Productivity Link

SINGAPORE PRODUCTIVITY ASSOCIATION

December 2015

Contents

1. **An Overview of Transport Engineering Sector**
2. **Productivity Challenges in the Transport Engineering**
3. **Enablers and Disruptive Technologies to boost Productivity in Transport Engineering**
4. **Possible Immediate Actions for Productivity Improvements**
5. **Conclusion**

Case Study
- *Singapore – Smart Mobility 2030, Intelligent Transport System (ITS) -- LTA and the Intelligent Transportation Society Singapore (ITSS)*
- *Global – Free-Flowing Driverless Vision for Sydney in 50 years -- Research Centre for Integrated Transport Innovation CITI)*

Recommended Readings

Productivity in Transport Engineering Sector

1. An Overview of Transport Engineering Sector

Transport engineering covers private and public infrastructure systems. Planning, design, and operations connect worldwide air, rail, road, and water highways using sophisticated electronics and other forms of technology. Sustainability, safety, and equity are developed to provide economical freight and travel costs with as little congestion as possible.

Singapore's transport engineering sector comprises aerospace, marine and offshore engineering, and land transport industries.

Ongoing development of Intelligent Transportation Systems (ITS) has provided technical tools to enhance productivity. Advanced traffic control systems include the use of electronic ramp meters to control traffic flow. Traveller information systems keep operators up to date on traffic situations with current data displayed on variable message signs.

2. What are the barriers/challenges facing the sector's productivity?

The challenges faced by the transport engineering sector's push for productivity include potential disruptions for road, rail, and air transportation companies in providing same-day delivery (short term), 3D printing (medium term), autonomous commercial vehicles (long term) and customer satisfaction. We explore these below.

2.1 Same-Day Delivery

The key challenge for e-retailers is finding the price points for delivery that makes business sense, practical consideration such as geographies and most consumers expect delivery to be free. Hence, same-day delivery will likely remain a niche offering in a small number of urban markets for now.

2.2 3D Printing

With the cost of 3D printing falling, it has the potential to disrupt product supply chains and the transportation sector.

The impact may be on air cargo companies that handle high-value, urgent products. The trade-offs between local manufacturing (using 3D printing) and remote manufacturing (using traditional manufacturing processes) by shipping customers will affect transportation companies.

Figure 1: First 3D Printed Car
Source: http://www.osborneclarke.com/media/filer_public/66/ee/66ee5cb5-89a3-42b6-8946-d4fadfb8267f/rohit_talwar_-_osborne_clarke_-_june_2nd_2015_master_c.pdf

2.3 Autonomous Commercial Vehicles

Autonomous commercial vehicles (ACVs) must overcome consumer speculation before they are widely accepted by the general public. Concerns include the loss of jobs as equipment and commercial vehicles complete tasks via electronics rather than human expertise. Productivity will increase as the ACVs need only limited breaks for routine maintenance.

Australia has self-driving trucks working at mining sites. Daimler has a self-driving truck that has been road-tested in the United States. The automation level of commercial vehicles will depend on human and equipment safety, and the area in which they operate. As citizens become comfortable with self-propelled vehicles, they will accept the next level of automated commercial equipment with greater confidence.

Figure 2: A Google self-driving car goes on a test drive near the Computer History Museum in Mountain View, Calififornia
Source: http://m.dailytelegraph.com.au/newslocal/city-east/the-free-flowing-driverless-vision-for-sydney-in-50-years/story-fngr8h22-1227409818086

2.4 Customer Satisfaction

The Public Transport Customer Satisfaction Survey (PTCSS) showed positive gains in important customer expectations. Customers increased overall ratings for Mass Rapid Transport (MRT) services in Singapore by almost four percent in 2014. Wait time improved by 8.6 percent compared to the previous year. Customer service improved by 6.7 percent and reliability by 4.2 percent.

Figure 3 below shows the satisfaction levels recorded in the past several years.

