How infrastructure contributes to fostering Regional Innovation System: The case of Pelalawan Regency – Indonesia

Z S Kusharsanto¹, N Maninggar¹*, Suhandojo¹, D Maulidya¹ and A R Muzaki¹

¹ Agency for the Assessment and Application of Technology (BPPT), PUSPIPTEK National Science and Techno Park, South Tangerang, 15314, Indonesia

*Corresponding author: nimas.maninggar@bppt.go.id

Abstract: Regional Innovation System (RIS) has been regarded by many regions in Indonesia as part of their smart development strategy. The system comprises various elements to be harmonised, including the urban infrastructure. However, despite its essential role in the system, how urban infrastructure contributes to the development of RIS is still unclear and needs to be measured. This paper tries to shed light on the role of urban infrastructure in RIS implementation especially its impact on the operationalization of local institutions and economic development. The case of Pelalawan Regency is examined where RIS has been implemented there since 2015. The mixed method is conducted to assess Pelalawan’s most prominent infrastructure, information and communications technology (ICT) and water supply system, by carrying out survey to Pelalawan’s government agencies and followed by deep interviews to validate it. The result shows that infrastructure only contributes less than 50% encouraging the ideal RIS development, in which ICT’s role outperforms the other.

Keywords: regional innovation system, infrastructure, Pelalawan

1. Introduction

The economic growth around the globe has been radically shifted from relying heavily on traditional productivity factors to other key drivers: knowledge and technology. Many studies show that countries with little natural resources but an abundance of knowledge and technology industries –mostly known as ‘knowledge economy’– are actually the most developed ones, e.g. Singapore and Hong Kong. Some scholars then raised the concept of a national innovation system as a recognition of that ‘knowledge economy’ in which knowledge or intellectual capital is used to create productivity and enhance value [1]. The emergence of region in the innovation system is then inspired by the national innovation system approach, although the system is more specific in the regional or sub-national level [2].

Regional Innovation System (RIS) as part of the National Innovation System has a basic concept of promoting interaction among actors in innovation as the key factor to improving technological performance [3]. This concept emerged when countries in north hemisphere realized that knowledge and technology were considered as determinant of regional development in 1970s. However, the solid concept of an “innovation system” was widely implemented hereafter during period of early 1990s. The first research on it was conducted in 1993, discussing the trade network where various actors were involved in the collaboration of Tinopolis industrial cluster in Wales, UK [4]. Innovation is perceived...
as an interactive system that emphasizes inter-actor cooperative relationship for exchanging ideas and learning [5]. These processes of knowledge transfer however is constrained by distance and access thus it requires infrastructure support to ease the production process and flow of ideas, goods and services.

Infrastructure can contribute to innovation system by increasing productivity and efficiency while simultaneously lowering costs related to distribution and access to markets [6, 7]. GII uses general infrastructure such as electricity, rail network, road, and services building to assess logistic performance and how it affects innovation system. It is obvious then that countries with great infrastructure ranked high: Sweden, Singapore, the Netherlands, Hong Kong, and so on. In Indonesia, some cities such as Semarang and Balikpapan have been successfully implementing RIS through infrastructure pillar as a platform to encourage collaboration. In Semarang, innovation system is presented through the collaboration in the management of Jatibarang Dam, while Balikpapan uses innovation among various actors in Manggar Integrated Landfill [8].

Nonetheless, the study related to the relation between urban infrastructure and innovation system is still limited. When talking about ‘infrastructure’ in the context of innovation system, not much literature puts urban infrastructure such as water supply, road, electricity, or energy into consideration. Instead, specialized innovation infrastructure such as knowledge capital or learning platform has been discussed often. Thus, this article tries to fill that gap by raising a research question of: *to what extent does urban infrastructure contribute to RIS development?* The aim of this study is to scrutinise the role of infrastructure in the endeavour to strengthen the regional innovation system. The case of Pelalawan Regency in Indonesia is used to elaborate this topic, since the regency has made visible effort, including developing its infrastructure, to strengthen RIS. Moreover, as one of the pilot projects of Indonesian smart cities [9], Pelalawan is interesting to be assessed on how infrastructure and innovation system can be related in practice.

