

Minimizing Total Cost of Work Zones on Two-Lane Roads With Managed Lanes

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ABSTRACT

Roadway work zones are associated with extensive spending budgets while resulting in significant traffic delays. Agencies and researchers aim to minimize construction cost and duration while reducing traffic interruption. When it comes to two-way two-lane roads, traffic is significantly impacted by the work zone due to a lane closure. Utilizing a shoulder as a temporary managed lane allows for two-way movement simultaneously. Utilizing managed lanes can increase the cost of construction but can enhance the efficiency of the work zone scheduling. This paper aims to evaluate managed lane strategies for two-lane work zones by optimizing the work zone length and project starting time while minimizing the total cost consisting of both the agency and the user costs. The mathematical model developed allows planners to compare costs associated with utilizing managed lanes. A Numerical example with sensitivity results is presented in this study. The results of the numerical example suggest that utilizing one-lane closure may provide the least total cost whilst limited to short work zones and low demand periods. The sensitivity analysis showed that managed lanes are more suitable to handle longer work zone segments and can accommodate high demands. Additional aspects to be considered are the safety and environmental impact of utilizing managed lane in the work zone.

INTRODUCTION

Two-way two-lane highways are an integral part of the United States' highway system, providing 54.6% of all principal arterials, 86.1% of all minor arterials, and 97.9% of all major and minor collectors in the nation.

Work zones on two-way two-lane highways block one lane of the traffic and both directions of the road alternate the use of the open lane with the help of a flagger or a signal as typical operation.

The use of shoulders as managed lanes allows for two-way movements, increases the capacity, and reduces delays in work zone segments.

Previous studies on two-lane work zone focused primarily on improving one-lane operations, while utilizing managed lanes are investigated for work zone on multilane roads.

This study aims at presenting a simplistic and practical model to estimate the minimized total cost and optimal work zone length and compare the results of one-lane operation with utilizing managed lanes.

METHODOLOGY

The total cost (C_t) function is represented as a combination of agency cost and user cost

The agency cost includes fixed setup cost (C_1), road-work cost (C_2), and managed lane preparation cost (C_3).

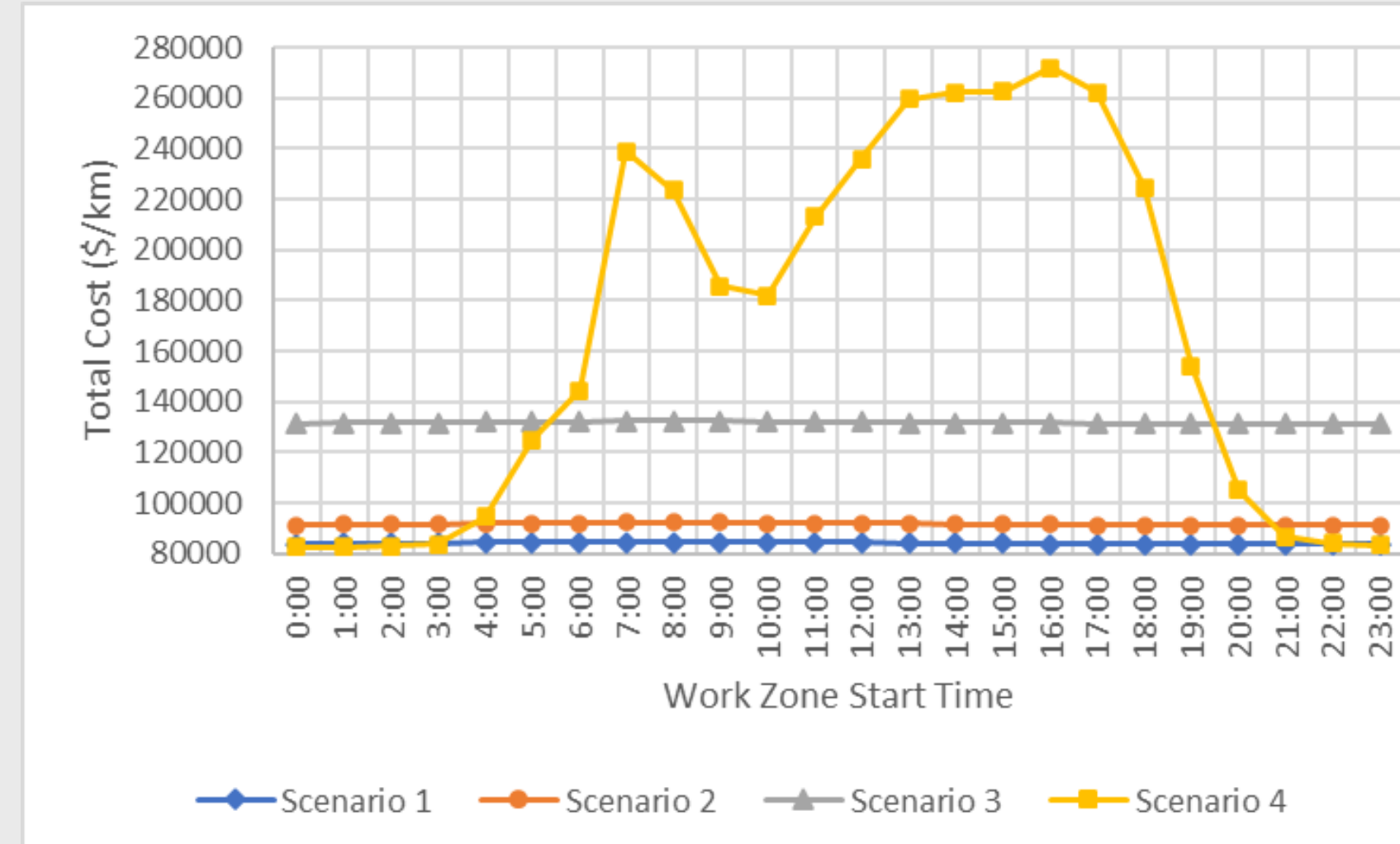
The user cost includes costs associated with queuing delay (C_q), moving delay (C_m), and stopping delay (C_s).

