Prequalification Criteria for Pavement Inspectors

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BACKGROUND
OCTA Measure M

- OCTA = Orange County Transportation Authority
- 34 cities, 3.1 million people, over 6,000 miles of city and county roads
- Eligibility for Measure M funds based on network PCI values
- Scope: Evaluate the ability of inspectors to identify and report distress according to ASTM D6433-11/Paver
Prequalification Study Design

• Select minimum 20 control sections
• Survey to establish “baseline” PCI values
• Factorial:
  ▪ Surface: AC, ST, PCC
  ▪ Condition: Poor to Very Good
  ▪ Traffic: Low to High
  ▪ Typical control section:
    • 100’ x 36’ (for manual surveys)
    • 200’ x 12’ (for automated surveys)
PREQUALIFICATION STUDIES AND CRITERIA
2011 Study Details

- First OCTA prequalification study
- 16 control sections (out of 20 candidate sections)
- 21 inspectors (manual surveys)
- 1 windshield survey
- Criteria:
  - More than 50% within “baseline” PCI +/- 5
  - Less than 10% outside “baseline” PCI +/- 15
2011 Results

The diagram shows a scatter plot with the x-axis representing Baseline PCI and the y-axis representing Reported PCI. The data points are distributed along several lines indicating a trend: the Equality Line, +5, -5, +15, and -15. The scatter plot suggests a positive correlation between Baseline PCI and Reported PCI, with most points falling above the Equality Line, indicating that reported PCI values are generally higher than baseline PCI values.
2011 Findings

- General trend:
  - Consultants **overestimate** PCI
  - Agency inspectors **underestimate** PCI
- Only 1 inspector met the prequalification criteria
- Outcome dependent on the number of sections (e.g. 10% of 16 = 1.6 sections: not practical)
2011 Recommendations

- RMSE proposed as better criterion

\[
RMSE = \sqrt{\frac{\sum_{i=1}^{n} (RPCI_i - BPCI_i)^2}{n}}
\]

- RMSE ≤ 12 recommended, would result in 12 inspectors being qualified out of 22

- Inspectors from the same firm/agency did not perform independent surveys

- The prequalification requirement was temporarily waived.
2013 Control Sections
2013 Study Details

- 19 new control sections, (originally 20, one eliminated later in the analysis)
- 18 inspectors (manual surveys, most of them participated in the 2011 study)
- 3 automated surveys
- Windshield surveys not allowed
- Modified Criteria:
  - More than 47% within “baseline” PCI +/- 5
  - Less than 12% outside “baseline” PCI +/- 15
2013 Results

The chart illustrates the relationship between baseline PCI and reported PCI across various consultants and agencies. Each point on the graph represents the PCI values for different projects managed by different consultants and agencies. The chart includes different symbols and colors for each consultant and agency to distinguish their data points.

Key takeaways from the chart include:
- The majority of data points are clustered around the diagonal line, indicating a strong correlation between baseline PCI and reported PCI.
- Some consultants and agencies show a higher deviation from the diagonal line, possibly indicating more significant differences in PCI reporting.
- The chart helps in understanding the performance consistency of different consultants and agencies in managing pavement assets.
2013 Findings

• Only 3 inspectors met the prequalification criteria
• No difference between agencies and consultants
• Surveys appear to be independent
• RMSE ≤ 14 was used instead and resulted in 13 inspectors being qualified out of the total 18 manual surveys.
• All 3 automated surveys had RMSE ≥ 18
2013 Additional Findings

- PCI variance higher for low PCI sections
- Same trend observed in 2011 study
- Same trend confirmed by 2014 study
Average PCI Vs. PCI Standard Deviation

\[ y_{\text{All}} = -3.5995x + 100 \]
\[ R^2 = 0.4135 \]

\[ y_{2011} = -3.0785x + 100 \]
\[ R^2 = 0.5035 \]

\[ y_{2013} = -3.5503x + 100 \]
\[ R^2 = 0.5248 \]

\[ y_{2014} = -4.4436x + 100 \]
\[ R^2 = 0.4727 \]
Estimate PCI standard deviation as a function of the baseline PCI using:

\[ SD_{PCI} = \frac{100 - PCI}{3.6} \]

- SD = 2.8 when PCI = 90
- SD = 9.7 when PCI = 65
- SD = 12.5 when PCI = 55
- SD = 18.1 when PCI = 35
Proposed Prequalification Criterion

- Normalized RMSE proposed as better criterion:
  \[ nRMSE = \sqrt{\frac{\sum_{i=1}^{n} \left( \frac{RPCI_i - BPCI_i}{SD_{PCI}} \right)^2}{n}} \]

- Suggested decision matrix:
  - \( nRMSE \leq 1.0 \): Prequalified for 2 years
  - \( nRMSE \leq 1.4 \): Prequalified for 1 year
  - \( nRMSE \leq 1.6 \): Allowed to repeat and resubmit
  - \( nRMSE > 1.6 \): Disqualified
2014 Study

- 20 new control sections, 13 Inspectors (most new, many out of state), no automated
- After consultation with OCTA it was decided to use the following simplified approach:
  - nRMSE ≤ 1.4: Prequalified for 2 years
  - nRMSE > 1.4: Allowed to revisit 2 control sections; Disqualified if still > 1.4
- 11 inspectors qualified (2 after reinspection), 2 disqualified
CONCLUSIONS AND RECOMMENDATIONS
PCI Variability

- 3 consecutive prequalification studies confirm that the condition of the pavement correlates with the amount of variability observed in the reported PCI values:
  - Better condition = lower variability
  - Worse condition = higher variability
- Although the correlation is not very strong, it should be accounted for in the evaluation of inspector proficiency.
Evaluation Criteria

• Fixed boundaries such as “no more than 5% of PCI values outside baseline PCI +/- 15”:
  ▪ are highly dependent on the number of data points (control sections) which is usually less than 20
  ▪ do not account for the expected change in PCI variability as a function of pavement condition.

• Numerical indices, such as RMSE or nRMSE are less dependent on the number of control sections.

• nRMSE takes into account PCI variability and allows for more estimation error on pavements with more distress and lower PCI.
Training and Continuous Improvement

- The slope of the PCI(SD) model can be used as a measure of improvement from one prequalification cycle to the next. The current trend shows continuous improvement.
- After each cycle, we identify common errors made by inspectors and let them know areas where they need to improve.
- OCTA learns from the results of each cycle and makes changes to the criteria and to the guidance documents and the prequalification process.

Graph:
- y2011 = -3.0785x + 100
  R² = 0.5035
- y2013 = -3.5503x + 100
  R² = 0.5248
- y2014 = -4.4436x + 100
  R² = 0.4727
Other Observations

- ASTM D6433-11 does not include distress definitions and deduct curves for surface treatments which are more and more common.
- Inspectors not familiar with “unusual” pavements (e.g. 100 ft long concrete slabs). Local calibration and training are therefore very important.
- Inspections are usually done without traffic control, therefore records of safety training should be required and formal safety programs developed. Training is usually performed by in-house staff, not by safety professionals.
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