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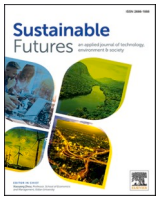

University business incubators in Indonesia: Navigating commercial viability and societal contributions

Domician Máté [a,b,*], Ni Made Estiyanti [c,d], Adam Novotny [b,e], Jolita Vveinhardt [f]

[a] Department of Engineering Management and Enterprise, Faculty of Engineering, University of Debrecen, Hungary
[b] DHET-NRF Sarchi Entrepreneurship Education, Department of Business Management, University of Johannesburg, Johannesburg, South Africa
[c] Doctoral School of Management and Business, University of Debrecen, Debrecen, Hungary
[d] Accounting Information System Study Program, Primakara University, Denpasar, Bali, Indonesia
[e] Eszterházy Károly Catholic University, Institute of Economic Science, Eger, Hungary
[f] Vytautas Kavolis Transdisciplinary Social and Humanities Research Institute, Vytautas Magnus University, Lithuania

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ABSTRACT

Purpose: This paper investigates whether University Business Incubators (UBIs) that emphasize broader societal impacts can achieve improved innovation performance and economic returns within the context of a developing economy.
Research methodology: Utilizing data from Indonesia, this study employs Heteroscedasticity and Autocorrelation Consistent (HAC) regressions to determine whether incubators focusing on societal innovations achieve greater success in bringing innovations to market.
Findings: Incubators devoting a higher proportion of their budget to societal start-ups have a stronger innovation performance, and ones with a higher number of societal startups have a higher number of successful exits.
Research limitations: The small sample size may restrict the generalizability of the findings, limiting the ability to apply the results across different contexts or larger populations.
Practical implication: Start-ups with societal impacts provide benefits for both incubators and society. Therefore, incubators should strive to support more start-ups among their tenants that contribute to broader economic, social, environmental, and cultural goals.
Originality value: Extant literature provides a broad assessment of the various support services incubators offer to start-up firms; however, more empirical analysis is needed regarding the success of incubators that try to align financial goals with positive societal impacts.

1. Introduction

Start-ups play a crucial role in introducing new products and services; they open up new markets and concepts that generate revenue, employment opportunities, and value for customers [1]. A start-up is a firm in its early stage of development [2]. Scholars and policymakers acknowledge the importance of start-up firms in fostering innovation and economic expansion. However, start-ups do not grow in a vacuum. The multitude of organizations that support the birth and successful evolution of start-ups has been referred to as a start-up incubation ecosystem [3].

As components of this ecosystem, incubators support start-ups with office space, research infrastructure, and business-development services such as consulting, coaching, mentoring, and networking [4]. Despite the widespread proliferation of business incubators, there is a need for a better understanding of whether and how effectively incubators can facilitate start-ups with societal impact, particularly in developing regions and countries such as Indonesia.

Societal impacts are "significant or lasting changes in people's lives, brought about by a given action or series of actions" (Roche, 1999, p. 21) [5]. Through the creation of new solutions, products and services, entrepreneurship is increasingly called upon to address various local and global development challenges. Fini et al. (2018, p. 8) [6] define the societal impacts of science-based start-ups and spin-offs as "the effect on or change or benefit to the economy, society, culture, public policy or services, health, the environment, or quality of life from new or improved products or services based on scientific knowledge". The impacts of societal innovations can be both positive and negative (ibid.).

* Corresponding author at: Department of Engineering Management and Enterprise, Faculty of Engineering, University of Debrecen, Hungary.
E-mail address: mate.domician@eng.unideb.hu (D. Máté).

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However, new ventures often face difficulties in monetizing their societal benefits, highlighting the need to develop support systems that effectively balance the dual objectives of fostering firm growth and achieving broader societal goals across diverse socioeconomic contexts [7]. Although incubators play a vital role in this landscape, they face various challenges, including resource limitations, regional disparities, and an increasing demand for solutions to both global and local sustainability issues [8].

Moreover, the private sector frequently undervalues long-term social benefits and underinvests in ventures that address societal challenges. This underinvestment results from market failures, such as a lack of resources for testing risky ideas, a limited number of early adopters, and insufficient long-term funding. Globalization and digital transformation further shape the role of incubators. Global markets push incubators to support the internationalization efforts of start-ups [9,10], whereas digital tools expand access to virtual services and broader start-up engagement [11,12]. These trends require incubators to adopt more flexible and technology-driven approaches. There is growing interest from public decision-makers in how incubators can contribute to sustainable economic development from a macro perspective [13]. While the literature shows that incubators contribute to local economic development through job creation [14] and technological innovation [15], studying incubators' broader impact on local wealth creation requires more focused research [16].

Start-ups are widely recognized as engines of innovation and economic growth [17]. However, their potential to create broader societal impact has received limited scholarly attention, particularly in developing economies. University Business Incubators (UBIs) have emerged as key facilitators, providing start-ups with critical support such as mentorship, funding access, and infrastructure [18]. Despite their growing prominence, the extent to which UBIs contribute to positive social outcomes in addition to the commercial success of start-ups is still insufficiently explored in the literature [19].

UBIs play a critical role in bridging the gap between academia and industry by fostering the commercialization of research and creating a supportive environment for start-up and spin-off growth [20]. They facilitate the transfer of knowledge generated by academic and research institutions to industry, contributing markedly to regional entrepreneurship, technology transfer, and economic development [21]. Recently, UBIs have expanded their services to address evolving business demands and societal needs. By supporting societal innovations, they add value to both universities and society. Science and innovation play pivotal roles in tackling societal challenges such as disease eradication, job creation, and quality-of-life improvements. Notably, university spin-offs have demonstrated significant economic and societal returns, further highlighting the impact of UBIs [22].

This study aims to evaluate whether UBIs that prioritize societal impact achieve superior outcomes in terms of innovation performance and economic returns. Specifically, it investigates the following research questions: Does increased resource allocation to societal start-ups enhance innovation outputs? Do socially oriented UBIs achieve higher rates of successful start-up exits? The study also sheds light on the types of incubator resources and practices that are most effective in advancing both commercial and societal objectives in the Indonesian context. While prior research has highlighted the general benefits of business incubation, there remains a lack of empirical studies examining how UBIs can effectively foster both economic and social value, particularly in emerging market settings. This study addresses this gap by providing quantitative evidence from Indonesia, employing regression analyses and drawing on multiple theoretical frameworks, including the Resource-Based View (RBV), human capital theory, and sustainable innovation.

