Public Private Partnerships for Upgrading Existing Roads

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Economikr Where Economic Expertise Counts

Abbreviations / Acronyms

- BCA – Benefit Cost Analysis
- DBST – Double Surface Treatment
- FYRR – First Year Rate of Return
- HDM-4 - Highway Development and Management model (World Bank)
- IRI – International Roughness Index
- LoS – Level of Service – not in the traffic sense of A-F, but rather a given standard of maintenance for a length of road / road network
- PBC - Performance Based Contracting
- PCC – Portland Cement Concrete (rigid pavement)
- PPP – Public Private Partnerships
- VTT – Value of Travel Time
- VOC – Vehicle Operating Costs

Background

- A growing trend over the past decade is the use of Performance Based Contracting (PBC) for maintaining and/or partially upgrading small to mid-sized road networks
- This trend is partly due to the increase in growth of road networks and less available funds to maintain them (or no funds at all)
- These PBC's can be PPP, PFI's, etc.
- This presentation will cover the challenges presented by upgrading an existing road, both in terms of increasing capacity and changing the road's surface (from a very thin poorly maintained road) to a rigid pavement in a central corridor in South East Asia.
- Brief background on PBC and transportation economics analysis of road upgrades.

Main Elements of PBC

- Measures outputs (road condition) and is not completely dependent on bills of quantities
- Contractor responsible for maintaining given LoS on the roads - encourages innovation
- Risk Sharing - Split up of Risks between Government and Contractor - each one according to comparative advantage
- Takes local conditions, user behaviors and criteria into account
- Contractor given responsibility for various lengths of time – 3 years, 5 years, 10 years, sometimes 30 years (usually for new construction)
- Comes at a price - Government has less budget flexibility, but is "guaranteed" of a portion of the road network in serviceable condition
- Some nations have advantages that others do not

Special Project Elements

- Changing the road surface – from DBST to PCC (!)
- Occurring in a semi-urban area – what will it do to traffic?
- Forms part of a corridor between 4 countries – China, Thailand, Lao PDR, Cambodia and Vietnam – will include both local traffic and also through traffic
- Other activities occurring at the same time – rail upgrade, bridge construction – serves as competition to this road upgrade
- Trying via a road project to change user behavior – wide road with low actual traffic speed
- Travel habits survey with stopping and interviewing people – trip purpose, vehicle occupancy – better model calibration
- Traffic Counts requested – 3, necessary – a lot more due to junctions and functional behavior

Stages in PBC

- Data Collection – existing road condition, drainage, bearing capacity, signage, bridges, etc.
- Conceptual Design with several alternatives – gives engineering solutions, but is not a detailed design
- Economic analysis of the several alternatives
- Choosing optimal economic alternative
- Performing risk analysis and risk mitigation analysis
- Financial and Payment Modelling
- Procurement Documents
- Selection of winning contractor and signing of contract

Project Selection

- Road Importance
- Similar road geometry, similar soil, similar standards
- Local contracting capacity capable of dealing with these roads?
- Making project attractive for both local and international contractors
- All of the above elements are meant to keep costs down
- Typical project between 30-200 miles in size

Data Collection

- Road condition - cracking, patches, roughness, etc.
- Drainage
- Road bearing capacity - usually with FWD
- Road furniture - inventory and condition
- Traffic - level and distribution, traffic growth forecast, proximity to city
- Road upgrade – estimate generated and induced traffic
- Employment levels
- Other local elements - fencing, right of way
- Environmental conditions - flora, fauna, etc.

