Development of a Bridge Master Plan for Rural Road Network in Thailand

V. Kunagulsawat, C. Bamrungwong, K. Manokhoon, and K. Punthuteacha
Thailand Road Network in 2008

389,787 km.

Department of Highway
51,537 km.
- Arterial Roads
  - Paved road 51,537 km.

Department of Rural Roads
40,800 km.
- Collector Roads
  - Paved road 33,600 km.
  - Laterite road 7,200 km.

Local Governments
297,450 km.
- Local Roads
  - Paved road 114,300 km.
  - Laterite road 183,150 km.

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Conventional Planning of Bridge Construction

- Availability of Community Requests
- Availability of Budgets

Consequently some constructed bridges cannot properly serve trip demands

Therefore, DRR was initially developed a bridge master plan to fulfill the effectiveness of bridge planning for the road system throughout the country
Objective of a Master Plan for Bridge Construction

- Existing Bridges
- Potential Areas for Bridge Construction
- Prioritization
- Information System
## Existing Bridges

<table>
<thead>
<tr>
<th>Organization</th>
<th>No. of Bridge Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Highway</td>
<td>8,443</td>
</tr>
<tr>
<td>Department of Rural Roads</td>
<td>8,263</td>
</tr>
<tr>
<td>Local Governments</td>
<td>12,646</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>29,352</strong></td>
</tr>
</tbody>
</table>
Methodology of Determining the Potential Areas

1. Pre-Processing
   - Preparing data in the GIS format
     - River Network
     - Road Network
     - Trip demand within area
     - Trip demand between areas
     - Existing bridge locations
     - Environmental Zoning
     - Community Requests

2. Intermediate-Processing
   - Spatial Analysis
     - Establish grids for potential surface analysis
     - Determine weighting score for each factors
     - Spatial Analysis by overlay data set

3. Post-Processing
   - Prioritization
     - Based on result from Inter-Processing to get the potential areas for new bridge construction

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An important step to identify potential areas for construction of bridges across rivers is to evaluate primary factors and set proper weight of each factor. In this study, the following seven factors were considered in the analysis:

1) **River networks**, $X_1$, (km. /km$^2$)
2) **Road networks**, $X_2$, (km. /km$^2$)
3) **Environmental zoning**, $X_3$, (km$^2$)
4) **Within-area trip demands**, $X_4$, (ADT)
5) **Between-area trip demands**, $X_5$, (ADT)
6) **Existing bridges**, $X_6$, (Lanes)
7) **Community requests**, $X_7$, (Requested = 1, Not Requested = 0)
Primary Factors For Evaluating the Areas

• In this step, Thailand area of **513,115 km²** was meshed into grids of **8 km. x 8 km.**

• which is the spatial area that **most detail information obtained** in this study.

• Determination of **weight for each factor** was based on the existing number of lanes in each grid to find **a relationship with the conducted seven factors**

• **Linear, Exponential and Logarithmic relationships** were performed to find the best fit between the seven factors and the existing number of lanes.
Primary Factors For Evaluating the Areas

The Equation and Table show the best fit relationship with the highest $R^2$. The coefficient values were converted to be weighting scores for the corresponding factors.

Where, $\Delta Y = \text{Required Number of Lanes} - \text{Existing Number of Lanes}$

$$\Delta Y = a \cdot X_1 + b \cdot X_2 + c \cdot X_3 + d \cdot X_4 + e \cdot X_5 - f \cdot X_6 + g \cdot X_7$$

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Value</th>
<th>Weighting</th>
<th>Factor</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a$</td>
<td>6.807</td>
<td>20</td>
<td>$X_1$</td>
<td></td>
</tr>
<tr>
<td>$b$</td>
<td>1.162</td>
<td>10</td>
<td>$X_2$</td>
<td></td>
</tr>
<tr>
<td>$c$</td>
<td>6.292</td>
<td>20</td>
<td>$X_3$</td>
<td></td>
</tr>
<tr>
<td>$d$</td>
<td>9.655</td>
<td>30</td>
<td>$X_4$</td>
<td></td>
</tr>
<tr>
<td>$e$</td>
<td>4.901</td>
<td>15</td>
<td>$X_5$</td>
<td></td>
</tr>
<tr>
<td>$f$</td>
<td>1.004</td>
<td>5</td>
<td>$X_6$</td>
<td></td>
</tr>
<tr>
<td>$g$</td>
<td>0</td>
<td>0</td>
<td>$X_7$</td>
<td>0.967</td>
</tr>
</tbody>
</table>

1) River networks, $X_1$, (km./km$^2$)
2) Road networks, $X_2$, (km./km$^2$)
3) Environmental zoning, $X_3$, (km$^2$)
4) Within-area trip demands, $X_4$, (ADT)
5) Between-area trip demands, $X_5$, (ADT)
6) Existing bridges, $X_6$, (Lanes)
7) Community requests, $X_7$
Spatial Analysis For Evaluating the Areas

- River Network
- Road Network
- Environmental Zoning
- Trip Demand within Area
- Trip Demand between Areas
- Existing Bridge

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Evaluation of the Potential Areas

**Traffic work concept in this study**

\[
\text{Min} \left( \sum_{i=1}^{n} (V_i L_i)_{a} + \sum_{i=1}^{n} (V_i L_i)_{b} \right)
\]
• From this analysis, the 64 grids of 1x1 km$^2$ in an 8x8 km$^2$ grid were ranked.

• The 1$^{st}$ rank of 1x1 km$^2$ grid of each 8x8 km$^2$ grid was expected to be the most suitable area to have a new bridge construction.

• However, In-situ surveys in selected grids were performed to verify the analyzed results. After the surveys, results showed that among the 1$^{st}$ – 20$^{th}$ of 1x1 km$^2$ grids are more likely to be the potential areas to have a new construction.
Prioritization of the Potential Areas

For the **coming 10 years** were based
1) Ranking grids of 8x8 km² from the spatial analysis scored from 9 to 1,
2) Ranking the same group in 1) by the traffic volume in 1x1 km² grids obtained in the traffic work concept
3) Considering areas of 8x8 km² where the existing bridges will be full capacity in the next 10 years to be high potential area to construct a new bridge.

Based on this prioritization, the results showed that Thailand will need to have **1,433 new bridges for the next 10 years** to meet the traffic demand predicted and other factor considered in this study.
Geographic Information System (GIS)

http://bridgemasterplan.drr.go.th

DRR’s Bridge System:

• Planning
• Surveying & Designing
• Construction (PM)
• Maintenance
Thank you for your kind attention.