This approach includes assessing whether a stronger focus on societal impacts results in a higher incidence of successful start-up exits and a greater number of licenses granted, and patents filed. Ultimately, the study endeavors to provide insights into how UBIs can effectively balance the dual aims of commercial viability and societal contribution and whether adopting a societal-focused incubation approach yields tangible benefits in terms of innovation and social progress.

The paper is organized into six sections. The introduction is followed by a literature review covering prior research on business incubators, particularly their societal impact. Next, we present our hypotheses regarding the relationship between incubator resources devoted to broader societal contributions and start-up/innovation success. The data design and methods section subsequently describes the sample, variables, and analytical methods (specifically, HAC-corrected linear regression). In the results section, we report the statistical findings and discuss their implications in the context of incubator performance. The paper concludes with a discussion that connects the results with existing theories and practical implications, followed by a conclusion that synthesizes key findings, acknowledges limitations, and suggests avenues for further research.

2. Literature review of business incubation

A business incubator (BI) is an organization that provides long-term support to new, innovative firms by offering tangible assets, such as office space and research infrastructure, as well as intangible assets, such as professional services and networking connections [23]. BIs are crucial in supporting young firms during their formative years, significantly contributing to local communities and regional development [24]. The impact of incubation is evident in start-up performance improvements, including revenue growth and faster market entry, highlighting the value of structured support in the start-up ecosystem [25].

BIs operate on three pillars: human, social, and organizational capital [23]. Various classifications of incubators have been identified, with Barbero et al. [26] defining four primary archetypes: economic development incubators, e.g., University Business Incubators (UBIs), basic research incubators, and private incubators. A growing area of focus within incubation is the emergence of "social incubators," which aim to foster start-ups with broader societal impacts [27]. Policymakers are encouraged to support social incubators to advance social entrepreneurship, address environmental and social challenges, and promote sustainable growth. These incubators balance the development of business models with the pursuit of social missions, transforming socially driven initiatives into sustainable, market-based organizations [28].

Recently, universities have embraced a "third mission", expanding their focus beyond teaching and research to contribute actively to societal well-being [29]. This mission emphasizes channeling academic innovations into industrial applications and fostering entrepreneurial economies and social progress. Universities play a crucial role in connecting academic research with societal needs, promoting both economic and social development [30]. By creating and supporting UBIs, universities can ease the development of innovations addressing regional and global challenges.

Despite their potential, incubators face a key dilemma in supporting sustainable innovations: the tension between profit-driven interests and broader societal benefits [8]. Private investors often prioritize scalable, modular technologies with clear market potential over community-based solutions. These misaligned incentives present challenges in achieving inclusive societal benefits. Although the role of incubators, including UBIs, is well documented, there is a need for research focusing on their effectiveness in addressing social and environmental challenges. We know little about how incubators with a broader societal focus function. Most research on business incubation focuses on how it supports the growth of businesses and the economy. Moreover, less attention has been given to how it functions as a source of societal innovations [31].

The literature increasingly recognizes the emergence of both social and commercial incubators, yet evidence regarding their relative effectiveness remains inconsistent [32]. Social incubators are typically more selective and mission-focused, but they often struggle with

long-term sustainability and the measurement of their societal impact. In contrast, commercial incubators prioritize market outcomes and financial viability, sometimes at the expense of social value creation. Recent studies indicate that hybrid or mixed incubator environments can foster peer learning and generate network effects [33]; however, they may also encounter tensions in balancing commercial and societal goals. This study contributes to this ongoing discourse by examining whether Indonesian UBIs that prioritize societal impact can simultaneously achieve both strong innovation performance and successful start-up exits – thus addressing the dual challenge of commercial viability and social advancement within a developing economy context.

Successful start-up exits refer to selling the start-up to investors or another company. Exit is a key indicator of the successful market introduction of new products and services, job creation, and a firm's integration into the local ecosystem [34]. Additionally, patent activity serves as a tangible measure of innovation, reflecting the ability of incubators to stimulate technological advancement and attract investment [25]. Patents filed by incubated start-ups indicate future revenue potential and innovation impact, whereas patents awarded validate the quality of research and development efforts [35].

2.1. Hypotheses statement

Considering contradictory evidence, in this paper, we propose that emphasizing a balance between commercial viability and broader societal missions in UBIs positively influences incubation success, particularly in terms of the innovation performance (patenting activity) and market performance (successful exits) of start-ups. Allocating a greater share of the budget to societal innovations (H1, H3) reflects the use of unique, valuable, and hard-to-imitate resources, in line with the principles of RBV as explained by Barney [36]. This approach helps to clarify how resource allocation decisions underpin the proposed links between incubator inputs and innovation outcomes.

Furthermore, sustainable innovation theory posits that strategic investments in sustainability-oriented ventures can generate both environmental and economic value. Hypotheses H2 and H4, which address the impact of sustainability budgets and green tenants, are based on this theoretical framework, highlighting the dual goal of creating commercial and societal value.

We explicitly link hypotheses related to staff and expertise, such as the impact of full-time staff on patenting and exits, to human capital theory. The involvement of external experts and engagement in collaborative networks further facilitates the flow of knowledge and resources [37], emphasizing that skilled personnel constitute a core intangible asset that enhances absorptive capacity and innovation performance. Drawing on both the RBV and human capital theory, we assume that allocating a greater share of the UBI's annual budget to societal innovations will result in increased innovation outputs (H1), as skilled human capital and targeted investments are critical drivers of competitive advantage and innovation. Consequently, incubators with greater capacity for resource allocation, strategic partnerships, and comprehensive support services are generally more successful in fostering innovation and supporting start-ups [38–41]. Similarly, a larger incubator budget is associated with stronger outcomes in patenting activity and start-up success [42]. This assumption is further supported by evidence that well-funded incubators are more effective at attracting industry partnerships and aligning innovation efforts with market needs [43].

Specifically, we hypothesize the following and visualize the contextual framework in Fig. 1:

H1. A higher percentage of the UBI's annual budget allocated to societal innovations leads to an increased number of (a) licenses granted, (b) patents filed by, and (c) patents awarded to, tenant start-ups.

