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REPAIR AND MAINTENANCE COSTS FOR SELF-LOADING TRUCKS IN FORESTRY HAUL OPERATIONS IN THE MARITIMES

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Abstract

When setting fair and reasonable haul rates with contractors, it is important to accurately estimate all costs. Contractors must also know their costs so they can identify areas of improvement. FERIC addressed this issue through a tractor-trailer repair and maintenance study in the Maritimes designed to provide more reliable costing information. The project tracked the repair and maintenance costs of 20 self-loading rigs (B-trains and semi-trailers) and one B-train without a loader that traveled on highways and logging roads in Nova Scotia and New Brunswick over a 2-year period. The results provided average costs for all repairs and maintenance, divided into the following categories: electrical, body and structural, maintenance, tires and rims, brakes and air system, suspension, engine and drive train, and hydraulics.

Introduction

Over the past decade, forestry companies in eastern Canada have moved towards almost exclusive use of contractors to haul wood to mills; some, including Stora Port Hawkesbury Limited, have always been 100% contractor operations. Thus, the overall situation has changed from one with few owners to one with many owners. This makes it difficult to consolidate information on operating, repair, and maintenance costs and thereby permit the calculation of average costs. Forestry companies therefore often lack the information they need to set payment rates that will cover a haul contractor's costs, and companies have begun to question the haul rates they currently pay.

Stora Port Hawkesbury Limited and J.D. Irving, Limited, asked FERIC to help determine a more accurate value for tractor-trailer repair and maintenance costs. Both companies consider the combination of repairs and maintenance to be one of the most significant costs for trucking contractors and a key point in contract negotiations. In cooperation with the two companies and their haul contractors, FERIC initiated a 2-year study to track these repair and maintenance costs. FERIC organized the study, and compiled and analyzed all data, and the contractors provided repair and maintenance information from their daily operations. The study was designed to provide more accurate average values for repair and maintenance costs and to identify areas with the greatest potential for improvements and cost savings.

Caution: The data in this report represent a specific sample of rigs working under specific operating conditions. Results for other equipment and operating conditions may be considerably different.

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Methodology

FERIC's study began in April 1995 with 23 self-loading tractor-trailers: 16 were owned by contractors with Stora Port Hawkesbury Limited, five were company-owned rigs, and two were contractor-owned rigs with J.D. Irving, Limited. The equipment model years covered a range of dates from 1988 to 1996, except for one loader that dated back to 1985; approximately three-quarters of the rigs were 3 years old or younger. During the study, two loaders and two trucks were replaced, but the participants continued to report on their new equipment and remained active in the study. As well, two contractors stopped providing information. In all, FERIC used the data from 21 rigs (seven B-trains with a tridem-plus-tandem axle configuration and 14 semi-trailers with a tridem or tri-axle configuration) as the basis for the analyses in this report. All but one B-train were self-loading rigs.

Participants reported repair and maintenance activities and costs for each tractor-trailer on forms designed by FERIC, and submitted the forms monthly for analysis. During the second year of the study, FERIC provided periodic summaries of the information to all participants so they could provide feedback and help identify incorrect data; all suspect data was rejected after verification. These summaries also allowed each participant to compare their information with the averages being developed by FERIC.

For the rigs in the study, 90% of a typical haul occurred on pavement and the remaining 10% occurred on gravel roads. The average one-way haul distance was 120 km for the semi-trailers and 180 km for the B-trains. Operators worked year-round, except for 6 to 8 weeks during the spring breakup (April and May), when roads were closed. The allowable gross vehicle weights (GVW) were 62.5 tonnes for B-trains (New Brunswick and Nova Scotia), versus 49.5 tonnes (New Brunswick) and 52 tonnes (Nova Scotia) for semi-trailers. Rigs working with Stora Port Hawkesbury Limited worked a single shift (8 to 12 hours per day), whereas rigs working with J.D. Irving, Limited, worked a double shift (20 to 24 hours per day). About half of the participants used a professional shop for repair and maintenance work, whereas the others performed this work themselves. The operating conditions were typical of forestry haul operations in the fleets studied and were thus deemed to be broadly representative of repair and maintenance costs in the region.

Data Collection and Analysis

Co-operation from the owners and drivers was a key factor in the data collection because participants were spread over a wide geographical area and the study ran over a long period of time. Thus, FERIC could not maintain direct contact with all participants. To facilitate reporting, data collection took place in two phases and followed instructions provided by FERIC to improve consistency. Each participant kept a logbook in the vehicle and another at the office. Drivers used reporting sheets in the truck logbook to record repair and maintenance jobs, then stored the sheets in the office logbook. When invoices arrived, participants verified them against the corresponding sheet from the truck's logbook and entered the data in the office logbook. Truck owners retained a copy of these sheets for their records, and returned the original to FERIC.

