FOREWORD

Rail is a proven driver of economic growth and prosperity and presents many opportunities for our future, smarter society. In the Middle East and North Africa (MENA) region alone there are an estimated 16 major railway projects underway, with over $350 billion being invested in passenger and freight rail networks.

As a region we have a unique and significant opportunity to create a legacy of truly world-class rail infrastructure that helps to achieve our leaders’ long term goals. At the same time we are facing up to the challenge of creating long term sustainability in our economies.

To fully capitalise on the benefits an integrated and effective rail network could bring to the MENA region we must develop more robust business cases and sensible procurement models; and implement clever planning and design that will optimise the investment and create real value for all stakeholders.

In this White Paper we outline some ideas about how we can make this a reality... Let’s Talk About... Rail.

Brendan Young
Head of Rail

INTRODUCTION

The MENA rail industry is relatively new, and is moving at a swift pace through the project development phase, having overcome challenges of funding and cash flow, supply logistics, resource scarcity and delivery complexity to lay down hundreds of kilometers of new rail infrastructure ready for operational service. Rail asset owners are faced with the next big challenge: transitioning from a project delivery-oriented organisation to that of an asset operator and maintainer. The investment commitment to operate and maintain a railway over its life time is significant – it dwarfs the project phase both in duration and cost and yet our observation is that the lion’s share of consideration is focused on initial project delivery, often with only limited thought to the long-term implications across the lifecycle. A successful transition requires an asset-oriented mindset from the outset with a focus not only on optimising upfront capital spend, but on operational cost reduction and potential revenue streams.

In this paper, we examine a whole-life approach to rail infrastructure development and delve into some examples where innovation and prudent investment can assist rail asset owners to build a sustainable long term business case and be at the forefront of smart infrastructure in the smart cities of the future.

Figure 1 - Overview of the railway asset lifecycle

THE WHOLE-LIFE APPROACH

In the more established rail operating markets, an entire sub-industry has been developed around costly preventative maintenance, failure detection/early-warning systems and clever corrective maintenance techniques. While there are some important innovations these regimes have brought about, it's reflective of a lack of proper integrated planning and a whole-life perspective during design.

With a more holistic approach, faults and failures can be designed out and future remedial works can be designed in. If effectively implemented industry-wide, this approach will enable the whole MENA rail industry to implement change more easily, and assets will last longer, cost less to maintain, and generally be more available, reliable and safe — in turn, providing passengers with a higher quality service and owners with a healthier fare box.

In the MENA region, we have the opportunity to get it right the first time around and not go through the pain of unscheduled, corrective maintenance and renewals and the risks it brings with it.

**Table 1 - Network Rail maintenance cost savings**

<table>
<thead>
<tr>
<th>Rail Sub-system</th>
<th>Annual Maintenance Cost (£) @ 2012</th>
<th>Predicted reduction in annual costs after 2-5 year control periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track</td>
<td>481M</td>
<td>5-10%</td>
</tr>
<tr>
<td>Signalling</td>
<td>167M*</td>
<td>10%</td>
</tr>
<tr>
<td>Electric Power &amp; Plant</td>
<td>84M</td>
<td>20%</td>
</tr>
<tr>
<td>Structures &amp; Geotech</td>
<td>451M</td>
<td>&lt;5%</td>
</tr>
<tr>
<td>Telecoms</td>
<td>77M</td>
<td>20%</td>
</tr>
</tbody>
</table>

*aPrior to adoption of new ETCS-based signaling.
Source: UK Office of Rail Regulation (2013): Opportunities from Good Practice Asset Management (UK).