H2: A greater number of incubator tenants focused on broader societal impact leads to an increased number of (a) licenses granted, (b) patents filed by, and (c) patents awarded to, tenant start-ups.

H3: A higher percentage of the UBI's annual budget allocated to societal innovations positively influences the successful exits of start-ups, i.e., when the start-up is sold to investors or another company.

H4: A greater number of incubator tenants focused on broader societal impact positively influences the successful exits of start-ups, i.e., when the start-up is sold to investors or another company.

3. Data design and methods

3.1. Sample description

The study focuses on UBIs in Indonesia, especially those linked to universities and higher education institutions. These incubators are affiliated with the Association of Indonesian Business Incubators (AIBI), which has grown to include more than 140 active members as of December 2024 [44]. Within this quasi-experimental research framework, 31 incubators (response rate of 22 %) participated in the survey. This response rate is consistent with, or even exceeds, those reported in

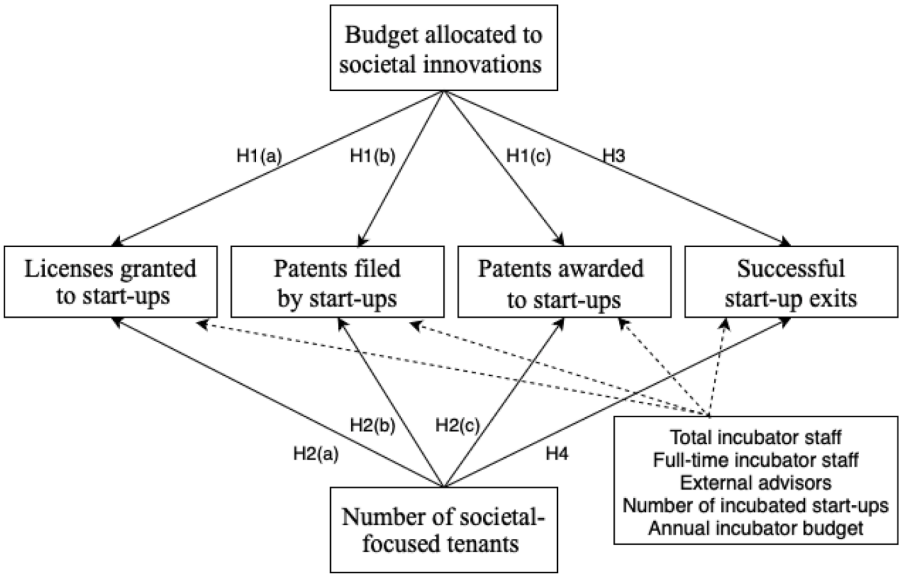

Fig. 1. Contextual framework.

similar survey-based studies involving organizational populations in Indonesia, where factors such as resource limitations and survey fatigue often hinder participation and data collection [45]. While the sample is not fully representative, its size is considered sufficient to yield meaningful and comparable insights. Moreover, the sample is diverse, encompassing university-based, private-sector, and government-affiliated incubators, thereby offering a broad and nuanced perspective on the sector.

The survey was thoughtfully designed with the assistance of two randomly selected incubator experts who refined the questions. It was distributed through Google Forms and remained accessible from September 2023 to March 2024. This duration ensured that a diverse range of respondents could participate and share their insights.

The questions were designed to gather information on the economic, societal, and environmental impacts, as well as the characteristics and sustainability initiatives of each incubator. The responses offer a comprehensive perspective on the role of incubators in fostering societal impact within Indonesia. This methodological approach guarantees a well-rounded view that aligns with the objective of assessing sustainable practices across different types of incubators. The design and data collection processes are appropriate for the research goals.

3.2. HAC-corrected linear regression

This study employed HAC-corrected regression to address potential heteroskedasticity in cross-sectional data. HAC estimators provide robust standard errors even in the presence of non-constant error variance, a common feature of organizational datasets. Although alternative methods such as Generalized Least Squares (GLS) were considered, their reliance on strict assumptions about the error structure and reduced reliability in small samples limited their applicability. Panel fixed effects models were also unsuitable due to the cross-sectional nature of the data. Therefore, HAC correction was chosen to ensure valid statistical inference in this research context.

HAC correction modifies the standard errors in a linear regression to address heteroscedasticity, where the variance of errors varies across observations and autocorrelation, which refers to the correlation of error terms across observations. This adjustment enhances the model's robustness in scenarios where the error terms may deviate from traditional assumptions, thus ensuring more reliable statistical inference for the regression coefficients [46]. The regression analysis was conducted via Gretl [47], an econometric tool.

The choice of variables aligns with established frameworks for assessing incubator performance while addressing gaps in measuring societal impacts. Each metric is supported by a strong methodological grounding in the literature, offering a robust measurement of both traditional innovation outputs and emerging dimensions related to societal and sustainability contributions. The contextual framework draws on the resource-based view (RBV) of companies, positing that incubators' resources and capabilities positively influence their competitive advantage in nurturing start-ups.

Multivariate linear regression predicts a continuous dependent variable, such as the number of successful start-ups that exist, from independent variables, e.g., the number of people, full-time staff and experts working in incubators, the annual budget, and the number of founded start-ups. We also assess how factors such as budgets and tenants with a green, sustainable, or environmental focus account for variability in the dependent variables, such as the total count of licenses granted, patent applications and patents awarded. The model structure is as follows:

3.2.1. Dependent variables (DVs)

LIC_GRANTS: Number of Licenses Granted to External Organizations over the last 3 years. This metric reflects the commercialization potential of incubated innovations. Licensing activity is a critical indicator of knowledge spillovers and collaboration with industry, as universities increasingly prioritize translational research [48].

PAT_APPS: Number of patent applications filed over the last 3 years. Patent applications signal R&D productivity and institutional commitment to intellectual property (IP) protection. While patents alone do not guarantee commercialization, they represent a foundational step in securing competitive advantage for start-ups [49].

PAT_AWRD: Number of patent awards over the last 3 years. Unlike patent applications, awarded patents measure the quality and novelty of innovations [50]. In the case of UBIs, the greater number of patent awards reflects the strength of mentorship in refining prototypes and aligning innovations with regulatory requirements.

