Analysis of the Emission Reduction Effect of Drop-and-Pull Transportation Based on System Dynamics Model

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Abstract. The most direct effect of energy saving and emission reduction brought by drop-and-pull transport as an advanced transport organization mode is to reduce the fuel consumption per unit volume by increasing the real load ratio. In this paper, the relationship between the influencing factors of enterprise logistics is studied by using system dynamics, and the effect of emission reductions brought by rejection of transportation is analyzed based on the actual logistics operation of the enterprise. Through analysis, drop-and-pull transport due to improved vehicle utilization, and increase the volume of logistics and transport, can achieve good emission reduction.

1. Introduction
As the mainstream transportation mode of global freight transportation, highway transportation has the absolute advantage of cargo turnover in most countries. From the current situation of China's logistics development, road transport is undoubtedly the main mode of transport of domestic short-haul freight. As the main carrier of multimodal transport, road transport accounts for about 80% of the total transport volume in 2016 [1]. With the rapid development of the logistics industry in recent years, the competition among enterprises is becoming fiercer. In order to enhance their own competitiveness, logistics enterprises are paying more and more attention to the scientific and reasonable construction of enterprises in the process of intensive and coordinated development. At the same time, logistics companies try various advanced technologies to improve transportation efficiency and reduce transportation costs. More and more logistics enterprises began to try to transfer the traditional transport mode of truck transport to drop-and-pull transport.

Drop-and-pull transport refers to the proportion of tractor and trailer configuration, during the transport pause the tractor can get rid of a trailer, hang up another trailer to continue the transport process of transport organization [2] Compared to the traditional truck, drop-and-pull transport can improve the efficiency of the tractor, reduce vehicle fuel consumption, thereby helping logistics companies reduce operating costs and improve the related revenue. In addition, the most direct effect of energy saving and emission reduction brought by drop-and-pull transport as an advanced transport organization model is to reduce the fuel consumption per unit volume by increasing the real load ratio [3].

2. Literature review
Flutter transport abroad developed earlier, especially in Europe and the United States, the region threw drop-and-pull transport developed.

At present, the research on thrusters transport in foreign countries mainly focuses on the specific operation, which is mainly divided into two major parts, the research on the path of thrown vehicles and the actual operation. Among them, Villegas, Juan G .Prins, Christian [4]A two-stage heuristic algorithm...
is used to solve the problems of the typical fixed trailer and the newly added trailer, thereby reducing the waiting time of the vehicle and improving the loading efficiency. Torres, Isis; Rosete, Alejandro; Cruz, [5], Et al. Think that the actual transport environment which is thrown off is dynamic and responsible, and the actual data is used to determine the decision tree in combination with examples to solve the problem of throttling under uncertain constraints.

Lin Tan [6] in order to verify the energy-saving and emission-reducing effect of slung transport, the mechanism of slung transport to promote energy conservation and emission reduction was analyzed theoretically. Empty driving, increase mileage utilization, improve fuel efficiency and reduce carbon emissions by means of intelligent dispatching technology. Meanwhile, based on the first batch of pilot projects and operational analysis data, the paper analyzes the transport efficiency and carbon emissions. Data were analyzed comparatively; Li Hongqi and Li Yanran [7] think that the performance evaluation of rejection and transportation at this stage plays an important role in promoting China's logistics enterprises to carry out the business of dropping and hanging transportation. With reference to the existing research results and considering the technical and economic characteristics of slung transport, the paper establishes a performance evaluation index system for logistics enterprises to carry out slung transport. The index system consists of a core index set and a peripheral index set. By using AHP and mutation model method, Evaluation method. However, due to the current development of enterprises hang-off transport limited, most of the above studies from a macro perspective, the data sources are mostly provincial-level statistics related data, and is not representative. Therefore, from the enterprise perspective, this paper studies the carbon emission of enterprises under the control of hang-off transport. The main idea is to use system dynamics to analyze the amount of fuel in the logistics of enterprises and to compare the carbon emissions of traditional transport and hang-off transport.

3. System dynamics model construction

In this paper, the logistics system is divided into two main sub-systems are logistics cost subsystems and logistics and transportation of two subsystems.

The logistics cost subsystem mainly includes the fixed costs and the mobile costs of the enterprises. The fixed costs are mainly the purchase cost of the vehicles and the construction costs of the stations. Mobile costs mainly include labor costs, vehicle maintenance costs, vehicle tolls and fuel costs.

The logistics of the logistics system mainly determine the actual amount of traffic, the actual amount of traffic taken from the logistics demand and the actual minimum capacity, and the actual capacity from the company currently has thrown volume of traffic as well as the traditional volume of traffic. This paper restores the entire logistics flow as much as possible. Therefore, in considering the actual drop-in and conventional cycle transport, this article takes into account the load factor of the cargo, the service life of the vehicle and the time required for vehicle maintenance and inspection.