**Figure 2 - Cost over the rail lifecycle**

**Design with lifecycle in mind – early design intervention to reduce whole-life costs**

In emergency or degraded service situations, the impact on passengers can easily be minimized or even avoided by earlier design intervention. Design intervention means that known eventualities are accommodated in the design. Let’s take major works like track maintenance; for example: an early decision to use slab-track and resilient fastenings rather than traditional ballasted-track, particularly where large temperature differentials exist, can bring downstream cost savings. It eliminates the need for track tamping, ballast placement and regulating and the risk of infrastructure damage it brings with it; it provides a greater rail restraint that reduces the serious risk of rail buckles and rail breaks associated with continuously welded rail, and results in less service disruption and overall better ride quality. So early planning with maintenance and renewal interventions in mind is extremely important to minimize costs of corrective maintenance and service disruption during operations.

**Get to know your asset better, earlier - improve asset information management**

A whole-life approach can also be applied to gathering system and component data before it’s built. During the design stage, configuration management data and records can be compiled for systems that are being developed and integrated. By adopting this approach, project data that is compiled for purposes of configuration management during the project design stage is structured based on the requirements for asset management that is required for the operational stage.

One of the great benefits is that owners have an irrefutable baseline from which asset condition can be assessed in the future, all in a convenient model. Add clever data collection and diagnostics technology, skilled O&M staff and clear processes, and owners can minimise maintenance spend from Day 1.

**In the UK, the Office of Rail Regulation projected Network Rail’s financial performance after the adoption of a risk-based maintenance regime. It shows an overall reduction in annual maintenance costs of over 10% is achievable by implementing a whole-life approach across people, platforms and processes.**
AREA 1 – DRIVE BETTER STATION PERFORMANCE

By insisting on station design that reflects operational functionality and maintenance considerations, as much as its aesthetic appeal, rail owners will create high performance stations and lower annual operating costs resulting in greater passenger satisfaction.

A high performing station:

- Is safe, attractive, comfortable and convenient and keeps passengers coming back
- Is easy to maintain, is future proof and has capacity to generate non-fare revenues
- Has a minimal physical footprint, low carbon footprint and a long asset life.

We’ve examined some areas where owners, through the design process can drive better station performance through the asset lifecycle either through form (using space planning and materials) or function (using technology and building science). We’ve focused on the three key aspects of modern station design:

- Cooling
- Security
- Waste

STATION COOLING: Climate control for passenger comfort and cost savings

Maintaining a comfortable internal environment in stations in terms of temperature and humidity can be challenging in the MENA region and if not done correctly can lead to high operational and energy costs, unwanted condensation and reduced comfort for passengers. We’ve looked at some common issues and potential solutions to make station cooling more efficient.

Despite good design in some cases poor finishing works make buildings leaky and can result in increased cooling costs of up to 20%.

In a sometimes hot, humid climate, stations can be extremely leaky due to infiltration of hot outside air and latent heat when people enter the building. When commuters enter the building from outside or trains arrive at the platform (where Platform Screen Doors are used) there is a short period whereby the building is open to the atmosphere. Depending on the train timings and level of passenger footfall in and out of the station, these short periods could be very frequent which in turn could mean a very leaky building. Pressurising the building to reduce the infiltration effect will help, however this is energy inefficient unless other measures are taken.

The control of the air conditioning is also important because stations generally have a very transient load when commuters are getting on and off trains. Peak loads appear at regular spikes throughout the day and through dynamic load profiling using computational fluid dynamic (CFD) modelling, these peaks in heat loads can be softened to improve energy efficiencies of the HVAC system.

Designing the system to a baseline cooling load with the ability to ramp up and down to suit train times and passenger loading can be very effective. This is known as ‘smart reactive building management’ and can be activated via a programmable controller linked to train times or existing passenger counting systems, so that the HVAC system is operating to the most optimum profile.

Offsetting lags in cooling effect could also be effective, whereby, on the platform as an example, the air conditioning would be brought on minutes before the train arrives to ensure the space is up to temperature when the commuters arrive at the platform. For platforms with more frequent train times, like metros, a more constant load profile would be needed but cooling could be directed to a platform where the peak direction is, at that time of day. During engineering hours or when the trains are not running, the building management system (BMS) would ramp down to background cooling to further reduce energy costs.