Traffic Data

- Major junctions – week long, 24-hour counts
- Areas with less traffic – regular day, 12-hour count
- Seasonality
- Road moves between urban, semi-urban and rural areas
- Possible reversal of traffic and not just through traffic
- Close to borders – allowing international traffic – identifiable via plates
- Buses stop on the road itself, creating blockages and congestion
- Some of the junctions are between paved and unpaved
- Most of the counts were junction counts
- Compared with similar areas to verify similar traffic patterns

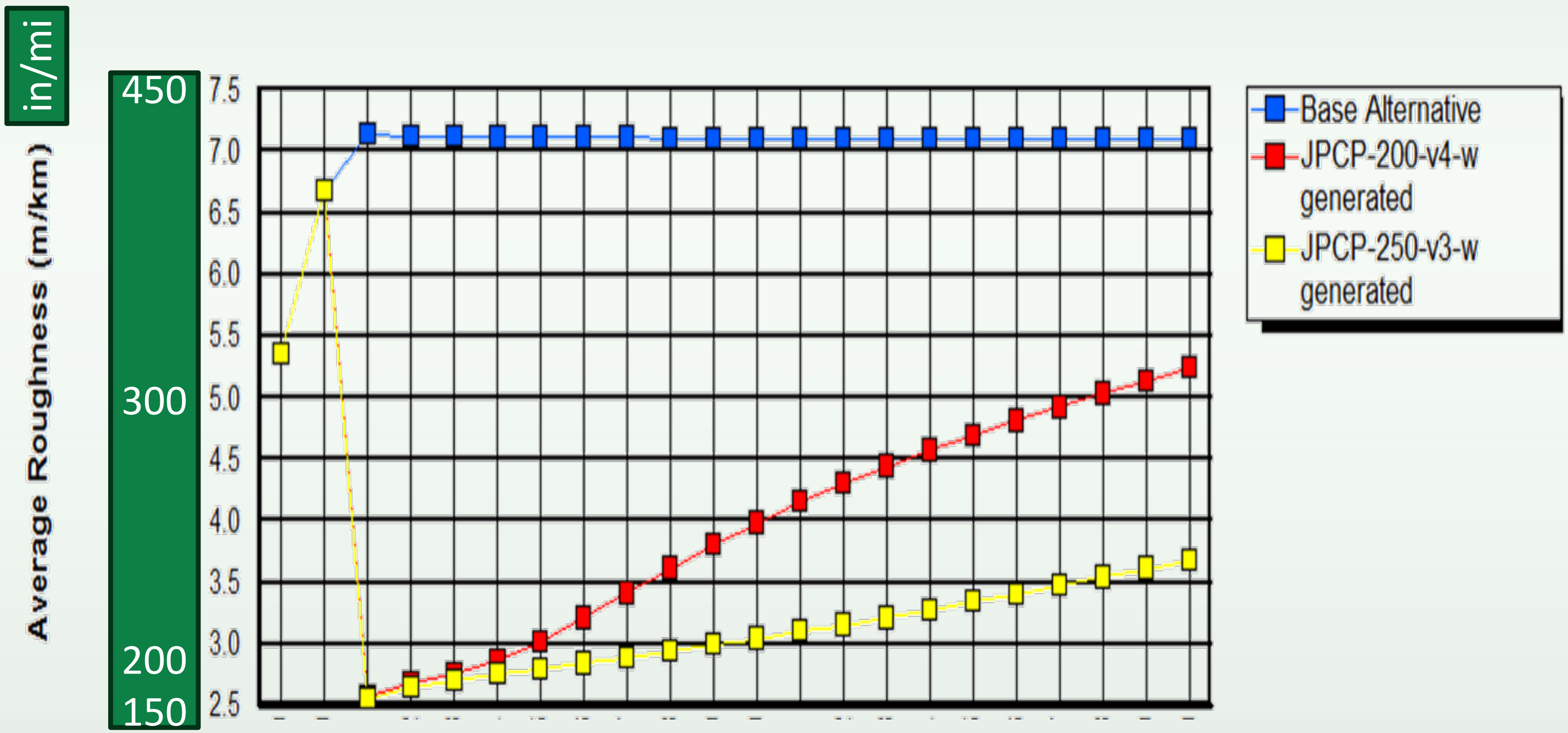
Induced Traffic

- All sections – changed from DBST to Rigid Pavement / Flexible option too
- First section with many semi-urban areas – 2 lanes to 4 lanes
- All the road sections – constructing bus bays and giving contractor power to enforce them, and widening the road in urban areas
- Due to the semi-urban centres – some of the traffic will go along part of the road and then reverse back to their origin – was also proven by o-d and trip purpose survey
- Drastic change in GTC – will create induced traffic
- Examine – changes in traffic in similar local (pre-post analysis) – by different vehicles. (5.2% to 14.7%; cars around 7%)
- Estimating elasticities based on simplified user perceived GTC, then ex-post calculation of traffic increase close to when a similar improvement was implemented

