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Cluster Formation and Government Policy: System Dynamics Approach

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This paper studies the effect of particular government policies on a cluster formation using a system dynamics modeling approach. A conceptual cluster dynamic model includes the interaction of the cluster with resources, workers, jobs, unemployment, salary, market demand, and production capacity. The considered government policies are providing export promotion, establishing the training and research institute, and enlarging the industrial park area. The results show that the cluster will be developed faster and grown larger if the potential export volume is high and the training institute for the firm is established. Increase in land area also enlarges the cluster but it takes a longer time to develop.

Keywords: System dynamics, Industrial cluster, Cluster formation, Government policy

1. Introduction

Clusters are another method for creating competitive advantages, not only for the firms in those clusters but also for the country where the clusters are located. Clusters offer opportunities for the firms to increase productivity, reduce the costs, create innovation, stimulate new business formation, acquire competitive resources and observe future trends (Porter 1998) as well as increase employment rate, enhance Gross Domestic Product (GDP), amplify the likelihood of transforming salaried workers to entrepreneurs, improve real income and stimulate economic growth for the country (Norman and Venables 2004; De Blasio and Di Addario 2005). Many governments in different countries raise cluster development as a key issue for example Sweden (Hallencreutz and Lundequist 2003), Germany (Kaiser 2003), Scotland (Learmonth, Munro, and Swales 2003), Mexico and Costa Rica (Altenburg and Meyer-Stamer 1999).

Many researches focus on cluster development, firms' strategy to develop cluster and government policy to encourage cluster creation. However, most studies are based on static and open-looped perception of the cause and effect of each factor to the cluster formation without including the feedback effect from the cluster to those factors. Therefore, the present research approach will target the effects of the involved factors to the cluster creation using dynamics and feedback involvement approach.

System dynamics modeling is used in this research to simulate the effect of particular policies on the cluster development. System dynamics is a suitable tool to explain complex situations by implementing feedback loops in the model (Sterman 2000). Besides, system dynamics modeling is also a proper tool in policy study, which is shown by an extensive research on policies using System dynamics such as urban development policy (Forrester 1974), health policy to control polio (Thompson and Tebbens 2008) and the climate policy (Fiddaman 2007).

In this study, we create a conceptual system dynamics cluster model which involves the effect of resources, workers, jobs, unemployment rate, average salary, market demand, and production capacity as a tool to understand the effect of government policies to the cluster formation. Three scenarios are used for the different policies applied to develop the cluster. The scenarios are increasing cluster's attractiveness, reducing new firms' failure rate and expanding the amount of resources. The results show that amplifying cluster's attractiveness and lowering the failure rate of new firms can increase the size of a cluster and also fasten the time to develop a cluster. Expanding the amount of resources also enlarges the cluster's size but it extends the time to form the cluster.

From these findings, a government should implement the policies that aim to increase the number of new firms coming into the cluster by attracting key global players to establish a firm in the cluster and thus lower the chance that new firms will fail by providing incentives for new firms and encourage group creation to share knowledge and skills between new firms.

This paper is structured as follows; the first section will examine previous studies on cluster formation patterns and factors that affect the cluster. The next section will discuss the policies that stimulate cluster creation based on current studies. Section 3 to 8 will provide details about the cluster model that was developed in this paper, terminology, scope of the model, assumptions and limitations, the linkages between each factor, scenarios for each implemented policy, the simulation results, and finally the discussion on the results. The last section discusses the implications of the findings regarding government policies and conclusions.

2. Cluster formation – pattern and related factors

Cluster creation is based on agglomeration economies – increasing return in spatial form – of the firms with homogeneous need. When a cluster starts forming itself, an increasing return will enhance the benefits for existing firms in the clusters and attract new firms. This process will strengthen clusters and clusters will be locked-in (Arthur 1994). However, clusters' growth is limited by "Cluster Resource Capacity" which are the essential resources for clusters formation and upgrading (Groothuis 2005; Mertz and Groothuis 2006).

Feldman and Francis (2004) disaggregate cluster formation into three stages. In the first stage, the region is inert and there is no significant entrepreneurial activity. The movement will start when there are external and unanticipated factors that lower the cost of entrepreneurship. Then the cluster will begin to form. The characteristic of this second stage is an increase of entrepreneurial activities such as the interaction between entrepreneurs and the surrounding environment. Entrepreneurs may alter the environment by setting up institutions that create further innovation. The last stage is when the location gains the reputation as the place "to be" for particular industries.

The factors that can assist cluster development and attract new firms to invest in the cluster are specific to the type of industry. For the high-tech industries, skilled labor with specific knowledge and expertise is a major factor that affects the decision making regarding the location. However, the location for high-tech industry tends to be attached to the location of technological innovations because the mobility of technology is limited in the early period (Feldman and Francis 2004). Brenner (2005) argued that process innovations help in cluster creation for every industry, not only high-technology industries, while product innovations do not show a significant effect. Brenner (2005) also presented from the empirical study that high cooperation between firms with suppliers and universities is observed in the area that the cluster is developing.

De Blasio and Di Addario (2005) studied the effect of clusters on the workers and found that workers gain benefits from the clusters because they have a higher chance of being employed and are more likely to develop their own business. Clusters also increase the job mobility for blue-collar workers but reduce it for white-collar workers. The return to education inside the cluster is lower than outside the cluster except for workers with elementary educations or less.

3. General policies for clusters development

The government can play and should play a major role in encouraging cluster development. Porter (2000) stated that the government has a role in facilitating cluster development and upgrading. Norman and Venables (2004) also indicated that the government policy has a significant role in cluster development. Without a government policy, the number of industrial clusters will be too many and each cluster will be too small, which makes the output lower than the level that maximizes world welfare.

The government can encourage cluster development and upgrading by removing obstacles and relieve constraints, including human resources, infrastructure and regulation. To be more specific, Porter (2000), based on a diamond model, suggested that a government should locate related departments around clusters, attract foreign investment to clusters, provide export promotion and reduce barriers to local competition, provide education and research facilities that target to specific cluster-related knowledge and enhance infrastructure, encourage pro-innovation regulation, provide testing and product certification infrastructure or act as buyers, create supporting industries by sponsor cluster-specific forum, attract cluster-specific suppliers and service providers and set up free trade zones, industrial parks or supplier parks. Rodriguez-Clare (2007) also recommend that the policy should concentrate on the benefits of clustering instead of creating price distortion.

4. Terminology in the model

In this model, some terminologies are used to present and illustrate the behavior of the cluster. The definitions are listed below

Terminology	**Definition**
Type of firms	
• New firms	Firms which are newly established and unfamiliar with the business environment. New firms are smaller, hire less people, and produce less products than mature and declining firms
• Mature firms	Firms which are established for a period of time, familiar with the business and competitive environment, growing and still competable with other firms. Mature firms will use more resources, hire more people, the produce more products than other firms' type
• Declining firms	Firms which are already passed the mature stage and stop growing. Declining firms will utilize existing resources such as brand image or existing innovative without creating new competitive resources.
Resources	
• Land	Land represents a limited resource for business operations besides labor
• Training labor	Workers who are willing to work in the clusters, whether employed or not, but have either no experience or limited experience. Trainees cannot work in a cluster until they are trained to be experienced workers

- Experienced labor — Workers who, whether employed or not, have been trained and have specific knowledge and skills to work in a cluster
- Job coverage — Represents the supply and demand of the labor. If job coverage is larger than one, it represents the unemployment in the cluster. If job coverage is lower than one, labor is shortage
- Perceived job coverage — The job coverage that is perceived by the public. People perceive job coverage as an average value of job coverage for a period of time, not an exact value in each year
- Average salary — Average salary that workers who are employed in this cluster will receive
- Perceived average salary — Average salary that is perceived by the public. People perceive average salary as an average value for a period of time instead of the exact value in each year
- Average salary ratio — The ratio between the average salary of this cluster and the average salary of other industries, calculated by dividing the perceived average salary by the average salary of other industries

Market demand and production capacity

- External market demand — The market demand that is not created or affected by the cluster
- Internal market demand — The market demand that is created or affected by the cluster
- External market demand coverage ratio — The ratio between production capacity and the external market demand. This ratio shows how well the clusters serve the existing market demand without creating internal demand.
- Perceived market demand — The total market demand - the sum of external and internal market demand - that is perceived by the public. Companies perceive market demand as an average value for a period of time instead of the exact value in each year in order to avoid overreact or under-react to a demand fluctuation
- Demand coverage ratio — A variable to present the demand and supply of products. If the demand coverage ratio is higher than one, the cluster produces products more than the market demand
- Worker efficiency — The number of products one worker produces in a year

5. Scope, assumption and limitation of the model

The variables included in this generic cluster model consist of the size of the cluster, the workers who are willing to work in this cluster, the job availability, the resource limitation, average wages and salaries of workers who work in this cluster, the production capacity and the market demand.

