

Investigating the Maintenance Cost of Rest Areas: A Case Study of Nevada

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Abstract: Highway Rest Areas are envisioned to provide an accessible space for rest and parking for travelers, especially those driving a long distance. In addition, modern highway Rest Areas provide many amenities to highway users, including wifi service, picnic tables, litter barrels, running water, public telephones, and sometimes even free coffee. Various studies were conducted in the domain of Rest Area facility design and their operating costs in different states; however, limited studies were conducted on the maintenance costs of these facilities. Therefore, this study's main objective is to compute the annual maintenance cost of Rest Areas in the state of Nevada. This study also analyzes the main cost categories of the maintenance works. The raw cost data of Nevada Rest Area maintenance from 1990 to 2012 were collected from the Nevada Department of Transportation (NDOT). Results show that the maintenance cost fluctuated over the study period; the maintenance cost decreased from 1991 to 2004 and then increased until 2012. The primary cost categories of maintenance work are labor, equipment, and material costs. Among these, labor cost was the largest category with 56 percent of the total maintenance cost, followed by equipment cost and material cost. The findings of this study may help NDOT and other transportation agencies plan their budget for future Rest Area maintenance activities.

Keywords: Rest Area, Maintenance Cost, Nevada

1. INTRODUCTION

Highway Rest Areas were introduced in the early 1900s in the United States [1]. These Rest Areas became a part of the National Highway System (NHS) when the government started NHS construction in 1956. The highway Rest Areas' primary purpose has been to provide for users' basic needs, such as restrooms, parking spaces, and drinking water, especially for those traveling long distances. Today, modern highway Rest Areas provide a wide range of amenities, including picnic tables, walkways, public telephones, tourist information with maps, RV dump stations, free wireless internet connection, litter barrels, vending machines for quick snacks and beverages, and free coffee. Because they provide rest to fatigued drivers, highway Rest Areas have become an essential part of the NHS for roadway safety. Furthermore, studies have shown that highway Rest Areas are also essential for highway safety [2]; around 20 percent of highway crashes and 12 percent of all near-crash incidents were due to fatigued drivers [3]. Another study showed that

highway Rest Areas are essential for reducing driver fatigue, distracted driving, and illegal roadside parking [4].

This study focuses on highway Rest Area maintenance costs. The maintenance work includes normal maintenance activities and repairs to keep the facilities working as expected. State Departments of Transportation (DOTs) maintain their highway Rest Areas using three basic methods. They are (i) the state force method, (ii) outsourcing maintenance work to private contractors under the traditional contracting method, and (iii) outsourcing work under the performance-based contracting (PBC) method [5].

Using the state force method, DOTs use their own staff to maintain Rest Areas [6,7]. They pay their staff regularly, purchase required materials, and use their own equipment or rent the necessary equipment to maintain their highway Rest Areas. As they use their own resources (labor, equipment, and materials), states plan their maintenance work as they need. Studies showed that the state force method is suitable for work that needs immediate attention. Roadway maintenance works (chip seal, striping, culvert cleaning, sweeping) accomplished by the state force method were cost-effective as compared to the work accomplished by private contractors [8,9,10].

State DOTs hire private contractors when they have more work that cannot be done with their in-house workforce on time [11,12,13,14]. States commonly use the traditional contracting method when they outsource the work to private contractors [15]. The traditional contracting method commonly awards the contracts to the lowest responsive bidder. Contractors perform the maintenance works based on method-based specification, which explains how to maintain the work, when to maintain the work, and what to maintain the work [15,16].

The PBC approach is a comparatively newer method to use in the transportation industry. This method focuses on the outcome performance of the PBC contractor, and payment to the contractor is tied with it. This means the payment to the PBC contractor is based on performance; incentives are provided for better work, and disincentives (penalties) are charged for out-of-quality work [6], [17,18,19,20]. The contractor's performance is evaluated based on the target values, which are clearly stated in the specification. Under complying with the performance target values, state DOTs issue payments to the PBC contractors in equal or unequal amounts regularly [6]. Existing studies showed that one of the main reasons for using the PBC method was to save costs [6]. Moreover, this method brings higher satisfaction levels to users [6], better work quality, fewer risks with state agencies, and better road user satisfaction [6,16].

