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Increasing Technology-Based Startup Grant Effectiveness

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Since its early introduction in 2013, Technology-based Startup Grant Program (Perusahaan Pemula Berbasis Teknologi or PPBT in the Indonesian language) has experienced selecting and bestowing grants to many startups. However, the selected businesses are not guaranteed to be sustained after the program is over. Therefore, this study explores the type and stage of business which possesses the highest probability to survive from the perspectives of experts. The authors interviewed four business experts with more than 20 years of experience and a chairman of a local business incubator. Analytic Hierarchy Process (AHP) method is used to organise and analyse the experts' decisions. This study found that the Internet of Things (IoT) is the business field is most likely to sustain independently regarding their rapid-growing ability to match consumer's demand. This study gives a suggestion of the type of business to consider on before selecting and applying for the funding.

Key words: *Technology, startup, AHP, government grant, PPBT.*

Introduction

In order to catch up with global progress in the era of Industrial Revolution 4.0, Indonesia is determined to speed up technology innovation as is witnessed as the root of economic development and advancement of several developing countries. In many countries such as United States, Korea, Japan, China, and Taiwan, research and development programs sponsored by the government are proved to be an effective approach to stimulate private companies to engage in research and development projects (Huang et al., 2008). The government through Kemenristekdikti, therefore, provides massive funding since 2013 which comprise of up to 78 billion rupiahs (approximately about $5.4 million) for 285 technology-based startup entrepreneurs in 2018. Innovative and technology-based startups are expected

to contribute to job creation, local economy increase, tax income boost, deriving foreign export exchange, and the use of local products. In 2016, Indonesia was positioned as the reference of startup growth, especially digital startups, due to achievement in the number of startups of approximately 2,000 units, the highest in Southeast Asia.

Perusahaan Pemula Berbasis Teknologi (Technology-based Startup), usually abbreviated as PPBT, is a yearly seed funding program introduced by Ministry of Research, Technology and Higher Education of the Republic of Indonesia (Kemenristekdikti) to induce growth and development of superior technology-based businesses to enhance national economic advancement. The program targets to prepare technology-based startup tenants to be profitable and sustainable businesses through business incubator institutions to carry out the incubation process. Selected tenants are possible to get funds for the second year based on their first-year achievement and qualifications. PBBT program aims to encourage commercialisation of local technology innovation outcomes and proliferating technology-based startups. This program prioritises to award grants to tenants in eight fields which are food, health and medicine, energy, transportation, information technology and communication, defence and security, raw material and advanced material. In addition to the grant fund, the recipients will be mentored for a year to help their business grow rapidly.

Since its early introduction, PPBT has experienced selecting and bestowing funding grants to many startups. However, successful applicants' businesses are not guaranteed to be sustained after the program is over. This study is motivated by the evidence of business failures experienced by former PPBT tenants after the program ended. Therefore, this study explores the kind of business which possesses the highest probability to survive after PPBT program from the perspectives of experts. Analytic Hierarchy Process (AHP) method is used to organise and analyse the experts' decisions.

Literature Review

Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) is one of the special methods of Multi-Criteria Decision Making (MCDM) which was introduced by Thomas L. Saaty in the 1980s. AHP is widely used to examine complicated multiple criteria alternatives with personal judgment (Durmusoglu, 2018). Since its initial creation, AHP and its development is already used well in various fields such as forecasting, employee selection, product concept selection, for determining policy project priorities (Liberatore, 1989) and selections in industrial R&D environment (Liberatore, 1987), oil fields development (Amiri, 2010), and to determine the most proper information system project (Muralidhar, Santhanam, & Wilson, 1990), ERP system (Wei, Chien, & Wang, 2005), project delivery method (Mahdi & Alreshaid, 2005). The simplicity and flexibility of AHP have made it one of the most prominent ways for decision making of parties (Durmusoglu, 2018; Karasakal & Aker, 2017; Martin & Daim,

2012). Among many studies, government-funded programs are only found in a few studies such as Huang et al. (2008) and Durmusoglu (2018). Durmusoglu (2018) proposed AHP model has been verified by empirical evidence of the success or failure of projects.