Expenses were divided into the following categories: electrical, body and structural, maintenance, tires and rims, brakes and air system, suspension, engine and drive train, and hydraulics. The category "maintenance" comprised oil changes, greasing and lubrication, cosmetic repairs, filter changes, and any other maintenance jobs that could be scheduled, such as checking and replacing belts, brackets, nuts and bolts. Work times (recorded in the logbook as hours) represented personal time only; time charged by a service center was recorded in terms of the labor costs in dollars. All costs include the relevant taxes. Operators who did not follow this procedure exactly were able to provide comparable data. *Repairs performed under warranty were not included in the cost summaries.*

FERIC designed a spreadsheet to store the repair and maintenance data and calculate individual and group averages, with the cost per kilometre traveled used as the basis for analysis. The times reported for *personal* work on repair and maintenance were included in the repair and maintenance costs at a labour rate of $30/hour. Although the shop charges in the study areas ranged from $30 to $55 per hour, FERIC chose the lower end of the range to represent the owner's or operator's time because this work required only minimal equipment and expertise and thus did not warrant the higher rate that a professional mechanic would charge.

Grouping data based on the vehicle's model year did not prove useful because two trucks with the same model year often differed drastically in their actual usage. Instead, FERIC calculated costs over 25 000-km intervals starting with the first interval after the original odometer reading (e.g., the first interval for a truck that started the study with 112 480 km began at 125 000 km).

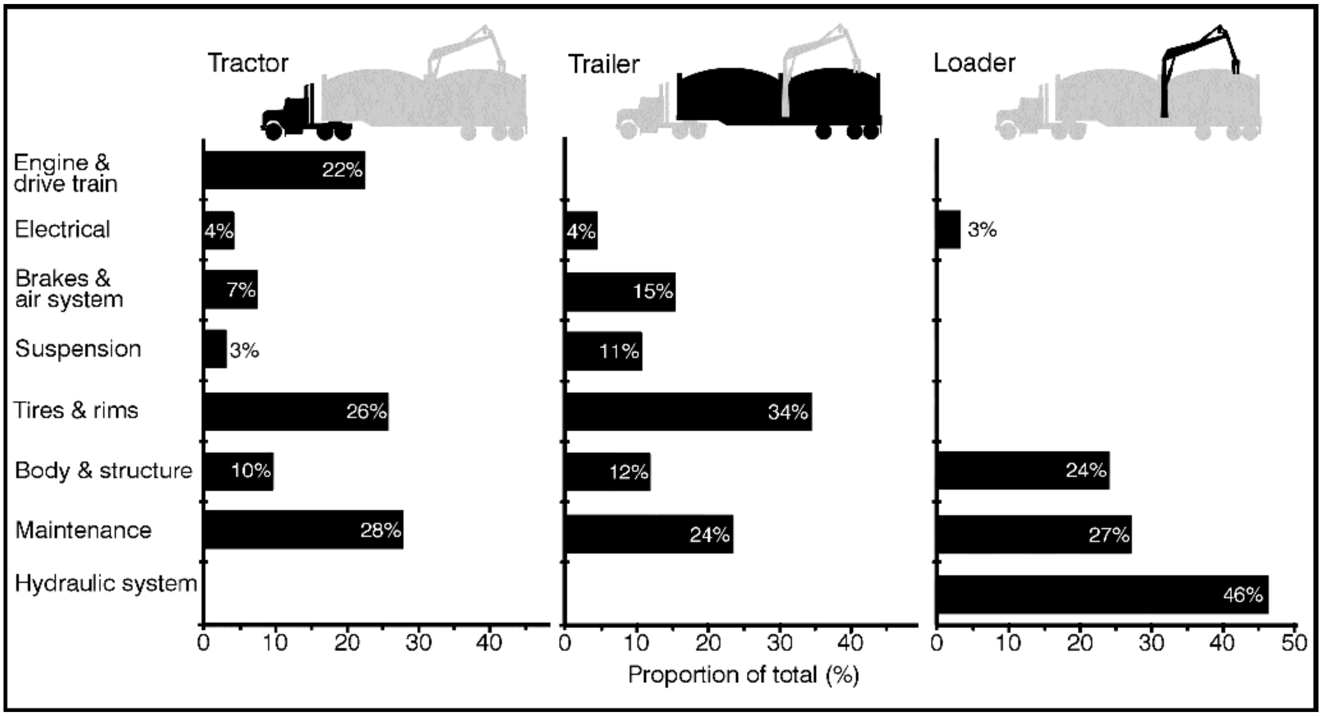

Figure 1. Proportions of total repair and maintenance cost in each category for the semi-trailer rigs.