In Nevada, there are 32 highway Rest Areas and one welcome center with a total of 102 buildings [21]. Some buildings are new (less than ten years old), while others are as old as fifty-two years. The statewide average age is 32 years. Figure 1 presents the Rest Area facilities (highlighted with yellow) on the NDOT Rest Area map [21]. As these Rest Areas are maintained by the state force method, the maintenance cost database was maintained by NDOT. Therefore, the cost database was downloaded from the NDOT database while visiting the Maintenance Division in Carson City, Nevada.

The overall goal of this study was to compute the annual maintenance cost NDOT spends for their Rest Areas and welcome centers and observe the maintenance cost trend over the study period. The primary objectives of this study were:

1. Identify and analyze the major cost components of the maintenance cost of highway Rest Areas and Welcome Centers
2. Compute the annual maintenance cost of highway Rest Areas and Welcome Centers for the study period of 1991 through 2012

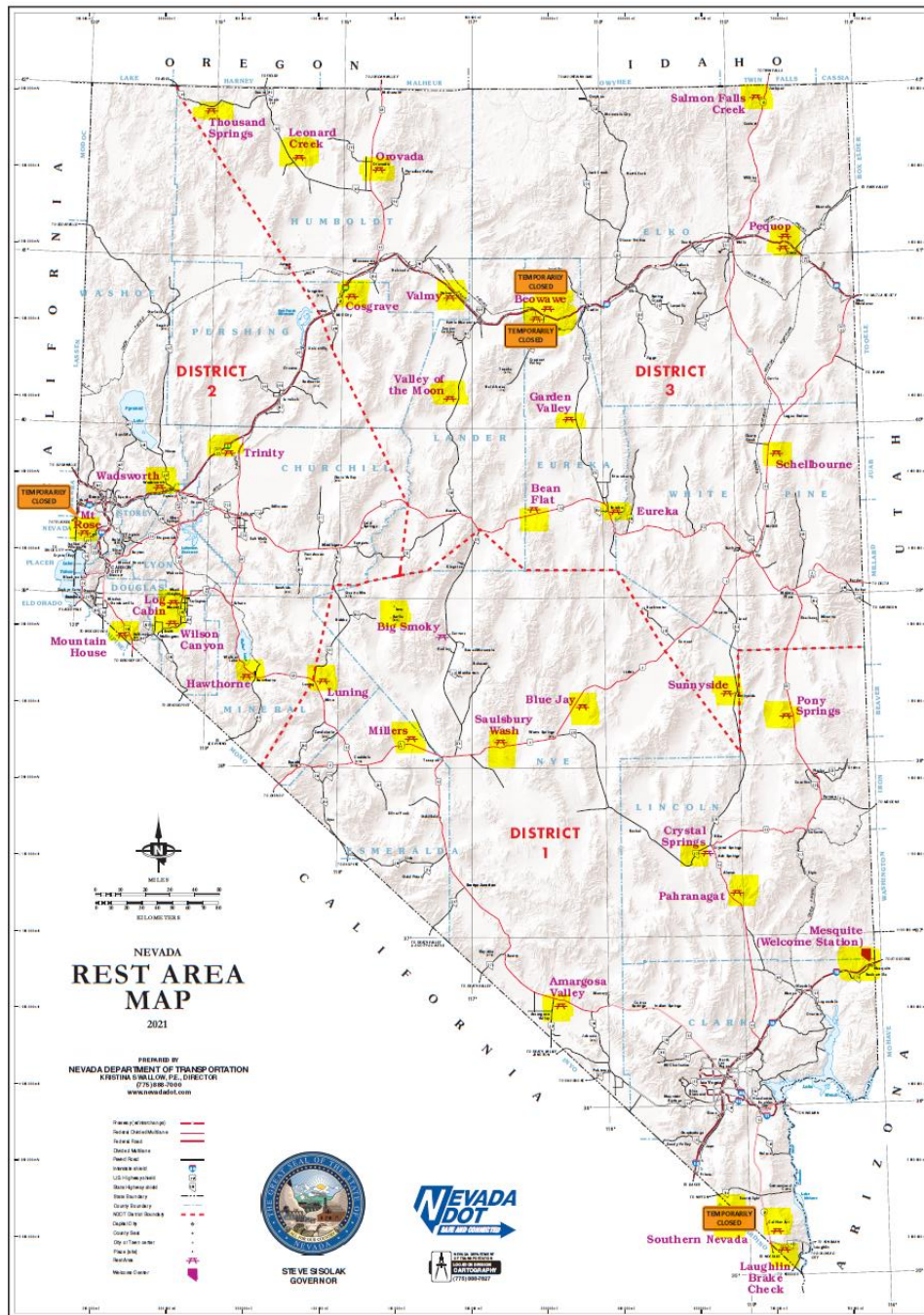


Figure 1. Rest Areas and Welcome Center in the state of Nevada [map credit: 21]

2. LITERATURE REVIEW

Shrestha and Powers (2017) conducted a study on Rest Area maintenance in different states [22]. A survey was conducted to identify in-depth information regarding methods used to maintain their Rest Areas. The study found that about 15 states, including Montana, used the PBC method to maintain their Rest Areas. The survey findings also showed that PBC and in-house workforce methods satisfied state DOT personnel more. The two main reasons that state DOTs switched to the PBC method were saving costs and reducing management strain. States reported they saved a

maximum of 15 percent in costs and improved their level of service using the PBC method. The respondents also shared lessons learned from using the PBC method. Some of the lessons learned were that the contract should be clear to the contractors and that they should use separate contracts for Rest Area maintenance and janitorial services.

