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Research Article

Proposed integrated policies and supports of university spin-offs: a case study from Institut Teknologi Bandung

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Abstract

Paper aims: This research explores proposed integrated policies and supports for university spin-offs by considering the growth level of the spin-offs.

Originality: According to the literature, different types of support are needed to make spin-offs become established companies. However, the literature lacks clarity in addressing the specific types of support required at each stage of spin-off growth.

Research method: This research employs a qualitative research method in which the data collection is based on nine interviews with the founders of the spin-offs, the inventor, the director of the technology transfer office, the head of the university incubator, the manager of the university technopark, and the director of university's company.

Main findings: Each level of spin-offs' growth has to be supported by specific policies and supports. There are different types of support expected at the pre-incubation stage, which are Intellectual Property Rights (IPRs) protection, patent incentives, royalties, matching funds between university and industry, and the Technology Transfer Office as a matchmaker of inventor and startup founders.

Implications for theory and practice: This study provides a theoretical contribution to the policy framework for university spin-offs and offers practical guidance for university management and incubator managers.

Keywords

University spin-off. The growth level. Integrated supports and policies. Technology transfer office. Incubator.

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Conflict of Interest
The authors have no conflict of interest to declare.

Ethical Statement
The authors declare that this research does not require ethical approval as it did not involve any experiments on humans or animals.

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1. Introduction

Universities worldwide are pushing for a series of policies that support the creation of successful academic spin-offs. Spin-offs can be defined as companies founded by individuals from the academic community, such as students, alumnae, and university scholars (Ayoub et al., 2017). Establishing this startup is an effort to exploit university knowledge (Fini et al., 2009), which is essential for economic growth (Ramaciotti & Rizzo, 2015). The main players in academic spin-offs can be university scientists who commercialize the technology they develop (Mustar & Wright, 2010) or entrepreneurs who use university technology to apply it to specific market opportunities (Shane, 2000).

The development of academic spin-offs is a concern for universities because it is an essential means for disseminating knowledge and has the potential to support economic growth (Hayter, 2013) in the form of job creation, purchasing, and production, which have a significant impact on the regional economy where the spin-off is located (Pressman et al., 2022). Furthermore, spin-off employment exceeds the job creation rate in large corporations or established firms that license university technology. Academic spin-offs also contribute to intelligent specialization by creating links between the educational-scientific, industrial, and institutional systems. Academic spin-offs contribute significantly to this (Vega-Gomez et al., 2018).

Many universities have proposed policies and supports to encourage academic spin-off to grow and can compete with other companies. However, the percentage of successful companies from universities is still smaller than those born outside campus. Interventions in the form of supports are needed because of the obstacles for universities due to market inefficiencies (Kochenkova et al., 2016) and systemic failures, namely ineffective active interaction among players (such as companies, government laboratories, and universities), that can be showed in the priorities, goals, and different targets (Salmenkaita & Salo, 2002). In addition to university supports, government supports are also needed to reduce system failures by creating incentives for interaction, collaboration, and exchange of knowledge and technology between organizations at various stages of the innovation process (Salmenkaita & Salo, 2002), as well as increasing the effectiveness of commercialization and knowledge transfer from universities to industry (Feldman et al., 2002).

Many universities have made various policies and supports for academic spin-offs, such as by forming incubators, accelerators, and even science and technoparks. Furthermore, they also have activities to support the growth of academic spin-offs, such as seed funding, mentoring, training, and even investment. However, not all these supports and policies correlate with the needs of academic spin-offs. The inaccuracy of this support is because it is not linked to needs to every growth level of the academic spin-off, which has different characteristics and problems. Support and policies that are aligned with the needs of each level of the academic spin-off can really help them so that they can move up grades naturally.

Most previous research on policies and supports for university spin-offs has focused on general frameworks without emphasizing the specific needs of academic spin-offs at different stages of growth. Furthermore, existing research has concentrated on national or university-level policies, often ignoring the characteristics of spin-offs. For example, Wonglimpiyarat (2016) proposed incubation programs as a national policy, while Horner et al. (2019) and Caldera & Debande (2010) highlighted the importance of universities' internal technology transfer policies emphasizing strategic choices as a key determinant of technology transfer effectiveness. Similarly, Kochenkova et al. (2016) offered a framework that included infrastructure support, financial assistance, and competency development.

To fill this gap, this study aims to develop integrated policies and support for the development of academic spin-offs that are tailored to different conditions and stages of growth. This approach is based on an indepth understanding of the challenges faced by academic spin-offs, their success factors, and existing support and policies identified from research findings and existing references. Consequently, this study seeks to answer the following research question: "*What and how are integrated policies and supports for university spin-offs considering different growth stages?*" The novelty of this study lies in the detailed division of academic spin-off growth stages and the identification of appropriate support and policies for each stage of spin-off development.

This research uses Indonesia as context. Indonesia was chosen as the object of study because it is a developing country with limited industrial innovation (Soenarso et al., 2013). Furthermore, even though Indonesia has 2638 universities, most of them are teaching universities rather than research or entrepreneurial universities. Specifically, this research takes case studies from university spin-offs in Institut Teknologi Bandung (ITB) Indonesia. ITB, which is the oldest engineering university in Indonesia, is the third best Indonesian university (Times Higher Education, 2025) which has a long reputation in terms of startup incubation in Indonesia. From ITB, we took three successful spin-off universities representing at all company levels; early established-incubated startup represented by Karla Bionics, Small and Medium Enterprise (SME) towards established company represented by Tesla Daya Elektrika (TDE), and established startup represented KAZEE. Because the three case studies represent each stage of startup growth, they have specific problems so that the right supports and policies can then be sought to support them so they can grow.

In terms of writing structure, after the introductory chapter, this article will be followed by existing literature which explains supports and policies to help the growth of academic spin-offs in the next chapter, the methodology used in this study, research results, discussion, and finally, the conclusion and limitations of this study.

2. Literature review

2.1. Spin-off development phase

The development of university spin-offs has been extensively studied, with researchers proposing various models to describe the stages of growth. Parmentola & Ferretti (2018) revealed that spin-off development can start from the research, pre-incubation, startup, and growth phases. Meanwhile, Ndonzuau et al. (2002) identified four stages of development, starting from the creation of business ideas, the birth of true entrepreneurial projects, the birth of new companies through spin-offs, and the creation of economic value by new companies. Vohora et al. (2004) proposed five stages starting from research then identifying market opportunities resulting from research, pre-organization for the preparation of business plans, reorientation for the creation of an entrepreneurial structure, and finally sustainable growth. Meanwhile, Clarysse & Moray (2004) mention three stages of spin-off growth starting from the research stage, approval stage and growth control.

Gübeli & Doloreux (2005) distinguished spin-off growth into three stages of development, namely starting from pre-founding which occurred before the formation of a new company, founding of firm which occurred when the company was formed; and finally post-founding, which occurs after the birth of the spin-off. Hindle & Yencken (2004) add that this stage involves converting research ideas into market opportunities, laying the foundation for a viable business model.

De Cleyn & Braet (2009) describe the spin-off creation process as a series of six stages: research, where researchers leverage their personal knowledge to create a new scientific discovery and begin to realize its potential commercial aspects; pre-incubation, where the research group has become an entrepreneurial group that has acquired the necessary resources to establish a new company; the incubation phase, where the product is tested on the market, utilizing the support of university resources; the startup phase, in which the academic spin-off organizes its independent production and commercial structure and carries out a definitive product launch on the market; and the growth phase, where the company begins to achieve satisfactory profits.

