

Pontis-Based Health Indices for Bridge Priority Evaluation



Daniel L. Scherschligt, P.E.

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Presentation Outline

- ◆ Background.
- ◆ Current Priority Formula.
- ◆ Incorporating Pontis into Bridge Priority Evaluation.
- ◆ Evaluating translated NBI ratings vs. health index vs. Pontis.
- ◆ Summary and Conclusions.

Background

- ◆ In 1979, the Kansas Legislature directed KDOT to develop a method of project selection that:
 - ◆ was clearly defined,
 - ◆ used documented criteria,
 - ◆ was systematic and consistent,
 - ◆ was reproducible,
 - ◆ used quantitative and verifiable factors in determining relative priorities.
- ◆ Out of that directive, the KDOT bridge priority formula was developed.

Bridge Priority Formula

		Adjustment Factors
Attribute (Need Value)	Relative Weight	AADT (From Table)
Bridge Width (Driver Exposure Attribute)	0.222	0 to 1
Deck Condition	0.169	0 to 1
Structural Condition	0.359	0 to 1
Operating Rating	0.25	0 to 1
Sum of All Weights	1	

The Comprehensive Transportation Program (CTP)

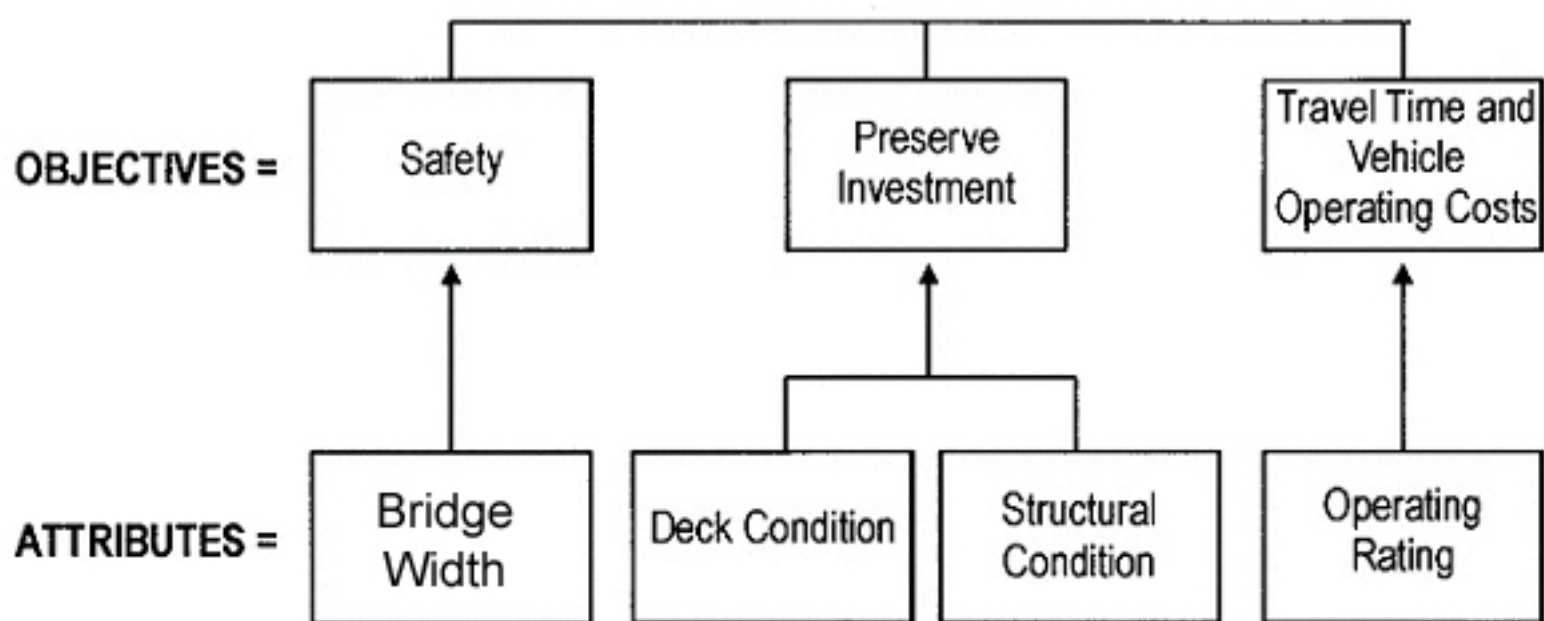
- ◆ Adopted in 1999.
- ◆ Is a 10 year program.
- ◆ Consists of Four Components:
 - ◆ Substantial Maintenance,
 - ◆ Major Modification,
 - ◆ Priority Bridge,
 - ◆ System Enhancement.