The objective function is: $min C_t = C_1 + C_2 + C_3 + C_q + C_m + C_s$

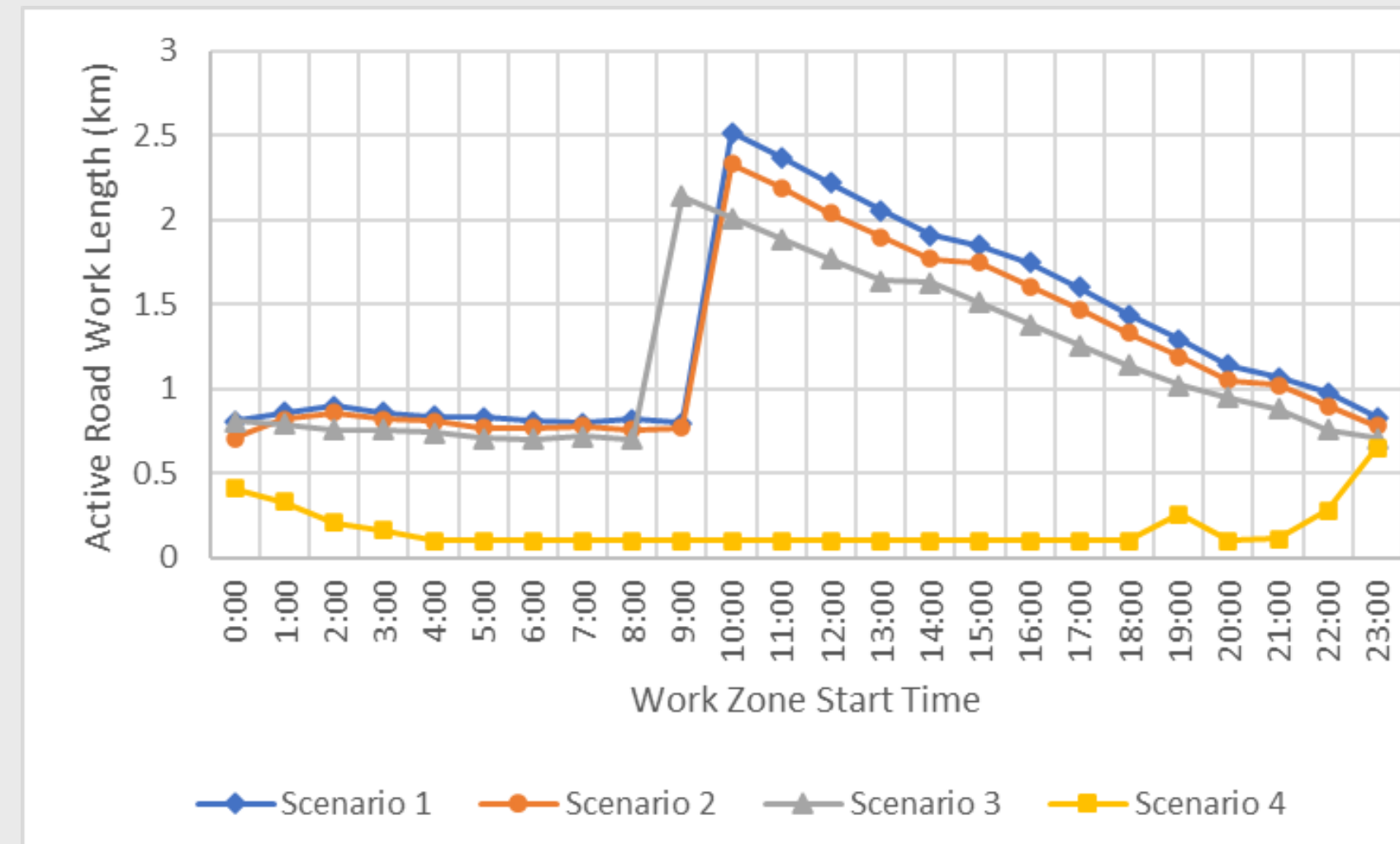
All cost components of the objective function are converted to \$/km to for comparison purposes.