Churchill & Lewis (1983) reveal that the growth phase of a new business can be realized in five stages. Stage-1 existence where the company has problems with customers and product services and only the owner runs the business. Stage-2 is survival where the main problem shifts from mere existence to the relationship between expenditure and income. Stage-3 is success where the size and complexity of the company grows rapidly. Stage-4 is take-off where the problem at this stage is how to grow and develop quickly and how to handle funding for this growth. Then Stage-5 is resource maturity where at this stage, companies need to strengthen and control the financial profits generated and maintain the benefits of a small scale that includes response flexibility and entrepreneurial spirit. This stage occurs when the startup is successful and considering an Initial Public Offering (IPO) exit strategy.

Combining the spin-off development phase of Parmentola & Ferretti (2018) and Churchill & Lewis (1983), we get a simplified framework for spin-off development into key phases; research & pre-incubation, incubation, and acceleration (see Figure 1). We propose stages based on the characteristics of the company and its growth scope: Stage-1, when the spin-off has not yet been formed but the product exists and is in the patenting process; Stage-2, when the company has just been formed and is in the university incubation process; and Stage-3, when the company has passed the incubation period and no longer relies on seed funding but on revenue streams and investments, ready to scale up.

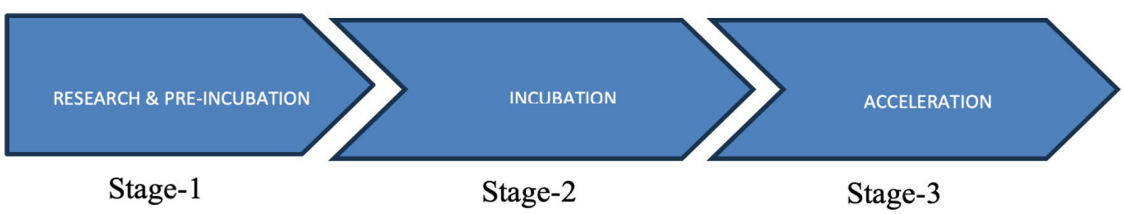

Figure 1. Stage of spin-off development. Adopted from Parmentola & Ferretti (2018) and Churchill & Lewis (1983).

2.2. Supports and policies for university spin-off

To overcome market inefficiencies and systemic failures, universities and governments must provide targeted supports and policies tailored to the specific needs of spin-offs at different growth stages (Kochenkova et al., 2016). Previous research highlights several critical areas of supports.

Research by Horner et al. (2019) using the UK context contributes to existing debates on technology transfer effectiveness by elaborating on the roles of strategic choice and strategic planning. This research found that investment in technology transfer infrastructure is necessary but insufficient and needs to be increased to enhance the effectiveness of technology transfer activity. Strategic choice is a crucial underlying determinant of technology transfer effectiveness. Unfortunatelly, this research focuses more on technology transfer strategies in general and does not touch on technology transfer through university spin-offs. Research related to support and policies that uses more specific levels is best explained as follows.

Within the university-level, supports can be in realizing incentives (Horner et al., 2019), university royalty distribution (Caldera & Debande, 2010), incubation programs (Wonglimpiyarat, 2016), entrepreneurship training (Benassi et al., 2022; Leger et al., 2024), and allocating funds to support proof-of-concept programs (POC) to bring inventions closer to the market by reducing risks for potential investors (Swamidass & Swamidass, 2013). Caldera & Debande's (2010) study, which used Spain as context, revealed that universities with established policies and procedures performed better, such as experienced TTOs and establishing science parks to manage technology transfer. This research has two significant findings regarding university policies that support technology transfer. First, university internal technology transfer policies and the nature and type of technology transfer intermediaries are essential factors influencing the performance of universities. Second, the university royalty-sharing policy strongly affects licensing income. Furthermore, long-term investments in research followed by quality of research results and presence of incubators are another important supports for spin-off growth (Iacobucci et al., 2020).

Meanwhile, at the Government-level, kind of policies include legislative/institutional, direct finance, and competency development (Kochenkova et al., 2016). Specifically, macro policies are implemented in the form of patent regulations (Fini et al., 2011), providing substantial investment in university research and development (Jung & Kim, 2018), and supporting high-tech university startups (Mustar & Wright, 2010). Kochenkova et al. (2016) propose a more complete policy framework: policies that support infrastructure, financial support, and competency development. However, they do not explain the spin-off characteristics. Their study is a literature clarification emphasizing public policy measures for technology transfer. Specifically, this study explores the role of the Government in facilitating the commercialization of academic research and university-industry collaboration. Even though this study proposes a coherent overall strategy, namely legislative/institutional reforms, direct financial support, and competency-building measures, the unit of analysis used is more macro (national) with an emphasis on the role of Government, resulting in a lack of information regarding the role of university management. Other research from Wonglimpiyarat (2016) states that incubation programs are an appropriate policy. Using Thailand as context and the triple helix as a framework, this research shows that the incubation program from the Government is a significant policy mechanism supporting innovation. The government policy emphasized here includes policies and programs to encourage the creation of new entrepreneurs and the development of firms' technological and innovative capabilities.

This supports and policies must be in line with important factors in the success of this commercialization initiative. Literature states there are four things. First, financing. Financing is the lifeblood for most spin-offs. This financing pattern depends on the maturity or readiness of the spin-off growth due to specific financing they need (Martínez-Martínez et al., 2022). This financial need starts at the seed funding stage from angel investors to investment from venture capital. Lack of network of academics in financial sources such as Venture Capital (VC) is a problem for universities (Lockett et al., 2003; Hayter, 2013). Therefore, the presence of VC and angel investors is significant (González-Pernía et al., 2013). Second, market. Early adopters are an important factor for academic spin-offs to carry out market validation and customer feedback. Therefore, close partnerships with industry are an important factor (O'Shea et al., 2005), especially for those who will utilize university technology. This form of collaboration can be in the form of joint ventures with other companies (Hayter, 2013) or social networks among early-stage academic entrepreneurs (Hayter, 2016).

Third, technology. Strong protection for technology that constitutes university IPR is needed as an effort to secure a competitive advantage. This step is necessary when fraud occurs by industry or other parties that produce similar technology. Apart from securing IPR protection, universities must have applied research capabilities (Lee & Jung, 2021) especially those with high market potential. Fourth, team capability is also an important factor. Unique university technology requires the inventor to directly undergo the commercialization process, such as becoming a founder team (Shane & Stuart, 2002) or a board of directors' academic spin-off

(Ferretti et al., 2020). Those who are hereinafter called academic entrepreneurs have more engagement with the technology (Wu et al., 2015) and motivation in commercializing their research output (Owen-Smith & Powell, 2001). Academic entrepreneurs are crucial determinants in running a spin-off (Pacheco & Franco, 2023). Apart from technical capability, business capability is also very necessary, especially for company management.

3. Methods

This research uses a multiple-case study approach, following the methodology outlined by Yin (2018) as what Ellram (1996) doing in his research. The study is embedded, as it examines multiple units of analysis within the same context. In this strategy, case selection, data collection strategy, and ensuring rigorous process is important (Voss et al., 2002). Multiple-case research ia a robust method for theory building (Eisenhardt, 1991) and qualitative approach that provide richer insights (Meredith, 1998). This strategy provides a unique way to develop theory by utilizing deep insights into empirical phenomena and their contexts and relying on analytical inference (Dubois & Gadde, 2002). This study uses a cross-sectional time horizon to capture a snapshot of the spin-off development process at a specific point in time. This approach allows for a complete analysis of the current state of spin-offs without requiring longitudinal data. We used semi-structured interviews as primary sources, observations, and secondary data (archives, documents) as sources of data collection, as mentioned by Eisenhardt (1989). The interview and observation protocols can be found in the Appendix A and Appendix B. We interviewed once, or several times for the interviewee based on the completeness of the data. Other informants were obtained through a snowball strategy.