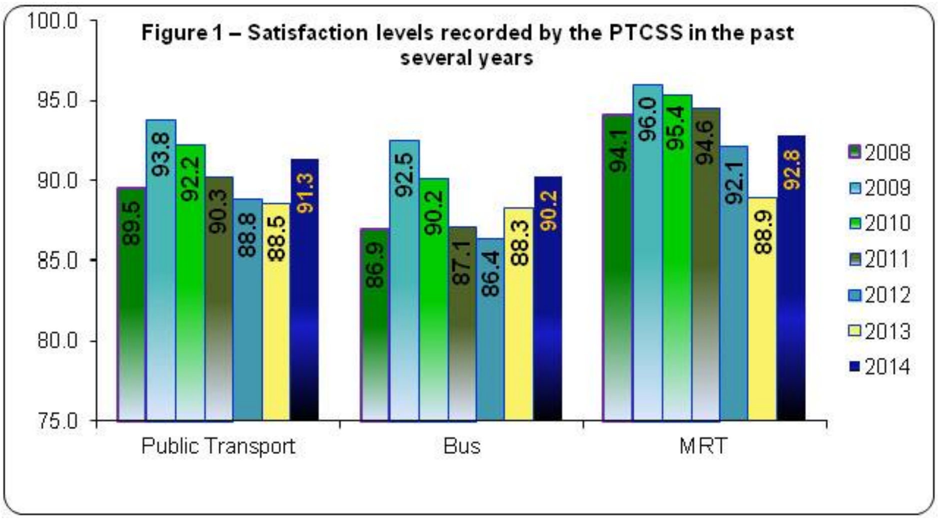


Figure 3: Public Transport Customer Satisfaction Survey (PTCSS) Results

Source: http://www.lta.gov.sg/apps/news/page.aspx?c=2&id=ec883090-d0c2-4b68-b5cc-37950debae74

Rail operators and the Joint Teams of Land Transport Authority (LTA) have worked to strengthen network reliability, particularly in train withdrawals and service delays. Further progress is required for added train capacity and an upgraded signaling system for the North-South and East-West lines. Continued transition to the Government Contracting Model for higher service levels in the latter part of 2016 will result in scheduled intervals of 10 to 15 minutes during the peak morning and evening transport hours.

3. What are the enablers and disruptive technologies available to boost productivity in the sector?

Productivity continues to increase at an amazing pace in the transport engineering sector through the use of new technologies.

3.1 Intelligent Transport Systems (ITS)

Directing and improving various types of traffic is an achievable challenge with the implementation of Supporting Intelligent Transport Systems (ITS) Technologies. ITS provide transport engineers with tools such as advanced traveller information systems (such as variable message signs), advanced traffic control systems (such as ramp meters) and vehicle-to-vehicle (V2V) communications to optimise the performance of the transport system.

Figure 4 shows a visual illustration of an ITS.

Starting at the bottom of the illustration, the idea is to collect vast amounts of data from various sources (cell phones, cameras, social media, etc.), analyse and use that data to help with planning, rerouting of traffic, providing commuters with real-time updates, and to create a system that is constantly being optimised based on current and future (predictive analysis) conditions.

