Legal information WPS for factory site location analysis

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Abstract

In local government's urban management system, factory construction approval is based on various standards and complex legal information. The characteristics of legal information are its huge quantity of the legal aspects to consider and constant updates for this information. Therefore reducing the cost and time in choosing the right legal information in site selecting process is necessary for the public.

In this research, Web Processing Service (WPS), an Open Geospatial Consortium (OGC) standard, is used in decision making for the selection of factory sites through spatial analysis algorithms regarding legal information. By using WPS on legal information process regarding factory site selection many remote users have easy access to legal-based process with spatial insights.

1. Introduction to factory site location analysis

Locating a factory site involves many geospatial factors besides return on capital investment which may be the initial interest of the investors. Automobile factory site location analysis process was analyzed in two phases; legal perspective and site specific perspective. The site location analysis model for automobile factory was based on a publication from Byun. (Byun, Dae-ho et al, 1998). The word "factory" in this paper refers to production facilities of automobile parts, petrol stations, junkyards and auto repair shops.

After identifying the related processes, only analytical processes with geospatial characteristics were selected and implemented as WPS of OGC(Peter Schut, 2007). Prior to the implementation of WPS, database tables were designed and then, relevant data from existing database were extracted and loaded to the newly created tables.

2. Design of database for factory site location analysis

In this system, there was already an existing spatial data warehouse and a number of scattered individual GIS systems within the municipality. Some of the existing seven GIS systems are construction management system, disaster management system, environment management system, land information system (Figure 1). For the implementation of WPS, land use zoning table and the parcel table were extracted from the land information systems. The fields for the land use zoning table are identifier, land use zoning, price of land, lot number and geometry. The fields for the parcel table are identifier, lot number and geometry. Initial query test with these two tables showed some problems in retrieval time, as there were about 102,000 records and the file size was about 140 megabytes. Retrieving records with simple queries took over 30 minutes. 6 separate tables were created as shown in Figure 2 to speed up the retrieval time to less than 30 seconds.

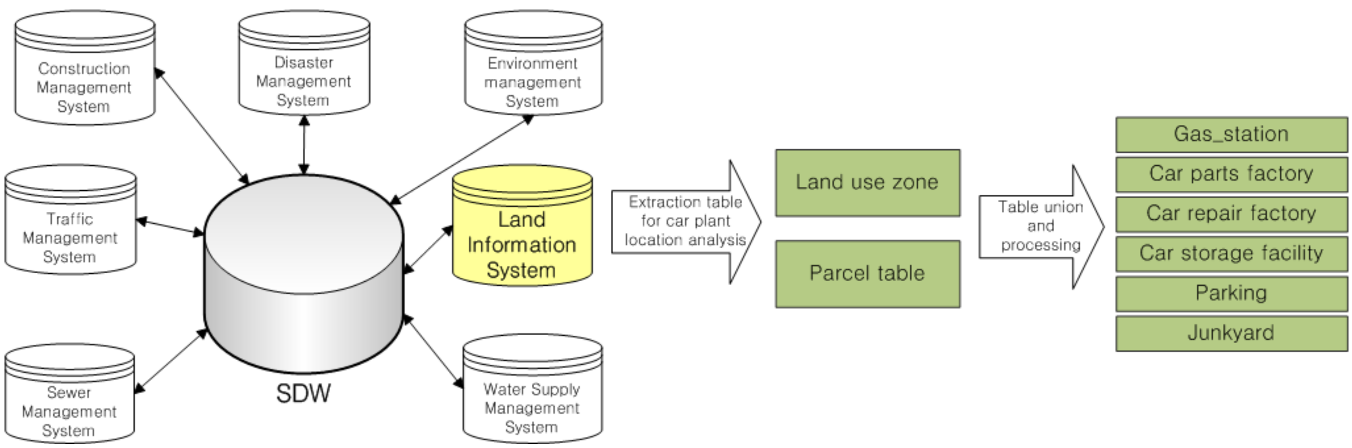


Figure 1. Extraction of database from existing GIS for WPS implementation

Gas_station	Car parts factory	Car repair factory	Car storage facility	Parking	Junkyard
+ID +price of land +land use zone +geometry	+ID +price of land +land use zone +geometry	+ID +price of land +land use zone +geometry	+ID +price of land +land use zone +geometry	+ID +price of land +land use zone +geometry	+ID +price of land +land use zone +geometry

