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NCORS OPEN DATA ECOSYSTEM: BEYOND OPEN DATA!

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1. Introduction

The concept of open data ecosystems is on the rise (Aziz et al., 2022; van Loenen et al. 2021; Pollock, 2011). van Loenen et al. (2018) define an open data ecosystem as "a cyclical, sustainable, demand-driven environment oriented around agents that are mutually interdependent in the creation and delivery of value from open data" (cf. Boley and Chang, 2007). The successes claimed in many countries around the globe convinced the government of Thailand to implement an open data policy for its National Continuously Operating Reference Stations (NCORS), a national system that processes Global Navigation Satellite System (GNSS) signals to improve the accuracy of positional data. However, after six months, the number of users remained limited to the traditional users, and the experiment was terminated. In this paper we explore explanations for the unexpected not increasing user base of open NCORS. More specific the research presented addressed the research questions:

What are the user characteristics that facilitate the use of NCORS data in Thailand? And what are the missing elements and interactions in facilitating the use of NCORS data in Thailand's rice farming as a potential use sector?

We applied a mixed method research approach, including a literature review to investigate the key concepts for the study; a case study research approach for studying the current NCORS situation in Thailand; and interview and survey instruments to study the characteristics of a promising, but so far latent NCORS user group: Thai rice farmers.

Section 2 briefly explains the fundamental key concepts for this study. In section 3, we detail the methodology applied to investigate the use of NCORS in Thailand. Section 4 presents the results of the case study, which are further discussed in section 5. Section 6 concludes with the conclusions and recommendations for further research.

2. Key concpets

2.1. Open data

The Open Knowledge Foundation has defined open data as: "Open data and content can be freely used, modified, and shared by anyone for any purpose" (opendefinition.org).

Open data has been associated with societal benefits such as increased transparency, improved economic value creation and more efficient operations both at the provider and user side. Although these benefits may be difficult to assess (Welle Donker et al., 2016), one characteristic that has been found most often after the implementation of open data is that open data results in a significant increase in the use of the data as well as its user base (van Loenen, 2018; see also https://www.pdok.nl/rapportages for the Dutch experience).

2.2. INCORS

Satellite positioning is a technology to define positions on the earth with a precision length from millimetres to meters. Global Navigation Satellite System (GNSS) is the umbrella term for the available satellite positioning systems, for example, the Global Positioning System (GPS) of the United States, the Global Navigation Satellite System (GLONASS) of Russia, Galileo of the European Union, and BeiDou of China.

CORS is a collective term for the ground station(s) that continuously observe GNSS signals. The first CORS network was established to support GPS users accessing the National Spatial Reference System (NSRS) of the United States and correction services. Later, many CORS networks were established to support the standardisation and interoperability of spatial data and other positioning activities such as autonomous vehicles, machine control, aviation, and precision agriculture (PA).

Thailand, among many countries, has established NCORS to observe and process the Global Navigation Satellite System (GNSS) signals to improve the accuracy of positional data that serve many spatially related activities of government agencies in Thailand.

2.3. INCORS in Thailand

The development of the governmental CORS networks in Thailand started in the late 1990s. Many public agencies set up CORS networks to support their missions, such as the Department of Lands (DOL)—around 181 stations (2021), the Department of Public Works and Town & Country Planning (DPT)—15 stations, and the Royal Thai Survey Department (RTSD)—80 stations. Other public organisations also arranged their CORS networks, such as the Geo-Informatics and Space Technology Development Agency (GISTDA) and the Hydro Informatics Institute (HII).

In 2017, the government established the National CORS Data Centre (NCDC) to integrate and service CORS data from public providers. NCDC will consist of around 290 stations with an average 30-80 km distance between stations.

HII and DOL have been providing their own CORS data free of charge. In comparison, for the national CORS network controlled by RTSD, after a six-month free of charge period between 2018 and 2019, a fee based policy was reintroduced. Later, the NCDC Management Working Group meeting on July 18th 2019, approved the policy to provide CORS data services free of charge in the initial stage to promote NCDC data use and review the data access policy every six months (National CORS Data Centre, 2021).