Fundamentally, the AHP method fragments a complex and unstructured situation into parts. After that, the parts or variables are organised into a hierarchical structure and assigned numerical values regarding the subjective considerations of the relative importance of each variable. Following that, those considerations are synthesised to set which variable has the highest priority and induces influence on the result in that situation. To get an accurate result, fragmentation is committed on constituents until there is no further fragmentation able to be performed; thus, several levels from the issue intended to be solved are obtained. The hierarchical structure of the decision can be categorised as complete and incomplete. A decision hierarchy is referred to as complete if all elements in a level hold relationship to all elements in the next level, while in incomplete decision hierarchy, not all elements in each stage have connections. Generally, real problems have incomplete structure characteristics.
Stages of Startup.

New companies are mostly start as small as startups. A startup is defined as an enterprise, an alliance, or temporary organisation arranged to explore repeatable and scalable business model (Blank, 2010). It is the first phase in the entrepreneurial innovation process (Picken, 2017) where novel entrepreneurial ideas are delivered to the market and transformed into profit (Spender, 2014) or to achieve economically sustainable phase (Blank, 2010). The scale of most startups tends to be very small for their whole lifetime and they never step on an important growth path (H. Aldrich, 1999; Paul Davidson Reynolds & White, 1997; Storey, 1994) hence they are unable to endure a sustained poor performance period (H. E. Aldrich & Auster, 1986). The root of the problem is their inclination to mimic businesses in fully grown corporations and to provide to local markets (H. Aldrich, 1999; Paul D Reynolds, Bygrave, Autio, & Arenius, 2004; Samuelsson, 2001, 2004). Small-firm managers are commonly reluctant to pursue growth in new ways due to uncertainty in profitability because low profitability often leads to low growth and low profits. Profitability has been indicated as the first thing to pursue before growth (Davidsson, Achtenhagen, & Naldi, 2005).

According to Juntunen et al. (2010), business growth processes are often depicted with life cycle that concentrate on describing how businesses adapt to growth (Dobbs & Hamilton, 2007) and or stage models that focus on the generic problems that organisations encounter during growth (Davidsson et al., 2005) as found in Lewis & Churchill (1983) and Scott & Bruce (1987). Firm's growth typically has four stages namely startups, transition, scaling, and exit (Picken, 2017). The startup's primary challenge is to characterise and verify the business idea: the market opportunity, the offering, the business model and a strategy needed to convey the offering dependably to the objective client at a benefit. The association of a startup is ordinarily casual, inexactly organised, and liquid but the centre is restricted, the

responsibility of time and assets is constrained, and the financial dangers are unassuming (Picken, 2017).

The time a startup obtain traction in the market, they are officially embarking on the transition which is the most critical stage in the entrepreneurial innovation process. This stage speaks to a necessary extension between the inexactly organised familiarity of the startup and the organised and taught structure required for quick scaling. The establishing group must set up the framework for a quickly developing business, build up believability and authenticity, and secure the underlying assets fundamental for development. The experience and ability requested of the supervisory crew grow dramatically in this stage (Hambrick & Crozier, 1985). In the United States, approximately only half of new enterprises last longer than five years (Bureau of Labor Statistics, 2016) around this phase. Barczak, Griffin, & Kahn (2009) on their Product Development Management Association Best Practices Study found that firms regarded only about 59% of new products commercialised to be successful based on the firms' views, while from a profit perspective only 54% of commercialised new products were considered successful.

