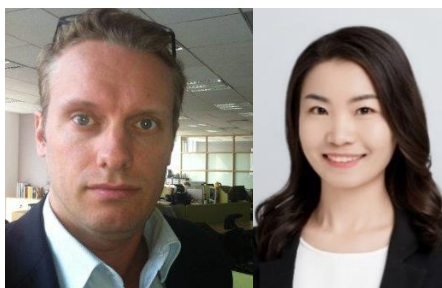# WHITE PAPER ON TRANSPORT ECONOMY AND CHINESE TRANSPORT MARKET

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## Abstract

The challenges faced by the logistics sector in China demonstrate that a different approach to the economy of logistics is needed in China to transform the industry toward sustainability and efficiency. Pricing mechanisms focusing only on the cost can result in overlooking the revenue of the carriers and the service quality. By introducing the concept of the TOE to the carriers and shippers, the shippers can understand the cost and revenue of the carriers. This study compares two cases to show how improved service could help achieve lower prices while achieving good service. The results indicate that the pricing based on TOE can ensure the carrier earns enough money for a reasonable profit as well as to reinvest in high-quality and compliant service.

**Keywords:** TCO, TOE, Freight Transport

## Introduction

Pricing of freight services in China has a direct impact on the potential quality of service rendered by a freight carrier. Therefore, when shippers insist on aggressive cost-cutting by carriers, unhealthy competition between carriers and illegal and non-compliant behavior such as unsafe practices, poor and inefficient equipment, and irrational use of China's world-class infrastructure is the result. There is a need for economic tools and new thinking that can help truck owners and operators as well as shippers to make better decisions for the economic benefit of all, and also fulfilling their responsibility as a corporate citizen.

In recent years, some Chinese carriers have begun to analyze their Total Cost of Ownership (TCO) to provide price quotes to shippers that reflect the true costs they face. However, the revenue side of a carrier's business – i.e. the Total Operating Economy (TOE) – must also be considered to understand if a carrier is profitable and able to offer competitive, compliant, safe, and sustainable service.

### Chinese Road Freight Market

The logistics industry in China, while gigantic at the national scale, can be described as "small, fragmented and disorderly" at the level of firms. 65% of operators are individual owners (Carrier, 2019). These small enterprises have limited capital to invest in fuel efficient vehicles and equipment and fuel management systems, and lack expertise in fleet management. Nearly 40% of truck road time is thought to be in empty miles (Roland Berger, 2018). Inefficiency and high logistic costs result from the following reasons:

Road freight transport is fragmented and disorderly. In 2019, the individual operators in China made up 65% (Carrier, 2019). There were 10,878,200 trucks in operation and the

turnover volume of road freight transport was 5963 billion tonne-kilometres[1] in 2019 (Ministry of Transport of PRC, 2019). While freight contracts are usually signed with relatively well-known large carrier companies, the transport tasks are often subcontracted and re-sub-contracted to small companies or individual owner-operators without validation by the shippers, especially during constrained periods such as before Christmas or the Chinese New Year.

With the slowing down of economic growth and less focus on international trade, the demand for road freight transport is withering. At the same time, due to the low threshold entering the freight transport industry, there is a large number of operators joining the already labor-intensive carrier service. As a result, the freight transport services are oversupplied. Oversupply causes unbalanced competition and higher requirement for legal enforcement, which is usually not there and tangled with local interests to allow non-compliant operation for the benefits of the local economy, hence leading to a race to the bottom in terms of pricing, with freight prices sometimes dropping lower than costs for the carrier. Moreover, since many self-employed freight operators take loans to purchase trucks, they drop the pricings below cost line in order to get the shipping order to refund the loan.

Shippers are only focused on lowest pricing during procurement facing with peer competition. Under a strong pressure from headquarters to reduce freight transport cost every year, lots of shippers cascading down the pressure to LSPs and ultimately carriers and individual driver owners, by reducing transport payment 2-5% annually.

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[1] "A tonne-kilometre (tkm) is a unit of measurement that represents the transport of one tonne over one kilometre. This unit of measurement serves as an indication of the overall level of freight transport activity as it takes into account both the amount of goods transported and the distance transported."(UNECE, 2019).

Road freight transport lacks organization. It leads to low operational efficiency, such as a low filling rate. Logistics equipment, including vehicle standardization are far from ready to bolster China' modern logistic development. Currently China has approved 13,000 truck models and 27,000 truck configurations(Ministry of Ecology and Environment of the People's Republic of China, 2020). Comparing dozens of truck models in the US, an optimized freight distribution in China thus been largely impeded.