This approach also facilitated comparisons between equipment that worked single versus double shifts. All data in this report is based on these intervals.

Results

Semi-trailers

Figure 1 shows the proportion of total cost accounted for by each category of repair and maintenance for the semi-trailer tractors, trailers, and loaders. For the tractors, three components (the tires and rims, the engine and drive train, and maintenance) each accounted for roughly 25% of the total cost. For the trailers themselves, tires and rims accounted for 34% of the total, versus 24% for maintenance and 15% for the brakes and the air system. For loaders, the hydraulic system accounted for 46% of the cost and maintenance represented 27%, versus 24% for structural repairs and 3% for electrical repairs.

FERIC calculated an average repair and maintenance cost (taxes included) of $0.262/km for the semi-trailers, divided as follows: $0.141/km for the tractor, $0.073/km for the trailer, and $0.048/km for the loader. Figure 2 shows the cumulative repair and maintenance costs for each of these three components as a function of distance traveled (R^2 values of 0.988, 0.958 and 0.965, respectively, for the tractor, trailer and loader). Because FERIC's statistical analysis revealed that the repair and maintenance cost per kilometre did not change over time, the average cost per kilometre over the course of the study was used to estimate the cumulative repair and maintenance cost after various total distances. Based on previous FERIC research (e.g., Williams 1989), qualitative observations of the data in the present study, and various statistical calculations, the actual costs for individual rigs in the study population can be expected to be as much as 20% above or below these average values.

Figure 3 illustrates the variation in average repair and maintenance costs as a function of total distance traveled. The high peaks in these figures illustrate the impact that repair and maintenance costs can have on a truck owner's cash flow. For the tractors of the semi-trailers, the average expenditure was $3535 per 25 000 km, versus $1832 for the trailer itself and $1207 for the loader. For the trailers, costs remained below the long-term average until 300 000 km, then tended to rise and fall thereafter. For the tractors and loaders, the repair and maintenance costs tended to rise and fall throughout the study.

B-Trains

Figure 4 shows the proportion of total cost accounted for by each category of repair and maintenance for the B-train tractors, trailers, and loaders. For the tractors, two categories (the engine plus drive train and the tires plus rims) each accounted for roughly 25% of the costs. For the trailers, tires and rims accounted for 46% of the total, versus roughly 20% for maintenance. For the