The delicate situation is occurred presumably due to four elementary difficulties in commercialisation pertaining to 1) internal capability, e.g. entrepreneurial skills (Boeker & Wiltbank, 2005; Dehghani, 2015), management failure and inefficiency of management competence or experience (Drucker, 2012; Gorman & Sahlman, 1989; Sohn & Moon, 2003), lack of clarity of capital markets, lack of awareness of customer needs, scarcity of funds (Sohn & Moon, 2003), lack patience in converting investment of time and resources into profits (O'Connor & DeMartino, 2006), and marketing strategy (Olson, Walker Jr, & Ruekert, 1995); 2) external condition, e.g. paucity of interactions between researchers and executives, variability and inaccessibility in technology (Sohn & Moon, 2003), foreign direct investment capability (Dehghani, 2015); 3) intellectual property, e.g. effective ownership of R&D results (Dehghani, 2015); and 4) government plan and policies (Dehghani, 2015; Sohn & Moon, 2003).

Lack of funds is one of the most significant adversities mostly encountered by startups. It is difficult for most ventures to secure investment in the early stage of their business (Picken, 2017) primarily to rely on the private sector investor to run the company at this critical situation; thus the government's grant could fulfil the risk gap at this stage. Startups find funds from many sources such as venture capital, angel investor, startup accelerator (incubator), crowdfunding and grants. Since Indonesia is a developing country, the most popular fund for startup recently is grant due to its less risky, especially from the government. PPBT is one of the popular programs that provide grants and mentorship to technology startups under the research and technology ministry. Mentorship in PPBT could prevent

failure as experienced by more than 75% firms that already obtained a considerable amount of funding from venture capitals (Ruhnka, Feldman, & Dean, 1992).

Technology Readiness Level

Since the PPBT grant is purposed mostly for a technology-based startup, then one of the most important criteria is the technology readiness level (TRL). Before submitting a proposal, startups have been informed that the TRL value must be between 7 and 8 as stated below (National Aeronautics and Space Administration, n.d.):

TRL-7: System prototype demonstration in an operational environment. From a hardware point of view, it means that a high-fidelity engineering unit that sufficiently addresses all-important scaling concerns is fabricated and operated in an appropriate environment to validate performance in the actual operational setting and platform. Prototype software prevails bearing, complete fundamental range of capabilities ready for use for trial and assessment. It is integrated with operational hardware/software systems showing operational feasibility with minor software bugs. Documentation of the prototype software is limitedly available.

TRL-8: Actual system completed and "flight qualified" through test and demonstration. For the hardware, the ultimate product in its final arrangement is successfully demonstrated through examination and scrutiny for its predetermined working environment and platform. The whole software has been thoroughly debugged and entirely integrated with complete operational hardware and software systems. All documentation of user, training, and maintenance is completed. The entire functionality successfully proved in simulated operational scenarios and the Verification and Validation (V&V) completed.

With the criteria mentioned above, not all startups could fulfil the condition, but there was some value adjustment given by the committee.

Techno-Based Startup Selection Guide

Most startups in disruption era have shifted to a new paradigm of "techno-entrepreneurship" which defined as intrapreneurial and entrepreneurial activities under technology-intensive environments (Thérin, 2007). Some countries, especially the developed countries, have prepared by providing the related policies based on the level of novelty. Techno-based products usually come from R&D projects which have significant uncertainties for further development. Thus, the techno-based startup selection should be given more attention especially the probability of product development and whether the products are matched with the market target proposed by startups. The go-to-market strategy is more challenging for

radical techno-based startups because customers have little experience and familiarity with the new product concept than when the new product concept is an incremental modification or extension of an existing product (Olson et al., 1995).

Anticipating the uncertainty of future product development, there must be some criteria during the evaluation process of the products themselves in order to fulfil the minimum expectations. The first criterion is as described by the technological readiness level (TRL) above, not only the technical level but also the innovational aspect of the products. This criterion focuses on state-of-the-art, competitiveness, ambiguity, and complexity of the technology in the products implementation and innovation level of the products or processes that will be developed (Karasakal & Aker, 2017).

