Procurement of Intelligent Transportation System (ITS) Projects present several challenges particularly since it does not precisely fall under the definition of Construction Projects rather, it often includes the application of complex telecommunications, computers, software, detection and a wide variety of electronic field devices. Traffic Management systems when truly integrated in a single system breed synergies which create better level of utilization, operational efficiencies and cost savings.

This paper focuses on the Design-Build approach for ITS Projects, and its relative advantages to the conventional Design-Bid-Build approach. Both project delivery methods are defined below:

- **Design-Build (D-B):** According to the Design-Build Institute of America (DBIA), the design-build form of project delivery is a system of contracting whereby one entity performs both engineering, design and construction under one single contract. Under this arrangement, the design-builder warrants to the contracting agency that it will produce design documents that are complete and free from error (design-builder takes the risk). The selection process under design-build contracting can be in the form of a negotiated process involving one or more contracts, or a competitive process based on some combination of price, duration, and proposer qualifications. Portions of the overall design or construction work can be performed by the design-build entity or subcontracted out to other companies that may or may not be part of the design-build team.

- **Design-Bid-Build (D-B-B):** Design-Bid-Build is the more traditional form of project delivery whereby the contracting agency either performs the design work in-house or negotiates with an engineering design firm to prepare drawings and specifications under a design services contract, and then separately contracts for at-risk construction by engaging a contractor through competitive bidding. Under this arrangement, the contracting agency warrants to the contractor that the drawings and specifications are complete and free from error (contracting agency takes the risk). The selection process for Design-Bid-Build is usually based on negotiated terms for the design contract and lowest responsible bid for the construction contract.

Other forms of Design-Build project delivery methods include:
- Design-Build-Maintain.
- Design-Build-Operate-Maintain.

Both above mentioned D-B Variations, also called “Performance based contracting”, allow shifting more project risk to the design-build contractor and hence provide an inherent incentive for the design-builder to provide a better quality project by creating a lifecycle responsibility and accountability for the performance of ITS project by the design-builder.

It's noteworthy to mention that in a D-B situation the engineer's (Consultant) role is essential since preliminary design and FUNCTIONAL specifications equivalent to about 30% of the complete...
plans, specifications and estimates (PS&E) package need to be prepared in advance to allow the D-B contractor to prepare his bid accordingly for completing the design and delivering the full system to meet the functional requirements, subject to the approval of the engineer.

A typical scope of services for a D-B contract includes:
- Engineering (detailed design).
- Project management.
- Specification development for the equipment, hardware and software.
- Delivery of hardware, software and services.
- Installation.
- System integration, test and evaluation of system and subsystem performance.
- Warranty, service, maintenance and training (possibly long term maintenance contract at a fixed price).
- Operation (optional).

Advantages of Design-Build procurement method for ITS projects

- **Single source responsibility:**
  With both detailed design, and complete delivery of the ITS project in the hands of the same entity, there is a single point of responsibility for quality, cost and schedule adherence. As a natural consequence there is less finger pointing because as ideas are generated, all team members make decisions with a cooperative approaches. The owner is able to focus on scope/ needs definition and timely decision making rather than the coordination between the designer and the builder.

- **Allows use of the latest and most appropriate technologies:**
  ITS technologies are continuously changing. Hence, an ITS project design done, say 2 years ago, to be implemented today would probably miss the opportunity of using the latest technologies developed during the interim period. Design-Build & Performance based contracting have shown to promote innovation in the use of the latest technologies to produce better results. Also, a D-B contractor who’s bound by a long term maintenance and/or operation contract will strive to use the latest and most appropriate technologies regardless of initial cost to guarantee smooth operation of the system under the long term maintenance/operation contract.

- **Time Savings:**
  Generally, D-B projects have shown substantial time schedule reductions over the traditional Design-Bid-Build. Overall time to design and build the project is reduced because design and construction activities overlap. The contractor can proceed with early procurement of critical materials, schedule labor and other resources while still in the design stage.

- **Cost Control & Cost Savings:**
  Fewer extra work orders and shortened project timeline lead to reduced cost overruns.

  **Facilitate Technology and Knowledge Transfer to developing countries:**
  D-B contracts help to develop complete rounded knowledge of the ITS technologies and processes from design to final implementation within each country. Such projects will help train high level professionals that not only can deliver the project but also know all its details to help maintain, operate and expand the ITS system in the future as necessary.
Case Studies:

Following are three examples for projects that have been successfully carried out using different forms of D-B contracting:

1. RAAR Tunnel Management System / Qatar

The new Ras Abu Aboud Road (RAAR) Tunnel in Qatar, which opened to traffic in January 2010, will serve the New Doha International Airport (NDIA) once the latter opens in 2011. The new airport will handle around 24 million passengers a year (three times as many as the existing airport) and this will grow to about 50 million on completion, making it the second-largest capacity holder in the region after Dubai International Airport. Around half of the NDIA is being built on reclaimed land. This has necessitated a whole new road layout and has effectively allowed designers the rare opportunity of a truly clean sheet of paper when it comes to design and systems selection.

