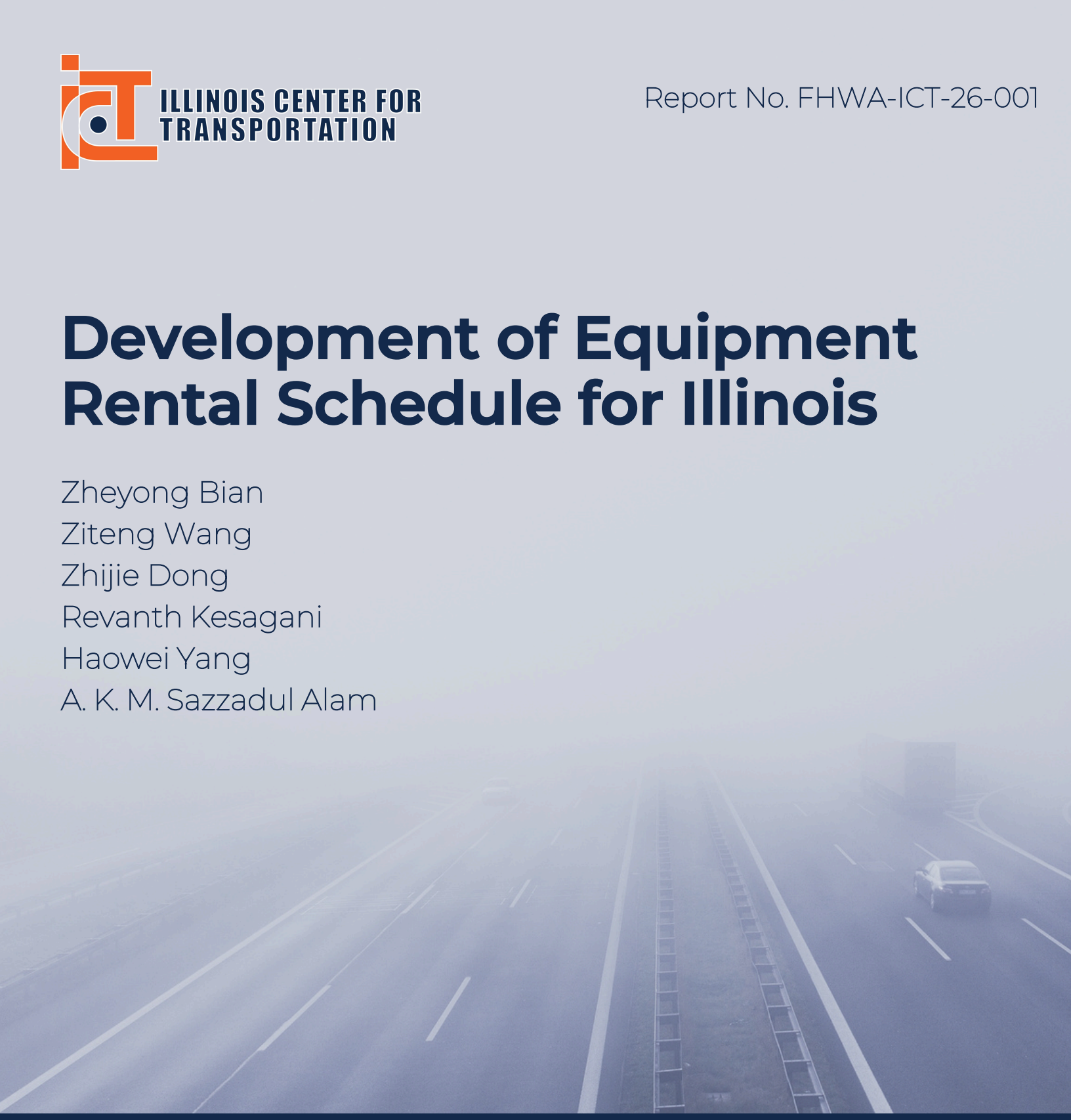
ILLINOIS CENTER FOR TRANSPORTATION

Report No. FHWA-ICT-26-001

Development of Equipment Rental Schedule for Illinois

Zheyong Bian
Ziteng Wang
Zhijie Dong
Revanth Kesagani
Haowei Yang
A. K. M. Sazzadul Alam



ICT Project R27-254

January 2026

ISSN: 0197-9191
ICT Series Report No. 26-001
https://doi.org/10.36501/0197-9191/26-001

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-ICT-26-001	N/A	N/A

4. Title and Subtitle	5. Report Date
Development of Equipment Rental Schedule for Illinois	January 2026
	6. Performing Organization Code N/A

7. Authors	8. Performing Organization Report No.
Zheyong Bian (https://orcid.org/0000-0001-9094-3333), Ziteng Wang (https://orcid.org/0000-0001-7763-8959), Zhijie Dong (https://orcid.org/0000-0003-0979-812X), Revanth Kesagani, Haowei Yang (https://orcid.org/0009-0007-3948-3061), A. K. M. Sazzadul Alam (https://orcid.org/0009-0005-5019-9323)	ICT-26-001 UILU-2026-2001

9. Performing Organization Name and Address	10. Work Unit No.
Illinois Center for Transportation Department of Civil and Environmental Engineering University of Illinois Urbana-Champaign 205 North Mathews Avenue, MC-250 Urbana, IL 61801	N/A **11. Contract or Grant No.** R27-254

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Illinois Department of Transportation (SPR) Bureau of Research 126 East Ash Street Springfield, IL 62704	Final Report 8/16/22–1/15/26 **14. Sponsoring Agency Code**

15. Supplementary Notes

Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.
https://doi.org/10.36501/0197-9191/26-001

16. Abstract

During highway construction, the Illinois Department of Transportation (IDOT) resident engineer commonly adds "extra work" to the contract as needed for satisfactory completion of the project. One of the formats for contractor reimbursement requires establishing an hourly compensation rate for contractor-owned equipment used to perform the extra work and similar equipment owned by local agencies eligible for Motor Fuel Tax funding. Construction equipment rental rates vary widely according to factors, including equipment age, type, overhaul labor and parts, field labor and parts, capacity, estimated operating costs, availability, the geographic and climatic conditions at the job site, etc. It is critical that each highway agency, including IDOT, establish specific policies and standard guidelines to deal with construction equipment reimbursement in force account work in a fair manner to contractors. This project develops a comprehensive equipment rate schedule model to establish hourly compensation rates for contractor-owned equipment used in performing extra work. The model incorporates ownership costs—such as depreciation, overhead, and overhaul costs—and operating costs, including fuel, tire, and lubrication expenses. A methodology for annual rate updates is also developed. Additionally, the project delivers a user-friendly, web-based tool that can be operated and maintained by IDOT.

17. Key Words	18. Distribution Statement
Transportation, Equipment Management, Cost Estimating, Construction Management	No restrictions. This document is available through the National Technical Information Service, Springfield, VA 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	73	N/A

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

ACKNOWLEDGMENT, DISCLAIMER, MANUFACTURERS' NAMES

This publication is based on the results of **ICT-R27-254: Development of Equipment Rental Schedule for Illinois**. ICT-R27-254 was conducted in cooperation with the Illinois Center for Transportation; the Illinois Department of Transportation; and the U.S. Department of Transportation, Federal Highway Administration.

Members of the Technical Review Panel (TRP) were the following:

- Douglas Dirks, TRP Chair, Illinois Department of Transportation
- Tim Peters, TRP Co-Chair, Illinois Department of Transportation
- Belinda Clifton, Illinois Department of Transportation
- Chris Fraley, Federal Highway Administration
- Jeremiah Houtekier, Illinois Department of Transportation
- Sal Madonia, Federal Highway Administration
- Mark Neale, Illinois Department of Transportation
- Scott Nuttall, Illinois Department of Transportation
- Lora Rensing, Illinois Department of Transportation
- John Senger, Illinois Department of Transportation
- Daniel Sommer, Illinois Department of Transportation

EXECUTIVE SUMMARY

This project aimed to establish a reliable, transparent, and efficient equipment rental rate schedule for the Illinois Department of Transportation (IDOT). IDOT relied on the commercially available EquipmentWatch *Rental Rate Blue Book* (2025), which was often cost-prohibitive and lacked flexibility for small-scale contractors. This research addressed these limitations by developing a customized rental rate model tailored to Illinois' unique needs, ensuring fair compensation for contractor-owned equipment involved in "extra work" during construction projects.

The study reviewed federal and state equipment rate schedules, analyzing practices from various departments, including the Federal Highway Administration (FHWA) and other state departments of transportation. The proposed Illinois-specific model and its accompanying digital tool were designed to improve rate transparency, cost-estimation accuracy, and contractor negotiation processes while significantly lowering costs and administrative burdens. This project delivered a practical and sustainable solution for IDOT, aligning with both fiscal and operational goals.

The report detailed the development of a comprehensive model that calculated hourly equipment rates. The methodology involved calculating both ownership costs, such as depreciation and overhead, and operating costs—including fuel, labor, and maintenance—to determine an hourly rate. The model incorporated critical data points such as equipment purchase price, operational hours, and economic life, adjusted for Illinois tax rates and market conditions. Regular updates were integral to this model, ensuring rates remained aligned with inflation, fuel costs, and evolving labor rates.

Furthermore, the project proposed an annual update methodology that adapted equipment costs dynamically to inflation and market trends. By implementing this model, IDOT gained a transparent and adaptable tool that aligned with state requirements, improved cost accuracy, and reduced administrative costs. This report delivered a robust framework for rate scheduling that addressed IDOT's objectives and set a benchmark for industry-wide equipment cost estimation.

Finally, the project developed a user-friendly, web-based tool that IDOT could operate and maintain. The "Equipment Rental App User Manual" provided a comprehensive guide for an application developed to streamline equipment data management for IDOT. This application was designed to enhance efficiency by offering tools that simplified managing, updating, and analyzing equipment and contractor data within IDOT's rental scheduling system. The app featured two main user modes—admin and general user—each with specific capabilities, such as data editing for admins and data viewing for general users. Key functionalities of the app included data authentication, equipment filtering, and cost calculations. Admin users could access advanced options, like editing equipment details, adjusting fuel and labor rates, and generating updated equipment data for the coming year. The app's data export feature also allowed administrators to compile and export selected equipment data into Excel for streamlined reporting. Built with Angular, Node.js, Express.js, and MongoDB, the app was structured for scalability and secure data handling. It integrated authentication protocols to protect data, with separate front-end and back-end connections to ensure smooth deployment and database interactions. This user-friendly tool provided IDOT with a modernized solution for rental data management, reducing dependency on external services and improving operational transparency.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

In highway construction, Illinois Department of Transportation (IDOT) resident engineers frequently add “extra work” to contracts to ensure project completion in accordance with Article 109.04 of IDOT’s (2022) *Standard Specifications for Road and Bridge Construction*. For contractor reimbursement, one approved approach requires using the EquipmentWatch *Rental Rate Blue Book* (2025), a subscription-based commercial resource, to establish hourly rates for contractor-owned equipment used in extra work and similar equipment owned by local agencies eligible for Motor Fuel Tax funding. However, for contractors handling a limited number of department projects each year, the cost of this subscription often outweighs the reimbursement they receive for equipment use.

Construction equipment rental rates can fluctuate significantly, influenced by factors such as equipment type, age, capacity, estimated operating costs, and the geographic and climatic conditions of the job site. Most states, including Illinois, use the blue book but face challenges with the accuracy of rate adjustments, as the standardized adjustments are often applied without reliable local data. Applying a uniform adjustment to all equipment types can lead to inconsistencies, resulting in either under- or over-compensation.

When external rental rate sources are used for force account work, IDOT and similar agencies have minimal influence over the data collection methods and cost parameters used, limiting their control over rate accuracy. Due to the variable nature of private rental rate publications, it is essential for highway agencies, including IDOT, to establish clear policies and standardized guidelines to ensure fair and transparent reimbursement for construction equipment in force account work. An equipment rate schedule is a structured document that provides standardized rental rates for different types of construction equipment. This schedule includes a comprehensive list of equipment, such as heavy machinery, vehicles, and tools, with each type identified by a unique code or name. Additionally, it details rate calculations broken down into components like hourly and daily rates for each equipment type, allowing contractors to select the appropriate rate based on the intended duration of use.

An equipment rate schedule is essential for precise cost estimation and budget control on construction projects. By standardizing and documenting equipment costs, project managers and contractors can quickly calculate expenses for additional work, helping them keep projects within budget. With standardized rates, contractors can also make well-informed decisions when comparing vendors and selecting the most cost-effective rental options, which ultimately reduces extra labor expenses. For negotiations, a rate schedule provides an objective basis, ensuring fair pricing and reducing potential conflicts over costs for additional work. Beyond budgeting, an equipment rate schedule promotes pricing transparency between clients and contractors by clearly showing how equipment costs are determined. This transparency reduces misunderstandings and improves communication about expenses related to extra work. The rate schedule also aids in project planning, as project managers can anticipate equipment costs and efficiently allocate resources. As a comprehensive record, the schedule supports documentation, serving as a valuable reference for audits, project analyses, and future cost planning. It also facilitates accurate cost recovery, allowing contractors to substantiate equipment expenses billed to clients.

The study examined both federal and state equipment rate schedules, analyzing practices across departments like the Federal Highway Administration (FHWA) and various state departments of transportation. A tailored Illinois model, along with a digital tool, was created to enhance rate transparency, improve cost-estimation accuracy, and support contractor negotiations, all while aiming to reduce costs and administrative workload. This project delivered a practical, sustainable approach for IDOT, aligning with both its financial and operational objectives. The model for calculating hourly equipment rates involves estimating ownership costs, such as depreciation and overhead, alongside operating expenses like fuel, labor, and maintenance. Key data points included equipment purchase cost, operational hours, and economic lifespan, adjusted to Illinois' tax rates and market conditions. To keep rates in step with changing economic factors like inflation, fuel prices, and labor costs, the model incorporated regular updates.

The project also proposed an annual update mechanism to ensure equipment costs dynamically reflect documented inflation and market shifts. With this model, IDOT gained a transparent, flexible tool that improved cost precision and reduced administrative expenses, while meeting state-specific requirements. The report provided a comprehensive framework for rate scheduling that not only met IDOT's goals, but also established a new standard for equipment cost estimation in the industry.

Additionally, the project developed a user-friendly, web-based application to facilitate equipment data management for IDOT. The "Equipment Rental App User Manual" offered a detailed guide for an application designed to streamline equipment rental scheduling, allowing IDOT to efficiently manage, update, and analyze equipment and contractor data. The app included two primary user roles—admin and general user—each with designated functions, such as data editing for admins and data viewing for general users. Core features of the app included data authentication, equipment filtering, and cost calculations. Admin users could access advanced options, such as updating equipment details, modifying fuel and labor rates, and generating the next year's data updates. The app's export feature also allowed for selected equipment data to be compiled in Excel for easier reporting. Built with Angular, Node.js, Express.js, and MongoDB, the application was designed for scalability and secure data management, with authentication protocols to safeguard data and a distinct front-end/back-end structure to ensure smooth deployment and database interactions. This tool provided IDOT with an efficient, modernized solution for rental data management, reducing reliance on external services and increasing operational transparency.

CHAPTER 2: LITERATURE REVIEW

This chapter provides a literature review on equipment rate schedules at the federal and state levels, Illinois' current practices, and a roadmap for establishing a customized equipment rate schedule in Illinois. At the federal level, this chapter reviews federal guidelines from agencies such as the Federal Highway Administration, Federal Emergency Management Agency, General Services Administration, Department of Defense, and U.S. Army Corps of Engineers. Each agency uses specific formulas and criteria to establish fair and transparent rates, with some offering custom rates for applicant-owned equipment. At the state level, most states utilize the EquipmentWatch *Rental Rate Blue Book*, a subscription-based resource, to determine equipment rental rates. However, states implement customized adjustments, such as regional and model-year adjustments, to align the rates with local economic conditions. Only California diverges by using a proprietary rate calculator. The report details the formula variations across states and shows how hourly and standby rates are calculated based on these adjustments.

The current practice in Illinois relies on the EquipmentWatch blue book, using the FHWA hourly rate for contractor-owned equipment. IDOT adds adjustments for Illinois' regional and model-year factors but faces challenges with high subscription costs and limited access for small contractors. This practice has led to difficulties in rate approval processes and customization for newly acquired equipment, affecting contractors' efficiency and costing them time. This chapter developed a roadmap to create an Illinois-specific equipment rate schedule, which concludes with a step-by-step process to develop a dedicated rate schedule for Illinois.

EQUIPMENT RATE SCHEDULE AT FEDERAL LEVEL

The Federal Highway Administration plays a key role in regulating equipment rates for federally funded transportation projects. FHWA regulations aim to standardize equipment rate schedules, ensuring consistency and fairness in project procurement.

FHWA regulations and guidelines typically cover the following aspects (Federal Highway Administration, 1986):

- FHWA requires standardized documentation for equipment rates that include factors such as equipment type, operating costs, ownership costs, and labor rates. It also emphasizes the importance of reasonable rates that should be actual and justifiable costs incurred in equipment operation and should not be excessive. FHWA regulations provide guidelines on how to calculate operating costs, ownership costs, labor costs, and depreciation. It also stipulates that the equipment rates must be reviewed and updated over a certain period to reflect changes in costs and market conditions. FHWA also covers regulations on audit and compliance to ensure that the rates are accurate and consistent with federal standards.
- FHWA provides regulations on standby equipment rates, contractor-leased equipment, and mobilization. Standby rates should not exceed 8 hours per day and 40 hours per week or the annual usage hours as established by rate guides and for contractor-leased equipment operating costs such as fuel, lubrication, field repairs, etc. should be reimbursed. The costs

required to mobilize or demobilize equipment not incurred by contractors are also eligible for reimbursement.

- FHWA determined that when the blue book is used to calculate equipment rental costs for less than one month, the best approach is to utilize an hourly rate developed by dividing the blue book monthly rate by 176.

Federal Emergency Management Agency

The Federal Emergency Management Agency (FEMA) uses their own equipment rental schedule, which is used for determining the cost of equipment and services used during federally declared emergencies and disasters, ensuring fair reimbursement. FEMA provides equipment rates only for applicant-owned equipment in good mechanical condition, complete with all required attachments. FEMA also provides rates that are not included in the schedule upon request. The rates provided by FEMA do not include labor costs and should be approved upon request separately from equipment costs. FEMA updates their equipment schedule every two years. The current schedule is for 2023 (FEMA, 2023).

FEMA relies on established industry standards and data sources to determine equipment rates for various types of equipment and services used in disaster response and recovery efforts. In addition, they use their own methodology for determining the cost of large construction projects.

General Services Administration

The General Services Administration (GSA, 2023) uses its Multiple Award Schedules (MAS) program for the creation and application of equipment rental schedules. Federal agencies can use GSA's MAS program, a government-wide contracting vehicle, to acquire a range of goods and services, including equipment rental services.

As part of its MAS program, GSA creates and manages equipment rental schedules. Usually, a competitive acquisition process is used to create these schedules, where vendor qualification takes place. Then, interested vendors who want to participate in GSA's equipment rental schedules must undergo a qualification process, and GSA negotiates contracts with selected equipment rental vendors and awards contracts to the vendors. Once contracts are awarded, GSA establishes equipment rental schedules that include a list of equipment and services offered by vendors. These schedules are made available to federal agencies for use in their procurement activities. Federal agencies seeking equipment rental services can use GSA's equipment rental schedules to procure equipment in a streamlined and efficient manner. GSA reviews and updates its equipment rental schedules regularly to ensure they remain relevant and competitive.

GSA currently has nine contractors that provide equipment rentals and are accessible through their website.

Department of Defense

The Department of Defense (DoD, 2022) uses equipment rental schedules for a variety of military and construction needs as part of its intricate and varied procurement procedures. The DoD determines

and uses equipment rental schedules through a methodical process that includes preparation, competitive procurement, and adherence to federal regulations. The DoD provides reimbursable rates for fixed wing aircraft and helicopters and updates the rate every year.

US Army Corps of Engineers

The US Army Corps of Engineers (USACE) establishes and applies an equipment rate schedule to enable effective equipment acquisition and use for a range of civil and military engineering projects. USACE provides Engineering Pamphlet 1110-1-8 (Construction Equipment Ownership and Operating Expense Schedule) and shows a method to calculate equipment ownership and operating expense rates for construction equipment when predetermined rates are not appropriate. USACE last published the pamphlet on August 12, 2021 (USACE, 2021).

USACE provides rates for 12 different regions and provides the following items for every region:

- Hourly equipment ownership and operating expense.
- Equipment age adjustment factors for ownership cost.
- Equipment age adjustment factors for standby cost.
- Local area factors.

EQUIPMENT RATE SCHEDULE AT STATE LEVEL

All states except California follow their department of transportation policies for equipment rate schedules. Every state has their own schedule of equipment rates and specifications. This section lists nine states in detail and summarizes states other than Illinois in Table 1.

Alabama

In Alabama, for rental rates of equipment (other than small tools) authorized by the engineer for use on force account work, the engineer uses the latest publication of the EquipmentWatch *Cost Recovery Guide* (formerly *Rental Rate Blue Book*) to determine payment to the contractor. Payment is made for the actual time that the authorized equipment is in operation on the force account work, including travel time to and from the jobsite, when that travel is specifically for the purpose of accomplishing force account work.

Rate calculation: The hourly rate for each piece of equipment is the monthly rate shown in the equipment table divided by 176 (Alabama Department of Transportation, 2016).

Alaska

The Alaska specifications on how to compensate for extra work are provided in section 109 on page 103 of Jeffers (2020). Figure 1 provides the rate calculation:

$$Reimbursement\ Rate = \frac{(Monthly\ Ownership \times Regional\ Adjustment_{Alaska} \times Model\ Year\ Adjustment)}{176} \times 1.00 + Hourly\ Operating \times 1.00$$

Figure 1. Equation. Alaska reimbursement rate calculation.

Source: EquipmentWatch (n.d.an)

Figure 2 displays the standby use formula:

$$Standby\ Rate = \frac{(Monthly\ Ownership \times Regional\ Adjustment_{Alaska} \times Model\ Year\ Adjustment)}{176} \times 0.50$$

Figure 2. Equation. Alaska standby calculation.

Source: EquipmentWatch (n.d.an)

Arizona

In Arizona, equipment that the engineer considers necessary for the performance of work is eligible for payment at the established rates only during the hours it is operated except as otherwise allowed in their specifications (Arizona Department of Transportation, 2021). Equipment hours are recorded to the nearest half hour. For the use of equipment owned by the contractor and approved by the engineer, the contractor is paid the rental rates, as modified herein, set forth in the EquipmentWatch *Rental Rate Blue Book* for construction equipment (Arizona Department of Transportation, 2021). All rate determinations are based on the blue book rental rate chapter revisions that are applicable at the time the equipment is used. Figure 3 displays the rate used for reimbursement:

$$Reimbursement\ Rate = \frac{(Monthly\ Ownership \times 0.993 \times 1.00)}{176} \times 1.15 + Hourly\ Operating \times 1.00$$

Figure 3. Equation. Arizona reimbursement rate calculation.

Source: EquipmentWatch (n.d.ao)

Figure 4 presents the standby use formula:

$$Standby\ Rate = \frac{(Monthly\ Ownership \times 0.993 \times 1.00)}{176} \times 0.50$$

Figure 4. Equation. Arizona standby calculation.