The size of the cluster is measured by the total number of firms in all stages in the cluster. In this model, firms are separated into three stages – new firms, mature firms and declining firms. The firms in each stage are assumed to be homogeneous. No firm has higher reputation or has better technological advancement than other firms in the same stage. Firms are always established in this cluster as new firms and then grow to mature and declining firms. There is no jump over between stages. New firms can enter the cluster without the limitation of investment capital. We also assume that there is no risk perception involved in decision making process of establishing firms in this cluster.

The workers in the model are the people who, whether employed or not, want to work and are ready to work in this cluster. We assume that all new workers who come to the cluster are training labor, have no experience and need to be trained to be able to work in the cluster. After finishing the training period, they will become experienced workers who can fill a position in the cluster. The workers in each category are assumed to be homogenous. Every experienced labor has the same opportunity and ability to find a job. No insiders or social networking involve in this model.

The job availability is the number of jobs that are available in the cluster. We assume that each type of firm offers a different number of jobs, but all jobs are homogeneous. All jobs require the same qualification and all experienced workers are qualified for any job. In the case of job reduction or a layoff, all firms will reduce the number of job at the same rate and current employees will be laid-off randomly.

The resource limitation is represented by land availability. We assume that the cluster is located in an area such as an industrial park which has a limited land area and is not easily expanded. Each type of firms uses a different amount of land but all firms in each stage have the same size. We also assume that all buildings are one-story buildings and there is no vertical expansion.

The salary of workers in the cluster is based on the average salary of other industries. We assume that workers in this industry earn the same salary as the overall industrial average before the simulation. The salary will be adjusted based on the supply and demand of labors – the job availability and the size of the experienced labor pool. We assume that the salary for this cluster

has no effect on the overall industrial salary. Moreover, the overall industrial salary is not increased over time.

The production capacity of this cluster is the sum of the production capacity of all the firms. The production capacity of each firm is calculated by multiplying the number of jobs offerings in each stage of the firm by the product each worker can produced per year. All products are considered homogeneous and the products are well accepted by customers. If the production capacity is higher than the demand, the products will be purchased randomly and without any preference.

The market demand comes from two sources: external market demand and internal market demand. Customers, whether they are from external or internal market demand, are homogenous, have no preference, and purchase the products randomly. Only the size of demand is different. However, the cluster is set to provide higher priority to the external demand. If the external market demand is not fulfilled until specific level, the firms will not create internal market demand.

We assume that there is no political risk and exchange rate risk involved in this model. Moreover, we assume that the interest rate and inflation rate are zero. The operation cost and the price of all products are the same. Therefore, customers will purchase products randomly. There is no trade barrier such as tariff or quota involved in this model. The transportation cost from the production location to both external and internal customers is equal.

6. Casual loop diagram of the cluster: the relationship between each factors

We present a casual loop diagram, shown in Figure 1, to illustrate the relationship between each of the factors involved in the behavior of the cluster. The factors shown in the casual loop diagram include the cluster size, land, job availability, workers, average salary, production capacity and market demand. Variables in the box represent the stock variable.

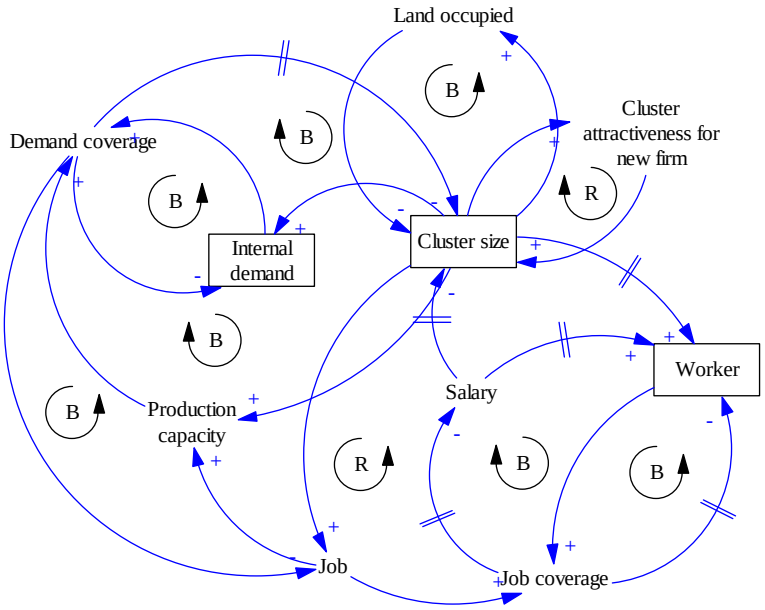

Figure 1: Casual loop diagram showing the relationship between each cluster-related factor

First, the cause and effect loop is the reinforcing loop between current cluster size and the entering of new firms as shown in Figure 2. We assume that the attractiveness of the cluster is related to the size of the cluster. The bigger the size of the cluster, the more firms come into the cluster providing the resources are available.

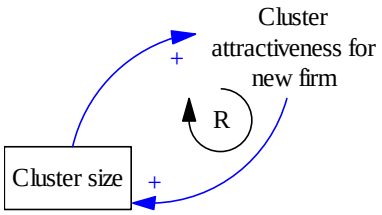

Figure 2: Reinforcing loop between current cluster size and new firms

The next loop is between the cluster and the land as limiting resources shown in Figure 3. The cluster occupies more land when it grows. As a land becomes less and less, the price of land will increase which will reduce the growth of a cluster.

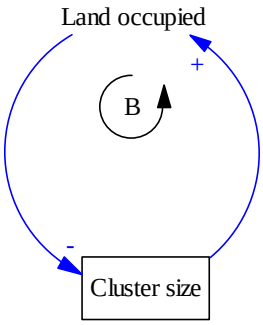

Figure 3: Balancing loop between the cluster size and a limited land

The nested loop shown in Figure 4 is the relationship between cluster size, number of jobs, number of workers and average salary. As the cluster grows, it attracts more workers willing to work in the cluster and also creates more jobs. Comparing the number of workers with number of jobs, we obtain the job coverage. In the unemployment situation, indicated by job coverage is more than one, the average salary of workers in the cluster and number of new workers coming into the cluster will be reduced. The reduced salary also attracts new firms to invest in the cluster.

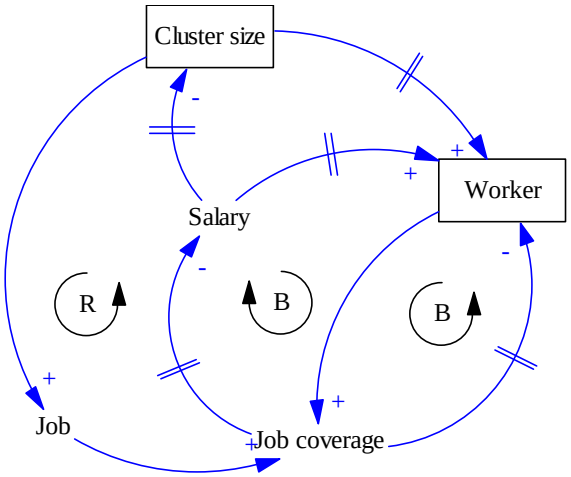

Figure 4: Loops between cluster size, jobs, workers and average salary

Figure 5 shows the connection between the cluster size, market demand, number of jobs and production capacity. A portion of the demand is created by the firms in the cluster. Production capacity is calculated by multiplying the number of firms in the cluster, the number of jobs and the worker efficiency. Comparing the market demand and the production capacity, we obtain the demand coverage ratio. If the demand coverage ratio is higher than one, it shows that the production capacity is over the market demand. An overproduction situation reduces the number of new firms coming into the cluster and also forces the firms to reduce the production by reducing the number of jobs. On the contrary, if the demand is higher than the production

capacity, unfulfilled demand has a chance to switch to a substitute product, which will reduce the total demand the next time.

