Improving Agricultural Innovation Systems in Rural Villages: Regional Innovation Systems in West Sumatra, Indonesia

Amna Suresti[1], Firwan Tan[2], Endrizal Ridwan[2], Febriandi Prima Putra[2] & Uyung Dinata[3]
[1]Faculty of Animal Husbandry, Andalas University, Padang, Indonesia,
[2]Faculty of Economics, Andalas University, Padang, Indonesia
[3]Faculty of Engineering, Andalas University, Padang, Indonesia
Email: amnasuresti@ansci.unand.ac.id

Abstract

To develop West Sumatra, the local government has taken significant measures to increase regional competitiveness through the agricultural innovation system. As part of the national innovation plan, West Sumatra is required to stand ready to participate in the regional innovation system to increase regional competitiveness.

This paper maps out the readiness of West Sumatra Province in developing a regional innovation system through policy instruments. For effectiveness and sustainability, this requires the application of a strong innovation system. One way to measure the maturity level of an innovation system is the Analysis of the National Innovation System (ANIS) model which has 4 variables (policies, institutions, programs, and innovation capacity) with 30 determinants.

The study looks at the impact of the relationship between policies, institutions, innovation programs, and innovation capacity in West Sumatra. It shows that the level of interest in the regional innovation system in West Sumatra is still at a developing level (2.46).

The study also shows that innovation policies, institutions, programs, and capacity have a positive effect on the maturity of the innovation system in the province. The variable that has a significant impact on the maturity and strength of West Sumatra regional innovation is the innovation policies implementation.

Keywords: Regional innovation system, Analysis of National Innovation System, Competitiveness, West Sumatra

Introduction

The development of the regional innovation system is one of the main strategies in the national innovation system which accommodates the integration process between its strengthening components. The regional innovation system also accommodates the National Mid-Term Development Plan. To support the achievement of economic, social, and cultural development in all districts and cities in Indonesia, one of the efforts made by the government is to strengthen agricultural innovation.

An agricultural innovation system is a network of actors (individuals, organizations, and enterprises), together with supporting institutions and policies, in the agricultural and

related sectors that bring existing or new products, processes, and forms of organization into social and economic use. Policies and institutions (formal and informal) shape how these actors interact and learn together, and how they generate, share, and use knowledge (the U.S. Government's Global Hunger and Food Security Initiative). Given the fact that a great majority of the Indonesian population lives a pastoral life, agriculture plays a significant role not only in the lives of the Indonesians but also and more importantly in the country's economy. In such a vital system, farmers are the artisans and key players and as such they need to be supported and protected through various government programs aimed at providing technology and innovation.

One way of achieving this is the establishment of the Regional Innovation System, a sub-project of the National Innovation System put in place by the Indonesian government. Good agricultural innovation systems must be collaborative, with all actors working in networks to produce innovations that the sector needs and can use. Good governance can help by forming clear strategic objectives and comprehensive mechanisms and procedures for evaluation.

This program plays an important role in supporting the National Innovation System Program based on the Minister of Research and Technology and the Minister of Home Affairs Regulations No. 3 and No. 36/2012 which aim to encourage regions to take advantage of the potential of institutions and innovations that exist in each region for the betterment of the society and development (BPPT, 2011).

Several aspects underlie the importance of a Regional Innovation System being formed. In the last decade, there has been a shift from an industry-based economy to a knowledge-based economy. In addition, regional competitiveness is determined by the ability to utilize human capital through innovation systems which can also be influenced by the dynamics of interaction with the outside world, both at home and abroad. With the regional innovation system, it is hoped that there will be synergy between R & D institutions/universities, the business world, and the government towards an era of science and technology-based economy. The West Sumatra Provincial Government realizes that the role of the private sector/business world, R & D institutions/universities is very important to improve regional competitiveness.

Innovation and competitiveness are important parts that cannot be separated from science and technology. The level of competitiveness is one of the parameters in the concept of a sustainable city. The hope is that the higher the level of competitiveness of a city, the higher the level of welfare of its people will be. However, a region will have a different reaction in responding to the impact of the globalization phenomenon. This will differentiate the position of each region in the arena of increasingly fierce global competition. The current conditions must be interpreted as a demand for each region in Indonesia to increase the competitiveness of each region, where the high competitiveness between regions in Indonesia as a whole support the increasing national competitiveness amid the high demands to be able to compete globally (Huda and Santoso, 2014).

A comparison of economic competitiveness between the regions can be carried out by assessing the performance of the economy as well as by indicating the level of economic efficiency in the global economic competition. Regional competitiveness is inevitably the spearhead for increasing national competitiveness. Based on the World Economic Forum (WEF) in its latest annual report, the 2019 Global Competitiveness Index (GCI) Report, Indonesia's competitiveness has dropped by five places from the 45th to the 50th position.

Likewise, the competitiveness ranking of regions such as West Sumatra has also decreased. A study by the Lee Kwan Yew School of Public Policy (National University of Singapore) revealed that West Sumatra's competitiveness ranks as low as 15th in 2017. The competitiveness of the West Sumatra region as an investment and industrial area is still far behind compared to the other regions in Indonesia such as Java. In the Sumatra region, the competitiveness of West Sumatra is still below Riau, Lampung, and South Sumatra (Statistics Indonesia, 2019). Therefore, it cannot be denied that regional economic development must be increased and sustainable to create justice and prosperity for the people of a region.

In improving the regional economy, regional governments and their organs strive to carry out their duties and functions effectively and efficiently and have the right development strategies and programs. Based on regional economic development, the capacity of provincial, regency, and municipal governments in West Sumatra in increasing regional economic development is still not maximized. This can be seen from the Gross Regional Domestic Product (GRDP) of West Sumatra based on the current price in 2017 which is ranked 14 nationally, while the GRDP/Capita of West Sumatra in 2017 is at number 20. Then the economic growth of West Sumatra in 2019 is lower than the national economic growth, namely 5.7% (BPS, 2019). This shows that the economic competitiveness of the West Sumatra region is not as good as the other regions in Indonesia. Capacity problems are caused by incomplete infrastructure and a lack of systems that support innovation in the regions. Although product innovation and regional innovation already exist in the districts/cities of West Sumatra, they have not been carried out comprehensively and there are still many partial ones. Therefore, an alternative to improve West Sumatra's competitiveness is to implement the Regional Innovation System.

The concept of the Innovation System in Indonesia nationally has been strengthened by the Joint Decree of the Minister of Research and Technology No. 3/2012 and the Minister of Home Affairs No. 36/2012 on the Development of a Regional Innovation System or Sistem Inovasi Daerah (hereafter referred to as SIDa). This joint decree "instructs" each regional official to design regional economic development by developing a regional innovation system. There is a strong message that the development of innovation in the regions is the right strategy for regional development in general. Therefore, it is important to know the condition of the regional innovation system.