Source: EquipmentWatch (n.d.ao)

Arkansas

In Arkansas, for any contractor-owned machinery or special equipment (other than small tools) that has been authorized by the engineer, the contractor shall receive the rental rates specified in the change order authorizing the work. The hourly rental rates shall be determined from the applicable monthly schedule in the current edition of the EquipmentWatch *Rental Rate Blue Book* for construction equipment (Arkansas Department of Transportation, 2018). EquipmentWatch (n.d.a) also provides the calculation of the cost recovery rates. Figure 5 presents the rate used for reimbursement:

$$Reimbursement\ Rate = \frac{(Monthly\ Ownership \times Regional\ Adjustment_{Arkansas} \times Model\ Year\ Adjustment)}{176} \times 1.00 + Hourly\ Operating \times 1.00$$

Figure 5. Equation. Arkansas reimbursement rate calculation.

Source: EquipmentWatch (n.d.a)

Figure 6 displays the standby use formula:

$$Standby\ Rate = \frac{(Monthly\ Ownership \times Regional\ Adjustment_{Arkansas} \times Model\ Year\ Adjustment)}{176} \times 0.50$$

Figure 6. Equation. Arkansas standby calculation.

Source: EquipmentWatch (n.d.a)

California

The state of California has their own standard specifications as well as a rental rate calculator that determines the approximate reimbursement rate for equipment used during extra work (California Department of Transportation, n.d.). Compensation for work paid by force account is the total of the direct equipment costs (rental rate) plus a 15% markup for all overhead not included as direct costs. The direct costs include fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs and maintenance, depreciation, storage, cost of facilities capital, overhaul, and all incidentals. The labor costs required to provide the above listed items are also included. The operator cost is not included in the equipment rate. The calculated rate represents the cost of owning and operating the equipment, which is likely to be lower than the rate charged by a rental yard. The rental yard rate may include additional overhead and profit as well as a premium for short-term rentals. In certain situations, factors are applied to the calculated rates to provide ownership-only rates for delay situations or operating-only rates for overtime situations. The rates are calculated using factors for the direct cost items described above. The factors represent an average and are applied to all makes and models of equipment within the class.

Colorado

In Colorado, the contractor will be compensated according to the provisions outlined below for the use of any machinery or equipment approved by the engineer, which is owned or leased by the contractor, subcontractors, or any related entities, including divisions, affiliates, subsidiaries, or parent companies. Rental rates will be based on the latest edition of the *Rental Rate Blue Book* for construction equipment (Colorado Department of Transportation, 2021). Figure 7 illustrates the applicable reimbursement rate:

$$Reimbursement\ Rate = \frac{(Monthly\ Ownership\ \times\ 1.06\ \times\ Model\ Year\ Adjustment)}{176} \times\ 1.00) + Hourly\ Operating\ \times\ 1.00$$

Figure 7. Equation. Colorado reimbursement rate calculation.

Source: EquipmentWatch (n.d.ap)

Figure 8 presents the standby use formula:

$$Standby\ Rate\ = \frac{(Monthly\ Ownership\ \times\ 1.06\ \times\ Model\ Year\ Adjustment)}{176}\ \times\ 0.50$$

Figure 8. Equation. Colorado standby calculation.

Source: EquipmentWatch (n.d.ap)

Connecticut

The Connecticut Department of Transportation will pay the contractor the applicable rental rate set forth in the *Rental Rate Blue Book* for any equipment (1) that the contractor uses, with the engineer's authorization, to perform cost-plus project work, and (2) that is owned by the contractor or a subsidiary, affiliate, or parent company of the contractor (no matter how far up or down the chain of ownership from the contractor). The Connecticut Department of Transportation (2017) outlines construction specifications for roads, bridges, and facilities, while EquipmentWatch (n.d.s) provides formulas for calculating cost recovery rates. Figure 9 presents the rate used for reimbursement:

$$Reimbursement\ Rate = \frac{(Monthly\ Ownership\ \times\ Regional\ Adjustment_{Connecticut}\ \times\ Model\ Year\ Adjustment)}{176} \times\ 1.00\ +\ Hourly\ Operating\ \times\ 1.00$$

Figure 9. Equation. Connecticut reimbursement rate calculation.

Source: EquipmentWatch (n.d.s)

Figure 10 displays the standby use formula:

$$Standby\ Rate = \frac{(Monthly\ Ownership \times Regional\ Adjustment_{Connecticut} \times Model\ Year\ Adjustment)}{176} \times 0.50$$

Figure 10. Equation. Connecticut standby calculation.

Source: EquipmentWatch (n.d.s)

Delaware

The Delaware Department of Transportation (DDOT, 2022) reports standard specifications for road and bridge construction, and EquipmentWatch (n.d.aj) provides formulas for calculating cost recovery rates. DDOT uses EquipmentWatch's blue book for reimbursement. There are certain rules that show how a contractor is paid and how to use the blue book. Some of the rules are listed below from the DDOT specifications:

- Determine the hourly rate by dividing the monthly rate by 176. Do not use the weekly, hourly, or daily rates.
- DDOT will pay for the number of hours that the equipment or plant is used to perform the changed work.
- DDOT will not pay for more than 176 hours per calendar month.
- Use the current edition of the blue book to establish the rates. The applicable current edition is the one that is current as of the first day of work performed on the change. That rate applies throughout the time it takes to perform the changed work.
- Make the area adjustment.
- Make the equipment life adjustment in accordance with the blue book rate adjustment tables.
- Charge the same rate for equipment used on overtime as charged for regular hours.
- Use the blue book operating rate for each hour the equipment or plant was in operation for the change. The blue book operating rate does not apply to idle time regardless of the cause.
- DDOT will not compensate the contractor for equipment idle time unless the equipment is held on the project site at the engineer's written request.

Figure 11 presents the rate used for reimbursement:

$$Reimbursement\ Rate = \frac{(Monthly\ Ownership \times Regional\ Adjustment_{Delaware} \times Model\ Year\ Adjustment)}{176} + Hourly\ Operating \times 1.00$$

Figure 11. Equation. Delaware reimbursement rate calculation.

Source: EquipmentWatch (n.d.aj)

Figure 12 displays the standby use formula:

$$Standby\ Rate = \frac{(Monthly\ Ownership\ \times\ Regional\ Adjustment_{Delaware})\ \times\ Model\ Year\ Adjustment)}{176} \times\ 0.50$$

Figure 12. Equation. Delaware standby calculation.

Source: EquipmentWatch (n.d.aj)

Florida

Florida uses the *Rental Rate Blue Book* for force account (Florida Department of Transportation, 2022). EquipmentWatch (n.d.ak) provides formulas for calculating cost recovery rates. Figure 13 displays the rate used for reimbursement:

$$Reimbursement\ Rate = \frac{(Monthly\ Ownership\ \times\ Regional\ Adjustment_{Florida}\ \times\ Model\ Year\ Adjustment)}{176} \times\ 1.00\ +\ Hourly\ Operating\ \times\ 1.00)$$

Figure 13. Equation. Florida reimbursement rate calculation.

Source: EquipmentWatch (n.d.ak)

Figure 14 presents the standby use formula:

$$Standby\ Rate = \frac{(Monthly\ Ownership\ \times\ Regional\ Adjustment_{Florida})\ \times\ Model\ Year\ Adjustment)}{176} \times\ 0.50$$

Figure 14. Equation. Florida standby calculation.

Source: EquipmentWatch (n.d.ak)

Other States

Similarly, every state except California uses EquipmentWatch's *Rental Rate Blue Book*. Table 1 shows the EquipmentWatch publication, rate calculation, standby rate, and specifications for states other than Illinois.

Table 1. Equipment Rate Schedule at State Level

State	EquipmentWatch	Calculation	Specifications
Georgia	EquipmentWatch (n.d.af)	Rate used for reimbursement: ((Monthly Ownership × Regional Adjustment, Georgia × Model Year Adjustment)/176 × 0.70) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Georgia × Model Year Adjustment)/176) × 0.35	Georgia Department of Transportation (2021)
Hawaii	EquipmentWatch (n.d.m)	Rate used for reimbursement: ((Monthly Ownership × Regional Adjustment, Hawaii × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Hawaii × Model Year Adjustment)/176) × 0.50	Hawaii Department of Transportation (2005)
Idaho	EquipmentWatch (n.d.v)	Rate used for reimbursement: ((Monthly Ownership × Regional Adjustment, Idaho × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Idaho × Model Year Adjustment)/176) × 0.50	Idaho Transportation Department (2018a)
Indiana	EquipmentWatch. (n.d.b)	Rate used for reimbursement: ((Monthly Ownership × Regional Adjustment, Indiana × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Indiana × Model Year Adjustment)/176) × 0.50	Indiana Department of Transportation (2018)
Iowa	EquipmentWatch (n.d.aq)	Rate used for reimbursement: ((Monthly Ownership × Regional Adjustment, Iowa × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00)	Iowa Department of Transportation (2022, 2023)

State	EquipmentWatch	Calculation	Specifications
Kansas	EquipmentWatch (n.d.q)	Rate used for reimbursement: ((Monthly Ownership × Regional Adjustment, Kansas × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Kansas × Model Year Adjustment)/176) × 0.50	Kansas Department of Transportation (2015)
Kentucky	EquipmentWatch (n.d.z)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Kentucky × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Kentucky × Model Year Adjustment)/176) × 0.50	Kentucky Transportation Cabinet (2019)
Louisiana	EquipmentWatch (n.d.t)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Louisiana × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Louisiana × Model Year Adjustment)/176) × 0.50	Louisiana Department of Transportation and Development (2016)
Maine	EquipmentWatch (n.d.ac)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Maine × Model Year Adjustment) / 176) + (Operator Payroll Rate* × 90%) + Hourly Operating Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Maine × Model Year Adjustment)/176) × 0.70	Maine Department of Transportation (2020, 2022)
Maryland	EquipmentWatch (n.d.al)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Maryland × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Maryland × Model Year Adjustment)/176) × .50	Maryland Department of Transportation State Highway Administration (2022a,b)

State	EquipmentWatch	Calculation	Specifications
Massachusetts	EquipmentWatch is used to determine the rates as per FHWA	Rate Used for Reimbursement: Hourly equipment rates shall be the FHWA rate supplied by EquipmentWatch. Adjusted FHWA rate is used. Standby Use Formula: (Adjusted FHWA Rate – Estimated Operating Rate)/2	Commonwealth of Massachusetts Department of Transportation (2020); Massachusetts Department of Transportation (2024)
Michigan	EquipmentWatch (n.d.c)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Michigan × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Michigan × Model Year Adjustment)/176) × 0.50	Michigan Department of Transportation (2022)
Minnesota	EquipmentWatch (n.d.d)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Minnesota × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Minnesota × Model Year Adjustment)/176) × 0.50	Minnesota Department of Transportation (2020)
Mississippi	EquipmentWatch (n.d.u)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Mississippi × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Mississippi × Model Year Adjustment)/176) × 0.50	Mississippi Department of Transportation (2017, 2019)
Missouri	EquipmentWatch (n.d.ag)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Missouri × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Missouri × Model Year Adjustment)/176) × .50	Missouri Highway and Transportation Commission (2021)

State	EquipmentWatch	Calculation	Specifications
Montana	EquipmentWatch (n.d.ad)	Rate Used for Reimbursement: FHWA ((Monthly Ownership × Regional Adjustment, Montana × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Montana × Model Year Adjustment)/176) × .50	Montana Department of Transportation (2020)
Nebraska	EquipmentWatch (n.d.e)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Nebraska × Model Year Adjustment)/176 × 1.15) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Nebraska × Model Year Adjustment)/176) × .50	Nebraska Department of Transportation (2023)
Nevada	EquipmentWatch (n.d.o)	Rate Used for Reimbursement: ((Monthly Ownership × 1.05 × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × 1.05 × Model Year Adjustment)/176) × .50	Nevada Department of Transportation (2014)
New Hampshire	EquipmentWatch (n.d.f)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, New Hampshire × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, New Hampshire × Model Year Adjustment)/176) × .50	New Hampshire Department of Transportation (2016)
New Jersey	EquipmentWatch (n.d.aa)	Rate Used for Reimbursement: ((Monthly Ownership × 1.00 × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × 1.00 × Model Year Adjustment)/176) × .50	New Jersey Department of Transportation (2019)

State	EquipmentWatch	Calculation	Specifications
New Mexico	EquipmentWatch (n.d.g)	Rate Used for Reimbursement: ((Monthly Ownership × 1.00 × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × 1.00 × Model Year Adjustment)/176) × .50	New Mexico Department of Transportation (n.d.)
New York	EquipmentWatch (n.d.h)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, New York × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, New York × Model Year Adjustment)/176) × .50	New York State Department of Transportation (2006, 2024)
North Carolina	EquipmentWatch (n.d.w)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, North Carolina × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, North Carolina × Model Year Adjustment)/176) × .50	North Carolina Department of Transportation (2018)
North Dakota	EquipmentWatch (n.d.i)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, North Dakota × Model Year Adjustment)/176 × .70) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, North Dakota × Model Year Adjustment)/176) × .50	North Dakota Department of Transportation (2025)
Ohio	EquipmentWatch (n.d.j)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Ohio × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Ohio × Model Year Adjustment)/176) × .50	Ohio Department of Transportation (2024)

State	EquipmentWatch	Calculation	Specifications
Oklahoma	EquipmentWatch (n.d.ab)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Oklahoma × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Oklahoma × Model Year Adjustment)/176) × .50	Oklahoma Department of Transportation (2019)
Oregon	EquipmentWatch (n.d.ah)	Rate Used for Reimbursement: ((Monthly Ownership × 1.00 × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × 1.00 × Model Year Adjustment)/176) × .50	Oregon Department of Transportation (2021)
Pennsylvania	EquipmentWatch (n.d.ae)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Pennsylvania × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Pennsylvania × Model Year Adjustment)/176) × .50	Pennsylvania Department of Transportation (2020)
Rhode Island	EquipmentWatch (n.d.x)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Rhode Island × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Rhode Island × Model Year Adjustment)/176) × .50	Rhode Island Department of Transportation (2018)
South Carolina	EquipmentWatch (n.d.n)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, South Carolina × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, South Carolina × Model Year Adjustment)/176) × .50	South Carolina Department of Transportation (2007)

State	EquipmentWatch	Calculation	Specifications
South Dakota	EquipmentWatch (n.d.r)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, South Dakota × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, South Dakota × Model Year Adjustment)/176) × .50	South Dakota Department of Transportation (2015)
Tennessee	EquipmentWatch (n.d.ai)	Rate Used for Reimbursement: ((Monthly Ownership x Regional Adjustment, Tennessee × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Tennessee × Model Year Adjustment)/176) × .50	Tennessee Department of Transportation (2021)
Texas	EquipmentWatch (n.d.p)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Texas × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Texas × Model Year Adjustment)/176) × .50	Texas Department of Transportation (2014)
Utah	EquipmentWatch (n.d.am)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Utah × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Utah × Model Year Adjustment)/176) × .50	Utah Department of Transportation (2022)
Vermont	EquipmentWatch (n.d.y)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Vermont × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Vermont × Model Year Adjustment)/176) × .50	Vermont Agency of Transportation (2018)

State	EquipmentWatch	Calculation	Specifications
Virginia	EquipmentWatch (n.d.k)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Virginia × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Virginia × Model Year Adjustment)/176) × .50	Virginia Department of Transportation (n.d.)
Washington	EquipmentWatch (n.d.l)	Rate Used for Reimbursement: ((Monthly Ownership × Regional Adjustment, Washington × Model Year Adjustment)/176 × 1.00) + (Hourly Operating × 1.00) Standby Use Formula: ((Monthly Ownership × Regional Adjustment, Washington × Model Year Adjustment)/176) × .50	Washington State Department of Transportation (n.d.)

EQUIPMENT RATE IN ILLINOIS

Policies Set by IDOT While Determining Equipment Rates

IDOT's *Construction Memorandum 09* (Kell, 2021) outlines the following policies to determine equipment rates.

Equipment Owned by Contractor

Equipment Already on Jobsite

The time paid for shall be the period that the equipment is in operation on the force account work. It should include traveling time to the locations of the force account work when the equipment is moved under its own power. (Loading and transportation costs will be allowed when equipment is moved through a means rather than its own power.)

Equipment Not Already on Jobsite

This policy is the same as equipment already on the jobsite except that the minimum total operating time paid for on the work shall be not less than four hours. The hourly rates for contractor-owned equipment are determined from the EquipmentWatch *Rental Rate Blue Book*. The blue book is available via subscription only to select district implementation support staff as well as district estimators.

- The blue book will be used in the following manner:
    - Determine the hourly rate using the FHWA hourly rate. The monthly, weekly, daily, or hourly rates will not be used.
    - Use the current revisions in establishing rates. The current revision applicable to specific force account work is as of the first day of work performed on that force account work and that rate applies throughout the period the force account work is performed.
    - Make the regional adjustment for Illinois as well as model year adjustment. No user-defined adjustments will be made.
    - Use the estimated operating costs per hour, included in the FHWA hourly rate, for each hour that the equipment is in operation on the force account work. Such costs do not apply to idle time regardless of the cause.
    - The rates established above include the cost of fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs, overhaul and maintenance of any kind, depreciation, storage, overhead, profits, insurance, and all incidentals. No additional compensation will be allowed for normal operating expenses. The rates do not include labor.
    - The contractor may submit Form BC 2370: Equipment Expense Rate Data Sheet to the engineer with sufficient information for each piece of equipment and its attachments to

enable the engineer to verify the rental rate. As a preferred option, the contractor may submit a copy of the printable report from the blue book. All equipment shall, in the opinion of the engineer, be in good operating condition. Equipment used by the contractor shall be described specifically and be of a suitable size and capacity required for the work to be performed.

  - Standby time for equipment beyond the end of the shift when the delay occurred will not be paid for, except where the equipment has been held on the jobsite on a standby basis at the request of the engineer. Such payment will be made based upon 0.5 × (FHWA Hourly Rate adjusted for Model Year and Region − Estimated Operating Costs).

- For equipment rates that are not listed but are available upon request from the blue book, contractors with a subscription to the blue book can obtain a custom rate from EquipmentWatch. Alternatively, the contractor may submit a fully completed Form BC 2370. Form BC 2370 information can be forwarded, by support staff, to EquipmentWatch for a rate determination.

- Individual pieces of equipment not listed in Attachment 1 of the memorandum (Kell, 2021) and having a replacement value of $1,000 or less shall be considered tools or small equipment and no payment will be made for their use on the work. Compensation will be allowed for the actual cost of consumables (oxygen, acetylene, propane, etc.) used by small tools.

Equipment Rented by Contractor

Whenever it is necessary for the contractor to rent equipment elsewhere, they shall pay the rental and transportation costs of such equipment to which 5% shall be added. The rental rates may not exceed those allowable for equipment owned by the contractor unless first approved in writing by the engineer before the work is started. In no case shall the rental rates exceed those of established distributors or equipment rental agencies.

When the contractor rents equipment from a related party and that equipment was used in the determination of the contractor's prequalification ratings, the contractor shall be paid per above regardless of the rental agreement between the contractor and the related party.

Survey of EquipmentWatch Blue Book

To evaluate the use of EquipmentWatch's *Rental Rate Blue Book* among Illinois contractors, a structured survey and follow-up interviews were conducted. A total of seven contractors were invited to participate, with three completing the survey. In addition, six IDOT staff also attended the interview. The survey was administered online via email in April 2023, followed by semi-structured interviews conducted via Zoom during August 2022 and June 2023.

The survey questionnaire included both open-ended and closed-ended questions aimed at identifying issues, challenges, and benefits experienced by contractors using the *Rental Rate Blue Book*. Key questions asked were:

1. How often do you use EquipmentWatch's *Rental Rate Blue Book* annually?
2. Which specific challenges have you encountered when using the Blue Book?
3. How frequently is your proposed rental rate rejected by IDOT, and under what circumstances?
4. How accessible do you find prior rates within the Blue Book for matching historical rates?
5. Describe your experience with obtaining custom rates from EquipmentWatch.
6. Have you encountered issues with regional engineer approvals, and if so, what were these issues?
7. What specific improvements would you recommend for the Blue Book system?
8. What benefits do you perceive in using EquipmentWatch's *Rental Rate Blue Book*?

After the survey was conducted, we found that in the past, contractors encountered challenges during extra work due to the unavailability of established equipment rates, particularly when utilizing newly acquired machinery, which resulted in a delay of 3–6 months for the approval process.

The problems mentioned by Illinois contractors and IDOT staff in the interviews are listed below:

- IDOT has been using the blue book for the past decade. The subscription is very expensive for small contractors, and they may use the blue book only a few times a year, depending on the contracts they receive. Most equipment used by contractors is not available in the blue book.
- Contractors must find equipment of similar specifications to what is already present in the blue book and adjust the rate approximately.
- The approximate rate provided by the contractors may sometimes get rejected by IDOT.
- EquipmentWatch's *Rental Rate Blue Book* does not let users see the prior rates to match the exact rate when the extra work was done.
- The blue book does not allow users to build and save lists of equipment that the contractors have, and they may lose a lot of time while searching for equipment.
- Obtaining custom rates from EquipmentWatch is a time-consuming process that may take months.
- Dealing with EquipmentWatch's rental rate is very difficult. To get the rates compensated, contractors first need the approval of a regional engineer. The regional engineer does not provide approval before approval by EquipmentWatch, which, again, is a difficult task.

- Contractors must create multiple accounts for different types of work involved, and it cannot be done by using one account.

Advantages mentioned by Illinois contractors and IDOT staff for using EquipmentWatch's rental rate include:

- EquipmentWatch's *Rental Rate Blue Book* is universally accepted.
- It can provide custom rates.

ROADMAP TO CREATE EQUIPMENT RATE SCHEDULE IN ILLINOIS

This section provides a roadmap to create an equipment rate schedule in Illinois.

1. Define Scope and Objectives:
    - Clearly outline the scope of equipment to be covered in the rate schedule.
    - Define the objectives of the equipment rate schedule, such as ensuring accuracy, easy access to the contractors, custom rates, and low cost.
2. Identify Equipment:
    - List all types of equipment commonly used in construction projects within Illinois.
    - Categorize equipment based on type, size, and functionality.
3. Gather Industry Data:
    - Research industry standards, guidelines, and practices related to equipment rates.
    - Identify benchmarks from reputable sources or industry associations.
4. Determine Usage Factors:
    - Consider factors that influence equipment usage rates, such as hours of operation, project duration, and seasonal variations.
5. Collect Cost Data:
    - Gather cost data associated with each piece of equipment, including purchase price, maintenance costs, fuel consumption, and insurance.
6. Consider Local Factors:
    - Account for Illinois-specific factors, such as local taxes, insurance regulations, and labor costs.

7. Consult with Industry Experts:
    - Seek input from industry experts, contractors, and equipment rental companies operating in Illinois.
    - Consider collaborating with industry associations for valuable insights.
8. Legal and Regulatory Compliance:
    - Ensure that the rate schedule adheres to all relevant legal and regulatory requirements in Illinois.
9. Create a Rate Calculation Methodology:
    - Develop a transparent and consistent methodology for calculating equipment rates.
    - Consider using factors like depreciation, overhead costs, and profit margins.
10. Select Software and Hardware:
    - Choose appropriate software for managing and updating the rate schedule. This could be a database system or specialized software for equipment management.
    - Consider hardware requirements, such as servers or cloud-based solutions.
11. Data Management and Updates:
    - Establish a system for regularly updating the rate schedule to reflect changes in equipment costs, market conditions, and regulations.
12. Testing and Validation:
    - Conduct a pilot phase to test the rate schedule in real-world scenarios.
    - Validate the accuracy and competitiveness of the rates against industry benchmarks.
13. Documentation:
    - Document the methodology, data sources, and any assumptions made during the rate schedule development.
    - Create user guides for those who will be using the equipment rate schedule website.
14. Training:
    - Provide training for users, including contractors, project managers, and other stakeholders who will interact with the rate schedule.