Engineering Solutions

- Must be more than 1 alternative to permit economic analysis
- Creation of homogeneous sections in terms of pavement condition, traffic, bearing capacity
- Homogeneous solutions in terms of treatment (with/without reinforcement, thickness) – requires careful selection of treatment
- Terminal serviceability at the end of the design period
- Different design periods will define different deterioration curves
- Compared with do-nothing / do-minimum alternative – interviews with road authorities, getting official documents, interviewing design companies and supervisors

Engineering Solution Deterioration Curves



Economic Analysis

- Based on BCA
- Costs - based on conceptual design –includes construction, routine maintenance and periodic maintenance for concrete
- Induced traffic spread over two years (ramp-up) – only when major section is completed
- Benefits - from VOC, VoT, accident savings, induced traffic in the case of improvement, and wider economic benefits (changes in labor supply, agglomeration economies, but only where there is not full participation in labour force and also some measure of unemployment)
- Examine project timing (FYRR)
- Usually performed for 20-year economic analysis period

Additional Considerations Economic Analysis

- Normal traffic and Induced Traffic
- Growth rates based on GDP forecast, increase in population, macro-economic forecast for thru traffic and also entry of competing projects
- Discount rate – 20-year bond rate if possible plus risk premium
- Concrete road life – usually larger than 20 years – therefore salvage value greater than 0
- Conservative assumption – increase in international traffic will not cause increase in government tax revenues
- Value of Time – based on trip purpose survey – weekdays, weekends

Performing Economic Analysis Under HDM-4

- Defining road network sections
- Defining vehicle fleet – both motorized and non-motorized vehicles
- Defining Works Standards which are dependent on LoS – one do-minimum alternative and several do-something alternatives
- The more the country is used to running HDM-4, and has performed calibration of road deterioration curves and vehicle fleet characteristics and costs – the better
- The heart of the model – the Project Analysis (Economic Feasibility study) and Sensitivity Analyses
- Concrete road – 20 years is not the end of its life, then salvage value is utilized
- Asphalt – 20 year design period

HDM-4 Project Analysis

- Project analysis can be section-by-section, or by entire project (many sections)
- Each road section has its initial traffic volume and its distribution and growth rate
- Induced traffic entered separately
- Defining discount rate – preferably 20-year bond yield rates because the investment is a long time in duration
- Length of economic analysis period – 20 years in most cases even if PBC is a shorter period
- Project analysis – allows application of the same standard – and makes the contractor's life simpler
- Separate costs for each road section – different mix of semi-urban and rural areas

HDM-4 Project Analysis (cont.)

- Definition of alternatives including:
  - Construction period – depending on total area of road to be constructed
  - Construction activities include replacement of drainage, bus bays, additional service levels
  - Periodic maintenance for concrete roads – every x years depending on the type of treatment
  - Turnover of road at year 9 – fixing cracked slabs
  - Can sometimes include one-time investments (additional drainage, bus stations, sign repair and replacement, etc)
- Do minimum –comprised of routine maintenance (several times a year), and partial periodic maintenance – maintaining average IRI throughout year

Post HDM-4 Analysis

- HDM-4 gives 3 types of benefits
  - VOC savings
  - Travel time savings (VTT)
  - Simplified form of accident savings based on millions of VkT
  - Generated traffic benefits – improvement standard only
- If additional benefits are desired – post HDM-4 analysis is required
  - Wider Economic Benefits:
    - Agglomeration
    - Changes in Labour Supply
  - Changes in modal split
  - Differentiating between capacity increases and changes in speed due to blockages / lack of bus and truck bays
  - Limiting benefits in case maximum capacity is achieved