S_EXITS: The number of successful start-ups that exit at the university. Successful exits, defined as start-ups acquired by investors or companies, reflect market validation [51]. This metric also indicates the long-term sustainability of innovations, as successful exits facilitate the reinvestment of resources into new entrepreneurial ventures.

3.2.2. Independent variables (IVs)

SUS_BGT: percentage of the annual budget allocated to sustainable or societal innovations. This variable quantifies UBIs' prioritization of sustainability-oriented ventures, as they often align with government sustainability agendas and attract public funding [52].

TEN_GRN: Number of incubator tenants with a green, sustainable, or environmental focus. The presence of green/social enterprises within incubators fosters collaborative innovation. Clusters of sustainability-focused tenants exhibit stronger peer learning effects, accelerating problem solving in waste management and renewable energy [53].

3.2.3. Control variables

INC_PEOP: Total number of people working in the incubator. Staffing levels directly influence mentorship quality and operational scalability. Larger teams enable specialized support across technical, legal, and business domains, which is vital for start-ups addressing complex societal challenges [54].

FULL_ST: Number of full-time staff in the incubator. Full-time staff members play a crucial role in providing consistent mentorship, which is a key factor in driving the success of start-ups, particularly in environments with limited resources [55].

EXT_EXP: Number of external experts assisting the incubator. External advisors bridge gaps in technical and market knowledge. This variable aligns with the concept of social learning, where external networks amplify innovation diffusion [56].

ST_FND: Number of start-ups/spin-offs founded at the university over the last 3 years. The number of new ventures reflects the degree of entrepreneurial culture at the university [57] (as well as UBIs' role as entrepreneurship catalysts). However, quantity does not guarantee quality [58].

AVG_BGT: Average annual budget (IDR million) of the incubator over the last 3 years. The size of the budget reflects an organization's overall capacity to offer services by influencing its access to essential resources such as infrastructure, human capital, training programs, and prototyping tools [59].

This regression analysis evaluates the influence of incubator resources devoted to societal innovations on the probability of successful start-up incubation in terms of patents, licenses and exits. HAC correction is employed to guarantee that the model's inferences are robust, even in the presence of error patterns that could bias standard errors.

4. Results of the analyses

Descriptive statistics provide an overview of each variable's central tendency, dispersion, and range. This detailed analysis facilitates a better understanding of the data distribution, enabling more informed interpretations in subsequent regression analyses and conclusions. The key descriptive statistics, e.g., the mean, median, standard deviation (S.D.), minimum (Min), and maximum (Max) values, are summarized in Table 1.

Table 1
Descriptive statistics of variables.

Variables	Mean	Median	S.D.	Min	Max
LIC_GRANTS	4.581	0	10.15	0	36
PAT_APPS	18.52	0	50.26	0	206
PAT_AWRD	5.642	0	17.67	0	93
S_EXITS	3.806	1	5.839	0	24
INC_PEOP	6.355	5	7.952	1	44
FULL_ST	3.774	3	4.387	0	20
EXT_EXP	9.806	5	15.14	0	76
AVG_BGT	251.2	80	361.9	0	1500
ST_FND	19.23	10	31.87	0	140
SUS_BGT	48.39	50	26.56	0	100
TEN_GRN	11.29	4	35.31	0	200

Note: Standard Deviation (S.D.).

The Pearson correlation matrix (Table 2) shows the relationships among the examined variables, highlighting both their strength and significance (p-levels). The matrix reveals strong connections between operational metrics, such as staff size, funding, and innovation outcomes, such as patents and start-ups. Furthermore, a significant positive correlation exists between licensing activity and patent applications. Patent applications also demonstrate a strong correlation with patent awards, as applications typically lead to awards. Additionally, the number of incubated start-ups is strongly correlated with the number of full-time staff, suggesting that larger staff sizes facilitate the incubation process. Start-up exits exhibit a moderate correlation with start-up funding, underscoring the role of financial resources in contributing to successful exits. Licensing activity is also moderately correlated with full-time staff, indicating that organizational capacity plays a significant role in licensing success.

In summary, licensing and patents demonstrate strong interdependence, suggesting that various innovation metrics, such as grants and applications, are interconnected. The roles of full-time staff and the number of incubated start-ups are vital for operational success. Moreover, funding positively correlates with successful start-up exits, emphasizing the importance of financial support. In contrast, e.g., sustainability metrics (SUS_BGT) appear to be weakly integrated with operational and financial factors, implying the need to prioritize sustainability in incubation strategies.

On the basis of the regression results provided in Table 3, the full-time staff (FULL_ST) effect positively affects the number of licenses granted consistently and is statistically significant at the 1 % level ($p < 0.01$) and contributes positively to the success of obtaining license grants. The (INC_PEOP) variable of people working appears in Models 2 to 7 ($p < 0.05$). It is significant at varying levels and indicates that having more people in the incubator is associated with a higher probability of receiving license grants. This finding supports the hypothesis that an increased incubator workforce positively impacts license grant outcomes. EXT_EXP is significant in Models 3 to 7, mainly at the 1 % level ($\beta = 0.257$ and 0.351), indicating a positive relationship between access to external expertise and license grants. This result supports the hypothesis that external expertise is a valuable resource for increasing the likelihood of license grant success. However, variables such as start-up funding, the general budget, the sustainable budget, and tenure in green initiatives are weaker or not statistically significant ($p < 0.1$), indicating that they may play a less direct role in achieving license grants (H1a, H2a is rejected).

Table 4 summarizes the results of PAT_APPS, which denotes patent applications, in relation to the independent variables across seven models. The coefficients for full-time staff (FULL_ST), incubator personnel (INC_PEOP), and external expertise (EXT_EXP) are consistently positive and statistically significant across all the models at high significance levels (1 % or 5 %). These findings support that incubator personnel play a crucial role in promoting patent applications by enhancing the support and expertise available to start-ups. They also reinforce the RBV theory by demonstrating that targeted resource allocation is a key driver of innovation.