A Revised Priority Formula

- ◆ While KDOT was in the early stages of a 10 year 'fixed' program, it seemed appropriate to visit the existing priority formula to see if:
 - ◆ More current technologies could be implemented within the formula,
 - ◆ Any changes in the agencies business practices could be incorporated into the formula.

Overview of Current Bridge Priority Formula

- ◆ Objectives of the formula are to:
 - ◆ Maximize user safety.
 - ◆ Maximize preservation of Investment.
 - ◆ Minimize user travel time and vehicle operating cost.
- ◆ Each objective is related to one or more attributes.
- ◆ A need function was developed for each attribute.
- ◆ Certain adjustment factors may be applied to some of the attributes.



Objectives and Attributes in the Bridge Priority Formula

ATTRIBUTE WEIGHTS

Bridge Width	0.222
Deck Condition	0.169
Structural Condition	0.359
Operating Rating	0.250

ATTRIBUTE ADJUSTMENT FACTORS

	AADT
Bridge Width	.85 to 1.0
Deck Condition	.85 to 1.0
Structural Condition	.85 to 1.0
Operating Rating	.85 to 1.0

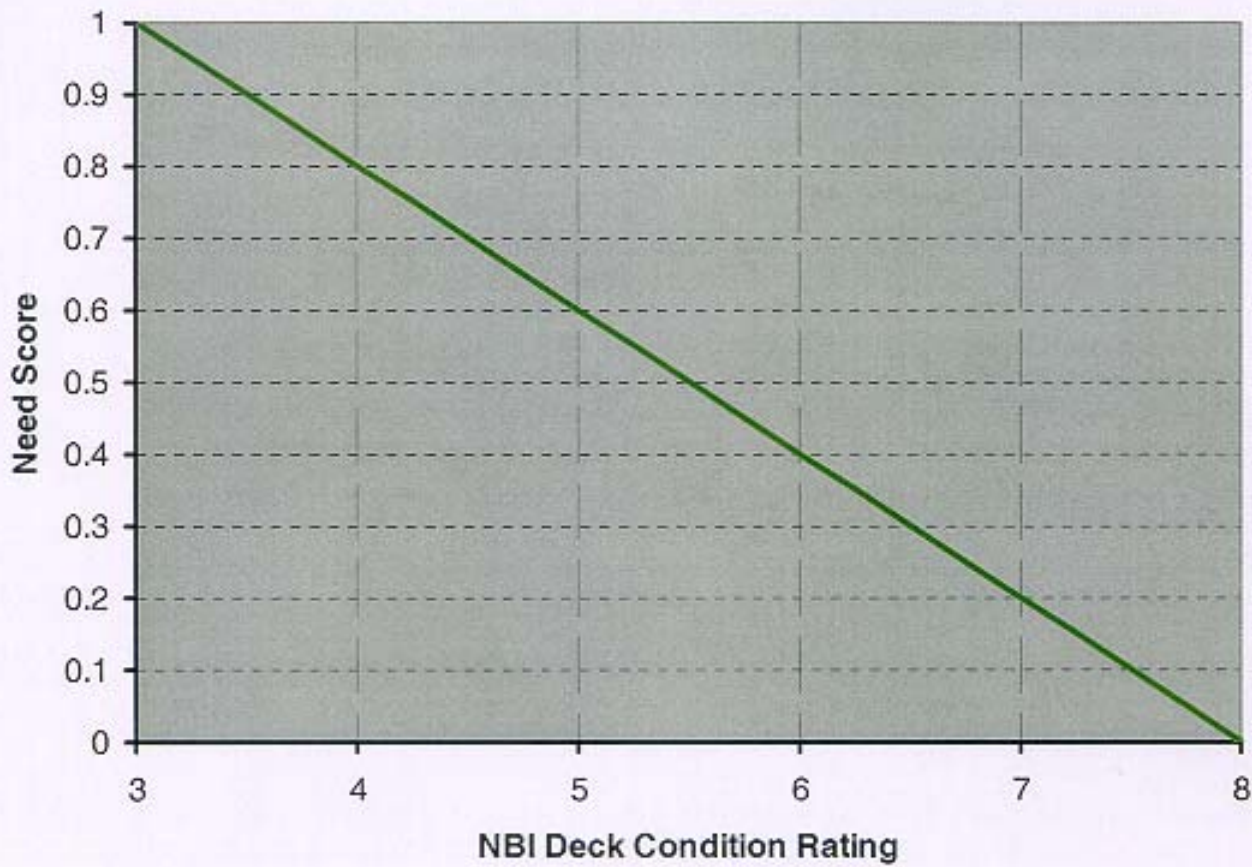


