

**“Technical Research and Development for Road Policy Quality Improvement”
Study Summary**

No.	Title	Principal Researcher
No.2020-4	Study on Road Infrastructure considering Double Trailer Truck and Truck Platooning System	Tokyo University of Marine Science and Technology, Professor Tetsuro HYODO

One of the measures to address the "2024 problem" is to increase the number of large size truck or the truck platooning, which are required new road infrastructure. The purpose of this research is to understand the problem and to quantitatively examine measures to solve it, and to consider SA/PA congestion countermeasures and the layout of logistics centers and how they should be located.

1. Backgrounds and Objects

The development of road infrastructure to meet the increasing demand for double trailer trucks is an urgent issue. In the medium to long term, there are many new roles to be played by road infrastructure, such as the extension of operation sections, including on public roads, and the scale and layout of coupling and uncoupling points for platooning. Therefore, this study set three themes and proceeded with the analysis.

2. Activities in Research Period

1) We study TDM measures using a simulator based on demand analysis of SA/PA using ETC/FF data in WG1. 2) We obtained important findings on the availability of double trailer trucks by analyzing its market analyses in WG1. 3) In 2021, we confirmed that the SA/PA layout can be evaluated by VISSIM as an additional analysis in WG1. 4) The development of a compact parking in Germany simulator is also an important result of WG1 in 2022. 5) The analysis of merging sections of long vehicles by reinforcement learning, which was a sub-topic of WG1, was conducted from 2020 to 2021. 6) In WG2, the analysis of the possibility of extending the length of the service section of double trailer trucks using the road traffic census and nationwide road network data, the results of the nationwide assignment were tested in 2022. 7) In WG3, the location and scale of future locations of the consolidation and deconsolidation points in Japan were discussed by the optimization method, and the results were obtained. Finally, we made a proposal for the future of logistics centers, taking into account not only double trailer trucks but also the emergence of Level 4 autonomous trucks.

3. Study Results

[WG1: Analysis of the actual conditions of SA/PA parking and study of congestion relief measures]

Using ETC/FF data, we estimated SA/PA choice model and duration model for 9 SA/PAs on the Tomei Expressway, and formulated the microsimulation model for nearly 170,000 vehicles per week. As examples of TDM measures to reduce congestion, quantitative analysis was conducted on 1) increasing parking lots, 2) parking time limit, 3) increasing vehicle size, 4) elimination of long-hour parking and 5) the effect of parking information system. It was found that the effects of increasing the number of vehicles and introducing an information system varied depending on the SA, providing hints for the development of future measures.

[WG2: Possibility of extending the operational section of double trailer trucks]

By using 2015 Road Traffic Census, a generalized minimum cost analysis was conducted in 2022. Long distance OD pairs with a gross weight of 20-25 tons were selected for analysis. The network data used for the nationwide assignment was a network with 6,490 B-zones and 43,969 nodes, excluding Hokkaido and Okinawa. The allocation is user equilibrium method using a standard BPR function. The results using the least generalized cost (Figure-1) indicate that travel demand is high in the Pacific Belt region from Kyushu to Kanto, and in the southern part of the Kan-etsu and Tohoku Expressways. Without considering physical constraints, the Chugoku Expressway, the Hokuriku Expressway between the Kurobe Interchange and Nagaoka JCT, and the Nishi-Meihan Expressway are considered to be candidates for high travel demand.

[WG3: Allocation for coupling and uncoupling logistics center for double trailer trucks and platooning]

The use of double trailer trucks and other large size trucks is highly related to the development of necessary logistics centers. We therefore considered the allocations of logistics centers for the nationwide. In the analysis of the optimal base allocation model, p -Median problem was applied. The results for 10 sites (Figure-2) show that as the number of sites increases, more sites are located on the Pacific Ocean and Seto Inland Sea sides, where traffic demand is high.

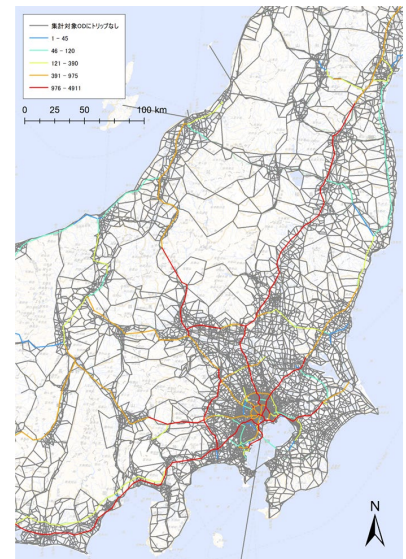


Figure-1 Result of the least generalized cost

4. Papers for Presentation

- 1) Aung, S. and Watanabe, D.: Optimization of Platoon Formation Center for Truck Platooning Proceedings of the 9th International Conference on Transportation and Logistics (T-LOG 2022), 1-25, 2022.
- 2) Tohtomi, R., Nishizaki S., **Hyodo T.** and Sakai, T.: Safety Evaluation of Highway Merging with Double Trailer Trucks and Truck Platooning using Reinforcement Learning, Journal of JSCE, D3, Vol.78, No.5, pp. I_809-824, 2023
- 3) Watanabe D., Hirata T., Sakai T., Nemoto T. and **Hyodo T.**: Study on Allocation of Logistics Centers for Truck Platooning and Autonomous Truck Operation, Journal of Japan Logistics Society, Vol.31, 2023
- 4) Yuki Misui, Toshinori Nemoto, Takao Goto, Tomo Kagabu, ‘Demand analysis of large-truck parking at expressway rest areas in Japan,’ ITS World Congress 2022 Conference Proceedings, 2022.Nov.



Figure-2 Results of p -Median

5. Study Development and Future Issues

- 1) It is necessary to improve the accuracy of the of SA/PA congestion relief simulator discussed in WG1
- 2) Developed simulator for compact parking in Germany could also be useful for future SA/PA layout studies.
- 3) A safety evaluation model for merging sections using reinforcement learning could serve as an option for validating the merging behavior of automated trucks.
- 4) The verification of the layout of the Ashigara SA by VISSIM requires further study of more SA/PAs verification.
- 5) The analysis of the feasibility of extending the operation section of double trailer trucks would be important for future discussions, since the missing link pointed out in this study also exists.
- 6) The results of coupling & uncoupling hubs are similar to those of some actual logistics company.
- 7) The issues related to logistics center are great significance for future road infrastructure. Therefore, we consider that it was very important to present sufficient knowledge on how to make policies that involve local governments.

6. Contribution to Road Policy Quality Improvement

From the company questionnaires, we were also able to identify some of the constraints to the spread of double trailer trucks. The spatial limitations of logistics companies' offices and the upper limit to the supply capacity of double trailer truck manufacturers indicate that the number will increase at a constant rate which is important information for road administration. In February 2022, a private real estate company announced the construction of a logistics center in Joyo City that is directly connected to an expressway IC and is compatible with Level 4 autonomous operation. In 2022, we conducted a series of hearings with related businesses and local governments and investigated related laws, and were able to summarize issues related to future logistics centers directly connected to expressways with Level 4 autonomous operation.

7. References, Websites, etc.

None