National Operations Center of Excellence
Agency Perspectives on Cost / Benefit Methods and TSMO
Virtual Peer Exchange

PURPOSE AND OVERVIEW

NOCoE's *Agency Perspectives on Cost / Benefit Methods and TSMO* virtual peer exchange hosted transportation agency professionals with experience in developing, implementing, and justifying to decision-makers cost / benefit and/or return on investment analysis for TSMO projects and programs to support policy makers and agency leadership.

The peer exchange was held virtually using the NOCoE's Zoom software and developed as a short one afternoon exposure to concise aspects of the topic. Staff from specific programs with experience in the topic were invited to speak and attend. The peer exchange was also open to state and regional TSMO stakeholders.

AGENDA

Tuesday, December 6, 2022

Time	Topic	Speakers
1:00 pm – 1:15 pm (15 min.)	**Module 1 – Welcome and Introduction** • Facilitator Welcome • Agenda Review • Summary of Advance Questionnaire	· Welcome from Faisal Saleem, NOCoE · All · Douglas Noble, ITE
1:15 pm – 1:45 pm (30 min.)	**Module 2 – Leadership and FHWA Perspective** • Agency Leadership Perspective • FHWA Resources	Tony Kratofil, HNTB, (formerly Michigan DOT) Jim Hunt, FHWA
1:45 pm – 2:30 pm (45 min.)	**Module 3 – Application of Cost /Benefit Analysis Methods** • Michigan DOTs Benefit-Cost Analysis for TSMO • TxDOT Statewide TSMO Benefit-Cost Analysis *Format: 8-10 min. presentations followed by ~half hour discussion / Q&A.*	Stephanie Palmer, Michigan DOT Barbara Russell, TXDOT
2:45 pm – 3:00 pm	**BREAK**	

3:00 pm – 4:00 pm (60 min.)	**Module 4 – ITS Deployment Evaluation and Evidence-Based Decision-Making** • Decision Support Resources • Return on Investment (ROI) Best Practice Guide • Use Cases *Format: 30 min. presentations followed by ~half hour discussion / Q&A.*	Marcia Pincus, ITS-JPO Claire Silverstein, Noblis Chris Bischak, Noblis Kathy Thompson, Noblis
4:00 pm – 4:30 pm (30 min.)	**Module 5 – Virginia DOT Return on Investment for TSMO Approach** *Format: 15 min presentation followed by ~quarter hour discussion / Q&A*	Paul Szatkowski, VDOT Inger VanOsdell, Kimley-Horn (VDOT contractor) Mike Harris, Kimley-Horn (VDOT contractor)
4:30 pm – 4:45 pm (15 min.)	**CLOSING** Gaps, Potential Actions, and Next Steps	

** All times list as Eastern Standard Time.*

SESSIONS

Introduction

The *Agency Perspectives on Cost / Benefit Methods and TSMO* virtual peer exchange was conducted in an "agile" format as a virtual 3 ¾-hour meeting. There was an introductory session and four content sessions with breakout discussion/question and answer periods. At the conclusion of the peer exchanges participants were asked to identify, gaps, potential actions, and next steps.

In advance of the peer exchange participants were sent a brief questionnaire with three questions:

- *What measures does your agency use to compare or justify TSMO investments (projects, programs, or services)?*

  More than 70 percent of the responses showed use of cost/benefit analysis and system performance measures. Less than 30 percent of the responses indicated use of return on investment analysis.

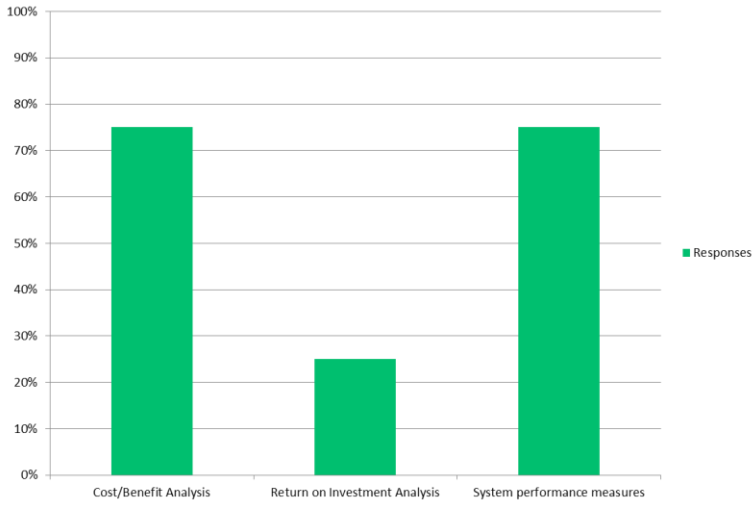

Figure 1. Measures Agencies Use to Compare or Justify TSMO Investments.