Figure 3. Need Function of NBI Deck Condition Rating

Incorporating Pontis Into Bridge Priority Evaluation

- ◆ Three alternative approaches were explored:
 - ◆ Use translated NBI ratings,
 - ◆ Use health indices,
 - ◆ Replace the bridge priority formula with Pontis.

Use Translated NBI Ratings

- ◆ Pontis ratings were translated into NBI ratings.
- ◆ The reliability was tested by evaluating the correlation between the field and translated NBI ratings.
- ◆ The project team concluded that the translated NBI ratings would not provide a reliable assessment of the bridges with high deficiencies.

Use Translated NBI Ratings (con't)

- ◆ The square of the correlation coefficient between the field and translated NBI deck condition ratings is 0.249. (This means that only 24.9% of the data variability in the translated NBI ratings is explained by the field NBI ratings)
- ◆ The square of the correlation coefficient between the field and translated NBI structural condition ratings was 0.117.

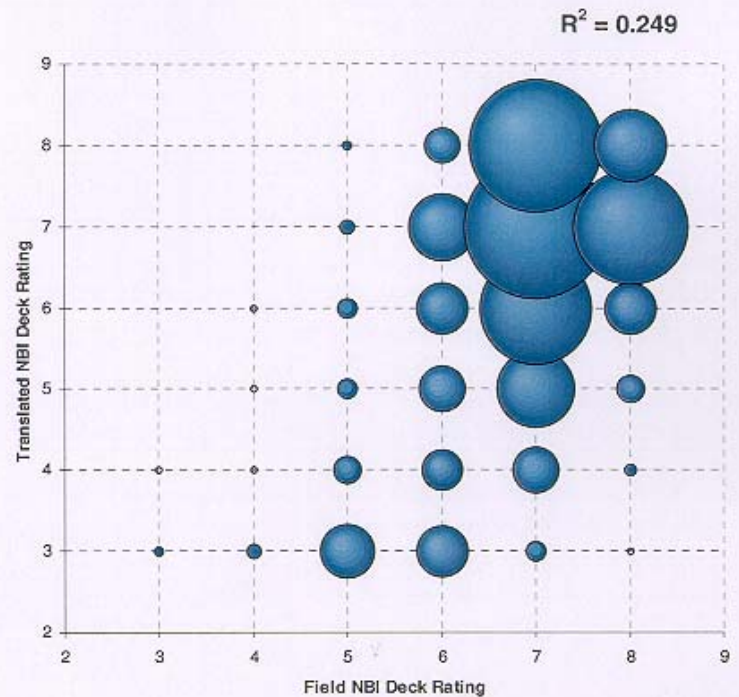
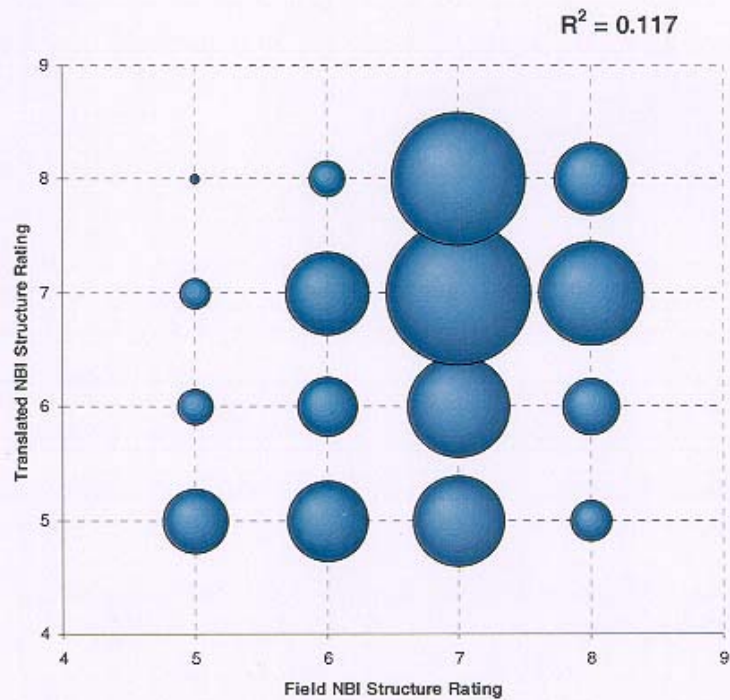