Four scenarios management are considered:
 Scenario 1: Low-cost managed lane
 Scenario 2: Medium-cost managed lane
 Scenario 3: High-cost managed lane
 Scenario 4: Typical Flagger operation

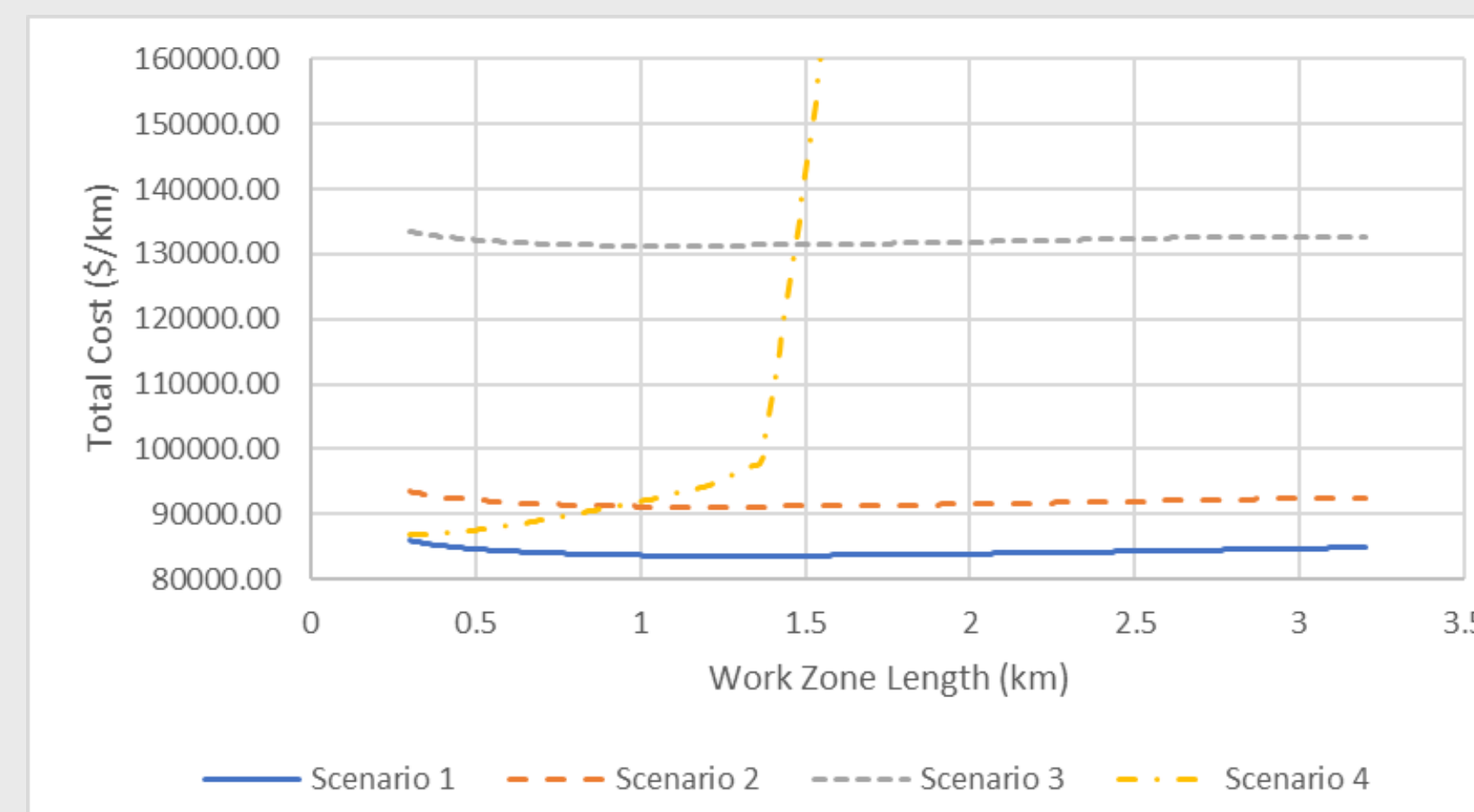
Total Cost Associated with Project Start Time



