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DETERMINATION OF ECONOMIC ADVISABLE DISTANCES OF AUTOMOBILE DELIVERY ON AUTOSERVICE ENTERPRISE

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In order to increase the efficiency of the operation of motor transport enterprises, the structure of production units for maintenance and repair of cars should be determined by the scope of work, taking into account the cost of implementation of the unit labor complexity of works. In case of inappropriateness of creating or maintaining an MTE of separate production units, maintenance and repairs of cars should be carried out at specialized service centers.

Therefore, with the improvement of production units of motor transport enterprises structure, it is important to provide economically expedient delivery distances for maintenance works and repair of cars by co-operation in car service companies, which provide relevant services.

The determination method of economically expedient distances of cars delivery and repair fund for car service companies is given. The cost of cars delivery and repair fund for 1 km to the car service companies or other motor transport enterprises (MTE), which accounts for 1 man-hour of labor-intensive maintenance and repair is determined.

The economically expedient delivery distances for maintenance and cars repair by cooperation in car service companies are determined. The results of the calculations show that for taxi-driven MTE economically appropriate in modern conditions of distance of delivery of cars to perform maintenance-1 and maintenance-2 are close to those recommended in literary sources. For truck and bus MTE the corresponding delivery distances for maintenance-1, maintenance-2 performance, ongoing repairs are significantly lower. When performing diagnostic works D-1 and D-2, most of the the district works of the ongoing repair, the economically reasonable distances of delivery to the car service companies are obtained that substantially exceed the recommendations given in the scientific literature.

Key words: *cars, car service companies, centralized specialized production (CSP), cost of delivery, daily service (DS), expedient delivery distances, maintenance, motor transport enterprises (MTE) , ongoing repair (OR).*

F. 2. Table. 2. Ref. 14.

1. Introduction

In order to ensure competitiveness in the market of transport services, the ructure of production units of motor transport enterprises should be determined by the volume of maintenance and repair of vehicles, taking into account the cost of performing a unit of labor.

The following tasks were solved to achieve this:

- the main directions analysis of reforming the production infrastructure of motor transport;
- a mathematical model development for evaluating the performance of production units for maintenance and car repair;
- a methodology for determining the expedient of creating production units for the maintenance and cars repair in motor transport enterprises and related software development;
- research using the developed method of works performance efficiency with maintenance and cars repair in motor transport enterprises depending on the volume of works and capacity of production units;
- practical recommendations for improving the structure of maintenance production units and vehicles repair in motor transport enterprises development. Determination of economically expedient distances of cars delivery for performance of maintenance works and cars repair of motor transport enterprises in cooperation with the enterprises of car service.

2. Analysis of recent research and publications

The normal production process course can proceed only in condition of continuous provision of its materials, tools, equipment, adjustment and equipment maintenance in a working condition, where the complex of these works constitutes the production infrastructure. Maintenance and repair is an essential part of the process maintenance and repair system in general, is regarded as ancillary, and includes functions to ensure the technical condition (readiness) and repair that must support the rolling stock of motor transport enterprises in a technically sound condition.

For the maintenance and cars repair it is necessary to have a certain complex of auxiliary services, or households: repair, instrumental, transport, delivery-warehouse, etc., which could satisfy the requirements for creation of separate production units of maintenance and repair of vehicles. Therefore, properly selected equipment and quality of work affect the repair efficiency.

Effective performance of many repair work types and maintenance of equipment using advanced technologies can be ensured by a widely developed system of scientific, industrial and other structures. Therefore, there is a need for continuous improvement of the household maintenance base, which creation, is an innovative project in Ukraine.

The changes taking place in this sector require reforms in the field of technical service. The proposed measures are aimed on repair development and maintenance base of the household, improvement of organization and technology of vehicles repair, the introduction of modern repair methods and organization of labor forms, which is not possible without the reconstruction of repair shops of the household [14].

