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CASE STUDY

January 2020

Integrating Geospatial Information: How the Republic of Korea Overcame Institutional Obstacles to Improve Data Management, 1998–2016

KPOK
Korea Program FOR Operational Knowledge

기획재정부
Ministry of Economy and Finance

PROJECT DATA

IMPLEMENTING AGENCY:
Ministry of Land, Infrastructure, and Transport (Formerly Ministry of Land, Transport, and Maritime Affairs [2008–2013], and prior to that, Ministry of Construction and Transportation [1994–2008])

DEVELOPMENT CHALLENGE:
Collecting and Disseminating Accurate Geospatial Data

DELIVERY CHALLENGES:
Intragovernmental Relations; Lack of Consensus; Stakeholder Engagement

SECTOR:
ICT, Land Administration

COUNTRY:
Republic of Korea

REGION:
East Asia

IMPLEMENTATION YEARS:
1998–2016

AUTHOR:
Kyuri Kim

LEAD PRACTITIONERS:
Sung Wook Chang, Senior Manager, Ministry of Construction and Transportation (and Formerly in the Ministry of Home Affairs); Byung Nam Choi, Research Fellow, Korea Research Institute for Human Settlements; and Kwang-mok Park, Deputy Director, Spatial Information System Division

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Executive Summary

Following two gas explosions in 1995 that resulted from poor management of information on underground pipes, the Republic of Korea accelerated its efforts to update and integrate spatial data, such as underground maps. The Ministry of Construction and Transportation (which became the Ministry of Land, Infrastructure and Transport in 2013) led the integration initiative, but the ministry faced a lack of cooperation from counterpart ministries and agencies. It was often at a stalemate with its main counterpart, the Ministry of Home Affairs: the two ministries could not reach a consensus over how land-related information should be collected, managed, and shared. This case study describes how the land ministry overcame these challenges by seeking mediation or windows of opportunity through higher bureaucratic channels, and by leveraging its experience and resources to scale up geospatial data integration. From its start combining just two datasets in 1998, it went on to establish a fully integrated geospatial data system consisting of nearly 80 datasets from different agencies, which it then disseminated across the entire nation. By 2016, the Republic of Korea's National Spatial Data Infrastructure (NSDI) had not only prevented further disasters, but also dramatically reduced administrative costs and inefficiencies in the public sector. The integrated data system also enabled government officials to make better-informed policy decisions.

Kyuri Kim authored this case study based on interviews conducted in August and September 2019. This research was supported by the Korea Program for Operational Knowledge, a partnership between the Ministry of Economy and Finance of the Republic of Korea and the World Bank Group.

Introduction

On the morning of April 28, 1995, construction workers in the city of Daegu, Republic of Korea, unknowingly bored holes through underground gas pipes. The gas leak led to an explosion that caused more than 100 deaths and 200 casualties, many of whom were children on their way to school. The disaster sent a shock wave across the entire country, as only a few months earlier, another gas explosion had taken place in the middle of Seoul, the capital city. Investigations into the causes of these two tragic events revealed that underground maps had not been maintained properly. Construction projects had deviated from their original plans, and contractors had not reported those details to the authorities. This resulted in a disparity between the underground maps on public record, which were based on initial construction proposals, and the actual position of underground facilities. Investigators concluded that such inconsistencies posed major safety threats, and they called for better maintenance of underground facilities and their maps.

At the time, the Korean government had been enthusiastically laying the groundwork for e-government by introducing digital infrastructure for government offices and agencies and by digitizing key national databases such as the land registry, the citizen registry, and the vehicle registry. The government planned to expand the digitization of the land registry (text-based information regarding land ownership) to construct a database for national geospatial data, starting with digitizing paper-based topographic maps of the entire nation. It aimed to implement these plans through the National Geographic Information System (NGIS) Master Plan (1995–2000). The implications of collecting and managing national geospatial data resonated closely with the lessons and recommendations gathered in the aftermath of the gas explosions.[1] The increased awareness of the need for geospatial data made implementation of the government's NGIS Master Plan even more urgent, and the government allocated more funds for digitization of geospatial data related to facilities and land management.

The gas explosions provided the impetus for the government to accelerate the plan, but digitization of geospatial data had more far-reaching applications that touched on the day-to-day work of citizens, public servants, and policy makers. The Korean government managed land through two distinct approaches—first by zoning and regulating land and its uses, and second by dividing land into individual plots based on ownership. This information was plotted on two separate sets of maps: land use maps and cadastral maps, respectively. Whereas the former comprised legal information related to land use and land-related regulations, the latter contained information on land parcels—individual plots of land—such as parcel boundaries, surface area, and ownership, for the purposes of real estate development and taxation. In other words, whereas land use maps pertained to planning, cadastral maps pertained to management. The public relied on these maps because they contained basic information required for many daily activities, such as construction and taxation, and official paperwork was often required to complete transactions (for instance, the purchase of real estate).

As well as making cities safer, digitization of public records was set to improve efficiency and reduce costs at public offices. Because these documents were so closely connected to daily transactions, issuing and revising official records and documents was a major part of everyday business at municipal offices. Moreover, demands for the services from the public increased as the country underwent rapid development and the volume of transactions increased.

Yong-in, a city in the Seoul metropolitan area that experienced a real estate boom in the mid-1990s, had "at least seven" public servants dedicated to land-related paperwork alone, according to Byung Nam Choi of the Korea Research Institute for Human Settlements (KRIHS).[2] Issuing a single document took those officials several hours or even days, said Choi. Revisions and updates had to be carried out by hand and were prone to delays, incongruities, and inaccuracies. Digitization of the registries had the potential to reduce staff numbers, speed up processing times, and eliminate errors.