- *How does your agency compare TSMO projects, programs, or services?*

  In the questionnaire responses agencies approximately 30 percent of agencies compared projects within TSMO only while 55 percent compared TSMO and ITS projects together. Only 10 percent of responses indicated that TSMO projects were compare with other projects across an agency's capital improvement program

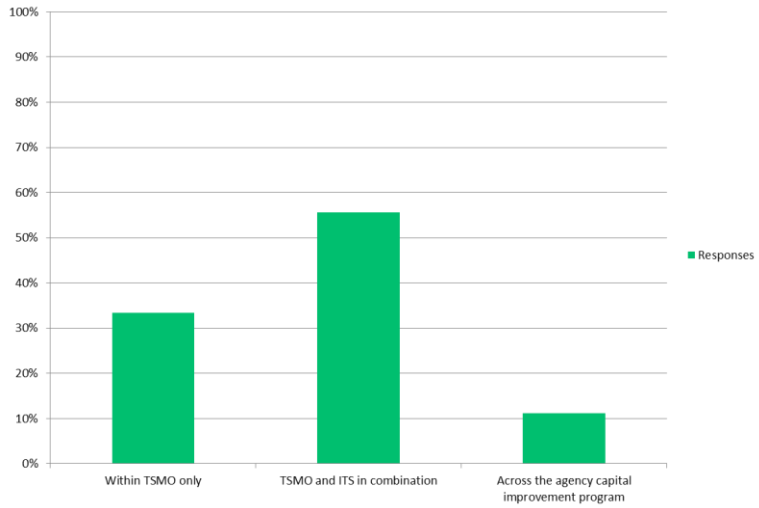

Figure 2: Responses How does your agency compare TSMO projects, programs, or services?

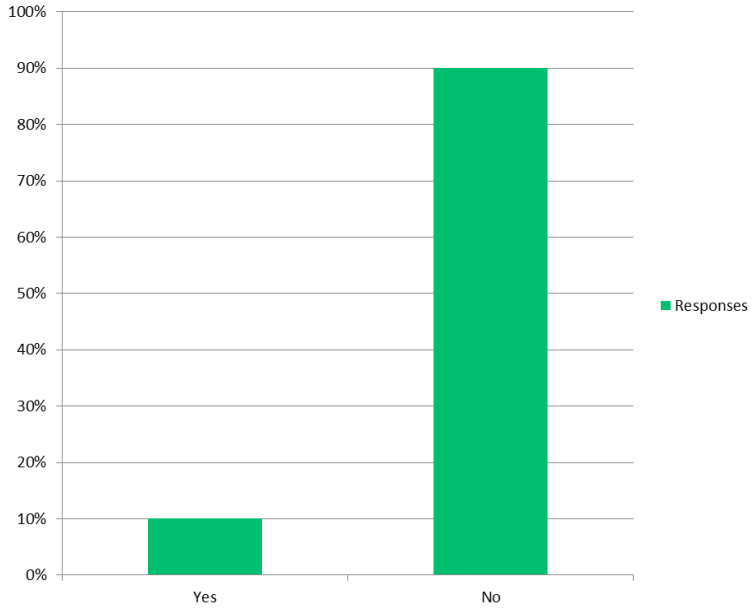

Figure 3: Does your agency incorporate full life cycle costs in your analysis method?

- *Does your agency incorporate full life cycle costs in your analysis method?*

  Somewhat surprisingly, 10 percent of the responses indicate that agencies incorporated full life cycle costs into their analysis method. This is a potential topic for future consideration.

Leadership and FHWA Perspective

Summary

To kick off the peer exchange the participants heard an agency leadership perspective from Tony Kratofil (formerly with Michigan DOT) on what executive level staff need from cost/benefit analysis to make

informed decisions as well as the current perspective from Jim Hunt on available resources available from the Federal Highway Administration (FHWA).