To create an environment that supports the innovation system, various approaches are produced to achieve a comprehensive innovation system degree. One of the methods used is the ANIS method, namely the Analysis of National Innovation Systems. This method is used in the development of an innovation system at the national level. However, the supporting elements analyzed in the ANIS instrument include comprehensive measurement and evaluation of various institutions starting from the central, regional, and other relevant indicators (Seidel et.al, 2013). Furthermore, Seidel et.al. (2013) argue that the ANIS system is used because the innovation system is influenced by 30 determinants which are divided into three hierarchical levels, namely:

1. The Macro-level, where national policies directly affect the framework of the innovation system conditions. All innovation investments from various sectors will be based on policies taken from this national level.
2. The middle level (Meso level), is usually marked by technology transfer, conducting innovation clustering, and financing innovation.
3. The micro-level targets innovation actors involved in running the innovation system such as companies (micro, small, medium, and large), entrepreneurs, universities, various institutions both public and private, other innovators, and financial institutions. related to the funding of innovation systems.

Based on the above conditions, this study determines the level of maturity of the West Sumatra regional innovation system and measures the influence of the ANIS variables in the form of policies, innovation institutions, innovation programs, and innovation capacity on the maturity level of the regional innovation system. This research aims to establish which variables and determinants of the innovation system are weak and need intervention for improvement.

This is because increased competitiveness must be followed by the maturity level of an established innovation system with a more comprehensive approach so that changes are significant in regional competitiveness. They affect the maturity of the regional innovation system in West Sumatra.

To determine the influence of policies, institutions, innovation programs, and innovation capacity on the maturity of the regional innovation system in West Sumatra

province, the data is processed by using Smart PLS (Partial Least Square) software. This analysis is used to determine how much influence the innovation policy variables (X1), institutions (X2) and programs (X3), and innovation capacity (X4) have on the maturity of the regional innovation system (Y) and see indirectly the relationship of indicators to the maturity of the innovation system in West Sumatra. This is based on the following hypothesis:

a. H1: Most innovations have a positive effect on the regional innovation system;
b. H2: The innovation institution has a positive effect on the regional innovation system;
c. H3: The innovation program has a positive effect on the regional innovation system;
d. H4: Innovation Capacity (Actor) has a positive effect on the regional innovation system.

The following shows how much influence each indicator has on the variable. The indicators that have a positive effect on the innovation system variables will later be used as recommendations for the regional innovation system model in West Sumatra. This study uses data analysis methods using Smart-PLS version 2.0.m3 software running on computer media. PLS (Partial Least Square) is a variant-based structural equation analysis that can simultaneously test the measurement model as well as test the structural model. The measurement model is used to test the validity and reliability, while the structural model is used to test the causality (hypothesis testing with predictive models).

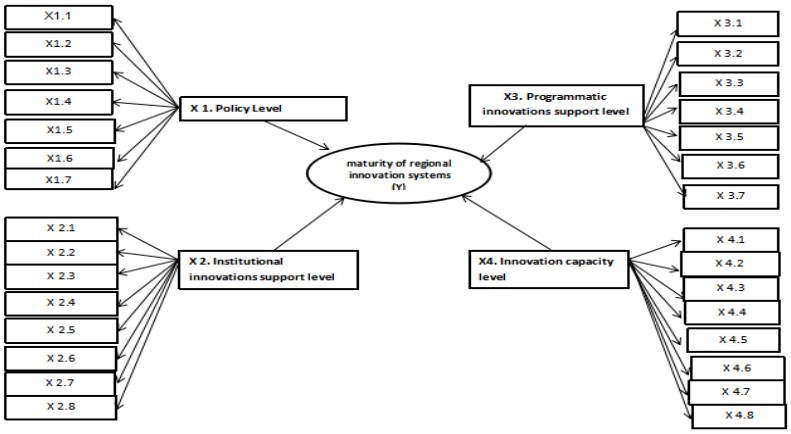

Fig. 1: Innovation System Model with ANIS concept

Hartono (2008) argues that the measure of the significance of hypothesis support can be used to compare the value of T-table and T-statistic. If the T-statistic is higher than the T-table value, it means that the hypothesis is supported or accepted. In this study, for the 95 percent confidence level (alpha 95 percent), the T-table value for the one-tailed hypothesis (one-tailed) was> 1.68023. PLS (Partial Least Square) analysis used in this study was carried out using the Smart-PLS version 2.0.m3 program which was run on computer media.

This study aim is to provide recommendations for strengthening regional innovation systems in West Sumatra.

Its objectives are:

1. To measure the Maturity Level of regional innovation system implementation. Maturity level measurement involves 3 levels of measurement at the macro level (policy), the meso level (institutional and program), and the micro level (innovation capacity) which includes 30 determinants of completeness from all levels
2. To measure the magnitude of the influence of policies, institutions, and programs as well as innovation capacity on regional innovation system maturity.

Literature Review

Previous studies have mostly analyzed regional innovation systems in Indonesia using the concept of the innovation policy framework developed by Taufik (2005). The framework has similarities with the concept presented by Fagerberg et al. (2008) and Cooke (2001) as discussed by Handayani et. al. (2018).

Although studies on the capacity of innovation systems (Santos et al, 2016; Budiarto et al., 2018), supporting policies and regulations (Brillyanes et al, 2018), institutions (Kurniati, 2019), and the role of human resources (Budiarto et al, 2018) already exist, there has not been a comprehensive measurement of the maturity level of the regional innovation system using the ANIS method at the regional level. The novelty of this study is that there has been nearly no previous research that has measured the maturity level of regional innovation systems using the ANIS method. So, therefore, this research seeks to serve as a basis for providing policy recommendations to strengthen the regional innovation system.

Many studies have suggested that to face the current era of global competition, various efforts are needed to strengthen the nation's competitiveness for the welfare and prosperity of society (Narutomo, 2014; Nurhayati, 2016; Prianto, 2015). Authors of these studies suggest that one of the efforts to make is to strengthen SIDa as an integral part of strengthening the National Innovation System (SIN) (Widianty et al, 2014). Many claims that a regional innovation that is integrated with national innovation is a necessity for strengthening sustainable regional and national competitiveness (Damayanti, 2018; Heru et al., 2019; Suresti et al, 2017).

Research Methods

This is a descriptive quantitative study drawing on a survey method consisting of a series of previously formulated questions and a sequence in a structured questionnaire to a sample of selected individuals to represent the defined population. This study mostly relies on primary data for analysis. However, secondary data was collected to support the primary data. Data collection techniques involved a document review and in-depth interviews with actors involved in agricultural innovation.

The maturity of the regional innovation system was measured by using the ANIS (Analysis National Innovation System) model with an Expert Opinion Survey consisting of 15 respondents consisting of 5 academics, 5 government officials, and 5 businessmen selected through purposive sampling. Data was gathered through face-to-face interviews during which a combination of open-ended and hypothetical questions were asked to respondents. Because of the Covid Pandemic, some of these questionnaires were mailed to respondents. Parts of the research consist of research variables, methods of data analysis, and the determination of the intervention portfolio.