Against this backdrop, the government launched the first NGIS Master Plan and appointed the Ministry of Construction and Transportation as the main implementing agency, responsible for coordinating

1 The terms *geographic* and *geospatial* are often used interchangeably in the context of data and information systems to refer to data that have a geographic component and that are stored in layers and integrated with geographic software so that they can be analyzed, manipulated, and visualized. Similarly, the terms *spatial data* and *geospatial data* are used interchangeably.

2 Interview with Byung Nam Choi, August 6, 2019.

with other ministries, agencies, and municipalities. The transport ministry launched four flagship projects under the first master plan:

- Digitization of topographic maps (1995)
- Digitization and servicing of underground facility information (1996)
- Digitization and servicing of thematic cadastral maps (1996): Parcel-Based Land Information System (PBLIS)
- Digitization and servicing of thematic maps for land use (1998): Land Management Information System (LMIS)

The first two projects were delegated to two technical agencies affiliated with the transport ministry: the production of digital topographic maps was assigned to the National Geographic Information Institute (NGII), the authority on mapping since the 1960s, and the program for the digitization of underground facility data was overseen by the Korea Research Institute for Human Settlements. The third project, digitization and servicing of cadastral map data—information related to land ownership and value for taxation purposes for individual land parcels—through the Parcel-Based Land Information System (PBLIS), was carried out by the Ministry of Home Affairs (which in 1998 merged with the Ministry of Government Administration to become the Ministry of Government Administration and Home Affairs), as parcel management had traditionally been under its jurisdiction.

This structure, whereby the flagship projects of the NGIS Master Plan were governed by two different ministries, began to pose a challenge when the transport ministry began work on the fourth initiative, the Land Management Information System (LMIS). The transport ministry began to establish LMIS in 1998 and soon learned that it shared many data points with PBLIS. Officials at the transport ministry thought that the launch of LMIS could be expedited if they could bring data from PBLIS into their system. But the Ministry of Construction and Transportation and the Ministry of Home Affairs had little history of close collaboration, and the transport ministry failed to receive the cooperation it had hoped for.

The inability to consolidate and integrate the data needed by the PBLIS and LMIS projects resulted in high maintenance costs. The end users of the systems—public servants in more than 200 provincial and municipal offices—bore the brunt of duplication of work in having to operate and maintain two separate systems. In addition to such inefficiency, problems of inconsistency in data arose between the two databases, which led to confusion and created the potential for territorial disputes and lawsuits over land use.

Such challenges arising from the failure to integrate data were not unique to PBLIS and LMIS. The transport ministry projected that data integration would be critical for efficient and effective operation of geospatial information systems, and more so as the national geospatial infrastructure development progressed. In fact, the same concerns had been raised following the pilot program for the digitization and servicing of underground facility information in the city of Gwacheon between 1996 and 1997. Because underground facility management required integration of seven separate underground facilities—sewerage, water, communication, gas, electricity, heating, and oil—the importance of data integration was a major lesson learned by the implementing agencies.

To prevent further duplication of work, reduce unnecessary transaction costs, and promote data compatibility, accuracy, and usability, the government had to integrate the two land administration and management systems, PBLIS and LMIS, to form a single system. After establishing the single system, the transport ministry then wanted to integrate a wider range of geospatial data collected by all government agencies.

Delivery Challenges

Intragovernmental Relations

The greatest challenge the Ministry of Construction and Transportation faced in its attempts to integrate geospatial data was the lack of interagency cooperation. Although the transport ministry had been put in charge of implementing the NGIS Master Plan, its main counterpart, the Ministry of Government Administration and Home Affairs, had greater political traction, and the transport ministry had limited influence over it.

The transport ministry faced similar challenges working with other ministries on the NGIS steering committee. By presidential decree, the steering committee was chaired by the minister of construction and transportation, and was made up of no more than 30 people: deputy ministers of member ministries, including the Ministry of Finance and Economy (responsible for government budget allocation)

and the Ministry of Commerce, Industry, and Energy, as well as heads of municipalities and public research institutes. Four technical subcommittees were set up to invite director-level officials and civilian experts.

In spite of the fact that the committee was intended to invite deputy ministers of member ministries, the actual attendees of committee meetings were usually mid-level officials rather than the deputy ministers themselves. Without high-level decision makers around the table, the officials of the transport ministry were unable to effectively garner the cooperation of larger and more powerful ministries. The challenge of persuading other ministries to actively engage in its efforts was a repeatedly occurring obstacle for the transport ministry to overcome.

Lack of Consensus

The second delivery challenge was the lack of consensus between the two main implementing ministries—the Ministry of Construction and Transportation and the Ministry of Government Administration and Home Affairs—over how the system should be managed. First, the two ministries held conflicting motivations and priorities regarding why and how land must be managed. Whereas the home affairs ministry focused on land ownership for the purposes of taxation, the transport ministry focused on land use and planning in the context of development. Reconciling these different definitions and opinions of land administration proved to be a major challenge even after the two ministries had agreed to cooperate.

A second area in which the two ministries failed to reach a consensus was on the implications of data management and sharing. The transport ministry and its affiliated agencies regarded data sharing as a key element of the data life cycle, in addition to data creation, processing, and use. In other words, it maintained the position that data could create more value when shared, hence its efforts to integrate geospatial data being generated by different ministries and agencies.

