VISITING DUAL PURPOSE SMART TUNNEL
KUALA LUMPUR, SEP 2019
THANKS TO MALAYSIAN NATIONAL COMMITTEE FOR PLANNING THE VISIT
Kamran Emami
VICE PRESIDENT of ICID (2018-2021)

Profile
Age: 55 years
Profession: Consulting Engineer (Water)
Education:
BS in Civil Engineering, Shiraz University, Iran (1989).
M.S. in Hydraulic Structures, Shiraz University, Iran (1992).
PhD in Water Engineering, Sharif University of Technology, Iran (1997).

Professional Experiences
29 years in 120 large projects:
• Dam Engineering
• Value Engineering
• Flood Management
• Historical Hydraulic Structures
• Water Resources Management

Posts held
• Founder and Managing Director of Kurit Kara Consulting Engineers (2001-2017)(Current Position)
• Technical Adviser to Water and Power Development Company (1993-2007)
• Senior Advisor in Technical Office of Power Ministry (Iran)(1994-2005)

Research
• Developing the concepts of “Adaptive Design of Hydraulic Structures” (1990-2000)
• Conducting 21 researches on water engineering and
CHAIRMAN OF 3 WORKING GROUP IN ICID
This Book demonstrates that in view of the ICID vision 2030 (Water-secure world free of poverty and hunger, through sustainable rural development), Value Engineering is an effective, efficient and proven technique to improve the value of large water projects. Furthermore, the procedures and techniques of VE are elaborated and a number of relevant case studies are presented.
کتاب‌ها در زمینه سیلاب

راهنمای برنامه‌ریزی رهیافت‌های سازه‌ای مدیریت سیلاب
ترجمه و تدوین: کروبکر رهیافت‌های فراکسی مدیریت سیلاب
کمیته ملی آب‌‌و‌زемین‌سازی ایران
و کمیته ملی کاهش آلات بلاجای طبیعی
نشریه شماره ۲۰۰
نشریه شماره ۱۳۷۹

Manual on Planning of Structural Approaches to Flood Management
Publication No. 126
2019
نشریه شماره ۱۲۶
نشریه شماره ۱۳۸۵

Value Engineering for Saving in Irrigation, Drainage and Flood Projects
Kamran Emami Tara Emami

شیوه‌ریزی
راهبردی جامع مطالعات طرح، بهره‌برداری و
گردآوری سامانه‌های بیش‌بینی
و هشدار سیلاب
نشریه شماره ۲۴۷-الف
نشریه شماره ۱۳۸۹
شیوه‌ریزی
شیوه‌ریزی
شیوه‌ریزی
شیوه‌ریزی
DUAL PURPOSE SMART TUNNEL

- Method of Construction
- Why SMART Project?
- Unique Feature
- SMART Components
- Control Centre
- Modes of Operation
- Events
- Mechanical & Electrical
- SMART Administrative Centre
DR. ABDOLLAH, PRESIDENT HON
VISIT BY CROWN PRINCE OF JAPAN (NOW EMPEROR)
GREAT FLOODS IN 1971 AND 2003
INUNDATION
Annual flood damage for Federal Territory of Kuala Lumpur alone: RM100 million.
Location: Sultan Abdul Samad Building / Merdeka Square
KUALA LUMPUR FLOODS

Banjir 1926 - Jalan Tun Perak (Jalan Jawa)
KUALA LUMPUR FLOODS

26 April 2001 - Jalan Ipoh (Gombak River)

26 April 2001 - Jalan Munshi Abdullah, Klang River
The confluence of Klang and Gombak Rivers at the Masjid Jamek (Jalan Tun Perak) is the founding place of KL
1 TO 1.5 M INUNDATION