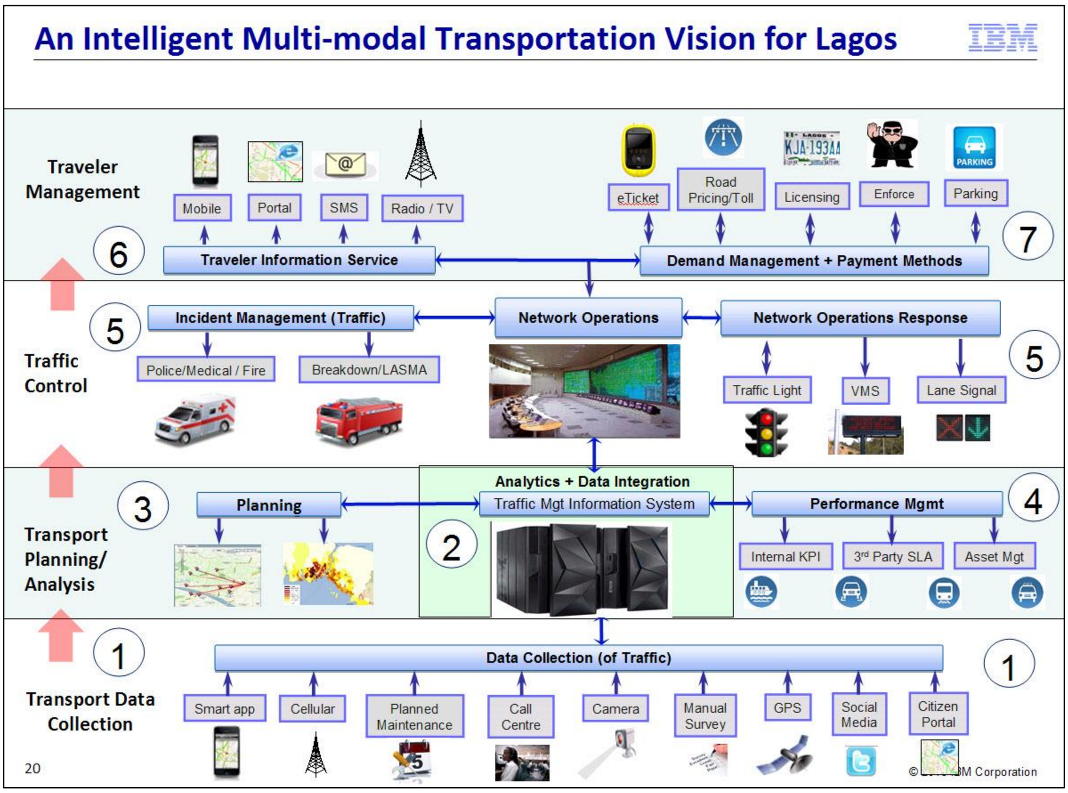


Figure 4: A visual depiction of what that an ITS system would look like
Source: https://smartercitieschallenge.wordpress.com/category/lagos-nigeria/

3.2 Smart Traffic Management and the Digital Road Authority

Electronics is bringing about the ability to send advice through an app to Amsterdam residents about traffic routes they are likely to take according to events calendared on their smart phone. The Digital Road Authority works with the Department of Traffic and Infrastructure of the Municipality of Amsterdam, Amsterdam Smart City and TrafficLink, coordinating with vehicular traffic and traffic signals. It encourages private parties and government bodies to cooperate with one another by offering personalised travel advice.

Travel slots are determined based on actual and predicted traffic density. Communication with traffic lights allows an extension of green light operation to improve the circulation of traffic.

The new app, which is being developed by the Dutch Research Institute for Mathematics and Computer Science (CWI) and TrafficLink, will be useful in two important ways. It will moderate rush hour traffic between the island of IJburg and the mainland. The two connecting bridges currently suffer from traffic jams at certain times of the day. Secondly, it will increase the appeal of living or working in IJburg with its improved traffic circulations.

Productivity will be enhanced once the required calculation models for traffic management reach the pilot stage and can be tested by IJburg residents. After testing and adjustments, the app will be available to all inhabitants.

Figure 5 shows how the Digital Road Authority – Incident Management will shorten the response time of emergency services.

Figure 5: Digital Road Authority – Incident Management

Source: http://amsterdamsmartcity.com/projects/detail/id/75/slug/the-digital-road-authority-ijburg

3.3 Internet of Things & Big Data Analytics

The Transport Engineering Sector increases productivity through dynamic methods of improving public transport services. Dublin City Council is creatively using the Internet of Things and Big Data Analytics by individually monitoring the city's 1000 buses to see if they are operating timely. It involves an intelligent traffic control solution that displays a city map of near-real-time positions of each bus based on GPS data.

Controllers immediately note delays and can obtain further information about the cause/s. Speed, traffic flow, and other measures for predictive analytics allow the controllers to make near-accurate estimates of transit and arrival times. Bus fleet trends are more transparent to planners and help the city:

- Reduce pollution.
- Save energy.
- Optimize bus routes.
- Increase rider service.

Figure 6: Figure: Dublin City ITS
Source: http://www.slideshare.net/dublinked/environment-dubmeet

3.4 Big Data in Aerospace, Planes, and 3D Printing

Cyber security, safety, and human-robotics interaction are ways in which big data affects the future of aerodynamics transport systems. Big data, a big part of the airline industry, is displayed through practices like Pratt & Whitney's 5,000 sensors in its new GTF engine. An anticipated 12PB of streaming data will be generated yearly. A Spanish printing enthusiast with the nickname of Harcoreta recently 3D printed and assembled a working model of a Boeing 787 jet engine. Technology continues to provide solutions and opportunities at an unbelievable pace.

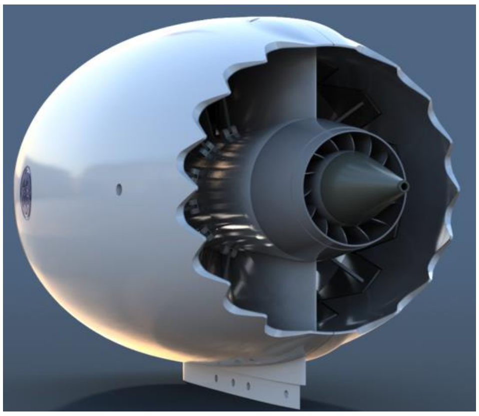


Figure 7: 3D printed and assembled a working model of a Boeing 787 jet engine
Source: https://www.3printr.com/maker-3d-prints-functioning-b787-jet-engine-0330725/

4. Possible Immediate Actions

These are some ways the Transport Engineering sector could explore in leveraging technologies for productivity. It is a challenging, exciting opportunity for transport engineers.