Figure 2. Redesigned table design to accelerate retrieval time

3. WPS profiling for factory site location analysis

3.1 Workflow analysis for process design

The work flow for factory construction involves three phases of locating, approval and construction and is as shown in Figure 3. The WPS in this study targeted only the first phase of locating (Korea Industrial Complex Corp, 2010)

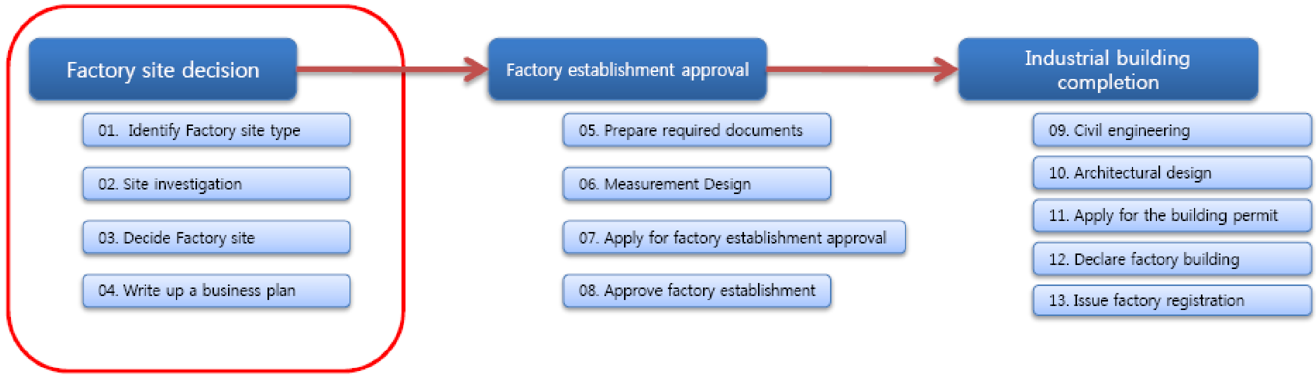


Figure 3. Work flow for construction of factory

Locating a factory site involves first globally identifying candidate sites within a region of interest where it is legally possible to construct a factory. Of course a region of interest must first be selected manually, such as within the boundary of a city limit or county. After identifying the candidate sites, each candidate has to be evaluated and graded after which the best candidate could be further evaluated in more detail. Identifying the candidate factory site type (01.Identify factory site type in Figure 3.) involves investigating compliances with zoning regulations and other planning regulations. The second phase of evaluating each candidate involves evaluating various business oriented factors (02.Site investigation in Figure 3.). Four geospatial evaluation criteria were selected from various business oriented factors suggested by Byun (Byun, Dae-ho et al, 1998); size of factory site area, proximity to market, proximity to materials, and cost of land acquisition. After computing the evaluation factors a selection process to decide on the best candidate should follow. Byun suggested an AHP model for this process but simple weighting model could also prove to be useful. This study did not implement the final best candidate selection process. The selection process is shown in Figure 4.