Passive facades or intelligent shading can also significantly reduce energy costs due to the ability to reduce solar gain on different elevations of the building at different times of the day. But this needs to be balanced with the need for natural light to save costs on lighting.

Overall, by both mitigating potential energy losses through designing to climatic influences and insisting on quality construction finishing, and using smart technology to control cooling and ventilation, overall energy savings of up to 40% can be achieved on an annual basis.
SECURITY: Creating safe station environments

Stations are designed to be open and welcoming to handle the high volumes of people that use them on a daily basis, but this makes them inherently vulnerable to particular threats. Traditionally, rail stations were easy to demarcate where they started and finished, but as they continue to get merged with other structures such as residential and commercial developments, airports and park and ride structures they become larger, more attractive targets to both common criminals and politically-motivated groups. But this should not deter us from creating great, safe stations.

In the MENA region, we have the opportunity to be more creative and flexible in design responses to safety and security issues on railways. Again, we need to get in early in the design process or we’ll end up with nothing but CCTV.

Smart station design captures the intended purpose of the station, the area it serves and future considerations, such as events and integration with future expansion and Transit-oriented Development. By understanding who uses the system and how they move within it we can create stations that reduce commuter conflict and can adapt to future expansion and support the safe management of crowds during peaks.

We believe that all new stations should be designed using Crime Prevention Through Environmental Design (CPTED) principles. CPTED can be used to create welcoming and open spaces that promote natural (passive) surveillance, remove areas of concealment and guide commuters efficiently through to their onward journey.

Safety and security are supported by good architectural design and good signage and wayfinding. Subsequently, good passenger behaviour is passively prompted. To take it a step further, social media can be used through apps and smart phone technology, for passengers to report risks and incidents directly to operators, assisting them to maintain eyes and ears on every aspect of station and passenger safety, leading to more swift action to eliminate or mitigate risks.

Ultimately, good station security design should comprise a combination of physical (design), technological and operational responses.

Technology is a vital tool which can help monitor the stations and highlight potential security issues before they develop. Video analytics can detect left objects, groups of people gathering, track people and provide facial recognition. These are becoming increasingly sophisticated and allow owner and operators to automate security, reducing manpower costs during operation.

Operational security is also necessary. Police and security personal provide a visual deterrent; while plain clothes officers can be trained in SPOT (Screening of Passengers by Observation Techniques) and are able provide covert monitoring around the station, they can also monitor areas where cameras can’t, such as restrooms for unattended packages.

But, early design intervention will provide a significant reduction in downstream costs during operation by decreasing dependence on active surveillance infrastructure and personnel. Each station should undergo a security risk assessment to determine the level of security intervention required; this will ensure security expenditure is appropriate for the context. Ultimately, a passenger who feels safe is more likely to be a regular user.

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Major global incidents

The likelihood of major security incidents in some parts of the MENA region remains low, but they cannot be completely ruled out when thinking about security design. Some examples of major incidents involved rail systems in recent times are:

- Cologne, Germany - About 1,000 drunk and aggressive young men were involved in assaults and robberies.
- London, England – Three bombs in quick succession aboard London Underground trains across the city were detonated.
- Tokyo, Japan - Five coordinated attacks saw perpetrators release chemical weapon, Sarin, on several lines of the Tokyo subway during the rush hour, killing 12 people, and severely injuring 50 others.

WASTE: Integrated waste management for operational efficiency

Preventing and reusing waste can achieve significant cost savings during operation while minimising a station’s environmental footprint. With resource scarcity in mind, the design of new stations should look to reduce the volumes of end waste and deliver on the triple bottom line.

We believe that by setting rigorous waste goals at the beginning of the design process and insisting on waste management KPIs during operation, significant cost benefits can be realised by rail owners.