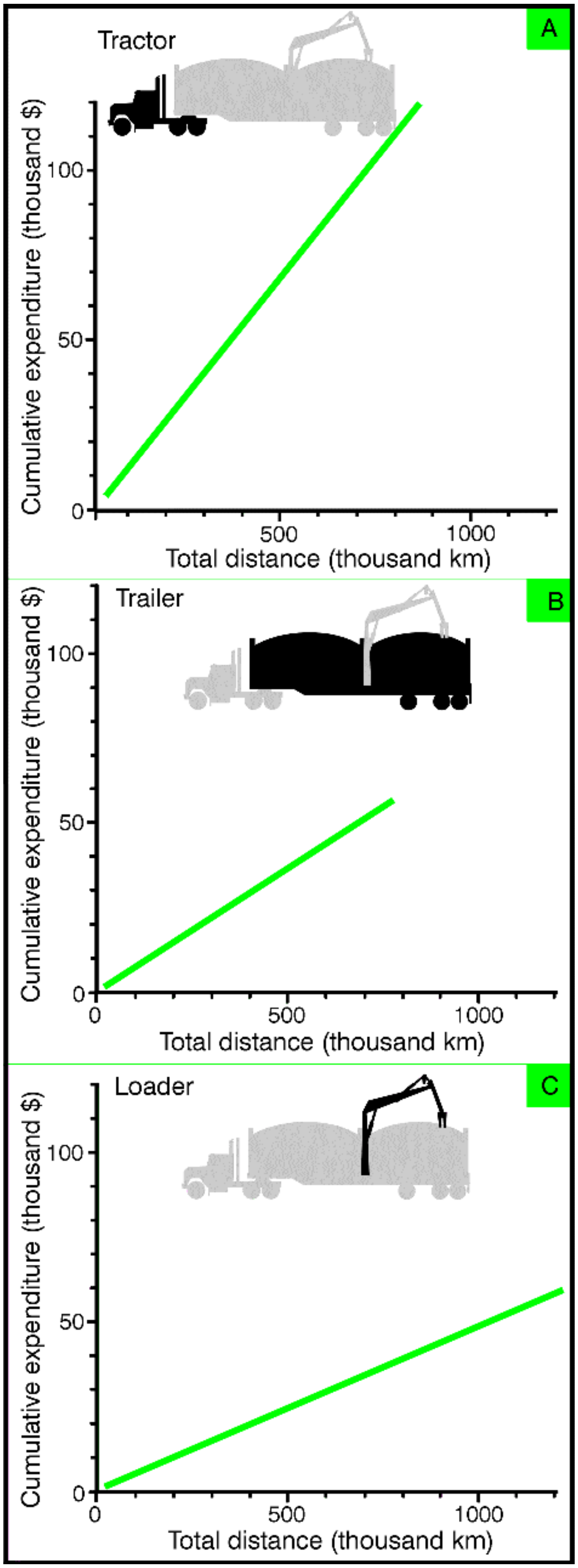

Figure 2. Average cumulative repair and maintenance costs for the semi-trailer rigs. Actual values may be as much as 20% above or below the graphed values.

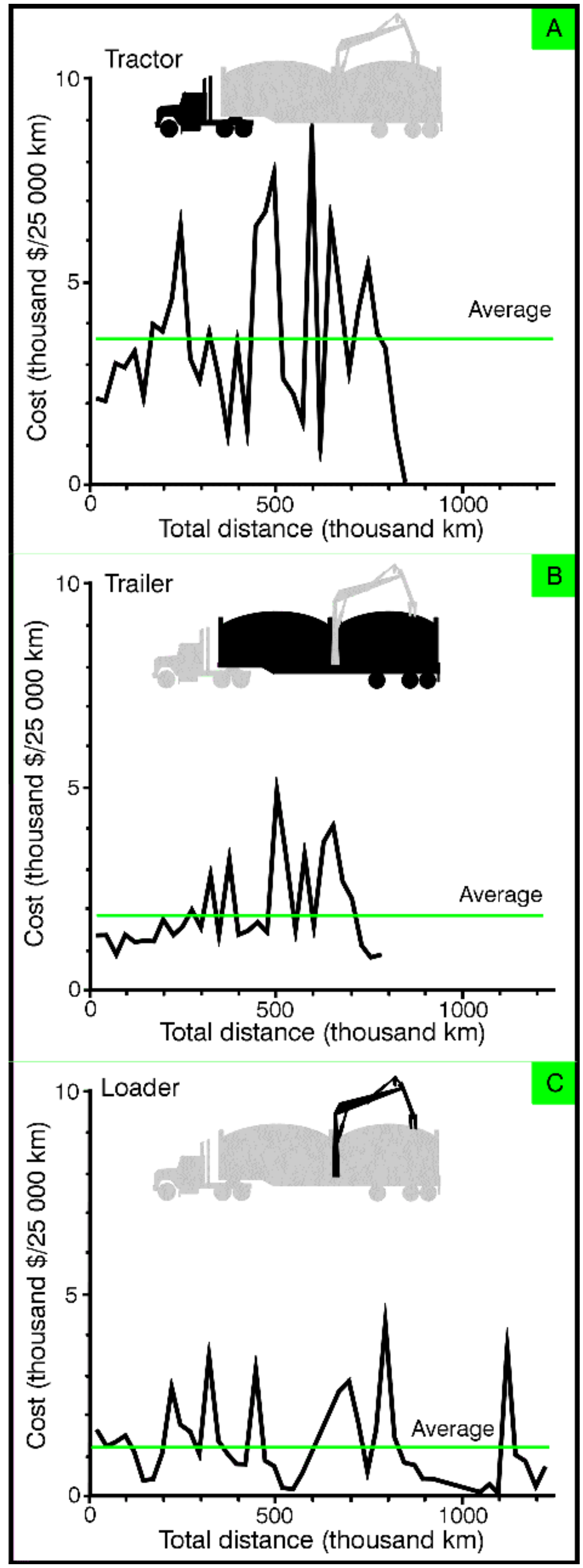

Figure 3. The variation in average repair and maintenance costs for the semi-trailer rigs as a function of the cumulative distance traveled.