We selected Institut Teknologi Bandung (ITB) as case study. ITB, one of Indonesia's best universities, has an official institution that handles technology commercialization activities with success stories in creating new businesses. ITB has 12 faculties and schools, 131 study programs, 111 expertise groups, and 24 research centers/centers. Since 2010, ITB has specifically established Institute for Innovation and Entrepreneurship Development (LPIK-ITB), which functions as an institution for entrepreneurship development and technology transfer. This institution oversees ITB's startup incubation function and the patent and licensing process for ITB's research results. Then, ITB officially established PT Rekacipta Inovasi ITB (RII) in 2016, which is an ITB company that focuses on commercializing the research results of ITB academics. Since 2022, ITB has been operating a Science Technology Park (STP) to help accelerate ITB's spin-off and startup.

From ITB, we chose three university spin-offs to explore further. Each of these case studies represents each of the characteristics of a spin-off university, including those in the pre-incubated startup category, namely Karla Bionics, incubated startup, namely Tesla Daya Elektrika (TDE), and accelerated startup, namely KAZEE. This case study was taken based on initial criteria: it is a spin-off university that can successfully survive amidst minimal support and policies. At least one founder/CEO represented each company as an interviewee. Apart from companies, other interviewees came from TTO managers, incubators, technoparks, and university companies who helped with the technology transfer process. We interviewed nine informants from April 2022 to July 2023 with an average of 1 hour 24 minutes/interview (see Table 1).

Table 1. List of the informants.

No.	Affiliation	Position	Linked with	Length of interview
1	KAZEE	CEO Founder KAZEE	Founding team, inventor	57 minutes
2	Tesla Daya Elektika (TDE)	CEO Tesla Daya Elektrika (TDE)	Founding team	1 hour 20 minutes
3	LPIK-ITB	Expert of university technology transfer office (LPIK-ITB)	IPR management	3 hours
4	LPIK ITB	Chairman of university technology transfer office and incubator (LPIK ITB)	Incubator	1 hour 7 minutes
5	Karla Bionics	Founder Karla Bionic	Founding team	1 hour 13 minutes
6	Karla Bionics	Product Development, Karla Bionic	Inventor	28 minutes
7	LPIK ITB	Secretary in entrepreneurship and business incubator (LPIK ITB)	Incubator	1 hour 11 minutes
8	Science Technopark (STP ITB)	Startup Division, Science Technopark (STP) ITB	Funding	1 hour 17 minutes
9	PT Rekayasa Inovasi ITB	University's commercialization company (PT Rekayasa Inovasi ITB)	Company partner	2 hours 4 minutes

This study employs an abductive approach, which involves iterating between empirical data and existing theory to develop new insights. Unlike inductive or deductive approaches, abduction allows for the generation of plausible explanations that are grounded in both data and theory. Each case study for the growth stage is quite representative because the nature of this study is to revise the existing framework for the best explanation and to get a deep understanding of a particular case, which, in this case, is a university spin-off based on its growth level. To validate the findings from this case study, a triangulation process was carried out following the procedure of Spens & Kovács (2006) with another data source, namely the Forum Group Discussion (FGD) and secondary sources such as websites and documents. This strategy is called iterative triangulation (Lewis, 1998). We conducted an FGD on July 12, 2023, with stakeholders related to the university spin-off at ITB.

We took a case study of a spin-off company for the pre-incubation stage, a company for incubation, and a company for acceleration. The case study was taken based on input from the university incubator manager (LPIK-ITB) regarding which university spin-offs could be used as studies in this research. Next, the findings from each of them will identify the similarities and differences in their problems and the forms of support and policies they need. The similarities or differences identified are the problems faced, existing support and policies that are felt, factors that cause survival/growth, and characteristics of growth level (age/size/number of employees). From now on, this method is called cross-case analysis (Eisenhardt & Graebner, 2007). The analysis of interviews, observations, and secondary data was conducted using thematic coding. Codes were developed based on the key themes identified in the literature review, such as financing, market, technology, and team building. These codes were then applied to the data to identify patterns and insights relevant to the research question. The coding process was iterative, with codes being refined as new themes emerged from the data. Finally, to check the validity and reliability of the findings, we do more structured procedure in the overall research design (Dubé & Paré, 2003), starting from asking research questions, taking data, analyzing data, and drawing conclusions.

4. Results

4.1. Case 1: Karla Bionics

Karla Bionics is a prosthetic arm startup founded by a lecturer of industrial management department and two student and alumnae of ITB. The startup establishment was carried out in early 2022 just before registering as a LPIK-ITB incubate. Before being founded, the founder first developed a prosthetic arm prototype by utilizing research funds from various schemes both from within and outside ITB. The prototype was patented through LPIK-ITB with a total of two patents namely a mechanism for adjusting the grip and the interface between the user and the tool.

In the initial process of creating a lab-scale prototype, founder Karla optimized various funding schemes from ITB and outside ITB by utilizing his position as a lecturer. Various funding was obtained, such as from P3MI Community Service (PM) ITB, Community service of Industrial Technology Faculty (FTI-ITB), and Science and Technology Park (STP-ITB). Besides that, appointment funding from STP-ITB was obtained because the founder Karla is an ITB lecturer, making the administrative process easier. Other funding was also obtained from startup competitions such as Swiss Challenge 2022, Bandung Startup Pitching Days 2022, and Indosat where Karla become winner. Karla used these funding sources for operations in addition to developing prototypes.

The participation of Karla Bionics as part of the LPIK-ITB incubation makes funding opportunities more open, starting from startup funding or opportunities to take part in competitions. Apart from receiving a competitive grant from LPIK-ITB, Karla also received various training which was held online at that time. During the incubation period at the end of 2022, Karla managed to produce 20 of their products through a manufacturer recommended by ITB company, PT Rekayasa Inovasi ITB (RII). Karla also received a request from a social foundation, Rumah Amal Salman, for 10 units. This first sale helped Karla's operations within a year.

Apart from funds, Karla also received various assistance opportunities to accelerate Karla, ranging from standard assistance to product testing. Karla even received acceleration funding assistance from STP-ITB who supported Karla with product market feed and distribution permit processing. With this grant, Karla was able to prepare a distribution permit from the Ministry of Health so that she could include her product in the e-catalogue and Social Security Agency on Health (BPJS). In addition to incubation and acceleration assistance, in the early stages Karla received incentives from two patents she owned from ITB with 10 million rupiahs each, which with the money was used to help Karla's operations.

In carrying out the commercialization process, founder Karla was faced with various problems. First, administrative problems are still a challenge for funding recipients like Karla. Confused financial procedures

hampered the process of disbursing funds, which had an impact on Karla's operations, such as the honorarium process. Borrowing the company name from outside as a third party as an option to accommodate temporary funds originating from ITB.

The second challenge faced is production. Production culture is different from the prototype development process in the lab. Karla terms R&D culture and R&D manufacturing. The difference in manufacturing R&D is more hands-on or experience so it is not easy to learn while R&D in the lab tends to be textbook. ITB has not yet bridged this difference, so Karla must coordinate intensively with a manufacturer that produces Karla products.

Third, lecturers' busy activities in teaching, research and institutional development are an obstacle in carrying out Karla's management in total. As a founder, the lecturer plans for Karla in the future to be led by a Chief Executive Officer (CEO), not himself, but someone else who can focus on the company's development. As a lecturer, he wants to only focus on developing Karla products, which is in line with his duties as a researcher at ITB.