Agency Leadership Perspective

- Noted where cost/benefit analysis fits into the Capability Maturity Model (CMM) as a part of the business processes element and what that means in the context of the CMM levels for TSMO as an agency moves from Performed Managed Integrated and Optimized
- Discussed TSMO as a complementary role in supporting the Safety System Approach with the following linkages:
  - Safer People → Traveler Information Systems
  - Safer Vehicles → Connected and Automated Vehicles
  - Safer Speeds → Active Traffic Management
  - Safer Roads → TSMO Infrastructure
  - Post-Crash Care → Traffic Incident Management

FHWA Perspective

- Definition of *benefit/cost analysis*:[1] A weighing of the net present value of direct benefits with the net present value of lifecycle costs of a project.[2]
- Observed that decisionmakers often have difficulty weighing the benefits of investing in operations strategies versus more traditional infrastructure capacity projects. Benefit/cost analysis helps decisionmakers consider the value of operations projects.
- Distinction between benefit/cost analysis and economic impact analysis:
  - Benefit/cost analysis is a tool for decision-makers that considers a project's or program's direct impacts on measures of effectiveness (MOEs) associated with the efficiency of the transportation system in their native measurement and converted to monetary value in comparison to lifecycle costs:

Benefits	Costs
▪ Travel time	▪ Equipment
▪ Safety	▪ Operations and Maintenance
▪ Reliability	▪ Software
▪ Congestion	▪ Communications
▪ Emissions	▪ Installation
▪ Energy costs	▪ Associated infrastructure
▪ Productivity	▪ Others

  - Economic impact analysis examines positive or negative change in overall activity of a geographic area due to project or program implementation:
    - Focused on more broad regional economic activity and jobs
    - Considers the direct, indirect, and induced impacts of the project or program
    - Serves as a tool for politicians and the public

[1] Note that FHWA and agency presentation use the term "benefit/cost analysis" which is interchangeable with the "cost/benefit analysis" used by other organizations.

[2] Note the "lifecycle" element to this definition vis-a vis the advance questionnaire responses in Figure 3.

- Benefit/cost analysis provides the ability to:
  - Prioritize operations projects based on expected efficiency of investment.
  - Compare operations with non-operations projects on an even playing field.
  - Justify operations projects and strategies for consideration.
  - Benefit/cost analysis supports pre-deployment and post-deployment evaluations.
- Benefit/cost analysis has key role in discretionary grant program applications.
- Hierarchy of applications to TSMO investments analysis:
  - Transportation tools
    (e.g., FHWA BCA.NET Highway Project Benefit-Cost Analysis System)
  - Transportation program areas
    (e.g., TOPS-BC operations benefit cost analysis tool)
  - Technology-specific tools
    (e.g., *Clear Roads* Road Weather Management benefit-cost toolkit and Traffic Incident Management Benefit-Cost [TIM-BC] Tool)
- Summary overview provided of the TOPS-BC Tool.
- Specific FHWA resources are listed in the Resources Appendix of this summary.

Application of Cost /Benefit Analysis Methods

Summary

The next section of the peer exchange presented two agencies' examples of benefit/cost analysis methods in practice. The first presentation was by Stephanie Palmer from the Michigan Department of Transportation (MDOT) sharing her agency's approach. She was followed by Barbara Russell of the Texas Department of Transportation (TxDOT) sharing information about their statewide TSMO benefit/cost analysis methodology.

<u>MDOT's Benefit/Cost Analysis for TSMO</u>

In 2018 MDOT created a new Traffic Operations Program funded at $50 million annually with the goals to improve traffic flow, congestion, reliability, safety and reduce user delay. This was created as a statewide performance-based competitive program. MDOT uses both the FHWA TOPS-BC Tool and their own in-house benefit/cost analysis tool for to evaluate TSMO projects:

TOPS-BC is used for active traffic management projects such as part-time shoulder use, ramp metering, and variable speed limits (e.g., used to evaluate US-23 Flex Route based on predicted performance). Parameters were updated in 2021 as part of in-depth research study by Michigan State University.