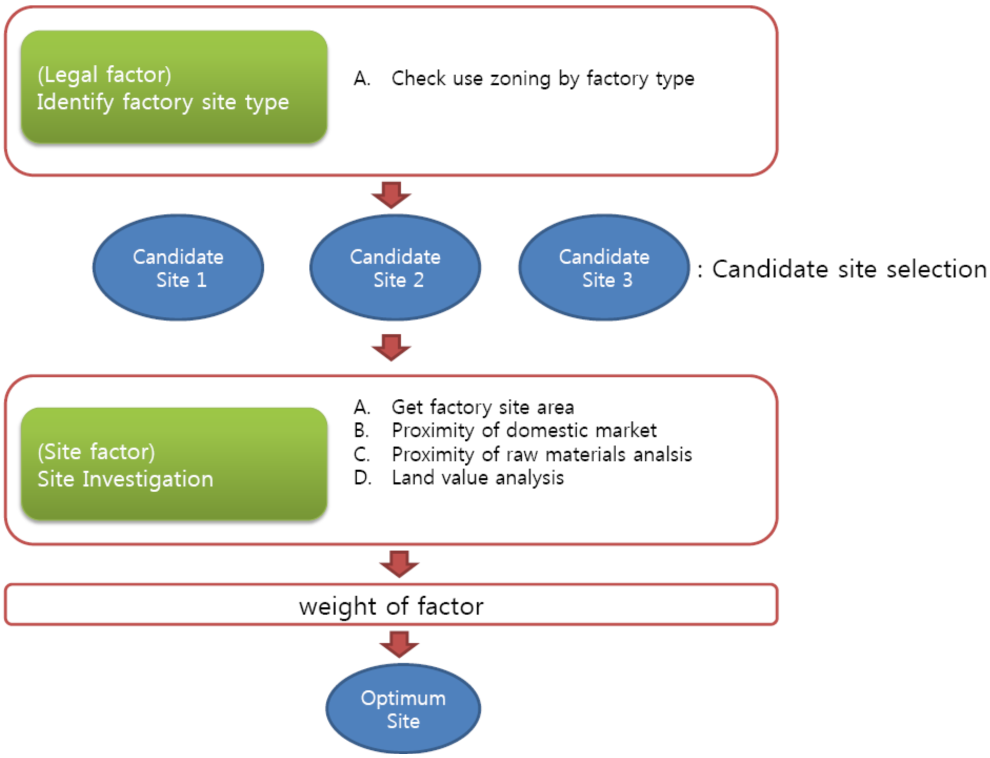


Figure 4. Work flow for selection of best candidate for factory locating

3.2 WPS profiling of factory locating

Based on the work flow model of factory locating, four basic WPS processes are identified (Figure 5). For reviewing compliance with planning regulations, a process titled GetUseZoning was designed and three other WPSs'; GetArea, Distance and GetValueOfLand, were designed to evaluate each candidate site.