Conversely, the other results provide limited support for the notion that start-up funding directly correlates with patent application outcomes. However, the average budget (AVG_BGT) achieves significance at the 10 % level in certain models, offering weak support for hypothesis H1b, which posits that the average budget allocated to incubators affects patent applications. Specifically, a one-unit increase in sustainability budget is associated with an additional 0.273 patent applications. Notably, the sustainable budget (SUS_BGT) is consistently positive and significant at the 1 % level across most models, reinforcing the assumption that increased sustainability-focused funding influences patent applications, likely by encouraging innovative and eco-friendly projects.

In addition, the tenure in green initiatives (TEN_GRN) regressor does not exhibit statistical significance, suggesting that it may not directly impact the number of patent applications. Consequently, H2a is rejected. This result may be because green tenure alone stimulates innovation only with the backing of additional resources or expertise. The results support the premise that full-time staff, incubator personnel, external expertise, and sustainably related budgets positively affect patent applications, indicating that these resources increase the potential for innovation. In contrast, variables such as start-up funding, average budget, and tenure in green initiatives show weaker or nonexistent statistical significance, suggesting a less direct or inconsistent role in promoting patent applications. As a result, H2b is rejected.

Table 5 presents the findings of a regression analysis that investigates the factors influencing patent awards among start-ups in incubators (PAT_AWRD). The key predictors identified include full-time staff (FULL_ST, INC_PEOP), external experts (EXT_EXP), and budgets (AVG_BGT, SUS_BGT), highlighting the critical role of comprehensive incubator support, skilled personnel, external expertise, adequate budgeting, and a focus on sustainability. Notably, the negative correlation between start-up funding and patent awards calls for further exploration, as it may reveal inefficiencies or context-specific dynamics.

Table 2
Pearson correlation matrix of the variables.

	LIC_GRANTS	PAT_APPS	PAT_AWRD	S_EXITS	INC_PEOP	FULL_ST	EXT_EXP	ST_FND	AVG_BGT	SUS_BGT	TEN_GRN
LIC_GRANTS	1										
PAT_APPS	0.868*	1									
PAT_AWRD	0.648*	0.847*	1								
S_EXITS	0.635*	0.367*	0.159	1							
INC_PEOP	0.664*	0.774*	0.413*	0.255	1						
FULL_ST	0.726*	0.770*	0.428*	0.350	0.817*	1					
EXT_EXP	0.409*	0.074	0.096	0.473*	-0.095	-0.069	1				
ST_FND	0.204	-0.018	-0.052	0.671*	-0.066	-0.092	0.427*	1			
AVG_BGT	0.441*	0.343	0.221	0.231	0.259	0.283	0.161	0.211	1		
SUS_BGT	0.151	0.018	0.055	0.314	-0.072	-0.096	0.256	0.261	0.013	1	
TEN_GRN	0.427*	0.347	0.077	0.381*	0.338	0.550*	0.030	-0.032	0.426*	-0.131	1

Note: * indicates significance at the 0.05 p-level.

Table 3
Regression analysis of licenses granted of start-ups in incubators.

DV	LIC_GRANTS						
IVs	Model1	Model2	Model3	Model4	Model5	Model6	Model7
Constant	−0.862	−1.355	−3.765	−3.806	-4.106	-4.951	-4.717
	(-2.86)***	(-3.34)***	(-5.37)***	(-5.11)***	(-5.11)***	(-3.67)***	(-3.46)***
FULL_ST	1.798	1.368	1.046	1.054	0.772	0.847	0.589
	(22.19)***	(5.73)***	(5.75)***	(5.79)***	(3.80)***	(5.29)***	(1.66)
INC_PEOP		0.224	0.374	0.401	0.507	0.531	0.571
		(1.96)*	(3.69)***	(3.94)***	(4.41)***	(4.83)***	(3.49)***
EXT_EXP			0.257	0.325	0.287	0.351	0.307
			(2.16)**	(3.03)***	(2.67)**	(3.07)**	(3.48)***
ST_FND				-0.022	-0.025	-0.036	-0.031
				(-1.01)	(-1.15)	(-1.72)*	(-1.47)
AVG_BGT					0.003	0.002	0.001
					(1.60)	(1.93)*	(0.95)
SUS_BGT						0.011	0.025
						(0.54)	(1.29)
TEN_GRN							0.062
							(1.31)
R^2	0.944	0.981	0.896	0.934	0.922	0.967	0.992
Adj. R^2	0.942	0.979	0.884	0.924	0.906	0.959	0.991
F value	492.26***	138.73***	77.59***	92.69***	59.47***	120.15***	131.26***
max(VIF)	-	3.013	3.027	3.034	3.099	3.085	4.085
Obs.	31						

Notes: The robustness of the heteroskedasticity-consistent (HAC) t statistics for the standard errors is indicated in parentheses. Significance levels are denoted as follows: *** indicates significance at the 0.001 p-level, ** denotes the 0.05 p-level, and * represents the 0.1 p-level.

Table 4
Regression analysis of patent applications of start-ups in incubators.

DV	PAT_APPS						
IVs	Model1	Model2	Model3	Model4	Model5	Model6	Model7
Constant	−4.976	−11.611	−3.765	−16.226	−15.394	−30.411	−27.747
	(-2.03)*	(-5.56)***	(-5.37)***	(-5.51)***	(-5.27)***	(-9.49)***	(-6.97)***
FULL_ST	5.909	4.911	1.046	4.311	2.017	1.903	3.821
	(4.63)***	(4.65)***	(5.75)***	(3.48)***	(1.83)*	(2.61)**	(2.87)***
INC_PEOP		2.431	0.374	2.711	2.941	3.534	3.133
		(4.41)***	(3.69)***	(4.21)***	(4.63)***	(7.83)***	(5.16)***
EXT_EXP			0.257	0.514	0.586	0.375	0.354
			(2.16)**	(4.02)***	(4.15)***	(3.21)***	(2.31)***
ST_FND				-0.031	-0.093	-0.093	-0.082
				(-0.82)	(-1.18)	(-1.24)	(-0.85)
AVG_BGT					0.012	0.016	0.020
					(1.31)	(1.72)*	(1.81)*
SUS_BGT						0.273	0.168
						(4.37)***	(2.02)*
TEN_GRN							-0.086
							(-1.08)
R^2	0.425	0.931	0.896	0.901	0.842	0.972	0.986
Adj. R^2	0.406	0.926	0.884	0.885	0.810	0.965	0.982
F value	21.51***	138.73***	77.59***	58.87***	26.72***	140.01***	246.23***
max(VIF)	-	3.013	3.027	3.034	3.099	3.085	4.085
Obs.	31						

Notes: The robustness of the heteroskedasticity-consistent (HAC) t statistics for the standard errors is indicated in parentheses. Significance levels are denoted as follows: *** indicates significance at the 0.001 p-level, ** denotes the 0.05 p-level, and * represents the 0.1 p-level.