The small-scale carriers invest in low-end trucks, which have higher fuel consumption and emissions. The average age of the truck in European Countries in 2018 is 12.4 years(ACEA, 2019). The average age of the truck in China in 2018 is 4.56 years(Sinoiov & Yunlian Research Academy, 2018).

Logistics service is not transparent and often involves non-compliant operations. Faced with the shipper's preference, low transport prices, and high freight transport costs, overloading has been a common phenomenon since before the 1990s. Based on a survey with 3000 respondents in China , it was found that about 43% of drivers work 8-12 hours daily, and 35.08% work 12-16 hours per day in 2019 (Transporter, 2019).

The challenges faced by the logistics sector in China demonstrate that a different approach to the economy of logistics is needed in China if this sector is to serve the long-term needs of an economy focused on high-quality economic development.

### TCO and TOE

Total Cost of Ownership (TCO) is the cost of an asset or service over its life span, including not only purchase price, but also cost of operation, maintenance, and repair (Ellram, 1993). TCO is usually applied to help carriers choose trucks. When utilizing TCO models for price estimation, it overlooks the revenue of the carriers and the service quality.

Total Operating Economy (TOE) is a relatively new and comprehensive business model concept. TOE aims at improving a company's economy by analyzing and including the revenue of the product and service throughout the whole life cycle (Xu, 2014). By using TOE as a calculation method in freight transport, profits by vehicle owners and vehicle manufactures can be understood and maximized. The vehicle manufacturers may even take responsibility for insurance, maintenance and repair, uptime, predictable cost, manageable risks of ownership, fleet management, and driver training during the whole operating cycle of the vehicle (Borgström et al., 2012) in order to reduce the pressure on the truck operator. Then these services can maximize the operational mileage, increase the flexibility of dispatching, and extend durable years. Ultimately, it can increase the profit for the vehicle owners, decrease operating costs as well as the cost of risks (Su & Logistics, n.d.). Moreover, since the annual mileage is the key factor of revenue, carriers should pay more attention to stabilize and increase the number of goods to transport.

To increase the profits of carriers, the concept of TOE can be transferred from the carrier manufacturer situation to the shipper. It means to take care of the profit of carriers jointly by carriers and shippers during the whole operating cycle, which brings benefit to both sides in the end. A study has shown that a high-quality, well-utilized truck and improved labor productivity can reduce transport costs by 33% (Agenbroad et al., 2016). LOTS Group[2], a carrier company, has estimated that the freight cost can be reduced by between 10-30% by improvements in operational efficiency, TCO of vehicle and equipment, and extended value chain. Through cooperation between LOTS and shippers, the cycle time of loads has reduced by 49% in 2019 compared to 2017, and each truck transported 40% more containers per day, resulting in a reduction in transport cost of 22% and an increase in revenue.

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[2] The official website of LOTS Group is https://lotsgroup.com

## Methodology

The main components of TCO and TOE and their influencing factors are listed in Table 1. In TOE, the cost side is linked to components of TCO. The revenue in TOE is the freight fee multiplied by the total amount of goods and driven mileage. The major components of the revenue-side include filling rate, truck utilization rate, annual mileage, and transport price.

The filling rate indicates how much of the available loading capacity of a truck is used. Here it is defined as the 'ratio of the tonne-kilometre that a vehicle actually carries to the tonne-kilometre it could have carried if it were running at its maximum gross weight (Department for Transport, 2009, p.42). Carriers can earn more money with a full truck than if they are operating a vehicle with empty space inside. Meanwhile, by maximizing the loading of each truck the total number of trips to transport a certain amount of goods can be reduced (Hosseini & Shirani, 2011). The filling rate can be influenced by many factors (Mi Piecyk, 2010; Hosseini & Shirani, 2011).

