The model of investment promotion policy scheme in science and technology park: a case study of technopolis in Indonesia

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ABSTRACT
Technopolis has close relationships to the development of science and technology park. Therefore, this research is intended to develop mathematical model for Promotion Policy Instrument (PPI) that can be implemented for investment promotion scheme by examining technopolis case in Indonesia. The model is formulated by adapting Game Theory Model (Model I) and Goal Programming Model (Model II). Three main activities group – productive, research and technology development, social activity and infrastructure – should be simultaneously developed. Game Theory model indicated that social activity and infrastructure projects are basically rejected due to negative payoff. While Goal Programming Model, by given 3 alternatives condition, shows that each alternative only give benefit to only one activity. Sensitivity analysis reveals the ability of the models in responding the possible adjustment towards uncontrollable input. The models from PPI scheme in KTP can also be implemented as the benchmarking to develop science and techno park in another location.

1. Introduction

Technopolis has close relationships to the development of science and technology park. This is based on the many elements possessed by science and technology park also found in technopolis (Keeble & Wilkinson, 2000). Elements such as technological development, infrastructure and research facilities (universities, laboratories, etc.), governmental institutions engaged in science and transfer technology are widely available in technopolis (Abdel-Fattah, Kashyout, & Sheta, 2013; Cha & Miyakawa, 2012). Moreover, the goal of developing science and techno park has the same goal of building optimal relationships between academics, industries and government (Aslan, 2014). Science and techno park are aimed to collaborate the ideas, innovations and know-how from academic, government, and commercial and industrial institution (Hashmi & Shah, 2013). It is expected that this collaboration will able to improve and accelerate...
science, technology, product development and transfer knowledge between institutions. Moreover, the relationship between the institutions could reduce the time required to move innovation into marketable technology products (Moeliodihardjo, Soemardi, Brodjonegoro, & Hatakenaka, 2012).

Indonesia in the near future will establish the first technopolis area in the district of Pelalawan as one of implementations of MP3EI (Masterplan of Acceleration and Expansion of Economic Development of Indonesia). Technopolis is a unify attempt for all high-technology activity, research centre, companies, universities and financial institutions which promote the connection between corresponding units in certain place (Phillips, 2012). Therefore, a synergism effect will be obtained where new ideas and technology innovation occur and creating a new start-up (Oh, Phillips, Park, & Lee, 2016). In the meantime, a technopolis district is a district containing more than one science and technology activity, productive activity and community movement in particular place as a development system which is shown by the presence of functional bond and hierarchy of innovation system chamber (Okubo & Tomiura, 2012).

Technopolis district of Pelalawan is located in Langgam Village, Region of Pelalawan, Riau Province, Indonesia. The development of the district is intended to nurture the innovation networking and learning tools which leads to not only the growth of economical capital but also intellectual and social capital (Warseno, 2014). However, a tremendous investment cost is inevitably necessary. As the comparison, the development of Bio Medical Centre Dortmund was built in three stages between 2002 and 2009 which consume €60 Mil (equivalent to Rp.720 Billion in 2009 (Bank Indonesia, 2015)) (Becker, Burger, & Hülsmann, 2014). Moreover, as another comparison as the effort to sustain a technopolis, the US government spent hundreds of millions of investments in research funding and entrepreneurial subsidization as the effort to sustain Austin technopolis (Gibson & Butler, 2013). Therefore, with the limited capability of Pelalawan Regency and Central Government to fund the investment, the efforts to promote investment to establish the district should be presented to attract investor intention.

Investment promotion is an effort of a country or region in order to attract and maintain the investor either from local or international (Šimelytė & Gediminas, 2012), (Kartasheva, 2012). Investment promotion of technopolis district is different from other specialized district such as industrial district and bonded district which only promote industry area which only focus on providing of policy facility to drive economy activity, especially for industry inside the district. In technopolis, the investment scheme should also highlight the aspects of science and technology development, thus enhance national capability in technology and productivity (Hu & Lin, 2013).

The book of ‘Handbook for Promoting Foreign Direct Investment in Medium-Size, Low-Budget Cities in Emerging Markets’ (VALE COLUMBIA CENTER, 2009) elaborates that framework of investment promotion scheme can be attained through several processes which are strategy formulation, organizing the institution, marketing and advertising activity, investor targeting, investment facilitating, and aftercare and advocate of policy. Furthermore, investment promotion has some approaches which incentive providing, monetary and fiscal policy, e-commerce strategy and location provision for industries (Wentzel & Steyn, 2014), (Nielsen, Asmussen, & Weatherall, 2017).
In the previous study related to technopolis, Kartasheva (Kartasheva, 2012) has conducted a study related to optimization of investment promotion policy design for infrastructure projects funded by public private partnership. The article aims to optimize investment promotion policy design for projects involved in the development of technopolis district. Erliza et al. (Erliza, Zakaria, Sutopo, Widiyanto, & Supriyanto, 2014) have developed investment promotion policy model in technopolis district with full information; as a result, government gain advantage which they have to consider net profit from operator to determine the amount of optimal transfer value given by them as investment promotion policy. In another study, Erliza, Sutopo, et al. (Erliza, Sutopo, Maret, Widiyanto, & Project, 2014) developed investment promotion strategy formulation scheme for technopolis district of Pelalawan by using SWOT analysis method beside resulted a possible investment promotion strategy. However, SWOT analysis is not sufficient in order to gain a sophisticated investment promotion scheme. Mathematical model is necessary as the quantitative approach to obtain a detailed depiction of the amount of investment required, the level of risk and the benefits of an investment project (Gong, Lei, & Ye, 2016). Therefore, game theory and goal programming model are adapted to analyse and modelling the investment promotion scheme by examining structural aspect, functional aspect and the target of the project which indicated by financial performance. The result from the model can be used as a reference for technopolis stakeholders to determine the policy for investment decisions.

