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Identifying relationships between Severe crash frequency and Characteristics of old Industrial complexes

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Background

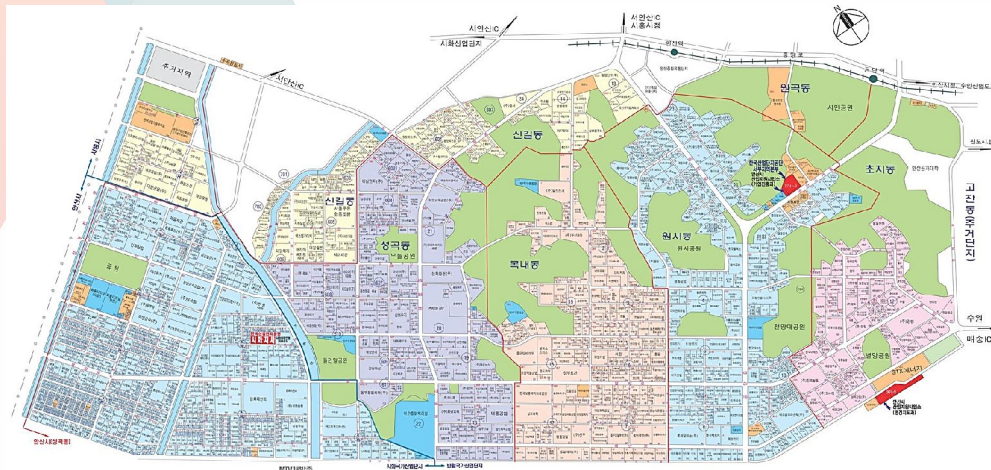
■ Introduction of Industrial Complexes (IC)

- Since the 1960s, Korean government has resolutely pushed ahead with economic development plans in order to recover from devastation and to revive collapsed economy after the Korean War ended.
- In this context, full-scale policies for industrialization began to be implemented. One of driving forces is to construct industrial complexes, which are located over different regions in Korea.
- An initial industrial complex focused on a factory site, which offered a minimum support facility. As “New industrial locations and development policies” have been implemented since 2000s, industrial complexes have become more complicated.
- Merits of IC construction
 - First, an industrial site equipped with an infrastructure and that offers tax and financial benefits can reduce the initial investment costs of companies.
 - Second, a business cluster formed in a complex may create synergy effects, which support the manufacturing activities of companies.
 - Third, at a national level, the collective placement of factories promotes efficient land use, which reduces social and environmental costs.