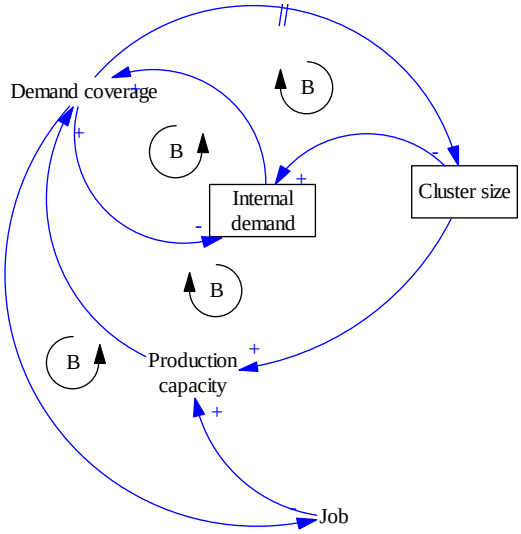

Figure 5: Nested loop between cluster size, number of jobs, production capacity and market demand

7. Stock and flow cluster model

The model is separated into seven modules. The first module includes the number of firms and transformation from new firms to mature and declining firms. Firms in each stage have a chance to fail and exit the cluster. The rate of transforming from one stage to another stage depends on the average salary of the workers in the cluster, the land availability and the demand coverage. The module is shown in Figure 6. The effect of the salary will slow down the firm's transition time. If the salary is low, the firm will expand faster to acquire the low-cost labor opportunity and vice versa. Percentage of occupied land also reduces the firm's transformation rate because the opportunity for new firm to invest is reduced when the available land is limited. The demand coverage ratio also slow down the transition period because if the demand coverage ratio is higher than one, which represents the oversupply situation, the firms will be discouraged to expand due to a current strong market competition.

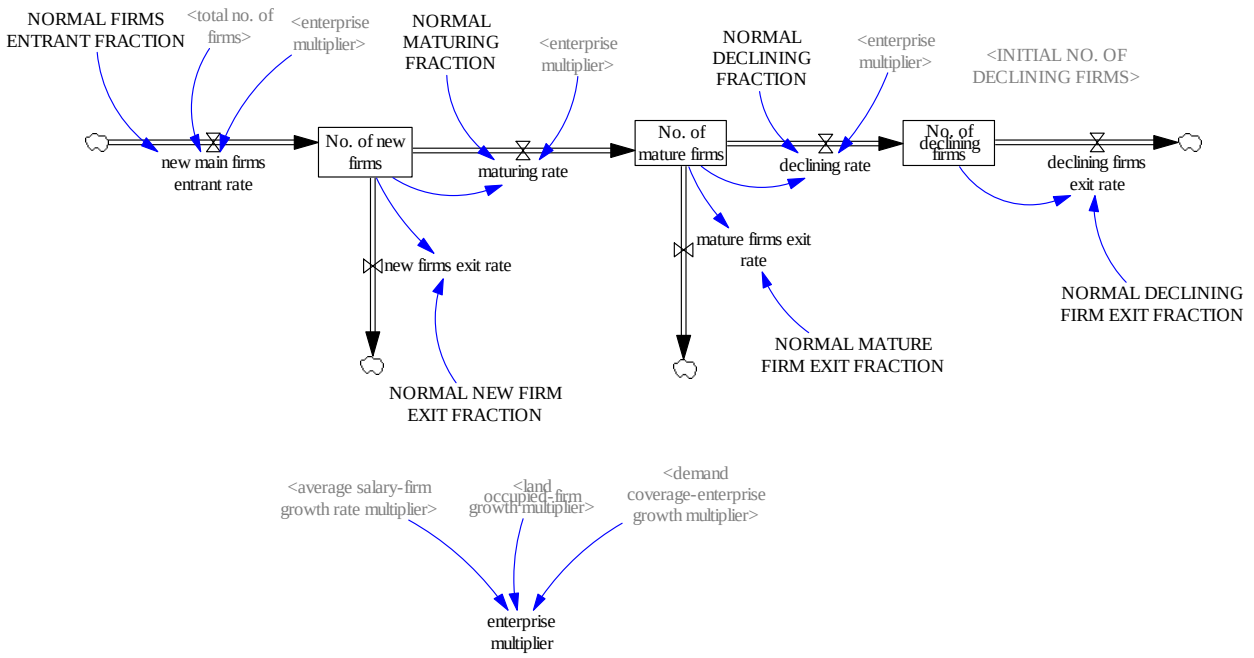

Figure 6: Enterprise module

The next module represents land usage (Figure 7). In this module, the occupied land is calculated by multiplying the number of firms in each stage with the land used per firm in each stage. Comparing land occupied to the total land area, we obtain a land occupied ratio. The land occupied ratio will affect to the transformation rate of the firms.

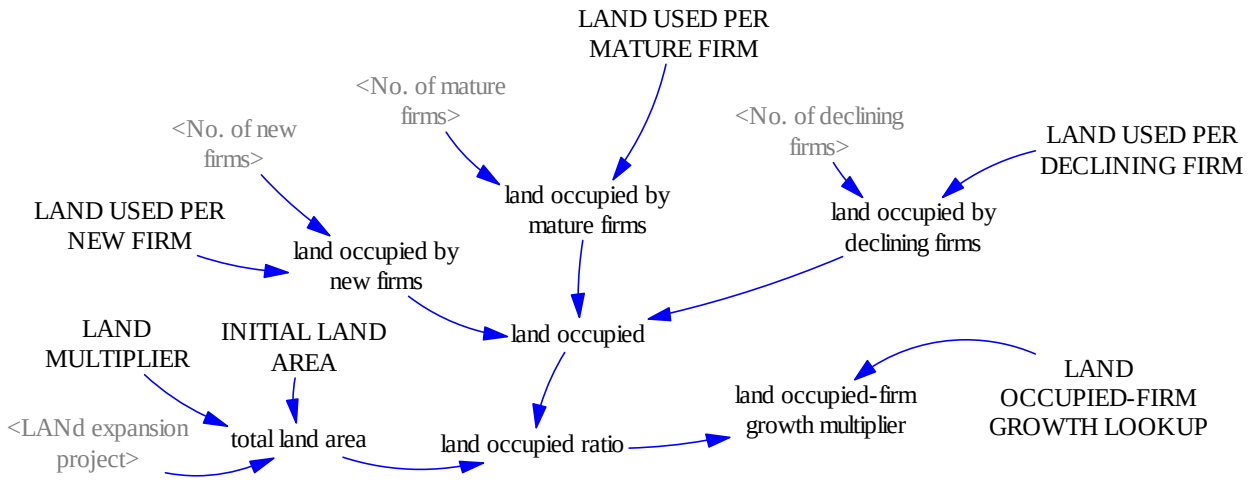

Figure 7: Land usage module

The module shown in Figure 8 presents the number of workers who willing to work in the cluster. Workers are separated into training labors, which are needed to be trained to work in the cluster, and experienced labors. The rate of new workers coming into the cluster is adjusted by

the job coverage ratio, average salary and the size of the cluster. The leaving rate of experienced labors is modified by the job coverage ratio and the average salary. The job coverage ratio lowers the number of new workers coming into and increases the rate of experienced workers leaving the industry because higher job coverage ratio means the number of workers per jobs is increased and the competition for jobs is intense. On the other hand, the salary encourage new worker coming into and prevent the experienced worker from leaving the industry. The number of firm is also pull in new workers because working in a big cluster provides better opportunity in career development than the small cluster.