The National Cooperative Highway Research Program (NCHRP) (1989) carried out a national survey and interviews to collect in-depth information regarding cost categories of operating Rest Areas and also calculated the benefit and cost ratio of having Rest Areas along highways [23]. This study reported that the annual operation cost of Rest Area facilities varied from \$26,000 to \$81,000 at that time. The main cost components of the total operation cost were labor, equipment, material, and miscellaneous costs. Out of these four cost categories, labor cost was almost 80 percent of the total annual operation cost on average. The findings also showed that the benefit and cost ratio was 3.0, which means the benefits of having highway Rest Areas were three times compared to the expenses.

Garcia-Diaz compared the cost of four routine maintenance works, including highway Rest Area facilities [24]. Cost data were collected from 403 projects for comparison purposes. The findings of this study showed that the maintenance costs of highway Rest Areas using the state force method in Texas were 34.7 percent higher compared to similar maintenance costs that used private contractors. For cost comparison, this study also considered indirect costs.

3. METHODOLOGY

After defining the objectives of this study, the researchers then carried out a literature review of existing studies. The highway Rest Area maintenance cost data were collected from the Maintenance Division of Nevada Department of Transportation, Carson City, Nevada. The Rest Areas were maintained by state force method. The cost data consist of data from 1990 to 2013 (calendar years); however, the 1990 and 2013 data were not complete. Therefore, only the data from 1991 to 2012 were considered in this study.

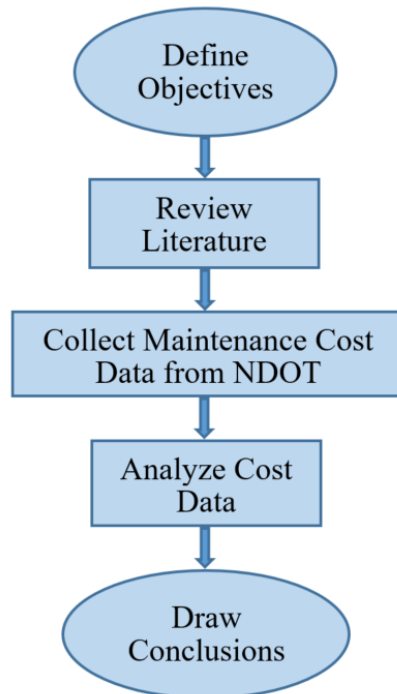


Figure 2. Research Methodology

The collected data consist of direct costs of labor, material, and equipment used for maintenance works. The labor cost was calculated by summing up all the costs charged under the labor category throughout each year; for example, the labor cost was \$953,955.62 in 1991 (see Table 1). This cost is the total labor cost spent to maintain all 32 Rest Areas and one Welcome Center in the state of Nevada in 1991. The same methodology was used to calculate the labor costs of the other years as well as the equipment costs and material costs of each year. These three direct costs were added up to compute the total maintenance costs of each year using Equation 1 below. With these annual maintenance costs, this study analyzed the cost data, and conclusions were made.