By mandating a recycling rate of 60% for station waste, rail owners could reduce the carbon footprint of railway stations by up to approx. 1,333 tonnes of CO2 emissions for every tonne of waste.1

Typically, around 32% of plastic waste generated in rail stations can be recycled and used for other products, like e-tickets.2

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1. Achieving the Vision of No More Waste, SITA/Suez Environment
2. Assessment of Plastic Waste and its Management at Airports and Railway Stations in Delhi, Central Pollution Control Board, December 2009
Before the design process commences, a waste management policy and guidelines which specifically detail the approach to manage all station wastes from generation to final disposal should be developed and implemented. The policy should include realistic milestones and comprehensive action plan with the overall aim of improving waste management.

The strategy should cover the full spectrum of the waste hierarchy, promoting waste prevention, reuse, recycling and diverting waste from landfill. We’ve proposed some ideas that will help reduce the cost of waste management during operation, if adopted early and incorporated into design.

Figure 9 - Waste hierarchy

All stations should be designed with waste segregation as a minimum requirement, enabling passengers to responsibly dispose of waste and operators to efficiently sort and remove waste from the station to an appropriate offsite facility. Bins should be located at clear, open locations that do not impact on passenger flows and do not present a security risk. Clear, graphical, informative signage should be displayed to encourage users to appropriately discard their waste.

Figure 10 - Use of recycling signage

Ticketless systems are becoming more commonplace allowing regular passengers to use their smart phones to go through ticket gates. Although, ultimately there may always be some form of physical ticket, for tourists or one-time users, for example, these should be made with recycled plastic (potentially from station plastic waste) and passenger should be incentivised to return them once no longer required. Discounts on e-tickets and plastic ticket fares above paper ticket fares will further incentivise the phase out of paper tickets.

A good waste management strategy, incorporating efficient waste collection and removal from the station will result in a reduced environmental footprint and more efficient operations, further reducing operating costs.

AREA 2 – CREATING SMART TRANSIT HUBS

By implementing smart transit hubs or transit-oriented developments, rail owners can immediately offset capital costs of construction and secure long term revenues to offset operating cost once in service while at the same time achieving important sustainability goals and smart city initiatives.

What is TOD and what makes it Smart?

Transit-oriented Development creates safe, vibrant neighborhoods around stations; short and well-connected pedestrian and cycling networks; densities that stimulate local commerce and transit ridership; and minimise car traffic.

A Smart TOD will create safer, more sustainable and technologically-interconnected urban environments around mass transit that enable its inhabitants to have more productive contributions to their wider communities, while minimizing the development footprint per capita. A Smart TOD gives governments more ‘bang’ for their infrastructure ‘buck’.

WSP | Parsons Brinckerhoff advocates the drive for smart growth and smart cities in the MENA region and sustainable growth to ensure our next generation enjoy what we have enjoyed. We see rail-based transit at the heart of this and transit hubs have the potential to be a great catalyst for adopting new development strategies that will make our cities more liveable.

Putting TOD in the context of the latest developments in rail and information technology, we see an opportunity for MENA rail owners to take the next step and create transit hubs that not only have the potential to generate vital revenue but serve the wider smart growth strategies envisioned by our region’s leaders. Here’s how we think it could be done.
Land use and transport are inextricably linked. A transit system that is well-integrated with land use (both existing and planned) will attract good ridership, going a long way to reaching farebox revenue targets helping offset operating costs. But where land is available near transit stations, rail owners have an opportunity to further improve integration through increasing densities which will further increase ridership.

An individual station TOD can increase ridership by 20 to 40 percent, and up to five percent overall at the regional level.

Similarly, infrastructure and people are also interdependent. Poorly designed infrastructure impacts on people’s mobility and in turn their quality of life: a vicious cycle impacting on a city’s economic efficiency. But a smart transit hub presents an opportunity to turn this on its head and create a virtuous circle of continuous feedback between infrastructure and people, which makes infrastructure fit for purpose and people more productive.

There are three sides to this:
• The station: designing stations that are passenger friendly, yet operationally efficient
• The development: annexing property development on and around stations for cost sharing or revenue generation
• The technology: improving ‘infrastructure’ to get railways and passenger interacting more and encourage more efficient infrastructure investment.