However, the use of NCORS data in Thailand, also after introducing open data policies, has been limited only to geodetic, survey and mapping, and other scientific works in the government. Only

a few cases of the use by private sectors for construction projects were found. Significant use by new users, such as users in agriculture or industries, was not found.

3. Methodology applied to better understand the lack of increase in NCORS use

To deeper understand the situation, rice farming was chosen for investigation for three reasons. First, this sector has a significant socio-economic role in Thailand. Second, the sector faces ageing farmers and labour shortages, which requires the precise and autonomous technology provided by NCORS data. Applying NCORS technology could support the sector in tackling the issues. Third, NCORS technology has proved beneficial in farming in many other countries.

First, a survey among rice farmers was conducted to acquire user characteristics involving NCORS data use. According to agricultural experts' advice, the farm's size significantly impacts the decision to adopt the technology. Therefore, farmers were divided into Small-scale farmers (S-farmers)—representing household farmers and Large-scale farm leaders (L-farm leaders)—representing the cooperative farms. Then, to explore potential explanations for the survey results, we interviewed several experts in the field.

4. Results

The survey received the complete responses of 195 L-farm leaders and 226 S-farmers, 421 in total. Most S-farmers (58%) and L-farm leaders (70%) are in their late working years and have only primary education. Both groups showed a firm intention to use (perception of use) NCORS technology. L-farm leaders showed a higher likelihood of adopting the NCORS technology. The cost of NCORS technology appeared to be acceptable among the L-farm leaders. More than half of the L-farm leaders and 44 % of S-farmers did not know about NCORS technology before. The majority are conservative (late adopters); therefore, they need to observe the use examples before deciding to use the technology themselves. The ageing farmers and a labour shortage are the driving forces to encourage the intention to adopt NCORS technology. Some survey respondents noted the absence of NCORS technology in Thailand.

The survey also illustrated that 1) farmers demand to use NCORS technology, but NCORS technology was not available in the market, 2) the respondents had limited knowledge about NCORS, and 3) annual data cost between 1-1,000 THB (30 EURO) is acceptable for most respondents.

Interestingly, the perception of use is contrary to some points of a recent study by Sayruamyat and Nadee (2020). The study suggested that farmers have yet to perceive the usefulness of digital technology in their lifestyles. Technology was considered for the next generation. This inconsistency may involve the type of technology farmers evaluated. Digital technology alone may be perceived as less useful and necessary than a specific technology subject to this study—autonomous and precise machinery. An expert of a machinery company confirmed that benefits should be explicit to the potential users. If they see the benefits, they will find a way to use them.

Meanwhile, agricultural machine companies were informed about the new open NCORS data availability, but decided not to quickly provide the technology to the market. Machine providers expressed doubts about NCORS data availability, stability, and user readiness. They considered

that the NCORS technology was too complicated for farmers. Furthermore, they lacked personnel with NCORS expertise to support customers. The field observations also revealed knowledge gaps about NCORS's relevant technology among the machine company's specialists. To provide after-sales services, they must bridge this gap. Overall, they still need more time to incorporate NCORS technology into their business.

5. Findings

The investigation revealed that, in addition to NCORS data availability and user demand, NCORS data use necessitates facilitating conditions such as access to NCORS technology and relevant NCORS knowledge. Furthermore, in addressing the NCORS data use issue, stakeholders must understand the complexities of the NCORS data ecosystem and the time aspect of policy implementation.

5.1. Access to NCORS technology and knowledge

The availability of NCORS technology is dependent on technology providers. The study discovered a gap between the demand for and supply of NCORS technology for agriculture in Thailand. The survey indicated significant potential for NCORS use in rice farming, but the demand did not excite agriculture machine companies. Even though one company was confident in the NCORS technology for rice farming, it expressed concerns about its complexity and farmers' readiness to use it. These concerns may explain the company's lacklustre efforts.

Next to equipment availability, NCORS technology experts should also be available. The field interviews and survey highlighted the lack of experience and knowledge among the machine companies, local staff of the agricultural agencies, and farmers. The findings suggested that the readiness of human resources in all parts of the NCORS value chain must be improved as part of making technology available.