$$\text{Maintenance Cost of Year } 1 = \sum^{Year\ 1} (\text{Labor Cost} + \text{Equipment Cost} + \text{Material Cost}) \quad (1)$$

After the annual maintenance costs for each year from 1991 through 2012 were calculated using Equation 1, five-year average maintenance costs were computed. For example, the five-year average cost data of 1995 (\$538,921.88, as seen in Figure 3) is the five-year average cost of 1991 through 1995. The exact process was adopted to compute other five-year maintenance costs.

4. RESULTS AND DISCUSSIONS

As per the study's objectives, the annual maintenance costs were computed using Equation 1; furthermore, five-year average maintenance costs were also computed, as explained in the Methodology section. Figure 3 presents five-year average maintenance costs of Nevada Rest Areas. It first decreased and then increased. The data point shows that the annual maintenance cost decreased until 2007 and then increased until 2012 (see Table 1 for details of annual maintenance costs). There are various factors that affect the maintenance costs of highway Rest Areas; one of the factors is the age of the facilities. Therefore, the reason for the increased maintenance cost after 2007 may be due to the increasing age of said facilities. The R-square value of the trendline is 0.68.

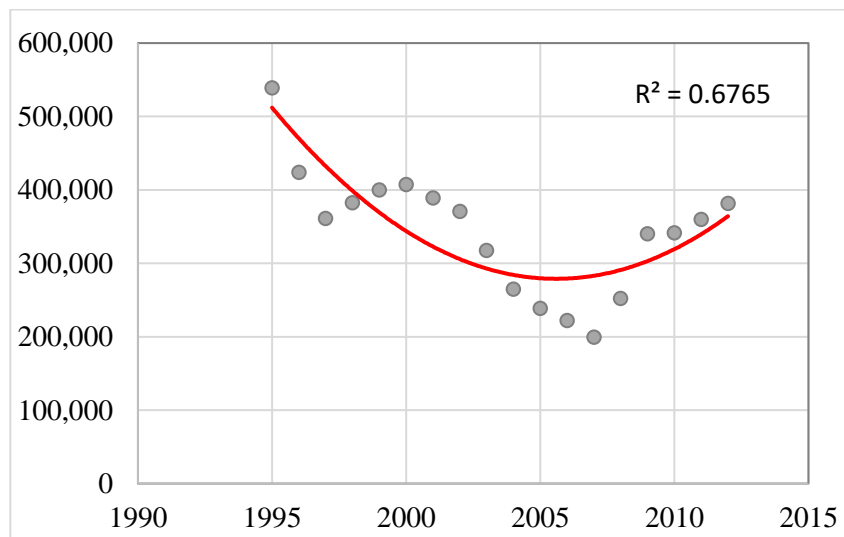


Figure 3. Total Annual maintenance cost (five-year average)

The annual maintenance cost (total cost in Table 1) consists of three cost components. They are labor cost, equipment cost, and material cost. Table 1 presents the detail of each of the cost components and the total costs from 1991 through 2012. The highest dollar cost spent was \$1.65 million in 1991, and the lowest dollar cost spent was \$0.30 million in 2004.

Table 1. Labor, equipment, material, and total maintenance costs from 1991 through 2012