Previous researches have identified the minimum amount of maintenance and
vehicles repair, at which, it is advisable to perform specific types of work in motor transport enterprises and to create or maintain appropriate production units. Minimum volumes of work are established by comparing the cost of performing works on the maintenance and cars repair in a motor transport enterprise with the cost of performing these works in repair or car service enterprises [5, 6].

In case of separate production units absence in motor transport enterprises or inappropriateness of their creation or maintenance, car maintenance and repair work should be performed at specialized motor transport enterprises.

Therefore, it is important to determine the economically appropriate distances for delivery of vehicles or enterprise repair fund MTE, providing relevant maintenance and repair services.

Cited in the literature [1, 2] economically reasonable distances of cars delivery when performing maintenance work and cars repair by cooperatives, which were determined in the 70-80 years of the last century, do not meet the current conditions.

Currently, two opposite trends are affecting expedient delivery distances. On the one hand, there have been significant changes in the structure of road transport companies recently. The economically reasonable delivery distances given in [1, 2] were determined for motor transport enterprises that had from 100 to 300 vehicles (63,4% of total MTE amount [2]). At present, the number of MTE with more than 100 cars is less than 1%. The vast majority of motor transport enterprises (about 64% from total) have a rolling stock of up to 10 units. This leads to an increase of economically reasonable distance of car delivery.

On the other hand, over the specified period of time, the cost of fuel has increased in dollar terms by almost 6 times (from $ 0,15-0,25 per liter in 70-80 years of the last century to $ 1,10-1,20 per liter now). The part of cost of fuel oils materials in the cost cars delivery and repair fund in car service companies is now almost 40%. This is where the cost of delivery increases and, accordingly, economically reasonable delivery distances performing maintenance and repair work of cars in cooperation with the motor transport enterprises reduction.

3. The aim of the research

The purpose of this work is to increase the efficiency of motor transport enterprises by improving the structure of production units for maintenance and cars repair.

4. Key research results

In order to ensure competitiveness in the market of transport services, the structure of production units of motor transport enterprises should be determined by the volume of maintenance and cars repair, taking into account the cost of performing a unit of labor.

Economically appropriate distance of cars delivery and repair fund for the performance of the *i*-th type of maintenance and repair at the enterprises providing the relevant services is determined by the formula:

$$R_i = \frac{(C_{MTE,10,i} - C_{CSP,i})}{C_{d-1,\ km,\ i}}, \quad (1)$$

where $C_{MTE,10,i}$ – the cost of performing the *i*-th type of work at the MTE, which has 10 cars, uah/man-hour; $C_{CSP,i}$ – the cost of the norm-hour of performing *i*-th type of work on the CSP, uah/man-hour; $C_{d-1\ km,i}$ – the cost of cars delivery to the CSP per 1 km, which accounts for 1 person-hour of complexity, uah/man-hour * km.

Determining the cost of 1 km for CSP, which takes 1 person-hour of complexity [4, 5, 6, 7, 8, 9, 11]:

$$C_{d\text{-}1\ km} = (C_{car} + SL_d + C_{fue} + C_{mar}) / c_{mar}, \quad (2)$$

where C_{car} – the cost of engaging the car when performing transportation, uah; SL_d – drivers' salary, uah; C_{fue} – fuel costs, uah; C_{mar} – maintenance costs and cars repair, uah; c_{mar} – complexity of work at delivery on maintenance and cars repair, uah.

The cost of cars delivery and MTE repair fund to a car service company for 1 km, which accounts for 1 person-hour of complexity, is shown in table 1.