Model building

Through the above analysis, we can draw business logistics and transport model, as shown.
4. Empirical Research

According to the actual operation of a company in China as an example, to study the effect of emission reduction by drop-and-pull transport. According to the simulation results and optimize the control. This article uses the month as a unit to simulate the 100-month logistics operation of the enterprise.

The main parameters of the model and the simulation equation.

In the process of logistics needs of enterprises, the main use of business conditions in previous years to determine the relevant functions. According to a company's actual logistics needs, and in the use of curve fitting tool Matlab analysis of the logistics needs of enterprises, the actual logistics needs of enterprises as shown in the following table, the function obtained in Matlab.

And R-square=1, we can see that the function of a good fit. And according to the prediction of the future logistics market, the annual logistics demand of the enterprise will increase by about 5% over the previous years.

The main simulation equations in this model are as follows:

\[ \text{Trailer transport volume} = \text{MIN} \left( \text{INTEGER} \left( \frac{\text{Tractor number} \times \text{Annual inspection time}}{2} \right) \right) \times \text{NT} \times \text{Rate} \times \text{Trailer load} \times 2 \]  

\[ \text{Vehicle purchase costs} = \text{MAX} \left( 0, \text{Tractor number} \times \text{The initial number of tractors} \times \left( 1 - \text{Tractor depreciation period} \times \text{Time} \right) \times \text{Tractor purchase costs} + 27 \times \text{Tractor purchase costs} + 152 \times \text{Trailer purchase costs} \right) \]  

\[ \text{Tractor number} = \begin{cases} \text{IF THEN ELSE} \left( \text{The initial number of tractors} = 0, 0, \text{IF THEN ELSE} \left( \text{Demand} < 100000, \text{The initial number of tractors} \times \left( 1 - \text{Tractor depreciation period} \times \text{Time} \right), \text{INTEGER} \left( \frac{\text{Demand}}{150 \times 30} \right) \right) \right) \end{cases} \]
4.1. Model test
The test of the model mainly includes model mechanical error test, validity test and extreme condition test. After verification, the model passed Vensim's related test.

4.2. Simulation results
This article mainly simulates the changes in the business within 100 months, the main consideration of the amount of fuel during transport, and based on the amount of fuel to determine the logistics and transport of carbon emissions,

The simulation results are as follows:
- The current operation of the company, the company does not exist when the drop-and-pull transport and the absence of the traditional vehicle transport case comparison of fuel quantity as shown below
- The company's current operation of the company, the company does not exist when the rejection of the transport and the absence of the traditional vehicle transport business case comparison of returns as shown below figure.

![Figure 2. Comparison of the amount of fuel](image)

The number of trailers=IF THEN ELSE(Tractor number >(The initial number of trailers/2 *(1-Trailer depreciation period*Time)) ,INTEGER(Tractor number*2) ,INTEGER( The initial number of trailers*(1-Trailer depreciation period*Time)))

(4)
Figure 3. Comparison of vehicles driving

Figure 4. Comparison of corporate profits

Fuel situation: The figure above shows that the fuel consumption of an enterprise without traditional truck transportation is lower than that of the current fuel consumption. In the latter part of the day, however, logistics enterprises increase the number of vehicle transportation to take into account the development of enterprises and the purchase of vehicles, thereby fueling gradually equal. However, in the absence of drop-and-pull transport, the logistics of the enterprise's fuel consumption is much higher than the current situation and the absence of conventional trucking. The main reason is due to changes in the number of vehicles transported. The number of vehicles driven by logistic activities involved in the roll-off is much lower than the number of logistic activities in which no logistic movement is involved.

Corporate profits: From the perspective of corporate profits, the current business logistics and operation of the proceeds is higher than that without hanging off participation and no traditional truck involved in the logistics activities, the main reason is that from the enterprise point of view, the more the enterprise transport vehicles, Can undertake the higher logistics activities, resulting in more business income.

5. Summary

Through research, we can get the following conclusions:

Starting from the actual operation of the enterprise, this paper studies the carbon emissions of the enterprise by hanging system and building a system dynamics model and analyzes the profit of the
enterprise on the basis of this. Drop-and-pull transport can reduce the amount of fuel used compared with the traditional transport, improve the utilization of vehicles, and bring about good emission reduction. Improve the utilization of resources.

In the case of an adequate supply of business logistics, compared to the traditional transport, drop-and-pull transport enterprises can bring more benefits. The main reason is that the company's revenue comes from the number of vehicle trips, the more vehicles travel, the higher the business income.

There are still many deficiencies in this article. This article does not specify the daily logistic operation of the logistic transport and traditional transportation. In this paper, the main analysis of carbon emissions is the carbon emissions during transport, not involved in other logistics activities. Possible carbon emissions issues.

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