In Model 5, these variables become statistically significant, with the coefficient shifting from –0.036 to –0.059 ($p < 0.05$), indicating a negative impact on patent outcomes. This outcome may indicate inefficiencies in funding allocation or diminishing returns on funding beyond a certain threshold. Moreover, an increase in the annual budgets allocated to societal innovations leads to an increased number of patents awarded to tenant start-ups (H1c is accepted). Thus, the greater number of tenants focused on broader societal impact does not lead to an increased number of patents awarded to start-ups ($p < 0.05$). Consequently, H2c is rejected. Therefore, incubators should emphasize robust support mechanisms, incorporating knowledgeable staff, annual and sustainability-oriented budgets, and strategic funding allocations to enhance start-up innovation and maximize patent output.

Table 6 reveals that full-time staff (FULL_ST) is significant across Models 1–5, demonstrating a positive effect on start-up exit ($p < 0.05$ and $p < 0.01$). The variable representing people (INC_PEOP) has a significant positive relationship in Model 6 ($p < 0.05$), suggesting a potential beneficial influence in specific contexts. Additionally, the presence of experts (EXT_EXP) in Model 4 ($p < 0.05$) indicates that a greater number of experts contributes to a greater likelihood of successful exits, all else being equal. The variable for founded start-ups (ST_FND) shows strong significance across Models 4 to 7 ($p < 0.01$ or $p < 0.001$), consistently indicating a positive effect, which suggests that robust foundational support is a crucial factor in achieving exit. However, variables such as the start-up general budget and sustainable budget in green initiatives are not statistically significant ($p < 0.05$), indicating that they may play no direct role in successful exits. Furthermore, green tenants (TEN_GRN) demonstrate strong significance

Table 5
Regression analysis of patent awards of start-ups in incubators.

DV	PAT_AWRD						
IVs	Model1	Model2	Model3	Model4	Model5	Model6	Model7
Constant	−0.600	−1.373	−2.174	−2.122	−2.361	−5.145	−2.195
	(-1.47)	(-4.28)***	(-5.48)***	(-6.50)***	(-6.43)***	(-7.89)***	(-2.21)**
FULL_ST	1.537	0.943	1.151	1.102	1.037	0.623	0.559
	(6.31)***	(3.65)***	(4.48)***	(4.98)***	(4.32)***	(2.98)***	(1.75)*
INC_PEOP		0.406	0.309	0.334	0.377	0.551	0.301
		(3.38)***	(2.88)***	(3.03)***	(3.37)***	(5.48)***	(2.55)**
EXT_EXP			0.109	0.141	0.175	0.152	0.134
			(2.45)**	(4.98)***	(4.08)***	(3.78)***	(2.40)**
ST_FND				-0.012	-0.058	-0.059	-0.036
				(-0.74)	(-2.23)**	(-3.15)***	(-1.62)
AVG_BGT					0.031	0.004	0.001
					(1.52)	(3.40)***	(0.90)
SUS_BGT						0.055	0.013
						(4.48)***	(0.89)
TEN_GRN							-0.027
							(-1.04)
R^2	0.578	0.858	0.871	0.943	0.963	0.953	0.976
Adj. R^2	0.564	0.848	0.856	0.934	0.956	0.941	0.969
F value	39.83***	85.18***	60.60***	108.24***	133.79***	81.22***	139.51***
max(VIF)	-	3.013	3.027	3.034	3.099	3.085	4.085
Obs.	31						

Notes: The robustness of the heteroskedasticity-consistent (HAC) t statistics for the standard errors is indicated in parentheses. Significance levels are denoted as follows: *** indicates significance at the 0.001 p-level, ** denotes the 0.05 p-level, and * represents the 0.1 p-level.

Table 6
Regression analysis of successful exits across start-ups in incubators.

DV	S_EXIT						
IVs	Model1	Model2	Model3	Model4	Model5	Model6	Model7
Constant	1.771	2.061	0.833	-0.401	0.415	-1.669	-0.652
	(1.76)*	(2.13)**	(0.89)	(-0.52)	(0.59)	(-1.53)	(-0.51)
FULL_ST	0.494	0.925	0.901	0.042	0.607	0.042	0.088
	(2.76)***	(2.13)**	(2.76)**	(2.52)**	(2.28)**	(0.24)	(0.38)
INC_PEOP		−0.240	−0.201	−0.081	−0.064	0.201	0.156
		(-1.11)	(-1.33)	(-0.68)	(-0.51)	(2.25)**	(1.31)
EXT_EXP			0.174	0.149	0.101	0.075	0.064
			(1.25)	(2.17)**	(1.31)	(1.41)	(0.92)
ST_FND				0.061	0.097	0.109	0.107
				(2.21)**	(4.08)***	(6.27)***	(5.79)***
AVG_BGT					−0.001	−0.001	−0.003
					(-1.35)	(-1.31)	(-1.47)
SUS_BGT						0.033	0.019
						(1.62)	(0.82)
TEN_GRN							0.063
							(4.94)**
R^2	0.208	0.562	0.854	0.834	0.785	0.784	0.958
Adj. R^2	0.181	0.531	0.838	0.808	0.742	0.731	0.945
F value	7.61*	18.02***	52.81***	32.74***	18.37***	14.57***	74.98***
max(VIF)	-	3.013	3.027	3.034	3.099	3.085	4.085
Obs.	31						

Notes: The robustness of the heteroskedasticity-consistent (HAC) t statistics for the standard errors is indicated in parentheses. Significance levels are denoted as follows: *** indicates significance at the 0.001 p-level, ** denotes the 0.05 p-level, and * represents the 0.1 p-level.

($\beta = 0.063$, $p < 0.05$) in Model 7, highlighting that an increase in green tenants positively influences start-up exits.

