangular fuzzy numbers

Linguistic term	Triangular fuzzy number (l, m, u)
Not at all important (NI)	(0.0, 0.0, 0.2)
Slightly important (SI)	(0.0, 0.2, 0.4)
Moderately important (MI)	(0.2, 0.4, 0.6)

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Linguistic term	Triangular fuzzy number (l, m, u)
Very important (VI)	(0.4, 0.6, 0.8)
Extremely important (EI)	(0.6, 0.8, 1.0)

Source: Adapted from Habibi et al. (2015).

4.4.2 Fuzzification, distance and consensus. Let n denote the number of experts. The rating of expert i for indicator j is expressed as the TFN

$$\tilde{n}_{ij} = (l_{ij}, m_{ij}, u_{ij}), \quad i = 1, \ldots, n \qquad (1)$$

and the group rating for indicator j is the arithmetic mean of the individual TFNs:

$$\tilde{m}_j = (l_j, m_j, u_j) = ((1/n) \Sigma l_{ij}, (1/n) \Sigma m_{ij}, (1/n) \Sigma u_{ij}) \qquad (2)$$

Agreement between each expert and the group is measured with the vertex distance (Chen, 2000):

$$d(\tilde{m}_j, \tilde{n}_{ij}) = \sqrt{[(1/3) \cdot ((l_j - l_{ij})^2 + (m_j - m_{ij})^2 + (u_j - u_{ij})^2)]} \qquad (3)$$

An expert is considered in agreement with the group on indicator j when $d \leq 0.2$. Group consensus is reached when at least 75% of experts are in agreement:

$$C_j = (\text{number of experts with } d \leq 0.2 / n) \times 100\% \geq 75\% \qquad (4)$$

In the first round, the distance exceeded 0.2 for 11 of the 28 indicators. The anonymized group results were returned to the panel together with each expert's own ratings, and a second round was conducted. After the second round, the distance was below 0.2 for every expert on every indicator, so all indicators met the consensus criterion.

4.5 Phase 4: defuzzification and selection

The consensus rating of each indicator was defuzzified with the average method to obtain a crisp importance score:

$$A_{max,j} = (l_j + m_j + u_j) / 3 \qquad (5)$$

Following common practice, the panel agreed a retention threshold (α-cut) of 0.5 (Bui et al., 2020; Habibi et al., 2015). Those indicators which had Amax 0.5 and above were kept and placed within their BSC view; the others were dropped. To be used in the following framework, the local weight of the retained indicators in its perspective was normalised Amax:

$$w_j = A_{max,j} / \Sigma_{k \in p} A_{max,k} \qquad (6)$$

where p is the BSC perspective to which indicator j belongs. The full calculations for each step are provided in the Supplementary Workbook.

4.6 Phase 5: finalization and reliability

Each retained indicator was given a quantifiable definition, unit and data source by a panel of four TBI managers (Appendix B). The agreement of inter-raters on these assignments was measured with Fleiss kappa (Fleiss, 1971) and derived with the benchmarks of Landis and Koch (1977). The resulting agreement was $\kappa = 0.78$, indicating substantial agreement.

4.7 Ethical considerations

Participation was voluntary, informed consent was obtained from all respondents and experts, and responses were anonymised before analysis.

5. Results

5.1 Applicability of candidate indicators

Mean applicability scores in the manager survey ranged from 3.94 to 4.83, with standard deviations below 0.90. All indicators scored above the scale midpoint of 3, so all candidate indicators were judged applicable to Pakistani TBIs and carried forward to the Fuzzy Delphi rounds.

5.2 Fuzzy Delphi screening

Table 4 reports the defuzzified score, within-perspective rank and decision for each of the 28 indicators. Nineteen indicators met the 0.5 threshold and nine were eliminated: four financial (grant income, royalties from patents and licences, percentage of occupied space, projected earnings from equity holdings), two customer (space per client, links to other and academic institutions), one learning-and-growth (qualification index of staff/tenants) and two internal-process indicators (percentage of applicants accepted, number of applicants).