Research Variables

Research variables are sourced from the model developed by Seidel (2013) outlined as follows:

1. Macro-level (innovation policy) includes national innovation policy, regional innovation policy, master plan, training and education, R&D foresight, cluster policy, and innovation regulation.
2. Meso level (institutional support and innovation programs) includes Innovation institutions consisting of technology transfer centers, technoparks, technology incubators, clusters, business promotion agencies, innovation service providers, and innovation funding agencies.
3. The meso level for the Innovation Support Program consists of the STI financing scheme, basic research programs, applied research programs, joint funding schemes for STI assistance efforts, entrepreneurial support, cluster development programs, and international support.

4. Micro-level (capacity for innovation) includes universities, basic research institutions, private research institutions, innovators, private investors, entrepreneurs, technology-based SMIs, and large technology-based industries.

Methods of Data Analysis

The model used refers to various kinds of data from the Expert Opinion Survey (EOS). Data were analyzed using a Likert scale which is a scale to measure attitudes, opinions, and perceptions of a person or group of people regarding a symptom or phenomenon. With a Likert scale, the variables to be measured are translated into variable indicators. Then the indicator is used as a starting point for arranging instrument items which can be in the form of questions or statements. The answer for each instrument item that uses a Likert scale has a gradient from very positive to very negative. The Likert scale is "original" to measure a person's approval and disagreement with an object, which levels are composed of:

a. Strongly agree given a score of 4;
b. Agree to be given a score of 3;
c. Disagree is given a score of 2;
d. Completely disagree given a score of 1.

The analysis is only in the form of frequency (number) or proportion (percentage), where later, the answers of all respondents are averaged to obtain a weighted average score. If the score obtained is above average, then the system is considered mature, and if the results obtained are below the average score, then the system is considered to be less mature.

Based on the findings of the EOS, it can be seen the condition of the maturity level of the innovation system for each indicator, namely:

1. The indicator “1” represents the determinant of the worst operating conditions or situations which indicates that a particular determinant is poorly developed or does not exist.
2. Indicator "2" means that a certain determinant exists and has shown a positive impact. However, there is a strong need to improve efficiency or functionality.
3. Indicator "3" means that certain determinants have matured and have a positive impact on the performance of the regional innovation system over a longer period. However, there is still room for further improvement toward excellent performance.
4. The indicator "4" represents the determinant of the best-operating conditions. It is highly developed and operates well in practice over a long period.

The value of the indicators above 3 is characteristic of areas with a mature and established innovation system where all the determining factors are determined and functioning properly. A value between 1.5 and 3 means that the determinant already exists and is in the development stage. A value below 1.5 means that a certain determinant may exist, but does not operate properly, this condition is characteristic of regions with fairly weak innovation system maturity.

Determining the Intervention Portfolio

After obtaining the results of the mapping of the maturity stage of the regional innovation system, the next question is interventions on which determinants can be carried out effectively and efficiently by the government to strengthen and develop the innovation system. In general, an intervention portfolio can be structured by taking the following steps:

1. Choosing the Determinants which are relatively weak when compared to the Determinants of the same level. For example: at the macro level. The macro-level determinant group means were used as a comparison. Determinants that are below the

group means are a priority focus to be developed. This step is optional. We decide together whether to map all the determinants into the intervention portfolio or only those determinants that are below average.

2. In the discussion forum, jointly stipulated the Index of Effort needed to develop each Determinant. The Index of Effort is composed of three components: a) the amount of Government Investment required, b) the length of time required, and c) the complexity associated with efforts to develop the Determinants. For the record, users can also increase the number of components that determine the Effort Size Index for a mutual agreement.

Each component that makes up the index is weighted as follows:

a. Amount of Government investment
   1= Low; 2= moderate; 3 = height; 4 = very high
b. Length of time required
   1 = under 1 year old; 2 = between 1 - 2 years; 3 = between 2 - 4 years; 4 = more than 4 years.
c. Related Complexities
   1 = low; 2 = moderate; 3 = height; 4 = very high.

3. The same is done for each Determinant to determine the expected Impact Magnitude Index. The Impact Magnitude Index consists of two components: a) the strength of the impact, and b) how soon the impact is felt. Index determinant quantities are weighted as follows:
   Strong-Weak Impact
   1 = weak; 2 = moderate; 3 = strong; 4 = very strong
   Gradually until the impact is felt: 1 = more than 4 years; 2 = between 2 - 4 years; 3 = between 1 - 2 years; 4 = less than 1 year

Findings and the Discussion

The maturity level of the regional innovation system in West Sumatra.

An innovation system is a system consisting of a set of actors, institutions, networks, partnerships, interaction relationships, and production processes that affect the direction of development and speed of innovation and its diffusion (including technology and best practices) and the learning process. Thus, the innovation system includes the basis of science and technology (including educational activities, research, and development activities, and engineering), production bases (covering value-added activities to meet the needs of business and non-business as well as the general public), and utilization and diffusion in society as well as the learning process that develops (Taufik, 2005). The Regional Innovation System (RIS) is a systemic and systematic approach to regional development. Through this RIS development approach, all actors, institutions, networks, partnerships, actions, production processes, and policies that affect the direction of development, speed, and diffusion of innovation, as well as the learning process, are implemented to achieve regional development (Taufik, 2006). Some of the basic principles of developing a regional innovation strategy include a strategic way of thinking that is consistent with a long-term framework, regional innovation strategies that are regional priorities and are an integral part of regional development strategies, regional innovation strategies are strategic policies to increase regional competitiveness, focusing on the best local potential and open to creative ideas that are beneficial to the progress of the region, and set clear goals and rational outcomes Najamudin (2021).

The ANIS method assesses the maturity level of the regional innovation system at each level which is influenced by the existing system and the interactions of the actors. Actors at the macro-level (policy) are public authorities and policymakers who carry out the function of setting and regulating the policy framework for the regional innovation system. Actors at the micro-level are institutions that support innovation and government programs related to innovation. Actors at the micro-level are companies, universities, policy institutions, research

institutions, and so on. ANIS study results with government officials, businessmen, and academics show that there are various strengths and weaknesses of RIS West Sumatra in terms of these three levels. The results show that the average maturity level of the West Sumatra Regional Innovation System is 2.46, which means that the maturity level of the regional innovation system in West Sumatra is still at a developing level (1.5 - 3) and is not yet established (3 - 4) (Fig. 1).