The home affairs ministry, on the other hand, held data ownership in high regard and considered it an asset that had greater value when possessed exclusively. According to Sung Wook Chang, a senior manager at the home affairs ministry, there was an unspoken understanding that data sharing would result in relinquishing of jurisdiction or bargaining power in the allocation of the budget. Moreover, incumbent officials were reluctant to open up their data archives for fear that it would reveal past mismanagement. At the time, a large proportion of the data were inaccurate because of technical limitations.[3] Officials at the time were wary that revealing those past shortcomings would lead to scrutinizing of their offices, would challenge their authority, or would result in their being held personally accountable.

Tracing the Implementation Process

To establish an efficient national geospatial information system, the transport ministry and home affairs ministry had to come to an agreement on how to promote interministry cooperation and data sharing and overcome bureaucratic or organizational barriers. Also, they had to scale up the system to encompass more than just land use and cadastral information by integrating geospatial data from other ministries and agencies in order to maximize utility. For instance, user demands would need to be monitored to adapt the system to provide better services depending on changing needs.

Establishing an Integrated Land Information System

Mediating an interministry disagreement

The transport ministry realized that a large portion of the data it needed to collect was already available in the home affairs ministry's PBLIS, but it had no access to the data. Shortly after the launch of LMIS in 1998, the dispute between the transport ministry and the home affairs ministry caught the attention of the Board of Audit and Inspection, an independent agency responsible for inspecting the quality of government operations and their prudent spending of government budgets.

The board was interested in the inefficiency created by the two systems, PBLIS and LMIS, for two main reasons. First, the government had generously funded geospatial

3 Older, analog techniques for data collection and storage were prone to inaccuracies, especially in the land administration sector. To measure the size of a land parcel, for instance, field technicians used a large ruler-like measuring apparatus made of bamboo. Because these bamboo strips would droop near the center, the measurement would be different depending on the strength of the technician's tug. Moreover, these measurements would be transposed onto paper maps, which were sensitive to humidity. Parcel drawings would shrink or expand minutely depending on the weather, and miuscule errors made while copying these paper-based plans would eventually add up to considerable inconsistencies.

information projects, having allocated approximately ₩2,800 billion (about US$3.6 billion at the time) to implement the first five years of the NGIS Master Plan. In addition, the government planned to allocate more than ₩4,000 billion for a second master plan, which was set to launch in 2001 (Korea Board of Audit and Inspection [BAI] 2015). Projects with such large budgets were naturally under the close inspection of the board. Second, these land information systems were expected to have widespread uses beyond simply land management—for instance, by providing the foundation for future NGIS projects and supporting government activities in urban planning and taxation.

After two months of close examination, the audit board issued a report stating that there was considerable duplication of work between PBLIS and LMIS. Moreover, it found that unnecessary costs were incurred because of a lack of cooperation and communication between the two ministries. The audit board concluded the report by recommending to both ministers that digitization of information for PBLIS and LMIS be integrated and that the governance structure for digitizing land information be reorganized to prevent further duplication (BAI 1998).

The audit board's recommendations, however, were not legally binding, and the two ministries failed to reach an agreement. In 2000, the audit board carried out a second inspection on the progress of NGIS projects, and it reiterated the same concerns from 1998. The 2000 report repeated that the operation of two separate systems caused a burden on municipalities and higher maintenance costs. Not only did end-user public servants need to operate two separate systems, they also had to purchase and maintain two sets of hardware and software licenses for each system, leading to unnecessary spending of approximately ₩50 billion (around US$44 million at the time), which added up to 40% of their combined budget (BAI 2000).

Although the audit board could not legally enforce its recommendations, it could exercise its power through different channels. Following the inspections in 2000, it took disciplinary action and censured several ministry officials for misconduct, thus indirectly pressuring the ministries to follow its recommendations. Nevertheless, the home affairs ministry insisted that its PBLIS was legally mandated under the Cadastral Act and hence was rightfully independent of LMIS, which was mandated under the National Land Planning and Utilization Act, and refused to comply with the board's recommendations.

Seeing the clear benefits of merging the two systems, the audit board began to put together a stronger case that would increase pressure on the ministries to comply with its recommendations. First, the board commissioned the Electronics and Telecommunications Research Institute (ETRI), a government-funded research organization, to carry out an assessment to examine the technical feasibility of integrating PBLIS and LMIS. After investigating the databases and server structures of the two systems, ETRI concluded that integrating the two systems was feasible. ETRI's assessment found that LMIS was a more adaptable and scalable system, and it recommended merging PBLIS into LMIS (Park and Chun 2013).

Providing these findings as supporting material, the Board of Audit and Inspection transferred the case to the Office for Government Policy Coordination under the prime minister's secretariat, which acted as the governing body of the central government. Brought to the negotiating table by the Office for Government Policy Coordination, the two ministries had no choice but to comply. The home affairs ministry (which became the Ministry of Government Administration and Home Affairs in 1998), especially, was at risk of losing jurisdiction over the entire project or facing more cases of disciplinary action, and it finally negotiated the terms of integration in late 2001.

Integrating the two types of land information systems

Under close monitoring of the prime minister's secretariat, the Ministry of Construction and Transportation and the Ministry of Government Administration and Home Affairs began to discuss in late 2001 how to integrate PBLIS and LMIS materially. Each ministry appointed a delegate to undertake the operation. The transport ministry appointed Byung Nam Choi, of the Korea Research Institute for Human Settlements (KRIHS), as its representative, and the home affairs ministry selected Sung Wook Chang as his counterpart. For the next year, the two specialists carried out a preliminary study to draft detailed administrative and technical plans for the launch of the newly integrated Korea Land Information System (KLIS).