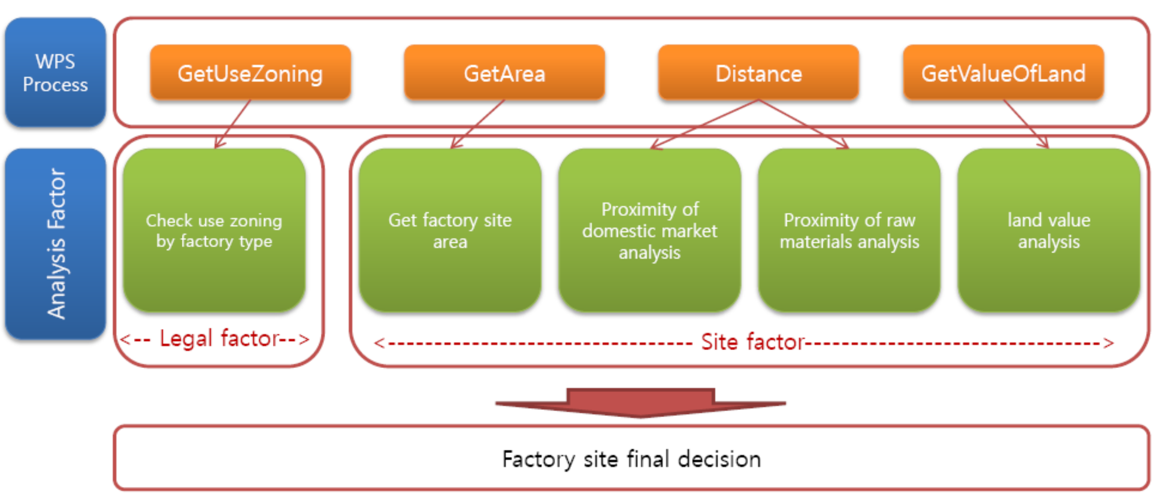


Figure 5. WPS process scheme for location analysis

Using the scheme of Figure 5, WPS profiling is documented following the publication by Nash (Edward Nash, 2008). Table 1 shows the result of WPS profiling where each process is described by a row. Each process has a URN (Uniform Resource Name) identifier value, a title and the Input and Output definitions. The profiling process was carried out considering the implementation WPS server, especially considering the input and output data type which were supported by the WPS server.

Table 1. Factory site WPS profile

Process Identifier / Title	**Input**		**Output**	
(sejong:wps:factorySiteLocationAnalysis :*)	**Name**	**Type**	**Name**	**Type**
database :useZoning / GetUseZoning	Factory type	Double	Parcel	MULTYPOLYGON(WKT)
spatialAnalysis:getArea / GetArea	Target parcel	POLYGON(WKT)	Area	Double
spatialAnalysis:distance / Distance	Parcel Point	POLYGON(WKT) POINT(WKT)	Distance	Double
database:getValueOfLand / GetValueLand	Target parcel	POLYGON(WKT)	Value of land	Double

4. WPS implementation and result

Using the WPS profile, WPS client was implemented using the uDig SDK 1.1 (uDig, 2010), and GeoServer 1.7 (GeoServer, 2010) as the WPS server. The database tables were managed by PostGIS 1.4.2 (PostGIS, 2010; Postgresql, 2010). Figure 6 shows the implemented system.

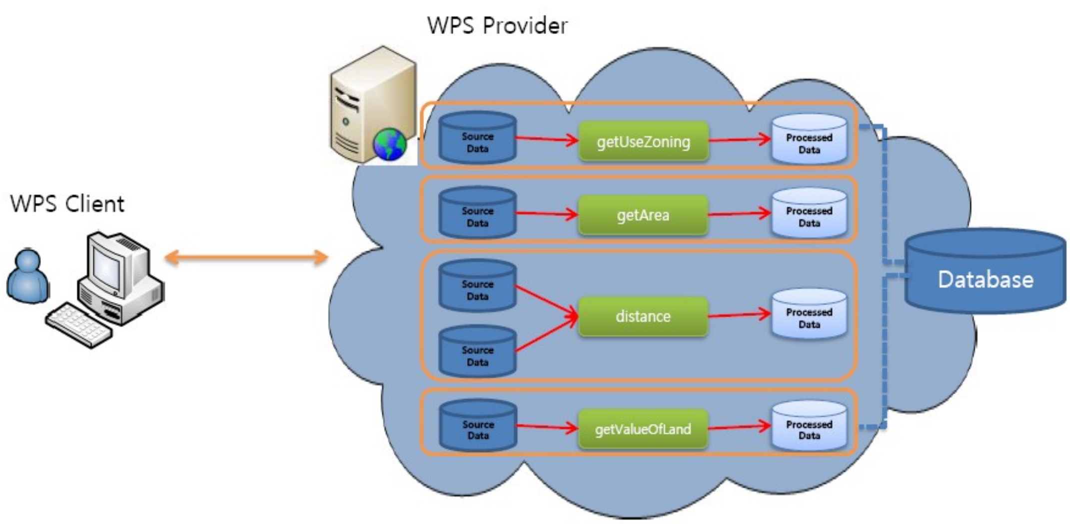


Figure 6. Implementation schema of factory locating WPS

Figure 7 and 8 show the result of the implementation following a scenario of locating an automobile factory site in a city at the southern part of Korea. The GUI (Graphical User interface) was designed with 4 main sections.

1 Data View where the region of interest is selected and viewed.
2 WPS request view where the result of GetCapabilities request is shown.
3 Analysis View where input data is keyed in for each process .
4 Result View where the computation result (area, distance, cost) for each candidate is displayed .