The presence of positive coefficients for FULL_ST, ST_FND, and TEN_GRN in high-significance models ($p < 0.05$) indicates that these factors influence start-up exit outcomes. Resources related to staffing, foundational support, and carefully selected tenants are crucial for enhancing the likelihood of successful exits. In conclusion, the analysis rejects hypothesis H3 and validates H4, indicating that elements, e.g., personnel, expertise, and green tenants, positively affect outcomes, particularly in more comprehensive models. Consistent with human capital theory, incubators with more full-time staff and external experts achieve significantly higher rates of patent applications and awards. These results indicate that investments in skilled personnel and external networks are not only statistically significant but also practically meaningful drivers of innovation performance in the Indonesian context. In contrast, the impact of green tenants appears inconsistent across models, suggesting that their contribution to successful exits may be contingent on additional factors such as funding availability or mentorship support.

The number of tenants with a green, sustainable, or environmental focus (TEN_GRN) generally lacks statistical significance for most innovation-related outcomes, including licenses, patent applications, and patent awards. Its influence emerges only in relation to successful exits in a single model (Table 6), indicating a limited and context-dependent effect.

The strong model fit across varying specifications further affirms the robustness of these findings. The adjusted R^2 values increase from Model 1 to Model 7 in each analysis, indicating improved model fit as more

variables are included. The variance inflation factor (VIF) values are mostly low across models (below 5), indicating minimal multicollinearity issues [60]. It also has highly significant F values, indicating that the models are statistically robust.

5. Discussions

The findings of this study provide essential insights into the factors affecting licensing processes, patents, and successful exits for incubated start-ups, offering empirical evidence for understanding the relative impact of various elements. The high significance observed across all the models reinforces the notion that continuous, full-time engagement is crucial for incubators striving to enhance licensing and patenting activities among their tenants. The positive effect of having full-time staff on patent applications aligns with human capital (HC) theory, which asserts that skilled and dedicated personnel are critical for knowledge-intensive endeavors such as innovation [61].

Full-time staff members likely offer stability, ongoing support, and expertise, thereby enabling start-ups to persist in research and development (R&D) activities essential for generating patentable innovations. This finding is supported by the resource-based view (RBV), which highlights organizational resources such as human capital as a strategic asset for providing competitive advantage [62]. It is essential to provide further evidence demonstrating how unique resources and capabilities contribute to competitive advantage and entrepreneurial success in different contexts.

Moreover, the strong correlation between workforce size and patent applications underscores the importance of incubator support networks, which is consistent with social capital (SC) theory [63]. Personnel in incubators, through mentorship, guidance, and administrative assistance, likely facilitate connections with external resources and alleviate the uncertainties typically encountered during the early stages of start-up development. This finding illustrates the distinctive value of incubators as ecosystems that leverage social capital to promote start-up success in a developing country.

The positive impact of expert involvement on patent applications underscores the importance of external knowledge sources in fostering innovation. Specifically, the significant effect of external experts on licensing and patent outcomes underlines the value of social capital in enabling access to external knowledge and collaborative networks, as theorized by Nahapiet and Ghoshal [64]. This finding aligns with open innovation theory, which posits that organizations can increase internal R&D efforts by integrating external ideas, technologies, and expertise [65].

Furthermore, the significant effect of a sustainable budget on patents filed by and awarded to tenant start-ups indicates that dedicated financial resources aimed at broader societal impact can drive innovative outcomes. This conclusion aligns with sustainable innovation theory, which contends that sustainability-related funding catalyzes the development of green technologies and sustainable product innovation [66]. Incubators that allocate budgets toward initiatives equip start-ups with the financial stability necessary to pursue environmentally conscious solutions. These insights are particularly relevant for developing economies, where funding resources can effectively address environmental challenges while meeting market demands and fostering innovations that align with sustainable development goals (SDGs) [67].

While green tenants may contribute to successful exits within specific contexts, our findings do not indicate a broad or consistent effect of the number of ‘green’ tenants (TEN_GRN) on innovation outputs. This result suggests that simply increasing the number of green-focused tenants is insufficient to improve overall innovation performance. Instead, factors such as staff expertise, engagement with external networks, and targeted sustainability funding have a more significant influence.

The findings also highlight various sustainable development goals (SDGs), particularly SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 13 (Climate Action). Start-ups often play a pivotal role in advancing sustainable development while simultaneously enhancing their competitive position in the marketplace [7]. By aligning their business strategies with SDG 8, start-ups can create job opportunities that promote socioeconomic growth and improve the quality of work within their communities [68]. Finally, aligning innovation initiatives with SDG 13 may result in market solutions that address climate change and its effects. Start-ups that prioritize environmentally sustainable practices not only contribute to global climate action but also capitalize on the rising market demand for green technologies and solutions [69].

The SDGs provide a global policy framework that Indonesia has effectively translated into a comprehensive national policy structure. This policy includes Presidential Regulation No. 59/2017 and the SDG Roadmap developed by BAPPENAS, the Ministry of National Development Planning in Indonesia. Within this framework, UBIs in Indonesia are strategically positioned to advance national priorities by fostering start-ups that align with the targets [70]. These priorities include inclusive job creation, technological innovation, and climate resilience. Furthermore, innovative financing instruments, such as SDG-linked bonds and the Indonesia Impact Fund, offer new opportunities for UBIs and their tenant start-ups to access funding and deliver measurable contributions to SDG indicators. Policymakers are encouraged to promote alignment between UBI performance metrics and the national SDG monitoring system, thereby strengthening the link between entrepreneurial innovation and Indonesia’s sustainable development agenda [71].

By embedding the SDGs into their core missions, Indonesian UBIs play a vital role in advancing global sustainability efforts while enhancing their market competitiveness and fostering long-term economic resilience. To address the challenges associated with funding, infrastructure, and collaboration effectively, research needs to be conducted concerning specific Indonesian targets [72]. Future studies should focus on innovative financing models, e.g., public-private partnerships (PPPs) and green bond fundings. Additionally, improving digital infrastructure is crucial for bridging the innovation gap between urban and rural areas and establishing SDG-aligned metrics to measure the societal impact of incubators [73].