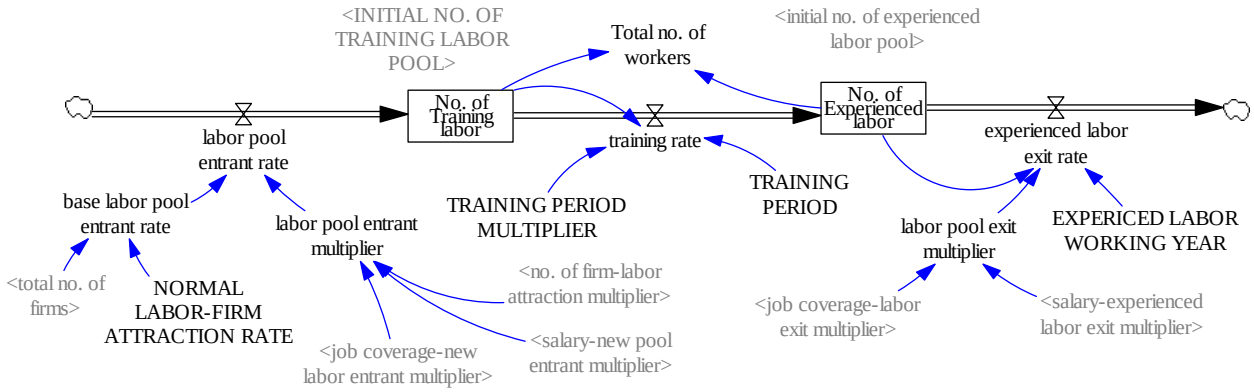

Figure 8: Number of labor module

The module presented in Figure 9 illustrates the linkage between the number of jobs and average salary and the effect on the number of workers and the growth of the firms. The total number of jobs is the sum of number of jobs in each firm stage after it is reduced by a layoff project. Comparing the total job to the number of experienced workers, we obtain the job coverage which will affect the rate of entry of training workers and the average salary. The salary will be averaged for a period of time to yield a perceived average salary, which affects the rate of firm growth, entrant rate of training labor and leaving rate of experienced labor.

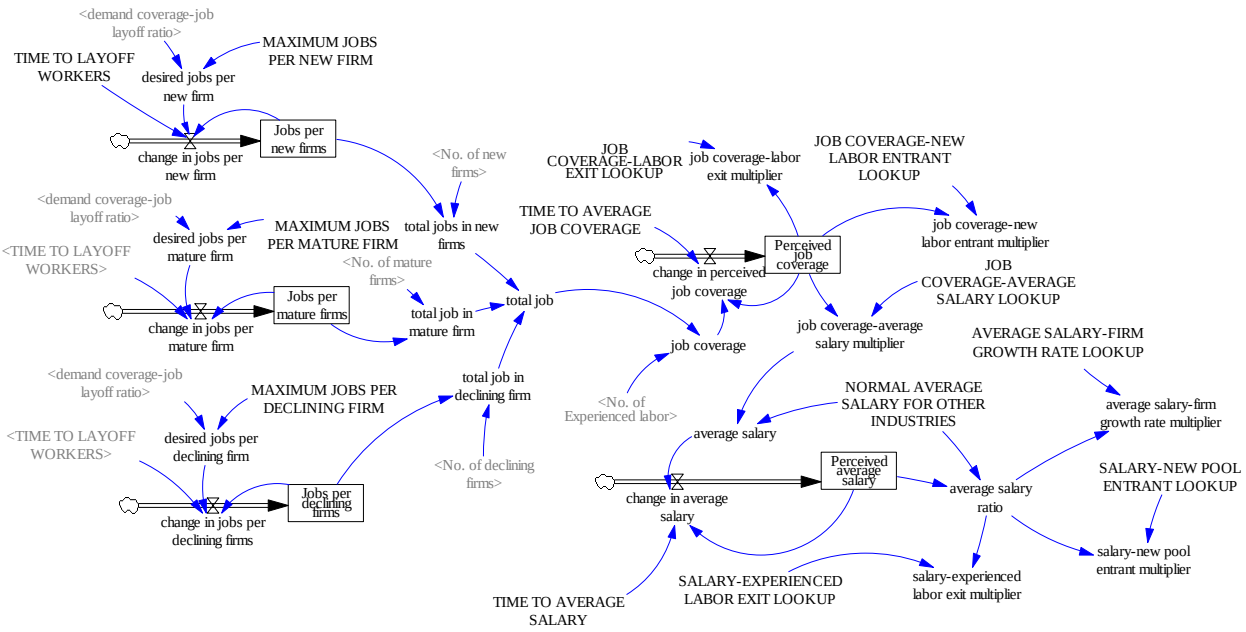

Figure 9: Job coverage and average salary module

Figure 10 shows the module that calculates the market demand, the production capacity and the effect of the demand coverage ratio. The demand comes from external market demand and internal market demand. External market demand is assumed to grow for a period of time. After that, the level of external market demand will be maintained. The model assumes that the product life cycle is long compared to the simulation period, therefore the external product demand does not decline. The internal demand is changed by the external market demand coverage, cluster size and the demand switching rate. We assume that the firms concentrate more on external market demand and will not create an internal market demand until the external market demand is fulfilled to a specific level. We also assume that the external market demand will not be reduced while the internal market demand can decline when the unfulfilled internal customers switch to substitute products. The total demand will be averaged for a period of time and become a perceived market demand.

Production capacity for each firm type is calculated by multiplying the number of jobs per firm, the number of firm and the worker efficiency. Total production capacity is the sum of the production capacity in all stages. Comparing the perceived market demand and the production capacity, we will get the demand coverage ratio. The demand coverage ratio will affect to the transformation rate of the firms and the size of layoff project.

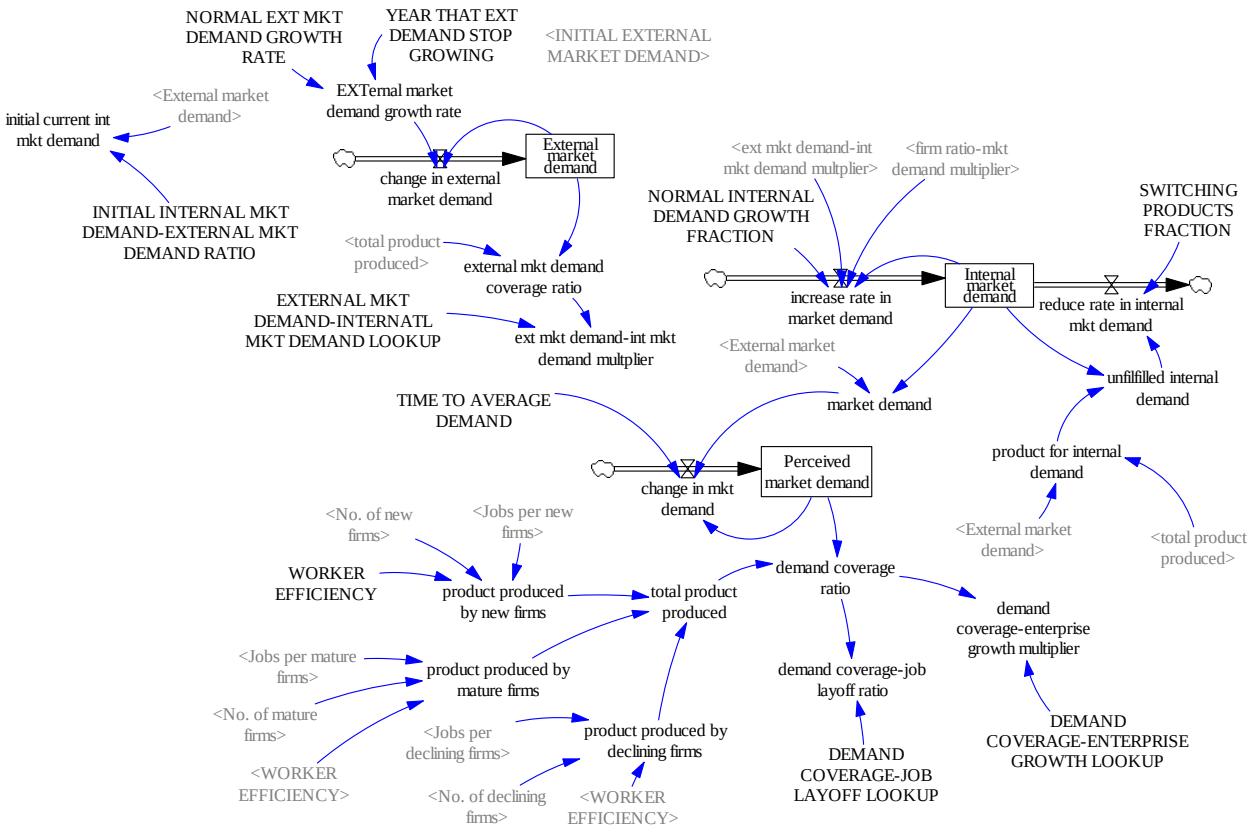

Figure 10: Market demand and production capacity module

The module shown in Figure 11 presents the effect of the size of the cluster, measured by the number of firms in the cluster. The total number of firms will be compared with the average size of the firm group to obtain the number of firm ratio. The firm ratio will affect the internal market demand and training worker entrant rate.

