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Science & Technology and Innovation Policies in Science & Technological Research, Development, and Implementation

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Abstract. This article analyses the observation of science & technology (Iptek) and innovation policies in activities of science and technological research, development, and implementation. Science & technology and innovation policies become an important study subject since in some countries this field gives positive effect to competitiveness of a nation. Qualitative approach was selected in studying science & technology and innovation policy in Indonesia since its appropriation with the objective of portraying national policy in science & technology and innovation. Method employed was content analysis qualitative with framing analysis, which in this study refers to concept of science & technological research, development, and implementation. The results of this study shows that national policy of Indonesia during 2000-2011 period were less supportive to development, research, diffusion, and implementation of technology in regions, proven by evidence that there was only few policies supporting the system implementation of science & technological research, development, and implementation in Indonesia.

Keywords*: science and technology, innovation, research and development, policy*

Abstrak. *Artikel ini menguraikan tinjauan kebijakan ilmu pengetahuan & teknologi (iptek) dan inovasi dalam kegiatan penelitian, pengembangan, dan penerapan iptek. Kebijakan iptek dan inovasi menjadi penting untuk dikaji karena dibeberapa negara bidang ini memberikan pengaruh terhadap daya saing suatu negara. Pendekatan kualitatif dipilih untuk mengkaji kebijakan iptek dan inovasi di Indonesia karena sesuai dengan tujuan untuk memberikan gambaran mengenai potret kebijakan nasional bidang iptek dan inovasi. Metode yang dipergunakan adalah analisis isi "content analysis" yang bersifat kualitatif dengan pembingkaian "framing analysis" yang dalam studi ini kerangkanya merujuk pada konsep penelitian, pengembangan, dan penerapan iptek. Berdasarkan hasil studi ini terungkap bahwa kebijakan nasional Indonesia selama periode 2000–2011 kurang berpihak pada pengembangan, riset, difusi, dan penerapan teknologi di daerah, terbukti dengan keberadaan kebijakan terkait pelaksanaan sistem penelitian, pengembangan, dan penerapan iptek di Indonesia yang masih sangat minim.*

Kata kunci*: ilmu pengetahuan dan teknologi, inovasi, penelitian dan pengembangan, kebijakan*

INTRODUCTION

Development of science and technology in a country is influenced by the capability of human resources in performing technology innovation so as to be able to compete with other countries in this era of global competition. In the era of future trading and economic development, it is improbable to survive by depending on conventional manufacturing industries only (Firmansyah, 2010). Putera (2008) explains that development activities relied on conventional manufacturing industries only or, in other words, development unsupported by science and technology can be resulted in high cost development symptoms, really depended on foreign science and technology, and discontinued. Therefore, policy of science and technology should be supportive to industries one another to maximize performance and science and technology-based economy, as shown by Organisation for Economic Cooperation and Development (OECD) countries.

Lundvall and Christensen (1999) defines innovation system in three perspectives, namely innovation system based on research and development (R and D) system, innovation system based on production system, and innovation system based on production system and human resources development. Stream and link of these three actors are important factors in science and technology development.

Fagerberg and Srholec (2007) points out that countries successful in developing and maintaining competencies in managing their innovation system, and supported by good government system, will not only yield profit from selling technologies, but also benefit of increase in quality of human resources and other benefits in developing their countries' economics, like OECD countries.

Besides those advanced countries, there are some

countries in Asian region, like Taiwan, Singapore (Fagerberg, Srholec, and Verspagen, 2009), and South Korea, also able to optimized the role of science and technology in building their countries' economics and competitiveness, even developing countries affiliated to BRIC (Brazil, Rusia, India, and China) are able to emerge as new economic power in the world by maximizing science and innovation in upgrading competitiveness. Brazil as a developing country in South American region can appreciate impact of government policy supporting science and innovation. This is proven by increasing total export of Brazil from only 27 billion dollar in 1984 into 81 billion dollar in 2004 with the market of exported products reach 65% in OECD in 2005.

This nation is not without attempt at science and technology empowerment in improving economic competitiveness. Researches have been conducted since Dutch colonialism era, even progressions in processing technology of sugar industries and railway system design of the era was excellent. Ironically, Zuhal in his book *Knowledge and Innovation* (2010) saw that past glory left no traces today. On the contrary, there are regressions particularly in post-monetary crisis in 1997.