15. Implementation and Monitoring:
    - Implement the rate schedule and closely monitor its effectiveness.
    - Collect feedback and continuously refine the schedule based on real-world experiences.
16. Review and Update:
    - Regularly review and update the rate schedule to ensure it remains relevant and competitive.

CHAPTER 3: MODEL DEVELOPMENT FOR EQUIPMENT RATE SCHEDULING

INTRODUCTION

The research team developed an equipment rate schedule specifically for the state of Illinois based on IDOT's policies and requirements. The equipment rate schedule involves determining the hourly equipment ownership and operating costs for different types of construction and highway maintenance equipment. The equipment hourly cost structure is shown in Figure 15, illustrating the detailed cost breakdown used to calculate the hourly rates for construction and highway maintenance equipment. This comprehensive cost structure is designed to align with IDOT's regulations and policies, ensuring that equipment use in the state of Illinois is both cost-effective and compliant with standardized practices. The following sections provide a detailed explanation of each cost item.

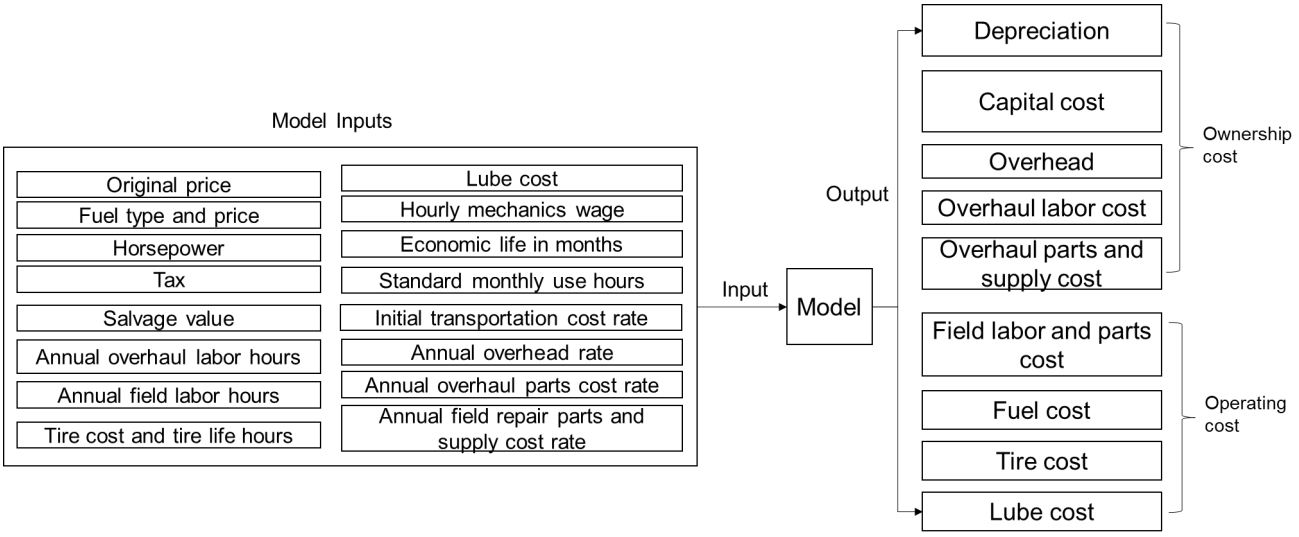


Figure 15. Diagram. Cost structure.

Source: University of Houston

MODEL INPUT PARAMETERS

This section introduces the definitions and descriptions of input parameters used in the equipment rental rate calculation model. These parameters include cost components, operational metrics, and financial rates essential for accurately estimating ownership and operational expenses associated with construction equipment. The parameters are defined clearly to ensure consistency and transparency in calculations. Additionally, intermediate variables derived from these parameters are presented, accompanied by their respective calculation methods and equations.

- P: Original Price

  The list price, alternatively referred to as the manufacturer's suggested retail price (MSRP), is the cost that the product's creator suggests for retail sales in stores accessible to consumers.

- F_{tax}: Factor for Sales Tax

  The sales tax calculation factor pertains to the mandatory fiscal contribution to state revenue, levied by the government at the point of sale (6.25% in Illinois).

- F_{SV}: Salvage Value Ratio

  The salvage value ratio represents the anticipated ratio of the value after full depreciation to the original price.

- CV: Current Value

  Current value refers to the estimated market value of a piece of equipment, at a given point in time. It represents the amount of money that could be obtained if the item were sold in its current condition.

- SMUH: Standard Monthly Usage Hours

  Standard monthly usage hours of equipment refers to the expected or typical number of hours that a piece of equipment is used in a month under normal operating conditions. This metric is often determined based on the equipment's purpose, industry standards, or historical usage data. It serves as a benchmark for estimating operating costs, maintenance schedules, and life cycle management, helping organizations understand the expected workload and plan for resource allocation accordingly.

- AOLH: Annual Overhaul Labor Hours

  Annual overhaul labor hours refer to the total amount of labor time required to perform a full overhaul or major maintenance on a piece of equipment or machinery over the course of a year. This includes all hours spent by technicians, mechanics, or service personnel to disassemble, inspect, repair, replace parts, and reassemble the equipment to restore it to optimal working condition.

- AFLH: Annual Field Labor Hours

  Annual field labor hours refer to the total number of hours spent by technicians, maintenance crews, or operators performing work on equipment at its operational location (i.e., the "field") throughout the year. These hours are accumulated through a variety of activities required to keep the equipment running efficiently, including repairs, troubleshooting, maintenance, and sometimes upgrades or modifications.

- TCR: Initial Transportation Cost Rate

  The initial transportation cost rate is determined by dividing the initial transportation costs by the original purchase price of the equipment. The initial transportation cost corresponds to the complete transportation cost from the factory to the owner's yard. All costs incurred during transportation should be accounted for in the ownership costs when calculating internal charge rates.

- AOR: Annual Overhead Rate

  The annual overhead rate is calculated by dividing the total annual overhead costs by the current resale value of the equipment. Overhead costs refer to the indirect costs associated with owning and operating equipment, including insurance, storage cost, financial cost, administrative cost, etc.

- AOPCR: Annual Overhaul Parts Cost Rate

  The annual overhaul parts cost rate is the ratio of overhaul parts cost to the original price. Overhaul parts cost refers to the expenses associated with replacing or refurbishing parts during an overhaul process. An overhaul is an extensive maintenance procedure that involves disassembling, inspecting, and repairing or replacing components to restore equipment to a like-new condition.

- AFSCR: Annual Field Repair Parts and Supply Parts Cost Rate

  The annual field repair parts and supply parts cost rate is the ratio of the cost of field repair parts and supply parts to the original price. The annual field repair parts cost refers to the annual expense associated with the parts needed for on-site or in-the-field repairs of equipment. Unlike repairs conducted in a workshop or facility, field repairs are performed directly at the location where the equipment is used, such as a construction site, farm, or remote operation area. Supply parts cost refers to the expense associated with procuring and stocking parts that are necessary to support the ongoing repair of equipment.

- AGECR: Annual Ground Engaging Component Rate

  The annual ground engaging component refers to the yearly cost or consideration of parts and equipment that come into direct contact with the ground during operation. These components are critical in industries such as construction, mining, agriculture, and other heavy equipment operation. The cost is also represented as a portion of the original price.

- ACCR: Annual Capital Cost Rate

  The capital cost rate, which is not the same as interest charges, addresses the cost of money invested, whether the machinery is purchased with cash or financed. The cost is also represented as a portion of the original price. In this model, we adopt a capital cost rate of 3%.

- LC: Hourly Lube Cost

  The lubrication cost per hour includes expenses related to oils, grease, coolants, and filters as well as labor and ancillary equipment involved in servicing.

- TNC: Cost of A New Set of Tires

  Replacement tire cost includes expenses related to the repair and/or replacement of tires, based on the current price of tires and average tire lifespan.

- TH: Tire Life Hours

  Tire life hours refers to the total number of operational hours a tire is expected to last before it needs replacement, based on its usage and wear conditions.

- MW: Mechanics Wage

  Mechanic's hourly wage refers to the hourly labor cost. This value can be adjusted to reflect local conditions. Based on Indeed (n.d.)'s data in 2023, the mechanics wage is $25.50/hour in Illinois.

- HP: Horsepower

  Engine power output, or horsepower (hp), is a measure of power, or the rate at which work is performed, typically in reference to the output of engines or motors.

- FP: Fuel Price

  Fuel price is the average cost of fuel in dollars per gallon. The cost can be found in American Automobile Association (n.d.).

- F_{Fuel}: Fuel consumption factor

  The fuel consumption factor is measured by consumed gallons of fuel per flywheel-horsepower-hour.

- EL: Economic Life in Months

  Economic life in months refers to the estimated period, expressed in months, during which an asset is expected to remain economically useful and cost-effective for its intended purpose under standard usage load and normal maintenance.

Based on the input parameters, the following intermediate variables can be calculated.

- SUR: Standard Usage Rate

  The equipment's standard usage rate is the expected or typical rate at which the equipment should be used over a given period. This rate reflects the equipment's designed capacity for productive operation without causing undue wear or accelerating deterioration. The rate can be determined by the number of standard monthly usage hours divided by 176 hours (monthly working hours), displayed in Figure 16.

$$SUR = \frac{SMUH}{176}$$

Figure 16. Equation. Usage rate.

Source: University of Houston

- TC: Initial Transportation Costs (Figure 17)

$$TC = TCR * P$$

Figure 17. Equation. Initial freight costs.

Source: University of Houston

- AO: Annual Overhead (Figure 18)

$$AO = AOR * CV$$

Figure 18. Equation. Annual overhead.

Source: University of Houston

- AOPC: Annual Overhaul Parts Cost (Figure 19)

$$AOPC = AOPCR * P$$

Figure 19. Equation. Annual overhaul parts cost.

Source: University of Houston

- AFSC: Annual Field Repair Parts and Supply Parts Cost (Figure 20)

$$AFSC = AFSCR * P$$

Figure 20. Equation. Annual field repair parts and supply parts cost.

Source: University of Houston

- AGEC: Annual Ground Engaging Component (Figure 21)

$$AGEC = AGECR * P$$

Figure 21. Equation. Annual ground engaging component.

Source: University of Houston

MODEL OUTPUTS

Ownership Costs

Ownership costs—including depreciation, overhead, capital expenses, and costs for overhaul labor, parts, and supplies—are first calculated annually and then adjusted to a monthly rate based on typical usage. This monthly rate is then divided to produce an hourly ownership rate. Specifically, the hourly rate is determined by dividing the monthly rate by 176, based on an average of 176 working hours per month. This average assumes a standard work schedule of 22 days per month, an 8-hour workday, and excludes weekends and holidays.

Ownership Costs Calculation

We use the straight-line method (Corporate Finance Institute, 2023) to calculate depreciation for equipment in regular use, displayed in Figure 22.

$$Annual\_Depreciation\_Expense = (Cost\_of\_the\_Asset - Salvage\_Value) \,/\, Useful\_Life\_of\_the\_Asset$$

Figure 22. Equation. Annual depreciation expense.

Source: Corporate Finance Institute (2023)

Depending on the type of equipment, the average salvage value at the end of the economic life can range from 10% to 35%. However, lower and higher values can be encountered, depending on the conditions of the equipment as well as the predominant market conditions.

We should use the final purchase price as *P* instead of the list price. The cost of sales tax (6.25% in Illinois) is part of the original purchase price and should be included as part of the final purchase price of the equipment (Illinois Department of Revenue, n.d.). In addition, initial transportation cost is also included in depreciable value. Thus, we get the monthly depreciation cost as

- Monthly Depreciation Cost, normalized to 176-hour usage (Figure 23)

$$Monthly\ Depreciation = \frac{\{P * (1 + F_{Tax})(1 - F_{SV}) + TC\}}{EL * SUR}$$

Figure 23. Equation. Monthly depreciation cost.

Source: University of Houston

- Monthly Capital Cost, normalized to 176-hour usage (Figure 24)

$$Monthly\ Capital\ Cost = \frac{(P * ACCR)}{SUR * 12}$$

Figure 24. Equation. Monthly capital cost.

Source: University of Houston

- Monthly Overhead Cost, normalized to 176-hour usage (Figure 25)

$$Monthly\ Overhead = \frac{AO}{SUR * 12}$$

Figure 25. Equation. Monthly overhead cost.

Source: University of Houston

- Monthly Overhaul Labor Cost, normalized to 176-hour usage (Figure 26)

$$Monthly\ Overhaul\ Labor\ Cost = \frac{AOLH * MW}{SUR * 12}$$

Figure 26. Equation. Monthly overhaul labor cost.

Source: University of Houston

- Monthly Overhaul Parts Cost, normalized to 176-hour usage (Figure 27)

$$Overhaul\ Parts\ Cost = \frac{AOPC}{SUR * 12}$$

Figure 27. Equation. Monthly overhaul parts cost.

Source: University of Houston

- Hourly Ownership Cost (Figure 28)

$$\begin{aligned} &Total\ Hourly\ Ownership\ Cost \\ &\quad = (Monthly\ Depreciation + Monthly\ Capital\ Cost + Monthly\ Overhead \\ &\quad + Monthly\ Overhaul\ Labor\ Cost + Monthly\ Overhaul\ Parts)/176 \end{aligned}$$

$$= \frac{\frac{\{P * (1 + F_{Tax})(1 - F_{SV}) + TC\}}{EL * SUR} + \frac{(P * ACCR)}{SUR * 12} + \frac{AO}{SUR * 12} + \frac{AOLH * MW}{SUR * 12} + \frac{AOPC}{SUR * 12}}{176}$$

Figure 28. Equation. Total hourly ownership cost.

Source: University of Houston

Operating Costs

The operating cost of equipment encompasses all expenses directly related to its day-to-day use and upkeep, ensuring the equipment remains functional and efficient throughout its operational life. A

primary component of operating costs is the fuel cost, which covers the expense of the fuel required to power the equipment and can fluctuate based on fuel prices and equipment workload. Another key component is the field labor and parts cost, which includes the expenses for routine maintenance, repairs, and any replacement parts needed to keep the equipment in optimal condition. This category also covers the labor costs of technicians performing these repairs. For mobile equipment, tire cost is significant, as tires or tracks wear out with extensive use and require periodic replacement to maintain safety and performance standards. Last, lube cost represents the expense of lubricants, oils, and other consumables necessary to reduce friction, prevent wear, and ensure smooth mechanical operation. Together, these operating costs offer a comprehensive view of the financial commitment required to maintain and operate equipment effectively on a daily basis. The following equations present the model to calculate operating cost.

Operating Costs Calculation

- Hourly Field Labor Cost (Figure 29)

$$Hourly\ Field\ Labor\ Cost = \frac{AFLH * MW}{SMUH * 12}$$

Figure 29. Equation. Hourly field labor cost.

Source: University of Houston

- Hourly Field Repair Parts and Supply Parts Cost (Figure 30)

$$Hourly\ Field\ Repair\ Parts\ and\ Supply\ Parts\ Cost = \frac{AFSC}{SMUH * 12}$$

Figure 30. Equation. Hourly field repair parts and supply parts cost.

Source: University of Houston

- Hourly Ground Engaging Component Cost (Figure 31)

$$Hourly\ Ground\ Engaging\ Component\ Cost = \frac{AGEC}{SMUH * 12}$$

Figure 31. Equation. Hourly ground engaging component cost.

Source: University of Houston

- Hourly Fuel Cost (Figure 32)

$$Hourly\ Fuel\ Cost = F_{Fuel} * HP * FP$$

Figure 32. Equation. Hourly fuel cost.

Source: University of Houston

- Hourly Tire Cost (Figure 33)

$$Hourly\ Tire\ Cost = \frac{TNC}{TH}$$

Figure 33. Equation. Hourly tire cost.

Source: University of Houston

- Total Hourly Operating Cost (Figure 34)

$$\begin{aligned} &Total\ Hourly\ Operating\ Cost \\ &\quad = Hourly\ Field\ Labor\ Cost + Hourly\ Field\ Repair\ Parts\ and\ Supply\ Parts\ Cost \\ &\quad + Hourly\ Ground\ Engaging\ Component\ Cost + Hourly\ Lube\ Cost \\ &\quad + Hourly\ Fuel\ Cost + Hourly\ Tire\ Cost \end{aligned}$$

$$= \frac{AFLH * MW}{SMUH * 12} + \frac{AFSC}{SMUH * 12} + \frac{AGEC}{SMUH * 12} + LC + F_{Fuel} * HP * FP + \frac{TNC}{TH}$$

Figure 34. Equation. Total hourly operating cost.

Source: University of Houston

Then the total hourly cost (FHWA rate) can be calculated by the equation in Figure 35:

$$FHWA\ rate\ = \frac{\frac{\{P * (1 + F_{Tax})(1 - F_{SV}) + TC\}}{EL * SUR} + \frac{(P * ACCR)}{SUR * 12} + \frac{AO}{SUR * 12} + \frac{AOLH * MW}{SUR * 12} + \frac{AOPC}{SUR * 12}}{176} + \frac{AFLH * MW}{SMUH * 12} + \frac{AFSC}{SMUH * 12} + \frac{AGEC}{SMUH * 12} + LC + F_{Fuel} * HP * FP + \frac{TNC}{TH}$$

Figure 35. Equation. FHWA rate calculation.

Source: University of Houston

The total standby rate can be calculated by the equation in Figure 36:

$$Standby\ rate = \frac{\frac{\{P * (1 + F_{Tax})(1 - F_{SV}) + TC\}}{EL * SUR} + \frac{(P * ACCR)}{SUR * 12} + \frac{AO}{SUR * 12} + \frac{AOLH * MW}{SUR * 12} + \frac{AOPC}{SUR * 12}}{176} * 0.5$$

Figure 36. Equation. Standby rate calculation.

Source: University of Houston

Model Implementation

This section provides an overview of the essential equipment for implementing the model for the purpose of interpretation, detailing each cost component's role in ensuring accurate and efficient performance.

Input Sample

Table 2 presents a sample of equipment input parameters.

Table 2. Input Sample Table

Equipment	Excavator
Fuel type	Diesel
Fuel unit price	4.17
Original price	78,715
Sales tax	0.0625
Salvage value	0.22
Standard monthly use hours	29
Economic life in months	196
Current value	59,920
Annual overhaul labor hours	45
Annual field labor hours	60
Fuel consumption factor	0.04
Cost of a new set of tires	0
Tire life hours	0
Hourly lube costs	1.5
Mechanics wage	25.5
Horsepower	50
Initial transportation cost rate	0.019
Annual overhead rate	0.048
Annual overhaul parts cost rate	0.052
Annual field repair parts and supply parts cost rate	0.053
Annual ground engaging component rate	0.0084

Output Sample Calculation

This section presents detailed, step-by-step calculations illustrating the determination of the ownership and operational costs for construction equipment. Each cost component is systematically broken down with equations and corresponding sample computations, clearly demonstrating how intermediate variables and final hourly rates are derived. The provided output sample (Table 3) summarizes these calculations for quick reference.

- SUR: Standard Usage Rate (Figure 37)

$$SUR = \frac{SMUH}{176} = \frac{29}{176} = 0.165$$

Figure 37. Equation. Output calculation for standard usage rate.

Source: University of Houston

- TC: Initial Transportation Costs (Figure 38)

$$TC = TCR * P = 0.019 * 78{,}715 = 1{,}946$$

Figure 38. Equation. Output calculation for initial freight costs.

Source: University of Houston

- AO: Annual Overhead (Figure 39)

$$AO = AOR * CV = 0.048 * 59{,}920 = 2{,}876$$

Figure 39. Equation. Output calculation for annual overhead.

Source: University of Houston

- AOPC: Annual Overhaul Parts Cost (Figure 40)

$$AOPC = AOPCR * P = 0.052 * 78{,}715 = 4{,}093$$

Figure 40. Equation. Output calculation for annual overhaul parts cost.

Source: University of Houston

- AFSC: Annual Field Repair Parts and Supply Parts Cost (Figure 41)

$$AFSC = AFSCR * P = 0.053 * 78{,}715 = 4{,}172$$

Figure 41. Equation. Output calculation for annual field repair parts and supply parts cost.

Source: University of Houston

- AGEC: Annual Ground Engaging Component (Figure 42)

$$AGEC = AGECR * P = 0.0084 * 78{,}715 = 661$$

Figure 42. Equation. Output calculation for annual ground engaging component.

Source: University of Houston

- Monthly Depreciation Cost (Figure 43)

$$Monthly\ Depreciation = \frac{\{P * (1 + F_{Tax})(1 - F_{SV}) + TC\}}{EL * SUR} = \frac{78{,}715 * (1 + 0.0625) * (1 - 0.22) + 1{,}946}{196 * 0.165} = 2{,}077$$

Figure 43. Equation. Output calculation for monthly depreciation cost.

Source: University of Houston

- Monthly Capital Cost (Figure 44)

$$Monthly\ Capital\ Cost = \frac{P * ACCR}{SUR * 12} = \frac{78{,}715 * 0.03}{0.165 * 12} = 1{,}193$$

Figure 44. Equation. Output calculation for monthly capital cost.

Source: University of Houston

- Monthly Overhead Cost (Figure 45)

$$Monthly\ Overhead = \frac{AO}{SUR * 12} = \frac{2876}{0.165 * 12} = 1{,}453$$

Figure 45. Equation. Output calculation for monthly overhead cost.

Source: University of Houston

- Monthly Overhaul Labor Cost (Figure 46)

$$Monthly\ Overhaul\ Labor\ Cost = \frac{AOLH * MW}{SUR * 12} = \frac{45 * 25.5}{0.165 * 12} = 580$$

Figure 46. Equation. Output calculation for monthly overhaul labor cost.

Source: University of Houston

- Monthly Overhaul Parts Cost (Figure 47)

$$Overhaul\ Parts\ Cost = \frac{AOPC}{SUR * 12} = \frac{4{,}093}{0.165 * 12} = 2{,}067$$

Figure 47. Equation. Output calculation for monthly overhaul parts cost.

Source: University of Houston

- Total Hourly Ownership Cost (Figure 48)

$$\begin{aligned} &Total\ Hourly\ Ownership\ Cost \\ &\quad = (Monthly\ Depreciation + Monthly\ Capital\ Cost + Monthly\ Overhead \\ &\quad + Monthly\ Overhaul\ Labor\ Cost + Monthly\ Overhaul\ Parts)/176 \\ &\quad = \frac{2{,}077 + 1{,}193 + 1{,}453 + 580 + 2{,}067}{176} = 41.88 \end{aligned}$$

Figure 48. Equation. Output calculation for total hourly ownership cost.

Source: University of Houston

- Hourly Field Labor Cost (Figure 49)

$$Hourly\ Field\ Labor\ Cost = \frac{AFLH * MW}{SMUH * 12} = \frac{60 * 25.5}{29 * 12} = 4.40$$

Figure 49. Equation. Output calculation for hourly field labor cost.