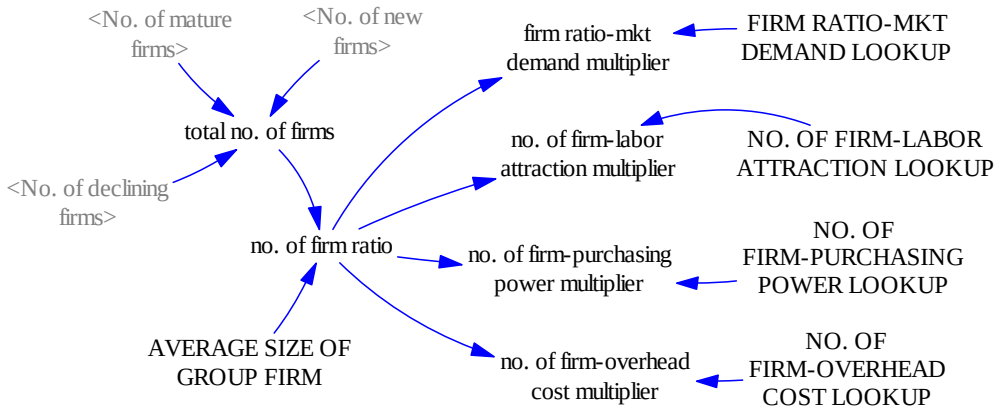

Figure 11: Effect of cluster size module

8. Simulation of the model

To understand the effect of each parameter on the behavior of the cluster and the related variables, we will use the "base run"[1] as a standard and create scenarios by changing each parameter. The studied scenarios are based on Porter (2000)'s recommendation on cluster development, which are providing export promotion, developing education and research facilities, and setting up industrial parks.

Scenario 1: Export Promotion

In this scenario, we study the effect of export promotion on the cluster formation. The export promotion will be incorporated in the model by adjusting the amount of external demand. If the export promotion is effective, the external demand will increase. Based on Porter (2000), we expected to see the improvement in cluster development when the export promotion is in place.

External demand is created to increase and flatten out at a particular time. Export promotion scheme will adjust the steepness of the graph during an increasing period of the external demand. Three cases are simulated to understand the effect of export promotion on the cluster development, which are base case, "EP_Medium growth", and "EP_High growth". The slope of the external demand during the increasing period will be 50% and 100% more than base case in the "EP_Medium growth" and "EP_High growth" case respectively. The external market demand for each case is shown in Figure 12.

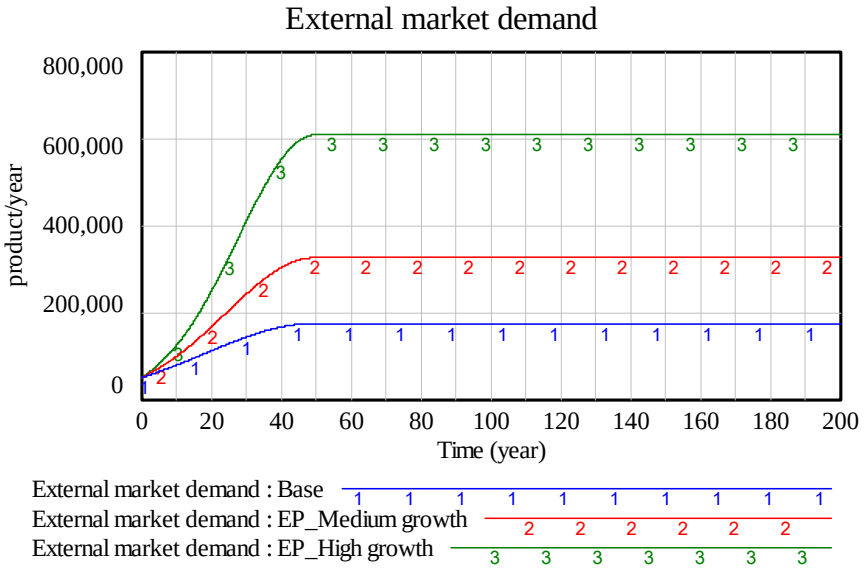

Figure 12: External market demand for each export promotion case

[1] The parameter for "Base Run" is shown in Annex 1.

The result of number of firms indicate that during the first decade, the cluster with high export promotion develop faster and reach the larger cluster size while the base case with no export promotion is the worst. However, after the first decade, the number of firm in the base case jumps up a little and become the second while the case for medium growth becomes the smallest cluster. This result is unexpected.

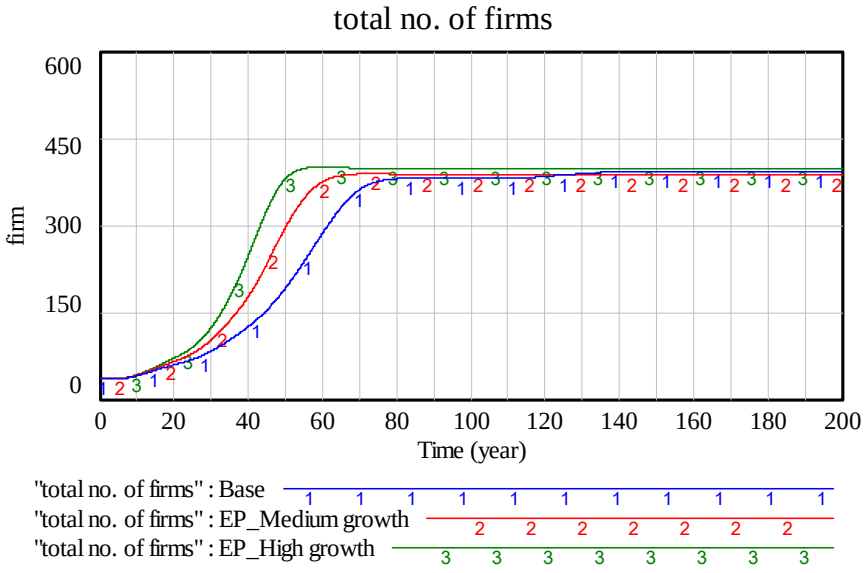

Figure 13: Number of firm for each export promotion case

We trace down for the reason of the jump during year 130 of the base case. We found that the jump is from the internal market demand as shown in Figure 14. The reason for the significant increase in internal market demand is from the market support priority in the model. The model provides the higher priority to the export while the internal demand will decrease if it is not fulfilled. For the base case, the internal market demand is served before it reaches the ground level and then picks up. For the case with export promotion, the internal market demand is eliminated because it is not served.

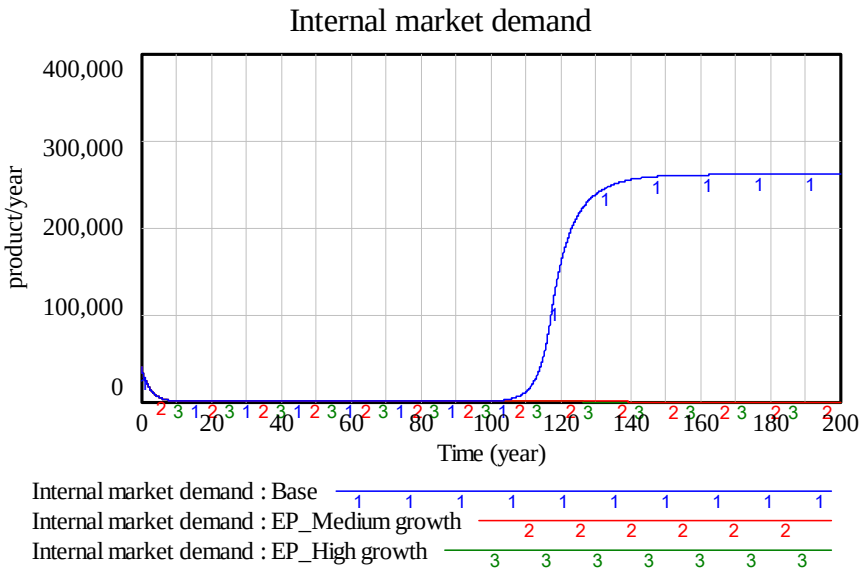

Figure 14: Internal market demand for each export promotion case

The average salary of workers in the cluster does not get a significant effect from the export promotion. Figure 15 shows the average salary of workers in each export promotion case. During the first period, the graph shows an oscillation pattern which comes from the time delay mismatch between the job increase and the worker training period.