In present time, development including science and technology can only proceed well when a nation is in strong condition whose ability to increase its capacity of building superior public policy. This condition requires nation to form "environment" or "climate" to build competitiveness of every actors inside. This climate is created through strengthening public policy by every organization in the nation.

Law No. 18 of 2002 on Research, Development, and Implementation of Science and Technology National System (Sisnas P3 Iptek) is a policy product in frame of managing and productive using of Indonesian resources and its contents. Management and productive use of resources and its contents require mastering, utilizing and progressing science and technology. In the attempts of developing mastering, utilizing, and advancing science and technology, a national system of research, development and implementation of science and technology containing and forming association is required. It will also take mutual reinforcement of institution elements, resources, and intact science and technology network in all regions of Republic of Indonesia.

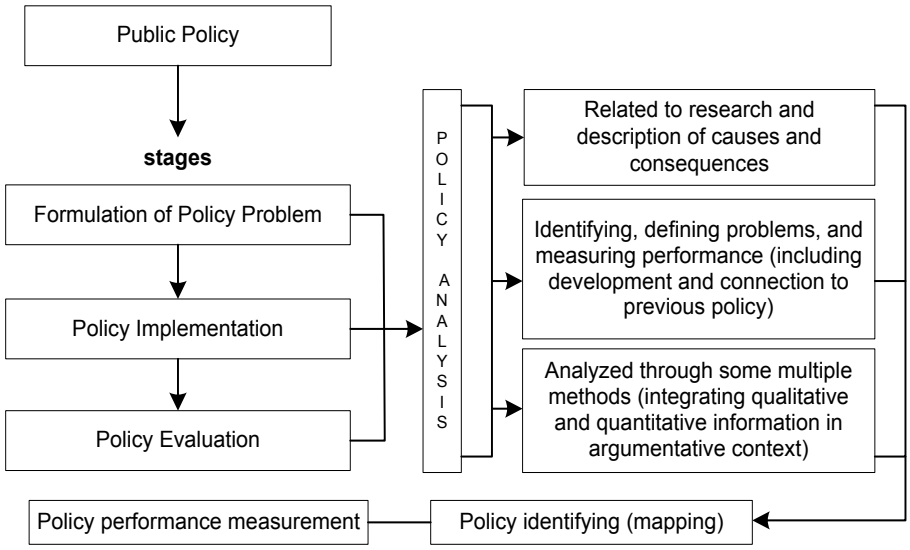
Content of Law No. 18 of 2002 on Sisnas P3 Iptek consists of 9 chapters, 32 articles, and explanations, including 2 chapters inside on sanction and transition stipulations. This policy has fulfilled conditions of its composing process and then was declared in 29 July 2002. As a policy product, it is realized that the law is a reference for all elements covered in innovation system building, including research and development institution, universities, industries, and other concerned parties.

Science and technology system is conceptually understood as an integral part of innovation system in various levels. Taufik (2005) states that it is very logical by putting strategic policy of science and technology system development in regions as inseparable part of strategic policy of innovation system development in concerning regions. Law of Sisnas P3 Iptek is surely used as a reference in composing strategic policy of regions in connection with development of science and technology in regions. Understanding this concept and referring to science and technology research, development, and implementation system, it is important to realize that regional or national scale science and technology system is an integral part of regional and national scale innovation system. Based on this contemplation, it is important to conduct policy review on science, technology, and innovation policy in research, development, and implementation of science and technology.

Policy analysis, in orthodox terms of Bobrow (1987) and Parsons (2006) was meant to increase method of identifying and defining issues, determining objective and evaluating alternatives and performance measurement. This intervention is based on analysis in making policies. Subarsono (2010) argued that even though policy analysis is part of administrative science, it is multidisciplined since it borrows theory, method, and technique from psychology, social, economic, political sciences.

According to Dunn (2003), policy analysis activities of intellectuals and practitioners are intended to create, critically valuing, and communicate knowledge about and in policy processes. Further, Dunn explained that policy analysis is studied with various methods of multiple studies in context of politic argumentation and debate to create, critically valuing, and communicate knowledge relevant to the policy. In general, Dunn saw methods of policy analysis as a combination five general procedures commonly employed in solving problems, namely *definition* by generating information on condition causing policy problems, *prediction* by providing information on consequences of implementing policy alternatives in the future, including when doing nothing, *prescription* by providing information on the price of consequences of alternatives of policy in the future, *description* by producing information on present and past consequences of implementing policy alternatives, and *evaluation* by usefulness of policy alternatives in solving problems.

