



APPENDIXD: Reimagining the C&P Report

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Reimagining the C&P Report

Over the past 50 years, the C&P Report series has provided an objective assessment of current system conditions and future investment needs. Its target audience includes the U.S. Congress, all levels of government, policy makers and analysts, academia, transportation associations, industry, news media, and the public. It raises public awareness of the physical conditions, operational performance, and financing mechanisms of highways, bridges, and transit systems, and promotes an understanding of the importance of these transportation investments.

The C&P Report is a dynamic and evolving product, which has periodically undergone substantial overhauls and enhancements. A good example is the introduction of benefit-cost analysis (BCA) to the process for estimating future investment needs through application of the Highway Economic Requirements System (HERS), introduced in the 1995 C&P Report; the Transit Economic Requirements Model (TERM), introduced in the 1997 C&P Report; and the National Bridge Investment Analysis System (NBIAS), introduced in the 2002 C&P Report. These models are presented and described in Appendices A, B, and C, respectively.

MAP-21 (the Moving Ahead for Progress in the 21st Century Act) incorporated performance management principles into the Federal-aid Highway Program. States have set targets for several key performance measures and are reporting on their progress in meeting these targets. This shift toward more performance-driven and outcome-based programs has direct and indirect implications for future C&P Reports. At the most basic level, the introduction of other performance reporting requirements in MAP-21 might necessitate some content changes to future C&P Reports, both to take advantage of newly available data and to avoid unnecessary duplication of information presented elsewhere. The accompanying shift in the processes that States and metropolitan planning organizations (MPOs) use for planning and performance management also has implications for assessing future transportation investment needs. State and local agencies are adopting more outcome-based approaches to investment decision-making, which has significant implications for the potential impacts of future investment on system performance and how these impacts are simulated. In addition, the data, analytical tools, and techniques developed to support the implementation of performance management could yield new approaches that can be adapted to refine or replace HERS, TERM, and NBIAS.

With these issues in mind, the Federal Highway Administration (FHWA) initiated the *Reimagining the C&P Report in a Performance Management-Based World* effort in late 2012. Preliminary scoping work was conducted in 2013 to document who uses the C&P Report, to assess the utility of the report to FHWA program offices, and to identify options for presenting information more effectively. This effort identified two areas of potential improvement to align better with performance measures: communication and methodology. Two major research projects were initiated in 2014, one with the objective of enhancing communication approaches and the other aimed at improving estimation methodologies to compute investment needs.

Enhanced Communication

Currently, the C&P Report is issued in print form and the entire report is posted online using standard Adobe Acrobat and HTML formats. Based on recommendations from the completed research project to enhance communication approaches, several features were introduced in recent editions of the C&P Report to improve its visual appeal. These improvements include a shift from black and white to color, addition of several infographics, new maps and photos, and changes to the writing style and structure of the report. It is anticipated that the demand for improved visualizations will lead to additional changes to the C&P Report.

Although the C&P Report contains useful information and serves as a valuable reference document, its sheer size creates some problems for users. Because writing and reviewing the document is a lengthy process, the report is often transmitted to Congress after newer data have been published

elsewhere. Many of the data series in the biennial report are updated annually, which means that readers must often look elsewhere to find the latest available data.

Another potential improvement under consideration, based on recommendations from the research project on communication approaches, is to develop an interactive website to complement the print report. An interactive website may improve the readability, accessibility, and usability of the information in the report by:

- Incorporating enhanced visualization of the graphs and tables;
- Adding interactivity in the report website that will enable readers to drill down to various subsets of data or create desired views of information of interest;
- Migrating some detailed, supplementary analyses to the website, allowing the print version to focus on key findings;
- Enabling readers to view and access the underlying raw data tables with added capability to export charts and graphs as tables and images; and
- Facilitating more frequent data updates than are currently possible for the C&P Report.

A follow-on to the 2014 communication project is underway to explore alternatives for enhancing the current report, focusing on data visualization and an interactive Web-based design. The underlying goal of this multiyear effort is to facilitate ease of use by a wider audience of readers and enable the alignment of performance-based information in the C&P Report with the information obtained from State and MPO performance management processes.

Data Visualization

Data visualization is the representation of data in a pictorial or graphical format. It is the easiest way for the brain to receive and process large amounts of information quickly and intuitively. As part of this follow-on effort, alternatives are being explored to improve the communication of data in print and on the Web through advanced data visualization tools and infographics. For the print version of the C&P Report, new static graphics are being developed to help readers visualize complex information on highways, bridges, and transit, making the details easier to understand at a glance, some of which have already been integrated into the 23rd and this 24th edition. FHWA is exploring ways to condense contents of each chapter into formats that are more accessible to the public, such as bullet points, at-a-glance boxes, and content optimization for print layout.