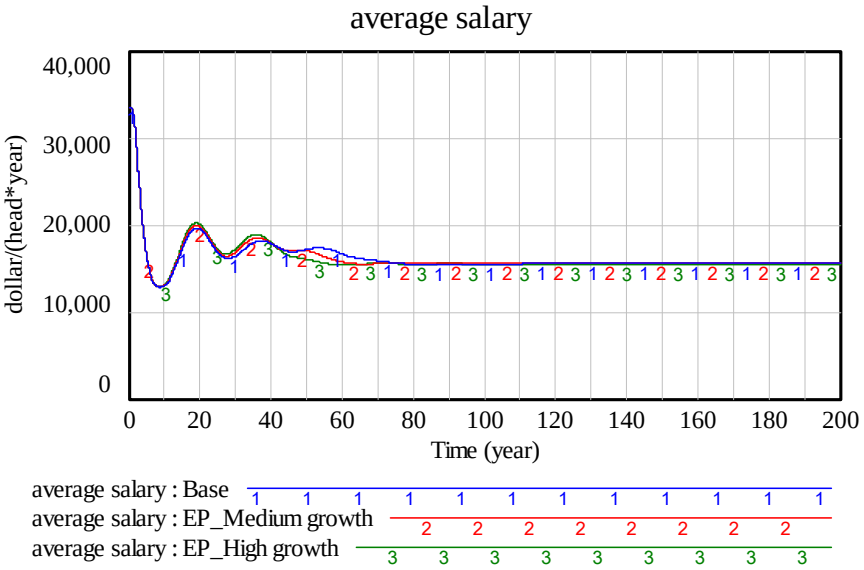

Figure 15: Average salary for each case of export promotion

Scenario 2: Training and research facilities

For scenario 2, we study the effect of training and research facilities on the cluster development. We divide this scenario into two sub-scenarios – training for worker and training for the firm. First sub-scenario, training for worker, is the development of the training institute to train the workers in the cluster for the industrial-specific knowledge. The training institute establishment will be incorporated in the model by reducing the training period from intern to experienced workers. Another sub-scenario is to set up the training and research facilities that provide the industrial-specific knowledge to the new firm in order to shorten the experience curve. In this case, we will apply the firm's training facilities in the model by reducing the exit rate of the new firm.

Three cases are studied for the first sub-scenario – base case, "WT_Medium training" and "WT_Fast training". "WT_Medium training" and "WT_Fast training" has 50% and 75% lower training period than the base case. The result shown in Figure 16 indicates that the effect of setting up worker training institute on the number of firms is not significant. However, the rate of training reduces the number of total workers as shown in Figure 17. The reduced in number of workers is from the reduction of training worker while the number of experienced workers is the same, as shown in Figure 18 and Figure 19.