4.1 Technology and Sustainable Urban Transport

Densely populated cities can benefit from technology and sustainable urban transport. Busy, highly-efficient transport systems can be designed to favour sustainability. Walking, biking, and public transport are efficient ways for commuters to travel in harmony throughout a dense urban environment. The transportation system could be built so it meets the ambition and behavior of local residents. Big data may require guidelines to ensure changes relate to public demands and convenience rather than requiring the public to adapt to an overzealous plan based on electronics.

4.2 Commercial Route Planning

At the same time, commercial route planning can be designed with data and electronics to reduce the number of private vehicles that interfere with commercial vehicles. Transport for London estimates collections and deliveries compose 17 percent of that city's traffic and 25 percent in central London. Smart control of routes will improve mobility by easing congestion.

4.3 Deliver Anywhere using Smartphones Tracking

Online shopping is a huge commercial success. Customers are disappointed when they miss a delivery that requires a signature. Smartphones enable carriers to track a customer and deliver the package to their current location, such as work or a nearby restaurant. It's an excellent way to build consumer satisfaction and reduce delivery costs.

4.4 Human-focused Policies

Smart city transport schemes to increase productivity like data integration in Singapore and messaging signs in Barcelona are innovative and useful. Studying human and traffic flows to develop policies that cater to human-focused policies are successful and promote goodwill and cooperation among people affected by the change.

4.5 Low Carbon Transport

Working towards low-carbon transport now develops sustainable city transport.

4.6 E-Mobility

E-mobility is defined by autonomous and electric vehicles. Goals include solar powered charging posts for electric vehicles as well as the opportunity for the vehicles sharing stored solar power with people who need it. Vehicles need to be powered more efficiently while traffic and energy use is reduced without interfering with consumer needs and wants.

Case Study

Case Study: Singapore – Smart Mobility 2030

The guide to successfully meeting Singapore's transport challenges is outlined in Smart Mobility 2030. The outlook of future productivity in the transport engineering sector is easier to grasp by using the following acronyms in place of complete names:

- Land Transport Authority (LTA)
- Intelligent Transportation Society Singapore (ITSS)
- Intelligent Transport System (ITS)
- Singapore Autonomous Vehicle Initiative (SAVI)

A joint development of the LTA and the ITSS, Smart Mobility 2030 addresses plans for achieving smarter urban mobility in a coordinated, orderly manner. The key areas are based on ITSS and LTA review and analysis of Singapore's current transportation needs and the best way to develop a sustainable, encompassing ecosystem in transport management over the next 15 years.

Figure 8: Smart Mobility 2030 Framework
Source: www.lta.gov.sg

The ITS is responsible for the safe traffic patterns in Singapore. ITS infrastructure includes more than 164 km of roads and tunnel systems. It maximises the limited amount of land available for traffic routes while focusing on safety and productivity in the transportation arena. Constant advances in electronics allow the sophisticated traffic and control systems that efficiently monitor and manage routes like Central Expressway (CTE), Kallang-Paya Lebar Expressway (KPE), and Fort Canning Tunnel (FCT).

Industry partners and stakeholders benefit from SAVI, a joint partnership between A*STAR and LTA. SAVI's technical platform promotes:

- Test-bedding of AV applications, solutions, and technology.
- Research and development (R&D).
- Preparation of statutory and technical requirements before deploying AVs in Singapore. JTC and LTA have identified routes to support AV testing.

Motorists benefit from ITS

Safer roads and a smooth flow of traffic are reached with ITS solutions and innovative infocomm. Traffic information is dispersed as soon as possible so motorists can determine the most effective way to reach their destination,, including a route and/or departure change. Residents of and visitors to Singapore enjoy the benefits of a healthy, beautiful city because of the cleaner air and environment brought about through the efforts of ITS.

Some of the vital components within the ITS network is shown in Figure 9 below.