2. Methodology

In order to acquire investment promotion scheme for science development and techno park, a case study is conducted on the Kawasan Technology Pelalawan (KTP) in Pelalawan Regency, Riau Province, Indonesia. Case study is possible as there are a lot of similarities of elements that exist between science and techno park and technopolis. Thus, the result of the case study can be applied as the investment promotion scheme in developing science and techno park. Three main activities which are productive activity, research and technology, and social activity and infrastructure need to examine in order to gain deep perception of best investment option and scheme.

In accordance with selection of the policy, the model is formulated by adapting Game Theory Model (Model I) and Goal Programming Model (Model II). Model I use dynamic games model with complete information in extensive form. Game theory model is chosen as the decision-making process regarding to investment promotion policy is diverged and involving two parties – Government and Project operator (Fudenberg, 2015). In addition, dynamic game method is selected as the information flow would affect in players’ behaviour in negotiation behaviour, as the players’ action is dynamic which depends on previous players’ decision. The broad analysis form illustrates the presence of multi-agent decision tree where players’ information and possible strategy can be explicitly well known in each game. Model II is implemented in order to select investment promotion scheme policy that involving more than one objective functions prior to two stakeholder’s interests – Government and Project operator (Aouni, Colapinto, & La Torre, 2014).

The result from the two models is verified afterwards to ensure that the models mathematically correct and logic. It is achieved by checking the consistency of whole
units of the mathematic expression used in the model. Verified model shows that all mathematical models have illustrated the assumed relations properly; thus, it can be applied in computer program appropriately. Next, the models are tested with Microsoft Excel 2013 for the Model I and Lingo 11.0 for Model II. Parameter data and objective function were, respectively, the input to the program and the desire output then examined.

Both Model I and Model II refer to previous model developed by Kartasheva (Kartasheva, 2012). The model is developed in aspects of concerned topic, structural aspect, functional aspect, target, model formulation and output solution. The differences between the models are explained in more detail in Table 1.

Final step of this study was analysing and interpreting the modelling process and result of the model testing. Analysis process consists of model compatibility and sensitivity analysis, while result interpretation consists of formulation of investment promotion policy strategy, investment promotion policy selection scheme and model of the selection scheme for technopolis district. Figure 1 illustrates flow of the method used in this research.

### 3. Result and discussion

#### 3.1. Investment promotion policy

One of the vital aspect in formulating strategies for investment promotion policy is by intensifying government role both in national and local level in creating appropriate circumstance to attract investor. Furthermore, it can be realized by developing regulation specifically related to technopolis. Regulation possesses urgent role in technopolis development through investment promotion policy (Vorobeva, 2014). Investment promotion policy in KTP, however, should correspond to three main areas of technopolis which are industrial zone, R&D and education, and management area (Erliza et al., 2014). Selection scheme of investment promotion policy

| Aspects                | Previous model                                      | Model in this research                                                      |
|------------------------|-----------------------------------------------------|----------------------------------------------------------------------------|
| Concerned topic        | Optimization the Design of Investment Promotion    | Optimization the Investment Promotion Policy Scheme of Technopolis District |
|                        | Policy towards Infrastructure Project in United     | Development Project in Indonesia                                           |
|                        | States of America                                  |                                                                            |
| Structural aspect      | Government, Project Operator and Funding Investor   | Government and Project Operator Investment Promotion stage                |
| Functional aspect      | Investment Promotion and Funding stage              | Investment Promotion stage                                                |
| Target                 | Minimization of government expenditure              | Minimization of government expenditure                                    |
|                        | Maximization of beneficial value                    | Maximization of beneficial value                                           |
|                        |                                                     | Maximization of NPV                                                       |
|                        |                                                     | Minimization of risks                                                     |
| Model formulation      | Game theory with asymmetric information             | Game theory with complete information                                      |
|                        | Analytical model                                    | Numeric model                                                             |
| Output solution        | Analytical model                                    | Numeric model                                                             |
needs to be identified; hence, it could grasp investor attention, related to internal and external stakeholders – central and local regulator, BPPT, project operator and investor.

In other studies, related to government role, the government of Taiwan had developed a series of Major Development Initiative projects since 1970s as the effort to boost national economy which then lead to Hsinchu Science-Based Industrial Park (HSIP) (Hu & Lin, 2013). The HSIP is aimed to develop the region to become the centre of a high-tech research foundation with distinguished quality, solid development and appropriate efficiency. The government is playing a role by providing sponsorship in order to
stimulate development of technology-based company in HSIP. In Mexico, the promotion of investment was conducted by the Mexico-State Council of Science and Technology (Comecyt), collaborated with the Inter-American Development Bank (IDB) and the National Council of Science and Technology (Conacyt) which resulting in a Development of Mexico State Innovation System (SEI Project). The project is intended to offering incentive and technical support for technology-based SMEs, promoting collaborative network between firms, and strengthen the linkage between universities, industries and government (Solleiro & Gaona, 2012).

It is common that in developing a particular region, government have project documents, priority as well as the budget in order to calculate the corresponding incentive package (Bode & Nunnenkamp, 2011). Naturally, government will develop investment promotion policy to consider the suitable incentive package given for running project (Lazzarini, 2015). The development process is the part of selection scheme of investment promotion policy especially for technopolis district which is expected to be appealed for investor with high expectation (Phillips, 2012). Therefore, the three main activities in technopolis district can be run simultaneously.

### 3.2. Characterization of promotion policy instrument (PPI) scheme

For every project conducted by government, government has their alternatives as a low- or high-priority project due to the purpose and stage of the region development (Chen, Sun, Tang, & Wu, 2011; Lazzarini, 2015). Besides providing the incentives, selection of the projects, as well as the acceptance to project operator, is measured as the government policy instrument in PPI (Kartasheva, 2012). Project risk is the first consideration input (i1) in determining PPI.