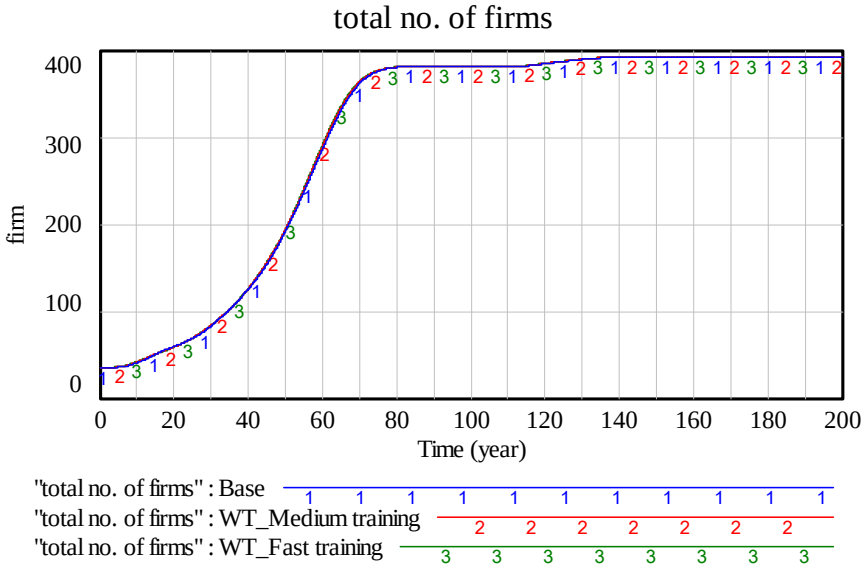

Figure 16: Number of firms for each worker training case

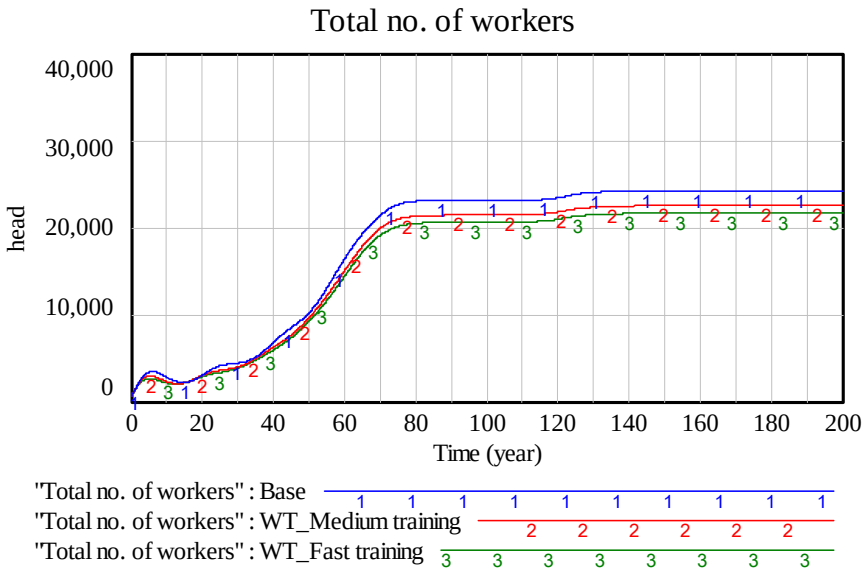

Figure 17: Number of workers in each worker training case

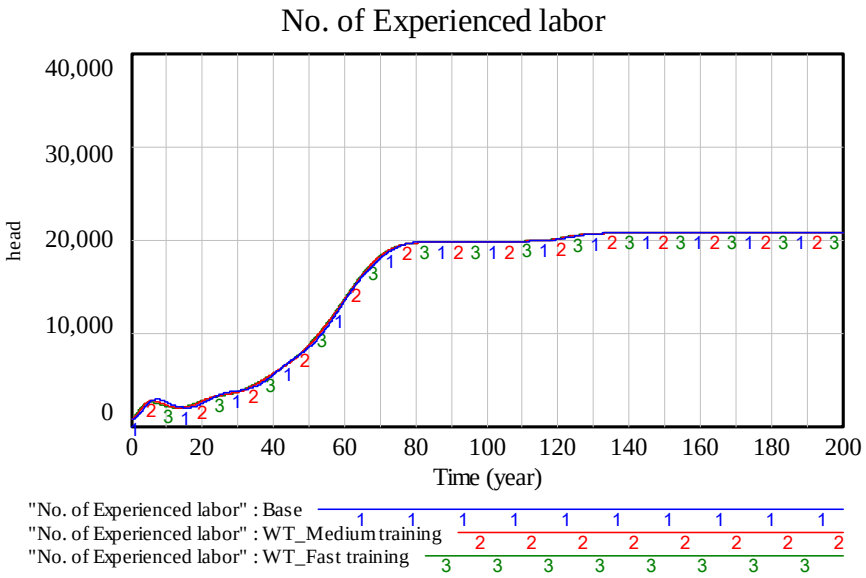

Figure 18: Number of experienced worker for each worker training case

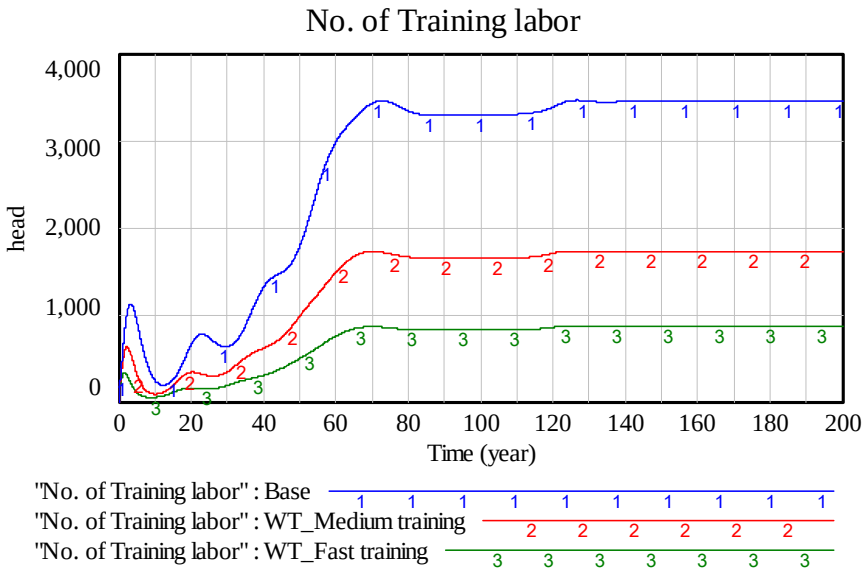

Figure 19: Number of training workers for each worker training case

The establishment of worker training institution does not affect to the average salary of the workers in the cluster as shown in Figure 20. However, the worker training institution helps in reducing the oscillation during the first period. From the graph, the case with worker training institution has lower oscillation amplitude and reaches the equilibrium faster than without the institution.

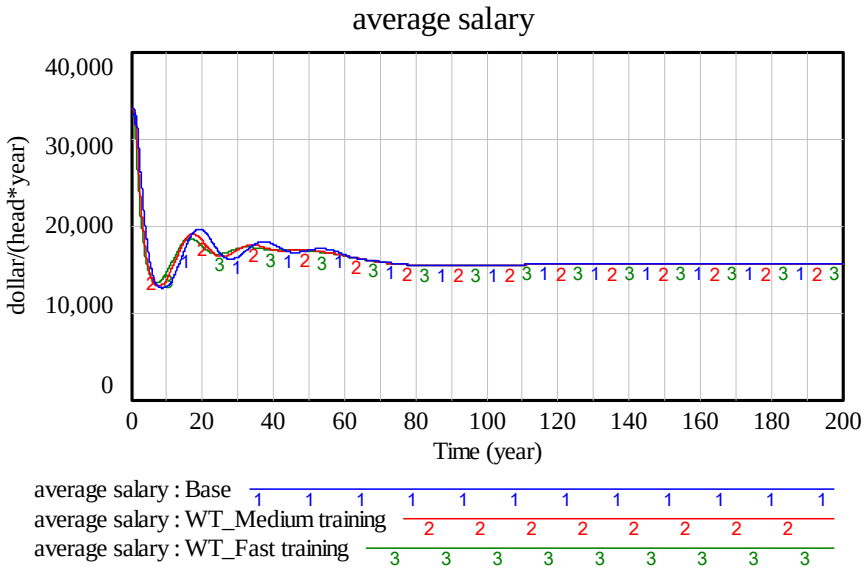

Figure 20: Average salary for each case of worker training

For the second sub-scenario, base case, “FT_Medium effect” and “FT_Strong effect” are used. “FT_Medium effect” and “FT_Strong effect” are the cases with 25% and 50% lower new firm’s failure rate than the base case. The results show that the number of firms in the case with firm’s training facilities grows bigger and develop faster than the case without the firm’s training facilities, as presented in Figure 21. This results is not unexpected from the recommendation by Porter (2000).

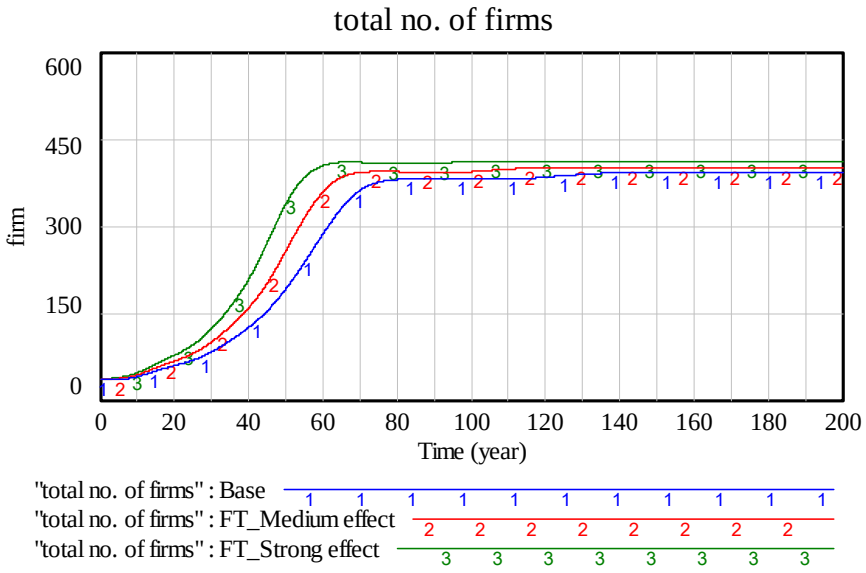

Figure 21: Number of firms for each firm training case

The average salary for the workers in the cluster does not get a significant effect from the firm training facilities as indicated in Figure 22. However, the training institution quickens the time to reach the equilibrium.

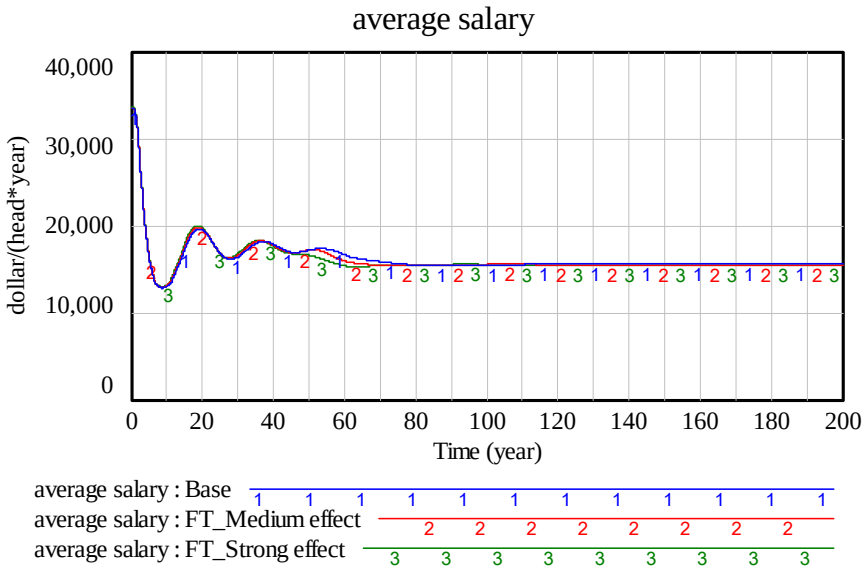

Figure 22: Average salary for each firm training case

Scenario 3: Set up an industrial park

For scenario 3, we study the effect of the policy on providing more industrial-specific area on the cluster development. The industrial park establishment policy will be incorporated in the model by changing the land area. Four cases are used in this scenario. The first case is "SC3_050" which the land is reduced by half. The other two cases are "SC3_150" and "SC3_200" which the land is 50% and 100% more than the base case successively.

The bigger size of land will increase the number of firms in the cluster and the number of workers as shown in Figure 23 and Figure 24. However, the cluster will take a longer time to equilibrate.