Background

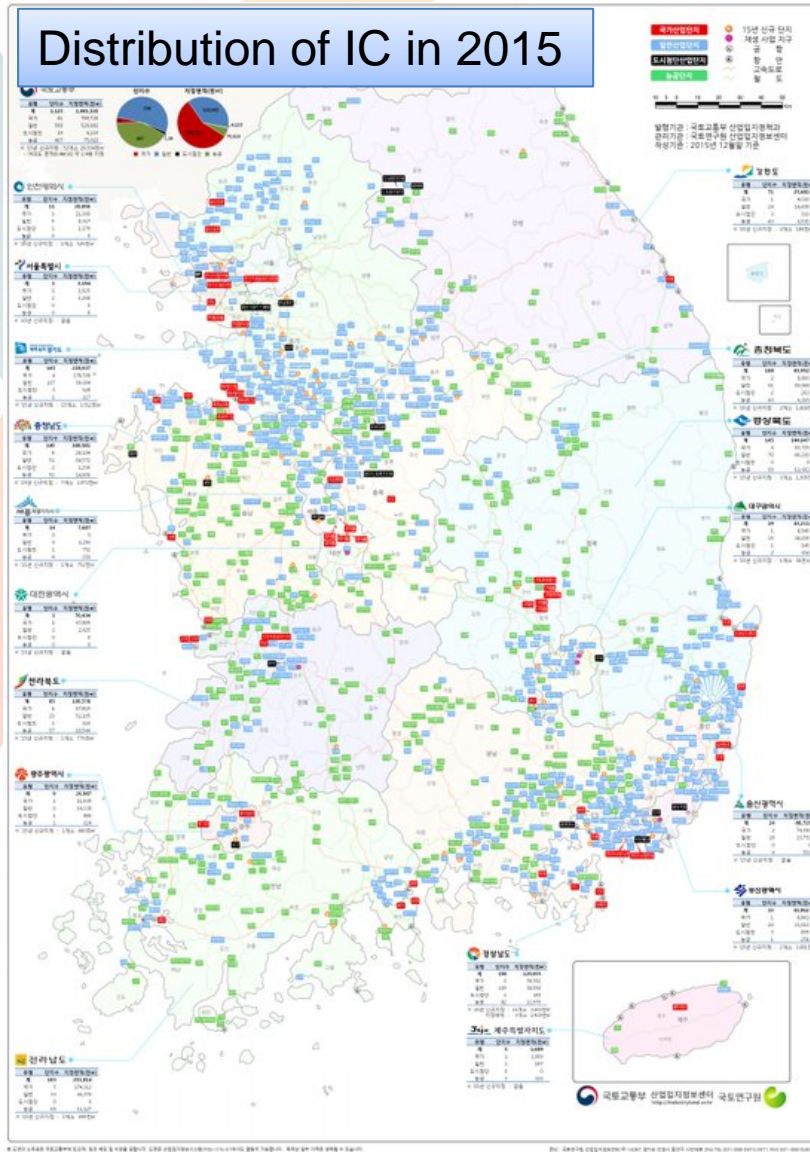
Introduction of Industrial Complexes

- Ansan Barwol + Siheung Sihwa National IC
 - Driving distance from Seoul : 44km
 - Area: 31.5 million squared meters
 - No. of Companies: 10,575
 - No. of Total employees : 175 K
- Sungnam General IC
 - Driving distance from Seoul : 31km
 - Area: 1.5 million squared meters
 - No. of Companies: 3,850
 - No. of Total employees : 43 K



Background

Distribution of IC in 2015



IC in nationwide (2016)

- Total 1,158 ICs
- Types: National IC, General IC, Urban High-tech IC, Agro IC
- No. of tenant companies : 92,165
- No. of employees : 2.2 million
- Total areas : 1,400 million squared meters

OIC (Old Industrial Complexes) in 2015

- Total 103 OICs
- 28 National ICs, 75 General ICs
- According to study results funded by Ministry of Land, Infrastructure and Transport, OIC has a weak public facility capability such as road and parking facilities, resident's amenities, and parks.

Background

Infrastructure of OICs

- However, along with these positive effects, there are still many problems, including an aging infrastructure and a degraded environment caused by development. In particular, industrial complexes that were constructed in the early 1960s have become less competitive because of the aging road infrastructure, which also presents a threat to safety.



Background

■ Traffic safety of OICs VS. NOICs

- In 2014, the Korea Transportation Safety Authority analyzed traffic accidents that occurred over a three-year period (2010–2012) in 18 old national industrial complexes. It was reported that the **fatality rate of the accidents was about 1.7 times the national average.**
- According to the statistics of traffic accidents provided by the Traffic Accident Analysis System (TAAS) of the Road Traffic Authority, 73,681 traffic accidents occurred over five years from 2011 to 2015 in OICs. This is about **3.1 times greater than** the number of accidents in “non-old” industrial complexes (NOICs, 23,912 crashes).
- With regard to the annual average number of traffic accidents per complex, each complex in the OICs had 33.12 traffic accidents per year, which is about 13.2 times the average value (about 2.47) of the NOICs. The OICs have an average of 1.1 fatal accidents per year, which is about **1.8 times higher than** in the NOICs (0.62).

Objectives

- Although old industrial complexes are vulnerable to traffic accidents, few improvement projects have been implemented to investigate and solve the safety problems in a comprehensive way. Accordingly, **those who work in these complexes are exposed to a hazardous environment, which requires urgent attention.** Unfortunately, less research associated with traffic accidents in industrial complexes were found.
- The main objective of this research is **to examine the relationship between the characteristics of each OIC and severe crashes occurred in the OIC in order to improve highway safety.**
- This study also aims **to determine which OIC urgently require an active regeneration project.** The study results can be used to provide government funds for remodeling road infrastructure of OICs.

Data collection and description

■ Data collection

- Data for this research are divided into two types: characteristics of ICs and data related to traffic accidents in each OIC.
 - The first type of IC data are extracted from the GIS-based industrial complex boundary layer, provided by the Industrial Sites Information Center of the Korea Research Institute for Human Settlements (KRIHS).
 - For the analysis, original data related to characteristics of OICs were converted into five variables: (1) type of industrial complex, (2) geographical location, (3) city size where the industrial complex is located, and (4, 5) numbers of tenant companies and employers per square meter.
- The traffic accident data for each old industrial complex were collected from the TAAS of the Road Traffic Authority. Data for five years, from 2011 to 2015, were used in the analysis.
 - This research aims to identify the characteristics of old industrial complexes, where many traffic accidents result in death or serious injury, and, thus to determine which complexes urgently require an active regeneration project. As such, the number of accidents, including cases resulting in death or serious injury, is used as a dependent variable.

Data collection and description

Data description of traffic accidents occurred in ICs

- Table 1 presents basic description of each variable used in the analysis.
 - A total of 87 OICs were surveyed for the analysis.
 - 23 national industrial complexes of 87 OICs(26.4%)
 - 33.3 % of OICs located in the capital area
- Six variables representing the characteristics of OICs were used as independent variables. The number of accidents resulting in death or serious injury in 2015 is set as a dependent variable.