Table 1

The cost of cars delivery and MTE repair fund to a car service company for 1 km, which accounts for 1 person-hour of complexity for maintenance and repair

Name of works on maintenance and repair	Delivery cost on 1 km to the service center, uah / person-hour.					
	Taxomotors MTE		Freight MTE		Bus MTE	
	small class cars (Daewoo Lanos)	medium class cars (GAZ-31105)	low lifting capacity cars (GAZ-33021 «GAZelle»)	especially weight lifting capacity cars (KAMAZ-53215)	medium class buses (Mercedes-Benz «Vario» TYP A407)	big class buses (LAZ A-183 D1 «LAZ City»)
1	**2**	**3**	**4**	**5**	**6**	**7**
Cleaning and washing	15,39	20,45	23,84	19,83	25,47	21,84
General diagnosis (D-1)	15,39	20,45	23,84	39,66	25,47	43,68
In-depth diagnosis (D-2)	10,26	13,63	15,92	19,83	16,98	21,84
Fastening, adjusting, lubrication works maintenance-1	7,70	8,18	9,53	4,96	3,40	4,85
Fastening, adjusting, lubrication works maintenance-2	1,71	1,57	1,99	1,28	0,85	1,21
Adjusting and collapsible works OR	7,70	6,82	11,92	6,61	8,49	10,92
Coloring	15,39	20,45	23,84	19,83	12,74	17,47
Aggregate	3,08	4,09	4,77	6,61	5,09	7,28
Locksmithing and mechanical works	3,08	4,09	4,77	6,61	5,09	7,28
Electrotechnical	5,13	6,82	7,95	7,93	6,37	8,74
Rechargeable	7,70	10,22	11,92	13,22	12,74	14,56
Repair of power supply devices	5,13	6,82	7,95	7,93	6,37	8,74
Tire fitting and vulcanizing	7,70	10,22	11,92	9,92	8,49	10,92
Blacksmith springs	7,70	10,22	11,92	7,93	8,49	8,74
Copper	7,70	10,22	11,92	9,92	8,49	10,92
Upholstery	5,13	6,82	7,95	7,93	6,37	8,74
Taxomotors	7,70	10,22	–	–	–	–
Wellding tin and armaturing	5,13	6,82	7,95	9,92	6,37	10,92

Economically appropriate for modern conditions of cars delivery distance, knots and units at performance of works on maintenance and repair by cooperation in specialized enterprises of conditions are shown in table 2.

Table 2

Economically appropriate for modern conditions of cars delivery distance, knots and units at performance of works on maintenance and repair by cooperation in specialized enterprises of conditions

Name of works on maintenance and repair	Economically appropriate delivery distance, km					
	Taxomotors MTE		Freight MTE		Bus MTE	
	small class cars (Daewoo Lanos)	medium class cars (GAZ-31105)	low lifting capacity cars (GAZ-33021 «GAZelle»)	especially weight lifting capacity cars (KAMAZ-53215)	medium class buses (Mercedes-Benz «Vario» TYP A407)	big class buses (LAZ A-183 D1 «LAZ City»)
1	**2**	**3**	**4**	**5**	**6**	**7**
Cleaning and washing	to 12	to 7	to 12	to 7	to 4	to 4
General diagnosis (D-1)	to 170	to 110	to 100	to 40	to 100	to 55
In-depth diagnosis (D-2)	to 200	to 120	to 170	to 65	to 150	to 100
Fastening, adjusting, lubrication works maintenance-1	to 17	to 15	to 15	0	to 3	to 3
Fastening, adjusting, lubrication works maintenance-2	to 6	to 2	to 8	0	to 10	to 8
Adjusting and collapsible works OR	to 95	to 60	to 130	to 80	to 130	to 95
Coloring	to 75					
Aggregate	to 160					
Locksmithing and mechanical works	to 180					
Electrotechnical	to 370					
Rechargeable	to 235					
Repair of power supply devices	to 365					
Tire fitting and vulcanizing	to 225					
Blacksmith springs	to 340					
Copper	to 1050					
Upholstery	to 280	to 190	–	–	–	–
Taxomotors	to 85	to 70	to 150	to 40	to 65	to 40

It is considered that when performing post work on maintenance and repair (daily service, maintenance-1, maintenance-2, diagnostic work, post work ongoing repairs (OR), coloring work OR, wellding tin and armaturing work OR) on centralized specialized enterprises (CSE) delivered directly by car. When performing ongoing works OR (aggregate, electrotechnical and other works) repair fund delivery on CSP is carried out by a low lifting capacity truck (GAZ-33021 «GAZelle»).