The Station

Stations should be designed to allow for easy connectivity to surrounding development. Direct, basement level connections to adjoining buildings provide passengers a quick, safe and comfortable link between the station and their destinations, be it a connecting bus or their home. Great directional signage and passenger information is also key. Savvy passengers demand it and in real time.

The station is the hub driving activity above and around it, so the ease of getting from platform to front door should be the key consideration. Stations must also be designed to be operationally efficient and responsive to their context, the safety and comfort of the passengers who use them and the maintenance requirements.

After all, a station is the centre of the TOD. If the station doesn’t perform well, the TOD will not perform well.

Figure 11 - Bond Street Station (Crossrail) overstation development

The Development

A well-structured, market-oriented development plan focusing on areas immediately surrounding and in some cases above key stations, can bring immediate opportunities for revenue generation or cost sharing.

A solid property business case can be based around solid ridership forecasts. An attractive, safe and efficient station with good footfall numbers will attract developers and retailers alike. Of course, revenues can be generated through land banking (buy land now, sell land when capital is needed for a new rail project) but planned transit-oriented development creates opportunities for both:
• cost sharing – developer contribution to rail capital investment for air rights
• revenue generation – property development (owner pays and sales fund capital investment)
• leasing (owner retains some or all property and rental income fund capital or operating investment)
• value capture (owner captures revenue through levies on land value increase).

Good control over the public realm is important in any case. A good TOD focuses on:
• the quality and appropriate mix of development programming at the destination;
• the quality of the pedestrian experience between station ingress and the TOD, and;
• the overall degree of engagement between transit commuters and the destination as a place.

Using a Value of Travel Time (VTT) rate of AED15/hr from a recent study, a 30 minute delay avoided for 10,000 people in a peak hour avoids a time cost impact of AED 750,000.

On the Crossrail project in London, property development forms the core of the overall funding strategy with $695mn in income targeted from property development alone.

The Technology

Information technology can bring people and rail infrastructure closer together and result in greater travel efficiency through informed decision-making. We think one way to do this is to use existing journey-oriented smart phone apps. Rail users, especially those who live in a TOD, can connect with rail passenger information systems and know in advance if service disruption might affect their usual journey, giving them valuable time to re-plan their route.

Prudent investment in technology research and innovation can bring many downstream savings. Some other areas where technology can create a truly smart TOD could be:
• Integrated power supply and cooling – using an integrated Building Management System to control peak and off-peak supply relating to train timetables and passenger flow
• Integrated ticketing and payment – e-cards to pay for tickets, groceries, coffees and discounts for people living or working in TOD
• Permanent asset condition surveying installation – install asset scanning equipment in front-of-house areas that doubles as security surveillance, perhaps with facial recognition technology. This is particularly useful when remediation work may affect the existing station structure.
• Social engagement to supplement station passenger information systems – podcasts going out through social media about changes to services; passengers report events and concerns via apps direct to operator.
• Use of OLED (organic light emitting diodes) information displays to augment traditional lighting – install more digital signage using OLED displays in place of some lighting lowering energy costs.

Figure 12 - Interface passenger information with smart phone technology

Portland, USA – Street-level success

According to a report from the City of Portland and Portland Streetcar, Inc., $3.5 billion in real estate investments were made within 2 blocks of the streetcar alignment in less than 7 years from opening. Since the total capital cost of the streetcar line was only $103 million, the benefits of the Portland Streetcar line far outweigh the costs.

The streetcar’s positive effects on real estate development are most easily seen in the Pearl District, a former declining industrial district just north of downtown Portland that is now a vibrant urban neighbourhood. Portland’s Pearl District is widely regarded as a national best practice model for urban revitalization.

Locations next to Metro stations can enjoy increases in land values of over 50 percent in comparison to locations away from Metro stations.