According to both Choi and Chang, the two argued a lot over how to integrate their respective systems. Not only did they come from two different ministries, they also came from different schools of thought on how

land must be managed. To Choi, Chang was often too bureaucratic, whereas to Chang, Choi was often too technical. Nevertheless, working closely together for a year toward a common goal allowed them to build the trust and respect necessary to sustain the project.[4]

One of the challenges the two aimed to overcome during this process was to change some of the misinformed perceptions regarding data collection and its quality. During the process of data integration, many of the inconsistencies and inaccuracies of the existing data began to surface. This had been one of the reasons why ministry officials had been reluctant to open up their data to other parties. A large portion of Choi's and Chang's work was to establish detailed guidelines on how to overcome these inconsistencies (for instance, through triaging which errors to fix first, recalibrating existing data, or even resurveying).

Revealing data inconsistencies was critical to move the integration forward, but it also made many officials fear they would be blamed for errors they were not directly responsible for. Most of the data stored in the two systems were dated as far back as 40 years, having been produced during the 1960s and stored on analog mediums and more recently converted into digital information. Choi and Chang understood that these inconsistencies were inevitable given the difference and limitation of data collection methods and technology available at the time of data collection, as well as the changes in relevant practices and concepts. In addition to carrying out the technical work that was necessary for integration, the two worked to spread the understanding that perfectly accurate data were difficult to achieve. By revealing the nature of the underlying problems and not turning the blame onto the officials currently holding office, they were able to earn the cooperation of their colleagues.

By the end of 2002, Choi and Chang finalized the project plan, and the two ministries were allocated approximately ₩3.2 billion (US$2.5 million at the time) for KLIS development. In 2005, the new KLIS service was disseminated to municipal and district offices across the nation. According to a report published by KRIHS, KLIS increased the productivity of municipality office workers because they no longer had to request land-related documents in person but could access them directly on designated computers at each municipality. The report also showed the results of a cost–benefit analysis carried out five years after the launch of KLIS and stated that productivity and efficiency—calculated by summing up cost reductions from reduced administrative costs (reduction in paperwork, printing, labor, and supplies), reduced subcontracting, avoided opportunity costs by redundant systems, and time saved from civil appeals—increased by more than 400 percent and saved as much as ₩223 billion (more than US$200 million) (Kim and Lee 2014, 98–100).

Integrating operations: One system, two organizations

By 2005, all provincial, municipal, and district offices had adopted and were using the integrated KLIS for managing land-related information. The governance of the system, however, was far from integrated. The departments that had managed PBLIS and LMIS at the two ministries both continued to operate independently on the integrated system, without much cooperation.

The competitive tension between the two parties had mostly dissipated, but new problems began to emerge. Besides the remaining duplication of work and spending, the databases were brought under one system, but the data points were maintained on different time schedules. For instance, the two ministries updated their data at different times of the year, hence the data points maintained by the two ministries did not correspond with each other.

More importantly, the two departments often had difficulty reaching a consensus on which functional improvements to introduce to the system. This arose from their fundamentally different views on why and how land should be managed. On the one hand, the Office of Land Information at the transport ministry maintained that administrative functions of land use and planning must be given priority. On the other hand, the Office of Cadastral Management under the home affairs ministry contended that land management from the perspective of ownership was paramount.

As the implementing body of the NGIS Master Plan, the transport ministry attempted to merge these offices into one organizational body, but once again, the ministry's limited mobilizing power hindered it from successfully negotiating with the home affairs ministry.

A window of opportunity for organizational integration opened up with the presidential election in 2007.

4 Interview with Sung Wook Chang, August 12, 2019; interview with Byung Nam Choi, August 6, 2019.

Following the election, President-elect Lee Myung-bak's transition committee drafted plans for governmentwide organizational reshuffling, which resulted in the two ministries also undergoing major restructuring. First, the incoming administration revamped the Ministry of Government Administration and Home Affairs and launched the Ministry of Security and Public Administration, and second, it expanded the transport ministry and launched the Ministry of Land, Transport, and Maritime Affairs, also called the land ministry. Most important, during this process the new administration moved all land-related activities under the home affairs ministry to the new land ministry, and in 2008 it created a new branch called the Directorate-General for Spatial Information Policy.

Eight years had passed since the decision to technically integrate the two systems, and the Korea Land Information System management was finally integrated into one bureaucratic structure. The organizational restructuring by the transition committee may have been a contingency, but it nevertheless served as a strong inflection point for KLIS. The change in organizational structure enabled significant improvements that had been difficult to achieve before. First, merging the offices resulted in further economization of the budget, for although the absolute budget for KLIS remained the same, it became possible to reduce data maintenance costs. The extra budget was then spent on improvements to the system instead. Second, government officials no longer lost time arguing over differences in policy priority, as the officials responsible for KLIS at the home affairs ministry were transferred to the land ministry. Being under the same ministry allowed them to focus their energy on working toward a common goal. Third, those two changes meant that officials at the Directorate-General for Spatial Information Policy possessed more and better financial and human resources to implement larger, more complicated projects.

Scaling Up Data Integration: Establishment of the National Integrated Information System (NIIS)

Scaling up under the new organizational structure

The establishment of the new and unified Directorate-General for Spatial Information Policy, under the new Ministry of Land, Transport, and Maritime Affairs, paved the way for more streamlined planning and implementation of geospatial data systems. Both the land ministry and home affairs ministry had plans that they had been unable to implement because they lacked resources. Such projects suddenly became feasible when the ministries were merged.