Scania Transport Laboratory (a Scania owned transport company transporting goods for Scania only) have been running trials using dual trailers [3] with a total vehicle combination of 32 meters. The characteristics about the dual trailer is shown in Figure 1. There is a reduction of 25% in fuel consumptions and $CO_2$ emissions by using the dual trailer concept (Björklund & Sterky, 2020). The total vehicle weight is 74 tonne from Södertälje to Malmö and 41 tonne on the average on the return trip due to the different mix of the parts that are loaded on the return trip (Björklund & Sterky, 2020). According to the Scania Transport Lab, the potential $CO_2$ saving is 25% by reducing the number of tractors in the case of the dual trailer concept (Björklund & Sterky, 2020). When

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[3] The European Modular System (EMS) regulation EC gives European countries the freedom to combine the transport modules for both longer and heavier transports with the considerations of road safety on the roads that allow the long and heavy vehicles (ACEA, n.d.).

combined with using renewable fuels (in this case HVO100), a reduction of 78% in $CO_2$ emissions per tonne-kilometre is achievable (Björklund & Sterky, 2020).



**Figure 1: Example of dual trailer system, picture is from Björklund & Sterky**

Truck utilization rate (uptime) is the ratio of days available for service to the total number of days. With a higher utilization rate, the truck can bring more revenue. The utilization rate also reflects the reliability of a truck. The utilization rate can be decreased directly due to frequent and long breakdown times, engine overhaul, and short transmission lubrication change intervals, etc. These issues are related to vehicle quality, maintenance, and usage (mileage driven, the aggressiveness of driving, vehicle load, vehicle's age, driving conditions).

The annual mileage of a truck is related to effective operating time and turnaround time. If vehicles waste lots of time to search for or allocate cargo, the effective operating time per year is shorter, which will then result in shorter annual mileage. Turnaround time of a truck is the total time cost to finish a cycle starting from the end of the first uploading to the next uploading. Turnaround time consists of traveling time, transit time, waiting time, loading, and unloading time. When the turnaround time is shorter, the truck can finish more cycles within a time period. As a consequence, annual mileage can be increased. If logistics providers and terminals collaborate to schedule truck dispatching and make truck arrival appointments, it can reduce turnaround time (Phan & Kim, 2016).

The transport price is paid to carriers for transporting a unit of goods per kilometer. Price reflects both the cost of carriers and the preferences of shippers (Combes et al., 2015). In the market economy, the transport price is influenced by the distance, the characteristics of the goods (such as goods that are fragile, corrosive, easy to be stolen, or is highly flammable, etc.), the density of goods, loading amount, loading capacity, supply and demand (Bowersox & Closs, 1996). Additionally, requirements of service quality, loading/unloading, and carrying influence the pricing as well. Not only should a reasonable price cover TCO, but also include a reasonable profit margin which should be at least higher than the interest of capital investment.

**Table 1 Example of the components of TCO and TOE and the factors**

| TCO | | Factors |
|---|---|---|
| Cost of capital =sum of purchase of equipment and vehicle | Purchase of Equipment | The life cycle of each equipment |
| | Purchase of Vehicle | Vehicle type, brand |
| Operating Cost =sum of the cost of repair, maintenance, fuel, driver, tire, and toll fee | Repair and maintenance | Quality of the vehicle, total mileage |
| | Fuel | Fuel price, driving behavior, road condition(slope), traffic congestion, total mileage, loading, vehicle fuel efficiency |
| | Driver | Operating years, the salary of the driver |
| | Tire | The fee for the tire, total mileage (linked to tire quality), number of axles |

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| | Toll fee | Total Tonne-kilometre |
|---|---|---|
| Interest = interest rate* year* capital investment | - | Interest rate, cost of capital, years of operating |
| Insurance = insurance rate* year* capital investment | - | cost of capital, years of operating, insurance rate |
| TOE | | Factors |
| Annual Revenue =annual mileage* transport price* loading capacity* vehicle utilization rate* filling rate | Annual mileage | distance between supply and destination, turnaround time; |
| | Transport price | transaction costs, market structures |
| | Loading capacity | vehicle type |
| | Vehicle utilization rate | Quality of vehicle, driving behavior |
| | Filling rate | Amount of demand, organization of distributions, etc. |
| Annual gross profit = annual Revenue- annual operating cost | - | The annual operating cost includes the annual cost of repair, maintenance, fuel, driver, tire, and toll fee |
| Annual profit before interest = annual gross profit- annual depreciation cost of tractor and trailer- annual | - | Management cost is for administration like dealing with accidents, processing information, and fee for telecommunication. |

| management cost | | |
|---|---|---|
| Annual profit before tax<br><br>=Annual profit before interest- annual interest of capital cost | - | - |

## Scenario Settings

This section compares the two cases to show how improved service could help achieve lower prices while achieving good service. Additionally, this section studies the sensitivity of pricing to each of the main parameters in TCO and TOE to discuss the implications for the LSP and shippers.