Incentive instrument such as tax dispensation and subsidies are provided by government to project operator as the support to attract investor intention. Appears from asymmetric information between government and project operator in calculating the cost, incentives are given to anticipate hardly unpredictable average cost (Guan & Yam, 2015). Moreover, the incentive can be utilized to minimize risks in every single project and increase net present value (NPV) for project operator (O’Malley, 2012). Thus, more activities in the project can be carried out. However, government budget (i2) is limited to redeem all incentive demanded by project operator. The circumstance has led the alternative incentives (i3) to become mutually exclusive for project operator regarding incentive general rule (i4). In addition, government as policymaker is ordered to maximize the advantages of running project for community. Implication of this PPI is decision for agreed project with minimal risk level, minimal government incentives (O1), maximum advantages value for community (O2) and maximum expected NPV level (O3).

### 3.2.1. Characterization of development project of KTP

According to three main activities in technopolis district, there are three main projects in development of KTP: productive activity, technology and science activity, and infrastructure and social activity. Priority level of each project has been determined by government. Table 2 shows the full list of the projects in KTP.
3.2.2. Characterization of PPI scheme

Instead of monetary incentive, fiscal incentive is implemented in this research due to the simplicity in calculation and its stability. Fiscal incentive is a government instrument which utilizes both national and local budget in order to affect business activity or economic growth implemented as tax elimination and dispensation or subsidies (Clear, 2011). Subsidies, or known as negative tax as well, are government expense that will increase the revenue of the receivers in condition they are consuming or buying subsidy-goods from government with low selling price (Kline & Moretti, 2014). Unlike fiscal incentives, project operator is only able to get one type of subsidy. Both fiscal and subsidy incentives used in this study are elaborated in Table 3.

3.2.3. Characterization of KTP development projects risk

Project-risk characterization is developed based on secondary data from previous researches. Five core project-risk criteria are built from various criteria elaborated from several literatures (Kendrick, 2009)–(Nurdiana, 2011) based on similarity definition. The five core criteria are economic and financial risk, external risk, operational risk, managerial risk and social risk. Each of them is classified into three level of risk: level 1 (low risk), level 2 (moderate risk) and level 3 (high risk). In grading the risk for every project in KTP, stakeholders take a role to provide sufficient information to assess the risk level. Literature study is another supporting method. Detail risk level for all projects in KTP development is shown in Table 4.

### Table 2. List of projects conducted in development of KTP.

| Activities group                  | Project code | Project name                                                                 | Priority |
|-----------------------------------|--------------|------------------------------------------------------------------------------|----------|
| **Productive activity**           |              |                                                                               |          |
| Manufacture industry              | P1           | Margarine industry development                                                | HP       |
| P2                                |              | Cooking oil industry development                                              | HP       |
| P3                                |              | Rubber factory construction                                                  | HP       |
| P4                                |              | Cow farming area development                                                 | HP       |
| P5                                |              | Other industries in Technopolis area                                          | LP       |
| P6                                |              | Corn processing factory construction                                          | LP       |
| P7                                |              | Coconut processing factory construction                                        | LP       |
| P8                                |              | Rice warehouse and rice milling unit construction                             | LP       |
| P9                                |              | Agro-business of patin fish culture in fish cage                              | LP       |
| P10                               |              | Development of food estate in Kuala Kampar                                    | LP       |
| Office affairs and service        | P11          | Office complex                                                               | LP       |
| P12                               |              | Golf and Sport Club area development                                          | LP       |
| **Science and technology activity**|              |                                                                               |          |
| RnD centre                        | L1           | Agency of Research and Development of Technology                              | HP       |
| University                        | L2           | University                                                                   | HP       |
| Incubator centre                  | L3           | Micro and SMEs and Business Incubator Center                                  | LP       |
| L4                                |              | Training Center                                                              | LP       |
| **Infrastructure and social activity** |          |                                                                               |          |
| Infrastructure                     | I1           | Harbor construction in Sokoi Village                                          | HP       |
| I2                                |              | Pangkalan Kerinci – Pekan Baru toll way construction (48 km)                  | HP       |
| I3                                |              | Road construction in Technopolis area                                         | HP       |
| I4                                |              | Electricity infrastructure development                                        | HP       |
| I5                                |              | Telecommunication infrastructure development                                   | HP       |
| Residence                         | I6           | Residence area                                                               | HP       |
| Tourism                           | I7           | Water recreational park (City Park) development                              | LP       |
| Social facility                   | I8           | RTH area development                                                          | LP       |
| I9                                |              | Public and social facility development                                        | LP       |
3.3. Model development

There are two models developed in PPI selection scheme: game theory (Model 1) and goal programming (Model 2).

3.3.1. Game theory model

Performance criteria in this model are to optimize PPI selection scheme given by government to KTP by maximizing payoff gained by government subjected to probability to accept project (P), social surplus and transfer value. Some assumptions are determined in this model which are: NPV of high payoff value is positive while the low one is negative; profit function is always increasing, concave and Inada; beneficial value function is always increasing, convex and satisfies Inada condition; increase in project

**Table 3. List of possible alternative incentives for PPP in KTP.**

| No | Project group               | Fiscal incentives                     | Subsidy incentives                      |
|----|----------------------------|--------------------------------------|----------------------------------------|
| 1  | Productive activity        | F1. Tax holiday                      | S1. Investment Allowance                |
|    |                            | F2. Investment allowance             | S2. Facility for Advanced Energy Resource Utilization Activity |
|    |                            | F3. Reduction in income tax for private limited company | |
|    |                            | F4. Reduction in income tax for limited scale business | |
| 2  | Science and technology activity | F1. Investment Tax Allowance            | S1. Reduction in public cost            |
|    |                            | F2. Reduction in income tax            | S2. Direct fund support                 |
|    |                            | F3. Special fiscal incentive for spin off company | |
| 3  | Social activity and infrastructure | F1. Income tax facility            | S1. Land Capping                       |
|    |                            | F2. Viability Gap Fund                | S2. Land acquisition fund               |