The RAAR Tunnel is a part of the last stage of the Ras Abu Aboud road project, a US$200 million network expansion that will link the country’s capital with its new airport. The tunnel saw the first use in Qatar of quite a number of ITS technologies including vehicle guidance, automatic incident detection, speed enforcement, and an automated system to manage incidents, emergency and traffic situation events.

True Collaboration

The Design-Build contractor introduced the idea of implementing a Tunnel Management System (TMS) in December 2008 and in the end gave over 20 presentations to key stakeholders including the main client, the NDIA Steering Committee, who were keen to implement a state-of-the-art TMS. The consultant, AECOM, provided professional advice on design issues during the project’s conceptualization phase. The main contractor empowered the Design-Build ITS contractor to propose an integrated TMS solution and eventually awarded a Design-Build contract for the TMS in August 2009 to be completed in early January 2010.

The implemented solution was chosen for its ability to seamlessly integrate all the elements necessary for a state-of-the-art TMS. As well as the traffic management and AID aspects, that also encompasses ventilation and smoke/environmental detection systems. These are all integrated onto a Graphical User Interface (GUI) which operators use to verify condition alerts and then select from preset scenarios. This removes subjectivity and the need for improvisation.

The resultant solution can respond very swiftly. Incidents can be detected within two seconds and scenarios can be enacted within five to ten seconds. Gantry-mounted variable message sign (VMS) located along the 1km approach to the tunnel entrance are supported by others at ground level and can be used to convey information to road users. Three complementing systems guard against fire; there are both smoke and heat detectors in the tunnel ceiling, and the AID cameras also have a fire detection capability. In any such emergency the ventilation systems act automatically, warnings are generated and the tunnel’s operators are taken into a scenario-led response.
To meet the necessary deadlines involved a round-the-clock design, production effort and a major logistical undertaking; equipment manufacture took place within a four-week time window and some 23 tons of equipment were shipped to site by air. The CCTV cameras, the smoke and heat detectors and other environmental systems came from other manufacturers. The D-B contractor’s field integration and installation crews were working in two daily shifts installing the equipment. On-site finishing took just two weeks, resulting to delivery of the fully functional TMS on schedule in January 2010 six months after the contract award. The advantage of this approach was that the system that fully satisfies all end user’s requirements and specifications was designed, supplied, installed and placed into operation in a period of about six months without the sacrifice of the detailed system design scrutiny by the end user employed independent consultant, something which in the more traditional approach very often takes a minimum of two years with often doubtful results as the system integrators face major problems to successfully integrate on separate tenders selected subsystems.

To show the extent of the work done in such a short period of time, following is a list of the subsystems supplied and integrated:

- Four gantry-mounted and two ground-mounted full-matrix VMS;
- Three ground-mounted LED signs for warning over-height vehicles;
- Three over-height vehicle detection systems;
- Four PTZ dome cameras;
- Four AID cameras;
- Two fixed cameras;
- Four emergency telephone points;
- 14 lane indicator signs (capable of displaying an ‘X’ or arrows);
- 16 variable speed limit signs;
- 2 radar detector-equipped variable speed limit signs (which flash if an approaching vehicle is being driven at above the set speed limit);
- Two pictogram-capable RGB signs;
- 50 LED LaneLight in-pavement markers;
- Nine LED inner illumination signs;
- Three roadside controllers;
- A complete Gigabit IP network over fibre optics;
- A complete control room equipped with servers, workstations, LCD screens and RAID storage for video recording; and
- Tunnel infrastructure subsystems including fire alarm system fire-fighting equipment, ventilation system with pollution control, flood control submersible pump system, and tunnel lighting with an optical sensor system (supplied by others but integrated in the TMS)

More info on this project can be found on: [http://www.traffic-tech.com/project_references_traffic_ITS_page2.php](http://www.traffic-tech.com/project_references_traffic_ITS_page2.php)
2. Amman Central Traffic Management System / Jordan

The project included the connection of 96 intersections to an Adaptive Traffic System (SCATS). A system that operates in a real time adaptive mode by automatically monitoring traffic at all approaches to intersections and adjusting cycle times, green splits and offsets every cycle to suit current conditions. It also provides an adaptive green wave at successive intersections to reduce the number of times drivers have to stop.

The project also included the installation of 1,200 inductive loop detectors (one per lane) at each intersection near the stop line, as well as 58 PTZ dome cameras at critical intersections for real time traffic surveillance and monitoring. A control room has been equipped to manage all operations centrally, with plans to turn the building to a full fl edge Transportation Control Center in the future.

Level of Innovation
In the absence of a fiber optic network, an innovative approach was devised to operate both the real time traffic signal control and the CCTV cameras on a single 512Kb digital VPN line leased from a local telephone company.