> *Culture R&D and manufacturing R&D are different. Karla products cannot be produced ourselves; we have to* (rely on) *suppliers. Manufacturing R&D and that expertise is not at the campus, but at the supplier or at the Polytechnic. STP should have a link to manufacturing R&D, namely having an industrial lab for manufacturing R&D... Furthermore, funding (for startups) is not awkward, it could be 1 billion rupiahs or even 10 billion at a time. Understand that government funds* (very small) ... *we don't expect much, we need the private sector to help.* Founder Karla Bionics.

4.2. Case 2: Tesla Daya Elektrika (TDE)

Tesla Daya Elektrika (TDE) is a startup that was incubated by Entrepreneurship Development Institute (LPIK-ITB) in 2017. This startup has a product in the form of a lightning rod developed by an Electrical Power Engineering ITB lecturer. This technology is patented in Indonesia through LPIK-ITB with a total of three patents. This patent is related to the design of a product in the form of documents and rough drawings. Then it was commercialized through the establishment of a startup called Tesla Daya Elektika (TDE) by the lecturer and three ITB students and alumni, namely assistant lecturers, alumni appointed by the leadership of LPIK-ITB and friends of the alumni. The startup, which is managed by students, is then incubated at LPIK-ITB. At that time, LPIK-ITB ran a Research and Technology program whose output was the creation of startups and the commercialization of research products where TDE was a startup included in this program.

The lecturer, who is also a lightning rod technology developer, was previously active in carrying out projects with various companies, including TDE's sole client. The existence of an existing market and an understanding of this market's needs from previous projects makes the process of selling these tools to clients easy. Even though this client is single, the need for lightning protection equipment is high because the client company has thousands of towers spread throughout Indonesia. This means that demand will always be there, even from a single market.

The commercialization of lightning rod patents by TDE is driven by LPIK-ITB which bridges between technology inventors and the team that will carry out their management, namely Tesla Daya Elektrika (TDE) through startup incubation. TDE itself was selected through a series of selection processes to become an LPIK-ITB incubate. Then the technology inventor, although acting as a founder, is not burdened on the management side so that he can still focus on carrying out research and opening market opportunities through his network.

Then, because the market that utilizes the product is single and is a large company, namely a state-owned company in electical industry, LPIK-ITB directed TDE to become a sub-licensee from ITB's company, PT Rekacipta Inovasi (RII). This is done to enable the appointment scheme for the client's projects to TDE through ITB to occur. From this step, TDE does not need to submit tenders to obtain projects from the client.

After the client succeeded in utilizing the lightning rod product, royalties were given from the TDE sub-license process to ITB which consisted of LPIK-ITB, ITB company, PT Rekacipta Inovasi (RII), and the inventor of this device. The distribution of royalties follows the 2017 ITB Chancellor's rules regarding intellectual property. The license process to the client lasted for three years and TDE managed to get a project with a total royalty given to ITB of up to 400 million.

In the process of commercialization, TDE faces two challenges. First, the ITB patented lightning rod is a tool that is purchased by the single market and is easy to imitate. TDE then takes care of the client's market which is the only user to continue using this TDE product. Until finally this tool was able to be made by the client itself, so TDE had to change its business direction by targeting various markets and with different products without the need for a license from an ITB patent.

The second challenge is that when a client violates a copyright, ITB as a patent holder does not take legal action. Even though this step is necessary to defend ITB's rights to its products. TDE has submitted a letter to ITB to stop the license for the patent so that the royalties ITB gets from this product stop. TDE also carried out new business practices by no longer relying on the commercialization of ITB patents. From here a third challenge arises, namely determining a new business model that does not only focus on the single market but on various markets. In the end, TDE did not only rely on the electricity industry as the main market, but also entered the oil & gas industry. This new business model requires TDE to develop new technologies.

> *ITB does not back us up (when there is a fraud problem with a client). Regardless of the advantages and disadvantages of our products, ITB should be able to speak out. (The reality) was beyond expectations, ITB could not speak out. Ultimately, at the limit. I ran out of resources to face the law, we finally accepted. After that, we switched (pivoting) after 3 years of existence, even though TDE's business didn't have a big impact. In fact, legally we can win in patent matters. If I look at it, the campus thinks that we are the only ones who have an interest in this matter. (This case was approached) in bureaucratic governance, not business... Several people I met; the reasons were always bureaucratic. Nobody looks at it business-wise. This institution (LPIK) is more concerned with bureaucracy, so we are not yet mature. There is a need to strengthen the LPIK institution.* Founder & CEO Tesla Daya Elektika.

4.3. Case 3: KAZEE

KAZEE is a startup under the LPIK-ITB incubation in 2017. The start of this startup focused on developing applications for media analytics, but client requests that required analysis from social media prompted them to establish KAZEE. This media analytics application is protected by a copyright scheme by inventors, one of whom is the founder of the company through LPIK-ITB. In the early stages, KAZEE focused on projects for the early stages where in this way they get revenue to develop their business which focuses on its main product, namely the media analytics platform. This step is called bootstrapping. KAZEE has a strategy not to focus on product protection but to develop product services as a strategy to get B to B customers.

While part of the LPIK-ITB incubator, KAZEE took part in a competition held by LPIK-ITB and Lintasarta, a national provider ICT total solution company, and came out as the first winner. Becoming first place made KAZEE get a strategic partner with Lintasarta. From here, KAZEE got several collaborative projects by bundling media analytics with digital infrastructure which is Lintasarta's core business.

Protection of the analytical media platform by the founder of KAZEE encourages companies to improve the quality of products, services and the amount of data mined for the analytical data software they develop. Through this step, KAZEE developed slowly. KAZEE's analytical media technology means that they collect data from various sources, then process it by installing Artificial Intelligence (AI) or Natural Language Processing (NLP), then display it in a dashboard for various clients. So, clients can subscribe to KAZEE products.

Furthermore, the co-incubation program between LPIK-ITB and industry, namely Lintasarta, creates an opportunity for KAZEE to get a strategic and market partner, namely Lintasarta itself. This digital infrastructure company provides an opportunity for KAZEE to get new clients from Lintasarta partners through a bundling program in addition to getting infrastructure support and mentoring.

There are two challenges facing KAZEE. First, there was no mentor provided by LPIK-ITB during incubation, making KAZEE must develop his business based on his intuition. The absence of a mentor means that this startup development strategy is carried out slowly through projects first. This mentor is needed because in the early stages the founder's experience in business literacy is low. Second, ITB's funding system is not based on startup staging. Relying on incubation funds is not enough to fully fund KAZEE's operations, let alone to optimize the media analytic software it is developing. That's why KAZEE implements a bootstrapping strategy by turning project results into supporting the company. Third, the name KAZEE, which is new in the startup world, makes it difficult for the team to recruit quality engineers that the company needs. A comparison between the three university spin-offs above is shown in Table 2.

> *At LPIK, most of the students have just graduated, so the founders have less experience. The ecosystem that needs to be improved is the (capacity) of the founder. The big challenge for LPIK is that as the company advances, the capacity of its founders must also increase. Specifically, this capacity lies in literacy education, namely being a good founder and able to manage finances... Second, for mid-level startups that are already large, even though the coaches are paid a lot of money because they must spend their time... Third, staging incubation. At LPIK the staging is just being incubated. There is no funding acceleration yet. There must be staging because the treatment at each startup is different. Lastly, universities must have the courage to invest in research that has high commercialization potential* (Founder & CEO KAZEE).