**Table 4. Risk level for all projects in KTP development.**

| Activity group                  | Project code | Risk – 1 | Risk – 2 | Risk – 3 | Risk – 4 | Risk – 5 |
|--------------------------------|--------------|----------|----------|----------|----------|----------|
| Productive                      | P1           | 3        | 2        | 3        | 2        | 2        |
|                                | P2           | 3        | 2        | 3        | 2        | 2        |
|                                | P3           | 3        | 2        | 3        | 2        | 2        |
|                                | P4           | 2        | 1        | 3        | 2        | 2        |
|                                | P5           | 3        | 2        | 3        | 2        | 1        |
|                                | P6           | 2        | 1        | 1        | 1        | 1        |
|                                | P7           | 2        | 1        | 2        | 1        | 1        |
|                                | P8           | 1        | 1        | 1        | 1        | 1        |
|                                | P9           | 2        | 1        | 1        | 1        | 1        |
|                                | P10          | 1        | 2        | 1        | 1        | 1        |
|                                | P11          | 3        | 2        | 2        | 3        | 2        |
|                                | P12          | 2        | 2        | 2        | 2        | 2        |
| Science and technology         | L1           | 2        | 2        | 3        | 3        | 2        |
|                                | L2           | 1        | 1        | 2        | 3        | 3        |
|                                | L3           | 2        | 1        | 3        | 3        | 2        |
|                                | L4           | 2        | 1        | 3        | 2        | 1        |
| Social activity and infrastructure | I1          | 3        | 3        | 3        | 2        | 2        |
|                                | I2           | 3        | 2        | 3        | 1        | 2        |
|                                | I3           | 3        | 2        | 3        | 1        | 2        |
|                                | I4           | 3        | 3        | 3        | 3        | 2        |
|                                | I5           | 3        | 3        | 3        | 3        | 2        |
|                                | I6           | 1        | 2        | 2        | 1        | 1        |
|                                | I7           | 3        | 1        | 2        | 1        | 1        |
|                                | I8           | 1        | 1        | 2        | 1        | 1        |
|                                | I9           | 3        | 1        | 3        | 2        | 1        |
profit marginal for high level of payoff value is higher than the low ones; however, the decrease is on the contrary; amount of positive transfer is positive and negative for negative transfer.

Game theory model development is divided into project proposal stage and project acceptance stage. In project proposal stage, government has projects with respective probability of $i \in \{H, L\}$ which refers to priority possessed by each project where probability of $H$ is more major compared to $L$ ($p_H > p_L$). While operator proposes projects of $x$ with certain size ($q$) and payoff either high ($h$) or low ($l$) which probability of $h$ for $H$ ($a$) is different from $L$ ($b$), respectively ($a \neq b$). For every proposed project, the payoff value is $\pi_{i,x}(q)$ with $\pi_{i,h}(q) > \pi_{i,l}(q)$. Government in this stage make project acceptance decision of $P(i,x)$ where:

$$P_{H,h} = pH x a$$  \hspace{1cm} (1)

$$P_{H,l} = pH (1 - a)$$  \hspace{1cm} (2)

$$P_{L,h} = pL x b$$  \hspace{1cm} (3)

$$P_{L,l} = pL x (1 - b)$$  \hspace{1cm} (4)

Government provide incentives ($\delta_{i,x}$) in project acceptance stage that is classified into positive transfer ($t_p$) and negative transfer ($t_n$). Incentive ($\delta_{i,x}$) decision determine the amount of transfer $t_p(i,h)$ with probability of $\sigma_{i,h}$ and transfer $t_n(i,h)$ with probability $1 - \sigma_{i,h}$. For $i,j \in \{H, L\}$ and $h,l \in x$ transfer $t_p(i,h)$ has probability of $1 - \sigma_{j,l}$ while transfer $t_n(i,l)$ is $\sigma_{j,l}$. Therefore, government has four PPI selection scheme models in this stage illustrated by function (5)–(8).

$$P_{H,h}, \delta_{H,h} = pH x a x (\sigma_{H,h} x t_p + (1 - \sigma_{H,h}) x t_n)$$  \hspace{1cm} (5)

$$P_{H,l}, \delta_{H,l} = pH x (1 - a) x ((1 - \sigma_{H,l}) x t_p + \sigma_{H,l} x t_n)$$  \hspace{1cm} (6)

$$P_{L,h}, \delta_{L,h} = pL x b x (\sigma_{L,h} x t_p + (1 - \sigma_{L,h}) x t_n)$$  \hspace{1cm} (7)

$$P_{L,l}, \delta_{L,l} = pL x (1 - b) x ((1 - \sigma_{L,l}) x t_p + \sigma_{L,l} x t_n)$$  \hspace{1cm} (8)

Ideally, positive transfer gained by government is able to cover the provided negative transfer. By assuming that $t_p > 0$ and $t_n < 0$, with $t_p = t_{p(H,h)} + t_{p(L,h)}$ balance budgeting constraint can constructed as shown in function (9). Meanwhile, maximum payoff for government as the objective function in this model can be seen in function (10). Functions (1)–(8) are considered as decision variables:

$$\{ (P_{H,h}\sigma_{H,h} + P_{H,l}(1 - \sigma_{H,l})) + (P_{L,h}\sigma_{L,h} + P_{L,l}(1 - \sigma_{L,l})) \} t_p$$

$$+ \{ (P_{H,h}(1 - \sigma_{H,h}) + P_{H,l}\sigma_{H,l}) + (P_{L,h}(1 - \sigma_{L,h}) + P_{L,l}\sigma_{L,l}) \} t_n$$

$$\geq 0$$  \hspace{1cm} (9)
max \( W = P_{H,h}\left[S_{H,h}(q) + \sigma_{H,h}t_p + (1 - \sigma_{H,h})t_n\right] + P_{H,l}\left[S_{H,l}(q) + (1 - \sigma_{H,l})t_p + \sigma_{H,l}t_n\right] \\
+ P_{L,h}\left[S_{L,h}(q) + \sigma_{L,h}t_p + (1 - \sigma_{L,h})t_n\right] + P_{L,l}\left[S_{L,l}(q) + (1 - \sigma_{L,l})t_p + \sigma_{L,l}t_n\right] \) 