10 June 2003

KL hit by floods

High Court Complex
Gombak River
City Hall Car Park

Jalan Tun Perak / Jalan Melaka Junction
1 TO 1.5 M INUNDATION

Jalan Tun Perak

25 August 2006

Masjid Jamek LRT Station
FLOODING AFTER 3 HOURS OF RAIN

3 June 2007
KL FLOODS

City center is a mud pond

View From Masjid Jamek LRT Station

Jalan Leboh Pasar

10 June 2007

Klang / Gombak @ Masjid Jamek
FLOOD = 10 JUNE 2007
SMART OPENS = 30 JUNE 2007

PM FUMES OVER FLOODS
Abdullah raps Drainage and Irrigation Department

Residents all riled up

Speed up work, says PM

DID: SMART would have averted floods

11 June 2007 - The Day After
## HISTORY OF FLOODING IN KL

<table>
<thead>
<tr>
<th>Period</th>
<th>Year of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 1950</td>
<td>1926, 1949</td>
</tr>
<tr>
<td>1970s</td>
<td>1971</td>
</tr>
<tr>
<td>30 June 2007</td>
<td>SMART starts operations</td>
</tr>
<tr>
<td>3 March 2009</td>
<td>Gombak River overflow – outside the protection of SMART system</td>
</tr>
</tbody>
</table>
INCREASED FLOOD RISK DUE TO URBAN DEVELOPMENT
Construction of Canals was not feasible
مفهوم "میرایی طوفان آبی و تونل جاده" است. این تونل به قطر 8.8 متر، از پلی انتقال سیلاب به طول 9.7 کیلومتر، به همراه یک جاده دو طرفه عبور وسایل موتوری (بزرگراه) به طول 4 کیلومتر درون تونل تشکیل شده است.

هدف اصلی تونل اسمارت:

1- حل مشکل طغیان سیلابی در کوالالامپور از رودخانه های سونگای، کلنگ و کرامونگ
2- کاهش ترافیک در ساعت کم‌زمان روزانه
Travel Time for 15 m to 4 m
TOTAL COST OF SMART: $500M

30000 CAR EACH DAY

$10M ANNUAL REV.

CONSTRUCTION: SUMMER 2004 TO SUMMER 2007
جبهه‌های آغازین حفاری
سگمنت پیش‌ساخته بتن مسلح
CONTRACT 2
Keroh River Diversion (2.2 km)

CONTRACT 2
Gombak River Diversion (3.375 km)

FLOOD PRONE AREA

CONTRACT 1
SMART Bypass Tunnel (9.7 km)
Debris Removal System

- Operates 24 hours
- Activated based on setting water level and timer
- Remove rubbish before water enters tunnel

Klang River

Ampang River

SMART – at the upstream

Refuse Bin
دو مرکز کنترل ۲۴ ساعته (سیلاب - حمل و نقل)
سامانه هشدار سیلاب

Location: cappi

Radar Loop from Doppler radar for cappi
Last updated: Thursday, 22 September, 2011 at 13:30 (MYT)
CATCHMENT MONITORING SYSTEM – HYDROLOGICAL STATIONS IN THE KLANG AND AMPANG CATCHMENT
THE SMART’S BRAIN:
THE FLOOD DETECTION SYSTEM

FDS SMART OPERATIONS MANAGEMENT

CRITICAL SYSTEM STATUS
- Catchment Sites: ONLINE
- Operation Sites: ONLINE
- VHF Repeater: ONLINE

TMCS INTERFACE
- Filling Status: READY
- Dewatering Status: READY

SCADA OPERATING MODES
- Holding Pond: MAN/AUTO
- Attenuation Pond: MANUAL

OPERATINGALARMS
- HP Auto Ready: ALARM
- AP Auto Ready: ALARM
- Gate Status: ALARM
- L8 Pump Status: ALARM

FORECAST FLOW @ L4 GATES
- 15 mins: 98.7 m³/s
- 30 mins: 98.6 m³/s
- 60 mins: 73.8 m³/s