For the online version of the C&P, FHWA is examining ways to present selected contents through interactive data visualization to convey information from in-depth and complex analytics. Through their intuitive interfaces, data visualization tools enable customized analytical views with flexibility and ease by multiple users with diverse demands. One option being considered is an online platform to support the use of more dynamic and interactive graphics, such as customized dashboards and charts filtered per the user's unique needs. For example, an interactive pavement ride quality dashboard would depict percent of vehicle miles traveled (VMT) on pavements with good, fair, and poor ride quality by functional classification. The user would have the option to filter results by year, by urban and rural boundary, ride quality (good/fair/poor), and roadway functional system. Then the user may decide to download the supporting data in different data formats, save an image for a presentation, or share the link to the exhibit on the social media.

Web-based User Interface

Another part of this follow-on effort is the development of a demonstration C&P website allowing FHWA to explore and evaluate visualization techniques and tools that could be used online. A goal of this exercise is to gather feedback from users regarding their preferences about the balance between the print and Web version of the report and the best ways to inform, attract, and retain users. Ultimately, a new digital publishing platform could integrate traditional formats such as PDF with many interactive elements such as embedded video and audio, and interactive graphs. To attract and maintain the attention of an increasingly mobile audience, an upgraded website could

use a responsive Web design to accommodate data exploration and communication across all common types of devices, including touchscreen and mobile devices.

A critical part of developing an enhanced future C&P Report website is ensuring that it complements existing online resources and potential new resources coming online in response to the MAP-21 State and MPO performance reporting requirements. In many cases, providing links to information posted in other locations might be sufficient, allowing the C&P website to focus mainly on elements unique and central to the C&P Report.

Methodology Improvement

The ability to analyze and forecast future investment needs of the Nation's highways and bridges has been and will continue to be a bedrock of FHWA responsibility. FHWA continues to seek ways to improve its analytical tools, as can be seen in its ongoing research project to improve estimation methodologies to compute investment needs.

Simulation modeling, used to forecast usage and investment needs, inherently involves compromises, as the desire for detailed, reliable predictions must be balanced against data collection burdens and computational tractability. The tools and methodologies currently used in the C&P Reports reflect several analytical simplifications introduced to conduct the desired analysis with the available data and resources. Since the initial introduction of these tools, a new generation of analytical tools and models has been developed that provides advanced methodologies in asset management and performance management.

HERS, TERM, and NBIAS are being revised and updated continually to incorporate newly refined data and tools. Building on this ongoing improvement effort, a research project is currently underway to scan and compare methods for assessing investment needs and to propose new and improved methods for more precise and comprehensive needs estimation in the C&P Reports. Several analytical frameworks are being explored to identify potential alternative methodologies and upgrades to the current BCA approach. This project, initiated by FHWA, includes a systematic review of performance management tools that States and local governments currently use and potential new approaches to be incorporated in the analytical framework. The goal is to identify practical approaches for improving the C&P Report methodology in the future.

Evaluation of Alternative Methodologies

The first stage of this research effort involved evaluating alternative methodologies that could be used to replace or supplement the BCA-driven tools currently used in the C&P Report. Two potential alternative decision methodologies were reviewed: the multi-criteria decision method (MCDM) and value for money.

MCDM allows for consideration of performance objectives that are difficult to monetize. Therefore, MCDM frequently includes some performance measures that are not limited to monetary terms or condition matrices. It is a flexible tool, enabling the evaluation of projects based on multiple performance measures such as environmental sustainability, livability, and safety. Its application, however, hinges on the selection of appropriate performance measures and assignment of weight to each performance measure, which could be challenging for national investment analysis, as well as being incompatible with the principles underlying the economic approach to investment modeling.

As defined in the Eddington Transport Study of the United Kingdom, value for money is another methodology that measures wider economic and reliability benefits.¹⁴⁷ It assesses the economic, environmental, social, distributional, and fiscal impacts of an investment based on both quantitative, monetized information and qualitative information at the project level. Although this approach helps

¹⁴⁷ The Eddington Transport Study (2006). *The Case for Action: Sir Rod Eddington's Advice to Government*. Available at <http://webarchive.nationalarchives.gov.uk/20090104005813/http://www.dft.gov.uk/about/strategy/transportstrategy/eddingtonstudy/>.

guide the modeling of reliability and economic impacts, scaling the findings from individual projects to the national system and obtaining a strategic allocation of resources for infrastructure investment would be challenging.

Other assessed methodologies and tools that may be used to incorporate additional performance measures into the C&P Reports include integrated land use and transport models, broader economic impacts models, life-cycle cost analysis models, highway operations and congestion cost measurement models, work zone models, bridge and pavement management models, and BCA models. Three modeling tools—the EconWorks Case Studies, the Transportation Economic Development Impact System (TREDIS), and the Prioritization Scenario Model (PRISM)—were examined closely for their potential contributions to C&P analytical framework improvement.