A technical challenge occurred when work began on the communications system. The initial tender specification required the use of analog phone lines for connecting the field controllers to the central computer. However, after the tender was awarded, the telephone company advised that they no longer provide analog lines.

The D-B contractor studied and tested several communications system options including GPRS and digital VPN with different bandwidths. The test involved converting all field equipment from serial to Ethernet communications. After testing both SCATSTM and CCTV System on the same line and achieving excellent results, 512Kb digital VPN lines were selected.

In the process, The D-B contractor also screened various camera options to meet the criteria of high quality video transmission within the limited bandwidth of 512Kb VPN line shared with the SCATS system and installed top of the line CCTV cameras.

Functionality
Before and after travel time study conducted by the Greater Amman Municipality on one corridor along Shaker Bin Zeid Street revealed that travel time decreased after SCATS™ implementation from a high of 30 minutes to 10-15 minutes. The CCTV recordings likewise proved invaluable when investigating incidents.

The Amman project has resulted in measurable improvements in traffic flow within the city and has proved to be a valuable tool with regard to getting traffic data in real time and improving traffic management strategies. In terms of economic impact, road users’ benefit on less travel time on their daily commute and gain significant savings on vehicle operation costs.

Traffic managers on the other hand became more capable in monitoring traffic and incidents in real time from a well-equipped control room, thus making their job far easier and shorten their response time to incidents on the road. Such project would have been almost impossible to implement in a
Award Winning

The project was evaluated by different bodies in terms of cost, time for completion, level of innovation & functional advantages, and based on that has won the Best Urban Project Award 2008 by the Greater Amman Municipality and the 2009 Innovation in Transport-Traffic Management at Gulf Traffic in Dubai 2009.

More info on this project can be found on: http://www.traffic-tech.com/project_references_traffic_ITS.php

3. Truck Weigh Stations on Salwa International Highway / Qatar

Salwa Highway is a newly constructed eight lane international highway linking Doha to the Saudi Border. The highway carries an average of eighteen thousand heavy trucks per day and in the absence of truck axle load enforcement, fifty kilometers of the highway were completely damaged even before the construction ended and had to be fully re-constructed again. In order to alleviate this problem, A Design-Build contractor was contracted to design, build and operate six truck weigh stations, a key project aimed to improving day-to-day traffic safety and reducing road maintenance cost through prevention of accidents and road damage caused by overloaded vehicles. During the construction of the fixed weigh stations the same contractor also operated portable/mobile enforcement scales in cooperation with the Qatar Police to enforce legal truck weights, and start educating truck drivers and owners on the importance of adhering to the legal limits.

State of the art truck weigh station design was adopted, and each station consisted of four major parts:

1- High Speed Weigh in Motion / Data Collection Station on the Mainline

2- Weigh in Motion / Ramp Screening for all Trucks Entering the Station

3- Multi-platform Static Scale for Weight Verification

4- Detection System and Enforcement Cameras to capture Trucks that Bypass the Weigh Station
Innovation
The use of Weigh-In-Motion (WIM) technology in the Mainline, Ramp Screening, and Bypass makes it possible to collect all the necessary data of moving trucks. This makes the system flexible and adaptable to the very high traffic volume demands of the freeway and at the same time delivers full enforcement of weight and height limits. Use of WIM has guaranteed high throughput through the stations with only vehicle with high probability of violation be directed to the static scale and stopped for investigation.

Achievement
The Design-Build contract was implemented in fast track fashion, on time and on budget. The percentage of overload violators on Salwa Highway before implementing axle load limit enforcement was as high as 83%-97% based on data collected in April 2007. This reduced to 30% when mobile enforcement started operation in July 2008. Overload violators further decreased to 6% based on data collected in September 2009. The percentage of violators decreased further to less than 1% by October 2010.

With the significant reduction of overload violators, road pavement damage significantly decreased.

Commitment & Replicability
With the success of the project on Salwa Highway, The Qatar Public Works Authority adopted the same design concept and committed to build 16 more Truck Weigh Stations throughout Qatar, five of which are currently under construction on North Road. In total, there will be 23 truck weigh stations that constituting a national truck weight enforcement system that will cover the Qatar road system.

Sustainability
Enforcement of vehicle weight limits has significantly reduced road pavement damage, which was a huge problem in Qatar, improved road safety and allowed collection of valuable data. The technology used allows integration with larger ITS systems and formation of an interconnected national commercial vehicle operations and weight enforcement system. The D-B contractor.

More info on the project can be found on:
http://www.traffic-tech.com/project_references_truck_weigh.php

Conclusion:
Design-Build approach, if properly dealt with, can reduce ITS project completion times, allow deploying advanced technologies and design methods, encourage contractor innovation, reduce total cost and impact to the public. However, to achieve the full benefits of this procurement method a good management style with a team based approach is necessary.

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