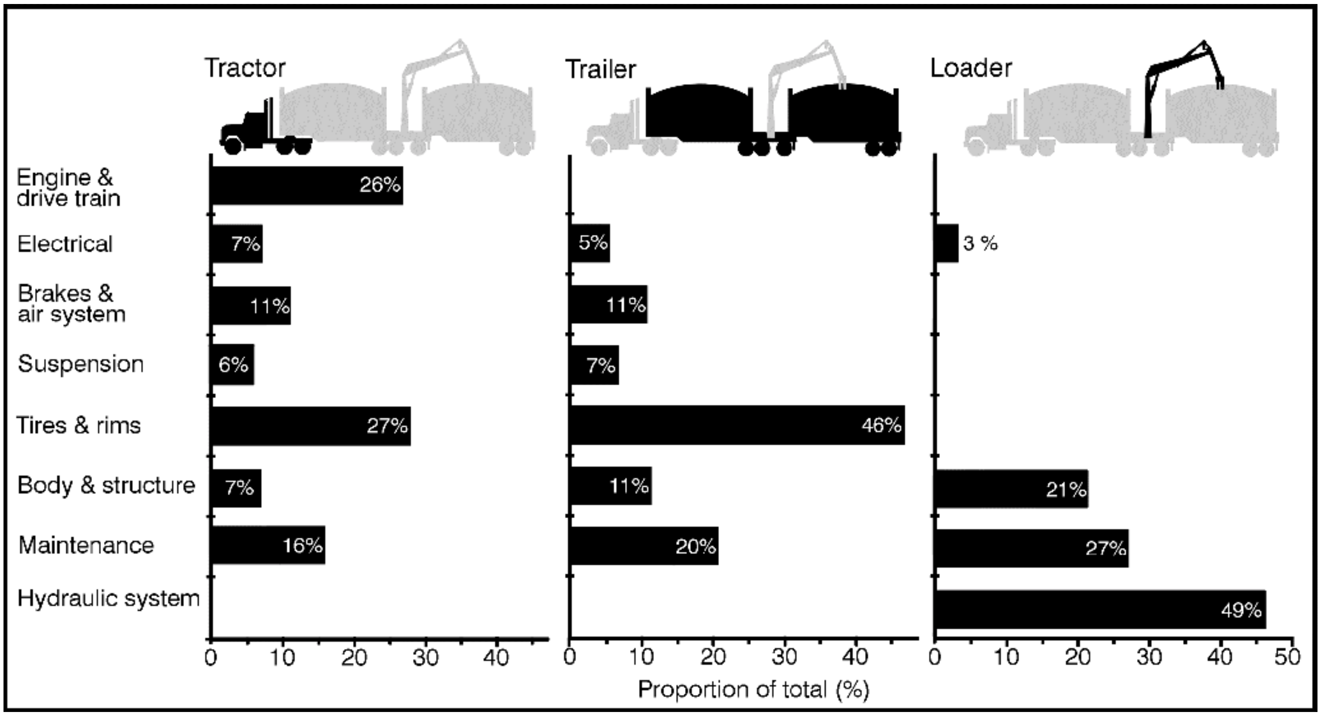

Figure 4. Proportions of the total repair and maintenance cost in each category of repair and maintenance for the B-train rigs.

loaders, the hydraulic system accounted for 49% of the cost and maintenance represented roughly 27%, versus 21% for structural repairs and 3% for electrical repairs. These results are similar to those for the semi-trailer loaders. Overall, maintenance represented a lower percentage of total costs for the B-trains than for the semi-trailers. This could be attributed to the fact that the drive train and tire components are working under higher loads with B-train rigs, thus increasing the repair portion.

As was the case with the semi-trailers, FERIC's statistical analysis did not reveal a relationship between the number of kilometres traveled and the repair and maintenance cost per kilometre. As a result, FERIC calculated an average repair and maintenance cost (taxes included) of $0.228/km for the B-trains, divided as follows: $0.154/km for the tractor, $0.053/km for the trailer, and $0.021/km for the loader (R^2 values of 0.984, 0.983, and 0.909, respectively, for the tractor, trailer and loader). Figure 5 shows the effect of these costs on the cumulative repair and maintenance cost for each component of the rig as a function of total distance traveled. As was the case for the semi-trailers, the actual costs for the study population may be as much as 20% above or below the average results.

Figure 6 shows the variation in expenditures as a function of the total distance traveled by the B-trains. As in Figure 3, the high peaks on the graphs in this figure illustrate the impact that repair and maintenance costs can have on a truck owner's cash flow. For the tractors, the total cost averaged $3842 per 25 000 km, and most of the repair and maintenance costs between 150 000 and 450 000 km were below this average cost. The corresponding averages were $1334 for the trailers and $514 for the loaders.

Discussion and Recommendations

It was initially surprising that FERIC's statistical analysis revealed no increase in repair and maintenance costs per kilometre with increasing total distance traveled. However, when FERIC closely examined the study conditions, this result seemed more reasonable. First, a considerable proportion of the repair and maintenance expenses results from repairs to systems such as tires and brakes that reoccur regardless of age. For example, an 8-year-old rig will use about the same number of tires per year as a 1-year-old rig. Second, most of the rigs operating in this study were working *under some form of warranty*, but with different amounts of coverage. Third, given that the rigs were mostly still under warranty, it can be assumed that the rigs in the study were still operating within their expected (designed) working life. If the rigs were working beyond their designed lifespan or their warranty period, the repair and maintenance costs would undoubtedly increase.