Source: University of Houston

- Hourly Field Repair Parts and Supply Parts Cost (Figure 50)

$$Hourly\ Field\ Repair\ Parts\ and\ Supply\ Parts\ Cost = \frac{AFSC}{SMUH * 12} = \frac{4{,}172}{29 * 12} = 11.99$$

Figure 50. Equation. Output calculation for hourly field repair parts and supply parts cost.

Source: University of Houston

- Hourly Ground Engaging Component Cost (Figure 51)

$$Hourly\ Ground\ Engaging\ Component\ Cost = \frac{AGEC}{SMUH * 12} = \frac{661}{29 * 12} = 1.90$$

Figure 51. Equation. Output calculation for hourly ground engaging component cost.

Source: University of Houston

- Hourly Fuel Cost (Figure 52)

$$Hourly\ Fuel\ Cost = F_{Fuel} * HP * FP = 0.04 * 50 * 4.17 = 8.34$$

Figure 52. Equation. Output calculation for hourly fuel cost.

Source: University of Houston

- Hourly Tire Cost (Figure 53)

$$Hourly\ Tire\ Cost = \frac{TNC}{TH} = 0$$

Figure 53. Equation. Output calculation for hourly tire cost.

Source: University of Houston

- Total Hourly Operating Cost (Figure 54)

$$\begin{aligned} &Total\ Hourly\ Operating\ Cost \\ &\quad = Hourly\ Field\ Labor\ Cost + Hourly\ Field\ Repair\ Parts\ and\ Supply\ Parts\ Cost \\ &\quad + Hourly\ Ground\ Engaging\ Component\ Cost + Hourly\ Lube\ Cost + Hourly\ Fuel\ Cost \\ &\quad + Hourly\ Tire\ Cost \end{aligned}$$

$$= 4.40 + 11.99 + 1.90 + 8.34 + 1.5 + 0 = 28.13$$

Figure 54. Equation. Output calculation for hourly total operating cost.

Source: University of Houston

- Total Hourly Cost Recovery (FWHA rate) (Figure 55)

$$FWHA\ rate = Total\ Hourly\ Ownership\ Cost + Total\ Hourly\ Operating\ Cost$$

$$= 41.88 + 28.13 = 70.01$$

Figure 55. Equation. Output calculation for hourly total cost recovery.

Source: University of Houston

- Standby Rate (Figure 56)

$$Standby\ rate = Total\ Hourly\ Ownership\ Cost * 0.5$$

$$= 41.88 + 28.13 = 20.94$$

Figure 56. Equation. Output calculation for hourly total cost recovery.

Source: University of Houston

Output Sample

Table 3 provides an illustrative example that summarizes the calculated intermediate variables and resulting hourly ownership and operating costs, based on the methodology described previously.

Table 3. Output Sample Table

Intermediate variables	
Standard usage rate	0.165
Initial transportation costs	1,946
Annual overhead	2,876
Annual overhaul parts cost	4,093
Annual field repair parts and supply parts cost	4,172
Annual ground engaging component cost	661
Monthly ownership cost	7,370
Monthly depreciation cost	2,077
Monthly capital cost	1,193
Monthly overhead cost	1,453
Monthly overhaul labor cost	580
Monthly overhaul parts cost	2,067
Hourly ownership cost	7,370/176=41.88
Hourly operating cost	
Hourly field labor cost	4.40
Hourly field repair parts and supply parts cost	11.99
Hourly ground engaging component cost	1.90
Hourly fuel cost	8.34
Hourly tire cost	0*
FHWA rate	70.01
Standby rate	20.94

* This model does not have tires.

UPDATE METHODOLOGY

This section introduces a methodology to update the FHWA rate and standby rate. The following parameters will be changed regularly: purchase price, unit fuel cost, overhead, and labor cost (i.e., mechanics wage).

Adjusting the Purchase Price

Adjusting the purchase price keeps the purchase price in line with the current market dynamics by adjusting it according to the inflation rate. The adjustment is on a yearly basis. The method utilizes an interest rate factor (F_{int}) that is reflective of the inflation rate to update the purchase price annually. For example, if the purchase price of a piece of equipment with a model year of 2023 is $50,000, then the purchase price for the new model of year 2024 would be calculated as 50,000 * (1+ F_{int}), which equals 51,000, given that F_{int} is 0.01.

Modifying Unit Fuel Cost

The objective of modifying fuel cost is to maintain an accurate and up-to-date record of fuel costs, allowing for budget adjustments and planning. The developed methodology enables IDOT

administrators to have the flexibility to update the unit fuel cost as necessary, based on the prevailing market values. The latest average fuel price, including diesel and gasoline, in Illinois can be found in American Automobile Association (n.d.). It is suggested to conduct a review and update of fuel costs based on market trends and projections.

Overhead Updates

The adjustment of overhead updates is to ensure that the overhead costs are reflective of the current market value of the product. The overhead is calculated based on the resale value of the equipment. We developed a systematic approach to track and adjust the resale value based on annual depreciation rates.

Figure 57 through Figure 60 present the formula to calculate the suggested dynamic resale value. We compared the model year of the equipment with this year's digit and then calculated the number of years used by subtracting the model year from the current year digit. Next, we determined the economic life in years, which is calculated by dividing economic life in months by 12. Following this, we computed the yearly depreciation percentage using the formula in Figure 59. Then the resale value is calculated by Figure 60.

$$Years\ in\ use = This\ year\ digit - Model\ year$$

Figure 57. Equation. Years in use.

Source: University of Houston

$$Economic\ life\ in\ years: EY = \frac{EL}{12}$$

Figure 58. Equation. Economic life in years.

Source: University of Houston

$$Yearly\ depreciation\ percentage = \frac{(1 - F_{SV})}{EY}$$

Figure 59. Equation. Yearly depreciation percentage.

Source: University of Houston

$$CV = P * (1 - Years\ in\ use * \frac{(1 - F_{SV})}{EY}))$$

Figure 60. Equation. Dynamic resale value.

Source: University of Houston

Then, the overhead can be calculated as displayed in Figure 61.

$$AO = Annual\ overhead\ rate * CV$$

Figure 61. Equation. Annual overhead.

Source: University of Houston

This formula thus provides a more nuanced approach to calculating the resale value, taking into account both the economic life of the equipment and its age in years and adjusting for the yearly depreciation percentage based on the final salvage value. This ensures a more accurate and realistic estimation of the equipment's current market value.

Labor Cost Update

Updating the labor cost maintains a realistic and fair labor cost that aligns with governmental policies and market trends. The labor cost is determined by multiplying the number of labor hours by the hourly labor cost, known as the mechanics wage, which is subject to updates based on government policies. We suggest establishing a mechanism to regularly update (e.g., quarterly or yearly) the hourly labor cost, considering factors such as government policies, industry standards, and economic indicators.

CHAPTER 4: EQUIPMENT RENTAL SCHEDULE WEB-BASED TOOL DEVELOPMENT

INTRODUCTION

The primary objective of this application is to manage equipment and contractor data efficiently by leveraging a robust and user-friendly model. Designed with user needs in mind, the application provides an array of features that simplify the processes of handling, organizing, and analyzing equipment-related information. From securing sensitive data to advanced filtering options and administrative tools, the application ensures a seamless experience for both general users and administrators. Below is a detailed overview of the features included.

- Application Security: The application prioritizes data security through its comprehensive authentication system. Users must register on the Signup page, providing a unique username, a valid email ID, and a secure password. Only after successful authentication on the Login page, using the registered credentials, can users access equipment data. This ensures that sensitive information remains protected.

- Authentication Modes: The application offers two user authentication modes: admin and general user. Admin users have full authority, allowing them to both access and manage equipment data. In contrast, general user mode permits access to data and utilization of the model without management capabilities. By default, all new users are assigned general user mode.

- Equipment Page: The Equipment page serves as a central hub, displaying all available model years for equipment and contractors' equipment, facilitating easy navigation.

- Equipment List Page: When users select a specific model year or contractor from the Equipment page, they are redirected to the Equipment List page, which displays detailed information about the equipment for the chosen model year or contractor.

- Equipment Filters: The Equipment List page includes an efficient filtering feature that allows users to refine the equipment list based on categories. Additionally, a search function is available to help users quickly locate specific subcategories. For further precision, the filtering options include a size filter, which displays all available sizes, enabling users to select the size that best meets their requirements.

- Equipment Page: After selecting any equipment from the list of equipment, the user lands on the Equipment Details page where the user can view various costs as well as essential parameters.

- Cost Calculator: The cost calculator on the Equipment Details page enables users to compute FHWA and standby rates.

- Save Model: With the Save Model feature, users can save customized versions of the model and retrieve them later for further analysis or application.

- Manage Equipment Data: This feature is only available for admin users. It is used to manage or modify equipment data. This comes with many features, described below.

    - Edit Equipment Details: After selecting any model year or contractor from the Manage Equipment Data page, the user can see an edit icon for each piece of equipment, within which the user can edit equipment details and save them.

    - Add New Equipment: With the edit icons, users can also see an Add New Equipment feature that will launch a form and allow users to add new equipment for the selected model year.

    - Edit Fuel Costs: There is an option to edit fuel costs in the Manage Equipment page. It allows admin users to edit various fuel costs in different quarters and counties, affecting the operating cost of a piece of equipment.

    - Edit Labor Wage: There is an option to edit labor wage in the Manage Equipment page. It allows admin users to edit the labor wage, affecting various equipment costs.

    - Generate Next Year Equipment Data: This feature, available on the Manage Equipment page, allows an admin user to generate equipment data for the coming year. This feature will only be available in the last month of the current year.

    - Export Equipment Data: This feature allows admin users to export all equipment data based on years and contractor data to an Excel workbook. Users will be able to select the model years or contractor names that the user wants to export.

TECHNOLOGIES USED TO DEVELOP THE APPLICATION

The application was developed using a combination of modern technologies to ensure a responsive, efficient, and scalable solution. Each component of the stack plays a vital role in delivering a seamless experience.

1. Front-End Technologies: The front end is built using Angular, a powerful framework for developing dynamic web applications. The use of TypeScript ensures strong typing and enhances maintainability, while SCSS provides advanced styling capabilities, enabling the creation of a visually appealing and responsive user interface.

2. Back-End Technologies: On the server side, the application employs Node.js for a robust and efficient runtime environment, coupled with Express.js for building the RESTful API that connects the front end with the database. This combination allows for fast and scalable back-end development.

3. Database: The application utilizes MongoDB, a NoSQL database, to manage and store data. Its schema-less architecture and scalability make it an ideal choice for applications requiring flexibility and the ability to handle large amounts of data.

4. Connecting the Front End and Back End: To integrate the front end and back end, specific configurations need to be adjusted after deployment:

    a. Front-End Configuration: Replace the placeholder AUTH_API in the auth.service.ts and user.service.ts files with the URL of the deployed back end. This step ensures the front end can communicate with the back-end API effectively.

    b. Back-End Configuration: In the back-end code (app.js), update the origin field within the corsOptions to include the deployed front-end URL. This setup allows cross-origin requests, enabling the two components to interact seamlessly.

5. Connecting the Back-End with the MongoDB Database: To establish a connection between the back-end and the MongoDB database, the tool (1) obtains the connection string from MongoDB Atlas; (2) updates the Mongoose connection in app.js with this string, ensuring that the appropriate MongoDB account credentials are included; and (3) verifies the connection to ensure the back end can interact successfully with the database for data retrieval and storage. By employing these technologies and following the outlined configuration steps, the application achieves a cohesive integration of its components, delivering a reliable and efficient solution.

DETAILED GUIDANCE OF ALL FEATURES

Signup Page

Users can register in the portal's Signup page by giving the username, email, and a password of their choice (Figure 62).

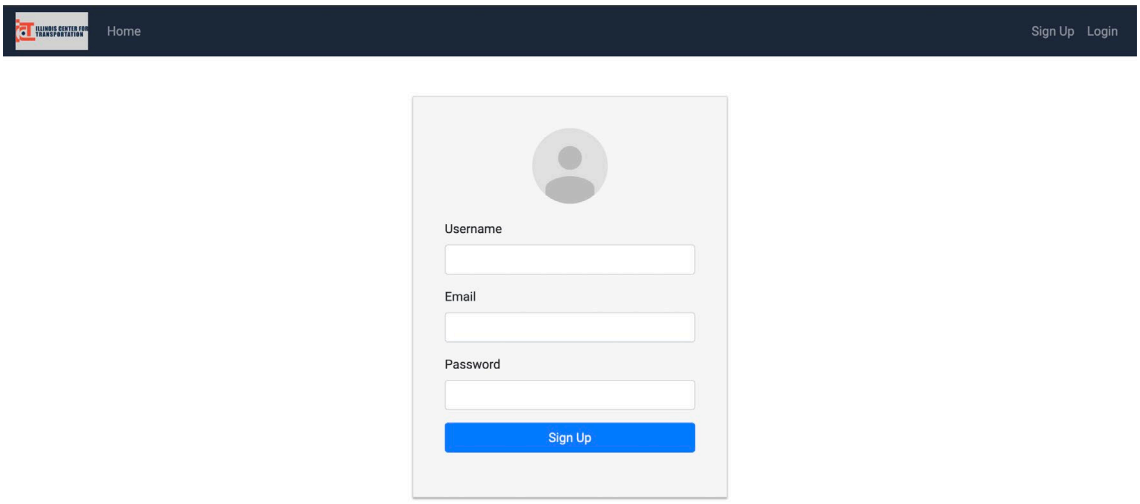


Figure 62. Screenshot. Signup page for registration.

Source: University of Houston

Login Page

After registration, users can log in with their username and password (Figure 63). The application will show an error if they use the wrong username or password to log in.

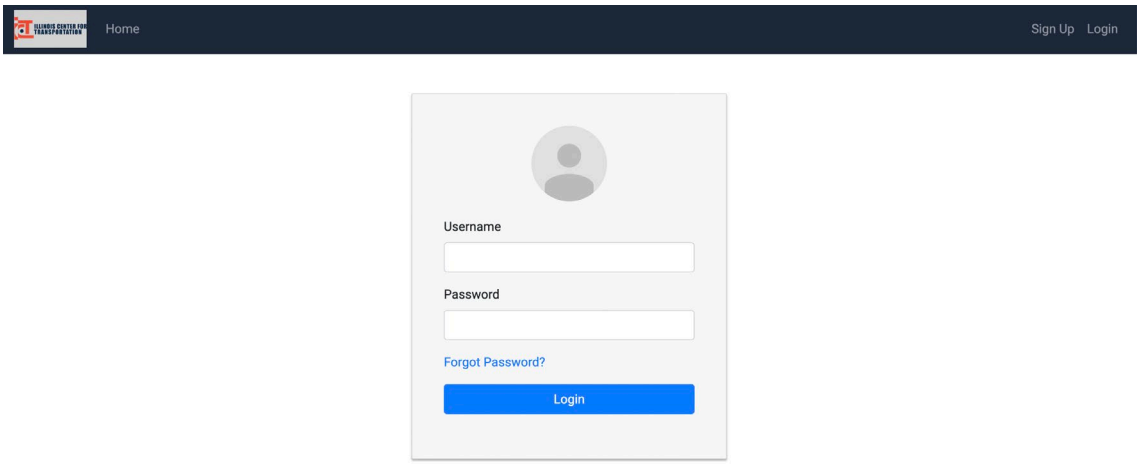


Figure 63. Screenshot. Login page for users to sign in.

Source: University of Houston

Login Status Page

After authentication, the user's access level is displayed. For instance, as shown in Figure 64, a user authenticated with "ROLE_ADMIN" has administrative privileges, granting full access to manage the data. Conversely, if a user has general access rights, "ROLE_USER" will display on the landing page, indicating limited access to data, as illustrated in Figure 65.

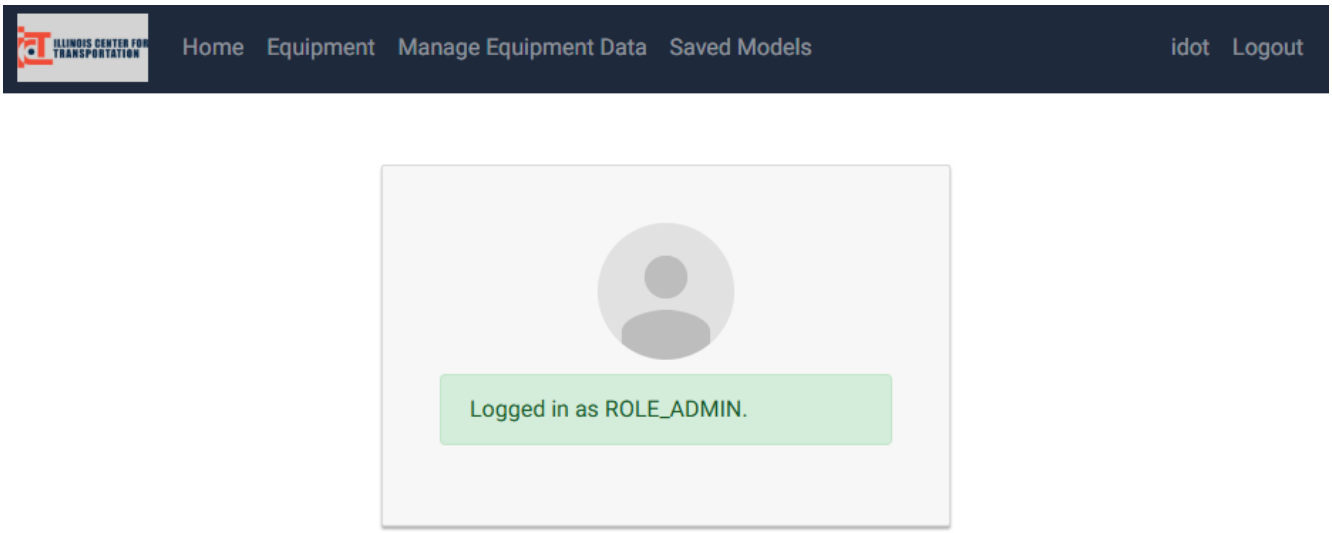


Figure 64. Screenshot. Admin access role display.

Source: University of Houston

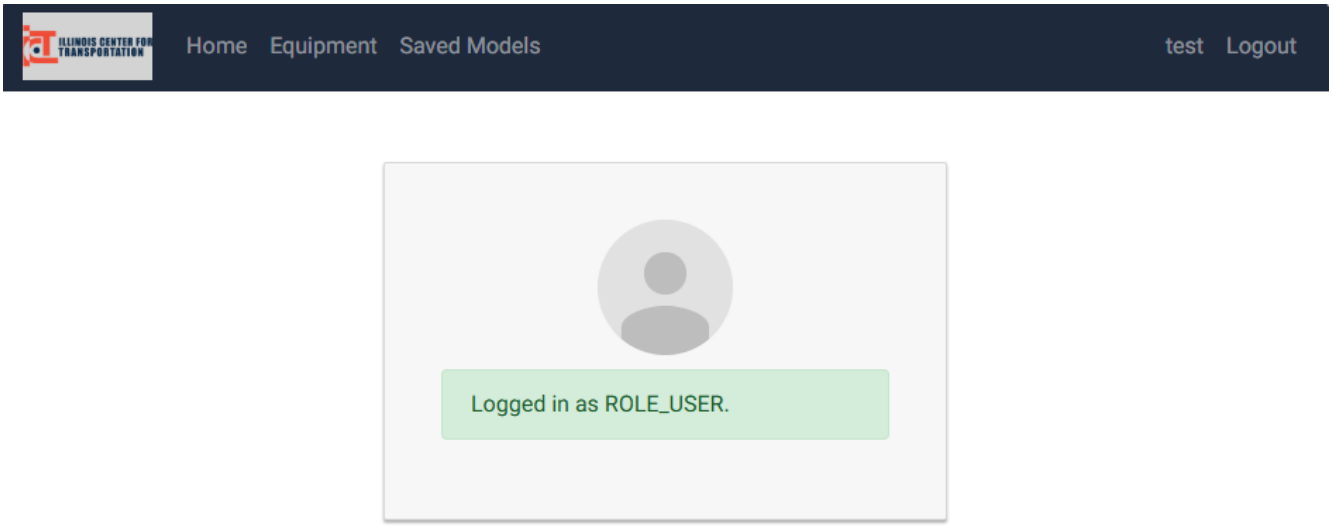


Figure 65. Screenshot. General user access role display.

Source: University of Houston

User Profile Page

The User Profile page can be accessed from a button on the top-right corner beside the Logout button. This page gives user information such as username, email used for registration, and the roles assigned to the user (Figure 66).

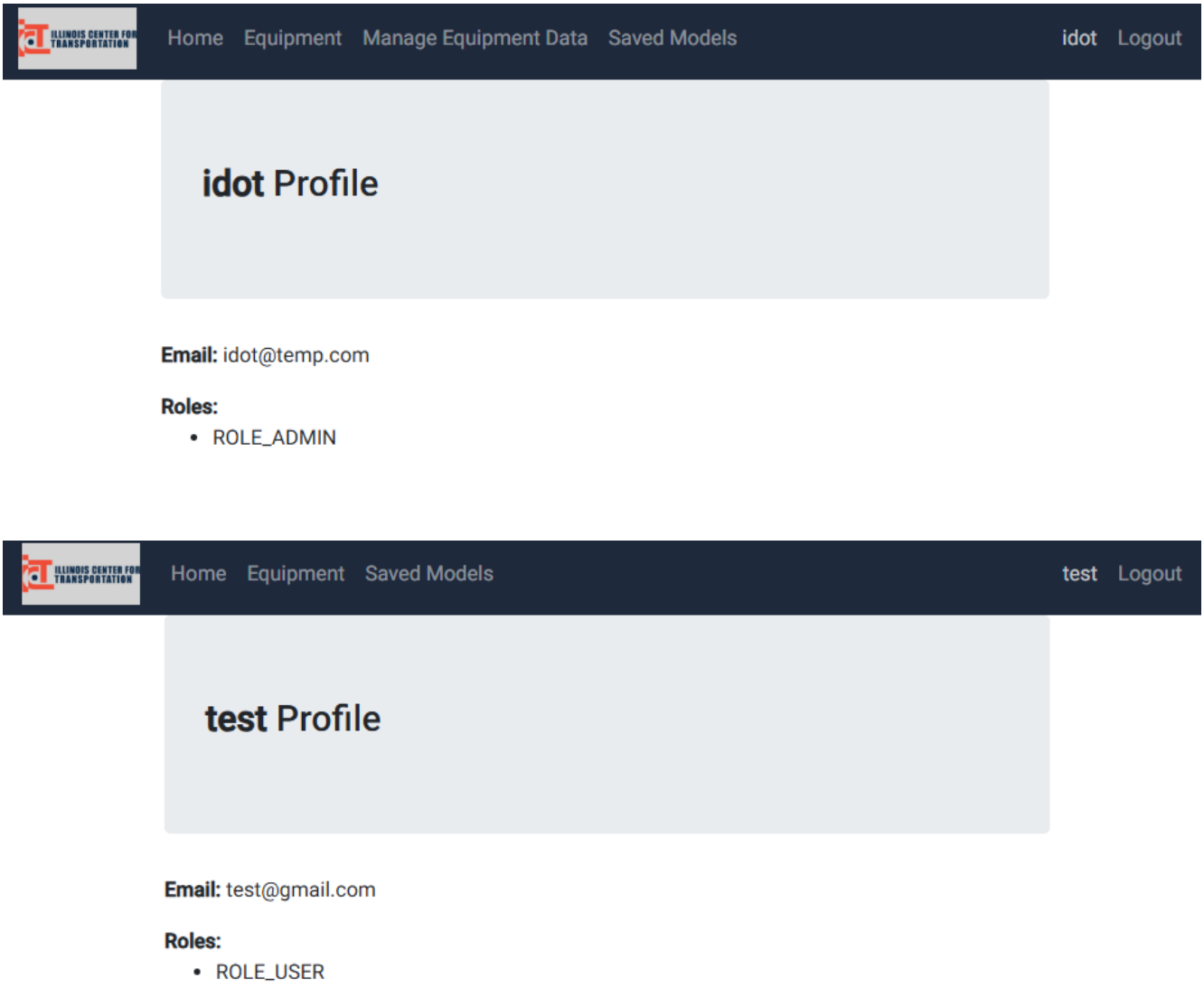


Figure 66. Screenshot. Profile page showing email used for registration and user's authentication level.