Existing analysis and references provide insights that; (1) policy analysis is related to research and description of causes and consequences of policy; (2) policy analysis is closely related to identification, problems defining, and measuring of policy performance (including development



**The policy as the object of this research was connected to science, engineering and innovation. This policy was viewed post-policy and later known as ex-post*

Figure 1. Concept Channel of Policy Analysis (Ex-post)

in connection to relation with previous policy); and (3) policy analysis utilizes multiple methods (integrating qualitative and quantitative information) in context of argumentation. Policy as object of this research is connected to science, technology, and innovation policy. This policy is perceived in post-policy then known as *ex-post* (Carley, 1980). Concept channel of science and technology policy analysis is shown in Figure 1.

Identification (*mapping)* of the content of this policy is carried out by taking inventory of various government policies in science and technology and innovation related to research and development, diffusion, and technology implementation. Policy substance can be categorized in three, namely relevance, significance, and efficiency.

Policy relevance measures directness of a policy. This relevance then sequenced based on consideration whether, such as; (1) government policy and laws have direct objective; (2) government policy and laws are indirect; (3) government policy and laws are indirect, but indirectly possess big influence; and (4) government policy and laws are indirect, and should not be regulated. Policy significance measures policy influence, whether policy has direct or indirect influence. Policy efficiency measures changing capacity of policy on policy at lower level, supporting institution, supporting program, capacity, and inefficient policy.

Frame of research, development, and science and technology implementation system in this research is emphasized on all activities including development, diffusion, and implementation of technology carried out by organizational actors, both government and private, interacted with each other in synergy (Putera, 2012). Scale of this research is region and focuses on policy, following concepts are gathered; (1) policy mentioned in this research is science, technology and innovation policies connected to development, diffusion, and implementation of technology activities at regional level; (2) actor is government or private institution carried out development, diffusion, and implementation of technology activities at regional level; and (3) interaction is connection or synergy carried out between institution conducting development, diffusion, and implementation of technology activities at regional level.

Analysis on policy related to identification (mapping) of policy substances and performance measurement of the policy itself is resulted in concept of policy analysis in this research, begin with; (1) identification (mapping) of contents of science, technology, and innovation policy connected to development, diffusion, and implementation of technology activities at regional level; and (2) followed by measurement of achievement of performance of science, technology, and innovation policy connected to development, diffusion, and implementation of technology activities at regional level.

Identification (mapping) of contents of policy is generally known as content analysis. This analysis employs frame of policy of policy instrument in science, technology, and innovation fields connected to development, research, diffusion, and implementation of technology activities. This policy has wide spectrum, then in general policies are categorized in three categories, namely: relevance, significance, and efficiency of policy on development, research, diffusion, and implementation of technology in regions (See Figure 2).

CATEGORY	CODE	EXPLANATION
Relevance	R1	Policy directly regulates development (research), diffusion & technology implementation in regions
	R2	Policy not directly regulates development (research), diffusion & technology implementation in regions
	R3	Policy not directly regulates development (research), diffusion & technology implementation in regions, should be regulated
	R4	Policy not directly regulates development (research), diffusion & technology implementation in regions, indeed should not be regulated
Significance	S1	Policy directly influences development (research), diffusion & technology implementation in regions
	S2	Policy indirectly influences development (research), diffusion & technology implementation in regions
	S3	Policy does not influence development (research), diffusion & technology implementation in regions, should be regulated
	S4	Policy does not influence development (research), diffusion & technology implementation in regions, indeed should not be regulated
Efficiency	D1	Policy alters policies at lower level
	D2	Policy on innovation supporting institution
	D3	Policy on innovation supporting program
	D4	Policy on innovation capacity
	D5	Inefficient policy

Figure 2. Government Policy Category
Source: Guna (2007)

Relevance of policy measures directness of policy in science and technology and innovation. This relevance then is sequenced based on consideration of whether; (1) government policy and laws have direct objective on development, research, diffusion, and implementation of technology in regions, such as law on research, development, and implementation of science and technology, implementing regulations, and various policy declared by concerning ministries and local governments; (2) government policy and laws are indirect to development, research, diffusion, and implementation of technology at regions, but have direct influence on development of science and technology and innovation, such as arrangement of layout for agro *technopark* area, and so on; (3) government policy and laws are indirect to development, research, diffusion, and implementation of technology in regions, but indirectly possess big influence on development of science, technology, and innovation; and (4) government policy and laws are indirect to development, research, diffusion, and implementation of technology in regions, and it should not be regulated.

