Enhanced Performance of Urban Site Selection in Yogyakarta using the Spatial Decision Support System (SDSS)

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Volume 14-Sep-CUL

Challenges & Opportunities in Cluster Urban Logistics: The Jurong Gateway Precinct
Volume 14-Mar-CUL

Collaborative Urban Logistics: Synchronized Last-Mile Logistics for Sustainable, Efficient Urban Delivery
Volume 13-Nov-CUL
Overview of SDSS and its application in Yogyakarta


Yogyakarta


Peningkatan aktivitas pergerakan barang perkotaan memberikan dampak yang nyata bagi sosial dan lingkungan. Dampak lingkungan terjadinya peningkatan volume kendaraan yang masuk ke perkotaan, dan menimbulkan kemacetan serta peningkatan emisi CO2 perkotaan Yogyakarta. Dari hasil pengolahan data sebaran emisi di Perkotaan Yogyakarta, sebaran emisi CO2 terbesar di Kota kawasan pusat Kota, dan jalan arteri ring road dan ruas jalan utama masuk ke perkotaan seperti Jalan Magelang, Jalan Solo, dan jalan Godean. Besarnya emisi CO2 di kawasan tersebut sudah mencapai 2800 ton/tahun. Disamping itu banyak terjadi kemacetan di kawasan perkotaan dengan ditandai VC Rasio yang mendekati 0,8. Permasalahan yang lain yakni,
keterlambatan delivery barang sampai pada konsumen. Proses delivery barang dan pergudangan di Perkotaan Yogyakarta belum memiliki regulasi yang baku. Walaupun dari arahan tataruang bahwa pergudangan diarahkan untuk di luar ring road, rest area sudah ditentukan, namun masih banyak pihak swasta yang melakukan bongkar muat di sembarang tempat. Hal ini karena belum ada kesepakatan dan kesamaan pemerintah dan masyarakat tentang konsep logistic perkotaan yang akan diatur.

Permasalahan yang lain dari aktifitas urban logistic yaitu kondisi geografis di Kota Yogyakarta yang rawan terhadap bencana alam menjadi hambatan sendiri. Ada beberapa natural disaster di perkotaan Yogyakarta, diantaranya gempa bumi, longsor, dan banjir dan volcano. Untuk bencana gempa bumi terjadi dikawasan selatan Kota Yogyakarta, bencana Volcano terjadi di kawasan merapi dan longsor beberapa perbukitan di bantul dan kulonprogo.

**Hasil Pemilihan Lokasi**

Hasil penelitian ini menunjukan bahwa wilayah yang memiliki berpotensi terbangunnya Consolidation center yaitu:

- **Wilayah Patuk**

   Ada beberapa hal yang menyebabkan wilayah ini terpilih menjadi prioritas yaitu karena wilayah ini terkases dengan moda rel kereta api barang, akses jalan ateri jalan wates tidak berada pada pemukiman padat, dan landuse yang mendukung, wilayah ini juga menjadi rekomendasi pihak holcim untuk melakukan pergudangan mereka.

- **Wilayah Sedayu**

   Alasan wilayah ini terpilih menjadi prioritas yaitu memiliki alasan yang sama dengan wilayah patuk. Wilayah ini searah dengan jalan arteri wates dan sejajar rel keeta api.

- **Wilayah Wates**

   Alasan wilayah ini terpilih menjadi prioritas yaitu akses menuju arteri dan dekat dengan rel kereta api. Wilayah ini kurang optimal jika dibandingkan dengan wilayah patuk dan sedayu.

- **Wilayah Kalasan**

   Alasan wilayah ini terpilih menjadi prioritas yaitu memiliki alasan bahwa landuse masih mendukung dan terhubung dengan akses utma jalan solo dan ring road utara.. Beberapa pergudangan banyak dikawasan kalasan terutama untuk komoditas barang yang berasal dari timur. Kawasan pergudangan yang ada dikalasan salahutnya Pergudangan Bulog.
Enhanced Performance of Urban Site Selection in Yogyakarta using the Spatial Decision Support System (SDSS)

Executive Summary

This whitepaper is developed as a part of “Temasek Foundation – National University of Singapore: Urban Land Transport Management for Policy Leaders/Specialists in Indonesia” program to provide local governmental agencies a deep insight into Strategic Freight Planning and Distribution in response to the Blueprint of the National Logistics System (or SISLOGNAS) launched by the Indonesian Presidential Office.