<u>Advantages</u>

- Easy to use spreadsheet format
- Minimal inputs are needed
- Great for ATDM such as ramp metering or hard shoulder running

<u>Disadvantages</u>

- Must choose only one strategy to evaluate
- Developed for specific TSMO strategies
- Although simple inputs- need to do some modeling or analysis

MDOT TSMO benefit/cost analysis tool is used for project specific improvements with the following scoring criteria for TSMO Projects:

- (30 points) Benefit/Cost Ratio
- (30 points) Overall Benefit based on program goals and strategies.
- (20 points) Safety Benefit based on Time of Return
- (10 points) PTI > 2 or LOTTR > 1.5
- (10 points) Level of Service: E or F, or Travel Time Index > 1.5

Advantages

- Easy to use spreadsheet format
- Developed to align with operation template requirements
- Adaptable for most operations projects

Disadvantages

- Additional analysis is needed to get inputs for tool
- Only safety and operational benefits are calculated (others entered manually)

TxDOT Statewide TSMO Benefit-Cost Analysis

As documented in the TxDOT Statewide TSMO Benefit-Cost Analysis this approach plays an important role in the TSMO decision-making process to determine:

- Whether or not a TSMO strategy or project should be implemented.
- When a TSMO strategy or project should be implemented.
- Which among competing strategies, alternatives and projects should be funded given a limited budget.
- Whether or not the TSMO strategy or project was cost effective after being implemented.

The 2020 Statewide TSMO Strategic Plan Update provides high level strategies to improve the capability maturity of the TxDOT organization in alignment with TSMO goals.

Three techniques used in the overall benefit/cost analysis process through project development are

- Benefit-Cost Analysis (Qualitative Method) – provides a high-level assessment of the benefits, costs and benefit-cost ratio (BCR) in qualitative terms.
- **B**enefit-Cost Analysis (Quantitative Method) – provides a more detailed methodology, and supporting software tools, to estimate quantitative benefits, costs and benefit cost ratio.
- Benefit-Cost Analysis (Before & After Study) – provides an assessment on how well the TSMO strategy is performing post implementation.

TxDOT uses a combined approach to benefit/cost analysis for a number of reasons. The FHWA TOPS-BC is a sketch-planning level decision support tool developed intended to be used to conduct benefit/cost analysis for a wide range of TSMO strategies. While TOPS-BC is useful for conducting analysis of "systems and technology" applications, the tool does not match up well in a relevant manner to the other CMM dimensions where qualitative analyses are more appropriate for the agency. To support the technical review, qualitative benefit/cost ratings are developed to prioritize the high level TSMO strategies that then feed into the District TSMO Program Plans. As a result the current set of near-term strategies are:

- Strategy No.1 - Develop and Apply Methodology to Allocate ITS/Signals O&M Funding to Align with TSMO Goals.

- Strategy No. 5 - Conduct Cybersecurity Vulnerability Analyses of IT Networks to Improve Resiliency.
- Strategy No. 10 - Develop Enhanced Traffic Signal System Implementation Plans.
- Strategy No. 18 - Support Rural District Operations that have Limited Resources to Support TSMO Goals.
- Strategy No. 19 - Strengthen TIM Collaboration with Stakeholders to Safely Reduce Incident Clearance Times.

The lessons learned, including benefit/cost analysis and before/after studies will be used as feed back to the next set of TSMO strategy implementation.

Discussion

In the ensuing discussion following the presentations the following points were raised:

- Always budget competition for scarce resources where there is never enough. Cost/benefit analysis is a common tool familiar to non-TSMO programs and hence allows consistent consideration across budget categories.
- Consistent demonstration of positive benefit/cost ratio for TSMO projects and programs helps keep them in consideration for budget allocation.
- There is a need for more routine consideration of TSMO at the project level.
- Reiterated that discretion grant programs require cost/benefit analysis as part of the applications.
- TSMO is useful in comparisons for tradeoff analysis at program level at Michigan DOT to consider which choice of state of good repair vs. TSMO vs. congestion management to split the whole budget pie.
- TSMO projects and programs necessarily have a life cycle approach.
- TSMO important in addressing non-recurring transportation impacts (system reliability MOE)
- Weighting of MOEs is an important consideration across the set of potential projects or programs as this can substantially affect the result ratios.
- Diversity, equity, and inclusion considerations are hard to quantify in benefit/cost analysis as are indirect workforce elements such as staffing considerations related to a particular strategy.
- An example service patrol contract has different 6 performance measures to compare, but to identify a reasonable baseline for comparison in TOPS-BC some measures need to be removed
- The available benefit/cost analysis tools assume implementation in isolation (e.g., service patrols and monitoring at the same time are not additive, but there is synergy) or don't allow for partial or overlapping implementation of strategies.
- A state representative stated that they do upfront work at the statewide level before moving to the district priorities, and even so the results from the consultant basically fell into two categories of strategies, integrated corridor management or signal timing.
- Another person observed that even with the benefit/cost analysis tools it is hard to directly attribute a $30M fiber communication project back to specific TSMO strategy vis-à-vis associated civil projects. In many cases there is no requirement for technology in infrastructure projects.
- MDSHA uses a consistent approach to TSMO benefit/cost analysis that is integrated into the capital improvement program.
- Concern that the monetization of benefits creates aggregate values the public and leadership simply find fanciful.

- There was discussion of the use of before and after studies to document benefits and costs associated with specific project level strategies.
- Local branding is important for public and internal buy-in

ITS Deployment Evaluation and Evidence-Based Decision-Making

Summary

Marcia Pincus and her support team from the ITS Joint Program Office of U.S. DOT provided an overview of their ITE Deployment Evaluation program with additional information on the data and decision support resources. The ITS Deployment Evaluation Program addresses a varied spectrum of needs throughout the full ITS deployment lifecycle and provides information to assist the ITS community with making evidence-based decisions on ITS investment, deployment, and assessment, more specifically to:

- Disseminate data on ITS deployment benefits, costs, and best practices
- Survey and analyze public sector ITS deployment trend data
- Knowledge and technology transfer

The following information is from a walk through the ITS Deployment Evaluation web resource and key topic area pages:

- General search and dropdown menus of subtopics
- Benefits by topic area and available content for each entry
- Costs by type and available content for each entry
- Cost element ranges and detailed data on sample unit costs paid in individual project for ITS elements
- Executive briefings
- Deployment case studies with learning objectives and context with-specific costs, benefits, and/or lessons learned

In addition, the ITS Deployment Evaluation web resource offers Decision Support Resources such as:

- Data visualizations (infographics, cost plots, and interactive)
- Return-on-investment (ROI) planning resources (guide and use cases)

Return on Investment (ROI) Best Practice Guide outlines a suggested high-level consistent methodology for approaching an ROI analysis using established research and data to provide a business case for project feasibility, program prioritize techniques, and approaches to communicate the value of a strategy to various audiences. The ROI Use Cases demonstrate how the methodology in the guide can be applied for a range of ITS and TSMO strategies.

VDOT Return on Investment for TSMO Approach

Summary

Paul Szatkowski of the Virginia Department of Transportation (VDOT) and Inger VanOsdell from VDOT's support consulanat Kimley-Horn presented on VDOT return on investment (ROI) approach for TSMO.

The agency uses ROI as a method for quantifying and then comparing the total costs to the total expected benefits of a project. In Virginia, ROI has been used in Interstate Corridor Improvement Plans to:

- Assess the *feasibility* of a strategy
- *Prioritize* operations strategies within a program
- Obtain *buy-in* from leadership and other stakeholders

The VDOT approach involves six steps beginning with identifying the transportation challenges with a data driven approach, public meetings and public comments along with meetings with VDOT traffic operations staff. Then the project team identifies potential TSMO strategies in traffic operations, multimodal service, and capital projects. With each of the possible TSMO strategies, benefits in safety, mobility, and environment are found and estimated/calculated with site specific data and trusted data sources such as VDOT dashboards and evaluations, ITS benefits database, FWHA's TOPS-BC, and other trusted sources. The benefits are then monetized.