Significance of policy measures influence of science and technology and innovation policy on regions competitiveness, whether policy have direct influence or not. Efficiency of policy measures changing capacity of policy on policy at lower level, innovation supporting institution, innovation supporting program, capacity of innovation, and inefficient policy.

RESEARCH METHODS

This study is policy research especially about policy review on science and technology and innovation policy in research, development, and implementation. National regulations as object of this study are important to analyze since as a policy study, development of national politics partakes in pushing, not only changes on regime at central level, but also issued regulations. Qualitative approach is used in this study. This approach is selected since it is appropriate to objective of this study which tries to depict the portrait of national policy on science and technology and innovation policy.

This study is methodologically a research on the policy contents. It is to appraise a policy from its contents. The method of inquiry employed is content analysis which is qualitative with framing analysis referred to concept of science and technological research, development, and implementation.

RESULT AND DISCUSSION

Based on identification and analysis on contents of

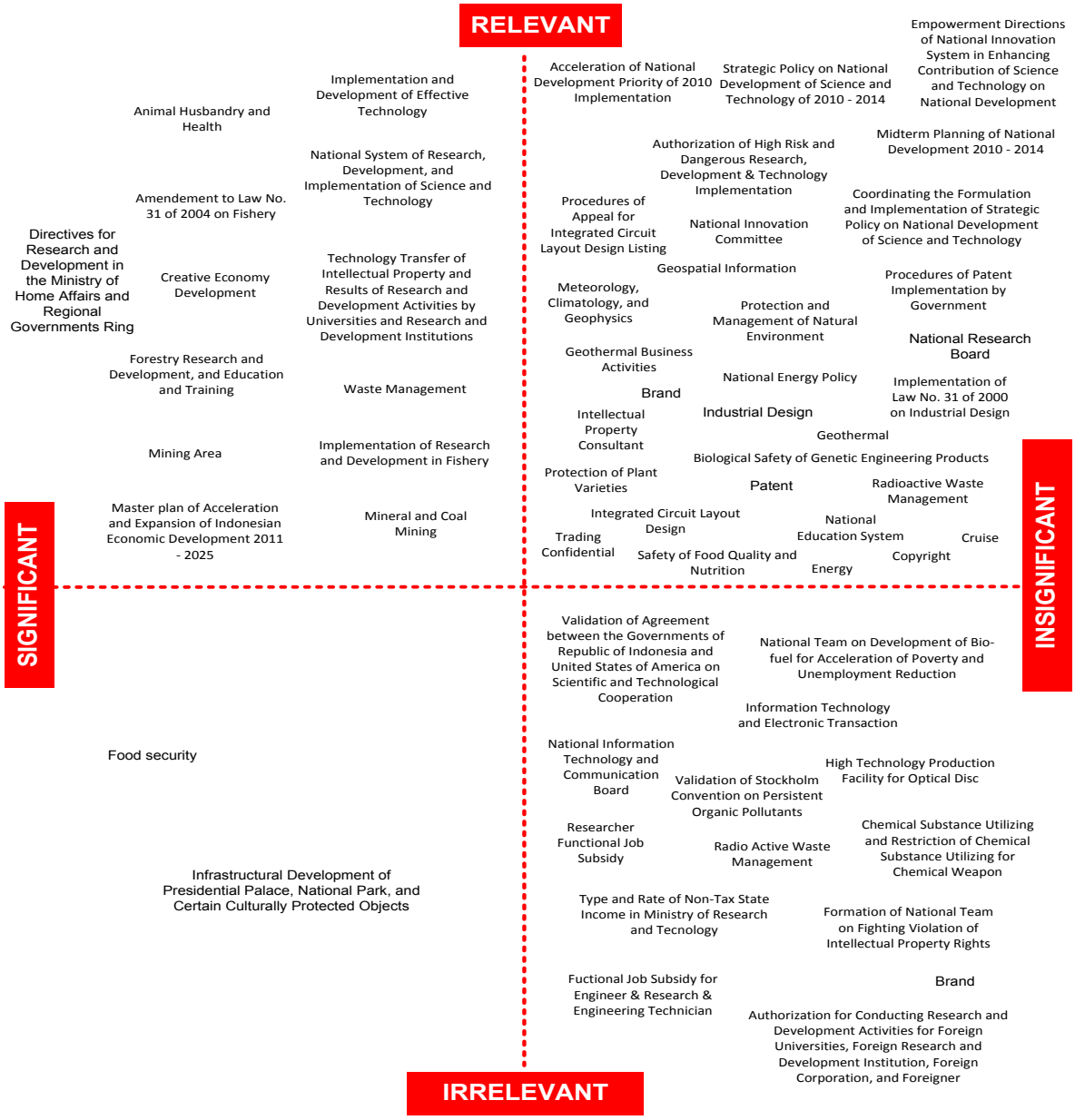


Figure 3. Identification Map of Contents Science & Technology and Innovation Policies on Development, Research, Diffusion, and Implementation of Technology in Regions in 2000-2011 Period.

national policy in Science and Technology and innovation during 2000–2011 period, it is known that there are 22 science and technology and innovation policies as laws, 18 policies as government regulations, eight policies in shape of presidential regulations, three policies as presidential decree, five policies as presidential instruction, and three policies as ministerial regulations or decree from concerning ministers.

Policy map based on identification from Figure 2 can be divided into four dimensions, namely. First dimension is policies possessing relevance and significance on science and technology and giving direct regulation, and influential to development, research, diffusion, and implementation of technology in regions. This dimension takes position at quadrant I between relevant and significant lines. Second dimension is policies possessing relevance but on significance side does not influence development, research, diffusion, and implementation of technology in regions. This dimension takes position at quadrant II between relevance and insignificant lines. Third dimension