A second surprise was that the B-trains, with more tires and heavier loads, had lower overall repair and maintenance costs. Breaking these numbers into their compo-

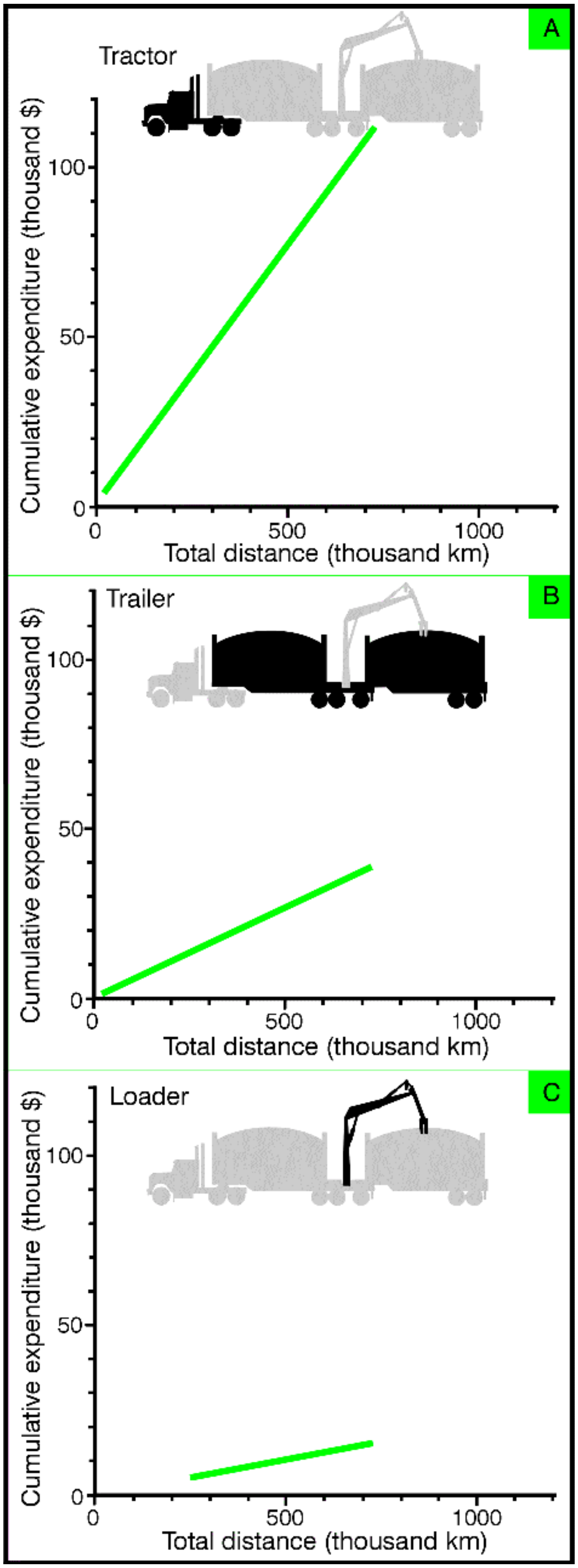

Figure 5. Average cumulative repair and maintenance costs for the B-train rigs. Actual values may be as much as 20% above or below the graphed values.