Figure 4. Graph of Translated versus Field NBI Ratings

(For the priority formula, the structural condition rating is defined to be the lower of the super- and sub-structure condition ratings.)

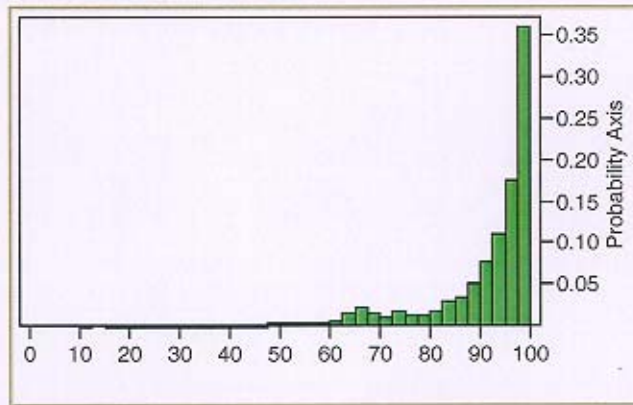
Use Pontis Health Indexes

- ◆ Health Index is the ratio of the current element value to the 'new' element value.
- ◆ The health indices were grouped into deck, superstructure, substructure, and culvert.
- ◆ The project team realized there could not be a perfect correlation between NBI and Pontis ratings.
- ◆ For example, deck health index ranged for 0 to 100, with an average of 84. NBI deck rating ranged from 3 to 8, with an average of 6.9.

Use Pontis Health Indexes (con't)

- ◆ Analysis of the priority rankings of bridges showed that there were significant differences between NBI ratings and Pontis health indices for individual bridges.
- ◆ However, the analysis did show there was correlation between NBI ratings and Pontis health indices for groups of bridges.
- ◆ For these reasons, the health index approach was considered to be promising.

Structure Health Index



Structure NBI Rating

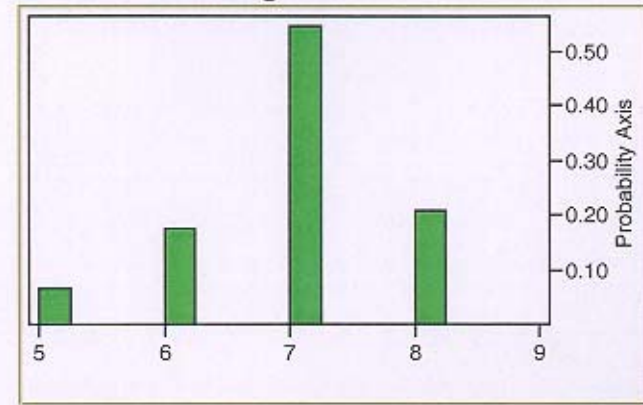


Figure 6. Histogram and Summary Statistics of Structure Health Index and Structure NBI Rating