### Scenario Description

The industry average case represents the general situation of the short delivery in China. The number is based on the experience of the experts and practitioners. The improved case represents the situation which the concept of TOE is applied to. The truck is Scania P440 with 3 axles. The truck is to transport pulp or roll paper between the port and warehouse. The improved case standardizes the working methods and operations to reduce the cost and improve efficiency. The information system, communication schemes and control tower are established to make continuous improvements. The order flow of customers is real-time synchronized to the carrier's system. The process flow starts from the trim plan, sales order, production process and progress shown on the Manufacturing Execution System, production volume, and inventory volume, to products released on Oracle Order Management System for transport. The carrier uses a real-time monitoring system to observe trucks and drivers by using digitalization and connectivity, resulting in real-time transparency into truck filling rate, cycle time, carbon emission, utilization, delays at port and warehouse, vehicles with ignition on, number of deviations reported, and number of transports. Additionally, carriers and shippers build effective communication channels. Finally, the control tower manages the flow and deviations. Based on real-time synchronization, real-time monitoring, communication

channels, and control tower, carriers and shippers will take measures to handle deviations, accidents and incidents efficiently, make effective improvements on the working methods and process, improve the route planning, maintain the trucks and equipment, and train the drivers and personnel. The carriers and shippers cooperate together to jointly improve operations and share the costs and profits. The industry average prices are agreed after quotation and agreement. After the first 6-month operation, the price is adjusted based on the re-evaluation of costs, which is called reference price. With continuous improvements, the price is updated with profit sharing in every quarter.

The parameter settings of the two cases are shown in Table 2. In the improved case, the management cost is much higher due to more expenses on the salary of office members, travel expense, parking, software, insurance, stationery, and annual vehicle inspection. And the operating mileage in the improved case is estimated based on the historical statistics data (250 containers are transported monthly by the truck and the average length of a round trip is 20 km). The transport cost of a single trip is around 261 RMB. The price is set by adding 8% onto the unit transport cost. Table 2 suggests that the company in the industry average case is going to offer a much lower price than the improved case. However, it is important to understand if the reliable service can be guaranteed at such low price in the long run. The next section will analyze the profitability in the two cases and check if the carriers can survive with low price but lacking of cost-cutting and efficiency improvement measures.

**Table 2 Parameters for each case**

| Inputs | Industry Average | Improved Case |
|--------|------------------|---------------|
| Fuel price | 5.99 RMB/l | 5.99 RMB/l |
| Fuel consumption per | 39 L/100 km | 37 L/100 km |

| kilometer | | |
|---|---|---|
| Driver's Payment | 8,000 RMB/month | 11,097 RMB/month |
| Repair and maintenance | 12,000 RMB/a | 44,039 RMB/a |
| Tire | 14,400 RMB/a | 32,447 RMB/a (22 tires incl. trailer, 3200RMB each) |
| Toll | 0 RMB/km | 0 RMB/km |
| Cost of a trailer | 70,000 RMB | 87,623 RMB |
| Cost of a tractor | 300,000 RMB | 807,230 RMB |
| Lifecycle of a tractor | 700,000 km | 2,000,000 km |
| Interest rate | 4.8% (incl. bank charge) | 4.8% (incl. bank charge) |
| Insurance rate | 3000 RMB/a | 3.4% |
| Depreciation of tractor | 5 Years (50,400.4RMB/a) | 5 Years (145,301.4RMB/a) |
| Residual value of tractor | 48,000(RMB) | 80,723 RMB |
| Depreciation of trailer | 5 Years (13,300 RMB/a) | 5 Years (15,772 RMB/a) |
| Residual value of trailer | 3,500(RMB) | 8,762 RMB |
| Management cost | 4,800 RMB/a | 375,911 RMB/a |
| Total operating mileage | 400,000 km within 15 years | 299,583 km within 5 years |
| Capacity | 29 Tonne | 29 Tonne |
| Utilization rate | 78% | 78% |
| Average filling rate | 40% | 50% |
| Pricing | 0.79 RMB/(Tonne*km) | 1.84 RMB/(Tonne*km) |

Sensitivity Study

To study how the factors influence the profit, additionally, two values are given to each of these factors while keeping the other factors in the industry average unchanged. The

two additional values of each factor are set as 20% higher and 20% lower than the default value. The factors for sensitivity studies include fuel price, fuel consumption per kilometer, driver's payment, repair and maintenance, tire, interest rate, management cost, annual operating mileage, capacity, utilization rate, and average filling rate.