NCORS' outreach program should first target human resources in machine companies and agricultural agencies that can be change agents in delivering knowledge to farmers. It is also critical to disseminate NCORS knowledge to farmers. Delivering the technology to the farmers is another challenge due to behavioural biases (Attavanich et al., 2019). The primary target groups can be the new generation of farmers, who are the technological capable human resources in agriculture (Faysse et al., 2020).

5.2. The NCORS ecosystem

Several factors in this study are beyond an NCORS data ecosystem—they are not directly controlled by the elements in the NCORS data ecosystem. An NCORS data ecosystem depends on, involves, and is linked to other external elements: the elements and functions of other ecosystems. The internal and external engagements of the NCORS data ecosystem and surrounding ecosystems must be considered to encourage the use of NCORS data (and other data). The NCORS data ecosystem coexists with other ecosystems as part of a larger ecosystem. Defining the boundary of a data ecosystem should be discussed further in light of these complexities.

5.3. Time

Stakeholders must remember that all policies and efforts take time to achieve their objectives. The research found that time delays were overlooked in the six-month open data policy trial for the NCORS network in Thailand. It was anticipated that open data would attract users in a wide variety of sectors. However, it turned out that the number of users did not increase and was restricted to those in government agencies. The provider appeared convinced that open data did not encourage the use of NCORS and decided to discontinue open data. Such a decision disregards the time required for society or a community to adapt existing processes to the new policy situation. As seen in this case, time is needed for the machine companies to acknowledge users' demands, the knowledge spreading process, and build confidence in the technology. All these delays contributed to the diffusion of NCORS data use in Thailand.

6. Conclusions and recommendations

This research aimed to explore the policy venues to encourage the use of data from Continuously Operating Reference Stations (CORS) at a national level (NCORS). Thailand, among many countries, has established NCORS to improve the accuracy of positional data that serve many spatially related activities of government agencies.

A specific user group sector was chosen for investigation – rice farming – due to its socio-economic role in Thailand and the potential of the activity in using NCORS data. The research applied a survey to investigate the farmers' needs, practices, and attitudes toward NCORS technology. The result showed that 1) most farmers were willing to use NCORS technology, but NCORS technology was not available in the market for them to purchase, 2) Around half of the farmers knew NCORS, and 3) the annual data cost between 1-1,000 THB (30 EURO) is acceptable for most respondents.

The investigation revealed that, in addition to NCORS data availability and user demand, NCORS data use necessitates the availability of facilitating conditions such as NCORS technology and relevant NCORS knowledge. This study identified three areas for improvement in encouraging NCORS data use: the availability of NCORS technology, relevant knowledge related to NCORS data use, and the cost of NCORS data use.

The first policy triggers the NCORS data use diffusion by making NCORS technology readily available. The availability of NCORS technology will allow the farmers to use NCORS data and trigger further adoption and diffusion of NCORS data use. The second policy is to accelerate the diffusion of NCORS data use by addressing the knowledge about NCORS data availability and NCORS technology. Farmers are the primary target of the knowledge campaign. In addition, the knowledge should target the change agents and opinion leaders, who have a crucial role in delivering/fostering the knowledge to/of farmers. The staff of machine companies and agricultural departments are the change agents. Successful farmers, village sages, and academics are examples of opinion leaders or influencers. The third policy is to enlarge the potential user size through Open Data NCORS (OD-NCORS). Although the annual NCORS data cost is acceptable for most farmers, the OD-NCORS is acceptable for all potential users.

These three policies should be implemented interconnectedly. More efforts are needed to facilitate conditions that empower potential users. The critical driving forces, such as political and public support and relations with machine companies, are the strategic areas to establish. Nevertheless, the stakeholders must consider that all policies and efforts take time to exhibit the expected result.

Further research is encouraged to apply the developed concept of the NCORS data ecosystem to explore NCORS in other contexts and data types. The application may provide insights to improve the NCORS and general data ecosystem concepts. For the NCORS in Thailand, further research should look into how to better understand and improve the facilitating conditions of data use to ensure the success of open NCORS data. Finally, future research into the alignment between NCORS and CCORS for the best interest of citizens will be vital since there is a possibility of the CCORS network establishment in Thailand.

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