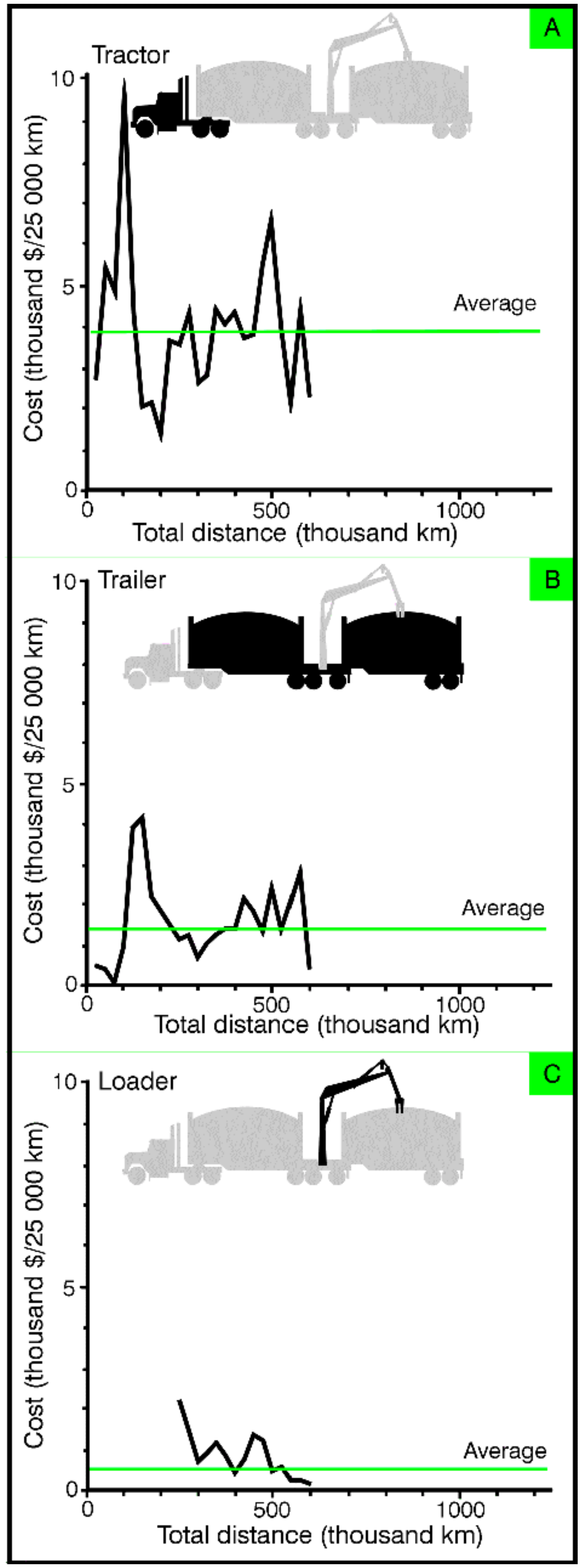

Figure 6. The variation in average costs as a function of total distance traveled by the B-train rigs.

nent parts explains this observation. The B-train tractors cost \$0.01/km more than the semi-trailer tractors, which reflects the higher loads on their engines, drive trains, and air systems as a result of the higher legal GVW values. In contrast, the B-train trailers cost \$0.02/km less than the semi-trailers. Although this lower value initially seems unreasonable (B-train trailers have more axles, more brakes, more suspensions, and more tires), the difference in actual workloads helps explain this result: with a full legal load, the individual tires, axles, and brakes of B-train trailers are subjected to only 74% of the weight supported by the corresponding components on semi-trailers, and the resultant improvement in the load distribution reduces the repair and maintenance costs of the trailer.

The lower overall repair and maintenance costs for the B-train loaders (a difference of nearly 50%) could have two possible explanations. First, the B-train loaders were more often detachable, and detached loaders would experience less vibration damage to their structure and less exposure of their hydraulics to dust and dirt. Second, B-trains tended to perform longer hauls from larger piles, so each kilometre traveled represents less work for the loader than with a semi-trailer.

It's also important to note the lack of a distinct pattern in Figures 3 and 6. The black lines in these graphs represent the fleet averages per period from the study, and averaging the information from more than one rig would be expected to smooth these peaks; since the peaks remained significant, this strongly suggests that owners must budget for sudden large expenses. The pattern from these graphs can help in budgeting, since it suggests that major repairs are followed by savings in subsequent months. Moreover, the nature of the haul business suggests that these peaks are likely to follow annual cycles to some extent. For example, major repairs and maintenance are usually done when work slows down; in forestry, this usually occurs during the spring (April and May) breakup. This factor likely contributed to the seeming irregularity in Figures 3 and 6.

Tires

FERIC's study showed that tires and rims represent one of the biggest expenses for owners of tractor-trailers: tire and rim repair costs were \$0.06 and \$0.07 per kilometre (respectively) for semi-trailers and B-trains. For a B-train on an average haul, tires cost around \$25 per round trip. With tire maintenance often low on the priority list or even overlooked, there is definite room for improvement. In a recent survey by FERIC, stakeholders in the forest trucking industry were asked how often they check engine oil levels and tire pressures. Nearly all agreed that oil should be checked daily, but the replies for tire pressure checks ranged from every 2 weeks to every 3 months.

Failure to maintain proper tire pressure sometimes results from a lack of driver knowledge. When tires operate at incorrect air pressures, they overheat and the risk of a blowout increases greatly; this has obvious implications for both costs and safety. Moreover, the treads of improperly inflated tires wear out quickly and unevenly, and the tires may also suffer internal damage that is invisible while the tire is mounted on the rim but that can nonetheless lead to rejection of the carcasses for use as retreads. The inside tire of each dual is a particular problem because its valve is sometimes hard to see and difficult to reach. As well, drivers may be reluctant to check the pressure on these tires out of fear that the valve core will stick open and lead to a flat tire.

Pressure differences between the two tires within a dual also causes difficulties because a tire with lower pressure than its partner will be dragged or pushed as a result of its higher rolling resistance. FERIC has studied several brands of relatively inexpensive tire-pressure equalizers that facilitate monitoring and equalizing tire pressures, and preliminary results suggest that these devices can help to reduce tire wear. The pressure equalizers also include visual indicators of the degree of inflation that let drivers monitor tire pressures without the inconvenience and risk of using a pressure gauge.