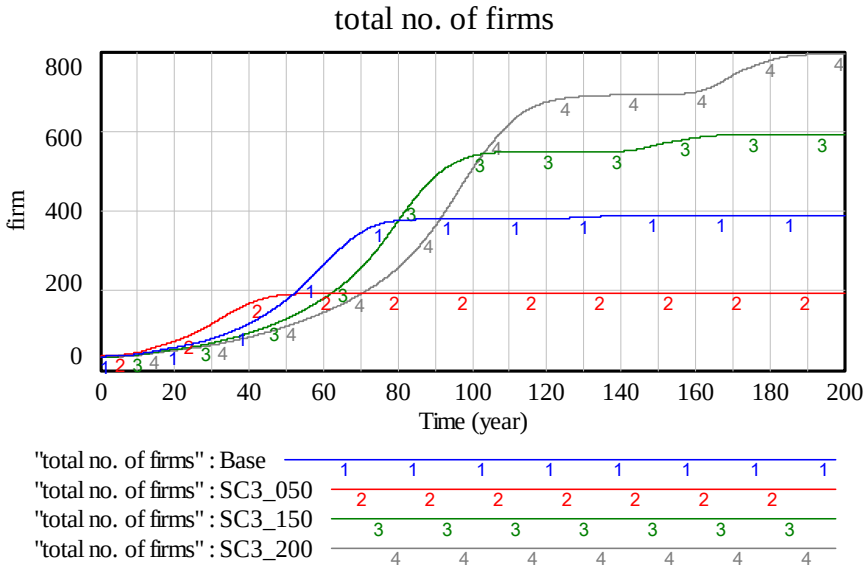

Figure 23: The effect of land size to the cluster size

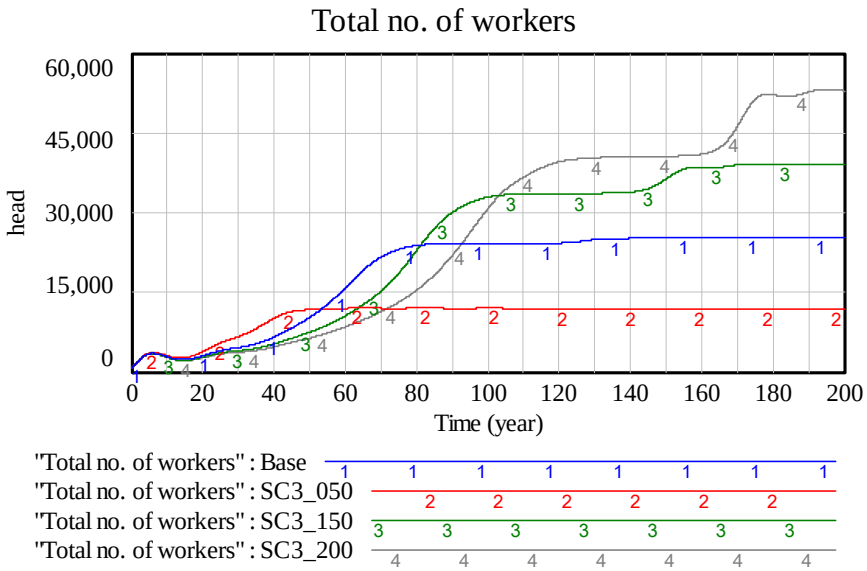

Figure 24: The effect of land size to the number of workers

The effect of land size on the average salary ratio and job coverage is not significant. However, the graphs in Figure 25 show that the bigger land will yield higher job coverage ratio but provides a lower average salary ratio.

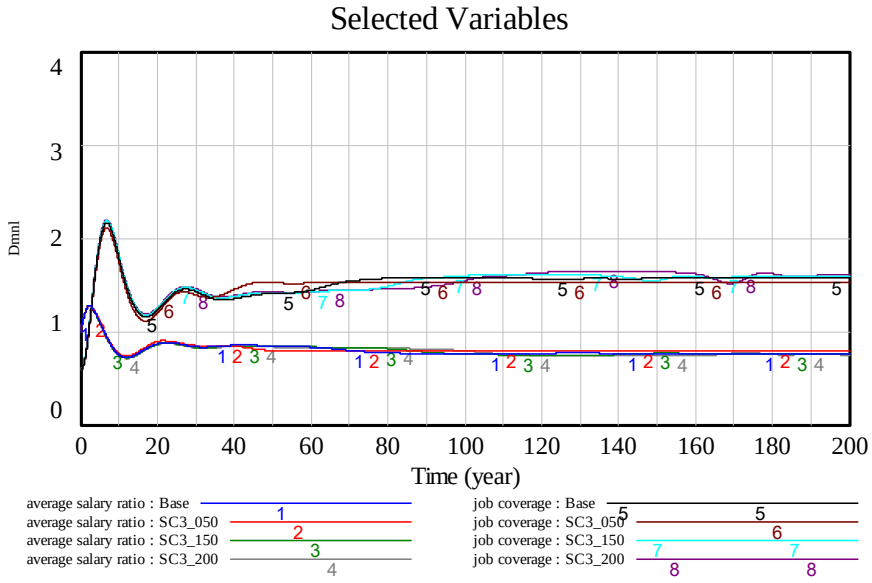

Figure 25: The effect of land size to the average salary ratio and job coverage ratio

9. Discussion of results

In this study, we examine the effect of cluster development policies, namely providing export promotion, establishing training and research institute, and setting up the industrial park on the cluster development. Most of the results support the Porter (2000)'s recommendation on cluster development. However, some of his recommendation needs to be more specific.

Providing export promotion can enhance the cluster development, given the internal market demand is not considered. If the internal market demand is considered and has a lower priority than the external market demand, higher export potential can provide both advantage and disadvantage for the cluster. If the additional export volume from the export promotion is lower than the equilibrium internal market demand, the cluster without the export promotion will get larger in the long run. However, if the additional export volume outweighs internal market demand, providing export incentive will enlarge the size of the cluster. In all cases, providing export promotion will make the cluster develop faster. For the salary, it is not affected by the export promotion in the long run. However, in the short run, export promotion can shorten the oscillation time which means that the salary reaches the equilibrium faster with the export promotion.

For the policy on establishing training institute, training institute for workers does not provide an incentive on cluster development while the institute that aims to distribute industrial knowledge to the firms enlarge the cluster size and make the cluster develop faster. However, establishing the worker training institute significantly reduces the number of training workers. For the salary,

institution for worker training does not affect the salary in the long run but it shortens the time to reach equilibrium in the short run. Institution for firm training, on the other hand, affects the average salary in both long run and short run. The firm training institution reduces the time to reach equilibrium but lowers the average salary in the long run.

The third policy is to provide the industrial park area. This policy can enlarge the size of the cluster but it makes the cluster took longer time to develop. For the salary, providing more area for the cluster lengthens the oscillation period for the salary and lowers the average salary for the workers in the cluster. The reason for the longer cluster development time is the rate of growth of the cluster is not affected by the size of the land. Therefore, the cluster needs more time to fill the bigger land which is manifested as a longer time to reach equilibrium.

10. Conclusion

This paper creates a system dynamic model to study the effect of government policies on the development of the industrial cluster. The studied policies are based on (Porter 2000) which include providing export promotion, establishing the training and research infrastructure, and setting up the industrial park. The results show that export promotion and establishment of firm's training infrastructure provide the benefits to the cluster development. Both policies shorten the time to develop the cluster and enlarge the size of the cluster. The development of workers' training institution, on the other hand, does not affect the cluster development but it reduces the number of training workers in the cluster. Providing more area for the cluster also enlarges the size of the cluster but it lengthens the time to develop the cluster.

This model is a conceptual-based model. In order to develop further from this research, the model can be applied to a specific industry in a particular country. This can provide better understanding of the relationship between each factor and the development of the cluster. Moreover, many factors are neglected in this paper but can be included in future studies. Among the omitted factors in the present study, the capital requirement to set up the firm, macroeconomic situation and barrier to entry and exit the industry are worth mentioning.

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Annex 1: "Base Run" parameter

Normal firms entrant fraction = 0.05	Normal maturing fraction = 0.1
Normal declining fraction = 0.025	Normal new firm exit fraction = 0.1
Normal mature firm exit fraction = 0.02	Normal declining firm exit fraction = 0.05
Initial no. of new firms = 15	Initial no. of mature firms = 20
Initial no. of declining firms = 0	Land used per new firm = 1
Land used per mature firm = 3	Land used per declining firm = 2
Initial land area = 1000	Normal labor-firm attraction rate = 10
Training period = 2	Experienced labor working year = 20
Initial no. of training labor pool = 0	Maximum jobs per new firm = 10
Maximum jobs per mature firm = 50	Maximum jobs per declining firm = 30
Time to average job coverage = 2	Time to average salary = 3
Normal average salary for other industries = 21000	Normal ext mkt demand growth rate = 0.05
Year that ext demand stop growing = 50	Time to average demand = 3
Normal internal demand growth fraction = 0.1	Switching products fraction = 0.5
Worker efficiency = 20	Average size of group firm = 40