This study is structured as follows: Section 2 explains about the materials and method, such as instrument, data collection, and analysis while Section 3 shows the result and discussion of the study. The score of the assessment as well as the further descriptions of every aspect of RIS are discussed to elaborate the condition of Pelalawan’s RIS-related infrastructure. Section 4 concludes the topic and mentions some points to lead the track for future research.

2. Methodology

2.1. Research Materials and Method

Many studies have acknowledged the dissemination of innovation, especially regional innovation system (RIS), as an important approach in regional development policy. The idea of RIS emerges as a way to provide a supporting environment which encourages innovation growth within the region (sub-national level), aiming to boost the regional economic performance as the result. Cooke [1] explains that RIS can properly work if various actors in innovation such as academia, government, and businesses can be involved in the triple helix collaboration [10]. The collaboration should then be reinforced with supporting regulations, infrastructure, and coherence with other components such as national innovation system and global standards.

In Indonesia, RIS has historically strong relationship with the Agency for the Assessment and Application of Technology (BPPT). It was first introduced by Taufik [11] which agreed with aforementioned scholars. He explained that RIS is supported by 6 innovation system frameworks (ISFs) as the foundation for actors to develop the coherence, synergy, and implementation of innovation in the region.

The six innovation system frameworks as well as all aspects and indicators used for assessment are listed in the table below.
| No | ISFs                                                                 | Aspects                                                                 | Indicators                                                                 |
|----|----------------------------------------------------------------------|------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 1. | General frameworks for conducive innovation and business             | Business and innovation database.                                      | • Database of infrastructure (of sources, of network, of accessibility, online or paper-based) |
|    |                                                                     | Regulations for conducive business and innovation.                      | • Legal document for infrastructure development                            |
|    |                                                                     | Basic platform for innovation.                                          | • Masterplan documents of RIS-related infrastructure                      |
|    |                                                                     |                                                                        | • Availability of online-based system                                     |
|    |                                                                     |                                                                        | • Institutions for infrastructure management                              |
| 2. | Institutional and capacity of R&D and the absorptive capacity of industries/SMEs | R&D institutions.                                                      | • The involvement of any R&D-related institutions in infrastructure development |
|    |                                                                     | Absorptive capacity.                                                   | • The involvement of innovation actors in urban infrastructure’s R&D     |
| 3. | Collaboration and diffusion of innovation and improvement in technology-based services | Innovation collaboration and partnership.                              | • The availability and scale of any inter-region collaboration/partnership |
|    |                                                                     | The rate of diffusion of innovation.                                    | • The involvement of universities or R&D institutions in implementing their R&D to infrastructure development |
|    |                                                                     |                                                                        | • Number of platforms available and operating                            |
| 4. | Innovation culture                                                  | Fostering the culture of innovation.                                    | • Number of training programs participated by innovation actors on infrastructure management |
|    |                                                                     | Innovation appreciation.                                               | • Number of innovation-related awarding programs                          |
| 5. | Coherence between regional and national innovation systems          | The initiative to implement national rules.                            | • The initiative of local authorities on infrastructure development based on national standards |
| 6. | Conformity with global issues and standards                          | Environment.                                                           | • Regulations on international environmental initiatives                   |
|    |                                                                     | Standardization.                                                      | • Number of international standard products/procedures used in the infrastructure development |
|    |                                                                     | Intellectual Properties.                                               | • Number of IPs in infrastructure development                            |
|    |                                                                     | Online-based services.                                                 | • The availability of online-based services in infrastructure management |
In this case, RIS-related infrastructure performance is measured using a composite indicator – the Regional Innovation System Radar – which summarizes the performance on 17 indicators. The performance is assessed based on data collected from the observation and evidence-based questionnaire form. This data was then translated into score of 0-1 where 0 means none or extremely low and 1 otherwise. In some indicators, a score in between 0 and 1 is possible and its values may vary. Total score is then depicted with the radar chart to elaborate the condition visually [12] so that we can see the level of infrastructure’s contribution to RIS. After every indicator has been scored, they may need further elaboration, thus we also apply qualitative descriptive analysis afterward.