Analysis of Results

- Four sources of benefits, split up into 5 sub-benefits:
  - Travel time savings – raising effective speed (no blockages) and increased capacity in some sections
  - Vehicle Operating Costs – higher speed (negative), much better road conditions (positive)
  - Induced traffic – rule of half
  - Changes in vehicle fleet – less pickups due to better roads
- Robustness
  - Examining person-trips and estimating savings
  - Sensitivity analyses – especially on growth rates and induced traffic
  - Making conservative assumptions – no additional tax revenue, no additional benefit from land use changes

Analysis of Economic Results

- Based on these benefits and costs we can calculate economic indices: NPV, IRR, BC, FYRR
- Costs include construction, maintenance, supervision costs, ESIA cost
- However, since these alternatives are mutually exclusive (i.e. we can do one or the other but not both) we prefer NPV for the economic decision and FYRR for timing of the decision – highest NPV equivalent to unlimited budget scenario

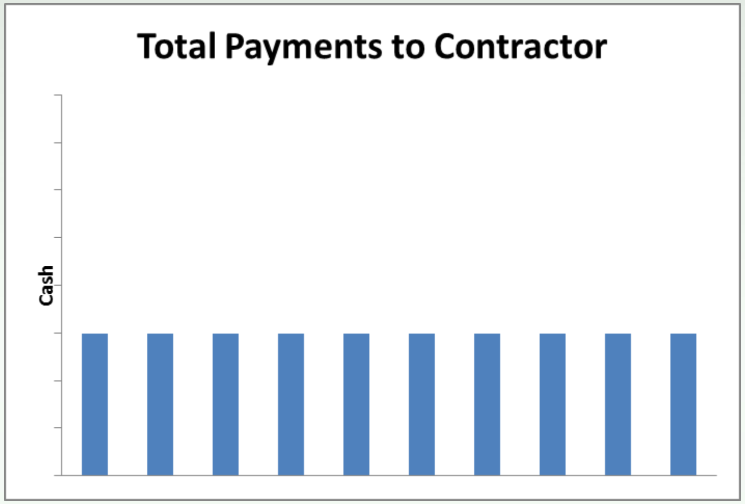
Risk Analysis

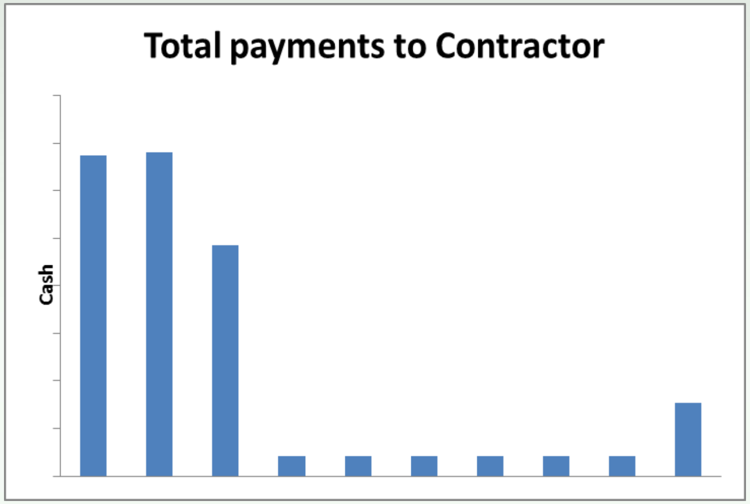
- Creating a risk profile
- Separated into phases – construction, maintenance, design
- Estimating risk (probability)
- Cost if risk is realized
- Assigning risk to those most capable of dealing with it – e.g. design to contractor; force majeure to government;
- What risks can be mitigated (insurance, provisional sums, public advertising to increase awareness)
- Estimating the unmitigated risk and adding to the cost and/or raising interest rate for Contractor (requires higher ROI)