Source: University of Houston

Equipment Page

Figure 67 displays the Equipment page, which organizes all equipment by year and lists contractor data. Additionally, the Manage Equipment Data option is visible exclusively to users in the admin group, enabling them to modify the equipment data as needed.

In contrast, Figure 68 shows the interface for general users. Here, only the Equipment and Saved Models tabs are available at the top, and the Manage Equipment Data option is not displayed. This setup allows general users to access and view the data using the model but restricts their ability to make any modifications to the equipment data.

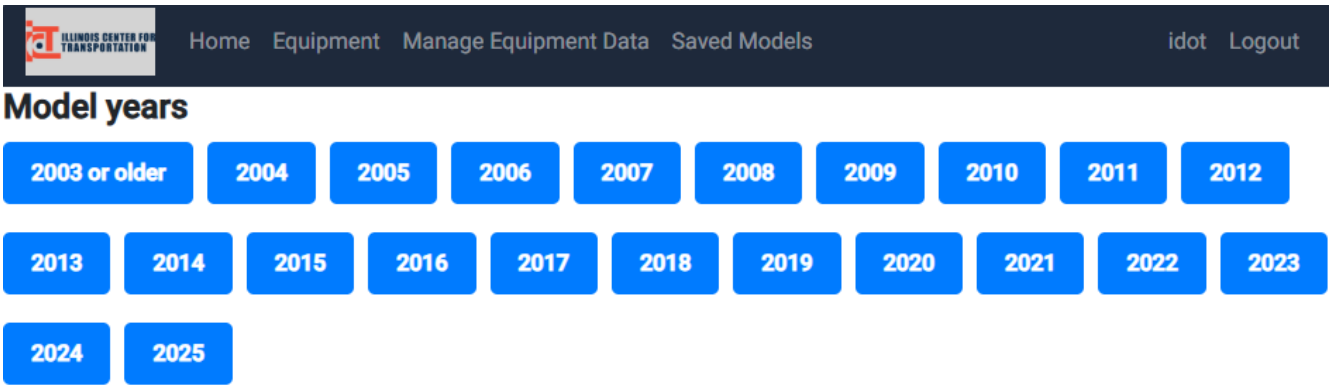


Figure 67. Screenshot. Admin equipment page showing manage equipment data option.

Source: University of Houston

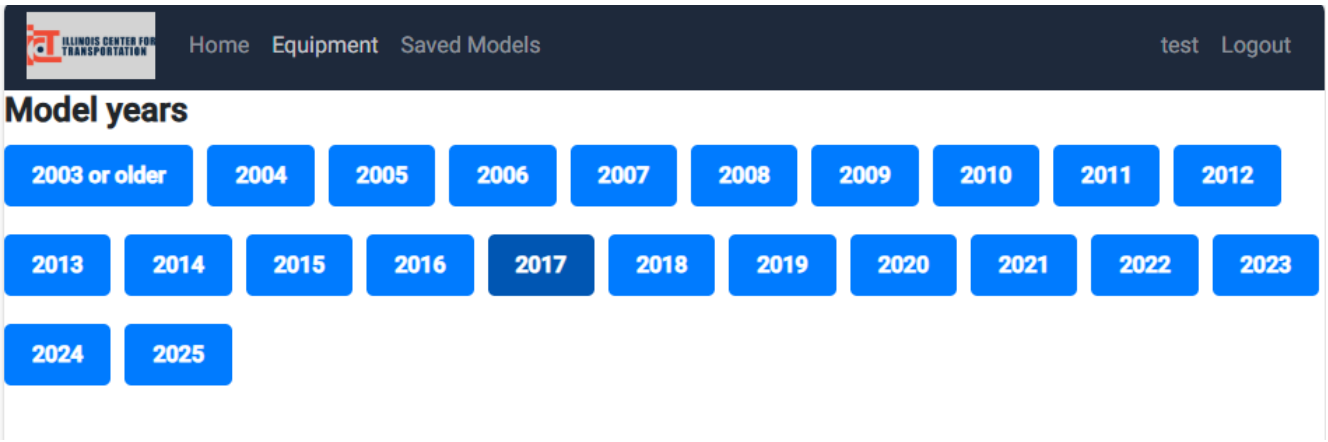


Figure 68. Screenshot. General user equipment page without the manage equipment data option.

Source: University of Houston

Equipment List Page

Figure 69 displays the equipment list that appears after a user selects a specific year or contractor to explore. This page provides basic information about the equipment and includes a filtering feature to help users navigate extensive lists. Additionally, pagination is available at the bottom of the page, allowing users to easily move to the next set of equipment entries.

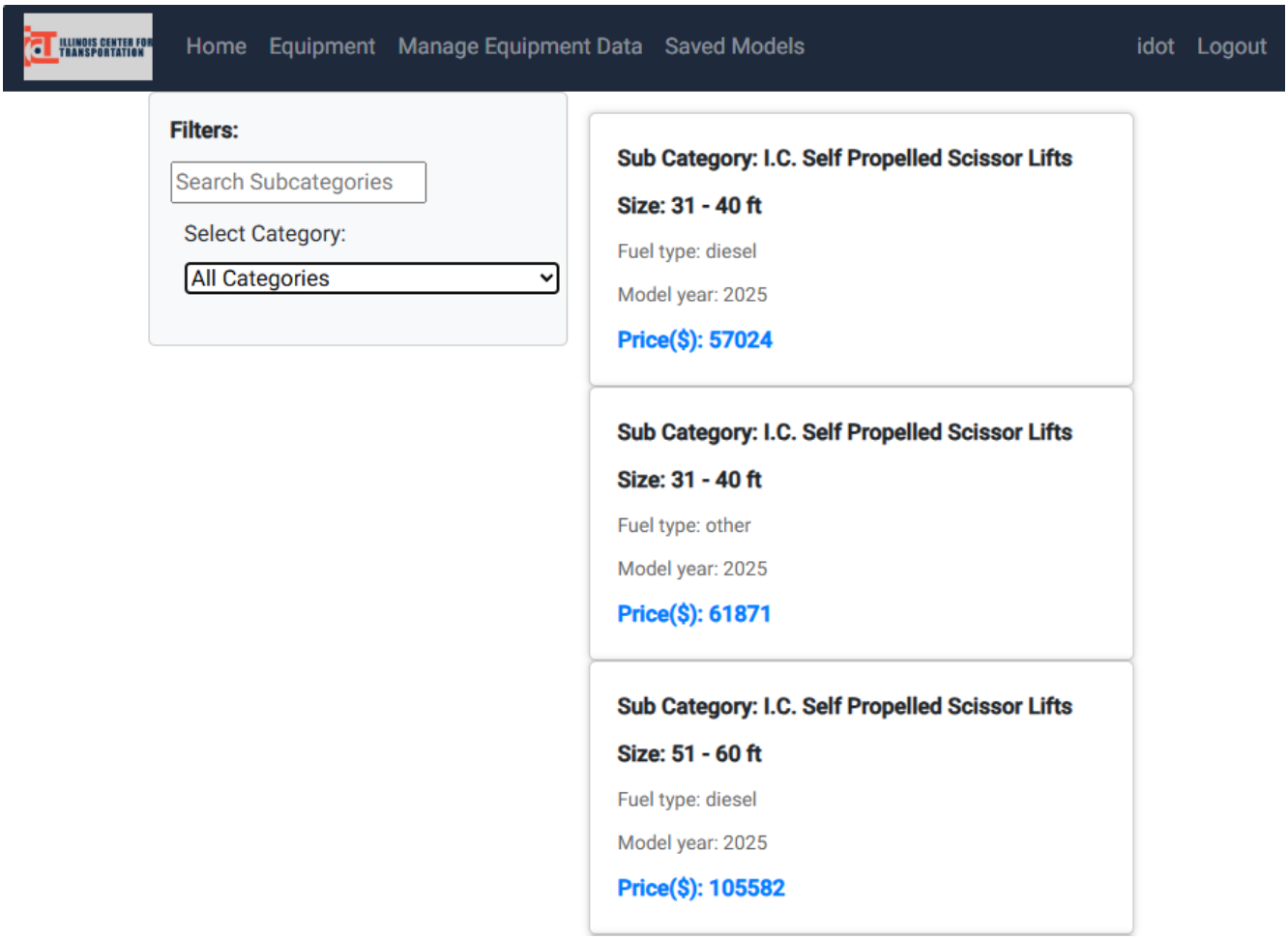


Figure 69. Screenshot. Equipment list page.

Source: University of Houston

The filters displayed in Figure 70 enable users to refine the equipment list for any selected year or contractor. Using drop-down menus, users can filter by category and subcategory, while a convenient search field allows for text-based searches within subcategories, making it easier to locate specific items.

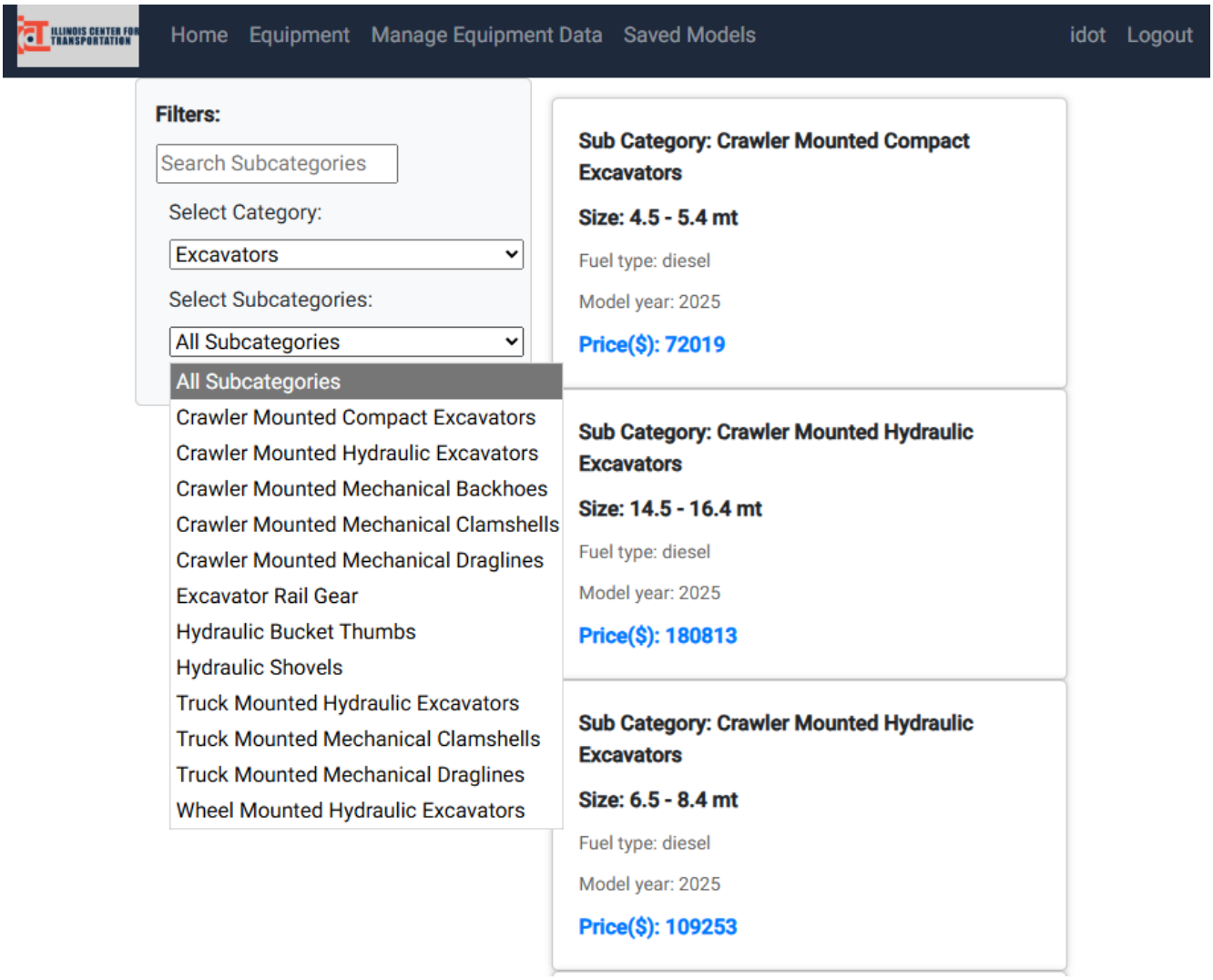


Figure 70. Screenshot. Filtering by category and subcategories.

Source: University of Houston

Additionally, a size filter is available, as shown in Figure 71, which displays the various sizes associated with the selected category and subcategory. This feature allows users to narrow down the equipment list based on size, helping them identify equipment that meets their specific requirements.

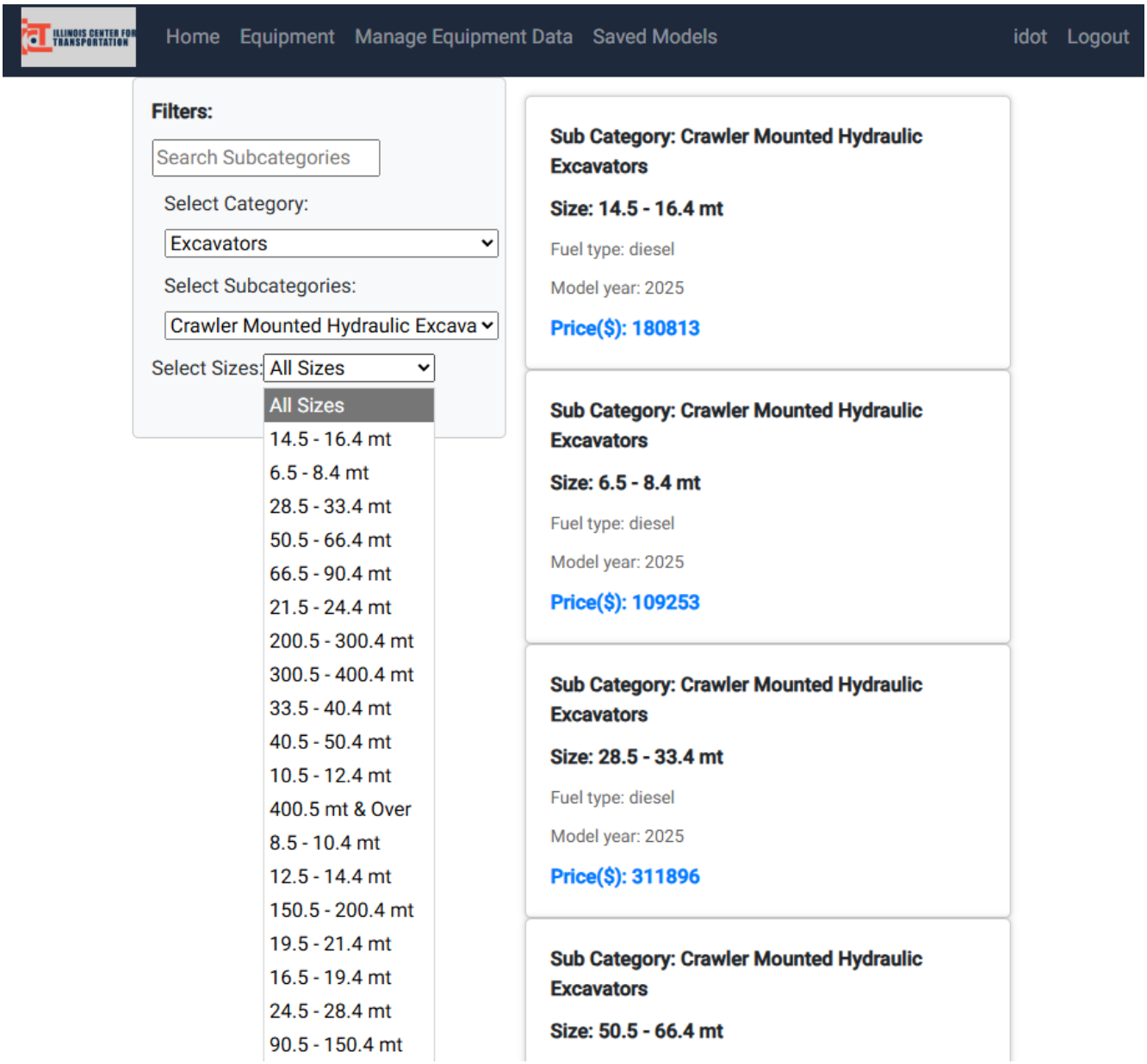


Figure 71. Screenshot. Filtering equipment by size.

Source: University of Houston

After the user selects a specific piece of equipment, an additional filter page is displayed (shown in Figure 72). This page allows users to select the county and quarter to constrain the displayed details of the equipment (shown in Figure 73).

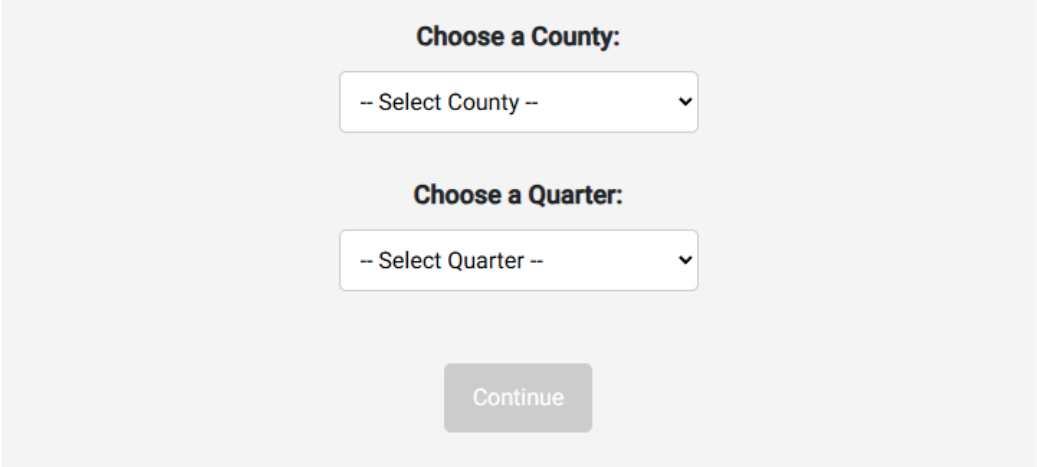


Figure 72. Screenshot. Additional filter of equipment by county and quarter.

Source: University of Houston

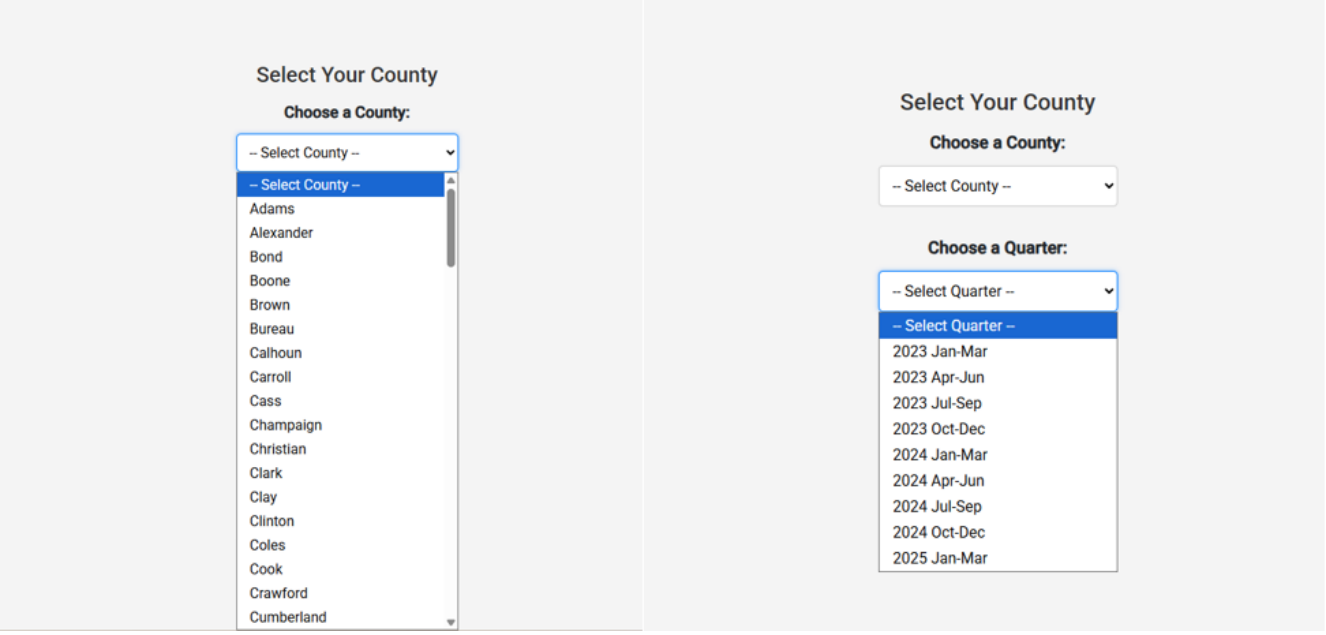


Figure 73. Screenshot. Filtering equipment by county and quarter.

Source: University of Houston

Equipment Details Page

When the user selects a specific piece of equipment, the Equipment Details page (shown in Figure 74) is displayed. There is a Print button at the upper right part of the page that, when clicked, pops up a page for printing, as shown in Figure 75. If the user scrolls down the page, it shows the current resale value of the equipment and the itemized ownership costs and operating costs, as shown in Figure 76.