The next criterion is both the quality of the product plan, research infrastructure and culture of the startups. This represents the visions of the startups' founder, and hence the authors could measure the sensing capability of startups in building the linkage between products and customer segments. The startups' plan must include the management planning for 1-2 years, scheduling, and the resources planning especially the market planning as the newcomers.

The last criterion for techno-based startup selection measures the probability of product transformation into economic and social benefits. One of the cues is that the prototype is open for the next innovation from the existing design and the startup could explain the futuristic features of the product.

According to Karasakal & Aker (2017), the evaluation criteria could be broken into some details. In terms of profitability to the company, conducting market research and potential of probability, improvements in productivity and cost are the most essential guide to assess the startups. The startup score should be high if the product has the potential to find an international market. The score will be medium if the product has the potential to find a national market. The score must be zero due to the difficulties to finding any market. In the point of the potential of profitability, improvements in productivity and cost, the highest score will be given to the startup with a reasonable expectation of high profitability or improvements in productivity or costs. If the expectation is reasonable, then the score will be medium. Otherwise, zero scores if no expectation in profitability, improvements in productivity and cost.

Another evaluation criterion derived from this concept is from job creation opportunity point of view. If the startup and its product development will create job opportunities by resulting in new avenues for the industry, then the score will be the highest. If the startup and its product development have a chance of job creation, then the score is medium. At the opposite, if only the startup creates a job just for his team, then the point should be zero.
For some government or private grants, environment issue becomes the critical point selecting a techno-based startup. The evaluation criterion is named as "benefit to environment and life" which the highest score determines the startup's product has a direct and positive impact on environment and life. If the startup's product has a direct and positive impact on the environment and life but it cannot explain or propose the detailed plan, then the score is medium. In contrast, if the product has a negative impact on the environment and life, then the score is zero.

Technology readiness level (TRL) is part of the contribution to the state of knowledge; thus, some grants prefer to invite university participation especially if it has a techno-based startup incubation centre. If the startup product has the potential to provide the continuity of university and industry collaborations, then the highest score will be obtained. If the startup product only creates the flow of knowledge from startup to university, then the score is medium. Otherwise, the score should be zero. The collaboration among industries, universities, and startups should be fostered in order to speed up economic growth.

Methods

The samples are five people taken purposively from business experts with more than 20 years of experience and a chairman of a local business incubator. Expert 1 is an Incubator Head of Program, Expert 2 is an entrepreneur and lecturer, Expert 3 is a Chief Marketing Officer of a multinational company, Expert 4 is a business owner of Information and Technology company, and Expert 5 is Operational Director of a big retail company. Regarding the focus of the study to determine the right business to receive grants from the PPBT program, the informants are asked to identify the most favourable factors, key actors, and indicators of a successful business; and business alternatives in future grant recipients. The options are then analysed through pairwise comparison of the Analytic Hierarchy Process. AHP in this study is conducted through several essential stages, namely Decomposition, Comparative Judgement, Synthesis of Priority, and Logical Consistency.

Decomposition. This stage involves fragmenting a complex system into a ,more straightforward formation to create a hierarchy.
Comparative Judgment. After the hierarchy is created, the experts compared each criterion to one another through paired matrix against a defined criterion and assess them using a comparison scale by Saaty (1988) to express importance intensity. Scale 1 shows equal

importance, 3 is slightly more important, 5 is strongly more important, 7 is very strongly more critical, and 9 is extremely more important. 2, 4, 6, 8 are intermediate values which given if there are two compromises among two options. Inverse value is if for activity i received one point compared to activity j, then j has inverse value compared to i.