For instance, the home affairs ministry had wanted to set up a service for municipalities to transfer text-only administrative systems onto visual maps to increase efficiency of public services. One example of this was overlaying textual information about restaurants onto a visual map so that sanitation officers could obtain a better sense of which areas required certain actions, such as heightened monitoring or area-customized notifications.

Similarly, the land ministry had forged other ideas to increase the productivity and effectiveness of public services. It had found that a myriad of GIS-based services had been developed and were operating independently across the different ministries, agencies, and municipalities, and it had planned to integrate those services to facilitate data sharing.

Officials at the National Spatial Data Center, a new office within the directorate-general, wanted to implement these planned projects through one megaproject: the National Integrated Information System (NIIS). The idea was that the NIIS would become the central depository for all geospatial data produced by public institutions.

Implementation slowly took off with the launch of a two-phase pilot program in 2009. Forty-four municipalities and district offices were selected for the pilot programs, which involved laying down the infrastructural foundations, such as developing the user operation system that different agencies and municipalities can use to upload and download the data, laying down the hardware and software to allow municipalities to connect to the central system, and developing integrated databases for various thematic geospatial information.

The land ministry contracted Samsung SDS, a subsidiary of Korean multinational conglomerate Samsung, to implement NIIS. Technical experts from Samsung SDS visited public offices to install the necessary equipment, assess the state of the data for integration, and work with the respective offices. According to Kyung-Ho Kim, a manager at Samsung SDS during the early stages of NIIS, the time allocated for the pilots was very short.[5] The pilots were repeatedly postponed as a result

5 Interview with Kyoung-Ho Kim, August 20, 2019.

of interagency negotiations, but the implementation timeline was not extended because the ministry had to spend the budget it had been allocated before the end of the 2009 fiscal year. As a result, Samsung SDS had just eight months to implement the pilot, about half the time that had been planned initially. Although the short time frame did not result in any critical shortcomings, Kim and his colleagues spent several arduous months traveling across the country to visit the municipalities for several days at a time, working around the clock to meet deadlines. Following the end of the two-phase pilot program in 2009, the government launched a three-phase dissemination program between 2010 and 2012, by the end of which NIIS was disseminated to all 246 municipality offices.

The dissemination of NIIS to the municipalities, however, was only half the picture. In order for NIIS to fully function, the data center needed the support of other government ministries and technical agencies, which collected diverse geospatial information that would benefit the municipalities. The Ministry of Environment, for instance, was an ideal partner because it and its subsidiary agencies had collected a great deal of geospatial data. But the mobilizing power of the land ministry was put to the test again as it attempted to gain the support of other much larger and more prominent ministries. Officials at the data center could rarely convince other agencies to disclose the list of geospatial data being collected, let alone agree to share their data.

To overcome resistance from other ministries, land ministry officials had to employ innovative work-arounds to get the information they needed. One tactic used to persuade counterpart ministries to cooperate was to first gather information on the information systems they were operating. Because the ministries would not provide this information firsthand, Kwang-mok Park, who worked on the NIIS during its early stage, went through budget spending reports for the agency he was interested in. Budget reports could be disclosed to the public upon request, and all agencies were obligated to provide details on their spending, so he combed through the pages to identify geospatial data projects. Once he had the exact name of the project, he would contact the people in charge directly, rather than working through the agency's hierarchy.

Another way Park collected information was through technical contractors, like employees of Samsung SDS, who worked on projects funded by other agencies. Park explained that because there were only a handful of technical contractors who could carry out the work, it was a small community, and often the contractor he worked with could directly or indirectly find out which agencies operated what kind of system.[6]

The data center should have been able to obtain the geospatial data that public offices were gathering after the enactment of the 2009 National Spatial Data Infrastructure Act. Article 18 (Establishment of National Spatial Data Center) mandated the land ministry to collect and process geospatial data, and Article 19 (Request for Submissions of Materials, et cetera) stipulated that the ministry may request other institutions' geospatial data. Recipients of such requests were to make the data available "except where extenuating circumstances exist."[7] The law, however, did not make it mandatory for agencies to respond or to provide the data center with the requested information, and they often did not. Even with the various organizational, legal, and technical advancements, the land ministry was once again faced with the challenge of garnering interagency support, and once again it turned to the Board of Audit and Inspections to mediate the situation.

Mediating interagency cooperation for national spatial data integration

According to Jeong Eun Jeong, deputy director of the National Spatial Data Center, NIIS was "a well-designed concept but one that failed to inspire others to join in on its vision."[8] In her opinion, failure to draw in other agencies was caused as much by a lack of influence by the land ministry as by the lack of awareness of the value of shared geospatial data. For these reasons, NIIS failed to fulfill its potential in its first five years of operation.

A major turning point for NIIS arrived in 2014, when the land ministry's NGIS projects came under the spotlight once again. In August 2014, the Board of Audit and Inspection launched an investigation into the effectiveness of the NIIS. After several months of investigation by both internal and external experts, the audit board concluded that the system needed to include databases that were in higher demand across public offices. Moreover, the data from different sources had not been synchronized, making it difficult for offices to

6 Interview with Kwang-mok Park, August 23, 2019.
7 National Spatial Data Infrastructure Act, Act No. 9440, passed Feb. 6, 2009.
8 Interview with Jeong Eun Jeong, August 22, 2019.

use the data that did exist. The government had spent ₩12 billion (more than US$100 million) on the NIIS, but the system had failed to meet expectations.[9]

Along with its criticism, the audit board issued clear guidelines on what to do next. First, it urged the ministry to ensure that all the databases were updated regularly and synchronously to ensure that information was accurate and up to date. Second, it recommended that more resources be spent on data quality assurance to improve the reliability of the system at large. And third, it recommended that 16 specific datasets also be integrated into NIIS. These were government geospatial databases that the audit board deemed to be particularly valuable for public administration—for instance, maps containing real estate prices and an information management system for state-owned woodland. The audit board's report painfully pinpointed the shortcomings of NIIS, but it also served as the catalyst the land ministry required.