is science and technology and innovation policies possessing no relevance with development, research, diffusion, and implementation of technology in regions, but on significance side these regulation policies are influential to development, research, diffusion, and implementation of technology in regions. This Dimension takes position at quadrant III between irrelevant and significant lines. Fourth dimension is science and

Table 1. National Science and Technology and Innovation Policies Possessing Relevance, Significance, Efficient on Development, Research, Diffusion, and implementation of Technology in Regions.

IDENTITY	YEAR	NUMBER	ABOUT / CONTENT OF POLICY
INPRES	2001	3	Implementation and Development of Effective Technology
UU	2002	18	National System of Science and Technological Research, Development, and Implementation
PP	2005	20	Technology Transfer of Intellectual Wealth and Results of Research and Development Activities by Universities and Research and Development Institution
UU	2008	18	Waste Management
PP	2008	30	Management of Research and Development of Fisheries
UU	2009	4	Mineral and Coal Mining
UU	2009	18	Ranching and Animal Health
UU	2009	45	Adjustment of Law Number 31 of 2004 On Fisheries
INPRES	2009	6	Development of Creative Economy
PP	2010	12	Research and Development, and Forestry Education and Training,
PP	2010	22	Mining Area
PERPRES	2011	32	Masterplan of Acceleration and Expansion of Indonesian Economic Development 2011-2025
PERMEN DAGRI	2011	20	Guidance of Research and Development in Ministry of State Affairs and Regional Government Circle

technology and innovation policies possessing no relevance with and significance on development, research, diffusion, and implementation of technology in regions. This dimension takes position at quadrant IV between irrelevant and insignificant lines.

Results of identification show that out of 59 national policies in science and technology and innovation, only 13 policies really possess policy relevance of directly regulates development, research, diffusion, and implementation of technology in regions, and on significance side these policies are directly influential to development, research, diffusion, and implementation of technology in regions, and possesses efficiency as a policy, both from influencing policies below, institution empowerment, program empowerment, and innovation capacity. These 13 policies are presented in Table 1.

The results of identification on national policies in science and technology and innovation during 2000-2011 period can besides being shown on figure 3 also be shown from each relevance, significance, and efficiency sides. This map can be viewed in Figure 4.