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Table 4

Fuzzy Delphi results for the 28 candidate indicators

BSC perspective/indicator	A_{max}	Rank within perspective	Decision
Financial			
Growth rate of tenant turnover	0.700	1	Retained
VC funds secured	0.650	2	Retained
Capital investments	0.550	3	Retained
External funding raised	0.533	4	Retained
Sales	0.528	5	Retained
Grant income	0.483	–	Eliminated
Royalties from patents and licences	0.400	–	Eliminated
Projected earnings from equity holdings	0.317	–	Eliminated
Percentage of occupied space	0.300	–	Eliminated
Customer			
Number of jobs created	0.667	1	Retained
Survival of tenants	0.550	2	Retained
Number of spin-offs / spin-outs created	0.526	3	Retained
Space available per client	0.483	–	Eliminated
Links to other and academic institutions	0.425	–	Eliminated
Learning and growth			
R&D budget	0.800	1	Retained
Number of innovative products	0.750	2	Retained
Number of products licensed out	0.744	3	Retained
Number of patents	0.600	4	Retained
Reducing risk of failure	0.517	5	Retained
Qualification index of staff/tenants	0.311	–	Eliminated
Internal processes			
Marketing budget	0.750	1	Retained
Access to funds	0.717	2	Retained
Number of virtual cohorts	0.650	3	Retained
Coaches/mentors per start-up	0.550	4	Retained
Length of engagement	0.533	5	Retained
Number of training hours	0.517	6	Retained
Percentage of applicants accepted	0.450	–	Eliminated
Number of applicants	0.450	–	Eliminated

Note: Retention threshold $A_{max} \geq 0.5$. All indicators reached consensus ($d \leq 0.2$) after Round 2.

5.3 Final indicator set and weights

Table 5 presents the 19 retained indicators with their normalized within-perspective weights (Equation 6) and their overall rank across the whole set. Three features stand out. First, the learning-and-growth perspective holds three of the four highest-scoring indicators overall (R&D budget, innovative products and products licensed out). Second, the internal-process perspective contributes the largest number of indicators (six), reflecting experts' emphasis on how incubation services are delivered. Third, the indicators most closely associated with long-run economic impact, namely survival, sales and spin-offs, sit in the lower half of the overall ranking.

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Table 5

Retained indicators, normalized weights and overall ranking

BSC perspective/indicator	Amax	Local weight (wj)	Overall rank (of 19)
Financial (5 indicators)			
Growth rate of tenant turnover	0.700	0.236	6
VC funds secured	0.650	0.220	8
Capital investments	0.550	0.186	11
External funding raised	0.533	0.180	14
Sales	0.528	0.178	16
Customer (3 indicators)			
Number of jobs created	0.667	0.383	7
Survival of tenants	0.550	0.316	11
Number of spin-offs / spin-outs created	0.526	0.302	17
Learning and growth (5 indicators)			
R&D budget	0.800	0.235	1
Number of innovative products	0.750	0.220	2
Number of products licensed out	0.744	0.218	4
Number of patents	0.600	0.176	10
Reducing risk of failure	0.517	0.152	18
Internal processes (6 indicators)			
Marketing budget	0.750	0.202	2
Access to funds	0.717	0.193	5
Number of virtual cohorts	0.650	0.175	8
Coaches/mentors per start-up	0.550	0.148	11
Length of engagement	0.533	0.143	14
Number of training hours	0.517	0.139	18

Note: Local weights sum to 1.000 within each perspective (±0.001 rounding). "=" denotes tied ranks. Perspective-level weights were not elicited in this study (see Section 7).

5.4 Operational definitions

To make the indicator set usable for performance assessment, each retained indicator was given a measurable definition, unit, indicator type and likely data source (Table 6). Indicator type distinguishes resource inputs, service processes, direct outputs and longer-run outcomes, which supports the cause-and-effect logic of the BSC.

Table 6

Operational definitions of the retained indicators

Indicator	Measure (annual unless stated)	Unit	Type	Data source
Financial				
Growth rate of tenant turnover	$(\text{Turnover}_t - \text{Turnover}_{t-1}) / \text{Turnover}_{t-1}$, aggregated over current tenants	%	Outcome	Tenant accounts
VC funds secured	Equity investment from VC funds closed by current and graduated tenants	PKR	Outcome	Term sheets, investor letters
Capital investments	Capital expenditure on incubator facilities, laboratories and equipment	PKR	Input	Incubator accounts
External funding raised	Non-VC external finance raised by tenants (grants, loans, angel, competition prizes)	PKR	Output	Award and loan letters