## Results and Discussions

### Comparisons of two cases

The industry average and the optimized case are compared with the aspects of TCO and TOE. The percentage difference is the difference of the values between the optimized case and industry average divided by the value in the industry average. The cost per kilometer during the lifecycle is resulted from the TCO of operating cost, capital investment, interest and insurance divided by total operating mileage. The cost per kilometer during the life cycle is 7.8 RMB/km in the industry average case, while it is 6.7 RMB/km in the improved case. The cost per kilometer in the improved case is 14% lower than the industry average.

**Table 3 Annual cost and profit of each case**

| Factor | Industry average | Improved case | Percentage Difference |
|---|---|---|---|
| Annual operating mileage | 26,667 Km | 59,917 Km | 125% |
| Annual operating cost | 188,296 RMB | 342,443 RMB | 82% |
| Annual revenue | 190,611 RMB | 1,246,888 RMB | 554% |
| Annual profit before tax | -85,045 | 324,508 RMB | 482% |

The annual revenue, operating cost and profit before tax are compared separately between the two cases. As the Table 1 explained, the annual operating cost includes the

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annual cost of repair, maintenance, fuel, driver, tire, and toll fee. The results of comparison are shown in Table 3. Due to the higher mileage, the annual operating cost in improved case is higher than industry average case. The improved case has higher revenue and profit, since it has higher annual mileage and filling rate. When the default price is set as 0.79 RMB/(tonne*km) in the industry average case, the profit will be -85,045 RMB. It means the price is too low to cover the cost and ensure profit in the industry average case. Only when the price is larger than 1.15 RMB/(tonne*km), the carrier would start to earn some money (the profit is positive). If the price in industry average case is increased to 1.84 RMB/(tonne*km), which is the same as the improved case, the revenue in the industry average case is still 1.8 times lower than in the improved case and its annual profit is 93% lower. Only when the price in the industry average case is increased to 2.48 RMB/(tonne*km), its profit is similar to the improved case.

## Sensitivities of Factors

Figure 2 and Figure 3 show each cost item's percentage of TCO in the industry average case and improved case correspondingly. They show obviously that the fuel consumption and driver's cost are the top two biggest portions of TCO. Figure 4 shows the absolute relative change of annual profit due to the 20% change in each factor of the industry average case. The most significant variables for the profits are annual mileage, utilization rate, filling rate, capacity; then the relative significant variables are driver cost, fuel consumption, fuel price. The least significant variables are tire, cost of capital investment, interest, insurance, repair and maintenance, and management cost.

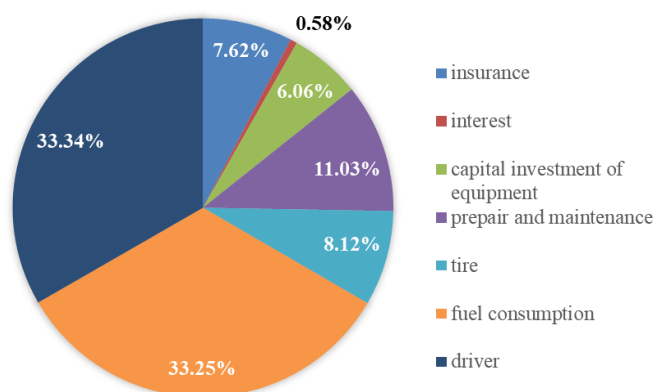**Figure 2: TCO in the industry average case**



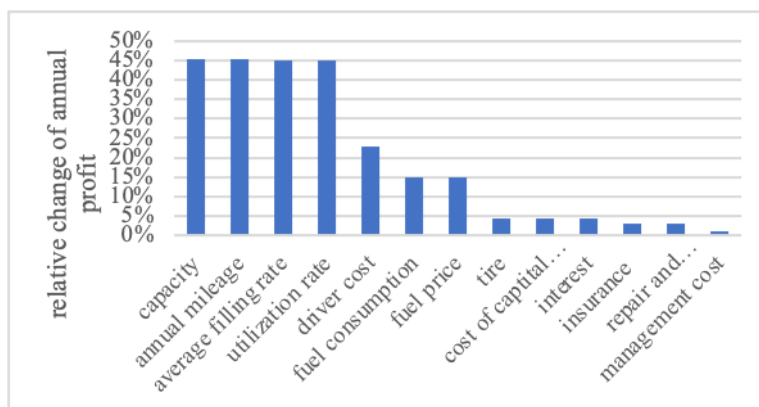**Figure 3: TCO in the improved case**



**Figure 4: Sensitivities of factors related to profit**

## Implications

Freight carriage pricing has an enormous impact on the quality of service possible. In an industry where intense competition forces carriers to cut corners, these companies survive only by saving money. Shippers are interested in receiving more reliable service while reducing the risks associated with illegal or non-compliant carriage practices. By