CRITICAL SITE LEVEL / FLOW
- U/S L4 Gates: 35.85 mlSD, 204.4 l/m²/s
- D/S L4 Gates: 34.92 mlSD
- D/S Diversion: 35.25 mlSD, 81.89 m³/s
- Holding Pond: 34.50 mlSD
- Upstream NJB: 15.50 mlSD
- Downstream SJB: 10.63 mlSD
- L8 Tunnel Outfall: 4.06 mlSD
- Attenuation Pond: 21.50 mlSD
- Tun Perak: 29.53 mlSD, 177.47 m³/s
- U/S Sg. Kerayong: 23.43 mlSD, 92.61 m³/s

TUNNEL OPERATING MODE
- MODE III

AVERAGE RAINFALL

D/S DIVERSION FLOW

TUN PERAK LEVEL

Menu

Current Category: III  Forecast Category: III  Tunnel Mode: III
## SMART’S 4 OPERATIONAL MODES

### Operational Modes of the Smart Tunnel

<table>
<thead>
<tr>
<th>Mode</th>
<th>Flow Thru' Lower Drain</th>
<th>Traffic Evacuation</th>
<th>Flow Thru' Traffic Tunnel</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. No Storm</strong></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>2. Moderate Storm</strong></td>
<td>√</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><strong>3. Major Storm</strong></td>
<td>√</td>
<td>√</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td><strong>4. Prolonged Major Storm</strong></td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>4</td>
</tr>
</tbody>
</table>

### Total Storage Capacity

- **Holding Pond**: 600,000m³
- **Northern Section**: 250,000m³
- **Motorway Tunnel**: 750,000m³
- **Southern Section**: 1,400,000m³
- **Attenuation Pond**: 3,000,000m³

Total: 3,000,000m³ at 3 main components

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**Flow**: cumec

- **Prolong**: more than 150
- **Flow**: less than 150

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THE SMART’S BRAIN: THE FLOOD DETECTION SYSTEM

FDS SMART OPERATIONS MANAGEMENT

CRITICAL SYSTEM STATUS
- Catchment Sites: ONLINE
- Operation Sites: ONLINE
- VHF Repeater: ONLINE

TMCS INTERFACE
- Filling Status: READY
- Dewatering Status: READY

SCADA OPERATING MODES
- Holding Pond: Manual / Auto
- Attenuation Pond: Manual

OPERATING ALARMS
- HP Auto Ready: ALARM
- AP Auto Ready: ALARM
- Gate Status: ALARM
- L8 Pump Status: ALARM

FORECAST FLOW @ L4 GATES
- 15 mins: 98.7 m³/s
- 30 mins: 98.8 m³/s
- 60 mins: 73.8 m³/s

TUNNEL OPERATING MODE
- Mode III

CRITICAL SITE LEVEL / FLOW
- U/S L4 Gates: 35.26 mLSD, 204.41 m³/s
- D/S L4 Gates: 34.52 mLSD
- D/S Diversion: 35.26 mLSD
- Holding Pond: 34.52 mLSD
- Upstream NJB: 15.50 mLSD
- Downstream SJB: 10.63 mLSD
- L8 Tunnel Outfall: 4.05 mLSD
- Attenuation Pond: 21.50 mLSD
- Tun Perak: 28.33 mLSD, 177.47 m³/s
- U/S Sg. Kerayong: 23.43 mLSD, 92.01 m³/s

AVERAGE RAINFALL

D/S DIVERSION FLOW

TUN PERAK LEVEL
SMART’S 4 OPERATIONAL MODES

Operational Modes of the Smart Tunnel

Mode I: No Storm
- Klang River
- Berembang Holding Pond
- Lower Drain
- Traffic Tunnel
- Desa Attenuation Pond
- Kerayong River

Flow (cumec): 70 - 150

Flow Thru' Lower Drain: X
Traffic Evacuation: X
Flow Thru' Traffic Tunnel: X
Mode: 1