2.2. Data Collection
Data collection involved a questionnaire for basic information, followed by an in-depth interview to clarify the data collected from the first stage (mixed methods). These interviews and secondary data are used to validate and corroborate any information given in the questionnaire. A paper-based questionnaire was given to each regional office which was related to every indicator of RIS assessment, e.g. Communication and Information Technology Office, Regional Planning and Development Agency, and Public Works and Public Housing Office. The questionnaire contained multiple choices questions to describe the condition of RIS in Pelalawan Regency. When necessary, there were blank forms to be filled in about the details of the choices they made.

After the questionnaire is returned and compiled, a semi-structured interview is conducted with several RIS-related actors: aforementioned regional offices/agencies, Agency for the Assessment and Application of Technology (BPPT), and SMEs. The interview questions probe on several topics, including but not limited to the 6 variables of ISFs of RIS assessment, such as: (1) supporting infrastructure policy for RIS, (2) supporting institution for RIS, (3) cooperation and collaboration to implement RIS, (4) community support in infrastructure programs, (5) the coherence between regional infrastructure programs and national policies, and (6) attempts to conform regional policies with global issues. The interview aims to collect more information and validate responses from the questionnaire.

3. Result and Discussion
3.1. Pelalawan’s RIS-related Infrastructure: Water and ICT
Pelalawan has two prominent types of infrastructure which are related to RIS and have seen major improvement programs: water supply and ICT systems. There are some success stories with their water infrastructure, such as in providing clean water in rural areas and setting up its management body. In ICT, Pelalawan has visions with comprehensive plans to become a smart city in the future, a bold vision considering that it was still categorized as undeveloped in 2006 [13].

The government of Pelalawan Regency believed water to be a crucial aspect for economic prosperity. Back in 2014, 10% of households did not have access to water and only 3% had access to water through pipeline system which was why Pelalawan concerned itself with providing water infrastructure. Also, the severe drought already happened during dry season in several sub-districts, making the situation even worse [14]. Since 2015, Pelalawan has been keen to expand its water systems with several infrastructure plans. At the same time, with the rise of the RIS initiative, this water provision program was then included as a strategy to support what would be called Pelalawan EMAS (jargon for "Ekonomi Mandiri, Aman, dan Sejahtera" or “Self-reliant Economy, Secured, and Wealthy” Pelalawan) [15]. The government believed that RIS would never be successfully implemented if the citizens did not have access to basic infrastructure such as water.

The government executed some plans to accomplish those targets. They made a masterplan of water supply system in Pelalawan to be the primary guideline of regional water management. They also formed a local authority (UPTD) for water management from sub-district level (kecamatan) to regency level (kabupaten). RIS strategy was used to intervene in the water management system with more collaborations among local government, community, and academia in the program called PAMSIMAS (Community-based Drinking Water and Sanitation Provision Program). With that collaboration, water management was integrated with the use of technology diffusion [16, 17] such as (a) residential-scale water treatment plant (100,000 liter/second), (b) residential-scale drinking water plant (10,000 liter/second), and (c) office-scale ready-to-drink water portable plant (10,000 liter/second). This
technology was estimated to increase the water accessibility in community by about 2.5%. In addition, Pelalawan Regency also invested in building 150 monitoring stations to report water flow from springs to settlement.

Besides water, Pelalawan Regency also put ICT provision into their strategy for regional development, especially in public services. Moreover, related to RIS, ICT infrastructure was one of the key elements and it also supports the vision of Pelalawan to become a smart city. Before RIS was considered a development strategy, Pelalawan had never involved ICT in providing basic services (health, education, transportation, permit issuance, and civil data security). Implementing RIS required Pelalawan to begin a digitalization in every aspect of public services, which is also a precondition to become a smart city. Presently, every office has a website of their own; a progress despite the lack of integration under Communication and Information Technology Office (as mandated by Government Regulation No 95 Year 2018). Pelalawan has also implemented E-Governance by publishing programs and budgeting plan online. Furthermore, the cooperation has been agreed between Pelalawan Regency and National Agency for the Assessment and Application of Technology (BPPT) to establish a smart city masterplan of Pelalawan to integrate ICT into government administration and daily services. That strategy aims to increase efficiency, enhance public services, and boost public welfare. Another cooperation was also set up with PT Lintas Arya for high-speed internet network procurement in Pelalawan. Those strategies appeared to be effective because Pelalawan went from an underdeveloped region in 2008 to top 10 nomination for Indonesian smart cities by Ministry of Communication and Information Technology in 2018 [9].