(10)

The other factors that should be taken into consideration are project operator interest – to gain profit as much as possible. To execute project with size of \( q \), an investment (fixed cost) of \( F > 0 \) and variable cost of \( q \) are required. With interest rate of \( r \), net present value (NPV) of operator can be calculated by function (11), while function (12) expresses net profit for operator. In special case, net profit of operator is 0 if the respective project is rejected:

\[
\Pi_{i,x(q)} = \frac{\pi_{i,x}(q)}{(1 + r)^n} - (F + q) \tag{11}
\]

\[
U_{i,x} = \Pi_{i,x} - t_{i,x} \tag{12}
\]

Functions (1)–(12) should be verified firstly before being tested by examining the consistency of all units used in all mathematical expression in the concerned model. Equations (1–4) are performance criteria as probability of random number between 0 and 1. Equations (5–8) are performance criteria expressed as funding dimension with unit of Rp (rupiahs) as well as with Equations (11) and (12). Objective function which is in Equation (10) also has the same dimension and unit Rp. Meanwhile, the set of constraint expressed in Equation (9) has dimension of funding and unit of Rp, which means has met all constraint formula in this model. In other words, the model has been mathematically corrected, logic and using the appropriate data.

Game theory uses a particular method to solve the model and find the optimum value. Number of player involved in the model is determined first. Then alternative of possible given incentives is decided as \( i \). Type of incentive is chosen from \( i = 1 \) to \( i = I \) in the next. Government payoff is calculated afterwards and checked if it has reached the minimum desire payoff. Selection of incentive will be repeated whenever the payoff is not able to satisfy government target yet and will be stopped otherwise. Resume of the model testing result is shown in Tables 5–7.

From Tables 5–7, it can be concluded that social activity and infrastructure projects are basically rejected due to negative payoff. The negative payoff occurs as the result of insufficient positive transfer from project operators to cover negative transfer given by government to them. However, government payoff may turn to positive whenever there is an adding beneficial value of the project, indicating the project is feasible as it provides huge beneficial value to public. In fact, the huge beneficial value is not accompanied with sufficient budget; hence, investor is urgent to support investment project funding.

### 3.3.2. Goal programming model

All activities in KTP should be considered in respective model as the aim of KTP development is to unite them. According to the three types of activities conducted in KTP, objective function in this model can be divided into productive activity function, science and technology activity function, and social activity and infrastructure function. Nonetheless, it is impossible to include every single project into one same function due to different budgeting from government. There are four variables used in this model.
which are risk level, incentives value given by government, beneficial value and NPV adjustment level of the project. Meanwhile, a performance criterion in this model is optimizing PPI given by government to KTP.

Regarding the model, several assumptions are determined. Subsidies incentive is given in the form of funding support. The given PPI is a negative transfer which means government gives a payment to investor through a particular incentive. Beneficial value function is always increasing, convex and satisfying Inada condition.

(a) Minimizing Risk Level of the Project

Table 5. Project incentive decision for productive activity.

| Project code | Project priority | F1 | F2 | F3 | F4 | S1 | S2 | Payoff                |
|--------------|------------------|----|----|----|----|----|----|----------------------|
| P1           | H,h              | ✓  | ✓  | ✓  |    |    |    | USD 60,856,733,917   |
| P2           | H,h              | ✓  | ✓  | ✓  |    |    |    | USD 33,403,833,219   |
| P3           | H,h              | ✓  | ✓  | ✓  |    |    |    | USD 10,510,574       |
| P4           | H,h              |    |    |    |    |    |    | -                    |
| P5           | L,h              | ✓  | ✓  | ✓  |    |    |    | USD 103,945,025      |
| P6           | L,h              | ✓  | ✓  | ✓  |    |    |    | USD 6,551,064        |
| P7           | L,h              | ✓  | ✓  | ✓  |    |    |    | USD 29,761,040       |
| P8           | L,h              | ✓  | ✓  | ✓  |    |    |    | USD 199.88           |
| P9           | L,h              | ✓  | ✓  | ✓  |    |    |    | USD 2,386.953        |
| P10          | L,h              | ✓  | ✓  | ✓  |    |    |    | USD 12,609.435       |
| P11          | L,h              | ✓  | ✓  | ✓  |    |    |    | USD 13,089.702       |
| P12          | L,h              | ✓  | ✓  | ✓  |    |    |    | USD -                |
| **Total Government Payoff** | | | | | | | | USD 94,439,620.809   |

Table 6. Project incentive decision for science and technology activity.

| Project code | Project priority | F1 | F2 | F3 | S1 | S2 | Payoff                |
|--------------|------------------|----|----|----|----|----|----------------------|
| L1           | H,h              | ✓  |    |    |    |    | USD 23,100,745,89    |
| L2           | H,h              | ✓  | ✓  | ✓  |    |    | USD 4,502,106,12     |
| L3           | L,h              | ✓  | ✓  | ✓  | ✓  |    | USD 53,353,692,68    |
| L4           | L,h              | ✓  | ✓  | ✓  | ✓  |    | USD 98,151,160,81    |
| **Total Government Payoff** | | | | | | | USD 179,107,705,50   |

Table 7. Project incentive decision for social activity and infrastructure.