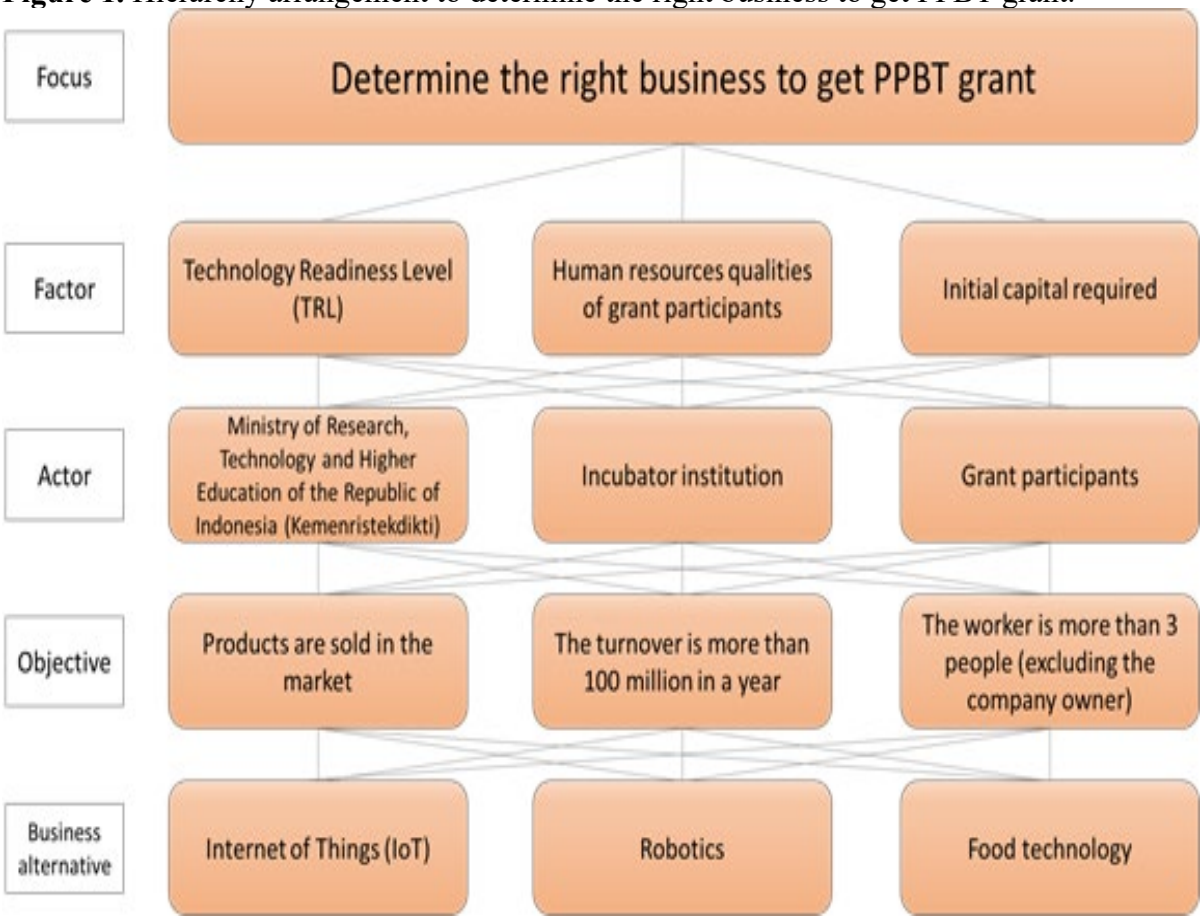
Synthesis of Priority. Priority from criteria elements is then decided based on the comparison result.

Logical Consistency. Consistency Ratio (CR) is calculated from the Consistency Index (CI) divided by Random Index Value (RI). Random Index Value (RI) is the average index value resulted randomly from Saaty (1988) experiment which used matrix number with 1 until 15 order. If CR is not fulfilling the requirement value of ≤0.1, then the assessment needs to be repeated.