Cost estimates include capital costs for all components and PS&E as well as integration costs for software and on-going operations and maintenance costs. Cost data is collected from VDOT current and historical costs, USDOT's ITS Deployment Evaluation Database(s), vendors, and other sources. Finally, the ROI is calculated:

$$\text{Benefit-Cost Ratio (BCR)} = \sum \text{Benefits} \div \sum \text{costs:1}$$

$$\text{Return-on-Investment (ROI)} = (\sum \text{benefits} - \sum \text{costs}) \div (\sum \text{costs}) \times 100\%$$

The agency identified and number of challenges and opportunities with their ROI approach:

Challenges

- Obtaining relevant benefits data can be challenging – especially for emerging TSMO strategies
- Assumptions and references need to be clearly cited
- Fatalities can have a significant impact on benefit calculations
- Rising costs (materials, fuel, etc.) can impact ROI results

Opportunities

- Develop a consistent framework for ROI/BCA in Virginia
- Contribute to FHWA Resources
  - ITS Benefits and Costs Databases
  - TOPS-BC
  - BCA/ROI Guide and Use Cases
- Revisit ROI/BCA results using actual costs and evaluation results

Discussion

After the presentations, the peer exchange broke into two groups for discussion and the following points were shared:

- Using public engagement to define challenges with real data and listening to the feedback to inform the process (e.g., an MDOT project had 71 public meetings).

- There needs to be a short answer to the regular more generic question of, "Why TSMO strategy xxxxxx in comparison to an additional traffic lane. What is the difference in benefit cost ratio? What are the overall and specific tradeoffs?
- Is there a need for a framework for TSMO strategy analysis to compare choices to traditional capacity analysis? There is work available on multimodal level of service vs. vehicular level of service for example.
- Support was expressed for the case study approach and the availability of more examples.
- What other topics for infographics in the ITS JPO Decision Support Resources would be useful?

The participants were asked what TMSO strategies were their agency's current focus. These included: dynamic messages signs, cameras, smart work zones, queue warning, variable speed limits, automated traffic signal performance measures, and early TSMO consideration in project development as well as considerations for connected and autonomous vehicles.

With regard to TSMO strategy costs it was noted that agencies are typically using installation, equipment, and operations and maintenance costs in their analysis.

Benefits measures include incident response time, reduced congestion, travel time reliability, safety improvement, and energy reduction. It was noted that the benefits identified in the ATTAIN grant program (e.g., equity, resiliency, etc.) are an emerging area where there are limited examples.

Agency representative identified the following needs:

- Shortage of technical staff who understand and can perform benefit cost analysis.
- Time and resource capacity to create alternatives and do calculations across multiple combinations of TSMO strategies.
- Methods other agencies communicate the information in reports, dashboards, etc.
- Converting qualitative benefits into quantitative measures
- How to quantify benefits that may also accrue to a neighboring jurisdiction (another state, or adjacent cities in a metropolitan area)

NEXT STEPS

NOCoE will meet the FHWA and ITS JPO representatives to review this peer exchange findings and work on next steps. FHWA noted that there is an older NOCoE webinar that steps through the TOPS-BC tool and a National Highway Institute course is planned, but is some time out. Based on participants'

feedback, it is anticipated that priority items that need to be further explored in a full peer exchange or other venue are:

- Detailed walk through of an example project(s) using the different available benefit/cost and/or ROI analysis tools and supporting data resources .
- Structuring of strategies and alternatives for benefit/cost and/or ROI analysis for areas and corridors.
- Addressing issues of synergy between different strategies as well as overlapping or partial implementation as part of an alternative.

Separately, it was suggested that a brief resource on the benefit/cost analysis methods used by different agencies would be useful. In addition, there was discussion during the course of the peer exchange on how benefit/cost and/or ROI analysis fits into the overall agency prioritization of capital and annual budget programming, especially at the local and regional level. Additional case study examples were supported by participants.

RESOURCES

Federal Highway Administration

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Sallman, Douglas, Krista Jeannotte, et al. *Operations Benefit/Cost Analysis TOPS-BC User's Manual*, Report No. FHWA-HOP-13-041. Washington, DC: U.S. Department of Transportation, Federal Highway Administration, 2013.

Lawrence, Michael, Paul Nguyen, et al. *Transportation Systems Management and Operations Benefit-Cost Analysis Compendium*, Report No. FHWA-HOP-14-032. Washington, DC: U.S. Department of Transportation, Federal Highway Administration, 2015.

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Virginia Department of Transportation. "I-95 Corridor Improvement Plan." Accessed March 30, 2023.

Virginia Department of Transportation. "I-81 Corridor Improvement Plan." Accessed March 30, 2023.

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