In this whitepaper, Yogyakarta - one of the fast-growing cities in Indonesia that is of particular characteristics - is chosen as a pioneering city for developing an efficient strategic freight distribution planning policy to locate a freight logistics facility (e.g. distribution center or inland port or freight village). The so-called Spatial Decision Support System (SDSS) – a spatially analytical platform to visualize different key information to support decision making – is employed for our strategic solution methodology. The benefit of SDSS is to assist users or decision makers in simultaneously handling and operating different criteria of interest (both quantifiable and non-quantifiable) for the sake of precisely pinpointing the proposed location. The findings from SDSS development on Yogyakarta case are also discussed and validated with the existing practices, thus signifying the superiority and practicality of the developed platform.
Recap

For the benefit of the new reader we recap from the whitepaper series. There is a requirement from the Indonesian Central Government to all local governmental agencies through the Presidential Regulation Number 26 Year 2012 in regard to the blueprint of the National Logistics System (SISLOGNAS)\(^1\), which seeks the integration of individual transport and logistics programs to effectively and efficiently connect the flows of freight and passengers throughout the country. The series of whitepapers disseminated in this program have, as a consequence, been collaboratively researched and developed to further equip local governmental agencies with comprehensive knowledge and skills on Strategic Freight Planning and Distribution, so as to enable development of individual strategic road maps and aid policy planning in response to the aforementioned requirement.

The first whitepaper\(^2\) conceptually developed a strategic freight planning and monitoring initiative of an e-market (freight exchange) platform to tackle the challenges arising in the island of Java. The e-market platform executes by assembling the stakeholders involved (i.e. suppliers, regulators, receivers, and service providers), facilitating interaction and enabling sharing of pertinent information as well as their requirements. With the use of an intelligent auction mechanism, the platform results in consolidated freight and cooperative routes, encouraging healthy competition for business and sustainable living for society. The second initiative\(^3\) is a strategic freight distribution planning policy whitepaper as an extension of the logistics network through the establishment of new facilities.

Accordingly, the Spatial Decision Support System (SDSS) platform as a computer-based visualization tool for geographic problems has been developed. A holistic framework of the SDSS platform has systematically been sketched, followed by the recommendations of interesting modules and approaches to be equipped on the platform. Following up our previous works, this whitepaper shows a case study of developing an efficient strategic freight distribution planning to locate a freight logistics facility in Yogyakarta using SDSS.

\(^1\) Presiden Republik Indonesia, Peraturan Presiden Republik Indonesia Nomor 26 Tahun 2012 Tentang Cetak Biru Pengembangan Sistem Logistik Nasional, 5 March 2012.
Introduction to Yogyakarta

Functional background

Like other big cities, Yogyakarta is also addressing major transport and inherent logistics challenges. Located in the Island of Java that is known as the center of freight distribution in Indonesia, Yogyakarta has to deal with a high proportion of freight movements. Outcomes are consequently increased congestion, transportation delay, lack of public and private logistics resources and infrastructure, and socio-environmental issues. Often, related activities of freight movements such as loading/unloading/parking are executed unplanned. The latter ad-hoc activities aggravate the congestion problems that already exist.

In response to SISLOGNAS that attempts to improve logistics efficiency over the country, there is an opportunity for Yogyakarta to strategically design and extend the logistics network by having a new logistics facility. However, there are practical challenges to the selection of a candidate logistics site. Usually, site selection involves many decision makers who always have different priorities and preferences (which are sometimes in conflict). However, common preferences of decision makers are cost minimization. Yet, as was highlighted recently, non-quantifiable (or qualitative) preferences such as economic geography and the accessibility conditions are also taken into consideration when selecting the site (see Figure 1). An absence of any preference can probably cause sub-optimal solutions, further leading to a failure of site selection and also to an inefficiency of managing and operating the logistics site afterwards.

![Figure 1 Criteria/preferences under three categories for site selection](image)

The following characteristics of Yogyakarta, which hence become the key criteria for site selection are briefly described under three categories:

**Economic factors**

The economy of Yogyakarta is driven by agricultural and manufacturing development with the orientation of import-export activities. The main transportation modes used to connect the freight flows of Yogyakarta with others are road and rail. The Special region of Yogyakarta (the
square area in the middle of Figure 2 (on the left side)) is the most crowded living and consumption area, while the availability of land and other relevant resources are relatively limited. The special region of Yogyakarta is surrounded by highway ring-roads, which are used either as the end-points and/or for the passageways of heavy trucks. In addition there is also the main railway passing through the region with the purpose of transporting passengers as well industrial and agricultural freight such as cement.

![Figure 2 Displays of Yogyakarta and its special region](image)

Source: Ministry of Transport DIY, Indonesia

**Social and Environmental factors**

Congestion and the corresponding delays, emissions, and lacks of appropriate logistics resources and infrastructure are the most highlighted problems in Yogyakarta, especially in the special region. As mentioned, Yogyakarta deals with a massive number of trucks going to and passing through the region, which consequently creates serious traffic congestion during peak hours. Quality of life in the city may also be compromised by the higher carbon footprints/pollution becoming more and more of a challenge.