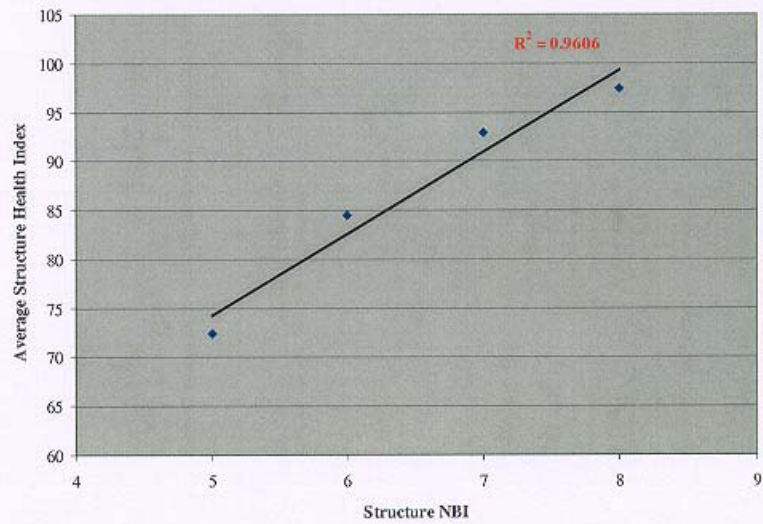
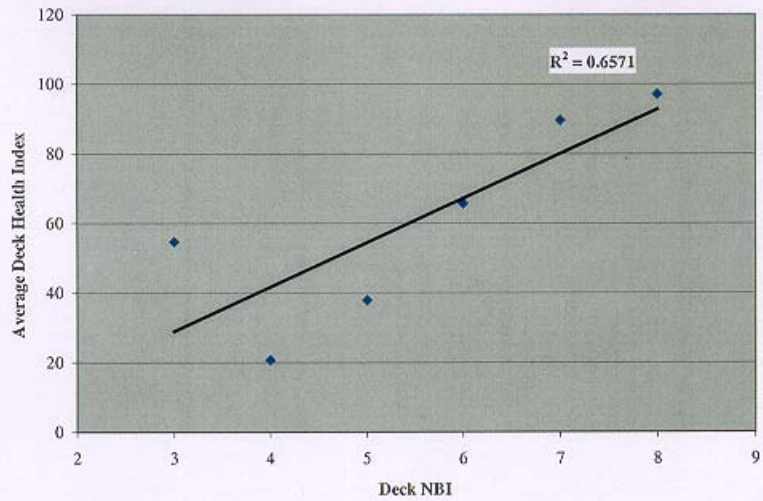
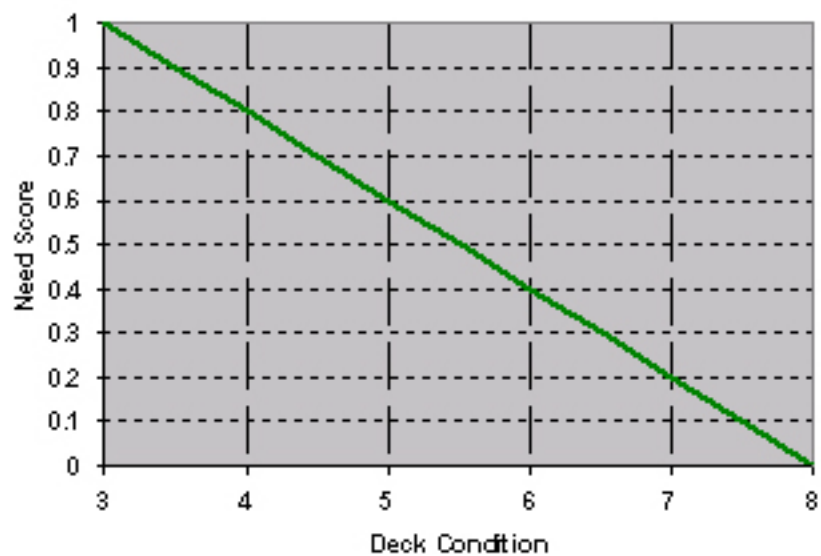