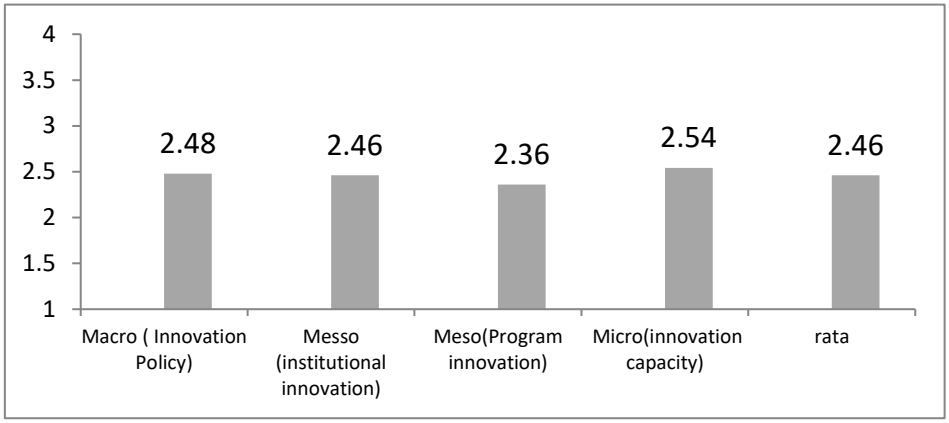

Fig 2: Average values of each macro, meso, micro-level, and the overall mean value

Fig. 2 shows that the maturity level of the West Sumatra regional innovation system is still at a developing level with a score of 2.46. The average value of each level group consists of the macro level, institutional Meso level, meso program level, and micro-level. At the macro level in the form of policy, the average value is 2.48; the meso level for institutions is 2.46; the meso level for the program is 2.36 which is the lowest value, and the value for the micro-level is 2.54 which is also the highest value. Based on the overall average score, it can be concluded that the level groups that are below and above the overall average value are at the meso program level, while the meso-embracing macro level and innovation capacity are at above-average values

Macro Level (Innovation Policy)

The Macro (Policy) level which includes national innovation policies, regional innovation policies, master plans, training and education, foresight R&D agenda, cluster policies, and innovation-friendly regulations for industrial development in West Sumatra has an average score of 2.48.

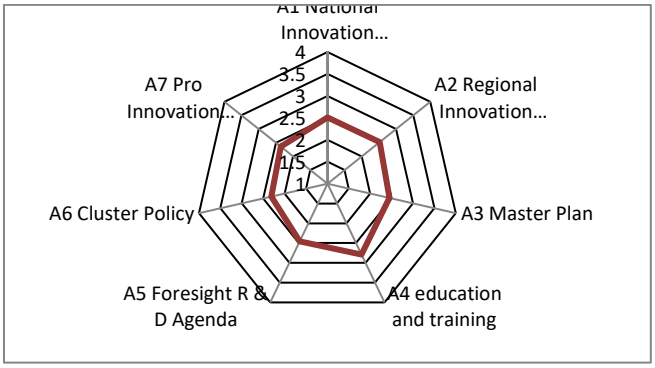

Fig. 3: Analysis of Indicators at the Level of innovation policy in West Sumatra
Source: Primary data (designed by authors)

Fig. 3 shows the determinants of the macro-level group for the innovation policies. The lowest score occurred in cluster policy (2.31) and pro-innovation regulations (2.36), while the highest score was in Education and Training Policy with a score of 2.79. This means that policies to increase the capacity of human resources which are manifested in the form of education and training activities in West Sumatra are good enough. However, as a whole, the macro-level value is around 2.49, indicating that at the level of innovation, and policy to increase competitiveness, West Sumatra is still at a developing level and is still far from reaching the established level of superior/optimal value of 4, this can be seen that national innovation (in the form of SINAS, the National Innovation System), There has been a regional innovation policy (listed in the West Sumatra RPJMD), the availability of education and training (in the form of various middle and tertiary education policies as well as training in the context of increasing human and community resources) and availability R & D foresight in the form of Regional Research Policies and Strategies (Jakstrada) West Sumatra compiled by the Regional Research Council (Defri, 2020). The role of this innovation policy is one of the parameters for determining the level of regional competitiveness. The higher the level of competitiveness of a region, the higher the level of welfare of its people. One of the indicators is increasing the regional competitiveness of industrial growth. This industrial growth contributes to economic development in the region, but must also be able to make a file of meaningful contributions to socio-political and cultural development (Suresti, 2020).

Meso Level (Institutional)

Fig. 2 shows the determinant value of the meso-level group for the institutional aspects of supporting innovation. At the meso level, this institution consists of a technology transfer center, technopark, incubator, cluster, business promotion agency, innovation service agency, and innovation funding agency. The average value obtained by this meso level is 2.46. At this meso level, the lowest score occurred in incubator institutions and innovation service institutions with a value of 2.35, while the highest score was in business promotion institutions with a value of 2.47.

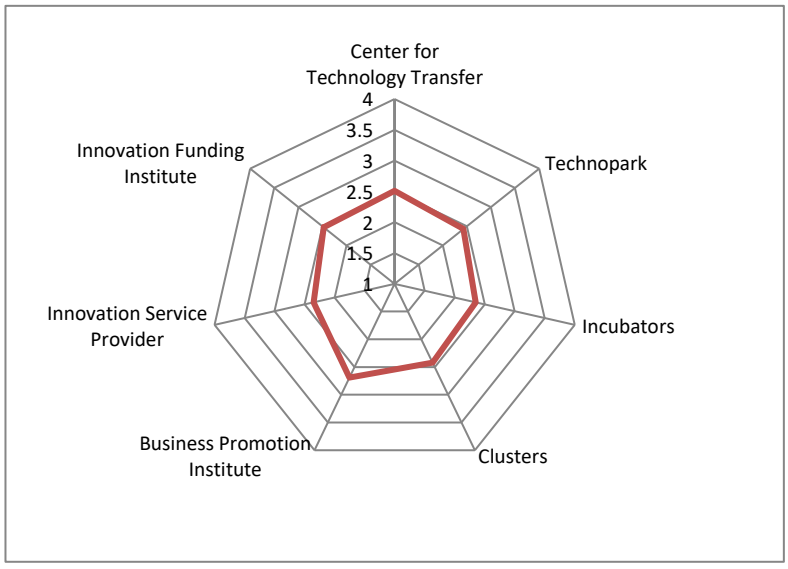

Fig. 4: Analysis of Indicators at the institutional level of Innovation
Source: Primary data (designed by authors)

This shows that to increase regional competitiveness, institutions that support the birth of independent business actors should be established. Institutions such as technology transfer centers, techno-parks, and incubators must intervene in their improvement because techno-

parks aim to develop businesses by creating permanent links between universities, industries/businesses/financial players, and the government. Technopark tries to combine ideas, innovation, and know-how from the academic world and the financial and marketing capabilities of the business world. It is hoped that this merger can increase and accelerate product development and reduce the time required to move innovation to marketable products, with the hope of obtaining a high economic return. The institutional level of innovation in West Sumatra can be seen in the existing Agrotechnopark institutions in 50 Cities District, there have been innovation service providers, and there have been business promotion agencies in each city regency as shown in picture 4.

Meso Level (Program)

Fig. 5 below shows the determinant values of the meso-level group of innovation support programs. This meso level is in the lowest position, namely 2.36 from the average level group. At this level, the lowest innovation support program is in the cluster development program with a score of 2.02, while the highest score is in Entrepreneurship Facilitation / Support with a score of 2.55.