A combination of good station design, a well-planned development scheme and public realm incorporation of information and automation technologies, can make smart transit hubs the centre of the new smart city, where residents and workers are mobile, informed and productive, ultimately creating a more resilient economy and stretching the infrastructure investment dollar further.

A pathway to Smart TOD

There are many aspects that need to be addressed to make Smart TOD happen but we’ve tried to boil it down to critical success factors.

1. Policy commitment
   Sometimes stakeholders have conflicting goals and priorities, but often a champion to push the rhetoric into action is lacking. A government commitment will make things happen. This is an easy leap for a government to make if it is committed to sustainability and smart cities.

2. Good placemaking
   The public realm must have a sense of place and be humanised. At the surface level, smart TODs need to accommodate the ‘sit down and soak it up’ people just as much as the ‘run fast and make my train’ people. No cars, please.

3. Technology selection
   Many technologies can be explored but fundamentally good ‘infrastructure’ is the key to the smart TOD where passengers are better informed about their journey ahead or how to find the nearest ATM when they’ve arrived. Links between rail passenger information systems and smart phones are a quick win with existing technology.

4. Regulatory change
   Cooperating with urban planning authorities, rail owners should seek to immediately freeze land around planned transit corridors, acquire it where feasible or rezone it to encourage higher density, complementary land uses. Smart TOD guidelines should be implemented to guide good TOD design.

5. Organisational capability
   An internal capability needs to be developed to create the business case and set up the governance required to make it happen. Partnering with consultancies, law firms and private developers helps accelerate this process ‘buying in’ the private sector. A combination of public funds and private investments may inevitably be needed. The capability must then evolve to manage the facilities.

6. A solid business case
   A real-estate market evaluation is required to confirm if a TOD scheme is feasible. It will assess future levels of supply/demand for asset classes and land uses. It is also important to establish a baseline property value in TOD locations to use when calculating property value fluctuations as a result of the Metro station. Within stations, opportunities for retail, entertainment and leisure should be sought. Above and in close proximity to stations both retail, commercial, employment and residential land uses should be encouraged.

7. Financial mechanisms
   Finally, the financial mechanisms required to capture revenue and direct it towards capital debt service and/or operating costs must be established. This requires legal and financial regulation to ensure all transactions are fair and lawful. Opportunities for joint-ventures could be explored to share knowledge and offset the risk associated with property development. However, marketing of opportunities and assessment of various joint-venture models must first be undertaken to inform decision making and assess likely market appetite.

CONCLUSION

How can we take these ideas forward?

To recap our challenge to the industry is to:

• Adopt a whole-life perspective to rail projects by:
  • Designing with the rail lifecycle in mind
  • Mandating asset information management during design
  • Thinking outside the box to deliver better value over the lifecycle.

And we think this could be achieved by:

• Driving station performance through design, for example:
  • Designing station cooling systems that are responsive to their context and passenger demand
  • Optimising passenger station security through architectural design
  • Minimising waste, encouraging recycling and optimising efficiency of waste removal.

• Creating Smart Transit Hubs or TODs:
  • Freezing land around stations
  • Creating well-planned developments that complement the stations
  • Incorporating technology to improve the station-passenger interface.

We are keen to challenge the industry to consider taking forward some of these ideas to ensure rail owners are able to optimise opportunities for capex offset now and improve operating ratios in the future so that rail passengers can enjoy continued high levels of service quality.

We’d like to hear from our clients and industry partners and colleagues to continue pushing the envelope in seeking ways to ensure a whole-life perspective is adopted by all stakeholders so that society can reap the tangible (and sometimes intangible) benefits of good design which will be reflected in a more resilient, sustainable, socially-inclusive and liveable society.

In Hong Kong, the MTR Corporation, now a publically-listed company, turned over $5.2BN in revenue in 2014 at a profit of $2BN. Around a quarter of revenues generated in 2014 were derived from either station commercial businesses or property sales and rent.⁵

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⁵https://www.mtr.com.hk

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