It is clear in Figure 4 that national policies on science and technology and innovation from relevance side are dominated by policies categorized as policies not directly regulate development, research, diffusion, and implementation of technology in regions (R2), while category of policies directly regulate development, research, diffusion, and implementation of technology in regions (R1) is spread similar to category of policies not directly regulate development, research, diffusion, and implementation of technology in regions, and indeed should not be regulate. These shows that national policies on science and technology and innovation field in 2000-2011 period are still dominated by policies not directly regulate or contain regulations about innovation system, particularly about development, research, diffusion, and implementation of technology in regions. However, there are still two national policies on science and technology field do not directly regulate development, research, diffusion, and implementation of technology in regions and should be regulated (R3) so those policies can support innovation system.

Figure 5 shows most of national policies on science and technology and innovation fields in Indonesia in 2000-2011 period are on category of policies indirectly influential to development, research, diffusion, and implementation of technology in regions (S2), while category of policies directly influential to development, research, diffusion, and implementation of technology in regions (S1) is not dominant enough and almost similar to category of policies do not influence development, research, diffusion, and implementation of technology in regions, and indeed should not be regulated. Policy of category is not influential to development, research, diffusion, and implementation of technology in regions and should be regulated only has one policy. This condition implies that during 2000-2011 period national policies on science and technology and innovation fields in Indonesia do not possess direct influence to innovation system. This is proven from contents of policies that still do not regulate development, research, diffusion, and implementation of technology in regions.

Identification of contents of policy from efficiency side as depicted in Figure 6 provides understanding