introducing the concept of the TOE to the carriers and shippers, the shippers can understand the cost and revenue of the carriers. Then the pricing based on TOE can ensure the carrier earns enough money for a reasonable profit as well as to reinvest in high-quality and compliant service. Furthermore, the understanding of TOE can simulate the cooperation between the shippers and carriers to jointly reduce the cost and increase the efficiency of the transport economy system. The comparison of two cases in short-haul delivery proves that the carriers can earn money, meanwhile the shippers pay lower transport prices. The achievements are based on improvement of the revenue-side related factors including the utilization rate, filling rate, and annual mileage, and the unit cost reduction.

For shippers and other cargo owners, a reasonable profit margin needs to be provided to carriers when agreeing upon a logistics price. Failure to provide such an economic incentive will encourage non-compliance, unfair competition, and a vicious circle to lower prices and poorer service. In the end, the shipper and society at large will have to bear safety and economic losses, and shippers may face reputational damage in more spectacular cases. A shared real-time monitoring platform and effective communication scheme between shippers and carriers can help jointly handle deviations, accidents, and incidents efficiently. It can also help make effective improvements in the working methods and process, and make a customized transport plan. Shippers streamline their supply chains with better coordination between their production departments to reduce the carriers' waiting time and empty haul. The shippers can collaborate, for example, by co-loading to further reduce empty miles, and increase the filling rate as well as annual mileage. Given the sophisticated logistics planning system and revenue model, the large shippers need to take the lead in the TOE applications.

For carriers, it is critical to foresee that "comprehensive" inclusion of operational costs, along with improving conditions, will ultimately bring a comparative advantage. A reasonable pricing mechanism brings better welfare to drivers and helps to meet compliance requirements. But it is most important to invest in highly-efficient and

sustainable vehicles, equipment, and solutions that bring both economic and social benefits. Carriers can invest in vehicles with better axle configuration in order to increase the filling rate. Furthermore, larger-scale fleet sizes offer greater utilization rates because they can earn the business of the big shippers due to their stable transport capacity and flexibility. In return, the large-scale fleet can generate more demand for transport services and therefore have a higher filling rate than the small-scale fleet. Truck utilization rate can be increased through well-planned and implemented repair and maintenance as well as through monitoring of the status of the vehicle. Fuel consumption is one of the most sensitive factors on the cost-side and occupies one of the biggest portions of TCO. Moreover, fuel consumption is directly correlated to $CO_2$ emissions. Therefore, the carrier needs to take an effort on the reduction of fuel consumption. The fuel consumption can be reduced by chosing an optimized vehicle configuration, by an energy-saving driving style with the help of driver training, eco-driving in-vehicle devices, monitoring of the driver's behaviors, and dynamic route planning for eco-routing.

For policymakers and industry associations, it is critical to make use of TCO and TOE principles to provide independent and fair pricing indicators to ensure a balanced freight market, which would allow industry players to focus on improving the TOE. Regulators also need to promote safe and sustainable logistics by strengthening and enforcing compliance requirements, vehicle standardization, and phasing-out of illegal oversized vehicles. Considering China's world-class road infrastructure, the Chinese regulators now need to urgently discuss the revision of GB1589-2016[4] to allow the industry the use of high-capacity road transport combinations similar to the either European Union Directive 96/53/EC[5] or performance-based standards (PBS)[6].

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[4] The document can be found on the following website:
http://www.gb688.cn/bzgk/gb/newGbInfo?hcno=4D4FEB86F718FA6C4E2F8A0BB0EC9AC2

[5] The document can be found on the following weibsit: https://eur-lex.europa.eu/eli/dir/1996/53/oj

As a summary, the application of the TOE can encourage the stakeholders in the logistics industry to improve the efficiency and sustainability factors, rather than taking an unlimited and lawless pricing fight. Moreover, society can benefit from the improvement of the TOE, such as fewer congestions and accidents due to trucks, lower $CO_2$ emissions and local pollution, and less loss of goods.

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