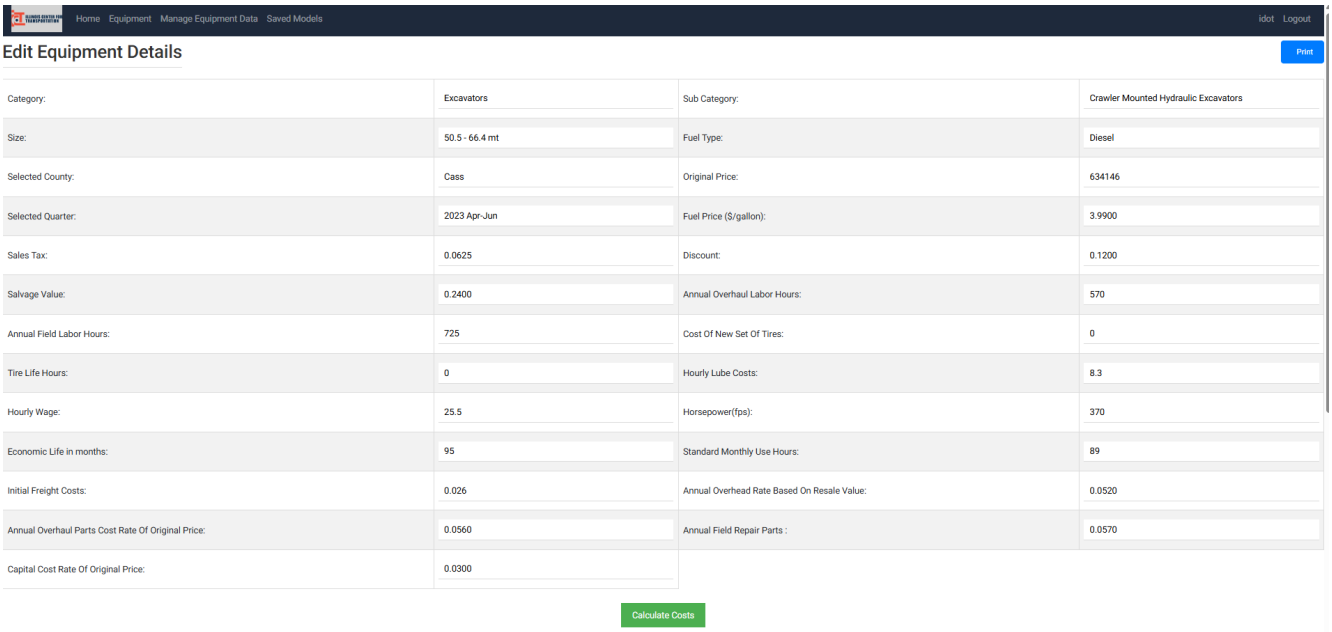


Figure 74. Screenshot. Equipment details page.

Source: University of Houston

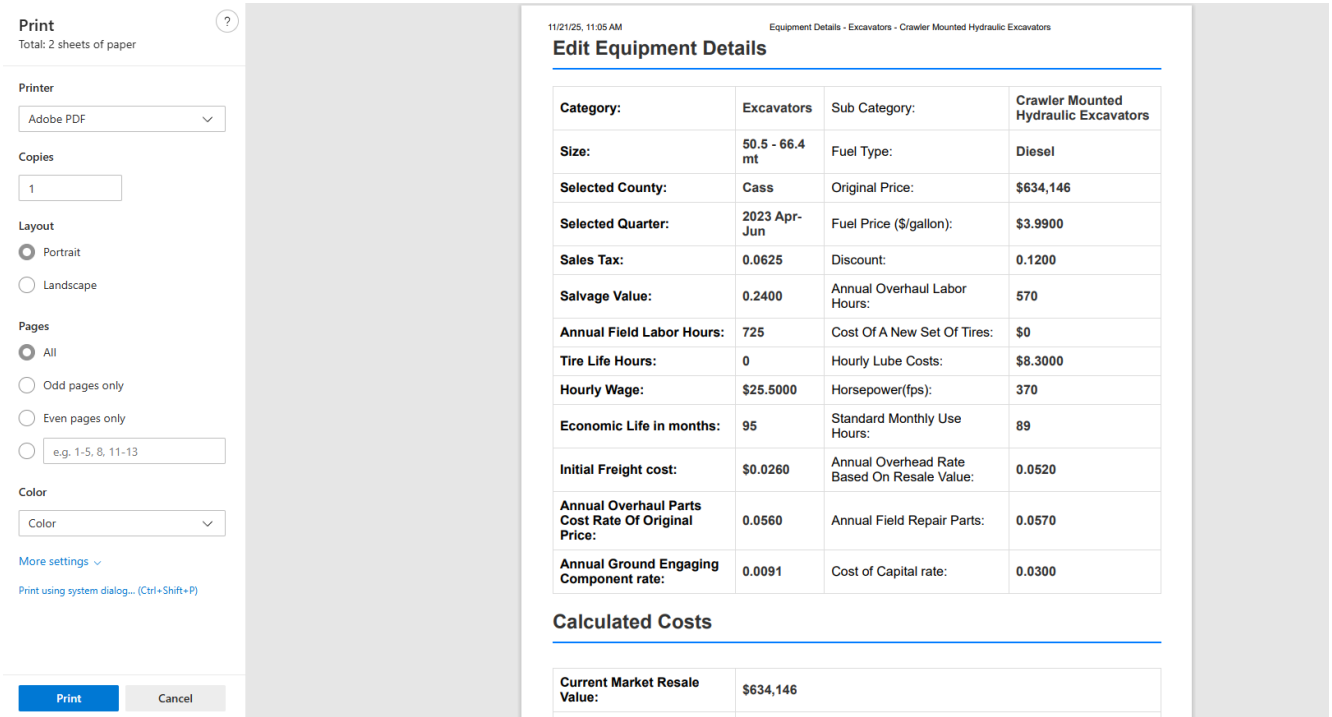


Figure 75. Screenshot. Print equipment details.

Source: University of Houston

Calculated Costs

Current Market Resale Value:	634,146.0000
Depreciation Ownership Cost (Monthly):	9,755.8885
Capital Cost (Monthly):	3,145.5655
Overhead Ownership Cost (Monthly):	5,452.3135
Overhaul Labor Ownership Cost (Monthly):	2,403.2738
Overhaul Parts Ownership Cost (Monthly):	5,871.7222
Total Ownership Cost (Hourly):	**151.2998**
Field Labor Operating Cost (Hourly):	17.3104
Field Parts Operating Cost (Hourly):	33.8449
Ground Engaging Component Cost Operating Cost (Hourly):	5.3914
Lube Operating Cost (Hourly):	8.3000
Fuel By Horse Power Operating Cost (Hourly):	59.0520
Tire Costs Operating Cost (Hourly):	0.0000
Total Operating Cost(Hourly):	**123.8987**
Total Cost Recovery(Hourly):	**275.1985**

Figure 76. Screenshot. Internal cost calculation results.

Source: University of Houston

At the lower part of the page in Figure 74, there is a Calculate Costs button that directs users to the Calculator page (shown in Figure 77), where the FHWA and standby rates, calculated by the model, are displayed. Users can print the details of the calculation by clicking the Print button, as shown in Figure 78.

Additionally, users can save their updated model by clicking the Save Model button, which stores the current model along with the newly generated cost recovery values. Figure 79 displays a list of the user's saved models, which can be shown after the user saves the model and clicks the Save Model button on the top of the page. Users can filter the saved models by keying in the ID, category, subcategory, size, quarter, and/or county. By clicking on a saved model, the user can return to the Equipment Details page.

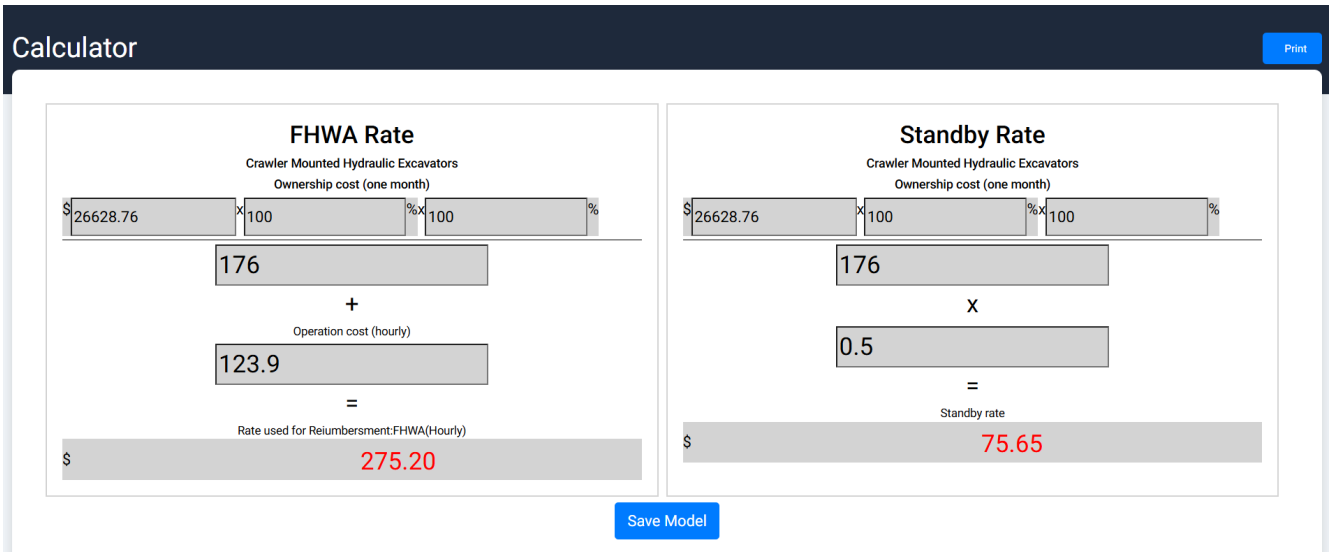


Figure 77. Screenshot. Cost calculation results showing FHWA and standby rates.

Source: University of Houston

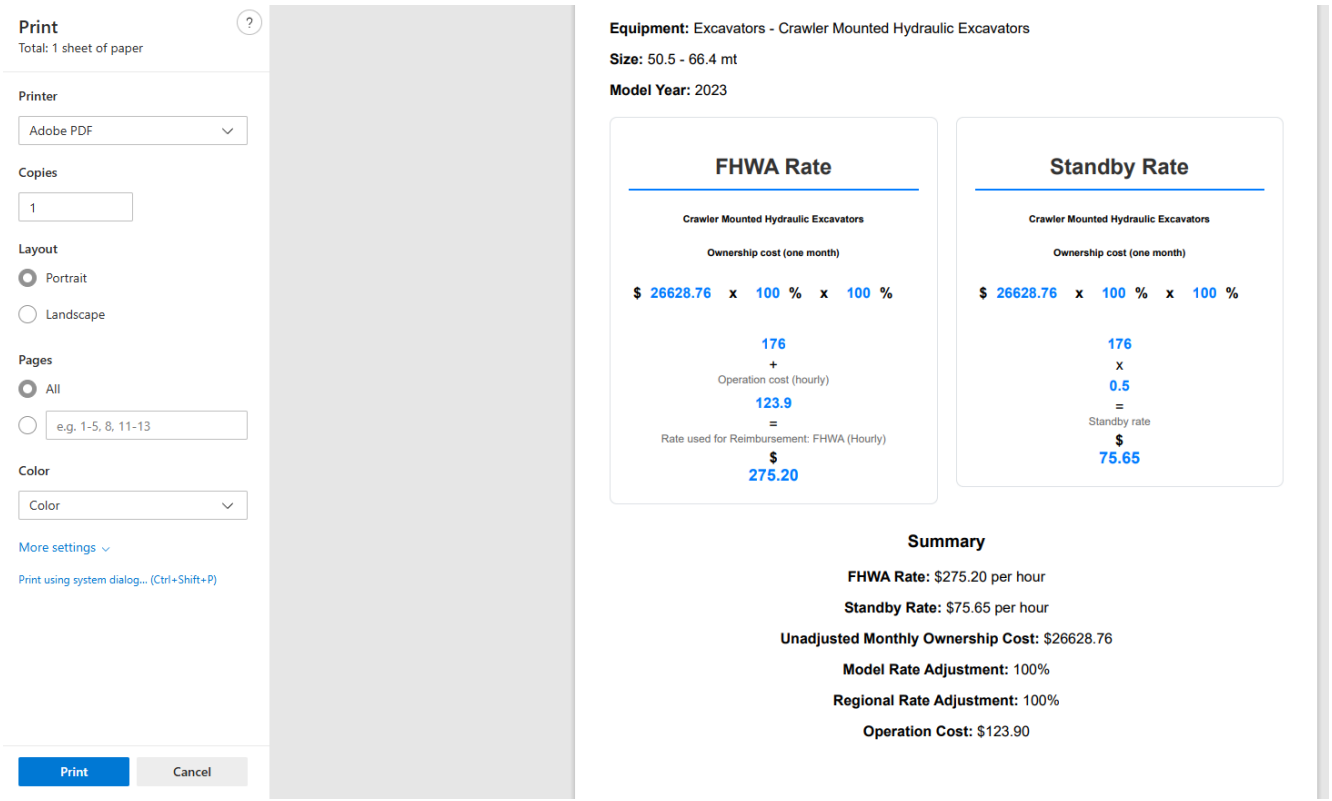


Figure 78. Screenshot. Printing FHWA rate and standby rate.

Source: University of Houston

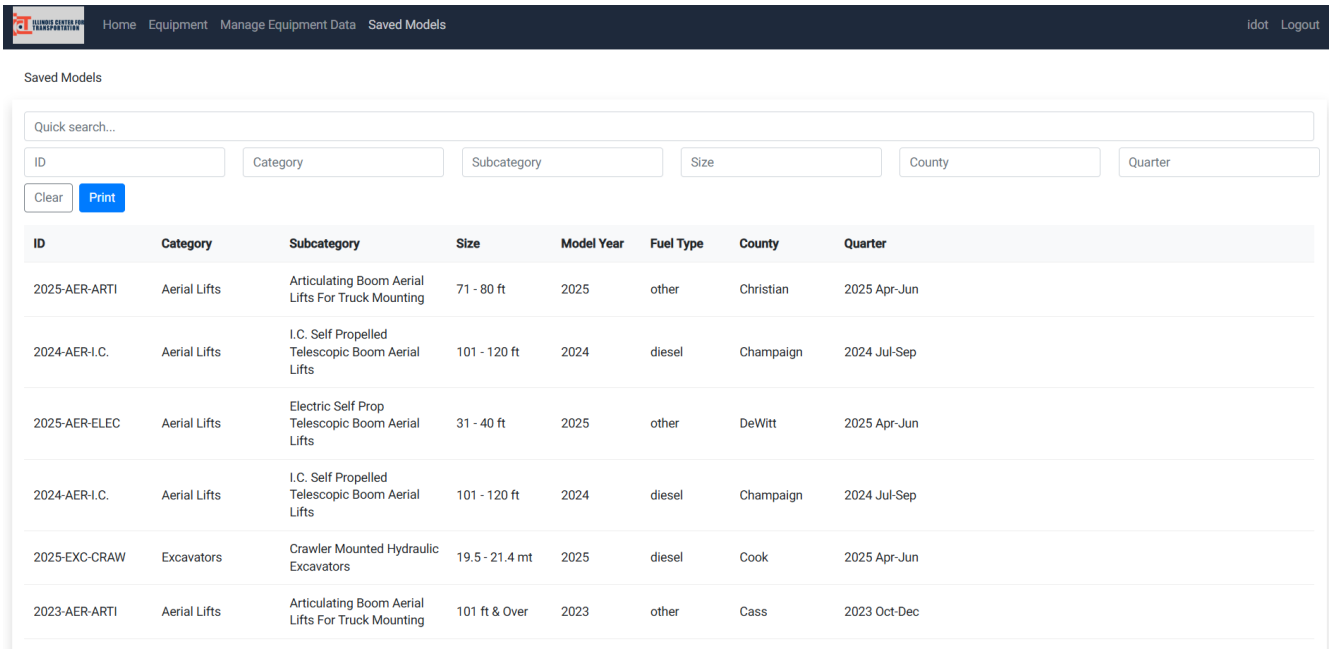


Figure 79. Screenshot. List showing saved models of the user.

Source: University of Houston

Manage Equipment Data

Admin users will see the Manage Equipment Data tab at the top of the page (Figure 80). This tab provides access to features that allow admin users to modify and manage equipment data, enabling a range of actions to be performed.

Figure 80. Screenshot. Manage equipment page showing the actions available for admin users.

Source: University of Houston

When the user clicks Generate New Data in the Manage Equipment Data section, they are directed to the form shown in Figure 81. This form allows the user to enter the price increase rate (in %) and, upon clicking the Generate button, generate data for the following year. Note that the new data can only be generated in December, the final month of the current year. Additionally, the form will prompt the user to reconfirm their action, as shown in Figure 82, since this is a data-altering operation.

Generate Next Year Data

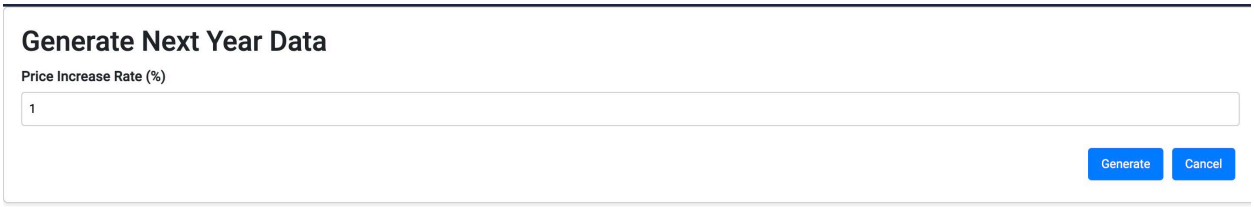


Figure 81. Screenshot. Generate data for the next year by giving the price increase rate.

Source: University of Houston

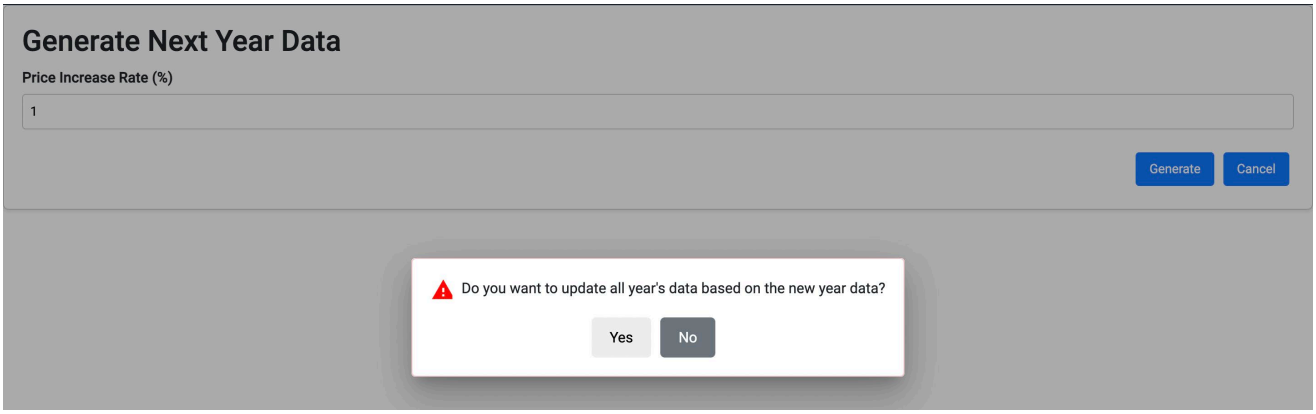


Figure 82. Screenshot. Form asking for reconfirmation to generate the new year's data.

Source: University of Houston

Edit Fuel Costs

The Edit Fuel Costs action presents a form that allows the user to modify fuel prices for gasoline, diesel, and other fuel types in the selected county and quarter, as shown in Figure 83. The user can also modify the information by uploading a CSV document, as shown in Figure 84. Updating these fuel prices will affect the costs across all equipment data for every year. Since this is a significant data-altering operation, it may take some time to complete.

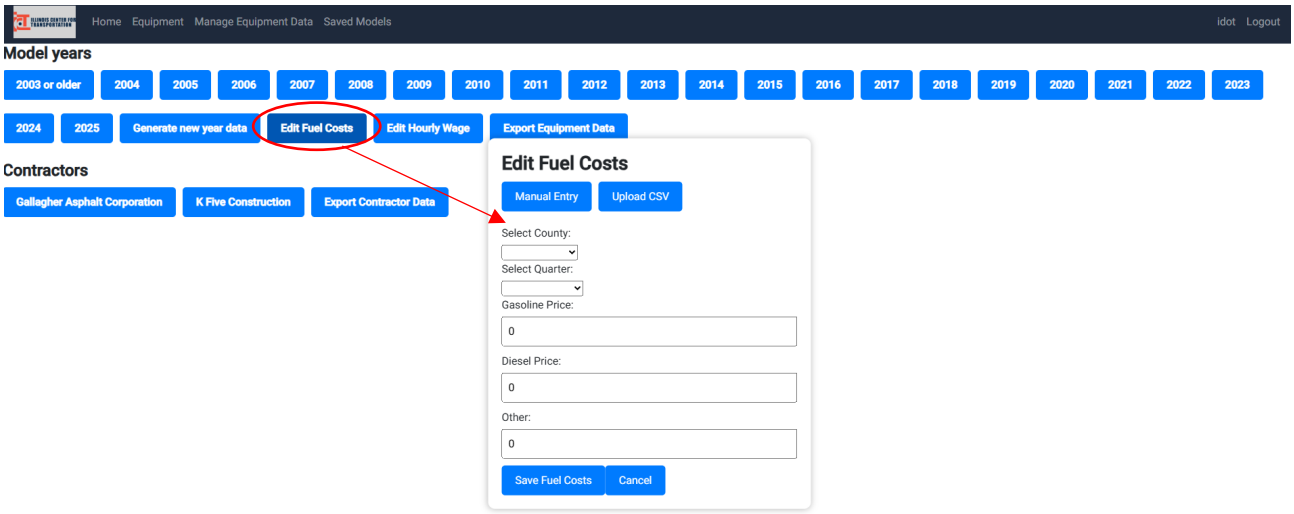
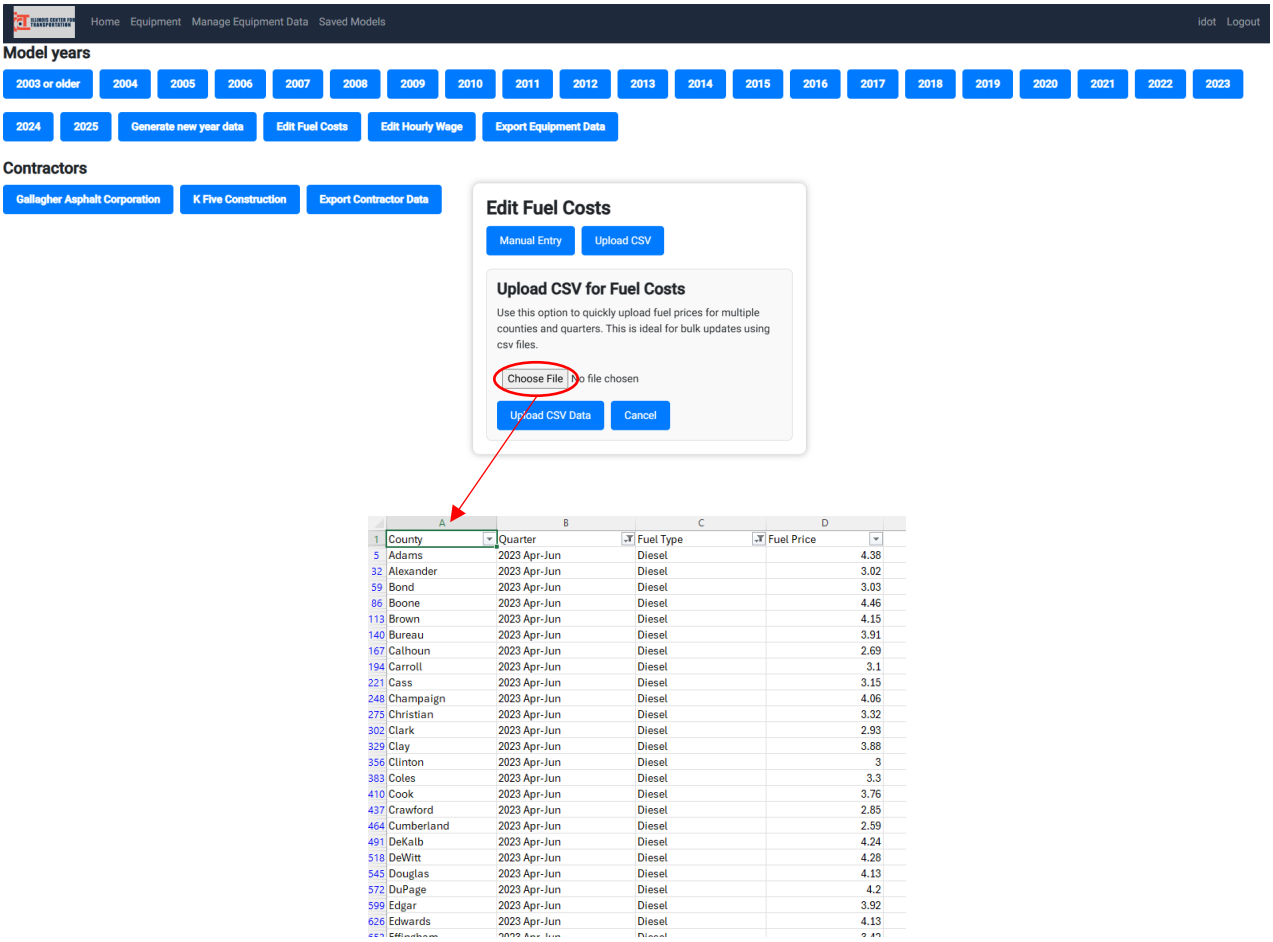


Figure 83. Screenshot. Form for editing various fuel costs.