| Project Code | Project Priority | Project Decision | F1 | F2 | S1 | S2 | Payoff                |
|--------------|------------------|------------------|----|----|----|----|----------------------|
| I1           | H,h              | Rejected         | ✓  |    |    |    | USD 10,590,106,34    |
| I2           | H,h              | Rejected         | ✓  |    |    |    | USD 3,478,351,22     |
| I3           | H,h              | Rejected         | ✓  | ✓  | ✓  |    | USD (5,035,365,15)   |
| I4           | H,h              | Rejected         | ✓  | ✓  | ✓  |    | USD 1,456,654,32     |
| I5           | H,h              | Rejected         | ✓  | ✓  | ✓  |    | USD 2,223,970,74     |
| I6           | H,h              | Rejected         | ✓  | ✓  | ✓  |    | USD -                |
| I7           | L,L              | Rejected         | ✓  | ✓  | ✓  |    | USD (60,998,732,87)  |
| I8           | L,h              | Rejected         | ✓  | ✓  | ✓  |    | USD 93,624,84        |
| I9           | L,h              | Rejected         | ✓  | ✓  | ✓  |    | USD 2,837,585,48     |
| **Total Government Payoff** | | | | | | | USD (45,353,805,09)  |
Risk level is calculated as the average from five identified project risks: (a) economic and financial risk, (b) external risk, (c) operational risk, (d) managerial risk and (e) social risk. Risk level from each activity in KTP is formulated as Equations (13)–(15).

- Risk Level for Productive Activity

\[
\sum_{p=1}^{12} R_p^P = \frac{\sum_{p=1}^{12} \sum_{a=1}^{5} R_{pa}^P}{5}
\]

- Risk Level for Science and Technology Activity

\[
\sum_{l=1}^{4} R_l^L = \frac{\sum_{l=1}^{4} \sum_{a=1}^{5} R_{la}^L}{5}
\]

- Risk Level for Social Activity and Infrastructure

\[
\sum_{i=1}^{9} R_i^I = \frac{\sum_{i=1}^{9} \sum_{a=1}^{5} R_{ia}^I}{5}
\]

(b) Minimizing Incentives

In general, incentive given by government is total amount from fiscal and subsidies incentive as shown in Equation (16). Incentive model for all activities in KTP both from fiscal and subsidies is shown in Equations (17)–(31). Equations (18), (23) and (28) illustrate that each project is only possible to get one fiscal incentive instrument. Restriction given by Equations (20), (25) and (30) shows that project receives subsidies not more than provided subsidies:

\[
\sum_{i=1}^{n} I_i = \sum_{i=1}^{n} IF_i + IS_i
\]

- Incentives for Productive Activity Project

3.4. Fiscal incentives

\[
\sum_{p=1}^{12} IF_p^P = \sum_{p=1}^{12} \sum_{a=1}^{4} IF_{pa}^P \times AF_{pa}^P
\]

\[
\sum_{a=1}^{4} AF_{pa}^P \leq 1
\]

\(AF_{pa}^P \in (0, 1)\) for \(p = 1, 2, \ldots, 12\) and \(a = 1, 2, \ldots, 4\)
3.5. **Subsidies incentives**

\[
\sum_{p=1}^{12} IS_p^P = \sum_{p=1}^{12} \sum_{\alpha' = 1}^{12} S_{p\alpha'}^P \times AS_{p\alpha'}^P
\]

(19)

\[
\sum_{p=1}^{12} S_{p\alpha'}^P \leq \sum_{p=1}^{12} S_{p\alpha'}^P
\]

(20)

\[
\sum_{\alpha' = 1}^{4} AS_{p\alpha'}^P \geq 0
\]

(21)

\[AF_{p\alpha'}^P \in (0, 1) \text{ for } p = 1, 2, \ldots, 12 \text{ and } \alpha' = 1, 2, \ldots, 4\]

- Incentives for Science and Technology Activity Project

3.6. **Fiscal incentives**

\[
\sum_{l=1}^{4} IF_l^L = \sum_{l=1}^{4} \sum_{\beta = 1}^{3} F_{l\beta}^L \times AF_{l\beta}^L
\]

(22)

\[
\sum_{\beta = 1}^{3} AF_{l\beta}^L \leq 1
\]

(23)

\[AF_{l\beta}^L \in (0, 1) \text{ for } l = 1, 2, \ldots, 4 \text{ and } \beta = 1, 2, 3\]

3.7. **Subsidies incentives**

\[
\sum_{l=1}^{4} IS_l^L = \sum_{l=1}^{4} \sum_{\beta' = 1}^{2} S_{l\beta'}^L \times AS_{l\beta'}^L
\]

(24)

\[
\sum_{l=1}^{4} S_{l\beta'}^L \leq \sum_{l=1}^{4} S_{l\beta'}^L
\]

(25)

\[
\sum_{\beta' = 1}^{2} AS_{l\beta'}^L \geq 0
\]

(26)

\[AF_{l\beta'}^L \in (0, 1) \text{ for } l = 1, 2, \ldots, 4 \text{ and } \beta' = 1, 2\]

- Incentives for Social Activities and Infrastructure
3.8. Fiscal incentives

\[
\sum_{i=1}^{9} IF_i^l = \sum_{i=1}^{9} \sum_{y=1}^{2} F_{iy}^l \times AF_{iy}^l
\]  
(27)

\[
\sum_{y=1}^{2} AF_{iy}^l \leq 1
\]  
(28)

\[AF_{iy}^l \in (0, 1) \text{ for } i = 1, 2, \ldots, 9 \text{ and } y = 1, 2\]

3.9. Subsidies incentives

\[
\sum_{i=1}^{9} IS_i^l = \sum_{i=1}^{9} \sum_{y'=1}^{2} S_{iy'}^l \times AS_{iy'}^l
\]  
(29)

\[
\sum_{i=1}^{12} S_{iy'}^l \leq \sum_{i=1}^{12} S_{iy'}^l
\]  
(30)

\[
\sum_{y'=1}^{2} AS_{iy'}^l \geq 0
\]  
(31)

\[AF_{iy}^l \in (0, 1) \text{ for } i = 1, 2, \ldots, 9 \text{ and } y = 1, 2\]

(c) Maximizing NPV Adjustment Level of the Project

There will be increasing in NPV whenever a particular project receives an incentive. Adjustment of NPV for every project in KTP can be calculated by formulas (32)–(34).