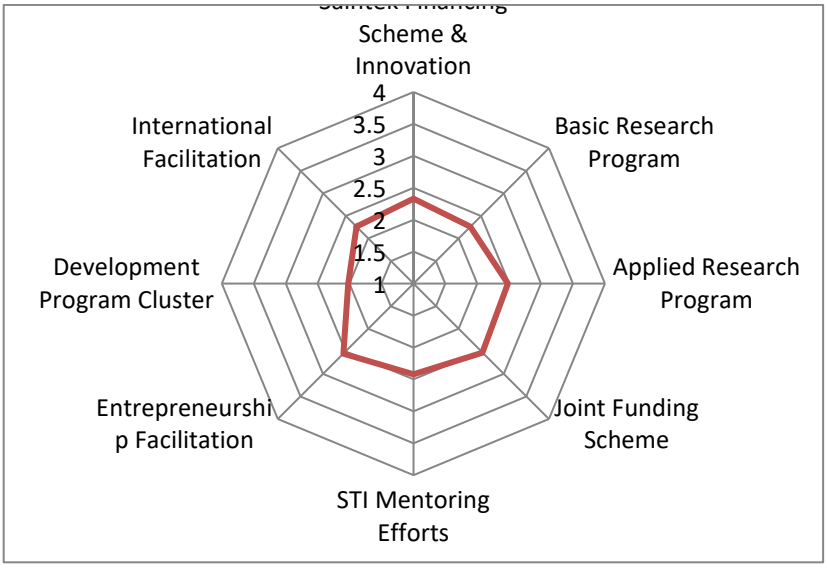

Fig. 5: Indicators at the level of innovation support programs in West Sumatra
Source: Primary data (designed by authors)

Micro-Level (Innovation Capacity)

The following figure shows the determinant values of the micro-level group that have the highest-level values, namely Small and Medium Enterprises (UKM) and entrepreneurship. This is per the data that in West Sumatra there are many MSMEs and entrepreneurs. The lowest score is in the role of a large industry.

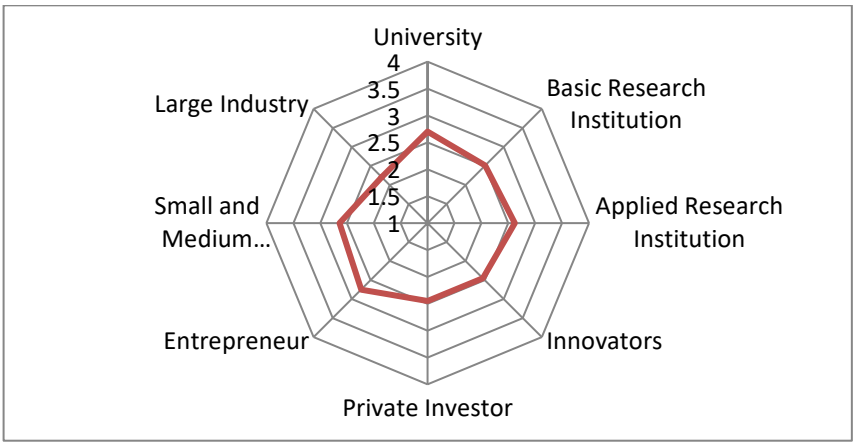

Fig. 6: Indicators on the Level of innovation support capacity in West Sumatra
Source: Primary data (designed by authors)

The highest score is at the micro-level, namely the level of innovation which shows a value above the average in total, but the maturity level of this micro-level has not yet been determined and can be improved. This shows that the determinant for innovation capacity is the existence of various universities both public and private as basic and applied education and research institutions, there has been innovation capacity in various R&D centers, there have been private investors and SME investors (Micro and Medium Enterprises). and the existence of relationships with large companies, although not yet maximally in increasing regional competitiveness. Various good public/private educational institutions are found in West Sumatra that carry out the tri-dharma of higher education and community service. For the application and training of technology, there are also technical service centers and units such as the UPTD Engineering Department of Industry and Trade, the Agricultural Mechanization Center (BMP) of the Provincial Agriculture Service in *Bukittinggi*, and the TPH at the West Sumatra Plantation Service (Febrin, 2020) Vocational Training Centers (BLK) (Riski, 2021), Baristand, agricultural research centers and horticulture (Najamudin, 2021; Sofianto).

To increase the maturity of SIDa in West Sumatra, based on the mapping of the maturity of the innovation system, maximum intervention is needed for policy direction and strategies. Based on Fig. 7 above, what needs to be increased is a determinant that has a value below the average, namely for the macro level. There is a need for a master plan for strengthening the regional innovation system based on regional superior commodities, cluster policies, and issuing pro-innovation regulations. Meso (institutional) levels that need to be intervened for improvement are techno-parks, incubators, clusters, and innovation service agencies. Meso levels (programs) that need to be improved are Science, Technology, and Innovation (STI) Assistance Efforts, cluster development programs, and international facilities. At the micro-level, the number of private investors, entrepreneurs, and small and medium enterprises will be increased.