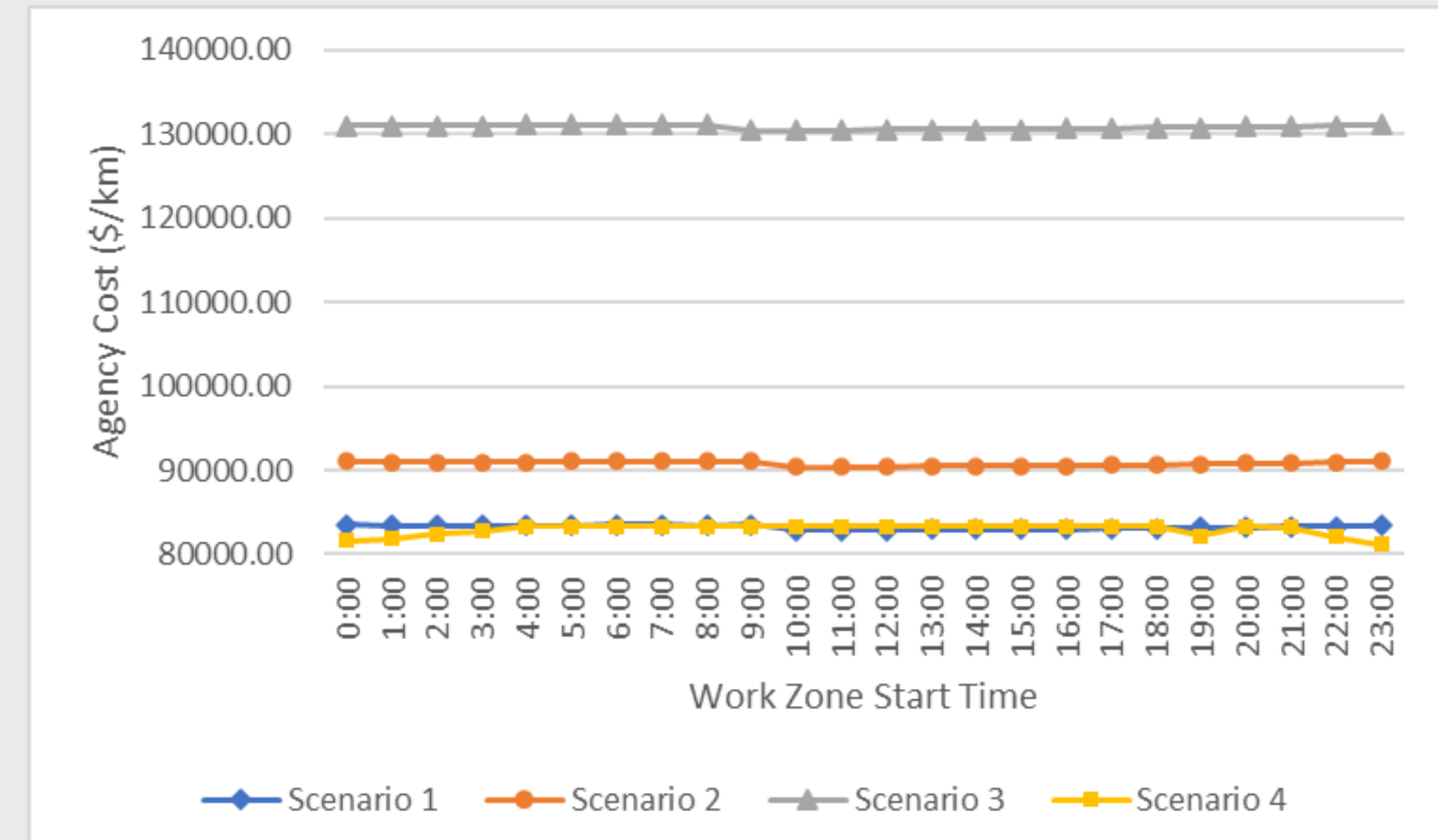
Optimal Work Zone Length Associated with Project Start Time