Results

Hierarchy arrangement is made through criteria and alternatives as shown in Figure 1. Following this are alternatives with each criterion according to the experts. The most guaranteeing success factors in technology-based startups are Technology Readiness Level (TRL), human resources qualities of grant participants, and initial capital required. The key roles in determining these factors are the Ministry of Research, Technology and Higher Education of the Republic of Indonesia (Kemenristekdikti), Incubator institution, and Grant participants. The most important objectives to indicate successful business are products being sold in the market, the turnover is more than 100 million rupiahs (approximately $6,900) in a year, and the worker is more than three people (excluding the company owner). The business alternatives that is easiest to meet the objectives are the Internet of Things (IoT), Robotics, and Food Technology.

Figure 1. Hierarchy arrangement to determine the right business to get PPBT grant.



The compilation of all experts' comparisons and assessments generate a priority rank of the hierarchy (Figure 2). The higher the assessed value, the more critical the factors for the informants. Some questions are repeated several times to ensure the experts comprehend the intended meaning and achieve CR equal to or less than 0.1. This is the weakness of AHP method that the comprehension of the researcher and respondents could diverge.

Figure 2. Priority of criteria elements according to experts

The answer compilation of all respondents shows that the Technology Readiness Level (TRL) is valued 0.65, the largest among other criteria. This indicates that TRL is the most crucial factor that contributes to business success while human resources (HR) quality and initial capital are almost equally less important. By value, HR quality shows more importance than initial capital. Expert 1, a head of an incubator institution; and Expert 4, a business owner; perceive initial capital more important than HR quality. Expert 2, a business owner and an academician; and Expert 5, an operational director; perceive that HR quality is more important than initial capital. Meanwhile, Expert 3, a chief of management officer, perceives that TRL and HR quality have equal importance stronger than initial capital required.

Ministry of Research, Technology and Higher Education of The Republic of Indonesia (Kemenristekdikti) is perceived to be the key role in determining a business TRL and HR quality of grant participants as it is answered by Expert 1, Expert 2, and Expert 3. In determining TRL, incubator institution role is only slightly less important than Kemenristekdikti while in determining HR quality, it is moderately-strongly less important.

Required initial capital is perceived to be determined by the incubator institution, Kemenristekdikti, and grant participants, respectively. The importance gaps are quite narrow due to the high divergence of answers from experts.

Kemenristekdikti, incubator institution and grant participants are viewed to consider products being sold as the key indicator of a successful business followed by turnover reaching up to 100 million or more and the number of workers achieving three or more in a year. Incubator institution and grant participants view turnover as more critical than how Kemenristekdikti sees it.

IoT has been considered to be the most accessible business to sell and to earn high turnover while the business more inclined to employ many workers is food technology. Robotics is perceived as harder to sell, earn high turnover, and hire more worker.

IoT has been the most feasible business in industrial revolution 4.0 today since its implementations in home appliances which are popular with "smart devices". There are three distinguishing features, namely context, omnipresence and optimisation. The context characteristic let objects to provide information such as location and physical condition (measured by sensors). Omnipresence describes the fact that objects today are much more than just connections to the user network. Optimisation is the expression of the functionality which every object possesses (Witkowski, 2017).

There are some reasons for IoT becoming an emerging business nowadays. It has two approaches for creating new value propositions or business models using the IoT: (1) the bottom-up or sustaining approach and (2) the visionary or disruptive approach (Krotov, 2017). IoT overwhelmingly is an accumulation of human and nonhuman objects implanted inside a physical environment and connected through a ubiquitous remote system. Each of objects involving the IoT has specific properties and strategies. Properties are attributes of a specific human or nonhuman object or a physical encompassing. Strategies allude whatever these objects can do or the exchanges with different objects or the physical condition that these objects can partake in. These exchanges are activated naturally with no social inclusion. Since objects with the physical condition are associated with a ubiquitous network, these objects can trade or impart their properties amid these exchanges.