Obtained economically appropriate delivery distances for maintenance and work repair of cooperative vehicles are significantly different from those reported in the scientific literature. So, according to the works [1, 2] economically appropriate cars delivery radius when performing cooperative works are for maintenance - 1 – 9…15 km, for maintenance - 2 – 20…45 km, for work OR - 40…80 km.

According to Table 2, for taxomotors and freight MTE, the economically viable distance for OR is up to 12 km, then for bus MTE - up to 4 km.

If it is economically appropriate for a taxomotor transport enterprises in modern conditions, the cars delivery distances for maintenance-1 and maintenance-2 performance are close to those recommended in the literature, then, for freight and bus companies, the corresponding delivery distances are significantly smaller. This also applies to the cars distance delivery to the car service companies for the execution of ongoing

works OR (regulatory and assembly work OR). For these works, the delivery distances shown in Table 2 substantially limit the ability to perform these works by cooperating with car service companies. That is, for maintenanc-1, maintenance-2, post work and ongoing repairs for small motor transport enterprises with up to 10 weightlifting capacity cars, it is advisable to have 1-2 working positions to perform these types of work.

Regarding the performance of D-1 and D-2 diagnostic work, most of the precinct ongoing repair works, then obtained economically appropriate delivery distances to the motor transport enterprises significantly exceed the recommendations given in the scientific literature [1, 2]. This is due to the small amount of these works in small enterprises and the considerable cost of performing these works directly in the trucking companies. First of all, it is caused by the high cost of technological equipment, especially, diagnostic posts.

5. Conclusion

Improvement of production units of maintenance works and cars repair on motor transport enterprises depending on the volume of these works necessitates the transfer of a works part for execution in the car service enterprise. However, the possibility of cooperative works in motor transport enterprises limited by economically appropriate car delivery distances or a repair fund in the central specialized productions, who provide relevant services.

The method of determination of economically appropriate distances of car delivery and repair fund for motor transport companies is presented. The economically expedient delivery distances for maintenance and cars repair by cooperation in car service companies are determined.

Installed, for small MTE with up to 10 weightlifting capacity cars, for maintenanc-1, maintenance-2, post work and ongoing repairs (OR) it is advisable to have 1-2 working positions to perform these types of work.

Regarding the performance of D-1 and D-2 diagnostic work, most of the precinct ongoing repair and post works, then the specified works in small motor transport enterprises appropriate to perfume in cooperation with the motor transport enterprises, this is due to the small amount of these works in small enterprises and the considerable cost of performing these works directly in the trucking companies. Economically appropriate delivery distance for implementation indicated works make up from 75 to 370 km.

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ВИЗНАЧЕННЯ ЕКОНОМІЧНО ДОЦІЛЬНИХ ВІДСТАНЕЙ ДОСТАВКИ АВТОМОБІЛІВ НА ПІДПРИЄМСТВА АВТОСЕРВІСУ

Для підвищення ефективності роботи автотранспортних підприємств структура виробничих підрозділів з технічного обслуговування та ремонту автомобілів повинна визначатися обсягами робіт з врахуванням собівартості виконання одиниці трудомісткості робіт. У випадку недоцільності створення або утримання в автотранспортних підприємств окремих виробничих підрозділів, роботи з обслуговування і ремонту автомобілів повинні виконуватися на спеціалізованих підприємствах автосервісу.

Тому важливе значення при удосконаленні структури виробничих підрозділів автотранспортних підприємств мають економічно доцільні відстані доставки для виконання робіт з технічного обслуговування і ремонту автомобілів за кооперацією в підприємствах автосервісу, які надають відповідні послуги.