Table 2. Comparative between TDE, KAZEE, and Karla Bionics.

	Karla Bionics	TDE	KAZEE
Age of company	3 years	7 years	7 years
Success factor	Seed funding from various sources	The existence of an existing market	The availability of strategic partner
Existing policy			
Financing	Incubation program (funding with 'appointment' schema)		
Technology	Incentive for patent application	• Policy for royalty • Sublicense with ITB company (PT Rekacipta Inovasi)	Copyright protection (software)
Market Team			Co-incubation with industry
Problems still being faced	• Complicated financial procedures make the process of disbursing funds.	• Technology with a single market and easy to imitate.	• There is no mentor provided by LPIK-ITB during incubation.
	• Lack of knowledge of production as this phase is different from the prototype development process in the lab. • The busy activity of lecturers in teaching, research and institutional development becomes an obstacle in carrying out total operations.	• If there is a copyright violation by the client, ITB as the patent holder does not take legal action.	• There is no funding system at ITB based on startup staging.

4.4. Existing policies and supports for university spin-off

The existing policy in the Research and pre-incubation phase, namely the policy of Intellectual and Property Right (IPR) ownership by universities, already exists, as does the Bayh-Dole Act in America in 1980. It is just that the policy in America is comprehensive. The Bayh Dole Act encouraged the creation of an innovation ecosystem (Aldridge & Audretsch, 2010) and the massive commercialization of intellectual property (Baglieri et al., 2018; Siegel & Wessner, 2012). In Indonesia, both have yet to develop well. Apart from this policy, patent incentives have also been provided by universities. Karla Bionics utilizes incentives for two patents it owns as part of seed funding. This startup also gets potential seed-funding from the Kedaireka program. This program, which has been rolled out by the Government through the Ministry of Education and Culture since 2021, is a matching fund platform between university research and the industry that will use it. The 2023 budget has been prepared up to 750 billion rupiahs (mediaindonesia.com, 2024) to encourage the development of Indonesia's innovation-based economic system (Kompas, 2024).

At this stage, IPR protection has also been carried out as part of university policy. From this policy, KAZEE benefits from protecting the analytical media platform, namely improving the quality of products and services without worrying about being imitated by other companies. ITB has also prepared technical regulations for incentives for ITB researchers who have patents through LPIK-ITB (Institut Teknologi Bandung, 2018) as well as royalties from patent licenses received by researchers and laboratories where researchers carry out research activities (Institut Teknologi Bandung, 2017). ITB even has copyright registration regulations with the publication of the ITB LPIK-ITB Regulations regarding copyright registration through LPIK-ITB (Institut Teknologi Bandung, 2023). IPR protection, such as patents, has a policy at the national level. The Republic of Indonesia Law number 13, 2016, concerning patents, was issued. This law provides an overview of patents and the rights of patent holders.

Not only the IPR protection policy, ITB has had an IPR management institution since the founding of LPIK-ITB in 2010 through the technology transfer division. The IPR protection process is carried out through a website-based platform, the Innovation Entrepreneurship System (IES), which can monitor the status of IPR registration, monitoring and evaluation, and online registration.

Meanwhile, policies in the incubation phase also exist. The existence of an incubation program at LPIK-ITB makes funding opportunities such as the Karla Bionics startup increasingly open, not only from internal but also from external sources and opportunities to take part in various competitions. Besides funds, Karla received various assistance opportunities to accelerate Karla Bionics, from standard assistance to product testing. Karla even received financial assistance from STP-ITB, which helped process product market feeds and arrange distribution permits. The existence of a Technopark has been encouraged by the Government since the 1970s (Sagena, 2016) which was strengthened by the existence of Law No. 18/2022, Law No. 17/2003, Law No. 17/2007, Joint Regulation between the Minister of Research and Technology and the Minister of Home Affairs No. 3/ 2012 and No 36/2012, and Presidential Regulation No 2/2015. However, the existence of the Technopark at ITB, which was expected to act as an accelerator, turns out to carry out the same function as the incubator under LPIK-ITB.

Another role of LPIK-ITB is as a bridge (matchmaking) between the inventors and the startup founder team. The commercialization of lightning rod patents by TDE is driven by LPIK-ITB, which bridges technology inventors and the team that will carry out their management, namely Tesla Daya Elektrika (TDE), through startup incubation. TDE was selected through several selection processes to become an LPIK-ITB incubated. Because the market that utilizes the product is single and is a large company, namely a state-owned company, LPIK-ITB directed TDE to become a sub-license of the ITB company, PT Rekacipta Inovasi (RII).

At this incubation stage, there is also a royalty policy for the licensing process. After the TDE's client succeeded in utilizing the lightning rod product, royalties were given from the TDE sub-license process to ITB, consisting of LPIK-ITB, ITB company PT Rekacipta Inovasi, and the inventor of this device. The distribution of royalties follows the 2017 ITB Chancellor's rules regarding intellectual property. Furthermore, a co-incubation program between LPIK-ITB and the industry, namely Lintasarta, creates opportunities for KAZEE to get strategic and market partners, namely Lintasarta itself. This digital infrastructure company provides an opportunity for KAZEE to get new clients from Lintasarta partners through a bundling program and infrastructure support and mentoring.

Since the issuance of Regulation of the Minister of Finance of the Republic of Indonesia in 2021 concerning guidelines for providing compensation originating from non-tax state revenues, copyright royalties to creators, patent royalties to inventors, and royalties for plant variety protection rights to plant breeders. Another government policy that has not been absorbed from this case study is the Regulation of the Head of the Indonesian Creative Economy Agency no. 10 of 2016. This policy is intended for digital startups that are under incubators. The second is the innovation startup program (dailysocial.id) under the Ministry of Research and Technology (now National Research and Innovation Agency/BRIN) which is currently called Startup Innovation Indonesia (SII). It is stated that this program has provided guidance and development for technology startups from universities and research institutions up to 1,307 startups with a total budget of up to IDR 371.71 billion.

Meanwhile, in the acceleration phase, there is a new super deduction tax policy through Government Regulation (PP) Number 45 of 2019 concerning the Calculation of Taxable Income and Payment of Income Tax for the Current Year. Through this regulation, the Government provides facilities for reducing gross income of up to three hundred percent for research and development (R&D) actors, including MSMEs or startups. With this facility, MSMEs or startups can charge costs incurred (tax deduction) up to 3 (three) times greater so that the tax they will pay becomes smaller than before, and they do not need to pay tax if the tax calculation results in a loss. A summary of the existing policies and supports for university spin-off is shown in Table 3.

Table 3. Existing policies and supports for university spin-offs based on their growth stage.

Research & Pre-incubation	Incubation	Acceleration
IPR protection	Incubation program	Super deduction tax for firm whose R&D activity
Patent incentive for inventor	Seed funding	
Royalty for inventor	-	-
Matching-fund (Kedaireka)	-	-

5. Discussions

Issues or challenges can be found during academic spin-off development process. These challenges can be incorporated into the three stages of spin-off development. First, at the research & pre-incubation stage. At this stage the important factor is the relaxation of the lecturer's workload in *Tridharma Perguruan Tinggi* activities (teaching, research, and community services). Lecturers' busy activities in teaching, research, and institutional development are challenges in carrying out Karla's operations optimally. The next problem is that the technology to be commercialized must have high novelty so that it is more competitive in the market. ITB patented lightning rod is a tool that is purchased by the single market and is easy to imitate. TDE then takes care of the State Electricity Company (PLN) market which is the only user to continue using this TDE product.