3.2. Measuring Infrastructure’s contributions to RIS development

The relation between infrastructure and RIS appears to be an interdependent relationship where they actually affect each other. Infrastructure have the ability to foster the development of RIS if it meets the requirements of six aforementioned innovation system frameworks (see Method section). Thus, in this section, this study will assess the score of infrastructures (water supply and ICT) based on the indicators set out by Regional Innovation System Radar.

By using scoring method on Regional Innovation System Radar, we obtain a total score of 0.34 out of 1.00 which comes from the mean value of all abovementioned ISFs: 0.00 for Innovation Culture, 0.17 for Collaboration and Diffusion of Innovation, 0.25 for Institutional and Capacity of R&D, 0.29 for Conformity with Global Issues and Standards, 0.58 for General Framework, and 0.75 for the Coherence between Regional and National Innovation Systems.

![Figure 1. The score of every ISF in the development of water supply and ICT in Pelalawan](image-url)
The total score of 0.34 means that the development of water supply in Pelalawan is on “average” level, slightly better than “poor”, in terms of its contribution in implementing the ideal RIS. The fifth ISF, the Coherence between Regional and National Innovation Systems, which scored 0.75, is the biggest contributor to the development of water supply. That is because Pelalawan Regency has been keen on programs related to water supply since the RIS initiation arose. They initiated programs called PAMSIKAS to involve public participation in water management. Following national regulations on water supply system, they also established a technical unit and 12 subunits to handle water management to a sub district scale. It is argued that it becomes a significant driver of the improvement of public wealth and the RIS condition because water plays a crucial role in region’s wealth [18].

The next big contributor is the General Framework, which is illustrated by local regulation and masterplan. They act as legal protection for the planning and development of water supply system. The availability of water supply database also contributes to the great score of this ISF, although it is still manually managed and distributed locally in every subunit of local authority in 12 subdistricts. Although the water management has been formally regulated, its effectiveness is still unassessed as the regulation was released merely a year prior to this research. However, the local regulation has ease the implementation of water supply programs and planning because they are legally protected [19].

Collaboration and Diffusion of Innovation has second lowest score due to the absence of any involvement of universities and collaboration platforms. However, an effort is made by Pelalawan in this regard by coordinating with Ministry of Public Works and Public Housing in the development of community-based drinking water and sanitation. The lowest score is on Innovation Culture because no programs related to training and awarding of water supply are found.

The measurement is also taken for ICT system. The scoring method expresses total value of 0.40 out of 1.00, which is the mean score of all 6 ISFs: (from the lowest): 0.13 for Conformity with Global Issues and Standards, 0.25 for Institutional And Capacity of R&D, 0.25 for Innovation Culture, 0.42 for Collaboration and Diffusion of Innovation, 0.61 for General Framework, and the highest, 0.75 for the Coherence between Regional and National Innovation Systems. Based on the score category, ICT system with score 0.40 has a level of “average”.

Similar with water supply, the biggest contributor of RIS-based ICT development is the coherence between regional and national innovation systems. The initiation of Pelalawan to become a national pilot-project smart city is notable as they have brought all regency offices’ information online on their website. It is also followed by the establishment of Pelalawan Smart City Masterplan, thus making its score in ISF of general framework the second best. With this masterplan, every regional office database is allowed and encouraged to be integrated with each other. They have provided data online in every local office website despite the lack of integration under the Communication and Information Technology Office. During this study, the regulation for smart city as the wider implementation of ICT is still on a legalization process.