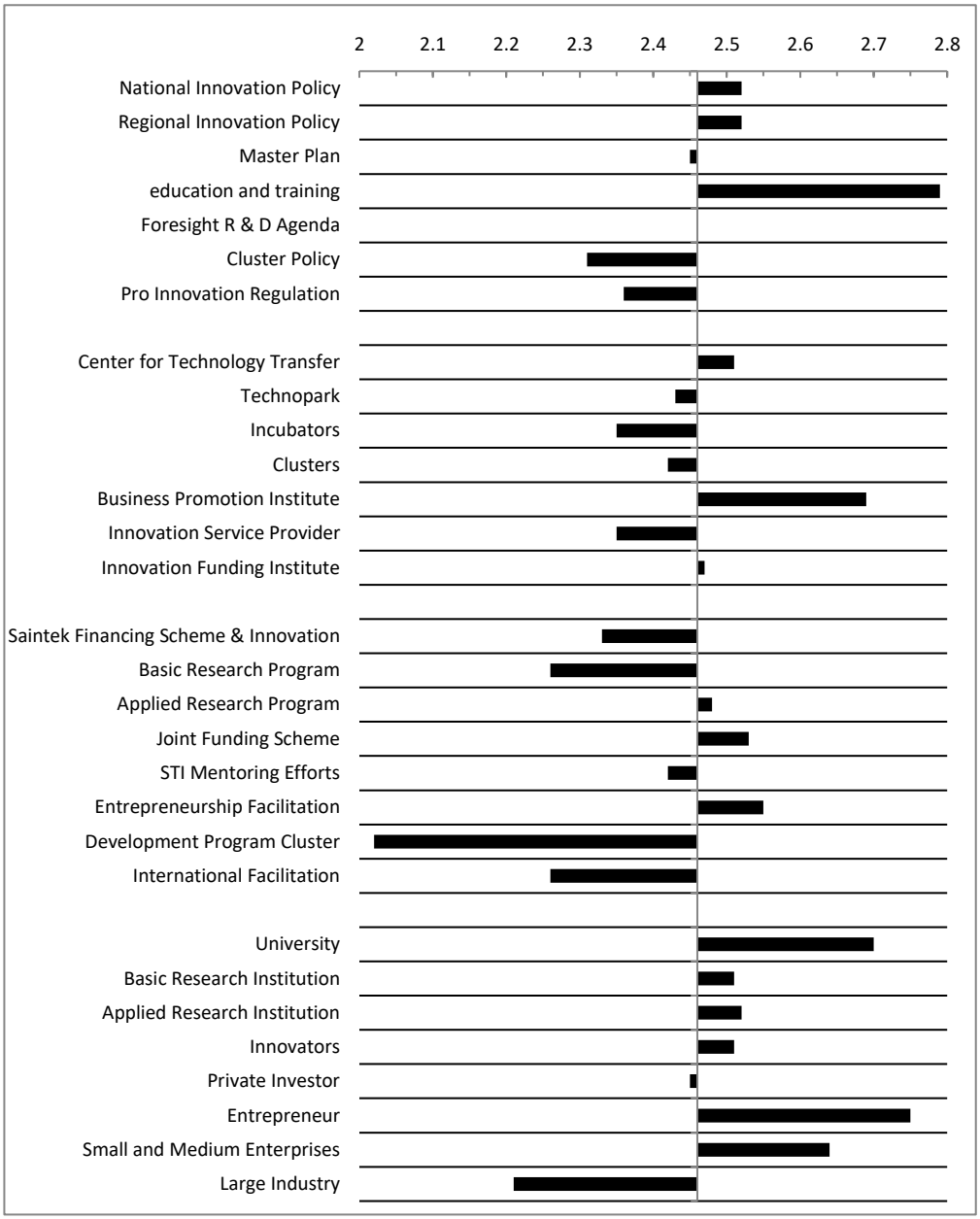

Fig. 7: The maturity level of the regional innovation system in West Sumatra
Source: Primary data, Authors)

In general, the West Sumatra Regional Innovation System is expected to involve elements, namely the government as a facilitator and regulator, researchers from research and development institutions and universities, the world of business/industry / financial institutions that will utilize science and technology, the legislature as a regulator through policy and funding support. It is hoped that the business/industry world will take advantage of the results of science and technology to create new jobs, increase competitiveness, increase added value, and create new entrepreneurs. The government as the regulator is expected to play a role through adequate regulatory support and funding.

The Influence of Policy, institutions, programs, and innovation capacity on Regional Innovation System Maturity in West Sumatra

Based on the results of the composite validity and reliability test, all variables forming the maturity of the regional innovation system in the form of policies, institutions, programs, and innovation capacity, the overall latent variables range from 0.465 to 0.688, meaning that the AVE value of all variables is greater than 0.5. These results indicate that all latent variables used in this study have good discriminant validity. Likewise, with the composite reliability value of all latent variables ranging from 0.821 to 0.917, it means that the overall reliability value of the composite is greater than 0.7. These results indicate that all latent variables have good composite reliability. The Composite Validity and Reliability Test can be seen in Table 1.

Table 1: Validity Test and Composite Reliability
Source: Primary data (designed by authors)

Variables	Average Variance Extracted (AVE)	Composite Reliability
Innovation Policies	0.512	0.838
Institutional Innovation	0.600	0.748
Innovation Programs	0.577	0.801
Innovation Capacity	0.570	0.797
Regional Innovation System Maturity	0.491	0.903

The determinant that affects each innovation system variable can be done with 2 iterations because there is a factor load value (loading factor) that is smaller than 0.5. The results of the second iteration show that the loading factor value (loading factor) of the final stage is presented by all indicators, both at the first and second-order levels, which have a loading factor greater than 0.5. These results indicate that all indicators have good convergent validity. Thus, the indicator is valid in measuring each of the latent variables. These results indicate that the valid indicators form the latent variables.

The determinants that determine the maturity of the regional innovation system in West Sumatra at the Macro level variable (innovation policy) can only be validly explained by indicators of national innovation policy (A1), regional innovation policy (A2), and cluster policy (A6), R&D. (A3) and pro-innovation regulation (A7). the institutional meso variable can only be explained validly by the determinant of technopark (B2) and industrial cluster (B4). The Meso Variable Innovation program can be validly explained by the Science, Technology, and Innovation Financing Scheme (B8)), the Science, Technology, and Innovation Assistance Scheme (STI) (B12), and the Cluster Development Program (B14). Micro Variable Innovation Capacity can be explained validly by indicators of the role of higher education (C1), C2 (Applied Research and Entrepreneurship (C3). Testing research hypotheses can be seen in the table Path coefficient structural model in Table 2.

Table 2: Path Coefficient of Structural Model
Source: Primary data, Authors

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Innovation Policies-> Regional Innovation System's Maturity Level	0,433	0,436	0,025	17,425	**0,000**
Institutional Innovation-> Regional Innovation System's Maturity Level	0,184	0,185	0,016	11,146	**0,000**
Innovation Program -> Regional Innovation System's Maturity Level	0,283	0,280	0,018	15,897	**0,000**
Innovation Capacity-> Regional Innovation System's Maturity Level	0,241	0,239	0,026	9,195	**0,000**

The table above shows that the sample mean value is 0.436, so the Macro variable (Innovation Policy) has a positive effect on the maturity of the Regional Innovation System in West Sumatra Province. Each increase in the score of the innovation policy for each indicator by 1 unit will increase the maturity value of the regional innovation system by 0.436. The greater the score for the Innovation Policy, the higher the score for the maturity value of the regional innovation system. The higher the score for the maturity value of the regional innovation system, the better the condition or quality of the regional innovation system. The statistical t value of 17.425 is greater than the t table (1.645) and the P-value is 0.000 <0.05, so the Innovation Policy has a positive and significant effect on the Regional Innovation System. The innovation policy is described by indicators A1 (national innovation policy), A2 (regional innovation policy), A3 (R&D), A6 (cluster policy), and A7 (pro-innovation regulation). The sample mean value is 0.185, the Meso Level (Institutional Innovation) variable has a positive effect on the maturity of the Regional Innovation System with an 11.146 statistical t value, which is greater than the t table (1.645), and a P-value of 0.000 <0.05.

The Innovation Institution is described by the Techno-park (B2) and cluster (B4) indicators. The sample mean value is 0.280, the variable Meso Level (Innovation Program) has a positive effect on the maturity of the Regional Innovation System with a statistical t value of 15.897 greater than t table (1.645), and a P-value of 0.000 <0.05. The Innovation Program is explained by indicators Science, Technology, and Innovation Financing Scheme (STI) (B8)), Science, Technology and Innovation Assistance Scheme (STI) (B12), and Cluster Development Program (B14). The sample mean value is 0.239, the MICRO variable innovation capacity has a positive effect on the maturity of the Regional Innovation System in West Sumatra Province with a statistical t value of 9.195 greater than t table (1.645), and a P-value of 0.000 <0.05. Innovation capacity is explained by indicators of the role of higher education (C1), and C2 (Applied Research and Entrepreneurship (C3).