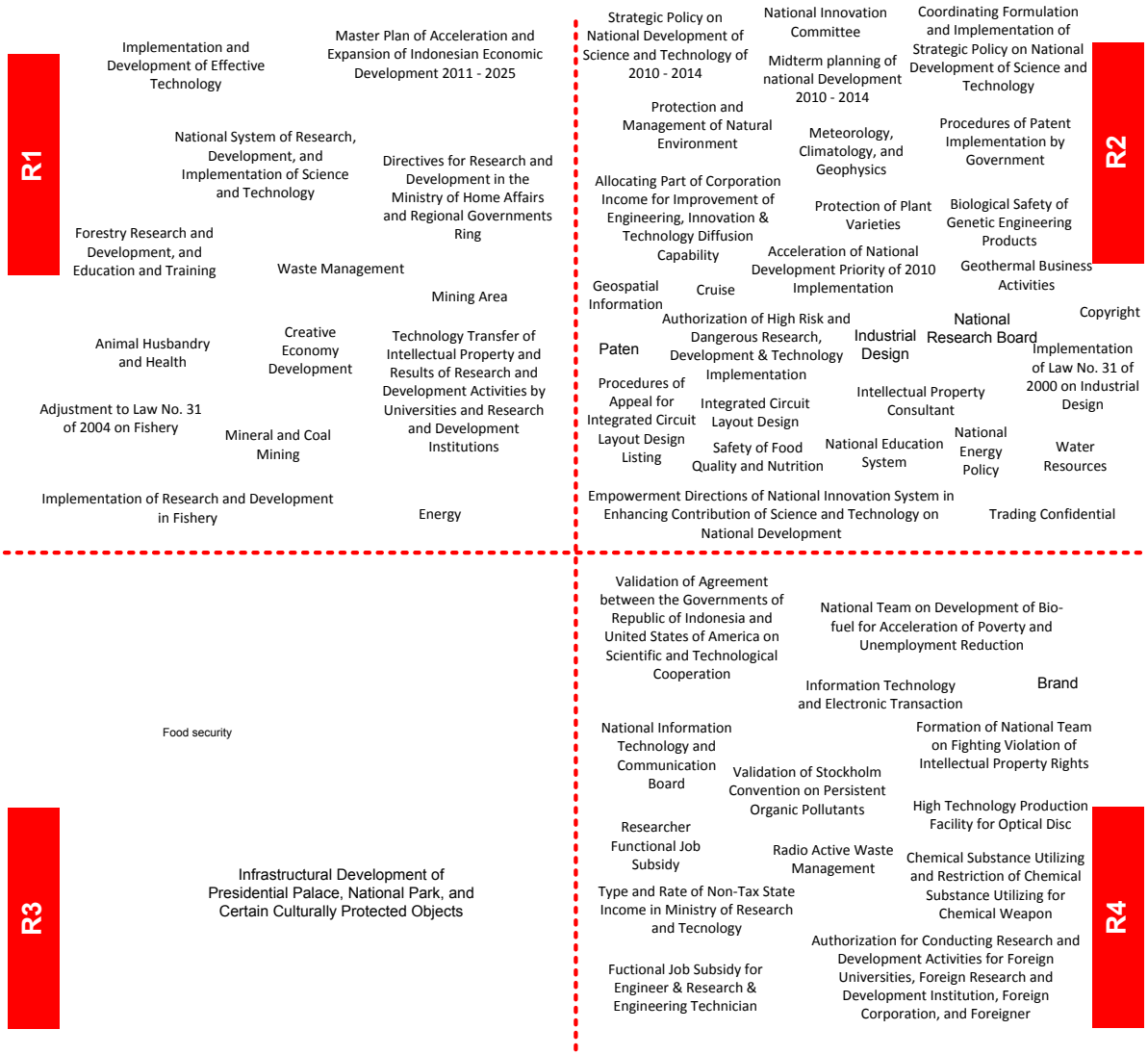


Figure 4. Identification Map of Contents of Science and Technology and Innovation Policies from Relevance to Development (Research), Diffusion, and Implementation of Technology in Regions-side

Explanation:

R1 = Policies directly regulate Development (Research), Diffusion and Implementation of Technology in Regions

R2 = Policies do not directly regulate Development (Research), Diffusion and Implementation of Technology in Regions

R3 = Policies do not directly regulate Development (Research), Diffusion and Implementation of Technology in Regions, should be regulated

R4 = Policies do not directly regulate Development (Research), Diffusion and Implementation of Technology in Regions, indeed should not be regulated

that national policies on science and technology and innovation in 2000-2011 period in Indonesia had efficiency to change policies below it (D1) in connection to development, research, diffusion, and implementation of technology in regions, or efficient in supporting science and technology and innovation institution in development, research, diffusion, and implementation of technology in regions (D2). Science and technology and innovation policies possessed by Indonesia are not strong enough in providing support to policies of science and technology and innovation supporting program (D3) and policy of innovation capacity empowerment (D4). This can be seen from a small number of science and technology and innovation policies in that category. However, from publicized national policies on science and technology and innovation, there are still some that

Figure 5. Identification Map of Contents of Science and Technology and Innovation Policies from Significance to Development, Research, Diffusion and Implementation of Technology in Regions-side

Explanation:

S1 = Policies directly influence Development (Research), Diffusion and Implementation of Technology in Regions

S2 = Policies indirectly influence Development (Research), Diffusion and Implementation of Technology in Regions

S3 = Policies do not influence Development (Research), Diffusion and Implementation of Technology in Regions, should be regulated

S4 = Policies do not influence Development (Research), Diffusion and Implementation of Technology in Regions, indeed should not be regulated

have no efficiency (D5) on innovation system particularly for development, research, diffusion, and implementation of technology in regions.

CONCLUSION

Based on the result and identification of science and technology and inovation policies in frame of schinece technological research development, and implementation system, it can concluded that Indonesian National Policies during 2000-2011 period were less supportive to development, research, diffusion, and implementation of technology in regions or there was still lack of policy support on implementation of national innovation system in Indonesia. Regulations in general can change policies at lower level as well as policies of institution science and technology and innovation supporting program strengthening. National policies on science and technology and innovation fields from resources-side have shown completeness needed in resources requirements, such as researchers and engineers as activities executor, although adjustment in regulations at Law level is not specifically mentioned, but it is clearly mentioned in regulations derivatives. Science and technology and