In Collaboration and Diffusion of Innovation Framework, ICT has an average performance, better than water supply in strengthening RIS. Similar with water supply, collaboration and partnership in creating smart city master plan with national agency, i.e. BPPT, enhance the score of this aspect. In innovation culture, ICT has brought Pelalawan to be among the national best in Electronic Procurement Services (LPSE). The local government also mandates ICT expertise to be basic skill for their employees thus trainings, such as on cyber security, are held annually. Lastly, the element of conformity with global issues and standards scored lowest due to the absence of ICT products which meet international standards.

The better score of ICT in contributing to RIS shows that ICT as an infrastructure plays an important role in implementing RIS. Its benefit is portrayed on the radar chart above: the tool to spur collaborations of innovation and national-regional coherence. In bigger sphere, ICT also becomes the basic resource to develop smart city and digital transformation in many regions [20, 21].
4. Conclusion and Recommendation

RIS has become an essential approach for regional development policy with its focus on the importance of collaboration and encouraging innovation processes within the region. Operationally, urban infrastructure such as water supply and ICT play an important role to ease those innovation processes by making ideas, goods and services flow among actors. It is thus important to find out to what extent infrastructure can contribute to RIS development in practice.

The case of Pelalawan is brought to this study due to its performance as the top 10 smart city pilot projects in Indonesia and its endeavours related to RIS development. Hence, we are keen on discovering the interdependency between its urban infrastructure and RIS. However, our study reveals that the contribution of urban infrastructure in Pelalawan is still slightly below average. The total score of 0.34 out of 1.00 is earned from water supply assessment, while 0.40 out of 1.00 from ICT assessment. With the indicators of Regional Innovation System Radar, we can see that ICT makes bigger contribution than water supply to encouraging the ideal RIS development. With support of ICT, Pelalawan is able to make changes in organizational structure and to spur more collaborations in innovation. The smart city initiative has motivated Pelalawan Regency to collaborate with National Agency for the Assessment and Application of Technology (BPPT) and thus makes Pelalawan RIS stronger.

The radar chart shows that ICT outperforms water supply in Innovation Culture and Collaboration and Diffusion of Innovation. How ICT outperforms water supply in contributing to RIS is depicted on the score of Innovation Culture. With ICT programs, Pelalawan is awarded for its digital governmental system and conducting annual training to improve ICT skill of its employees, while none of these are found in water supply. This strategy has proven by many previous studies to be an effective way to shift culture and economy into digitalization based on knowledge and technology, thus strengthening the performance of RIS.

Aforementioned condition shows that some strategies can assist water supply and ICT development to contribute more to RIS. Collaboration and partnership among various stakeholders, including R&D institutions, are highly needed to encourage technology transfer and knowledge spillover. The regency can also provide training for managers so that ISFs such as Innovation Culture and Institutional and Capacity of R&D in infrastructure management will be significantly improved. Further study is also needed in order to develop better understanding on how infrastructure can contribute to RIS development. For instance, discovering the social benefit of infrastructure may probe another contribution to RIS.

5. References

[1] Cooke P. Regional Innovation Systems, Clusters, and the Knowledge Economy. *Ind Corp Chang* 2001; 10: 945–974.

[2] Benneworth P, Coenen L, Moodysson J, et al. Exploring the Multiple Roles of Lund University in Strengthening Scania’s Regional Innovation System: Towards Institutional Learning? *Eur Plan Stud* 2009; 17: 1645–1664.

[3] Pan TW, Hung SW, Lu WM. Dea performance measurement of the national innovation system in Asia and Europe. *Asia-Pacific J Oper Res*. Epub ahead of print 2010. DOI: 10.1142/S0217595910002752.

[4] Cooke P. Regional innovation systems: origin of the species. *Int J Technol Learn Innov Dev*. Epub ahead of print 2008. DOI: 10.1504/IJTLID.2008.019980.

[5] Lundvall B-Å. The learning of Economy Some Implication For The Knowledge Base of Health and Education Systems. In: *Knowledge Management in The Learning Society Education and Skills*. Paris: OECD Publishing. 2000, pp. 125–142.

[6] Martinus K. City infrastructure supporting innovation. *Int J Knowledge-Based Dev*. Epub ahead of print 2012. DOI: 10.1504/IJKBD.2012.047033.