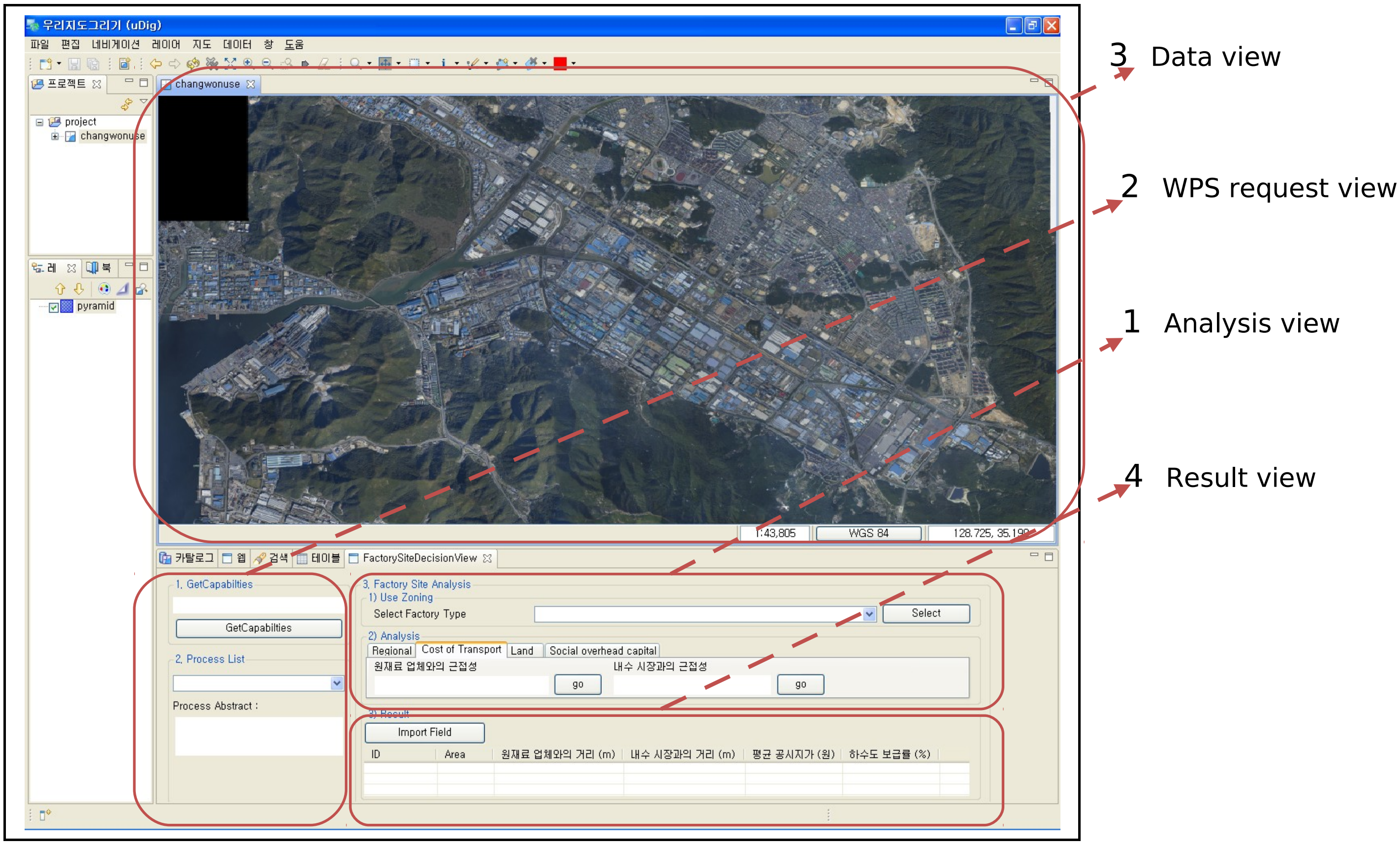
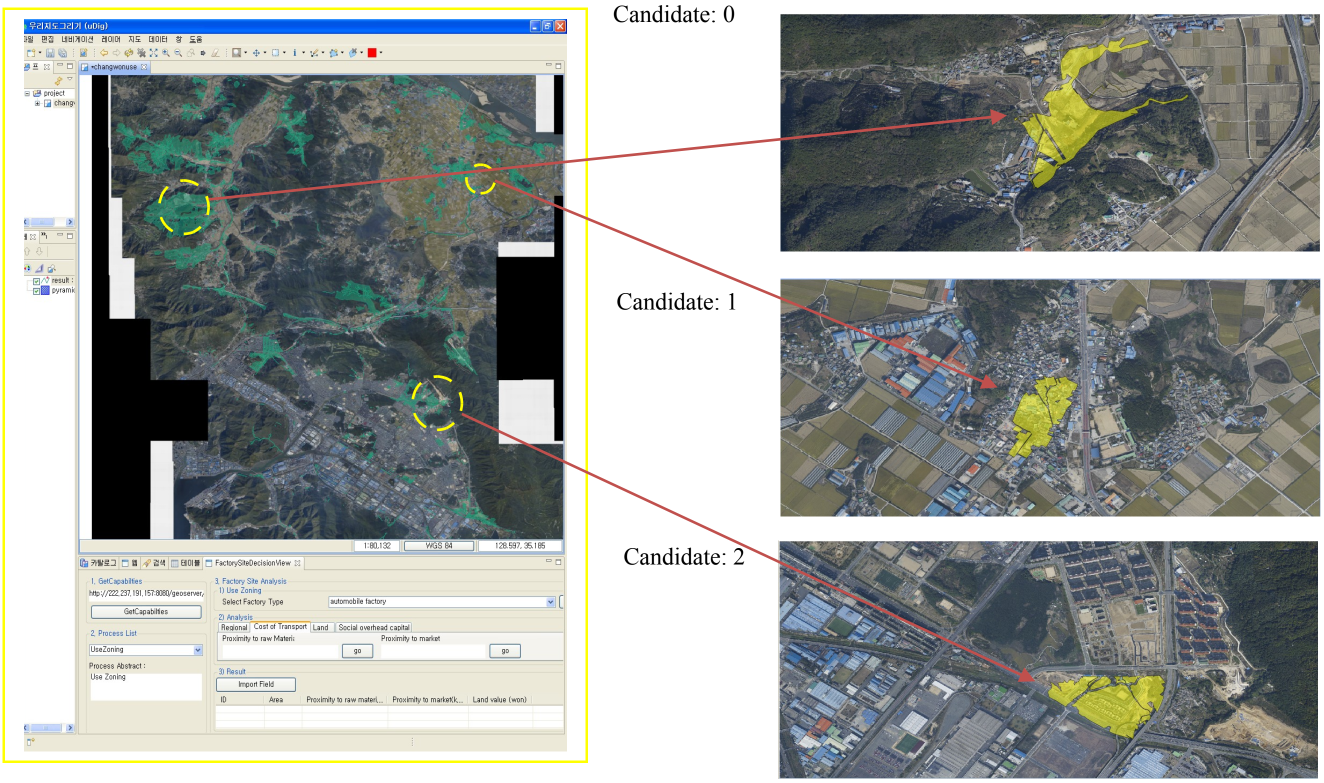