Source: University of Houston



	A	B	C	D
1	County	Quarter	Fuel Type	Fuel Price
5	Adams	2023 Apr-Jun	Diesel	4.38
32	Alexander	2023 Apr-Jun	Diesel	3.02
59	Bond	2023 Apr-Jun	Diesel	3.03
86	Boone	2023 Apr-Jun	Diesel	4.46
113	Brown	2023 Apr-Jun	Diesel	4.15
140	Bureau	2023 Apr-Jun	Diesel	3.91
167	Calhoun	2023 Apr-Jun	Diesel	2.69
194	Carroll	2023 Apr-Jun	Diesel	3.1
221	Cass	2023 Apr-Jun	Diesel	3.15
248	Champaign	2023 Apr-Jun	Diesel	4.06
275	Christian	2023 Apr-Jun	Diesel	3.32
302	Clark	2023 Apr-Jun	Diesel	2.93
329	Clay	2023 Apr-Jun	Diesel	3.88
356	Clinton	2023 Apr-Jun	Diesel	3
383	Coles	2023 Apr-Jun	Diesel	3.3
410	Cook	2023 Apr-Jun	Diesel	3.76
437	Crawford	2023 Apr-Jun	Diesel	2.85
464	Cumberland	2023 Apr-Jun	Diesel	2.59
491	DeKalb	2023 Apr-Jun	Diesel	4.24
518	DeWitt	2023 Apr-Jun	Diesel	4.28
545	Douglas	2023 Apr-Jun	Diesel	4.13
572	DuPage	2023 Apr-Jun	Diesel	4.2
599	Edgar	2023 Apr-Jun	Diesel	3.92
626	Edwards	2023 Apr-Jun	Diesel	4.13

Figure 84. Screenshot. Form for editing various fuel costs by uploading CSV.

Source: University of Houston

Edit Labor Wage

The Edit Hourly Wage action, displayed in Figure 85, allows users to edit the cost of labor wage as well as update costs that depend on labor wage for all equipment and years. This operation may take some time as it is a huge data-altering operation.

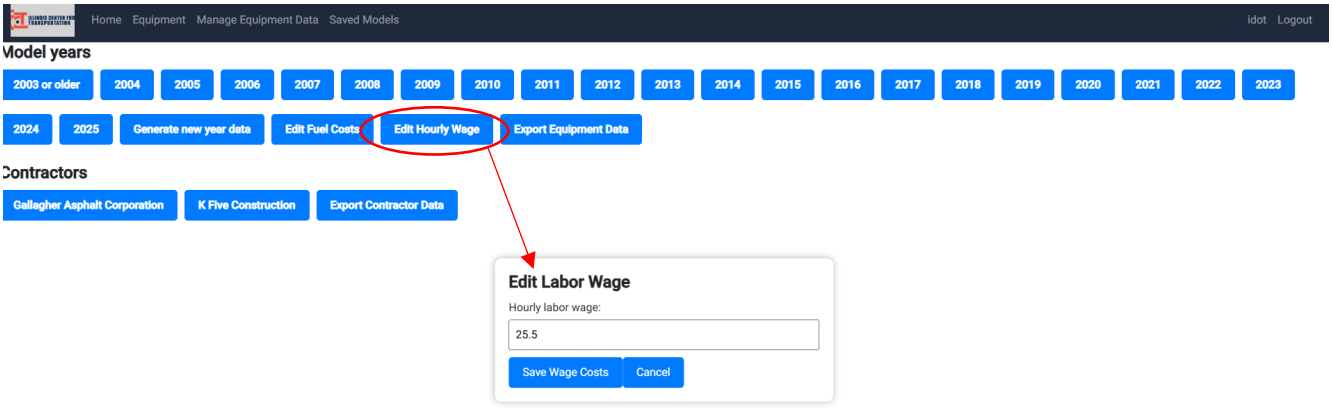


Figure 85. Screenshot. Form for editing labor wage.

Source: University of Houston

Alter Equipment Data

Figure 86 displays the equipment list for any selected year or contractor, with edit icons next to each piece of equipment and the option to add new equipment. Figure 87 shows the form for editing equipment data, allowing users to make changes and save them permanently. These updates will also adjust the associated costs based on the newly edited values.

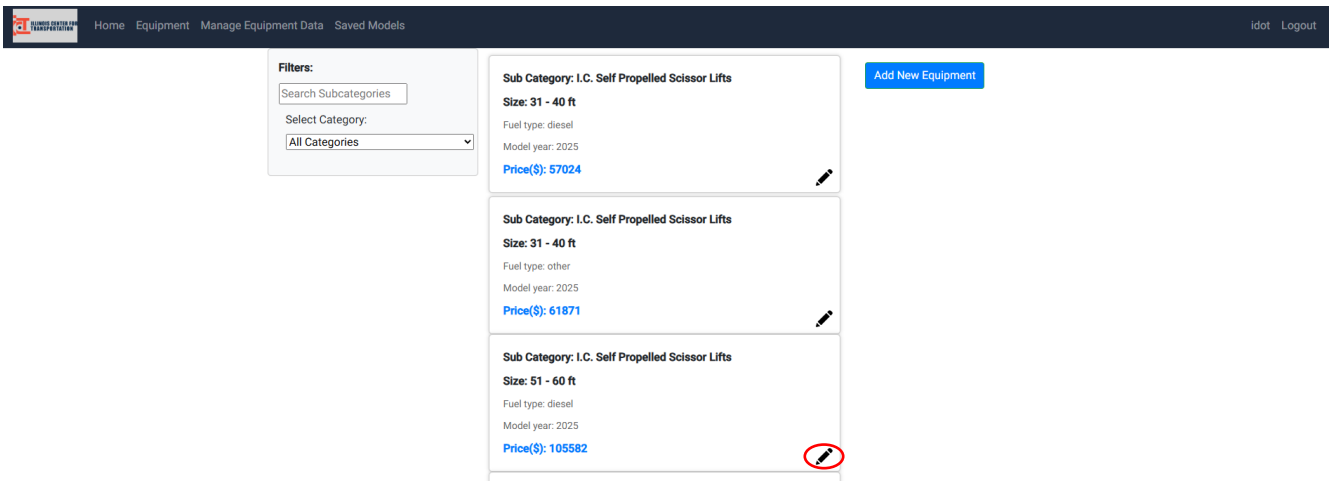


Figure 86. Screenshot. Equipment list page in the manage equipment data page.

Source: University of Houston

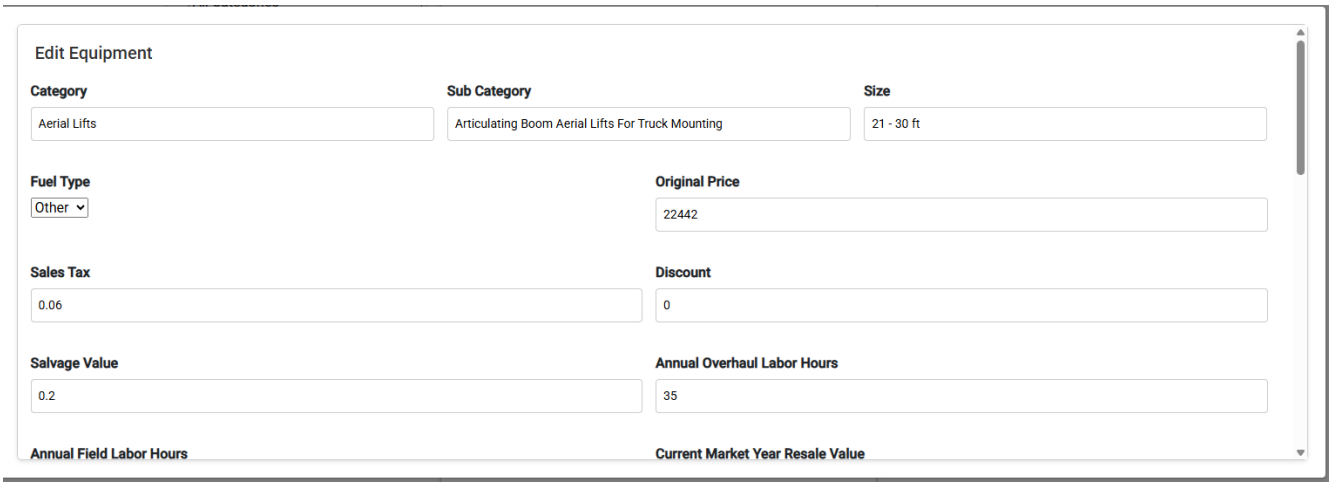


Figure 87. Screenshot. Edit equipment form.

Source: University of Houston

Figure 88 displays the form for adding new equipment. Users can select categories and subcategories from existing options or create new ones if necessary. After entering values for all required fields and clicking save, the system will calculate the costs based on the created model and save the new equipment data.

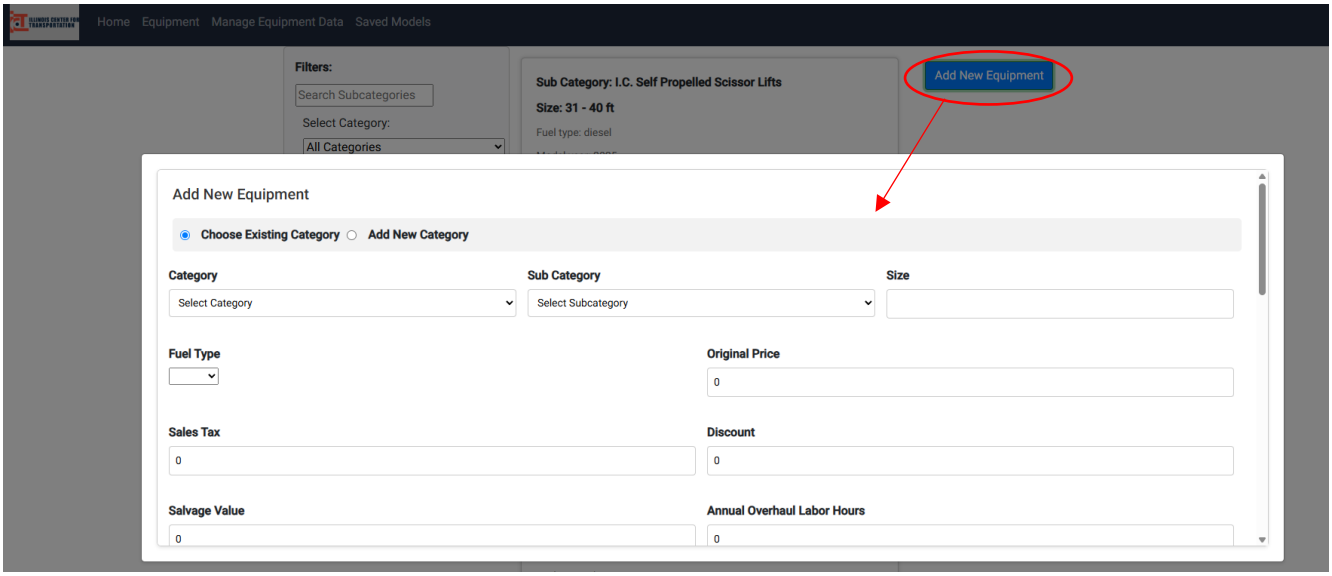


Figure 88. Screenshot. Add new equipment form.

Source: University of Houston

Export Data to Excel

Admin users can export equipment data to an MS Excel workbook with the help of the Export Equipment Data and Export Contractor Data features available on the Manage Equipment page.

Figure 89 shows that when the user clicks on Export Equipment Data, a form will appear allowing the user to select specific equipment years or contractors. Once the selections are made and the Export button is clicked, a file containing the selected data will be downloaded (Figure 90).

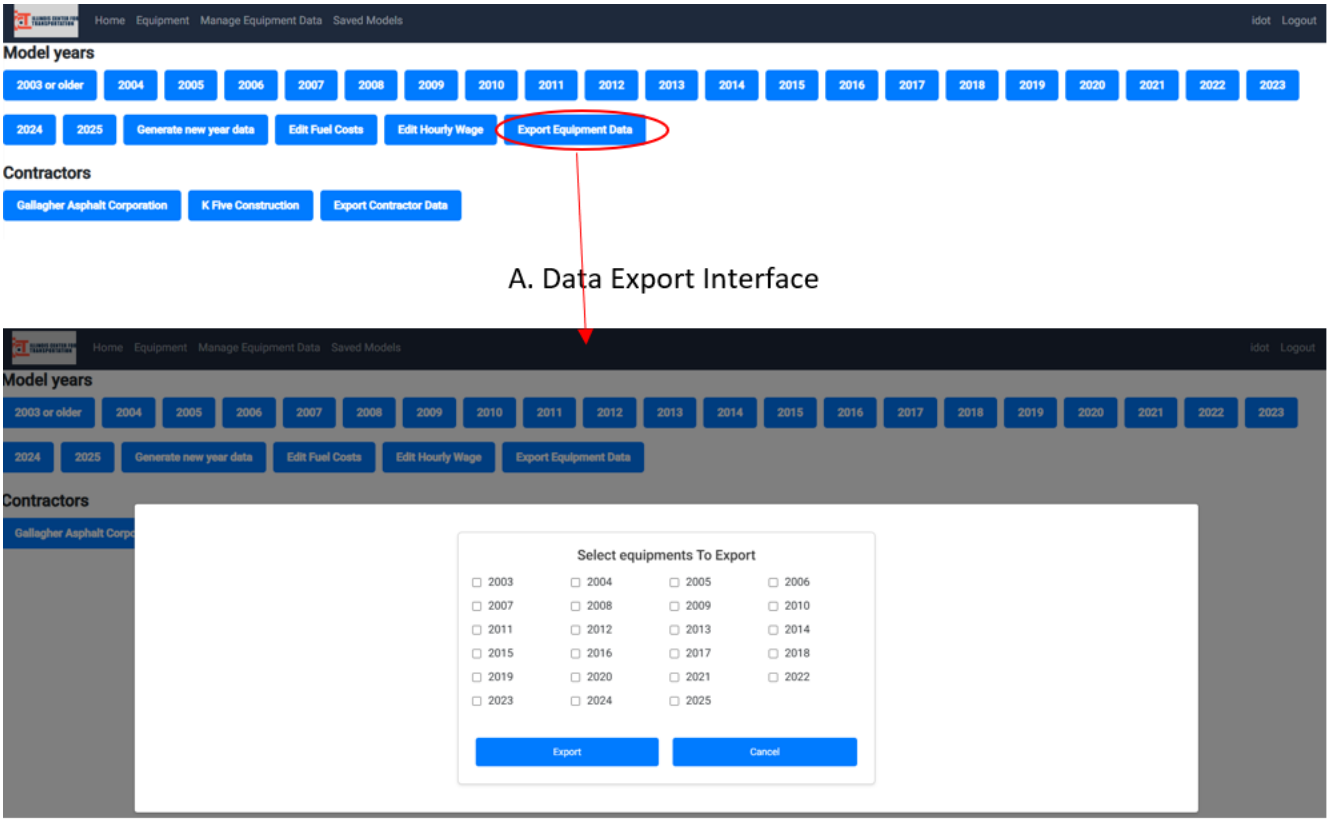
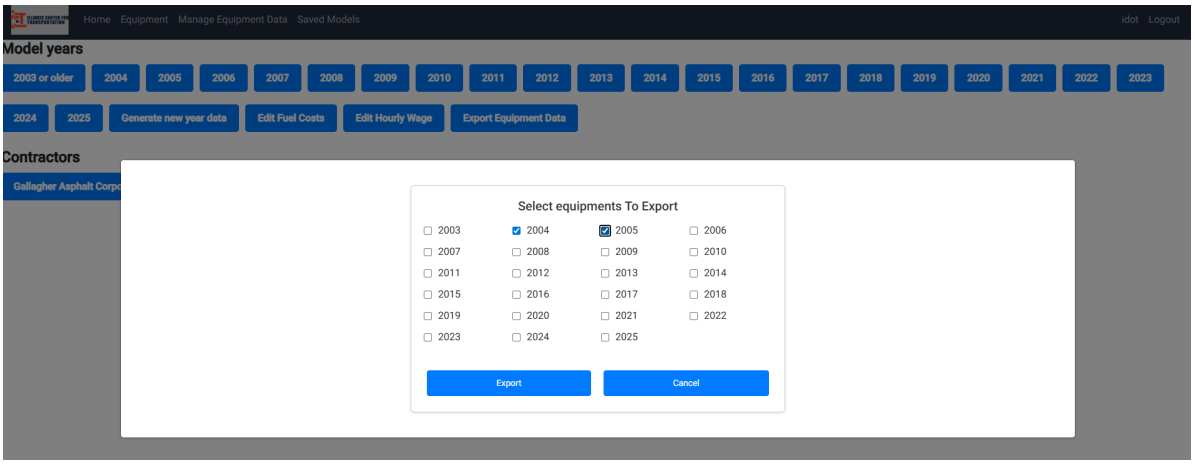
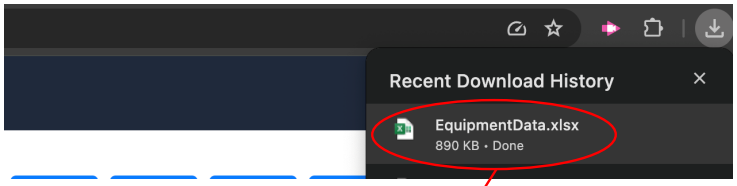


Figure 89. Screenshot. Exporting equipment data to Excel.

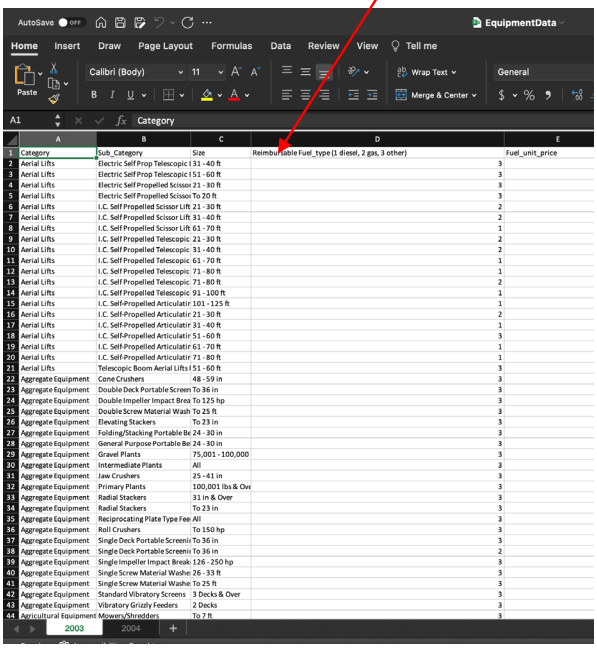
Source: University of Houston



A. Equipment Model Year Selection for Export



B. Download Confirmation



C. View of Exported Data in Excel

Figure 90. Screenshot. Exported equipment data in Excel.

Source: University of Houston

LIMITATIONS OF THE TOOL

The current web-based tool substantially improves transparency and usability for IDOT staff, but several limitations should be acknowledged. First, the tool generates rental rates at the level of equipment categories defined by similar model types, sizes, and functional characteristics, rather than at the individual brand–model level. As a result, the output represents an internally consistent estimate for a "typical" unit in each category, not a brand-specific schedule. In contrast, EquipmentWatch publishes rates at the brand and model level, with distinct schedules for different manufacturers and configurations. Consequently, for any given piece of equipment, the tool's category-based rate may deviate from the corresponding EquipmentWatch rate, especially in categories where there is substantial price dispersion across brands, optional attachments, or performance tiers. Users should therefore expect some variance between the Illinois schedule and the commercial Blue Book when comparing rates for specific makes and models. The variance is normally ±10%, with some exceptions reaching as large as ±89% and mean absolute deviation of 7.39% using the same parameters of all pieces of equipment.

Second, the model's overhaul parts cost component does not explicitly incorporate tariffs and trade-policy–driven surcharges on replacement parts. Overhaul parts costs in the tool are represented through an annual overhaul parts cost rate, expressed as a fixed fraction of the original purchase price. This rate is calibrated from historical cost experience and applied uniformly across equipment, regardless of manufacturer or country of origin. The model does not include separate parameters for customs duties, safeguard tariffs, anti-dumping duties, or other import-related charges that can apply to engines, hydraulic components, electronic controls, or ground-engaging parts sourced from overseas. When a piece of equipment relies heavily on imported components subject to higher U.S. tariff rates, the actual cost of overhaul parts may be systematically higher than the model's assumptions. Unless IDOT administrators manually adjust the overhaul parts cost rate to reflect these policy changes, the resulting FHWA and standby rates are likely to underestimate ownership costs for tariff-sensitive equipment and overestimate costs for equipment with predominantly domestic parts.

Third, the annual update mechanism for rental schedules applies a single inflation factor to adjust purchase prices and generate next-year data. While this approach offers a practical and transparent way to keep the schedule current, it implicitly assumes a uniform price escalation across all equipment categories. In practice, price dynamics vary significantly between equipment types: Specialized construction machinery, on-road trucks, compact equipment, and attachments often experience different inflation patterns due to supply-chain conditions, technological change, and manufacturer pricing strategies. Similarly, replacement equipment may see sharper price increases in some segments than others. Because the current tool does not differentiate inflation rates by equipment category or manufacturer, the updated rates may drift away from actual market values for specific types of equipment, especially during periods of highly uneven inflation across sectors.