[7] Cornell University, INSEAD, WIPO. *The Global Innovation Index 2020: Who Will Finance Innovation?* Ithaca, Fontainebleau, and Geneva. 2020.

[8] Kusharsanto ZS, Handayani W, Artiningsih A. Regional Innovation System Performance in Indonesia: Case of Semarang and Balikpapan. *Asian J Technol Manag* 2017; 10: 58–73.
[9] Fikri H, Suharto DG, Nugroho RA. Government innovation: The challenges and the best practice of smart city in Indonesia. 2018. Epub ahead of print 2018. DOI: 10.2991/iccsr-18.2018.32.
[10] Kinnunen T, Rinkinen S, Majava J, et al. Innovative regional development through triple helix collaboration: a comparative case study of strategic structures and implementation. *Int J Innov Reg Dev*. Epub ahead of print 2018. DOI: 10.1504/ijird.2018.092084.
[11] Taufik TA. *Pengembangan Sistem Inovasi Daerah: Perspektif Kebijakan*. Badan Pengkajian dan Penerapan Teknologi (BPPT), 2005.
[12] Hongliang L, Anxin L, Bin Z, et al. A fuzzy comprehensive evaluation method of maintenance quality based on improved radar chart. In: *Proceedings - ISECS International Colloquium on Computing, Communication, Control, and Management, CCCM 2008*. 2008. Epub ahead of print 2008. DOI: 10.1109/CCCM.2008.208.
[13] Pratama MER. Komisi V DPRD RI Siap Dukung Pembangunan Strategis di Kabupaten Pelalawan. *Pemerintah Daerah Kabupaten Pelalawan*, https://pelalawankab.go.id/web/berita-daerah/komisi-v-dprd-ri-siap-dukung-pembangunan-strategis-di-kabupaten-pelalawan (2020, accessed 31 October 2020).
[14] Hernaningsih T. Mitigasi Bencana Kekeringan di Kabupaten Pelalawan, Riau. *J Sains dan Teknol Mitigasi Bencana*. Epub ahead of print 2019. DOI: 10.29122/jstm.v11i1.3681.
[15] Bappeda Pelalawan. Musrenbang RPJMD Kabupaten Pelalawan Tahun 2016-2021. *Bappeda Pelalawan*, https://bappeda.pelalawankab.go.id/berita/sekretariat/34-musrenbang-rpjmd-kabupaten-pelalawan-tahun-2016-2021/ (2016, accessed 27 September 2020).
[16] Hernaningsih T. Perancangan Pilot Plant Pengolahan Air Minum untuk Zona Pendidikan dan Riset Kawasan Techno Park, Kabupaten Pelalawan. *J Air Indones*. Epub ahead of print 2018. DOI: 10.29122/jai.v8i2.2375.
[17] Sudrajat I, Syarif MS. Development of science and technology park (STP) using the innovation system strengthening framework (case study: The pelalawan technopolis). In: *PICMET 2016 - Portland International Conference on Management of Engineering and Technology: Technology Management For Social Innovation, Proceedings*. 2017. Epub ahead of print 2017. DOI: 10.1109/PICMET.2016.7806573.
[18] Ashraf N, Glaeser E, Holland A, et al. Water, Health and Wealth. *Natl Bur Econ Res*. Epub ahead of print 2017. DOI: 10.3386/w23807.
[19] Grafton RQ, Hussey K. *Water resources planning and management*. 2011. Epub ahead of print 2011. DOI: 10.1017/CBO9780511974304.
[20] Zhang J, Liang XJ. Promoting green ICT in China: A framework based on innovation system approaches. *Telecomm Policy*. Epub ahead of print 2012. DOI: 10.1016/j.telpol.2012.09.001.
[21] Putra ZDW, van der Knaap WGM. Urban innovation system and the role of an open web-based platform: The case of Amsterdam smart city. *J Reg City Plan*. Epub ahead of print 2018. DOI: 10.5614/jrcp.2018.29.3.4.

Acknowledgments
The authors would like to gratefully thank RISPRO LPDP for the financial support of this work.