TABLE 1 Descriptive Statistics of Variables Used in the Analysis

| Variables | Description | Mean | S.D. | Max | Min |
|------------|---|--------|--------|-------|--------|
| SEVERE_CRA | Frequency of fatal and major injured crashes occurred within a 500m boundary of old industrial complexes | 57.080 | 125.73 | 946 | 0 |
| TYPE | Industrial complex type (1=National industrial complex, 0=otherwise) | 0.264 | 0.443 | 1 | 0 |
| LOC | Location of industrial complex (1=Seoul metropolitan area including City of Seoul, City of Incheon and Gyeonggi Province, 0=otherwise) | 0.333 | 0.474 | 1 | 0 |
| SIZE | City size of industrial complex (1=population over 1 million people, 0=otherwise) | 0.299 | 0.460 | 1 | 0 |
| NCOM | Number of companies per m ² in a complex | 0.231 | 0.543 | 4.458 | 0.0001 |
| NWOR | Number of employees per m ² in a complex | 5.996 | 10.498 | 82.74 | 0.104 |
| TYPE*LOC | Interaction term between TYPE and LOC (1=National industrial complex located in Seoul metropolitan area, 0=otherwise) | 0.080 | 0.274 | 1 | 0 |

Analysis method and model estimation results

■ Model estimation and its results

- A negative binomial regression model was employed since the dependent variable is count data. As shown in Table 2, four variables were found to be statistically significant at the 95% significance level: type of industrial complex, location of industrial complex, number of tenant companies per square meter, and national industrial complex in the capital area.
- In addition, an over-dispersion parameter, α , were found to be significant, indicating that the industrial complex crash data are better fitted with a negative binomial model rather than a Poisson model.
- The results indicate that among the OICs, national OICs have a larger number of serious accidents than general OICs do because national OICs typically have many wide and straight roads and thus speeding occurs frequently, and many accidents are caused by traffic signal violations and occur at crossroads

Analysis method and model estimation results

Model estimation and its results

- **The OICs were found to be negatively related to serious accidents.** This means that the OICs in the capital area had fewer serious accidents than those located outside the capital area. This result may be attributed to the fact that the OICs in the capital area have maintained the road infrastructure relatively well or travel speed is not fast as much as to cause serious and fatal accidents.
- It can also suggest that the OIC has larger number of average traffic accidents than the non-old industrial complex but is not linked to relatively serious accidents.

TABLE 2 Estimation Results

| Variables | Coefficient | Standard Error | P-value |
|-----------|-------------|----------------|---------|
| Constant | 2.788 | 0.248 | 0.000 |
| TYPE | 1.798 | 0.326 | 0.000 |
| LOC | -1.062 | 0.330 | 0.001 |
| SIZE | 0.489 | 0.271 | 0.071 |
| NWOR | -0.024 | 0.042 | 0.571 |
| NCOM | 1.261 | 0.606 | 0.037 |
| TYPE*LOC | 1.595 | 0.581 | 0.006 |
| α | 1.192 | 0.170 | 0.000 |

Analysis method and model estimation results

■ Model estimation and its results

- **The number of tenant companies per square meter is positively related to the number of accidents resulting in serious injury or death.** This indicates that among the same types of industrial complexes, those that are densely developed and, thus, have a greater number of tenant companies, experience higher numbers of serious accidents.
- **The area size where an IC is located is significantly related to the number of accidents resulting in serious injury or death** at the 90% significance level. This could be because an OIC located in a metropolitan city, which has a population of over one million, has actively utilized nearby land, which contains a significant number of people and vehicles and, hence, traffic. This can also be understood as a transformation of the problem of OICs that were previously located near a city, but are now incorporated into the city, into a problem of traffic safety.

Conclusions

- The Korean government has pushed ahead with economic development plans and, thus, full-scale policies for industrialization.
- However, industrial complexes, along with their positive effects, also cause problems, such as an aging infrastructure and a degraded environment due to reckless development.
- In particular, the aging road infrastructure not only weakens the competitiveness of the complexes, but also threatens people's safety. In addition, as an old industrial complex becomes incorporated into an expanding city, this causes environmental and traffic problems, as well as conflicts with local residents.
- This research aimed to identify the characteristics of old industrial complexes, where many traffic accidents occur that result in death or serious injury and, thus, to determine which IC urgently require an active regeneration project.

Conclusions

- A negative binomial regression model was used for the analysis.
- Among the independent variables, being a national IC, the number of tenant companies per square meter, and being incorporated into a metropolitan city were found to influence the incidence of traffic accidents resulting in death or serious injury from the modeling results.
- The results show that OICs that are vulnerable in terms of traffic safety are those that are large-scale complexes with many tenant companies, and are located outside the capital area.
- Therefore, while the Ministry of Land, Infrastructure, and Transport implements large regeneration projects for OICs, consuming a large amount of the national revenue, the findings described here need to be considered when determining appropriate industrial complexes.
- In particular, OICs outside the capital area seem to more urgently require investments in the road infrastructure and efficient traffic management.