Furthermore, in the Incubation phase, several important factors are first, administrative problems. Administrative problems are still a challenge for funding recipients like Karla. Convoluted financial procedures hampered the process of disbursing funds which resulted in Karla's operations such as the honorarium process. Borrowing company names outside as a third party as an option to accommodate temporary funds originating from ITB. This is coupled with the absence of an ITB funding system based on startup staging. Relying on incubation funds is not enough to fully fund KAZEE's operations, let alone to optimize the media analytic software it is

developing. That's why KAZEE implements a bootstrapping strategy by turning project results into supporting the company. However, if the funding scheme in seed funding is optimized, it will be able to help spin-offs during the incubation period. For example, Karla, who is in the initial process of creating a lab-scale prototype, founder Karla optimizes various funding schemes from ITB and outside ITB by taking advantage of his position as a lecturer. Various funding was obtained, both from internal and external.

Next is knowledge of the production process. Production culture is different from the prototype development process in the lab. To get the initial market, the influence of the relationship between the inventor and the previous initial market becomes important. For example, a lecturer who is also a lightning rod technology developer was previously active in running projects with various companies, including the single client of TDE. The existence of an existing market and an understanding of this market's needs from previous projects makes the process of selling these tools to clients easy. Furthermore, the mentor factor becomes important. There was no mentor provided by LPIK-ITB during the incubation, so KAZEE had to develop their business based on their intuition.

The next stage is acceleration. At this stage, spin-offs face market-driven products so a solid legal side is needed to deal with problems. When a client violates copyright, ITB as the patent holder does not take legal action. Even though this step is necessary to defend ITB's rights to its products. Furthermore, ITB does not provide funding in the acceleration phase with the support of Venture Capital or other investment institutions. For example, when KAZEE entered the scale-up phase, the existing incubation funds were not sufficient to fully fund KAZEE's operations, let alone to optimize the media analytic software it was developing. That's why KAZEE implements a bootstrapping strategy by turning project results into supporting the company. Apart from that, the name KAZEE, which is new in the startup world, makes it difficult for the team to recruit quality engineers that the company needs. However, in this phase, the key to success is the presence of strategic partners. For example, KAZEE obtained a strategic partner with Lintasarta. From here, KAZEE got several collaborative projects by bundling media analytics with digital infrastructure which is Lintasarta's core business.

From the findings above, it is found that the main problems of spin-off growth that have not yet received a comprehensive solution are funding for each stage of spin-off, early adopter availability, founding teams' capability empowerment, and strong IPR protection. These problems will be grouped into a spin-off growth stage which is taken from the combination of spin-off development phase from Parmentola & Ferretti (2018) and Churchill & Lewis (1983). From here, we will get a comprehensive policy for pre-incubation, incubation, and acceleration.

5.1. Analysis for policy and support

To stimulate academic scientists in universities to commercialize their research results in the form of academic spin-offs for universities that already have an IPR protection system and their management institutions, universities need to provide incentives. Patent incentives for inventors have indeed been proven to stimulate the number of patents at universities, but the number of patents is not directly proportional to the level of patent commercialization. This patent incentive policy needs to be evaluated. Incentives for patents that are successfully licensed could be considered as a policy. This incentive is in addition to the royalty policy for inventors who successfully commercialize their patents. With this, universities can increase revenue even higher from licensing channels.

Furthermore, universities need to program co-incubation with established industries. This program is oriented towards suitability between the spin-off being incubated with an industry that is in accordance with the core technology being developed. Industrial partners in this co-incubation not only act as incubators but can also act as investors. The match-marker program between inventors and startups is an active program where through this program, LPIK-ITB can go directly to academic scientists to see potential technologies for commercialization. This incubation program must also be oriented towards academic spin-offs to advance to a company that is ready not to depend on seed funding, but rather investment from venture capital or investors. Universities must think about the equity of the incubated startup so that it will still make a profit in the future when the spin-off developed has become an established company. Next, in the acceleration phase, the effectiveness of the super deduction tax needs to be evaluated. Also, the university is expected to become a magnet for investors or Venture Capital to invest in campus-assisted spin-offs.

Spin-off growth at universities still faces various problems, such as there being no investment funds for scale-up, so many of them stop at the incubation stage or are completely separated from the university environment because their role in the acceleration phase is absent. Furthermore, spin-offs that have passed the incubation period are faced with problems that could intersect with the law. For example, what happened to TDE was that its clients imitated and then developed their own technology, thereby denying ownership rights to this technology patent. In this case the university did not help solve it so that in the end TDE changed its market orientation. In fact, if the university can assist in this process, cooperation with clients will be stronger and wider. Not only the client as a market but also can become a research partner.

From the problems above, we put forward several policy recommendations. First, patent incentives are not effective in the long term, so it is necessary to evaluate and consider incentives for patents that are successfully commercialized outside of royalties. Second, the policy of equity shares for universities to foster startups as the university's commitment to spin-off development. Thus, the university remains in control when the spin-off has passed the incubation period and finally accelerated and established. Third, the funding policy is adjusted to the stage of startup development, whether seed funding or investment involving venture capital firms or investors. Fourth, TTO becomes a business entity so that it runs outside the university bureaucracy so that it can be more agile. Fifth, the roles of the institutions involved in the process of developing an academic spin-off must be clear, so there should be no overlapping. Sixth, it is necessary to consider the sand boxing policy as part of the program in the startup incubation phase. This step is to accelerate the diffusion of academic spin-off products to the market.

5.2. Integrated policies and supports for university spin-off growth

We can combine the spin-off development process from the research to development phase (Parmentola & Ferretti, 2018) with the business growth stages of Churchill & Lewis (1983). We get a more comprehensive spin-off development phase from both research and pre-incubation, incubation, and acceleration. Policy support is obtained from each stage to make the spin-off development process successful. This categorization based on growth stage was proposed by the Government in the STP policy. Quoting Soenarso et al. (2013), based on the 2010 ISTP Action Plan arranged by UNESCO-WTA and Ministry of Research and Technology Republic of Indonesia, three stages of technology commercialization through startup/spin-off development are shown, namely pre-incubation (stage-1), incubation (stage-2) and post-incubation (stage-3). The government divides the three based on the period where pre-incubation by startups lasts 2 years, then incubation by high-tech venture firms lasts 3 years, and post-incubation by venture parks lasts 5 years. Here, it is emphasized that STP has a role during the incubation period. Unfortunately, this categorization does not consider the characteristics of the new company at each stage so that appropriate policies are then proposed.

Next, we must consider key success factors as conceptual underlying policies to support spin-off growth as explained in the chapter two of this manuscript. The study found that factors that play an essential role in the success of a spin-off are financing support, the managerial team of the founders, technology or IPR protection, and the existence of early adopter market. University infrastructure support, such as education and incentives, also play a role but are not significant. Therefore, in designing a comprehensive policy, it is necessary to place those factors as the basis for policy formulation in each phase.

Kochenkova et al. (2016) previously presented comprehensive policy support for academic spin-offs and divided the policy into three areas: legislative, financing, and competence building. In the proposed framework, they do not consider the level of growth of academic spin-offs for financing. There is also an incomplete exploration of strengthening the competence building of a startup. The legislative aspects are separate, as if the financing and competence-building aspects are not part of the policy. Therefore, this research simplifies supports for academic spin-off into four domains: financing, market, technology, and team. These four domains, like financing, are in line with Martínez-Martínez et al. (2022) who states that each growth phase of a spin-off company has specific needs.