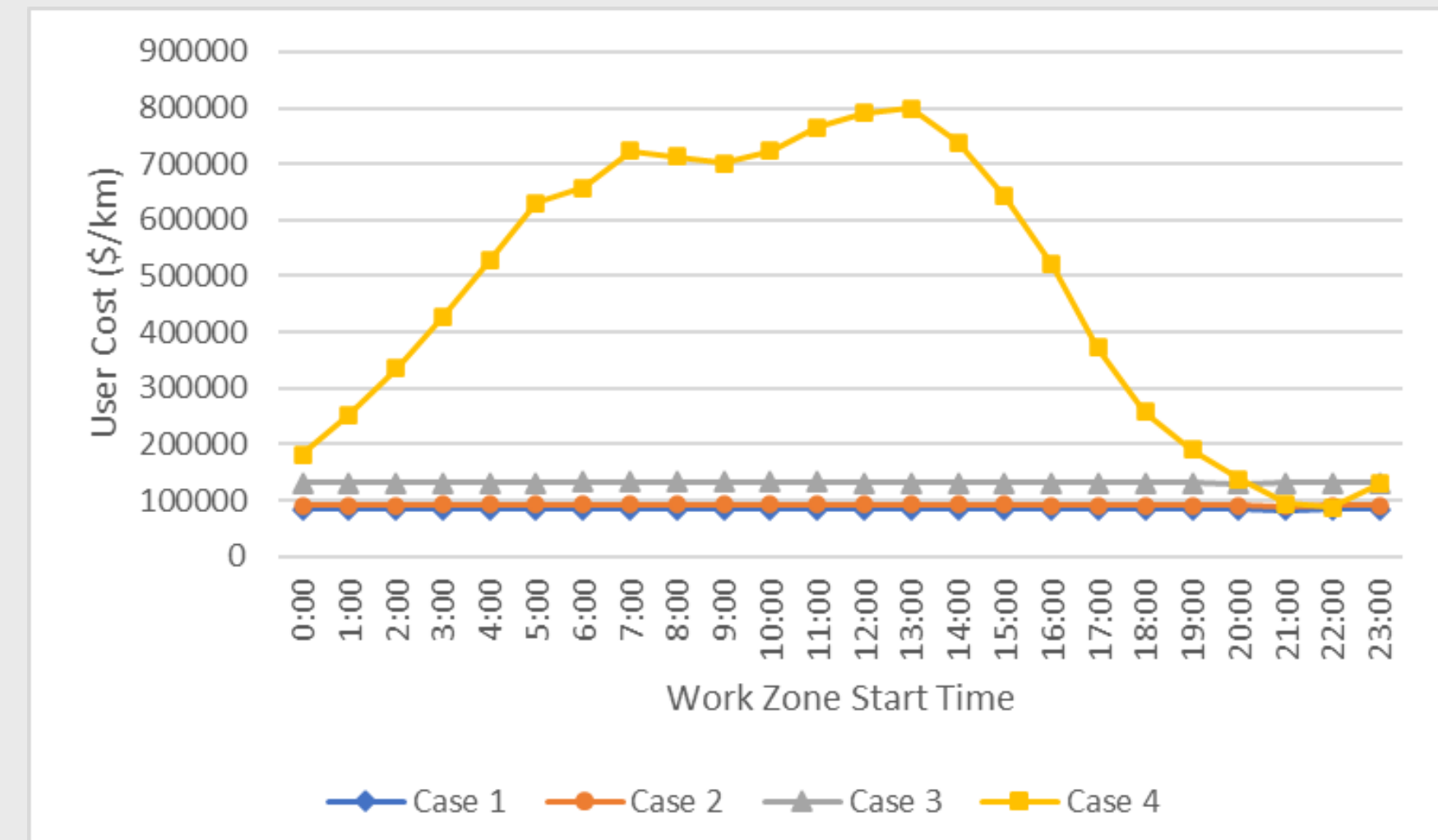
Affect of Work Zone Length on Total Cost



Agency Cost Associated with Project Start Time



User Cost Associated with Project Start Time



CONCLUSIONS

Flagger operation is suitable during low demand periods and for small work zone segments.

Managed lanes improves the capacity of the work zone segment, allowing for longer segments and fewer work zone setups.

Work zones during peak hour demands can be handled when utilizing managed lanes.

Continuation of the study will investigate variation in labor cost, safety concerns, and environmental impacts.