Determining the Intervention Portfolio

After the results of the maturity of the regional innovation system are known, for the development of the system, West Sumatra Province determines the intervention portfolio from determinants that are below the average value. Following are the results obtained from respondents regarding the impact and effort on all ANIS determinants.

Table 3: Effort and Impact Value for ANIS Determinants in Sumatra Province
Source: Primary data, Authors

Determinants	Value	Average	Effort	Impact
National Innovation Policies	2,52	0,06	1,33	2,50
Regional Innovation Policies	2,4	-0,06	1,00	2,50
Master Plans	2,52	0,06	1,33	3,50
Education and Training	2,79	0,33	1,00	4,00
Foresight R & D Agenda	2,46	0	1,00	3,00
Cluster Policies	2,31	-0,15	1,00	3,50
Pro-Innovation Regulations	2,36	-0,1	1,33	4,00
Center for Technology Transfer	2,51	0,05	2,33	3,50
Technopark	2,43	-0,03	3,00	3,00
Incubators	2,35	-0,11	2,67	3,50
Clusters	2,42	-0,04	1,67	3,50
Business Promotion Institutes	2,69	0,23	1,33	4,00
Innovation Service Providers	2,35	-0,11	1,33	3,50
Innovation Funding Institutes	2,47	0,01	1,67	3,50
Saintek Financing Scheme & Innovation	2,33	-0,13	1,67	3,5
Basic Research Programs	2,26	-0,2	2,00	1,5
Applied Research Programs	2,48	0,02	1,67	2,5
Joint Funding Schemes	2,53	0,07	1,33	3,5
STI Mentoring Efforts	2,42	-0,04	1,33	3,5
Entrepreneurship Facilitations	2,55	0,09	1,00	3
Development Program Clusters	2,02	-0,44	1,00	2,5
International Facilitations	2,26	-0,2	1,33	2
Universities	2,7	0,24	1,33	3,5
Basic Research Institutions	2,51	0,05	1,33	1,5
Applied Research Institutions	2,52	0,06	1,33	2,5
Innovators	2,51	0,05	1,00	3
Private Investors	2,45	-0,01	1,00	3,5
Entrepreneurs	2,75	0,29	1,67	4
Small and Medium Enterprises	2,64	0,18	2,33	4
Large Industries	2,21	-0,25	1,00	3

The table above shows that there are several negative determinants because they are below the average. From the condition of the maturity of the regional innovation system in West Sumatra, most of these interventions are crucial to realize as relevant inputs for the policy implementation plan. To prioritize measurement, given the limited resources available, portfolio analysis is carried out for actions on the impacts and efforts that can be carried out by West Sumatra Province.

To provide recommendations for intervention, the general rule is to prioritize determinants with low effort but high impact. However, it is possible to prioritize determinants that require high effort and produce high impact. Research results indicate that even though implementing technopark (D) and Incubator (E) is a big effort, it has a big impact on the

maturity of the regional innovation system. While the recommended determinants of intervention are those that have low effort and high impact, namely regional innovation policy (A), cluster policy (B), cluster institutionalization (F), Innovation Service Provider (G), Engineering Financing Scheme & Innovation (H), STI. Mentoring Efforts (J), Development Program Clusters (K), Private Investors (M), and Large Industry (N).

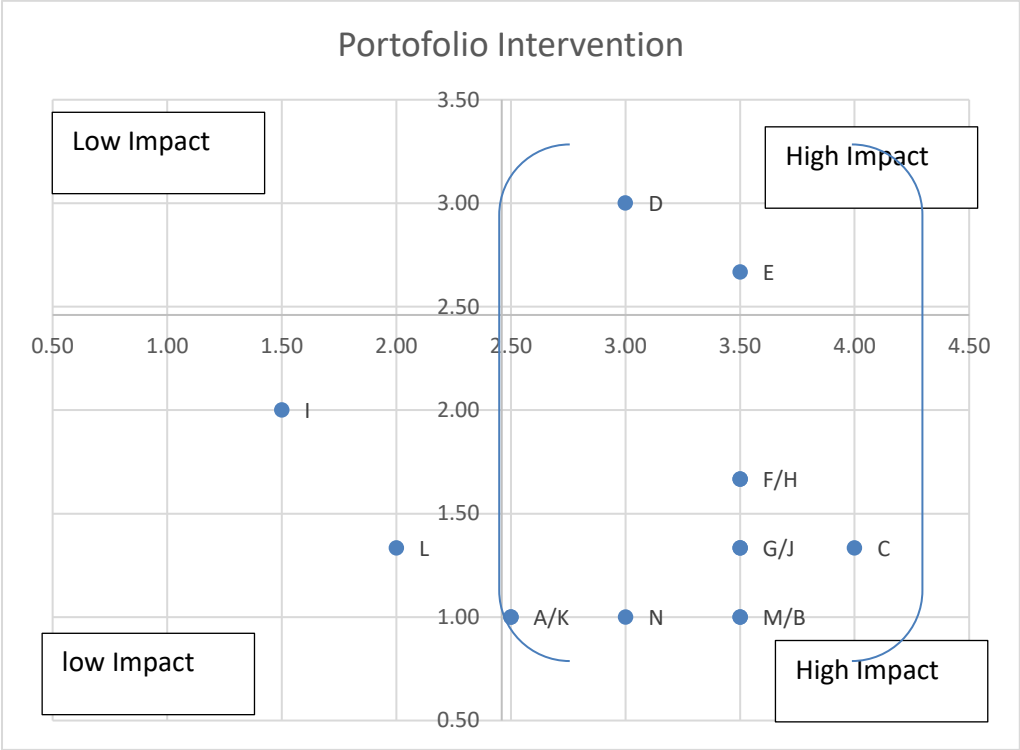

Fig. 8: Portfolio of interventions to increase the maturity of the regional innovation system in West Sumatra. Source: Primary data, Authors

Conclusion

Although the development of a regional innovation system is one of the main strategies in the national innovation system, it has not been implemented consistently and systematically by all provinces in Indonesia, including the province of West Sumatra. As a result, the system works either partially or is incomprehensively integrated.

The study showed that the maturity level of the Regional Innovation System in West Sumatra Province is still at a developing level (2.46) and has not yet been established (3 - 4) with the average value of each level group consisting of the macro level, the institutional Meso level, the meso level. The program, and the micro-level. At the macro level in the form of policies, an average value of 2.48 was obtained, the meso level for institutions was 2.46, the meso level for the program was 2.36 and the score for the micro-level was 2.54 which was also the highest score. Of all these variables after statistical tests, policy factors, institutions, programs, and innovation capacity have a positive effect on the maturity of the regional innovation system in West Sumatra. The innovation policy is a variable that greatly influences the regional innovation system in West Sumatra with a sample mean value of 0.436. To improve regional innovation systems in West Sumatra, the study recommends the implementation of regional innovation determinants, Cluster policies and institutions, innovation service providers, technical financing Schemes, cluster development programs, private Investments, and large-scale industrialization to transform and manufacture agricultural products and create jobs.