Supporting business techniques use IoT to upgrade existing products or services. This methodology requires dissecting properties of existing objects and formulating new routes for moving forward existing procedures or exchanges including these objects. For instance, a ready-to-cook meal mentions its required cooking time on the package in the form of RFID tag. Supposing that there is a microwave equipped with a timer as cooking time and a sensor to read RFID tags. When someone puts the meal package into the microwave, the microwave will cook the package with a proper time, as mentioned in its RFID. Hence, the transaction

between a meal package and the microwave can be enhanced by eliminating the extra efforts on the customer side when it comes to cooking the meal using a microwave. This is the way that startups might create an extended value proposition to the existing products.

Another way for IoT business opportunities for startups is by implementing a disruptive strategy in creating new business models with IoT visionary approach. Startups ought to envision a world where each object is a part of a global and ubiquitous network and then think of another kind of new transactions or possible business model. For example, everyone will have a, more natural way to maintain the garden while he/she is away from home for a quite long time using a smart garden application. All things required by the garden are running from IoT such as nourishing the flowers on schedule.

Discussion & Conclusion

This study found that experts perceived Technology Readiness Level (TRL) as the most critical factor contributing to technology-based business success, especially in a short-term program like PPBT. This factor is followed by human resources (HR) quality and initial capital with relatively equal importance. Compared to the high TRL businesses, the startups with lower TRL would require more investment in terms of time and money before they are ready to launch their products or services to the market. Therefore, these low TRL businesses are considered to be less successful and harder to sustain after the one-year financing term is over. As the most critical factor in the success of technology-based business in PPBT program, business TRL is perceived to be determined only by the ministry along with incubator institution. However, the low TRL businesses would have a chance to be successful if they are fast enough in escalating their TRL to the final level.

The rapidness of startup's improvements is supported by two factors that the experts mentioned as second most important after the TRL, the HR quality and initial capital. The HR quality comprises of the business owners' attitude, the skills of the workers, and management talents. The HR quality of grant participants would also significantly affect the result of funding assessment; hence it is perceived to be determined only by the grant giver, which is the ministry. Initial capital here points to the amount of money to finance the business operation. There are diverged perspectives about the determination of the required initial capital of startups. On the other side, while all informants agree that three key roles consider the number of sold products as the primary indicator in indicating a successful business, different standards are also found in high turnover importance to define a successful business. The ministry regards turnover as less critical than it is felt by the startups and incubator institutions. These unaligned views regarding the initial capital and turnover importance between startups, the business incubator, and the ministry might engender problems such as undermotivated startups, performance inefficiency or ineffectiveness in their business conduct.

From the findings, the authors conclude that the grant participants are perceived to not having significant power in determining their TRL, HR quality, and initial capital. The ministry is perceived as the primary decision-maker, which is reasonable due to its role as the funder, and business incubator institution is considered as the second most capable in influencing the decision. Therefore, the grant participants would benefit by following the favourable requirements the authors found in this study to be seen as most likely to succeed in the program. This research found that Internet of Things (IoT) is perceived as the industry that is most likely to sustain due to its high ability to sell and obtain higher turnover if compared to food technology and robotics. IoT's small necessary initial capital and rapid-growing ability to match consumer's demand are presumably the reason behind it. Therefore, the one-year short PPBT program should prioritise IoT businesses as promising candidates for funding. Technology-based startups that intend to apply for the grant should also consider IoT to

enhance the chance to be accepted by the program. Implementations of IoT into appliances have created new business opportunities for system integrators such as smart home, smart building, smart garden, smart factory, etc.

Limitation & Further Research

There are some limitations of this study that spare room for improvements in the future study. Among three important actors in this research, only incubator institution and business startup representations were interviewed about the roles in determining business Technology Readiness Level, human resources quality, and initial business capital of grant participants. A future study could add the perspective from the Ministry of Research, Technology and Higher Education along with other supporting actors from the government, venture capital, sustained tech-startups, and failed tech-startups. Regarding the findings, the authors suggest creating a group comprising the three key actors in the assessment practice of prospective tenants. There are many opportunities to take this study further. Other methods such as Fuzzy AHP, Artificial Intelligence methods of Artificial Neural Network (ANN) and Expert System should shed more light to validate our result.

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