Mode II: Moderate Storm
- Traffic evacuation = 1 hour

Flow (cumec): > 150

Flow Thru' Lower Drain: 
Traffic Evacuation: X
Flow Thru' Traffic Tunnel: X
Mode: 2

Mode III: Major Storm
- Traffic evacuation = 1 hour
- Upper Deck
- Lower Deck

Flow (cumec): > 150

Flow Thru' Lower Drain: 
Traffic Evacuation: 
Flow Thru' Traffic Tunnel: 
Mode: 3

Mode IV: Prolonged Major Storm
- Traffic evacuation = 1 hour
- Lower drain = 70 m³/s

Flow (cumec): > 150

Flow Thru' Lower Drain: 
Traffic Evacuation: 
Flow Thru' Traffic Tunnel: 
Mode: 4

Total Storage Capacity
- Holding Pond: 600,000m³
- Northern Section: 250,000m³ (8%)
- Motorway Tunnel: 750,000m³
- Southern Section: 1,400,000m³
- Attenuation Pond: Total 3,000,000m³

3 million cubic meters at 3 main components
## Storm Monitoring and Operation Modes

<table>
<thead>
<tr>
<th>Condition</th>
<th>SCC Action</th>
<th>MCC Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear weather, light rainfall, river flow less than 70 cu. m/s</td>
<td>SCC monitors FDS</td>
<td>MCC monitors motorway traffic</td>
</tr>
<tr>
<td>Moderate to heavy rainfall, river flow exceeds 70 cu. m/s</td>
<td>SCC declares Mode 2</td>
<td>MCC mobilises patrol units</td>
</tr>
<tr>
<td>Prolonged heavy rainfall, river flow exceeds 150 cu. m/s</td>
<td>SCC declares Mode 3</td>
<td>MCC diverts traffic, executes tunnel closure protocols</td>
</tr>
<tr>
<td></td>
<td>If Mode 3 prolongs, SCC declares Mode 4</td>
<td>Stormwater released into Motorway section</td>
</tr>
<tr>
<td>Storm passes, river flow decreases</td>
<td>SCC declares end of Mode 3 and 4</td>
<td>MCC executes tunnel-cleanup</td>
</tr>
</tbody>
</table>
### Tunnel System Profile

#### SCX SCADA Mimic Screen

**Tunnel Operating Mode:** MODE I

**1. Sg. Klang**
- L4 Upstream: 33.66 mLSD
- L4 Downstream: 33.52 mLSD

**2. Offtake**

**3. Holding Pond**
- Holding Pond: 29.28 mLSD

**4. Intake**

**5. Traffic Tunnel**

**6. Outfall**

**7. Attenuation Pond**

**8. Culverts**
- Culvert 1: 20.97 mLSD
- Culvert 2: 20.95 mLSD

**9. Sg. Kerayong**
- Storage Pond: 21.00 mLSD

**Holding Pond Gating**
- G1: 100%
- G2: 100%
- G3: 100%
- G4: 100%
- G5: 0%
- G6: 0%
- G7: 0%
- G8: 0%

**North and South Junction Box**
- SJB - TL5: 17.97 mLSD
- SJB - TL6: 13.39 mLSD

**Tunnel Outfall & Attenuation Pond**
- L8 - TL11: 4.56 mLSD
- L8: STopped

**L8 Pumps**
- AP1: STopped
- FP1: STopped
- FP2: STopped
- FP3: STopped
- FP4: STopped

**L9 Gates**
- G1: 0%
- G2: 0%

**L10 Gates**
- G1: 0%
- G2: 0%

**Sg. Kerayong**
- Sg. Kerayong: 20.95 mLSD

**SMART’s SCADA System interface**

**Menu**

**Current Category:** I  
**Forecast Category:** I  
**Tunnel Mode:** I
آمار انحراف سیلاب از تونل اسمارت از سال ۲۰۰۷ تا ۲۰۱۲