- NPV Adjustment Level for Productive Activity Project

\[
\sum_{p=1}^{12} NPV_{iP}^l = \sum_{p=1}^{12} \frac{IP_i^p}{NPV_{iP}^p} \times 100\%
\]  
(32)

- NPV Adjustment Level for Science and Technology Activity Project

\[
\sum_{l=1}^{4} NPV_{iP}^l = \sum_{l=1}^{4} \frac{IL_i^l}{NPV_{iL}^l} \times 100\%
\]  
(33)

- NPV Adjustment Level for Social Activity and Infrastructure Project

\[
\sum_{i=1}^{9} NPV_{iP}^l = \sum_{i=1}^{9} \frac{IL_i^l}{NPV_{il}^l} \times 100\%
\]  
(34)
c. Maximizing Beneficial Value of the Project

All government’s project should possess huge beneficial value for public and can be formulated as Equations (35)–(37).

- Beneficial Value of Productive Activity Project

$$TM^p = \sum_{p=1}^{12} M^p$$  \hspace{1cm} (35)

- Beneficial Value of Science and Technology Activity Project

$$TM^l = \sum_{l=1}^{4} M^l$$  \hspace{1cm} (36)

- Beneficial Value of Social Activity and Infrastructure Project

$$TM^i = \sum_{i=1}^{9} M^i$$  \hspace{1cm} (37)

The model itself is subjected to amount of budget from government where the given incentive should be not more than respective provided budget as seen in Equation (38)–(40).

$$\sum_{p=1}^{12} t_p^p \leq BI^p$$  \hspace{1cm} (38)

$$\sum_{l=1}^{4} t_l^l \leq BI^l$$  \hspace{1cm} (39)

$$\sum_{i=1}^{9} t_i^i \leq BI^i$$  \hspace{1cm} (40)

Similar with Game theory model, all formulas used in this model have to be verified first before being tested. Equations (13)–(15) are performance criteria based on number of level. Equations (17), (19), (22), (24), (27) and (29) are performance criteria with dimension of funding (Rp) as well as the Equations (35)–(37). Adjustment level (%) is dimension for Equations (32)–(34). The constraints in Equations (38)–(40) have dimension of funding (Rp) which means the state of constraint is adequate for this model.

Before the test is running, objective functions and constraint of the model have to be transformed into goal programming model form. Objective function is transformed into new constraint called as soft constraint by adding the desire goal ($\omega$), positive
deviation \((p)\) and negative deviation \((n)\). Meanwhile, the constraint is transformed into hard constraints which have been expressed in Equations (18), (20), (21), (23), (25), (26), (28), (30) and (31).

Target of each objective function as well as initial target is determined firstly in goal programming solving method. Then, by using simplex method, deviation variable is minimized. The process is ended if all of the goals are obtained; otherwise, target in objective function with deviation is reset. Model testing is run by inputting the model and value of each parameter into Lingo 11.0 program. There are three scenarios used to run the test. Scenario A is pessimistic scenario where target level for each goal is set to low level. Scenario B is the otherwise, setting high target level of the goals. Meanwhile, scenario C is approximately optimum which means if any level is set to be higher than before, then there will be unachieved goal. The three scenarios criteria are described on Tables 8–10.

Based on goal programming result on Tables 11–13, scenario A is not able to satisfy any activity group project as one or more goals cannot be achieved. Only

### Table 8. Scenario for productive activity.

| Performance criteria          | Government |
|------------------------------|------------|
|                              | A          | B          | C          |
| Goal 2 – Government Incentive| USD 52,173,913,04 | USD 43,478,260,87 | USD 34,782,608,70 |
| Goal 4 – Project Total Benefit| USD 63,708,038,708,19 | USD 63,710,000,000,00 | USD 63,710,000,000,00 |
| Goal 1 – Risk Level          | Level 3    | Level 2    | Level 2    |
| Goal 3 – NPV Level           | <20%       | <30%       | <40%       |

### Table 9. Scenario for science and technology activity.

| Performance criteria          | Government |
|------------------------------|------------|
|                              | A          | B          | C          |
| Goal 2 – Government Incentive| USD 34,782,608,70 | USD 30,434,782,61 | USD 17,391,304,35 |
| Goal 4 – Project Total Benefit| USD 299,847,738,42 | USD 300,000,000,00 | USD 300,000,000,00 |
| Goal 1 – Risk Level          | Level 3    | Level 2    | Level 2    |
| Goal 3 – NPV Level           | <20%       | <30%       | <40%       |

### Table 10. Scenario for social activity and infrastructure.

| Performance criteria          | Government |
|------------------------------|------------|
|                              | A          | B          | C          |
| Goal 2 – Government Incentive| USD 69,565,217,39 | USD 65,217,391,30 | USD 52,173,913,04 |
| Goal 4 – Project Total Benefit| USD 56,714,656,61 | USD 56,800,000,00 | USD 56,800,000,00 |
| Goal 1 – Risk Level          | Level 3    | Level 2    | Level 2    |
| Goal 3 – NPV Level           | <20%       | <30%       | <40%       |
productive project group goal is not fulfilled by scenario B. Notwithstanding the capability of scenario B applied to other project groups, scenario C is chosen instead as it uses less amount of incentives and provides more NPV rate. Not all of project activities in respective group are accepted. I np r o d u c t i v e p r o j e c t group, only marine industry development (P1), cow farming area development (P4) and agro-business of patin fish culture in fish cage (P9) are accepted. Except Agency of Research and Development of Technology, all project activities in group science and technology can be accepted (L2, L3, L4). Meanwhile, there are three project activities in social activity and infrastructure group which are accepted: road construction in technopolis area (I3), electricity (I4) and telecommunication infrastructure development (I5).