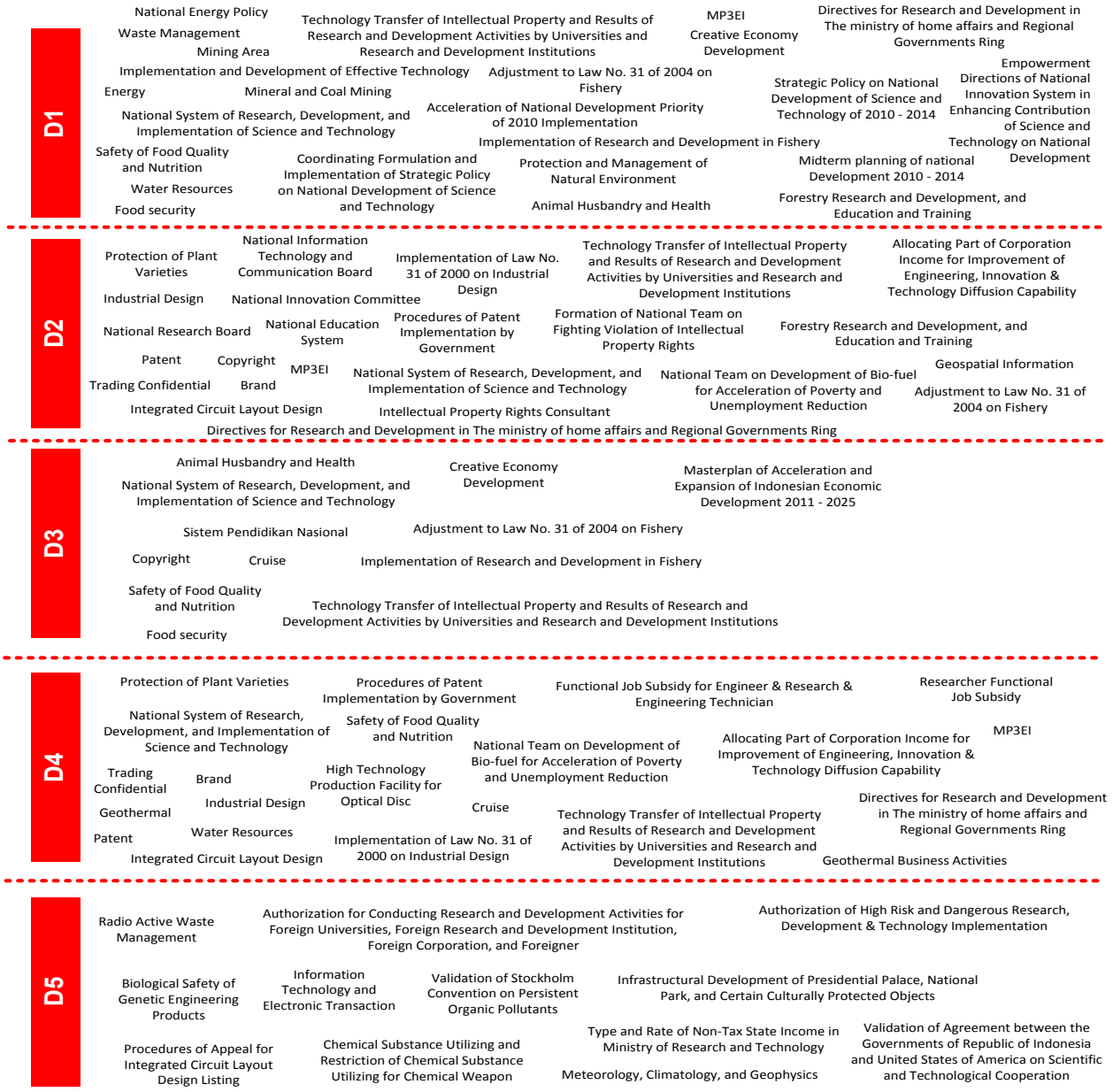


Figure 6 .Identification Map of Contents of Science and Technology and Innovation Policies from Efficiency to Development, Research, Diffusion, and Implementation of Technology in Regions-side.

Explanation:

D1 = Policies change policies below them
D2 = Policies on innovation supporting institution
D3 = Policies on innovation supporting program
D4 = Policies on innovation capacity
D5 = Inefficient Policies

innovation facilities and infrastructures start to be mentioned clearly, not only science and technology park (UU Sisnas P3 Iptek) but also mentioning of regional innovation clusters (MP3EI), even supportive science and technology budget starts to be mentioned as big as 1% of GDP in year 2014 (MP3EI). Science and technology and innovation institution born during 2000-2010 period, from the exsistence of plants variety protection office in 2000 to the existence of national innovation comittee in 2011 supports from national leadership in implementation of science and technology and innovation policies, particularly in strengthening activities of research and development, presentation of stimulant, budgeting and incentives, development and empowerment of National Innovation System frame, as well as strengthening science and technology and innovation institution within

National Innovation System through planning of building center for research, information, and other science and technology and innovation institutions.

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