Given the fact that Indonesia is an agricultural country, good agricultural policy should focus on measures to improve the sector's long-term productivity and sustainability, such as investments in human capital, infrastructure, and farmers' connections to markets. A sound regulatory policy environment and well-functioning markets ensure that there is a good business case for producers to innovate and respond to the current productivity and environmental challenges of food systems. Finally, there needs to be a way to bring new ideas such as the one proposed in this study into practice to help farmers to build the skills they need.

References

Abdillah, W. & Jogiyanto, H. M. (2009) Konsep dan Aplikasi PLS (Partial Least Square) Untuk Penelitian Empiris. Badan Penerbit Fakultas Ekonomi dan Bisnis UGM: Yogyakarta\

BPS. (2019) Sumatera Barat Dalam Angka 2019. Badan Pusat Statistik Sumatera Barat, Padang.

Brillyanes, & Wilopo. (2018) Regional Innovation System in Rural Areas and The Role of SMEs as Countermeasures for Poverty: A Case in East Java, Indonesia. (June 2017). https://doi.org/10.18551/rjoas.2017-06.25. Russian Journal of Agricultural and Socioeconomic Sciences. 6(66). ISSN 2226-1184.

Budiarto, M. S. and Listiani. (2017) Impact of Regional Innovation System (SIDa) Sabajuhut to Fulfillment of Economic Right. Proceeding. Regional Research and Development Agency of East Java.

Cooke, P. (2001) Regional innovation systems, clusters, and the knowledge economy. Ind Corp Change, 10(4), 945–974.

Damayanti, E. (2018) Pelayanan Terintegrasi Sebagai Resolusi Inovasi Daerah Di Kabupaten Banyuwangi. Jurnal Spirit Pro Patria, 4(1).

dos Santos, M. J. P. L. (2026) Smart cities and urban areas—Aquaponics as innovative urban agriculture. Urban Forestry & Urban Greening Volume 20, 1, pp. 402-406

Defri, B. (2021) Regional Research Policies and Strategies, Padang, West Sumatra, Interview. October 14, 2021

Fagerberg, J. & Srholec, M. (2008) National innovation systems, capabilities, and economic development. Research Policy Volume 37, Issue 9, pp. 1417-1435

Febrin, S, (2021) West Sumatra Plantation Service, West Sumatra, Interview, Padang Pajamg, November 12, 2020

Handayani, W., Kusharsanto, Z., & Artiningsih (2018) Regional Innovation System Performance in Indonesia: Case of Semarang and Balikpapan. The Asian Journal of Technology Management (AJTM). Vol. 10(2). Doi: 10.12695/ajtm.2017.10.2.2

Heru, F., Wahyudi, A., Hidayah, K., Sartika, D., Fadhly, M., Rahmawati, I., & Noor, A. (2019) Strategi Penguatan Sistem Inovasi Daerah (Sida) Di Kota Samarinda. Jurnal Riset Inossa, 1(1).

Huda, M. & Santoso, E. B. (2014) Pengembangan Daya Saing Daerah Kabupaten/ Kota di Provinsi Jawa Timur Berdasarkan Potensi Daerahnya. Jurnal Teknik Pomits,3(2), C81-C86.

Kementerian Riset dan Teknologi dan Kementerian Dalam Negeri. (2012) Peraturan Bersama.

Kurniati, E. D., Susilowati, I. & Suharno, S. (2019) Regional Innovation System in Rural Economic Institutional: Empirical Evidence from Semarang, Indonesia. Jurnal Ekonomi Pembangunan: Kajian Masalah Ekonomi dan Pembangunan, 20 (1), 108-129

Menteri Negara Riset dan Teknologi Republik Indonesia dan Menteri Dalam Negeri Republik Indonesia Nomor 03 Tahun 2012 dan Nomor 36 Tahun 2012 tentang Penguatan Sistem Inovasi Daerah.

BPPT (2011) Naskah Akademik Buku Putih Penguatan Sistem Inovasi Nasional, Jakarta: Deputi Bidang Pengkajian Kebijakan Teknologi Badan Pengkajian dan Penerapan Teknologi.

Malerba, F. (2006) Sectoral Systems: How and Why Innovation Differs across Sectors. In J. Fagerberg, D. C. Mowery, & R. R. Nelson, The Oxford Handbook of Innovation (pp. 380-406). Oxford: Oxford University Press.

Najamudin, S. B. (2021) Deputy chairman of the Regional Representative Council, West Sumatra. Interview, Padang, June 23, 2021

Narutomo, T. (2014) Program Penguatan Sistem Inovasi Daerah (SIDa) Sebagai Exit Strategy Program Nasional Pemberdayaan Masyarakat (PNPM). Jurnal Bina Praja, 06(02), 143–156. https://doi.org/10.21787/jbp.06.2014.143-156

Nurhayati, S. (2016). Strategi Penguatan Daya Saing Usaha Kecil Dan Menengah (Ukm) Batik Menghadapi Asean Economic Community (Aec). Jurnal Ekonomi Dan Bisnis, 19(2), 15–23.

Prianto, A. (2015) Urgensi Penguatan Budaya Wirausaha Untuk Meningkatkan Daya Saing Indonesia Di Era Mea. Jurnal Economia, 11 (1), 89. https://doi.org/10.21831/economia.v11i1.7760

Seidel, U. & Muller, L., Kocker, Zu, G. M. & Filho, G de A. (2013) A New Approach for Analysing National innovation System in Emerging and Developing Countries. Industry & Higher Education Journal, 27(4), August 2013, pp. 279-285, DOI: 10.5367/ihe.2013.0159.

Suresti, A., Wati, R., Dinata, U. & Hasan, A. (2020) Competitiveness of Livestock Sub Sector in West Sumatera, Indonesia. American Journal of Animal and Veterinary Sciences. Vol 15 issue 3.

Suresti, A., Dinata, U., Hellyward, J. & Wati, R. (2017) Pemetaan Tingkat Kematangan Sistem Inovasi Daerah Peternakan di Kabupaten Lima Puluh Kota. COSTING: Journal of Economics, Business, and Accounting, 1(1), pp. 35-42. https://doi.org/https://doi.org/10.31539/costing.v1i1.52

Taufik, T. A. (2005) Pengembangan Sistem Inovasi Daerah: Perspektif Kebijakan.

Safrizal, (2021) Interview with the Head of the Department of Agriculture and Innovation, West Sumatra, , Padang, August 20, 2021

Jakarta: Pusat Pengkajian Kebijakan Teknologi Pengembangan Unggulan Daerah dan Peningkatan Kapasitas Masyarakat, Deputi Bidang Pengkajian Kebijakan Teknologi, Badan Pengkajian dan Penerapan Teknologi (BPPT)

U.S. Governments' Global Hunger and Food Security Initiative (2023) Capacity Development for Agricultural Innovation: A Practitioners' Guidebook to a System Approach. https://cd4ais.ifpri.info/what-is-an-agricultural-innovation-system/. Accessed on 05/29/2023