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Indicator	Measure (annual unless stated)	Unit	Type	Data source
Sales	Total revenue from sales of tenants' products and services	PKR	Outcome	Tenant accounts
Customer				
Number of jobs created	Net new full-time-equivalent jobs in tenants and graduates	Count	Outcome	Payroll records
Survival of tenants	Share of firms graduated three years earlier still trading	%	Outcome	SECP registry follow-up
Number of spin-offs / spin-outs	New firms spun out of host-university research or of tenants	Count	Output	ORIC and SECP records
Learning and growth				
R&D budget	R&D expenditure made available to tenants as a share of incubator budget	%	Input	Incubator accounts
Number of innovative products	New products or services launched to market by tenants	Count	Output	Tenant reports
Number of products licensed out	Licence agreements executed by tenants or host university for incubated technologies	Count	Output	ORIC records
Number of patents	Patent applications filed and granted by tenants	Count	Output	IPO-Pakistan records
Reducing risk of failure	Share of tenants with a reviewed risk-mitigation plan; complemented by failure-exit rate	%	Process	Incubator records
Internal processes				
Marketing budget	Expenditure on outreach, branding and tenant promotion as a share of budget	%	Input	Incubator accounts
Access to funds	Share of tenants connected to at least one funding source during the year	%	Process	Incubator records
Number of virtual cohorts	Cohorts (or tenants) supported through virtual incubation	Count	Process	Programme records
Coaches/mentors per start-up	Active mentors divided by number of tenants	Ratio	Process	Mentor logs
Length of engagement	Mean months from admission to graduation or exit	Months	Process	Incubator records
Number of training hours	Structured training hours delivered per tenant	Hours	Process	Attendance records

Note: Definitions are the authors' proposed operationalization and should be read together with the measurement form in Appendix B. SECP = Securities and Exchange Commission of Pakistan; ORIC = Office of Research, Innovation and Commercialization; IPO = Intellectual Property Organization.

6. Discussion

6.1 Financial perspective

The financial perspective is led by growth in tenant turnover, followed by VC funds secured, capital investments, external funding raised and sales. Every retained financial indicator concerns the finances of tenants or investment in the incubator, while all four indicators of the incubator's own income (grant income, royalties, equity earnings and occupancy) were rejected. This is contrary to BSC nonprofit incubators in Europe, in which the financial axis is also used to measure the sustainability of the incubator itself

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(Messeghem et al., 2018). The most likely answer is that the vast majority of Pakistani TBIs are publicly-funded university departments, which do not have requirements to generate rent, royalties or equity returns, and so the experts thought that these measures would be irrelevant to the existing practice. With the constrained public funding, however, it is likely that financial self-sufficiency will become a policy issue, and these indicators should be reexamined as a part of the framework study. The considerable position of VC funds raised, even in the face of the significant decline in national venture funding (Invest2Innovate, 2024).suggests that experts view investor readiness as a core incubator outcome, consistent with the intermediary role of incubators in financial networks (van Rijnsoever, 2020) and with evidence linking mentoring to access to finance (Clayton, 2024).

6.2 Customer perspective

The customer perspective consists of jobs created tenant survival and spin-offs and resembles the outcome indicators that are used to traditionally justify the public incubation (Hackett and Dilts, 2004; Azadnia et al., 2022). First is job creation, as is typical of the preeminence of employment in the discourse of national policy. The lower rank of survival is notable because survival is the outcome on which international evidence is weakest (Clayton, 2024; Lukeš et al., 2019); stating it explicitly in the scorecard would help to test whether Pakistani incubators improve it. Two rejections deserve attention. Space per client was judged unimportant, which is consistent with the shift in incubator value from physical space toward services and networks (Bruneel et al., 2012). The rejection of links to other and academic institutions is more surprising, given the central role of networking in the literature (Pattanasak et al., 2022; van Rijnsoever, 2020) and the university-based model of HEC BICs. It may reflect experts' scepticism about the substance of existing linkages; the HEC's own evaluation found that many BIC steering committees were inactive or lacked industry representation (HEC, 2023). This points to a gap between the intended and perceived role of university links that merits further study.

6.3 Learning and growth perspective

The learning-and-growth perspective contains the highest-scoring indicator in the entire set, R&D budget, followed by innovative products, products licensed out, patents and reducing risk of failure. The emphasis on technology development and commercialization is consistent with evidence that technology-related factors are associated with TBI performance (Yuan et al., 2022) and with calls to measure commercialization more directly (Pattanasak et al., 2022). Because R&D budget is a resource input, it should be read alongside its outputs (innovative products, licenses and patents) so that spending is not rewarded for its own sake. The rejection of the qualification index of staff and tenants contrasts with the literature identifying staff expertise as a success factor (Pattanasak et al., 2022) and with the HEC finding that many BICs lack a dedicated manager (HEC, 2023). We therefore suggest keeping staff capability as a monitoring condition in the framework, even though it is not a scored performance indicator.

6.4 Internal process perspective

Marketing budget, access to funds, virtual cohorts, mentor ratio, length of engagement and training hours were retained. Their prominence indicates that experts regard the design and delivery of incubation services as the main lever managers control, which accords with process-based views of incubation (Sohail et al., 2023). The retention of virtual cohorts reflects the growth of remote incubation since 2020; the HEC reported around 200 start-ups supported through a virtual program in 2022–23 (HEC, 2023). In contrast, both selection indicators (number of applicants and acceptance rate) were rejected, although selection is regarded as a best practice (Bergek & Norrman, 2008) and entry criteria have been linked to performance (Gozali et al., 2020). Experts may see applicant volume as easy to inflate through outreach without improving tenant quality. A selection-quality measure, such as the share of admitted ventures with a validated prototype, may be a better alternative to test in the framework study.