In the research and pre-incubation phase, forms of support lie in IPR ownership by universities, patent incentives for inventors, IPR protection, and the existence of an IPR management agency. Incentives for academics (Fini et al., 2009; Mano et al., 2012) and the establishment of the University Technology Transfer Office (UTTO) (Ramaciotti & Rizzo, 2015) have proven to be decisive factors. In the incubation to acceleration phase, the form of support is in the incubation program at LPIK-ITB by involving mentors according to the type of industry where the spin-off enters, LPIK-ITB as a matchmaker between inventors and startup founders, royalties from the licensing process, and co-incubation between ITB and industry. Subsidies or public funding (Fini et al., 2023; Ajagbe & Ismail, 2013; Parmentola & Ferretti, 2018) and public support in training and bureaucracy (Vega-Gómez et al., 2020) can improve management-level practice (Mano et al., 2012). Meanwhile, more than a super deduction tax for companies carrying out R&D is needed in the acceleration phase. This scale-up phase requires the involvement of Venture Capital (VC) or external investors (Fu et al., 2022; Rodríguez-Gulías et al., 2016; Parmentola & Ferretti, 2018) and the existence of potential demand (Parmentola & Ferretti, 2018). In addition, there is strengthening of the university's IPR protection institution to be able to resolve fraud problems with competitors or customers. Another important policy is sandboxing, especially for the incubation phase. This program is to internally test product readiness before entering the market where universities act as early adopters.

Besides policy support at each spin-off growth stage, universities must take the following steps simultaneously. First, TTO management must be linked primarily to IPR protection. Second, the incubation program is placed in a business perspective and as a revenue generator. The manager of this program is expected to be a university

business entity that also manages accelerators such as the Science and Technopark (STP). Third, the main tasks and coordination between institutions related to spin-off development must be straightforward and directed so that there are no overlapping roles, and they are placed in efforts to support the innovation ecosystem. A proposed framework for integrated policies and supports is illustrated in Figure 2. This framework integrates the stages of spin-off development (Parmentola & Ferretti, 2018; Churchill & Lewis, 1983) with the supports and policies for academic spin-offs, focusing on four key areas: financing (Lockett et al., 2003; Hayter, 2013; González-Pernía et al., 2013), market (O'Shea et al., 2005; Hayter, 2013, 2016), technology (Lee & Jung, 2021), and team capability (Shane & Stuart, 2002; Ferretti et al., 2020; Wu et al., 2015).

Financing	Matching fund	Seed funding	Venture Capital (VC) Investment
Market	Matching fund	Sandboxing	Market scale-up
Technology	• IPR protection • Patent incentive • Royalties for inventor	IPR protection strengthening	• Incentive (superdeduction tax) • IPR protection strengthening
Team	TTO as matchmaker between inventor and founding team	• Incubation program • Co-incubation with industry • Mentor support from industry	• Mentor support from industry • Strategic partner with established company

Figure 2. Integrated Policies and Supports for University Spin-offs Based on their Growth Stage.

6. Conclusions

Policies and supports for academic spin-off are constructed at each stage by tracing the development phases and success factors considered, namely financing, market, technology, and team building. In the research and pre-incubation phase, forms of support lie in IPR ownership by universities, patent incentives for inventors, IPR protection, and the existence of an IPR management agency. In the incubation phase, the form of support is in the university incubation program by involving mentors according to the type of industry where the spin-off enters, UTTO as a matchmaker between startup inventors and founders, royalties from the licensing process, and co-incubation between university and industry. While in the acceleration phase, a super deduction tax for companies that carry out R&D is needed in addition to the support of the involvement of Venture Capital (VC) or external investors and potential demand. Furthermore, universities also simultaneously carry out UTTO management, which must be linked mainly to IPR protection. The incubation program is placed in a business perspective. As a revenue generator, the primary duties and coordination between institutions related to spin-off development must be clear and directed so that roles do not overlap and placed on efforts to support the innovation ecosystem.

The results of this research have a theoretical contribution in two ways. First, the distribution of spin-off academic growth stages already exists, but there is no policy for each stage. This research fills this gap with the assumption that each level of spin-off has its own characteristics in terms of the problems it faces so that it requires special solutions through special policies. Furthermore, the sandboxing policy that is integrated to accelerate spin-offs is something new that is tried to be proposed in this study.

Through policy and support approach for each growth stage of academic spin-off, it is hoped that academic spin-off will be able to level up gradually. The pre-incubation stage will advance to the incubation stage and then to acceleration. Policies that have been implemented in Indonesia, such as tax incentives, startup seed funding

programs (Kedaireka), and matching-fund are currently less effective. This is demonstrated by the absence of academic spin-offs that become big companies that can compete with companies outside universities. Therefore, government support for the formation of an innovation ecosystem needs to be placed in the academic spin-off framework so that it can be promoted to become an established and competitive company. The form provides support and policies based on the characteristics of the spin-off university, whether it is still in pre-incubation, incubation, or acceleration conditions.

Supports and policies that are oriented towards academic spin-off growth will enable universities to optimize a clear division of roles for university organizations/agencies that are included in the innovation ecosystem. TTO is more about IPR management and licensing, incubation is more about the early stage of startup, STP is more about pre-investment and next-level investment (Business to Business), and university company holding is to ensure the success of the academic spin-off business in which the university holds shares inside it. The implication is that the existing university's practice in engaging with industry needs to be changed because it is not placed within the framework of increasing the spin-off growth level. TTOs which have a limited focus on licensing activities need to focus on generating academic spin-offs, incubation programs which are volunteering in nature need to be managed professionally and business-mindedly so that universities through incubators and STPs hold shares in academic spin-offs. Finally, the management of university innovation organizations that follow rigid university management needs to be managed in a more professional approach outside the general university bureaucracy. Universities ultimately need to adopt new practices, namely generating academic spin-offs placed on a par with the licensing process, universities through incubators and STPs holding shares in academic spin-offs, and the management of TTOs, incubators and STPs following corporate culture outside the university bureaucracy.

Practically, the management strategies and implementation process of university spin-off that universities can carry out for each stage are as follows. In stage 1 (research & pre-incubation), the university carries out IPR protection with the existence of a unique institution, provides patent incentives for academics who successfully produce patents (IPR), the university provides royalties to researchers from the results of patents that are successfully licensed, and TTO becomes a matchmaker between inventors and the founding team that carries out the commercialization of the inventor's patent. In stage 2 (incubation), apart from carrying out seed funding and incubation programs through incubators, universities carry out sandboxing of startup products that will enter the market; universities and industry carry out co-incubation, universities through incubation provide mentors from the industry directly and adapt them to the products being entered. By university spin-offs and strengthening the IPR side to minimize fraud with other parties regarding using IPR for commercialization. Finally, in stage 3 (acceleration), the university facilitates Venture Capital (VC) to invest in university spin-offs, the university as a shareholder as a liaison to create strategic partners with established industries for university startups, facilitates mentors from industry, and strengthens IPR protection to prevent disputes with other parties.

Meanwhile, supporting government policies at each stage can include the following. In stage 1 (research & pre-incubation), the Government carries out a continuous matching fund program to act as a bridge for commercializing research results from university researchers with technology users from the industry. In stage 2 (incubation), the Government facilitates a seed-funding program for startups with a scheme that is not only a grant but also a targeted grant which is part of pre-investment. The Government can collaborate with seed investors for national and global startups. The Government incentivizes universities that carry out sandboxing functions and encourages public/government institutions to become captive markets. Finally, in stage 3 (acceleration), apart from issuing a deduction tax for companies that successfully carry out R&D, the Government creates an ecosystem, especially by guaranteeing the existence of VC to invest in university spin-offs. The Government also incentivizes domestic industries that establish strategic partnerships with spin-off universities.