<table>
<thead>
<tr>
<th>YEAR</th>
<th>MODE 2</th>
<th>MODE 3</th>
<th>MODE 4</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>۲۰۰۷</td>
<td>۱۳</td>
<td>۲</td>
<td>۰</td>
<td>۱۵</td>
</tr>
<tr>
<td>۲۰۰۸</td>
<td>۳۰</td>
<td>۲۱</td>
<td>۱*</td>
<td>۵۲</td>
</tr>
<tr>
<td>۲۰۰۹</td>
<td>۲۱</td>
<td>۱۳</td>
<td>۰</td>
<td>۳۴</td>
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<td>۲۰۱۰</td>
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<td>۲۵</td>
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<tr>
<td>۲۰۱۱</td>
<td>۲۱</td>
<td>۱۹</td>
<td>۱**</td>
<td>۴۱</td>
</tr>
<tr>
<td>۲۰۱۲</td>
<td>۰</td>
<td>۰</td>
<td>۳*</td>
<td>۳</td>
</tr>
<tr>
<td>TOTAL</td>
<td>۹۶</td>
<td>۶۹</td>
<td>۵</td>
<td>۱۷۰</td>
</tr>
</tbody>
</table>

* Mode 4 on the ۴th September, ۲۰۰۸
* Mode 4 on the ۷th March, ۲۰۱۲
** Mode 4 on the ۲۱st May, ۲۰۱۲\textsuperscript{nd} May and ۲۶th November, ۲۰۱۲
Snap Shots Showing how the SMART has saved the day

22 March 2008

Inflow to Holding Pond at L5
High Water Level at Tunnel Intake at 5.11pm
High Water Level at Tunnel Intake at 6.03pm

1 m to over top River Bank

High Water Level at Masjid Jamek LRT Station at 5.35pm
High Water Level at Sg. Gombak/ Sg. Klang Confluence at 5.40pm

Pond water level rise rapidly
Enhancing Value for Money of Mega Infrastructure Projects Development Using Value Engineering Method

Mohammed Ali Berawi*, Bambang Susantono, Perdana Miraj, Abdur Rohim Boy Berawi, Herawati Zetha Rahman, Gunawan, Albert Husin

IDTech Research Group, Faculty of Engineering, University of Indonesia, Kampus Baru UI, Depok 16424, Indonesia
اتصال ويبي لي بي فورودگاه دراندونزي
افزایش کارکردشونل

Fig. 5. (a) Cross Section of PRASTI Tunnel; (b) Diameter Analysis of PRASTI Tunnel.
5. Conclusion

Value engineering (VE) has been widely applied to produce optimum result for projects developments through the fulfillment of the required quality, application of advanced technology and achievement of innovative ideas. VE application for mega infrastructures (i.e. Sunda Strait Bridge and PRASTI Tunnel) has produced added value to the projects.

A combination of qualitative and quantitative approaches was used to identify stakeholders’ perception regarding additional functions generated from FAST diagram in Value Engineering process. Result and discussion section has shown additional functions to increase feasibility for both projects. Additional functions for the Sunda Strait Bridge development are: 1) Power plant development based on renewable energy by using tidal and wind power; 2) Integration of oil and gas as well as (3) fiber optic pipelines to the bridge; 4) Tourism Development in Sangiang Island which may be accessed by using either road bridge or hanging train; 5) Development of industrial area. While innovation for the SHIARL project are: 1) Passenger MRT; 2) Airport Passenger Train; 3) Potential Commercial Area Underground, 4) Fiber Optics, and 5) Flood control. Value for money for both proposed projects developments are achieved by conducting Life Cycle Cost analysis that produces a positive NPV and significant Internal Rate of Return (IRR). Findings of this research are expected to contribute a significant insight to the public and private sectors and can be used as a benchmark for similar case to enhance project’s feasibility by using Value Engineering.

Further research on public private partnership scheme and detailed engineering design are suggested to increase the projects feasibility.