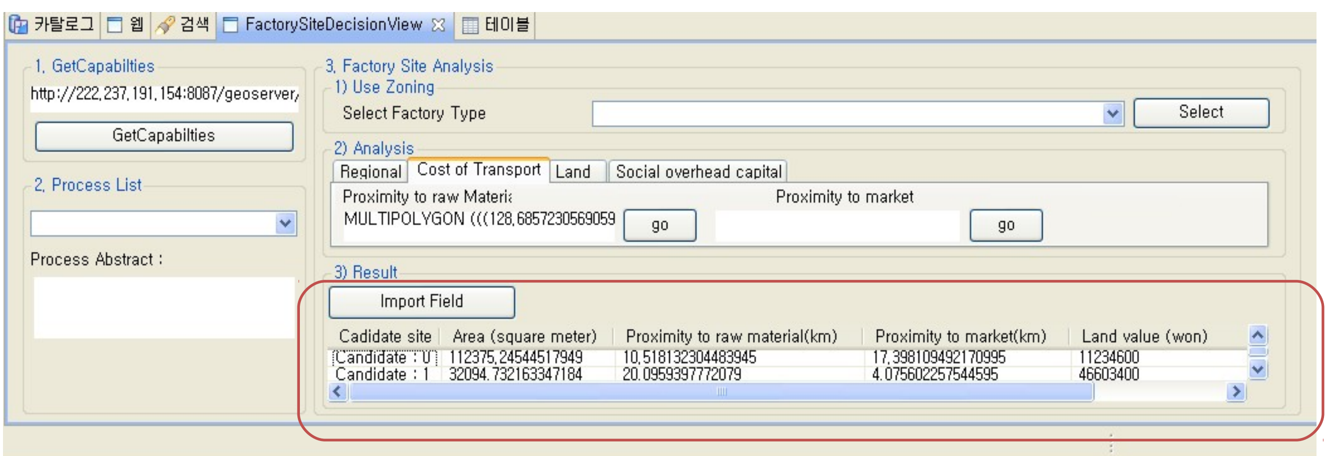