Fourth, the developed tool updates only fuel prices on a quarterly basis, and even this update requires manual intervention by administrators. All other cost inputs, such as depreciation assumptions, overhaul costs, cost of facilities capital, and indirect costs, remain static unless they are manually revised. In contrast, EquipmentWatch recalculates its published hourly rates on a quarterly basis using a comprehensive set of updated inputs. These updates incorporate not only fuel price

changes, but also revisions to depreciation, overhaul costs, capital costs associated with equipment ownership and facilities, and indirect cost factors. As a result, EquipmentWatch's quarterly rates more fully reflect prevailing market conditions, whereas the developed tool's hourly rates may lag or diverge if non-fuel inputs are not updated at the same frequency.

In addition to these cost-structure limitations, there are several practical constraints related to coverage and data management. The initial database cannot feasibly include every niche or highly specialized piece of equipment used on IDOT projects. Although the tool allows administrators to add new equipment records, doing so requires manual entry of all model parameters (purchase price, economic life, usage hours, cost rates), and the accuracy of the resulting schedule depends heavily on the quality of those inputs. The application also does not automatically pull updated fuel prices, labor wages, or cost indices from external data sources; instead, administrators must periodically update these values through the Edit Fuel Costs and Edit Labor Wage functions. This manual process can introduce time lags and data-entry errors, and different update frequencies for fuel, labor, and equipment costs may create short-term inconsistencies in the schedule. Finally, the system currently operates as a transactional database without explicit version control or a built-in audit trail for parameter changes. Once fuel prices, labor rates, or equipment characteristics are overwritten, reconstructing prior rate schedules or explaining historical discrepancies requires separate recordkeeping outside the tool.

CHAPTER 5: CONCLUSIONS

This project provides a comprehensive solution to the challenges faced by the Illinois Department of Transportation (IDOT) in managing and reimbursing equipment costs for “extra work” in highway construction. By addressing the limitations of external rental rate sources, the project introduces a standardized, transparent equipment rate schedule and a digital tool that enhances cost estimation, improves negotiation processes, and reduces administrative workload. The tailored Illinois model, which incorporates local economic factors, offers a more accurate and flexible approach to calculating hourly equipment rates, while the proposed annual update mechanism ensures that rates remain relevant amid fluctuating market conditions.

The development of a web-based application further supports IDOT by streamlining equipment data management, with a user-friendly interface for both admin and general users. This app allows for easy data updates, cost calculations, and the ability to export data for reporting, enhancing both efficiency and transparency. The application’s secure, scalable architecture ensures reliable performance and data integrity, ultimately reducing the need for external services while providing a more accurate and responsive solution to equipment cost management.

Overall, the project delivers a sustainable, practical solution that aligns with IDOT’s financial and operational objectives, promoting fair pricing, improved budget control, and effective project planning. By establishing a new standard for equipment cost estimation in the industry, this initiative not only enhances IDOT’s ability to manage costs, but also sets a precedent for other state transportation agencies to follow.

REFERENCES

Alabama Department of Transportation. (2016). *Extra and Force Account Work.* https://www.dot.state.al.us/publications/construction/pdf/Specifications/2012/GASPSummary/12-0769(2).pdf

American Automobile Association. (n.d.). *Gas prices in Illinois*. Retrieved September 7, 2025, from https://gasprices.aaa.com/?state=IL

Arizona Department of Transportation. (2021). *Standard specifications for road and bridge construction* (2021 ed.). https://azdot.gov/sites/default/files/media/2021/04/2021_Standard_Specifications_for_Road_and_Bridge_Construction_PC.pdf

Arkansas Department of Transportation. (2018). *Weighted average unit prices for the year 2018: Items under standard specifications—Edition of 2014*. Program Management Division. https://www.ardot.gov/wp-content/uploads/2020/11/2018WtdAve.pdf

California Department of Transportation. (n.d.). *Equipment rental rate calculator.* https://mets.dot.ca.gov/equipment-rental-rate-calculator/

Corporate Finance Institute. (2023). *Straight line depreciation*. Retrieved September 7, 2023, from https://corporatefinanceinstitute.com/resources/accounting/straight-line-depreciation/

Colorado Department of Transportation. (2021). *Standard specifications for road and bridge construction*. https://www.codot.gov/business/designsupport/cdot-construction-specifications/2021-construction-specifications/2021-specs-book

Commonwealth of Massachusetts Department of Transportation. (2020). *Standard specifications for highways and bridges*. https://www.mass.gov/doc/2020-standard-specifications-for-highways-and-bridges/download

Connecticut Department of Transportation. (2017). *Standard specifications for roads, bridges, facilities, and incidental construction (Form 817)*. https://portal.ct.gov/-/media/dot/publications/817/_form_817_july_2017.pdf?rev=e82d3fed31a04e19a6445e01ffeda7bf&hash=BDF4C3B55B148E45D0A33495724AAB45

Delaware Department of Transportation. (2022). *Standard specifications for road and bridge construction.* https://deldot.gov/Publications/manuals/standard_specifications/pdfs/2022/Standard_Specification_Revision2_JUNE2022.pdf

Department of Defense. (2022, December 9). *Unified Facilities Criteria (UFC) 3-740-05: Construction cost estimating*. Whole Building Design Guide (WBDG). Retrieved January 5, 2026, from https://www.wbdg.org/FFC/DOD/UFC/ufc_3_740_05_2022.pdf

EquipmentWatch. (2025). *Rental Rate Blue Book*. https://equipmentwatch.com/blue-book-cost-recovery/

EquipmentWatch. (n.d.a). *Arkansas State Highway Transportation Department specifications.* https://equipmentwatch.com/specifying/arkansas-state-highway-transportation-department-ahtd-specifications-2/

EquipmentWatch. (n.d.b). Indiana Department of Transportation. https://equipmentwatch.com /specifying/indiana-department-transportation-indot-specifications/

EquipmentWatch. (n.d.c). *Michigan Department of Transportation specifications.* https://equipmentwatch.com/specifying/michigan-department-of-transportation-mdot-specifications/

EquipmentWatch. (n.d.d). *Minnesota Department of Transportation*. https://equipmentwatch .com/specifying/minnesota-department-transportation-mndot-specifications/

EquipmentWatch. (n.d.e). *Nebraska Department of Transportation specifications.* https://equipmentwatch.com/specifying/nebraska-department-of-roads-ndor-specifications/

EquipmentWatch. (n.d.f). *New Hampshire Department of Transportation specifications.* https://equipmentwatch.com/specifying/new-hampshire-department-of-transportation-nhdot-specifications/

EquipmentWatch. (n.d.g). *New Mexico Department of Transportation specifications.* https://equipmentwatch.com/specifying/new-mexico-department-of-transportation-nmdot-specifications/

EquipmentWatch. (n.d.h). *New York State of Transportation specifications.* https://equipmentwatch .com/specifying/new-york-state-department-of-transportation-nysdot-specifications/

EquipmentWatch. (n.d.i). *North Dakota Department of Transportation specifications.* https://equipmentwatch.com/specifying/north-dakota-department-of-transportation-nddot-specifications-2/

EquipmentWatch. (n.d.j). *Ohio Department of Transportation specifications.* https://equipmentwatch .com/specifying/ohio-department-of-transportation-odot-specifications/

EquipmentWatch. (n.d.k). *Virginia Department of Transportation specifications.* https://equipmentwatch.com/specifying/virginia-department-of-transportation-vdot-specifications/

EquipmentWatch. (n.d.l). *Washington State Department of Transportation specifications.* https://equipmentwatch.com/specifying/washington-state-department-transportation-wsdot-specifications/

EquipmentWatch. (n.d.m). *Hawaii Department of Transportation specifications.* https://equipmentwatch.com/specifying/hawaii-department-transportation-hidot-specifications/

EquipmentWatch. (n.d.n). *South Carolina Department of Transportation specifications.* https://equipmentwatch.com/specifying/south-carolina-department-transportation-scdot-specifications/

EquipmentWatch. (n.d.o). *Nevada Department of Transportation specifications.* https://equipmentwatch.com/specifying/nevada-department-transportation-ndot-specifications/

EquipmentWatch. (n.d.p). *Texas Department of Transportation specifications.* https://equipmentwatch.com/specifying/texas-department-of-transportation-txdot-specifications/

EquipmentWatch. (n.d.q). *Kansas Department of Transportation specifications.* https://equipmentwatch.com/specifying/kansas-department-of-transportation-kdot-specifications/

EquipmentWatch. (n.d.r). *South Dakota Department of Transportation specifications.* https://equipmentwatch.com/specifying/south-dakota-department-transportation-sddot-specifications/

EquipmentWatch. (n.d.s). *Connecticut Department of Transportation specifications.* https://equipmentwatch.com/specifying/connecticut-department-of-transportation-ctdot-specifications/

EquipmentWatch. (n.d.t). *Louisiana Department of Transportation specifications.* https://equipmentwatch.com/specifying/louisiana-department-trasportation-development-ladotd-specifications/

EquipmentWatch. (n.d.u). *Mississippi Department of Transportation specifications.* https://equipmentwatch.com/specifying/mississippi-department-of-transportation-mdot-specifications/

EquipmentWatch. (n.d.v). *Idaho Department of Transportation specifications.* https://equipmentwatch.com/specifying/idaho-transportation-department-itd-specifications/

EquipmentWatch. (n.d.w). *North Carolina Department of Transportation specifications.* https://equipmentwatch.com/specifying/north-carolina-department-of-transportation-ncdot-specifications/

EquipmentWatch. (n.d.x). *Rhode Island Department of Transportation specifications.* https://equipmentwatch.com/specifying/rhode-island-department-transportation-ridot-specifications/

EquipmentWatch. (n.d.y). *Vermont Agency of Transportation specifications.* https://equipmentwatch.com/specifying/vermont-agency-of-transportation-vtrans-specifications/

EquipmentWatch. (n.d.z). *Kentucky Department of Transportation specifications.* https://equipmentwatch.com/specifying/kentucky-transportation-cabinet-ktc-specifications/

EquipmentWatch. (n.d.aa). *New Jersey Department of Transportation specifications.* https://equipmentwatch.com/specifying/new-jersey-department-of-transportation-njdot-specifications-2/

EquipmentWatch. (n.d.ab). *Oklahoma Department of Transportation specifications.* https://equipmentwatch.com/specifying/oklahoma-department-transportaion-okdot-specifications/

EquipmentWatch. (n.d.ac). *Maine Department of Transportation specifications.* https://equipmentwatch.com/specifying/maine-department-transportation-mainedot-specifications/

EquipmentWatch. (n.d.ad). *Montana Department of Transportation specifications.* https://equipmentwatch.com/specifying/montana-department-transportation-mdt-

specifications/

EquipmentWatch. (n.d.ae). *Pennsylvania Department of Transportation specifications.* https://equipmentwatch.com/specifying/pennsylvania-department-transportation-penndot-specifications/

EquipmentWatch. (n.d.af). *Georgia Department of Transportation specifications.* https://equipmentwatch.com/specifying/georgia-gdot-specifications/

EquipmentWatch. (n.d.ag). *Missouri Department of Transportation specifications.* https://equipmentwatch.com/specifying/missouri-department-transportation-modot-specifications/

EquipmentWatch. (n.d.ah). *Oregon Department of Transportation specifications.* https://equipmentwatch.com/specifying/oregon-department-transportaion-odot-specifications/

EquipmentWatch. (n.d.ai). *Tennessee Department of Transportation specifications.* https://equipmentwatch.com/specifying/tennessee-department-transportation-tdot-specifications/

EquipmentWatch. (n.d.aj). *Delaware Department of Transportation specifications.* https://equipmentwatch.com/specifying/delaware-department-of-transportation-deldot-specifications/

EquipmentWatch. (n.d.ak). *Florida Department of Transportation specifications.* https://equipmentwatch.com/specifying/florida-department-transportation-fdot-specifications/

EquipmentWatch. (n.d.al). *Maryland Department of Transportation specifications.* https://equipmentwatch.com/specifying/maryland-department-transportation-mdot-specifications/

EquipmentWatch. (n.d.am). *Utah Department of Transportation specifications.* https://equipmentwatch.com/specifying/utah-department-of-transportation-udot-specifications-2/

EquipmentWatch. (n.d.an). *Alaska Department of Transportation*. https://equipmentwatch.com /specifying/alaska-department-transportation-adot-specifications/

EquipmentWatch. (n.d.ao). *Arizona Department of Transportation*. https://equipmentwatch.com /specifying/arizona-department-transportation-adot-specifications/

EquipmentWatch. (n.d.ap). *Colorado Department of Transportation*. https://equipmentwatch.com /specifying/colorado-department-of-transportation-cdot-specifications/

EquipmentWatch. (n.d.aq). *Iowa Department of Transportation specifications.* https://equipmentwatch.com/specifying/iowa-department-transportation-iowadot-specifications/

Federal Emergency Management Agency. (2023). *FEMA 2023 Schedule of Equipment Rates.* https://www.fema.gov/assistance/public/tools-resources/schedule-equipment-rates

Federal Highway Administration. (1986, October). *Equipment Rental Rates for Contractor Owned Equipment*. https://www.fhwa.dot.gov/construction/contracts/861030.cfm

Florida Department of Transportation. (2022). *Standard specifications for road and bridge construction.* https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/programmanagement/implemented/specbooks/july-2022/july2022ebook.pdf

General Services Administration. (2023). *Multiple Award Schedules (MAS) Program.* https://www.gsa.gov/buy-through-us/purchasing-programs/multiple-award-schedule

Georgia Department of Transportation. (2021). *Standard specifications construction of transportation systems*. https://www.dot.ga.gov/PartnerSmart/Business/Source/specs/2021StandardSpecifications.pdf

Hawaii Department of Transportation. (2005). *2005 Standard Specifications*. https://hidot.hawaii.gov/highways/s2005-standard-specifications/2005-standard-specifications/

Idaho Transportation Department. (2018). *2018 Standard specifications for highway construction*. https://apps.itd.idaho.gov/Apps/manuals/SpecBook/SpecBook18.pdf

Illinois Department of Revenue. (n.d.). *What are the sales and use tax rates in Illinois?* Retrieved September 7, 2023, from https://tax.illinois.gov/questionsandanswers/answer.139.html#:~:text=The%20Illinois'%20general%20state%20sales,%2C%20drugs%2C%20and%20medical%20appliances

Illinois Department of Transportation. (2022). *Standard specifications for road and bridge construction* (Adopted January 1, 2022). IDOT Policies & Publications Center (PowerDMS). https://public.powerdms.com/IDOT/documents/1945348/Standard%20Specifications%20for%20Road%20and%20Bridge%20Construction%202022

Indeed. (n.d.). *Automotive mechanic salary in Illinois*. Retrieved September 3, 2023, from https://www.indeed.com/career/automotive-mechanic/salaries/IL

Indiana Department of Transportation. (2018, November). *Construction memorandum 18-06.* https://www.in.gov/dot/div/contracts/conmemo/18-06.pdf

Iowa Department of Transportation. (2022). *Iowa DOT schedule of equipment rates - FY 2022* [Excel file]. https://iowadot.gov/local_systems/publications/Equipment-Rates-for-FY2022.xlsx

Iowa Department of Transportation. (2023). *Iowa DOT schedule of equipment rates - FY 2023* [Excel file]. https://iowadot.gov/local_systems/publications/Equipment-Rates-for-FY2023.xlsx

Jeffers, J. C. (2020). *Standard specifications for highway construction*. Department of Transportation and Public Facilities. https://dot.alaska.gov/stwddes/dcsspecs/assets/pdf/hwyspecs/sshc2020.pdf

Kansas Department of Transportation. (2015). *Standard specifications for state road and bridge construction - 2015*. https://www.ksdot.gov/bureaus/burConsMain/specprov/2015specprov.asp

Kell, T. (2021). *Construction Memorandum 09*. Illinois Department of Transportation. https://idot.illinois.gov/content/dam/soi/en/web/idot/documents/doing-business/memorandums-and-letters/highways/construction/const-memo-09.pdf

Kentucky Transportation Cabinet. (2019). *Standard specifications for road and bridge construction edition of 2019.* https://transportation.ky.gov/Construction/StdSpecsWSupplSpecs/2019%20Standard%20Spec%20-%20No%20Supplements%20Apply.pdf

Louisiana Department of Transportation and Development. (2016). *Standard specifications for roads and bridges manual.* http://wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Engineering/Standard_Specifications/Standard%20Specifications/2016%20Standard%20Specifications%20for%20Roads%20and%20Bridges%20Manual/00%20-%202016%20-%20Standard%20Specification%20(complete%20manual).pdf

Maine Department of Transportation. (2020, March). *Standard specifications.* https://www.maine.gov/mdot/contractors/publications/standardspec/docs/2020/2020%20Standard%20Specification.pdf

Maine Department of Transportation. (2022). *2022 labor reimbursement and private equipment rates*. https://www.maine.gov/mdot/csd/docs/slrper22.pdf

Maryland Department of Transportation State Highway Administration. (2022a). *Price index January 2022*. https://roads.maryland.gov/ohd2/MDOTSHA_Price%20Index_Jan2022.pdf

Maryland Department of Transportation State Highway Administration. (2022b). *Standard specifications for construction and materials.* https://www.roads.maryland.gov/ohd2/2022%20Standard%20Specifications%20for%20Construction%20and%20Materials.pdf

Massachusetts Department of Transportation. (2024). *Attachment A: 2024-2025 hourly rental rates and vehicle codes.* https://www.mass.gov/doc/attachment-a-hourly-rental-rates-and-vehicle-codes-for-2024-2025/download

Michigan Department of Transportation. (2022). *Equipment Rental Rates (Schedule C)*. https://www.michigan.gov/mdot/-/media/Project/Websites/MDOT/Programs/TSMO/Maintenance/Schedule-C-Equipment-Rental-Rates-2022.pdf?rev=f0a48a483658490d8637e389c6c89771&hash=B4A8CCC091E4DDFA1FBD1223615F09E5

Minnesota Department of Transportation. (2020). *MnDOT Standard Specifications for Construction and Supplemental Specifications.* https://www.dot.state.mn.us/pre-letting/spec/

Mississippi Department of Transportation. (2017). *Mississippi standard specifications for road and bridge construction.* https://mdot.ms.gov/documents/Construction/Specifications/2017%20Standard%20Specifications.pdf

Mississippi Department of Transportation. (2019). *Equipment Rental Rates.* https://mdot.ms.gov/documents/LPA/Projects/Emergency%20Relief/Vehicle%20and%20Equipment%20Rental%20Rates.pdf

Missouri Highway and Transportation Commission. (2021, October). *Missouri standard specifications for highway construction.* https://www.modot.org/sites/default/files/documents/2021%20Missouri%20Standard%20Specific%20-%20MHTC%20%28Oct%202021%29.pdf

Montana Department of Transportation. (2020). *Standard and supplemental specifications for road and bridge construction.* https://www.mdt.mt.gov/other/webdata/external/const/specifications/2020/SPEC-BOOK/2020-SPEC-BOOK-V2.3.pdf

Nebraska Department of Transportation. (2023). *Construction manual*. https://dot.nebraska.gov

/media/sp4h0xg2/cst-manual_2023.pdf

Nevada Department of Transportation. (2014). *Standard specifications for road and bridge construction*. https://www.dot.nv.gov/home/showdocument?id=6916

New Hampshire Department of Transportation. (2016). *Standard specifications for road and bridge construction*. https://www.dot.nh.gov/sites/g/files/ehbemt811/files/inline-documents/2016-nhdot-spec-book.pdf

New Jersey Department of Transportation. (2019). *Standard specifications for road and bridge construction.* https://www.nj.gov/transportation/eng/specs/2019/pdf/StandSpecRoadBridge2019_20210823.pdf

New Mexico Department of Transportation. (n.d.). *Standard specifications and drawings.* https://www.dot.nm.gov/infrastructure/plans-specifications-estimates-pse-bureau/standards/

New York State Department of Transportation. (2006, June). Equipment rental rate schedule. https://www.dot.ny.gov/main/publications/publications-repository/equiprates.pdf

New York State Department of Transportation. (2024). *Official electronic standard specifications and standard sheets*. https://www.dot.ny.gov/main/business-center/engineering/specifications/busi-e-standards-usc

North Carolina Department of Transportation. (2018). *Standard specifications for roads and structures*. https://connect.ncdot.gov/resources/Specifications/StandSpecLibrary/2018%20Standard%20Specifications%20for%20Roads%20and%20Structures.pdf

North Dakota Department of Transportation. (2025). *Standard specifications for road and bridge construction*. https://www.dot.nd.gov/sites/www/files/documents/Standard%20Specifications/2025%20NDDOT%20Standard%20Specifications%20for%20Road%20and%20Bridge%20Construction.pdf

Ohio Department of Transportation. (2024). *2024 Equipment standard rates*. https://www.transportation.ohio.gov/working/publications/equipment-rates

Oklahoma Department of Transportation. (2019). *Standard specifications for highway construction*. https://oklahoma.gov/content/dam/ok/en/odot/documents/c_manuals/specbook/2019--full-spec-web-version.pdf

Oregon Department of Transportation. (2021). *Oregon standard specifications for construction*. https://www.oregon.gov/odot/Business/Specs/2021_STANDARD_SPECIFICATIONS.pdf

Pennsylvania Department of Transportation. (2020). *Publication 408: Standard specifications*. https://www.dot.state.pa.us/public/PubsForms/Publications/Pub_408/408_2020/408_2020_3/408_2020_3.pdf

Rhode Island Department of Transportation. (2018). *Standard specifications for road and bridge construction (Blue Book)*. https://www.dot.ri.gov/documents/doingbusiness/Bluebook.pdf

South Carolina Department of Transportation. (2007). *Standard specifications for highway construction*. https://www.scdot.org/content/dam/scdot-legacy/business/pdf/2007_full_specbook.pdf

South Dakota Department of Transportation. (2015). *Standard specifications for road and bridges*. https://dot.sd.gov/media/documents/2015_SDDOT_SpecBook.pdf

Tennessee Department of Transportation. (2021). *Standard specifications for road and bridge construction.* https://www.tn.gov/content/dam/tn/tdot/construction/2021-standard-specifications/January_1_2021_Standard_Specifications.pdf

Texas Department of Transportation. (2014). *Standard specifications for construction and maintenance of highways, streets, and bridges*. https://equipmentwatch.wpenginepowered.com/wp-content/uploads/spec-book-1114.pdf

U.S. Army Corps of Engineers. (2021). *Construction equipment ownership and operating expense schedule: Engineering regulation: EP 1110-1-8 (Rev. 1).* https://www.publications.usace.army.mil/Portals/76/Users/182/86/2486/EP%201110-1-8_RV1-12.pdf

Utah Department of Transportation. (2022). *2022 standard specifications for road and bridge construction*. https://highways.dot.gov/federal-lands/specs/state-specifications

Vermont Agency of Transportation. (2018). *Standard specifications for construction*. https://outside.vermont.gov/agency/VTRANS/external/docs/construction/02ConstrServ/PreContract/2018SpecBook/2018%20Standard%20Specifications%20for%20Construction.pdf

Virginia Department of Transportation. (n.d.). *Road and bridge specifications*. https://www.vdot.virginia.gov/doing-business/technical-guidance-and-support/technical-guidance-documents/road-and-bridge-specifications/

Washington State Department of Transportation. (n.d.). *Standard specifications for road, bridge, and municipal construction (M 41-10)*. https://www.wsdot.wa.gov/publications/manuals/fulltext/M41-10/SS.pdf


Illinois Department
of Transportation


ILLINOIS