Year	Labor Cost (\$)	Equipment Cost (\$)	Material Cost (\$)	Total Cost (\$)
1991	953,955.62	528,101.10	169,230.90	1,651,287.62
1992	709,840.26	324,582.54	144,853.10	1,179,275.9
1993	367,326.72	199,862.37	79,026.74	646,215.83
1994	335,157.66	205,761.86	67,072.90	607,992.42
1995	328,329.14	202,814.41	66,985.62	598,129.17
1996	378,997.60	239,209.50	86,602.97	704,810.07
1997	396,427.50	226,819.34	74,352.95	697,599.79
1998	473,028.36	260,093.20	96,302.14	829,423.70
1999	423,144.51	224,382.32	88,811.46	736,338.29
2000	364,918.15	179,763.75	90,955.22	635,637.12
2001	288,588.74	139,918.45	62,831.91	491,339.10
2002	304,710.05	142,779.43	48,124.78	495,614.26
2003	205,316.63	129,437.66	33,336.04	368,090.33
2004	160,047.77	119,486.76	24,501.19	304,035.72
2005	233,536.09	148,971.31	40,289.98	422,797.38
2006	205,781.53	112,356.09	27,294.70	345,432.32
2007	192,980.43	124,499.69	27,721.77	345,201.89
2008	467,872.31	215,082.49	218,775.72	901,730.52
2009	601,822.41	190,288.78	342,651.92	1,134,763.11
2010	238,941.29	102,045.43	103,256.46	444,243.18
2011	298,411.58	134,412.71	130,636.18	563,460.47
2012	299,990.55	140,755.82	129,457.15	570,203.52

The total labor cost, equipment cost, and material cost from 1991 through 2012 were calculated from Table 1. The percentage of each cost category was computed to see the highest and lowest spending categories. The results showed that labor cost is the highest cost category (56%) of the total maintenance cost. The NCHRP study also showed that the labor cost category was the highest expenditure in maintaining the highway Rest Areas [23]. This may be because the highway Rest Area maintaining work is labor-intensive and uses minimal materials and equipment. Moreover, labor cost is expensive in the United States. Figure 4 illustrates the percentage of three cost components in a pie chart.

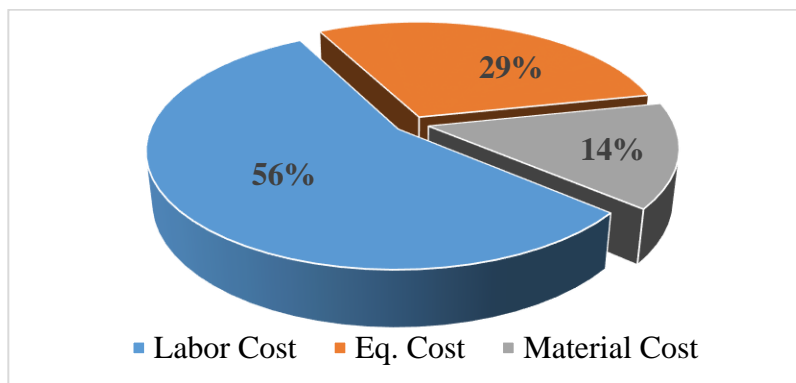


Figure 4. Cost components of annual maintenance cost

5. CONCLUSIONS AND RECOMMENDATIONS

Rest Areas along highways are essential infrastructure for highway safety. They provide places to rest, parking spaces, and restrooms. They also provide many amenities, including wireless internet service, picnic tables, litter barrels, running water, tourist maps, public telephones, and sometimes free coffee. The annual maintenance cost is important for states to plan their maintenance budget, and there are limited studies carried out on the maintenance cost of Rest Areas. The key objective of this paper was to compute the annual maintenance cost of Rest Areas in the state of Nevada and their cost components.

The Rest Area maintenance cost consists of three different cost components. They are labor, equipment, and material costs. The results show that labor cost is the highest category, with over half of the total maintenance cost, followed by equipment cost (close to one-third of the total cost) and material cost. This may be because the nature of maintenance work is labor-intensive, with labor being more expensive compared to the rental cost of equipment and material cost used in this type of work. When the labor cost of this study was compared with the findings of another study conducted by the NCHRP, the labor cost percentages were found to be similar; the percentage was over half of the total cost [23].

This study calculated overall annual maintenance cost of Rest Areas and Welcome Center in the state of Nevada from 1991 through 2012. The annual maintenance cost spent by the Nevada Department of Transportation fluctuated over the study period, and five-year average costs were calculated for analysis. The result shows that the annual maintenance cost decreased until 2004 and then increased until end of the study period of 2012. This may be because the age of the buildings. The maintenance cost of older buildings are higher than newer buildings.

For further study, it is recommended to collect more detailed maintenance cost data for each Rest Area and compare the maintenance cost of Rest Areas between states. It would also be helpful to include major renovations and the age of the buildings.

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