Figure 7. Client GUI for WPS

Figure 8. shows the result of GetUseZoning process which filters the candidate regions for compliance with zoning regulations. The result polygon is superimposed onto a digital orthomap. The result of other 3 WPS processes are shown in the result view and this is arranged again in Table 2.



[Result of use zoning by factory type] [Three factory site candidate]



[Result of factory factor analysis]

Figure 8. Factory site candidate decision by use zoning

The result of Table 2 should go again to another WPS process of selecting the best candidate such as weighting or AHP process which was not implemented in this study.

Table 2. Result of computing evaluation factor for each candidate site

Candidate	Area (m^2)	proximity to raw material (km)	proximity to market (km)	Land Value (won)
Candidate 1	112375.245	10.518	17.398	11,234,600
Candidate 2	32094.732	20.095	4.075	46,603,400
Candidate 3	113021.598	15.642	9.734	257,517,800

5. Discussion

A prototype of a WPS for factory locating has been presented introducing various phases of building a WPS. The implementation started with a factory location analysis model from a domain expert, and then geospatial factors were extracted from this model and transformed to WPS. WPS such as the one in this study could serve its specific purpose in the real world, if it is further refined and complemented with other functionalities with relatively little extra effort.

But considering the fact that WPS should be a distributed service on the web, the reusability of the atomic processes of the WPS and the coupling (chaining) of these atomic processes to accomplish a specific domain task remains a critical issue. Assuming that the atomic geospatial processes are well defined and "standardized" and are readily available on the web, the maintenance and governance of the atomic processes would still be necessary. Any WPS server will have to comply with this standardized atomic process supporting the defined input and output data types. This is not the case at present where a WPS client works with only certain WPS servers which supports the same input and output data types as expected by the client.

Chaining of atomic processes to perform specific task remains another tough challenge. Although chaining is technically possible, discovery of the necessary atomic processes would be a problem, and even when the correct process to be included to the chain has been discovered, the physical location of the process server may be a serious problem when considering the huge data that has to navigate through the web. Deploying the atomic process in a cloud computing environment could be a solution to this problem as it is likely that the data and the process reside in nearby servers within the cloud computing environment. But if the data and the process exist in different computing clouds, enabling sets of standardized atomic processes to be readily and easily deployed to any multiple WPS servers could help the situation.

Acknowledgement

This research work has been conducted through funding from the Seoul R&BD program (10540).

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