To comply with the audit board's recommendations, the data center set in motion two projects the following year. First, it launched the bidirectional integration program under which it more actively negotiated with other agencies for data. Under the program, the data center sent out formal requests for interagency agreement on sharing of data and information systems. Moreover, it began to leverage the data already in the NIIS database. Until 2015, the data center provided its data, including the KLIS data, unconditionally to whoever requested it, and many public agencies had been using those data without reciprocally opening up their databases. The data center announced that it would no longer provide data unidirectionally, and that all agencies that requested NIIS data had to agree to the terms of the bidirectional integration program.

Some agencies also started to recognize the added value of integrated data systems and approached the data center for assistance. For instance, the Korea Environment Corporation, a subsidiary agency of the Ministry of Environment, approached the data center and requested that its data on the location of dumpsters and waste sites be shared on the open platform for wider public use.[10]

The new program also provided positive incentives and elbow room for negotiations. Bidirectional integration required the installation of hardware and software components, called an application programming interface or API. The land ministry covered the purchase and installation of these components, which helped to convince reluctant agencies.

Part of the reason that some agencies had been reluctant to share data was that they thought their data was too sensitive to be made widely accessible. For instance, the National Policy Agency collected a lot of geospatial data but had not provided any of it to the land ministry because it considered some of it to be too sensitive. After negotiations, the policy agency and land ministry agreed to exempt certain data, such as the residential addresses of sex offenders and defectors from the Democratic People's Republic of Korea, which were considered geospatial data, from the list of data to be shared through NIIS. Their rationale was that, whereas locations of sex offenders could be of public interest, making the data public posed the risk of inciting protests. Similarly, addresses of defectors had to be kept undisclosed for reasons of privacy and security.[11]

Many such instances arose across different agencies, whose data required consideration before disclosure to avoid subtle yet complex repercussions. In such cases, individual agencies could submit proposals for deliberation to the dispute mediation committee, as stipulated under the 2013 Act on the Promotion of the Provision and Use of Public Data. The decision to disclose the data would then be decided by the members of the committee—made up of current and former public officials, judges, public and private lawyers, members of academia, or other experts whose expertise has been approved by the Ministry of Security and Public Administration.

A second project launched subsequent to the 2014 Board of Audit and Inspection report was the establishment of the National Spatial Data Infrastructure Portal. Since all the ministries and agencies had been collecting their own data, they had also developed their own channels and systems for gathering and disseminating the data. NIIS and the bidirectional integration program had been an attempt to bring the data together in one place

9 Summary of Plans for NIIS, unpublished document provided to author by Kyung-Ho Kim.

10 Interview with Kwang-mok Park, August 23, 2019.

11 Defectors from the Democratic People's Republic of Korea that seek refuge in the Republic of Korea are resettled by the government through publicly funded educational and financial programs. However, because of the long history of tension between the two countries, settlers from the Democratic People's Republic of Korea are often socially marginalized and stigmatized, hence their identities require protection. Roughly 32,000 defectors were resettled in the Republic of Korea between 1998 and 2017.

and heighten their compatibility, but they needed to be serviced on a platform. In 2015, the land ministry drafted a proposal for the National Spatial Data Infrastructure Portal (nsdi.go.kr), a web-based portal for all geospatial data collected by public offices and agencies that the public can freely gain access to. The National Spatial Data Center began operating the portal in 2016 with funding from the Korea Land and Geospatial InformatiX Cooperation (known as the LX Corporation).[12]

Outcomes

The underground gas explosions in 1995 had sent shock waves across the nation and accelerated the government's plans for better management of geospatial information, both above and below the ground. As both Byung Nam Choi and Sung Wook Chang remarked, there has been no major accident resulting from poorly managed geospatial information since the digitization and integration of geospatial maps.[13]

As the two gas explosions had served as a catalyst for the government, geospatial infrastructure was neither a program that was pursued in a vacuum nor a standalone technical intervention that was suddenly introduced. Rather, it was part of a series of larger, longer-term digital policy initiatives. In this case, the NGIS Master Plans were drafted following a series of policies on digitization in e-government, establishment of communications infrastructure, and establishment of legal and regulatory foundations, with the continued support of the office of the president. Moreover, as Sung Wook Chang pointed out, Korea had a long history, dating back to the precolonial period of the 19th century, of land governance and land ownership, which provided the foundational demand for effective land management practices moving into the digital age.[14]

Hundreds of programs have been carried out since the initial launch of the first NGIS Master Plan in 1995, but the digitization of land-related information for the establishment of the two management systems—PBLIS and LMIS—were among the first few programs. The merging of these two systems into one to create KLIS was a valuable experience through which the transport ministry, which later became part of the land ministry, underwent not only technical integration but also, just as importantly, bureaucratic integration.

The digitization and the integration of land information drastically increased the efficiency of, and reduced the costs required for, data access and maintenance. For instance, whereas it took the help of several people and up to a day to get a copy of a land ownership certificate in the 1990s, by 2019 such certificates could be obtained at an unmanned kiosk in just two minutes. More important, public offices were better able to ensure the integrity of land-related information, thereby preventing losses, and significantly reduced errors and administrative costs, thus better protecting the public's real estate assets. Finally, by providing up-to-date, multidimensional, and accurate information, policy makers became better informed, with more objective and analytic tools they could use in the decision-making process.

