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Project Title

Analysis of Benefits and Costs for Gravel and Unpaved Roads

University

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Research Needs

According to the Bureau of Transportation Statistics, there are approximately 1.4 million miles of unpaved road in the United States comprising 33% of all road miles. (Bureau of Transportation Statistics 2017) In rural states such as North Dakota, the proportion of unpaved roads is much higher (83%). (North Dakota Department of Transportation 2014).

Unpaved and gravel roads are the primary facilities for the transportation of agricultural products in the upper Midwest. Two major changes in the agricultural industry affecting these roads are increased tonnage per acre due to a shift to corn/soybean rotations and consolidation of elevator locations (Upper Great Plains Transportation Institute 2016). These factors combined result in a higher concentration of additional truck trips to fewer locations. In North Dakota, shale oil production and distribution have increased the damage to unpaved roads resulting in extreme maintenance demands for counties and townships.

Unpaved roads are owned and maintained by county, township or tribal jurisdictions. Due to lower funding levels, there may be a lack of formal planning and prioritization of unpaved road networks with a focus on repair rather than preservation. As construction costs increase, prioritization of scarce funds is required to maintain an existing system. Over the last decade, construction costs have increased while funding has remained relatively constant (Federal Highway Administration 2018).

The question of whether a road is paved or not may be determined using a life-cycle cost analysis (South Dakota Department of Transportation Office of Research 2004). At higher traffic levels, a paved surface may be justified on a life-cycle cost basis. However, this type of analysis does not include user costs, which may lead to justification of a paved surface at lower traffic levels than under life-cycle cost analysis alone. Even in cases where surface type change is not

warranted, consideration of user costs may result in justification of current or increased maintenance and improvement activities. “There is a significant difference in the cost to the user between driving on a gravel surface and on a paved surface. User costs, therefore, are appropriate to consider in the pave/not pave decision” (Federal Highway Administration 2000).

Justification of paved surfacing is only one rationale for study of user costs. Increased overlay and maintenance of gravel roads to maintain condition comes also comes with a cost. Continued or accelerated maintenance and overlay and usage of base stabilization and dust control of gravel roads to maintain and/or improve surface condition will impact road users through maintaining or reducing user costs. Quantification of benefits and costs of road improvements is critical for two primary reasons: project justification and project prioritization. A breadth of research exists on user costs in relation to paved roadways and when combined with pavement deterioration models, forecasts of costs under various build scenarios can be analyzed over time. Similar research related to gravel and unpaved roadways is limited, with a focus on developing countries (R 2004) as well as in the region (Xiao Quin 2013). A variety of gravel road deterioration models have been specified (Uys 2011) utilizing condition, weather and traffic data among other variables. Linking these models to existing condition-related user cost models could be used to develop estimates of the benefits of ongoing maintenance and improvement.

This research is intended to develop a framework that includes user costs, condition analysis, life-cycle analysis and benefit-cost analysis for use in quantifying the impacts of maintenance and improvement activities on unpaved and gravel roads.

Research Objectives

1. Compile a summary of literature on the impact of surface condition to road user costs
2. Compile a summary of literature on the user costs for travelers on unpaved roads
3. Develop and implement a benefit-cost framework to assess the benefits and costs of gravel road maintenance practices under differing cost, condition, and traffic levels considering improvement, maintenance, and user costs
4. Develop and implement a model that utilizes the benefit-cost framework in objective 3 in conjunction with life-cycle analysis to compare costs of maintaining unpaved to paved surfaces as well as different levels of gravel road maintenance

This study ultimately will develop and document a model which links life-cycle cost analysis with a benefit-cost framework to analyze the costs and benefits associated with unpaved roads under varying traffic levels. As traffic levels increase, life-cycle cost analysis may justify an improvement that would improve roadway condition or convert an unpaved roadway to a paved roadway. This study would add to the analysis by including a comparison of user costs as a result of roadway type and condition.

Research Methods

- Life-cycle cost analysis
- Benefit-cost analysis
- Road condition impacts on user costs
- Project Prioritization

This study will utilize a combination of existing methods for application to gravel roads. The traditional benefit-cost framework will be enhanced with additional modeling of user costs resulting from improvement or deterioration of roadway condition. Gravel road deterioration models will be utilized to estimate the impact of higher traffic volumes on roadway condition. These models in conjunction with the surface type selection criteria outlined by the South Dakota Department of Transportation will compare surface type options using life-cycle analysis. Comparison of benefits and costs of roadways exhibiting various traffic levels (and corresponding maintenance costs) will serve as a framework for project prioritization.

Expected Outcomes

This research will develop a framework for use for local planners to plan and prioritize investments on unpaved roads. In addition, the resulting model will be of use to policymakers as it can be used to demonstrate benefits of investment in low volume unpaved roads.

Relevance to Strategic Goals

Preserving the existing transportation system: this study addresses preservation by attempting to quantify the economic benefits of continued investment in very low-volume unpaved roads or potential conversion of those roads to paved surfaces.

Educational Benefits

Graduate student involvement in data collection, literature review, and outreach.

Technology Transfer

Presentation to county officials through Transportation Learning Network, training sessions for interested counties, and presentations to academic and professional audiences will be used to share project findings.

Work Plan

1. Literature Review
    a. User costs for unpaved roads
    b. Maintenance and improvement practices related to traffic levels
    c. Road condition under different maintenance practices and traffic levels
    d. Life-cycle cost analysis under differing traffic levels
    e. Surface type analysis under differing traffic levels

2. Model of user costs based upon roadway condition

3. Model of maintenance practices under differing traffic levels
    a. Data collection
    b. Development of analytical model based upon reported practices and existing literature

4. Benefit-Cost Model of Gravel Improvement and Maintenance Practices
    a. Spreadsheet-based tool

5. Surface Type Selection/Intermediate Improvements Based Upon Traffic Levels
    a. Update existing South Dakota study to current funding levels

6. Compilation of spreadsheet-based models to estimate benefits and costs of maintenance under varying traffic levels

The timeframe for this project is two years. During Year 1, Tasks 1 and 2 will be the primary focus. Task 1 will develop a summary of relevant literature for each of the subcategories of this study. Task 2 will utilize the output of task 1 to link roadway condition to user costs in a similar manner to existing pavement models. Task 3 will begin during year 1, but will be the primary focus of year two. Tasks 4 and 5 build upon Task 3 and deliverables include narrative as well as a spreadsheet tool for analysis. Though not specified in the proposal, tasks 4 and 5 will involve outreach to roadway superintendents and engineers for input before finalization. Task 6 will be completed as the study progresses in both years as preceding tasks are completed.

Project Cost

Total Project Costs:	$140,000
MPC Funds Requested	$ 70,000
Matching Funds:	$ 70,000
Source of Matching Funds:	NDSU Uncollected Indirect Costs

References

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