Figure 7. NBI Ratings versus PONTIS-based Health Indices

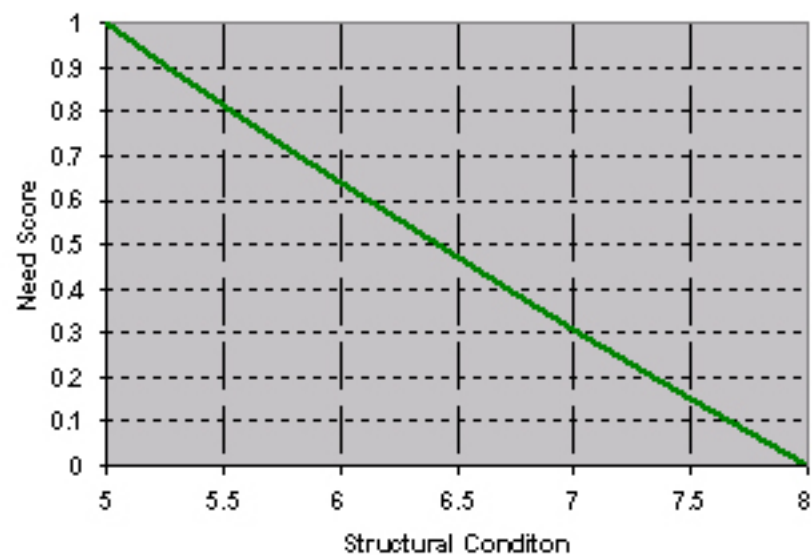
Use Pontis Health Indexes (con't)

- ◆ Need curves for health indices would have to be developed.
- ◆ These need curves were developed through delphi sessions, in the same manner the original NBI need curves were developed.

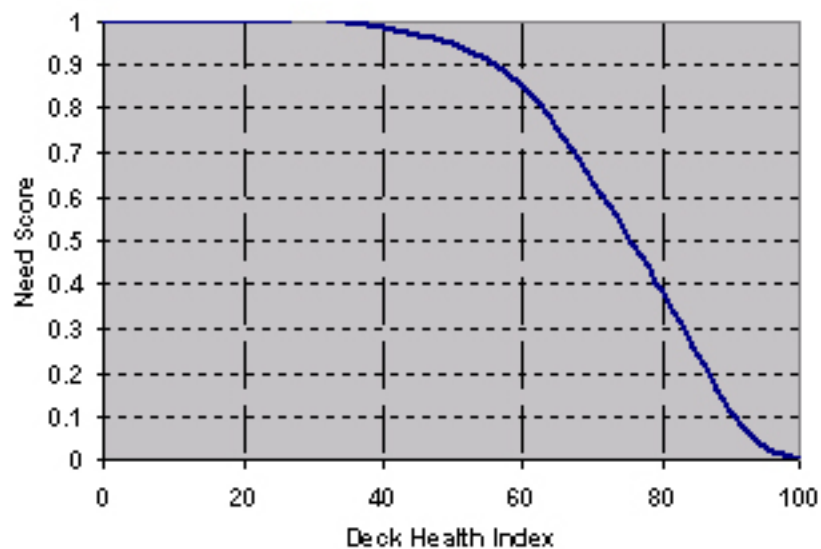
Priority Formula: Bridge
Attribute: Deck Condition
Current need function