Once the system had stabilized, further adaptation to better meet user demands emerged as a priority. As a result, in the mid-2010s, the land ministry removed a significant portion of KLIS to create a separate service called the Korea Real Estate Administration Intelligence System (KRAS). The adjustments made demonstrated that data services were not static but needed to remain fluid depending on current needs of users.

By the end of 2019, the bidirectional integration program had integrated 65 geospatial data systems operated by 37 different agencies. In addition, the NIIS had centralized 78 information systems across 27 bodies of the central government and had opened channels across 246 provincial, municipal, and district offices.[15]

As of 2019, the challenge still remained of dissemination and better use of the government's geospatial data, especially by the private sector or the general public. To promote more active use of the wealth of geospatial data by industries, the land ministry introduced VWorld (www.vworld.kr), an online open platform with an easy-to-access user interface that gave access to geospatial data containing three-dimensional information on buildings and facilities above and below ground, roads, national parks, industrial zones, and so on. Another attempt to engage the public had been to host a competition for early to mid-stage startups that

12 LX is a government-owned corporation that supports the construction of the national geospatial information system by conducting land and cadastral surveys for public use.

13 E-mail correspondence with Byung Nam Choi, December 10, 2019, and Sung Wook Chang, December 10, 2019.

14 Interview with Sung Wook Chang, August 12, 2019.

15 See appendix A for a more detailed list of geospatial information integrated under the Master Plan (1995–2000).

used geospatial data, and to award the winners by funding their incubation programs.

Lessons Learned

Organizational solutions are just as important as technical solutions.

During the implementation of KLIS and NIIS, years passed in which very little progress was made because the government had focused on the technical solutions rather than on the organizational solution. Implementation may have been faster and smoother had the government paid more attention to improving the working relationship of the land ministry and home affairs ministry. Organizational changes, however, were more difficult to introduce than technical changes. For instance, whereas the decision to technically integrate PBLIS into LMIS was accomplished within two years, the process of making the two ministries work seamlessly together took eight years.

Moreover, the tension between the two offices did not subside with simple organizational reshuffling. After the merging of the ministries, officials said that innate differences remained between those who started their careers at the home affairs ministry and those originally from the land ministry. The tension was deeper than interministry competition; it had more to do with the epistemic backgrounds of the officials themselves. Whereas officials at the home affairs ministry were bureaucrats trained in governance and management, officials at the land ministry were often more technical-minded and engineers by training. Merging these two heterogeneous groups, with contrasting perspectives on land management, took time and effort.

Turning to an impartial body proved helpful in overcoming stalemates.

When at a bureaucratic stalemate, escalating the issue to an impartial and independent office higher in the bureaucratic hierarchy and using government mediation can be a solution. One of the most effective interventions in solving the problem of intra-agency collaboration had been to seek mediation through the Board of Audit and Inspection or the Office for Government Policy Coordination. Being audited and scrutinized by such offices inevitably revealed many shortcomings, at times resulting in certain officials being given disciplinary action, but it was through such processes that the implementing agencies gained greater momentum and justification for previously difficult organizational changes. In addition, windows of opportunity also opened during the process of administrative change following the 2007 elections, when the incoming president's transition committee stepped in to assess and reshuffle inefficiencies across the entire public sector.

Perceptions of the value of data sharing had to be changed first.

Although both the land ministry and the home affairs ministry recognized the importance of geospatial data, the lack of consensus on the fundamental role and implications of data sharing prevented the two parties from collaborating effectively. In this case, the traditional viewpoint that stressed ownership of data restricted agencies from opening up their data to others, wary that it would lead to relinquishing their bargaining power or agency legitimacy. This tendency was further observed when the National Spatial Data Center under the land ministry faced difficulty in convincing public offices and agencies to disclose their datasets following the 2009 National Spatial Data Infrastructure Act. However, in time, officials at the data center were able to collaborate with greater ease with counterpart agencies as the perception of data ownership itself changed considerably. According to Jeong Eun Jeong, deputy director of the data center, counterpart agencies participated readily in the bidirectional integration program, partly as a result of their persuasion but also partly as a result of individual agencies realizing the value of data sharing. As in the case of the Korea Environment Corporation, a subsidiary agency of the Ministry of Environment, the rise of concepts such as innovation and big data made officials across more conservative offices become interested in data exchange, and more willing to make their datasets available across different offices and even to the public.

Ensuring data privacy and security prevents putting the interests of some parties at risk.

The land ministry, the data center, and the center's many counterpart agencies established the integrated system on the basis of the assumption that the value of data can be leveraged when shared with other parties. Nevertheless,

it was also important to pay attention to which data can be harmful when shared beyond certain boundaries, such as examining certain data to assess the appropriate level of confidentiality, or deliberating whether disclosure of specific data may benefit some members of society while putting the interests of others at stake. By setting up an expert committee independent of the land ministry, the Korean government introduced an oversight body to ensure that data were not shared indiscriminately.

Data infrastructure needs constant improvement and maintenance.

As Jeong Eun Jeong, deputy director of the National Spatial Data Center, explained, data infrastructure, like roads, electricity, water, and telecommunications, requires constant maintenance, readjustment, and improvement. A large portion of the center's work was to maintain a close working relationship with the agencies that produced the data, and to forge new relationships in response to user demands. Just as roads need maintenance, data infrastructure had to be mended and rerouted depending on demands. KLIS underwent a lengthy process of resurveying as digital measuring equipment and software replaced analog methods. The NIIS collected a vast amount of data throughout the year, and considerable effort was put into deleting duplications and ensuring that data were up to date.