**Geographical and Disaster factors**

Yogyakarta can also be considered prone to disasters. The North of this region is vulnerable and runs the risk of eruptions from one of the most active volcanoes called “Mount Merapi”. The coastal areas in the South of Yogyakarta are flanked by the Indian Ocean. As such, the possibility of a tsunami is always a hovering threat. Yogyakarta consists mainly of lowland areas, and this lends the city prone to flood and landslides resulting from the impacts of annual typhoons and overflows of the three main rivers across the region (i.e. Gajah Wong (East), Code (middle), and Winongo (west)).

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Efficient Strategic Planning for Site Selection using SDSS

Once again, the reason behind using SDSS for the strategic planning of site selection is that many preferences from different decision makers need to simultaneously be taken into account when executing the plan. Therefore, SDSS which can handle and operate both quantifiable and non-quantifiable information at the same time is desired for this purpose.

SDSS is an analytical platform that assists planners in visualizing different and key information variables on a multi-layer display along with the evaluation modules in order to provide better foresight / insight into the strategic problems and challenges. The SDSS is, thus, able to support in the strategic decision making process. The main highlight of the SDSS is the flexibility of the platform that simply allows various features, techniques or approaches to be assessed.

In this whitepaper, we develop the SDSS platform equipped with the Spatial Multi Criteria Evaluation (SMCE) technique as shown in Figure 3. The SMCE generally allows makers/users to analyze and evaluate certain potential logistics sites (alternatives) based on the specified spatial criteria and their assigned performances (weights) using a GIS-based software, namely ILWIS (see more details in http://www.ilwis.org), as a mapping and translating tool.

Figure 3 SDSS platform equipped with SMCE
Source: Lindawati (2014)5

The technique of SMCE on SDSS platform begins with collecting, storing, as well as managing data. Important data to be used for evaluation includes the Yogyakarta map, road network, logistics infrastructure network, land use, population, geographical data, traffic data, emission level, historical and forecasted disaster data, and so on. Since the exploration and gathering necessary data of Yogyakarta are quite large and time-consuming, the data collection has been made through field observations, interviews and surveys as well as the survey through literature and open source databases.

Then, criteria or preferences that help to meet the specific objectives of site selection need to be identified. Over 40 criteria under three categories as previously mentioned have been identified for the Yogyakarta case, and examples of these criteria are shown below.

- **Economic factors:** logistics infrastructure connectivity, population, utilities, land cost, and industrial zone
- **Social and environmental factors:** traffic condition, crime rate, air emissions, and noise
- **Geographical and disaster factors:** disasters including volcano, earthquake, flood, and landslide

The performance evaluation of SMCE on several alternatives is based on the identified criteria and their assigned weights, where these assigned weights to each criterion have been computed through discussions, interviews, and consults with experts from various perspectives in Yogyakarta such as academic, regulators, and operators. Ultimately, the outcome of the SMCE technique on SDSS platform is a set of potential candidate sites.
Findings

Figure 4 displays the outcome of our SDSS platform executed on Yogyakarta case. Four potential sites that can be the candidate locations for logistics facility, e.g. distribution center, consolidation center, inland port, or freight village, are found over the region comprising Patuk, Kalasan, Sedayu, and Wates. These four candidates are systematically the appropriate solutions to the efficient strategic planning of site selection since they address a set of criteria that the proposed logistics facility should possess.

Figure 4 also illustrates the validation of obtained results from SDSS platform by mapping potential logistics sites found by the platform with the existing logistics and transport facilities operated by public sector and leading private companies in Yogyakarta. For instance, the potential site in Kalasan is now the location of Adisucipto International Airport and also the main distribution center for rice-related products of BULOG. The potential site in Wates is also found to be the location of the new International Airport. It can then be said that the validated performance of the SDSS platform is applicable and indeed pragmatic.
Summary

The SDSS is a powerful platform for the efficient strategic planning and distribution such as site selection, which can assist governmental agencies in evaluating policies and making strategic decisions. By integrating the different criteria, preferences, and concerns from various stakeholder perspectives under different categories, the developed SDSS platform is able to effectively visualize all the important data to describe the existing conditions, to address problems and challenges as well as to determine the opportunities for suitable sites for the candidate logistics facility over the respective defined area.

In particular, in order to be more comprehensive for strategic planning of site selection, extra approaches and methodologies can additionally be added to SDSS platform. Two more approaches are then recommended.

First is a Multi-Objective Facility Location (MOFL) approach that particularly seeks to minimize overall logistics costs. Both external costs (e.g. land costs, utility costs, and labor costs) and internal costs (e.g. facility fixed and operating costs, supplier costs, and logistics provider costs) are altogether taken into consideration and optimized.

Second is a discrete simulation-based approach to analyze the direct and indirect impacts of the selected logistics sites when connecting with the current logistics network to ensure the smooth network orchestration.

Figure 5 illustrates the SDSS platform equipped with three approaches (SMCE, MOFL, and discrete simulation).