Although these alternative methodologies could provide a new framework for the C&P evaluation of a national investment program, it would be challenging to generalize them from individual projects to the entirety of the highway system at the national level. The BCA technique currently used in HERS remains an appropriate approach for examining traffic condition, capacity, and current and future traffic load.

Identification of Alternatives for Refining BCA Methodology

After identifying BCA as the main methodology for investment prioritization for the C&P analysis, the second stage in this research effort involved identifying and specifying alternative techniques to refine the current BCA approach. After reviewing many options, four possible alternative refinements were picked for in-depth study to evaluate their feasibility and relevance to be integrated into the HERS framework: integrating performance measures, tradeoff analysis, freight analysis, and incorporating connected and automated vehicles (C/AV).

MAP-21 established national performance goals for Federal highway programs in safety, infrastructure condition, congestion reduction, system reliability, freight movement, environmental sustainability, and reduced delays in project delivery. After careful study, the research team selected performance measures related to pavement, safety, congestion and reliability, and bridge performance. These performance measures, which are similar to values already used in BCA methods, can be integrated into HERS predictive models in C&P analysis and reporting without substantial coding efforts.

Currently, project selection in HERS is based on the type of deficiency and the improvement's benefit-cost ratio (BCR). The tradeoff analysis allows the user to intervene in this process by changing project selection priorities other than HERS's current economic analysis. Once HERS develops the ability to report costs and budgets by performance categories (safety, congestion, and pavement), tradeoff analysis can be performed by the priority order of performance categories based on BCR. In each funding period, projects are selected in the priority category until the category's budget is exhausted. Alternatively, projects could be selected based on the priority category with the highest BCR. For example, if both congestion and pavement projects are being evaluated by HERS and the priority category is pavement, then the pavement project is selected even if its BCR is lower than that of the congestion project.

Section 167(h) of title 23, United States Code requires a biennial report describing the conditions and performance of the National Highway Freight Network, which is included in Part III of this report. Options for enhancing freight analysis capabilities for the C&P Report are being explored as part of the effort to reimagine the C&P Report. One option is to create a freight corridor sketch tool to display the freight performance measures on a national network based on the Freight Analysis Framework. The process will enable reporting of annual freight flows by region and easy extraction of routing data through existing travel demand models. Another option is to include additional logistics-specific benefits for national freight network corridors.

The increasing deployment of connected and automated vehicles will have significant impacts on national highway conditions and performance. Many experts have indicated that this will represent

the most significant discontinuity in the relationship between highway demand and supply since the development of the Interstate System. Although estimating the C/AV market penetration is highly uncertain at this point, it can affect highway system traffic patterns, VMT, safety, pavement, and infrastructure needs. Hence, C/AV merits consideration in C&P methodologies and reporting. A potential approach to incorporating C/AV analysis is to develop sensitivity testing of key C&P parameters related to C/AV, including a time frame for introduction and adoption, market penetration, and automation level mix. Impacts of C/AV on highway conditions and performance are bracketed between different partial and full automation scenarios.

FHWA also considered the feasibility of integrating needs analysis for pedestrian and cyclist infrastructure and of integrating network analysis into the C&P highway needs assessment. However, these two enhancements can be implemented only after the establishment of data standards and appropriate modeling approaches. For current research efforts, only the four refinements discussed above are being further explored for the feasibility of being integrated into the HERS framework.

Integration of Performance Management and Needs Estimation

With the completion of the systematic review of tools and potential new improvements, the project has now moved to the next stage, which involves integrating the findings identified in the assessments of BCA refinements and alternative decision methodologies with HERS modeling. This combination will enable a detailed evaluation and comparison of several comprehensive approaches to upgrading the current national needs estimation process. The decision of feasible combination will be based on policy priority, data availability, the time requirement, and program coding complexity.

Once appropriate analytical frameworks are identified, new components could be added to HERS and NBIAS, or a new generation of analytical tools could replace these models.

Moving Forward

FHWA invited an external panel of experts representing State departments of transportation, MPOs, academia, and other experts to review the analytical framework of the C&P reports in mid-2018. The review presented a series of recommendations for research options to improve the methodologies, models, and tools in C&P reporting and the feasibility of implementation.

Although FHWA began the research initiatives described in this appendix, the Federal Transit Administration (FTA) is a full partner in the development of the C&P Report and is closely involved in these efforts. FTA has initiated its own reviews regarding future analytical approaches and report presentation and content. As potential enhancements become more fully refined through current research efforts, external outreach will be conducted to ensure that any changes to the report content and structure will improve its usefulness to Congress and other stakeholders. Although the objectives of the report will remain unchanged, the goal of this effort ultimately is to provide a multimodal product with cutting-edge analytics that improve users' experience.