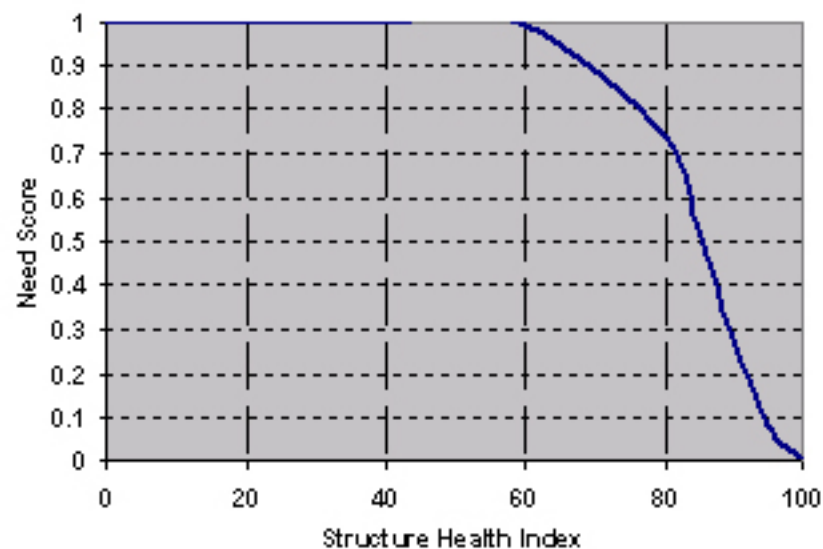
Priority Formula: Bridge
Attribute: Structural Condition
Current need function



Preliminary recommended need function



Preliminary recommended need function



Replace the Priority Formula with Pontis

- ◆ The priority ranks of individual bridges from Pontis were compared to the priority ranks of individual bridges from the existing Priority Formula.
- ◆ Pontis employs a cost-benefit analysis, while the Priority Formula uses a need-based methodology.
- ◆ As a result, the priority ranked lists derived from these two methods were quite different.

Results from Comparing Pontis Ranked List versus Priority Formula Ranked List

- ◆ There was a very low match between the project selections of Pontis and the Priority Formula.
- ◆ Pontis generally selected projects with lower costs so that the fixed budget allows more work to be done.
- ◆ The Priority Formula does not consider user costs and benefits in ranking projects, it selected projects in order of highest need.

Results from Comparing Pontis Ranked List versus Priority Formula Ranked List (con't)

- ◆ A Pontis scenario was run, using the 10 year CTP funding.
- ◆ 327 bridges were selected by Pontis when all budget dollars were exhausted.
- ◆ Only 74 of these matched the top 327 bridges selected by the Bridge Priority Formula.
- ◆ For comparison purposes, the 327 bridges were further broken down into high, medium, and low priority.