Hydraulic systems

FERIC's results suggest that hydraulic systems represent approximately 50% of a loader's total repair and maintenance cost, so proper hydraulic maintenance has considerable potential for cost reductions with self-loading rigs. Contaminated oil damages the loader's filtration system because iron particles abraded from moving parts are themselves very abrasive. The pump, which is the heart of the hydraulic system, is the first component to be affected by such contaminants; it is also affected by the numerous cold starts that these self-loading units experience. Oil should be inspected at every service interval recommended by the manufacturer, and oil testing can give a good indication of the system's overall health. Premature wear and failure could be avoided with the addition of a bypass filter system at the time of purchase to remove contaminants and the use of a hydraulic oil heater to avoid cold-start problems.

Maintenance

The purpose of maintenance is to maximize vehicle life, identify components or systems with defects or deficiencies so as to avoid outright failures, minimize the overall cost of vehicle repairs, and plan maintenance so that overall availability increases. It is widely recognized that regular maintenance can reduce overall repair and maintenance costs by preventing or delaying major breakdowns, but conversations with service managers revealed that this ongoing expense is often not done wisely or properly. Given that this maintenance can represent 25% or more of total repair and maintenance costs, and that it greatly affects the remaining 75% of costs, owners must understand the principles on which maintenance is based. Doing so can help make this important work repay its costs.

Providing operators with a daily checklist and ensuring that they complete it is a good first step towards good maintenance. Computerized maintenance is another option, since properly designed software can help track what must be done and minimize paperwork. The software would also make it easy to create customized maintenance checklists, analyze life-cycle costs, and track warranties. Improved organization and planning of maintenance could help reduce the 25% of total costs that it represents. Although regular programmed maintenance costs are often predictable and constant, other costs (e.g., major repairs) generally occur unpredictably, as shown by the peaks and valleys in Figures 3 and 6. Planning an overall maintenance budget should include a budget for such repairs. Steadily increasing maintenance expenses also suggest that it may be time to replace a particular piece of equipment, although no such trend appeared in FERIC's study.

The potential savings from regular maintenance make this task an important part of regular operations. For those who find it difficult to implement their own plan for regular maintenance, one good option might be to form a local co-op with various owner-operators. This co-op could inform owners of the advantages of repair and maintenance costs, help remind its members when maintenance is due, and negotiate better prices from suppliers. Alternatively, various management companies now perform this function for vehicle owners.

Warranties

FERIC recommends that owners study and completely understand the warranties offered by equipment manufacturers. Warranty coverage on tractor engines can differ by as much as 300 000 km over a 5-year period. Given the size of the investment in a tractor-trailer, buyers should carefully investigate extended warranties. A relatively modest initial expenditure may save thousands of dollars on expensive engine repairs at a later date. For example, some operators had 400 000- or 500 000-km warranties, but if all warranties had been the maximum length (800 000 km), overall repair and maintenance costs could have been lower, and the engine and drive-train component would have represented a much smaller percentage of the total cost.

An extended warranty on the engine, transmission, axles, and drive train might cost as little as $2000, yet would pay for almost all repairs on these components for 5 years or 800 000 km. For an operator who plans to keep a rig for 7 years and drive an average of 120 000 km per year, the extended warranty represents an excellent investment, since FERIC's study showed that engine and drive train repairs account for approximately 25% of the total tractor repair and maintenance cost.

Conclusions

FERIC's study established benchmarks for average tractor-trailer repair and maintenance costs in the study region. Semi-trailers can anticipate average repair and maintenance costs of about $0.262/km including taxes for self-loading tridem configurations similar to those in FERIC's study. B-trains had a lower overall cost ($0.228/km including taxes); although their tractors cost about $0.01 more per kilometre, costs were lower for the loader and trailer components. It's important to note, however, that there was significant variation in these costs, both over time and between trucks, so owners and operators should plan accordingly. Though statistical analysis revealed no trend towards increased costs with increasing total distance traveled, more and larger fluctuations from the average cost can likely be expected after longer total distances.

The first improvements to adopt should be those in areas with the greatest potential payback. For self-loading tractor-trailers in the Maritimes, tires and hydraulic systems offer the greatest potential for cost reductions. Both systems require careful maintenance to detect potential problems and avoid catastrophic operational failures that would result in high repair costs. The steps outlined in this report will help. Moreover, future FERIC research on repairs and maintenance will undoubtedly reveal additional ways to reduce repair and maintenance costs in forestry haul operations.

Reference

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Acknowledgments

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