Our findings suggest that Indonesian university-based incubators (UBIs) can strengthen their societal impact by allocating a specific portion of their annual budgets to support sustainability-oriented start-ups. This financial commitment should be complemented by tailored mentorship programs, robust impact measurement tools, and the formation of diverse advisory boards. To optimize funding, UBIs should leverage existing government initiatives such as the Competitive Fund, Matching Fund, and Pre-Startup Fund, as well as SDG-linked and green financing instruments [74]. Furthermore, UBIs are encouraged to diversify their revenue streams and foster public–private partnerships to ensure long-term sustainability while balancing both commercial and societal outcomes.

By integrating insights from infrastructure analyses, green entrepreneurship frameworks, and international academic partnerships, UBIs have the potential to evolve into centres for sustainable economic transformation [75]. Policymakers should incentivize industry collaboration through tax breaks and SDG-linked grants, ensuring that UBIs effectively contribute to Indonesia’s vision of inclusive, innovation-driven growth [76].

This study emphasizes the diverse role of incubators in promoting sustainable innovation and addresses the existing research gap regarding the contribution of incubator resources to patent applications in developing regions. The results underscore the need to enhance traditional support systems and mechanisms by prioritizing key resources such as specialized personnel, incubator staff, and budget allocations. Instead, a holistic approach that incorporates human capital, external expertise, and targeted funding for sustainability proves more effective in fostering patentable and granted innovations to start-ups.

These implications for both incubators and policymakers highlight the importance of building capabilities and facilitating access to external networks to spur innovation in start-ups.

6. Conclusions

The primary objective of this study was to evaluate whether university business incubators (UBIs) that focus on broader social and sustainability contributions are more successful in bringing innovations to the market. The findings offer new insights into the challenges incubators face in developing economies when they navigate the balance between commercial viability and social contributions. By employing HAC-corrected regression analysis, we evaluated the effects of orientation toward societal goals on patenting and firm outcomes while controlling for other incubator resources that might influence innovation performance.

The strength of this research lies in its comprehensive, data-driven analysis, which reveals how targeted incubator resources facilitate impactful, patentable innovations. Unlike previous studies that provided broader overviews of incubator advantages [77], our approach considers the multifaceted factors present within the Indonesian context, thereby facilitating a more precise formulation of recommendations aimed at enhancing innovation through incubation. The main findings indicate that a higher percentage of a UBI budget allocated to broader societal innovations is associated with more successful patenting by tenant start-ups (H1b–c). In contrast, a greater number of tenants focused on societal and sustainability impacts facilitates a higher rate of successful exits (H4). Given the limited statistical significance of TEN_GRN across most models, we urge caution in interpreting the presence of green tenants as a primary driver of incubator innovation success. Future research should explore the specific conditions under which green tenants can positively influence start-up outcomes.

These results suggest a win–win outcome for socially oriented incubators, start-ups, and society at large. Our findings also indicate that the number of full-time staff and access to external expertise in UBIs serve as significant drivers of patent applications and successful start-up exits. The results underscore the vital role that incubators can play in promoting patentable innovations by concentrating on these strategic support elements.

The theoretical implication of this study is that incubators can indeed be powerful instruments for advancing societal and sustainable innovations within emerging economies. From this standpoint, our findings are significant for policymakers and incubator managers in Indonesia, as they identify specific areas where targeted resources can enhance the innovative capacity of start-ups. By concentrating on the SDGs, incubators can make substantial contributions to national economic development and social progress while simultaneously achieving positive commercialization outcomes.

Importantly, the limitations of this study warrant further consideration. First, the relatively small sample size may restrict the generalizability of the findings, limiting the ability to apply the results across different contexts or larger populations. Second, although several variables were controlled, there may be unobserved factors affecting patent and license applications that need to be captured in this model. This study is based on cross-sectional, observational data and employs HAC-corrected regression to analyze the relationship between incubator resources and innovation outcomes. While the analysis controls for several observable confounders, it does not fully address potential endogeneity concerns, such as reverse causality or omitted variable bias. Therefore, the results should be interpreted as indicative associations rather than as conclusive evidence of causal relationships. These limitations affect the robustness and validity of the conclusions, as they suggest that additional variables could moderate or mediate the observed relationships.

Some control variables, such as the number of start-ups founded (ST_FND), display inconsistent significance and occasionally negative coefficients across different model specifications. This result is a common occurrence in multivariate regression, particularly when predictors are intercorrelated and sample sizes are modest. Negative coefficients may reflect underlying trade-offs, for example, a dilution of resources when the number of start-ups increases without a corresponding expansion in support capacity. Additionally, the coefficients of control variables should not be interpreted as causal effects, as they may be subject to residual confounding or suppressor effects. We recommend cautious interpretation of these findings and encourage future research to examine these dynamics using larger and more diverse samples.

This study provides valuable insights into the role of UBIs in fostering societal and sustainable innovation. However, several areas merit further research. First, longitudinal panel studies tracking start-ups over time could clarify the causal impact of changes in resource allocation on innovation outcomes. Second, experimental trials within UBIs may help identify which support mechanisms, such as sustainability-focused mentorship, are most effective. Third, comparative analyses across urban and rural incubators, as well as cross-country studies, could reveal contextual factors shaping incubator effectiveness. Future research should also aim to develop and test metrics aligned with SDGs to standardize societal impact measurement, and examine how innovative financing models, such as SDG-linked bonds, can enhance incubators' societal impact. Lastly, network analyses of advisory structures may reveal optimal strategies for leveraging external expertise to support start-up success.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used GRAMMARLY software to improve the readability and language of the work and not to replace key authoring tasks such as producing scientific, pedagogic, or medical insights, drawing scientific conclusions, or providing clinical recommendations. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Ethical statement

All data were anonymized prior to analysis. Both direct and indirect identifiers were removed to protect the identities of individual respondents and their affiliated organizations. The research team will not attempt to re-identify any participants or institutions and will only share anonymized, aggregated data in publications or upon request.

Ethical approval statement

Participants were informed of the study's purpose, procedures, and their rights through an information sheet provided at the beginning of the survey. Participation was entirely voluntary, and informed consent was implied through survey completion. No personal or sensitive data were collected, and participants retained the right to withdraw at any time without penalty.

Human experiments

Not applicable.

Animal experiments

Not applicable.

Clinical Trial

Not applicable.

Data availability statement

The data supporting the conclusions of this article will be made available by the corresponding author.

Author contributions

Both leading authors made equal contributions to the study.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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