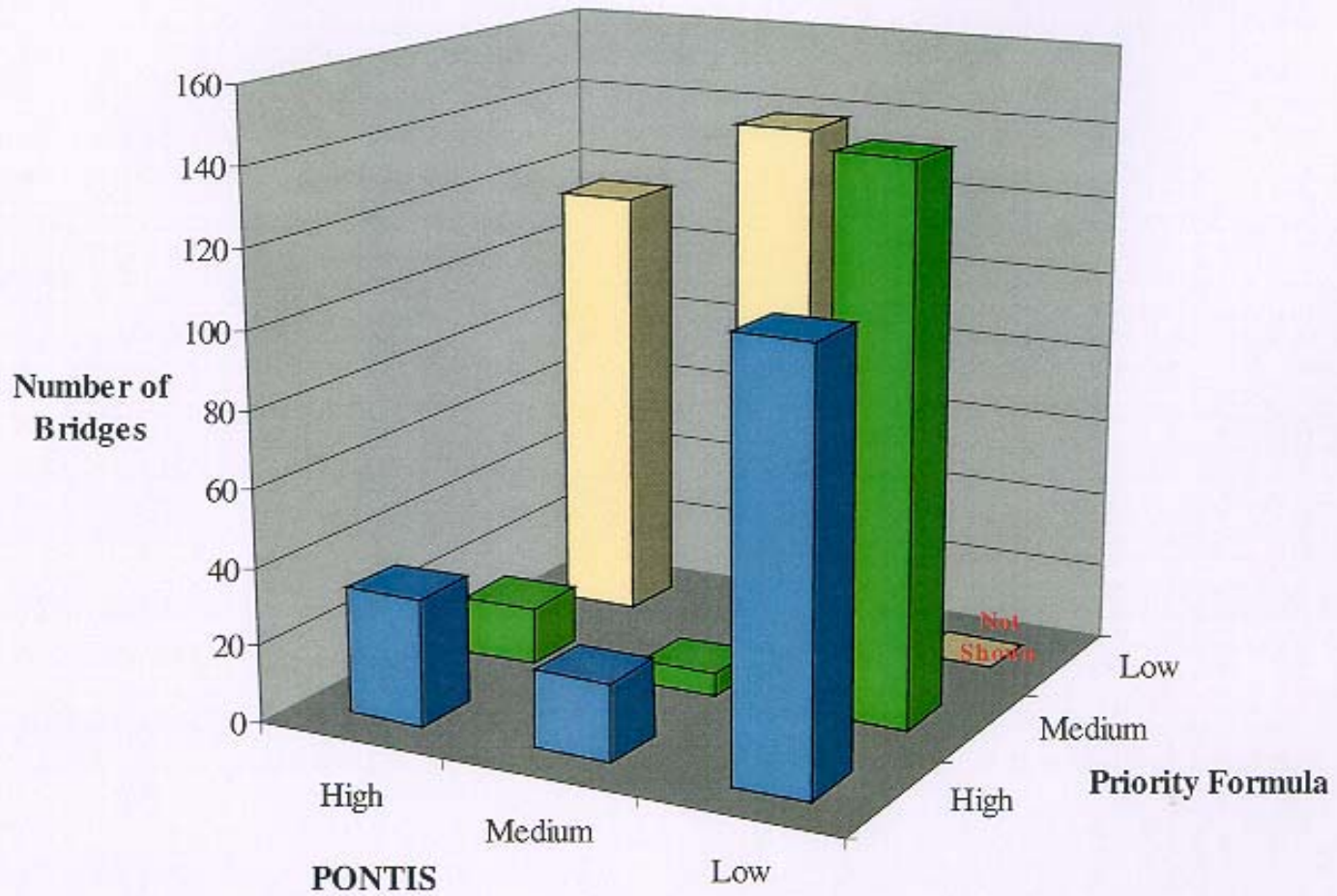


Figure 8. Bridge Priority Groups based on PONTIS and Bridge Priority Formula

Summary and Conclusions

- ◆ KDOT wanted to explore ways in which Pontis element level data could be incorporated in the Bridge Priority Formula.
- ◆ The motivation for this change was to avoid the duplication of bridge inspections and data collection, and to take advantage of the superior Pontis element level inspection methodology.

Summary and Conclusions (con't)

- ◆ Three alternative approaches were evaluated for incorporating Pontis data into the Bridge Priority Formula.
 - ◆ Convert Pontis data into equivalent NBI ratings through the translator.
 - ◆ Use health indices calculated based on the Pontis inspection data.
 - ◆ Replace the Bridge Priority Formula completely with Pontis analysis.

Summary and Conclusions (con't)

- ◆ From analysis of the three alternative approaches, the project team made the following recommendations:
 - ◆ Conversion of Pontis element data into equivalent NBI ratings using FHWA's translator produced inconsistent results and was dropped from further consideration.
 - ◆ Using Pontis in place of the Bridge Priority Formula was not considered an acceptable option because it was not consistent with KDOT's long standing philosophy of replacing bridges with the most severe deficiencies first.

Summary and Conclusions (con't)

- ◆ The third method of using health indices proved to be most effective for incorporating Pontis data into the Bridge Priority Formula.
- ◆ This method not only utilizes the Pontis element level data, but also provides the agency the opportunity to eliminate dual Pontis and NBI inspections.

Summary and Conclusions (con't)

- ◆ KDOT is currently revising the Bridge Priority Formula to replace the NBI ratings for deck and structural conditions with the corresponding Pontis based health indices.

Questions?