Наведено методику визначення економічно доцільних відстаней доставки автомобілів та ремонтного фонду на підприємства автосервісу. Визначено вартість доставки автомобілів та ремонтного фонду на 1 км в підприємства автосервісу або інші автотранспортні підприємства (АТП), яка припадає на 1 людино-годину трудомісткості робіт з технічного обслуговування (ТО) і ремонту.

Визначені економічно доцільні відстані доставки для виконання робіт з технічного обслуговування і ремонту автомобілів за кооперацією в підприємствах автосервісу. Результати розрахунків свідчать, що для таксомоторного АТП економічно доцільні в сучасних умовах відстані доставки автомобілів для виконання ТО-1 і ТО-2 близькі до рекомендуємих в літературних джерелах. Для вантажних і автобусних автотранспортних підприємств відповідні відстані доставки для виконання ТО-1, ТО-2, постових робіт поточного ремонту (ПР) суттєво менші. При виконанні діагностичних робіт Д-1 і Д-2, більшості дільничних робіт поточного ремонту, отримані економічно доцільні відстані доставки в підприємства автосервісу суттєво перевищують рекомендації, наведені в науковій літературі.

Ключові слова: *автомобілі, автотранспортні підприємства (АТП), вартість доставки, доцільна відстань доставки, підприємства автосервісу, поточний ремонт (ПР), технічне обслуговування (ТО), централізовано-спеціалізовані виробництва (ЦСВ), щоденне обслуговування (ЩО).*

Ф. 2. Табл. 2. Літ. 14.

ОПРЕДЕЛЕНИЕ ЭКОНОМИЧЕСКИ ЦЕЛЕСООБРАЗНЫХ РАССТОЯНИЙ ДОСТАВКИ АВТОМОБИЛЕЙ НА ПРЕДПРИЯТИЯ АВТОСЕРВИСА

Для повышения эффективности работы автотранспортных предприятий структура производственных подразделений по ТО и ремонту автомобилей должна определяться объемами работ с учетом себестоимости выполнения единицы трудоемкости работ. В случае нецелесообразности создания или содержания в АТП отдельных производственных подразделений, работы по обслуживанию и ремонту автомобилей должны выполняться на специализированных предприятиях автосервиса.

Поэтому важное значение при совершенствовании структуры производственных подразделений автотранспортных предприятий имеют экономически целесообразные расстояния доставки для выполнения работ по техническому обслуживанию и ремонту автомобилей по кооперации на предприятиях автосервиса, которые предоставляют соответствующие услуги.

Приведена методика определения экономически целесообразных расстояний доставки автомобилей и ремонтного фонда на предприятия автосервиса. Определена стоимость доставки автомобилей и ремонтного фонда на 1 км на предприятия автосервиса или другие автотранспортные предприятия, приходящаяся на 1 человеко-час трудоемкости работ по техническому обслуживанию (ТО) и ремонту.

Определены экономически целесообразные расстояния доставки для выполнения работ по техническому обслуживанию и ремонту автомобилей по кооперации на предприятиях автосервиса. Результаты расчетов показывают, что для таксомоторного АТП экономически целесообразные в современных условиях расстояния доставки автомобилей для выполнения ТО-1 и ТО-2 близки к рекомендуемым в литературных источниках. Для грузовых и автобусных АТП соответствующие расстояния доставки для выполнения ТО-1, ТО-2, постовых работ ПР существенно меньше. При выполнении диагностических работ Д-1 и Д-2, большинства участковых работ текущего ремонта, полученные экономически целесообразные расстояния доставки на предприятия автосервиса существенно превышают рекомендации, приведенные в научной литературе.

Ключевые слова: *автомобили, автотранспортные предприятия (АТП), ежедневное обслуживание (ЕО), стоимость доставки, целесообразна расстояние доставки, предприятия автосервиса, текущий ремонт (ТР), техническое обслуживание (ТО), централизовано-специализированные производство (ЦСП).*

Ф. 2. Табл. 2. Лит. 14.

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