Table 11. Goal programming output for productive activity.

| Project code | Risk level | F1  | F2  | F3  | S1  | S2  | Total (USD) | NPV Level | Beneficial value (USD) |
|--------------|------------|-----|-----|-----|-----|-----|-------------|-----------|------------------------|
| P1           | 2,4        | √   |     |     |     |     | 38,838,080,00 | 0.11%     | 36,260,580,000,00     |
| P2           | 2,4        |     |     |     |     |     | 264,902,30   | 39%       | 670,479,70             |
| P3           | 2,4        |     |     |     |     |     | 5,633,098,00 | 0%        | 5,633,098,00           |
| P4           | 2,4        |     |     |     |     |     | 264,902,30   | 39%       | 670,479,70             |
| P5           | 2,2        |     |     |     |     |     | 5,434,783,00 | 5.10%     | 106,536,100,00        |
| P6           | 2,2        |     |     |     |     |     | 14,516,530,00| 9.02%     | 160,955,500,00        |
| P7           | 2,2        |     |     |     |     |     | 29,522,447,16| 4.00%     | 9,376,696,00           |
| P8           | 2,2        |     |     |     |     |     | 5,764,583,00 | 0%        | 5,764,583,00           |

Total Government Expense: 39,130,437,94 USD

Table 12. Goal programming output for science and technology activity.

| Project code | Risk level | F1  | F2  | S1  | S2  | Total (USD) | NPV Level | Beneficial value (USD) |
|--------------|------------|-----|-----|-----|-----|-------------|-----------|------------------------|
| L1           | 2          |     |     |     |     | 157,382,70  | 5.88%     | 2,676,727,00           |
| L2           | 1          |     |     |     |     | 5,434,783,00| 5.10%     | 106,536,100,00        |
| L3           | 1          | √   |     |     |     | 14,516,530,00| 9.02%     | 160,955,500,00        |
| L4           | 2          |     |     |     |     | 29,679,480,00| 4.00%     | 9,376,696,00           |

Total Government Expense: 20,108,695,70 USD

Table 13. Goal programming output for social activity and infrastructure.

| Project code | Risk level | F1  | F2  | S1  | S2  | Total (USD) | NPV Level | Beneficial value (USD) |
|--------------|------------|-----|-----|-----|-----|-------------|-----------|------------------------|
| I1           | 2,6        |     |     |     |     | 85,269,570,00| 40.88%    | 4,574,795,00           |
| I2           | 2,2        |     |     |     |     | 347,826,10  | 36.19%    | 1,750,535,00           |
| I3           | 2,4        | √   |     |     |     | 347,826,10  | 36.24%    | 4,798,952,00           |
| I4           | 2,6        | √   |     |     |     | 17,656,940,00| 0.00%     | 17,656,940,00           |
| I5           | 2,8        | √   |     |     |     | 803,131,00  | 0.00%     | 803,131,00              |
| I6           | 1,4        |     |     |     |     | 4,762,960,00| 0.00%     | 4,762,960,00           |
| I7           | 1,6        |     |     |     |     | 13,043,480,00| 0.00%    | 13,043,480,00          |
| I8           | 1,2        |     |     |     |     | 410,730,00  | 0.00%     | 410,730,00              |
| I9           | 1,8        |     |     |     |     | 4,762,960,00| 0.00%     | 4,762,960,00           |

Total Government Expense: 85,965,222,20 USD
3.9.1. **Compatibility and sensitivity analysis**

Given assumption that project beneficial value, net profit and transfer amount along the planning horizon is deterministic, the two models can be used to solve selection scheme of PPI considering government and operator tendency.

Game theory model is able to determine incentive selection and government payoff in determining PPI. Meanwhile, goal programming model can calculate project-risk level as seen in formulas (13)–(15). The model also can determine the amount of both incentive and subsidy subjected to government’s budget (function (16)). Incentive’s impact to NPV adjustment level is expressed well in Equations (32)–(34). Moreover, the model calculates total beneficial value from all activities in KTP as expressed in Equations (35)–(37). By formulating those interests, the model is compatible to solve the PPI problem into solution with minimal risk and government expense and maximum beneficial value and project NPV.

Sensitivity analysis reveals the ability of the models in responding the possible adjustment towards uncontrollable input. In this research, sensitivity analysis examines US dollar currency rate and interest rate against government payoff. Both US dollar currency and interest rate alteration influence the payoff. US dollar currency directly affects the transfer amount from government, while interest rate has different trend. Whenever government is planning to increase interest rate by monetary incentive, government will expense more budgets for fiscal incentive.

4. **Conclusion**

Selection scheme of PPI is based on alternatives project that held by government with their respective priority which is divided into high- and low-priority project. On the other side, operator has sufficient knowledge about commercial level of particular project. However, not all projects offer commercial value to result certain payoff level. The existence of project with low level of payoff needs the support from government. Hence, the investor will be interested to venture their investment. Government, in this case, has two policy instruments which are project acceptance and transfer. Once the project is accepted, government will consider about the incentive that will be transferred to project operator.

Two models have been developed in this study in order to solve selection scheme of PPI in KTP. Game theory model optimizes the PPI selection scheme by minimizing government expenses in funding the project development but still provides big beneficial value for public. In another side, goal programming model solve the problem by considering project risk level, incentive amount given by government, beneficial value and NPV adjustment level of the project. Furthermore, the models from PPI scheme in KTP can also be implemented as the benchmarking to develop science and technopark in another location. This is due to the criteria in the models not far different from investment for production criteria in general, particularly in term of technopolis.

In future study, the model may be developed and analysed deeper by involving other stakeholder business such as region manager, Pelalawan Regency Officer and other parties related to investment in technopolis area. Deeper study about policymaking regarding investment promotion in Indonesia, particularly in science and technology area, is another alternative for future research to create more optimum result.
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