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Annex

TABLE A1. LIST OF OPEN GEOSPATIAL DATASETS, BY DATA CLASSIFICATION

High-Level Classification	Mid-Level Classification	Note
Orthographic photos	Aerial photos	Orthophotos by year and resolution
	Satellite images	1 meter, 15 meter, and so on
	Digital elevation model (DEM)	Digital elevation
3D	Video topographic maps	Processing of terrain and images
	Modeling building	Three-dimensional models of buildings
	Urban planning maps	Land use zoning and urban planning facilities
Zoning district	Continuous thematic maps	Continuous cadastral map-based land use zoning maps
	Editing thematic maps	Editing cadastral map-based land use zoning maps
	Urban planning maps	Land use zoning and urban planning facilities
Coastal information	Coastal information maps	Bathymetric contours, mud flats, and so on (scale of 1/250,000)
	Coastal thematic maps	Undersea mining areas, fishing ports, parks, and so on
Public health	Public health thematic maps	Physical disaster prevention target areas, obligatory disinfection target facilities
Digital topographic map (versions 1.0 and 2.0), scales of 1/1,000 and 1/5,000	Railways	Railway lines, stations, tunnels, and so on
	Rivers	Rivers, lakes, reservoirs, and so on
	Roads	Roads, bridges, tunnels, and so on
	Structures	Buildings, apartments, fences, and so on
	Facilities	Industrial facilities, residential facilities, agricultural facilities, and so on
	Anchor points	Triangular points, horizontal reference points, pass points
	Contour lines and elevations	Intermediate contours, half interval contours, elevation points
	Index maps	1/500, 1/1,000, 1/5,000, 1/25,000, and so on
	Political boundaries	City-province, city-county-district, and other municipal boundaries
New address system	Building gateways	Location of the main entrance
	Road segments	Sections of a road with a single road name
	Real road width	Road surface, road centerlines
	Political boundaries	City-province, city-county-district, and other municipal boundaries
Cadastral map	Continuous thematic maps	Snaps of individual cadastral maps
	Editing thematic maps	Editing and processing of topographic maps and continuous maps
	Anchor points	Triangular points, triangular secondary points, supplementary control points
	Political boundaries	City-province, city-county-district, and other municipal boundaries

High-Level Classification	Mid-Level Classification	Note
Thematic map	Appraised value of land	Status maps displaying appraised value of land
	Ecological-nature maps	Rating based on the ecological and landscape values of natural environment
	National and public property maps	Locations of national and public property
	Industrial park maps	National industrial facility locations
	Protected-area maps	Water source, wetlands, ecological landscapes, wildlife
	Park maps	National and provincial parks
	Cultural heritage maps	Cultural heritage preservation districts, historical and cultural environment preservation districts, preservation of original state
	Administrative thematic maps	Tourist maps, beauty, food, and so on
	Land use maps	Land use maps based on land use classification
	Biotope type maps	Display of biotope types on topographic maps
	Forest type maps	Forest type maps based on the types, distribution, age of trees
Soil	Land surface maps	Classification maps displaying the physical status of land surfaces
	Geological distribution and structure maps	Geological distribution, geological boundary, and fault boundary
	Hydrogeological maps	Aquifers, faults, and contour water level and equal depth level of groundwater
	Soil characteristics and classification maps	Classification maps based on soil characteristics
Underground facility	Water supply facilities	Water pipes, drain pipes, manholes, and water treatment facilities
	Sewerage facilities	Storm water pipes, sewage water pipes, manholes, and sewage treatment plants
	Underground facilities (oil pipes)	Communications, LPG, electric power, and hazardous materials
	Underground facilities (industry)	Danger lines and hazardous material facilities within industrial parks
Points of interest	Fuel sale businesses	Gas stations, LPG stations, and aviation gasoline stations
	Wholesale businesses	Markets and supermarkets
	Leisure businesses	Ski resorts, swimming pools, and golf courses
	School facilities	Kindergarten, elementary, middle, and high schools, universities, and vocational training centers
	Hospitals	General hospitals and clinics
	Welfare facilities	Senior citizen centers and community centers
	Transportation	Bus stations, subways, and train stations
	Public offices	City halls, police stations, school boards, and public health centers

Source: Kim and Lee 2014, 114–19.

Note: LPG = Liquefied petroleum gas.

TABLE A2. LIST OF OPEN GEOSPATIAL DATASETS INTEGRATED FROM PRIVATE SECTOR

Name of Geospatial Data	Geospatial Data Contents (Nationwide Information)
Residential population	National target population, based on age and sex (households, population, age)
Apartments	Apartment price, floor plans
Villas	Villa price, floor plans
Estimated income bracket	National average income bracket
Employed population	Number of employees in the country, by age and sex
Venture firms	Number of venture firms
Import and export businesses	Import and export companies
KOSDAQ listed companies	Number of KOSDAQ companies
Foreign-invested companies	Foreign-invested companies in the country
Top 1,000 corporations	Names of national top 1,000 firms
Banks	Locations of banks
Children's centers	Locations of children's centers
Kindergarten	Locations of kindergartens
Elementary schools	Locations of elementary schools
Junior high schools	Locations of junior high schools
High schools	Locations of high schools
Universities	Locations of universities
Hospitals	Number of general hospitals, oriental hospitals, oriental medicine clinics, premature birth centers, clinics, hospices, dental clinics, and so on
Convenience stores	Number of convenience stores
Land	Appraised value of land

Source: Kim and Lee 2014, 120.

Note: KOSDAQ = Korean Securities Dealers Automated Quotations.