Field studies in construction equipment economics and productivity.

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Construction equipment has evolved significantly.

Increase in size and capacity
Improvement in technology
General vs special purpose application

Understanding economics and productivity has gained significant grounds.

Hand notes
Onboard instrumentation
The purpose of this paper is to validate and extend some aspects of equipment economics and productivity.

- Repair cost.
- Resale value.
- Total cost of ownership (TCO).

**REPAIR COST**

**CCI curve for a group of wheel loaders:**

\[ y = 8 \times 10^{-9}x^2 - 3 \times 10^{-5}x + 1 \]

\[ R^2 = 0.9432 \]
Repair cost curves for FTM approach:

Repair cost when using probabilistic approach for component life:

Future research on repair costs:

- System or tool to track equipment repair and maintenance costs.
- Link onboard electronics to store the repair related cost information onboard the machine (part of the machine DNA).
- Predicting a band of repair costs for a class of machines - at the time of making a decision on repair, it should be possible to estimate the life earned because of the repair.
- Predict failure of components based on data gleaned from onboard instrumentation.
RESALE VALUE

Model to predict resale value:

- Hours on the machine (SMU),
- Type of job and operating conditions during its life,
- Manufacturer and dealership network,
- Physical conditions at the time of sale, and
- Market – supply and demand for type of equipment.

$$RV = C - BM - Ax$$

RV is the resale value in the auction year, C, B, A are constants which vary by classes, M is the Brand index and x is the number of hours on the machine.

Behavioral analysis suggest that resale value is linked to repair cost.
Future research on resale values:

- Effect of currency movements play on resale value of equipment.
- Impact of “population control.”
- Impact of emission standards as well as the legislation on used equipment.
- An objective way to establish the condition of the machine.

TOTAL COST OF OWNERSHIP

TCO (Total cost of ownership) brings together economics and productivity.

\[ TCO = \frac{\$/hr}{\text{ton/hr}} = \frac{\$/\text{ton}}{\text{ton}} \]

$/hr$: Life cycle costs  
ton/hr: Productivity
Life Cycle Costs (LCC):

- **Acquisition costs**
  - Purchasing
  - Installation
  - Set-up

- **Discounted value of**
  - Operation costs
  - Financing costs
  - Training costs
  - Maintenance costs
  - Insurance costs
  - Tax
  - Inventory carrying costs
  - Administrative costs

**Time (Years and hours) are critical component of life cycle cost.**

**The proportion of costs varies over the life.**
Road class structure and curves impact "rideability" and hence the use of throttle.

Increase in Travel Time as a function of Throttle Position

Total cost of ownership (TCO) is a function of organization.

Site Simulation helps to study the impact of project- and machine-related parameters on Productivity and Cost.
Job Site Simulation: Results

Future research on TCO:

• Systems to capture the cost of equipment ($/hr) at the serial number level.
• Domain specific simulators - in particular, the ability to predict the performance of a piece of equipment such as grader or paver based on its subsystems.