This study provides a comprehensive framework for understanding the policies and support needed at each stage of academic spin-offs. However, there are several areas for further research. First, future research can explore the long-term impact of the proposed policies on the success rate of spin-offs. Second, a comparative study with other universities in Indonesia is needed to provide a better generalization of the findings. Third, government policies in encouraging university-industry collaboration can be further explored by taking studies from other developing countries that have imperfect innovation ecosystems. Finally, future research needs to further explore the effectiveness of various funding mechanisms, such as venture capital and angel investors in supporting spin-off growth.

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Data availability

Research data is available in the body of the article.

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Appendix A. Interview Protocol.

1. Introduction and Consent

- Purpose of the Interview:

Explain the purpose of the research: "This research aims to explore the integrated policies and supports needed for university spin-offs at different growth stages, with a focus on Institut Teknologi Bandung (ITB)".

- Confidentiality Assurance:

Assure the interviewee that their responses will remain confidential and used solely for academic purposes: "Your responses will be anonymized, and no identifying information will be shared in the final report."

- Consent:

Ask for verbal or written consent to proceed with the interview: "Do you consent to participate in this interview? If yes, we will begin recording."

2. Information on the Interviewee

- Role and Experience:
  - "Can you briefly describe your role at ITB and your involvement with university spin-offs?"
  - "How long have you been involved in supporting or managing spin-offs?"
- Relevance to Spin-Offs:
  - "What is your primary responsibility in relation to spin-off development or technology transfer?"
  - "Have you been directly involved in the creation or growth of any spin-offs?"

3. Spin-Off Development Stages

- General Understanding:
  - "How would you describe the typical stages of spin-off development at ITB?"
  - "What are the key milestones or challenges at each stage (e.g., research, pre-incubation, incubation, acceleration)?"
- Current Practices:
  - "How does ITB currently support spin-offs during the research and pre-incubation phases?"
  - "What mechanisms are in place to help spin-offs transition from incubation to acceleration?"
- Growth and Scaling:
  - "What strategies or supports are available to help spin-offs scale up and achieve sustainable growth?"
  - "How does ITB measure the success of spin-offs at different stages?"

4. Existing Policies and Supports

- University-Level Policies:
  - "What policies or programs does ITB have in place to support spin-offs (e.g., funding, incubation, intellectual property rights)?"
  - "How effective are these policies in addressing the needs of spin-offs at different stages?"
- Government and External Supports:

- "Are there any government policies or external programs that ITB leverages to support spin-offs?"
- "How do these external supports complement ITB's internal policies?"

- **Gaps in Support:**
  - "Are there any gaps in the current policies or supports provided to spin-offs?"
  - "What additional supports do you think are needed to improve spin-off success rates?"

5. Challenges and Success Factors

- **Challenges Faced by Spin-Offs:**
  - "What are the most common challenges faced by spin-offs at ITB, particularly during the early stages?"
  - "How do these challenges differ across the growth stages (e.g., research, incubation, acceleration)?"

- **Critical Success Factors:**
  - "What do you think are the most important factors for the success of a university spin-off?"
  - "How important are factors like financing, market validation, technology protection, and team capability?"

- **Role of Stakeholders:**
  - "How do stakeholders such as universities, government, and industry contribute to the success of spin-offs?"
  - "What role do academic entrepreneurs play in overcoming challenges and driving growth?"

6. Closing and Follow-Up

- **Final Thoughts:**
  - "Is there anything else you would like to add about the policies, supports, or challenges related to university spin-offs at ITB?"
  - "Do you have any suggestions for improving the support system for spin-offs?"

- **Follow-Up:**
  - "Thank you for your time and valuable insights. If we have any follow-up questions, may we contact you?"
  - "Would you like to receive a summary of the research findings once the study is completed?"

- **Closing:**
  - "This concludes our interview. Thank you again for your participation!"

Appendix B. Observation.

1. Setting and Context

- **Location:** Institut Teknologi Bandung (ITB), Indonesia, focusing on its Technology Transfer Office (TTO), incubator programs, and spin-off companies (e.g., Karla Bionics, Tesla Daya Elektrika, KAZEE).
- **Participants:** Founders of spin-offs, TTO managers, incubator staff, university administrators, and industry partners.
- **Objective:** To observe the implementation of policies and supports for university spin-offs at different growth stages (pre-incubation, incubation, acceleration).
- **Timeframe:** Observations will be conducted over 1,5 years (April 2022 to July 2023), with regular visits to ITB's innovation ecosystem (e.g., incubator offices, TTO meetings, spin-off workspaces).
- **Tools:** Notebook, audio recorder (with consent), camera (for non-sensitive documentation), and observation checklist.

2. Key Activities to Observe

1. TTO Operations:

- Meetings between TTO staff and spin-off founders.
- Processes for intellectual property (IP) protection, patent filing, and licensing.
- Interactions with industry partners for commercialization.

2. Incubator Programs:

- Training sessions, mentoring, and workshops for spin-off founders.
- Allocation of seed funding and resources to spin-offs.
- Monitoring and evaluation of spin-off progress.

3. Spin-Off Operations:

- Daily activities of spin-off teams (e.g., product development, market validation, investor pitching).
- Interactions between spin-off founders and university/industry stakeholders.
- Challenges faced by spin-offs at different growth stages.

4. University-Industry Collaboration:

- Joint projects or partnerships between ITB and industry players.
- Role of industry mentors in guiding spin-offs.
- Feedback from industry partners on spin-off performance.

3. Notable Behaviors and Outcomes

- Behaviors to Note:

1. Founder Engagement:

- Level of involvement of academic entrepreneurs in commercialization activities.
- Willingness to adapt to business challenges and pivot strategies.

2. **TTO/Incubator Support:**

- Responsiveness of TTO and incubator staff to spin-off needs.
- Effectiveness of policies (e.g., royalty-sharing, IP protection) in supporting spin-offs.

3. **Industry Involvement:**

- Degree of industry participation in mentoring, funding, or co-development.
- Industry feedback on spin-off technologies and market readiness.

4. **University Leadership:**

- Commitment of university leadership to fostering an innovation ecosystem.
- Alignment of university policies with spin-off needs.

- Outcomes **to Document:**

1. **Spin-Off Growth:**

- Progress of spin-offs through pre-incubation, incubation, and acceleration stages.
- Key milestones achieved (e.g., product launch, revenue generation, investment secured).

2. **Policy Effectiveness:**

- Impact of university policies (e.g., patent incentives, royalty-sharing) on spin-off success.
- Gaps in existing policies and supports.

3. **Collaboration Outcomes:**

- Success stories of university-industry partnerships.
- Challenges in aligning academic research with market needs.

4. **Reflection Questions**

1. How **do the observed activities align with the proposed integrated policies and support?**
2. **What are the main challenges faced by spin-offs at each stage of growth, and how are they addressed?**
3. **Are TTO and incubator programs effective in fostering spin-off growth?**
4. **What are the roles of industry partners in the commercialization process, and how can their involvement be strengthened?**
5. **Are there gaps** in current policies or support?

5. **Checklist**

Category	Details to Observe	Notes
Setting	Physical environment, resources available, and accessibility of facilities.	
TTO activities	IP protection processes, licensing agreements, and interactions with spin-offs	
Incubator programs	Training sessions, funding allocation, and progress monitoring.	
Spin-off operations	Product development, market validation, and founder engagement.	
Industry collaboration	Mentoring, funding, and feedback from industry partners.	
University leadership	Policy implementation and support for innovation ecosystem.	
Outcomes	Spin-off milestones, policy effectiveness, and collaboration results.	