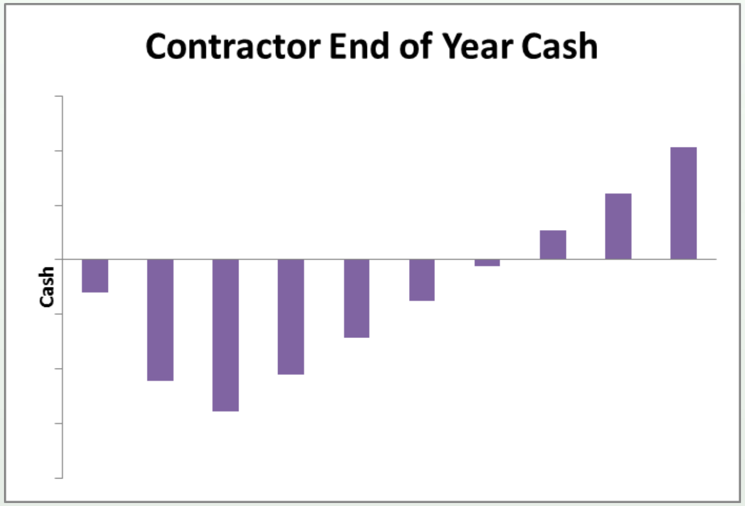
Financial Modelling

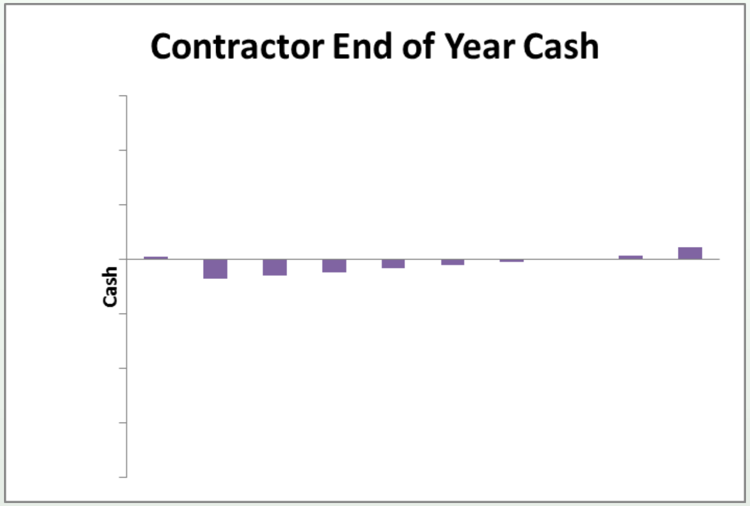
- Several types of payment models – fixed payment, partial coverage of payments and delaying payments further into the contract
- Disadvantages – delaying payments (retention, etc) will cause price increase
- Payments are not necessary entirely linked to costs
- Maintaining financial ratios for Contractor, DSCR on possibly several levels of debt
- These payments form a commitment on the government

Samples of Financial Models









Conclusions

- Sometimes projects of such magnitude will alter people's behaviour
- Even when a road is a highway, urban areas can pose modelling issues
- Induced traffic – never assume it is the same for all types of vehicles
- Use pre-post analysis if available
- Follow traffic patterns and calibrate traditional models
- Existing roads are candidates for PPP, not just new construction
- Perhaps higher do-minimum standard will deem unnecessary to perform the surface upgrade – asphalt might be enough in another locale

Additional Lessons Learnt

- Make sure to learn local environment
- Full cooperation w/ contractor to prevent scaring him away
- Encourage local participation by utilizing local materials
- Project cost distribution -sizable sum at beginning of works, few years of routine maintenance only, periodic maintenance in middle of period, and end-of-life rehabilitation (year 9-10) - do not put too much at the beginning
- Choose roads carefully for max visibility to the local population and induce international travel

Thank You!

In case of questions:

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