6.5 Cross-cutting observations

Two cross-cutting patterns emerge. First, the highest-scoring indicators across all perspectives are dominated by budgets and innovation inputs, while longer-run outcomes such as survival, sales and spin-offs rank lower. A scorecard weighted in this way risks rewarding incubators for spending rather than for results. The BSC remedy is to make cause-and-effect links explicit in a strategy map, pairing each input with the

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output or outcome it is expected to drive (Kaplan & Norton, 1996). Table 6 provides the typology needed for this step. Second, comparison with the HEC scorecard shows partial overlap: its heads on funding opportunities and linkages, and on capacity building and mentoring, correspond to the retained access-to-funds, VC, mentoring and training indicators, but its head on post-incubation strategies has no outcome measure attached, whereas the present set adds tenant survival, jobs and turnover growth. The indicator set can therefore complement the existing scorecard by adding consensus-weighted outcome indicators to its activity measures.

6.6 Theoretical implications

The study extends BSC research on incubators (Messeghem et al., 2018; Azadnia et al., 2022) to an emerging-economy, predominantly public and university-based system, and shows that the financial perspective in such systems is understood mainly through tenant finance rather than incubator income. It also demonstrates that FDM can serve as a transparent screening stage for scorecard construction, producing both a reduced indicator set and weights that can feed later multi-criteria models. Finally, the contrast between the literature's emphasis on networks and selection and the experts' rejection of those indicators suggests that what counts as performance is context-dependent, supporting calls for more context-sensitive incubation research (Ratinho et al., 2020).

6.7 Managerial and policy implications

For sponsors (HEC, Ignite and provincial boards): add tenant outcome indicators, especially survival three years after graduation, jobs and turnover growth, to existing scorecards, and require evidence that can be verified against independent sources such as company registration data, given concerns about overstated reporting.

For incubator managers: priorities investment-readiness support, access to funding networks and structured mentoring, which experts rank highly, and pair R&D and marketing budgets with measurable outputs in products, licenses and patents.

For universities: strengthen the substance of industry and academic linkages, including active steering committees with industry representation, because experts did not currently regard such links as a performance contributor.

For framework designers: treat staff capability and selection quality as enabling conditions to monitor, even though they were not retained as scored indicators.

7. Conclusions, limitations and future research

This study set out to identify and priorities performance indicators for TBIs in Pakistan within a BSC structure. Using a literature-based candidate set, a manager survey and interviews, and a two-round Fuzzy Delphi process with ten experts, it retained 19 of 28 indicators: five financial, three customer, five learning-and-growth and six internal-process indicators. Their respective perspectives are headed by growth in tenant turnover, the jobs created, R&D budget and marketing budget. The resulting set, including normalized weights, and operation definitions, is the basis upon which the performance assessment framework will be determined in the following phase of this research.

The study has limitations. The ten-member expert panel, though sufficient in a Delphi design, is based on judgement instead of performance and the rankings fail to provide causal relationships between indicators and outcomes. The applicability survey was based on the managers who were listed by the HEC, thus NIC, provincial and privately operated incubators might have been under-represented. Two databases were searched in the literature search and conference papers and grey literature were eliminated. The views have disproportionate numbers of indicators, and FDM results in in-perspective rankings and not perspective-level weights. Lastly, the evidence is limited to one country at the time when there was a reduction in funding which could have influenced the priorities of experts.

These restrictions establish the plan of the next framework study. The first step is to obtain perspective level and global weights by a pairwise algorithm like fuzzy AHP or best worst method with the retained set as input. Second, targets, normalization rules and scoring bands must be given, which would allow the indicators to be aggregated into a composite TBI performance index. Third, to test its validity and discriminating power, the index should be tested on real incubator data, e.g. scorecard submissions to the HEC

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over a number of years. Fourth, the dimensions that are not reflected in this set of indicators should again be reconsidered, such as financial sustainability of the incubator, gender-disaggregated outcomes and environmental sustainability, which are increasingly demanded of incubators funded by the government (HEC, 2023; Klofsten et al., 2020).

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Author contributions (Credit): Azhar Naeem: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing - original draft. **Muhammad Umer**: Supervision, Conceptualization, Methodology, Validation, Writing - review and editing.
Asim Masood: Methodology, Validation, Resources, Writing - review and editing.
Faizan ul Haq: Software, Formal analysis (fuzzy Delphi computations), Visualization, Writing - review and editing. All authors have read and approved the final manuscript.

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