ITS Centre

The Operations Control Centre (OCC) operates 24 hours a day, seven days a week, and powers theITS Centre. Intelligent transport systems monitor traffic and dispatch ground recovery crews to helpmotorists when needed. Electric message signs display current traffic situations to motorists.

i-Transport

The integrated, unified platform of i-Transport centralises ITS management, such as:

- Provision of real-time traffic advisory information.
- Traffic monitoring and incident management.
- Traffic signal control.
- Tunnel and highway monitoring.

<u>Expressway Monitoring & Advisory System (EMAS)</u>

Monitoring & Advisory System (EMAS) alerts motorists of traffic incidents and ensures swift response to these incidents as it monitors expressway traffic. Its effective productivity is due to EMAS capabilities on major arterial roads.

EMAS Arterial

A total of 10 major arterial road corridors with a combined road length of about 142-km will be fitted with EMAS Arterial capabilities by early 2014. Extending EMAS to the major arterial roads will manage traffic and guide motorists more effectively.

<u>Junction Electronic Eyes (J-Eyes)</u>

Junction Electronic Eyes (J-Eyes) monitors traffic conditions at major signalised junctions through a system of surveillance cameras.

<u>Green Link Determining (GLIDE) System</u>

Monitors, adjusts and optimises green time in an intelligent and adaptive manner to provide “green-wave” along main roads in response to changing traffic demand.

<u>e-TrafficScan</u>

Taxis equipped with GPS act as road network probes to deliver island-wide traffic conditions to motorists.

Green Man+

Extending green man time for pedestrians requiring additional time to safely cross the road.

Your Speed Sign

Displays the real time speed of vehicles and alerts motorists that they are speeding.

Parking Guidance System

A parking guidance system alerts shoppers of traffic and available parking spaces in popular shopping areas like Marina Centre and Harbourfront. The data allows a better flow of vehicles in the area.

Figure 9 : Components of ITS in Singapore
Source: http://www.lta.gov.sg/content/ltaweb/en/roads-and-motoring/managing-traffic-and-congestion/intelligent-transport-systems.html

Case Study: Global – Sydney, Australia - Free-Flowing Driverless Vision for Sydney in 50 years

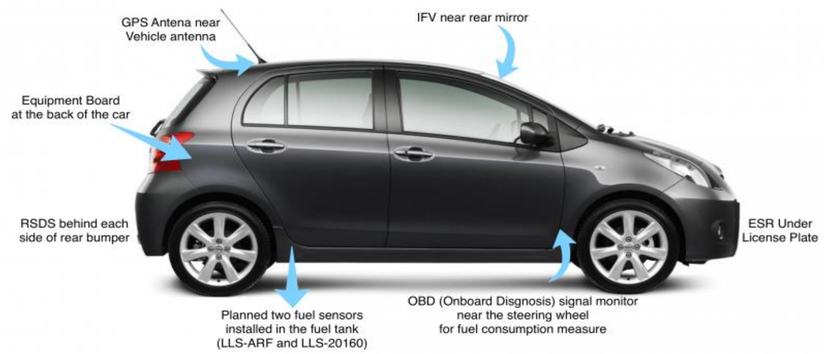
In June 2015, Professor Travis Waller of the UNSW's Research Centre for Integrated Transport Innovation (RCITI) predicted that driverless cars would be part of Sydney's road ecosystem within the next 50 years. One of the most significant changes is expected to be the incredible reduction of parking space, leaving land available for other use.

Figure 10: Professor Travis Waller with a self drive research vehicle at UNSW in Kensington.

Source: http://m.dailytelegraph.com.au/newslocal/city-east/the-free-flowing-driverless-vision-for-sydney-in-50-years/story-fngr8h22-1227409818086

The productivity of driverless vehicles would be evident in cars moving continually to pick up and drop off passengers. Intersections would be less likely to jam up with traffic. Electronics would create a different type of operation with traffic signals and driverless cars, since the cars would move in a different fashion than human-operated vehicles.

GoGet, an Australian car sharing company, loaned a self-driving prototype to the centre in 2014. Researchers at RCITI have been collecting driver behavior data and will soon progress to a driverless simulation. The vehicle is equipped with four radar sensors which detect bicycles, other cars, pedestrians, and roadside infrastructure. It also has a small on-board computer and video camera.



RCITI

goget.com.au

Finalist in the 2014 Sydney Engineering Excellence Awards in two categories:

Welfare, Health and Safety **and** *Research and Development*

Figure 11: A self-driving prototype
Source: http://www.rciti.unsw.edu.au/goget-carshare

Motorways and city planning are areas of concern. Urban driving will be a challenge as human drivers, pedestrians, and cyclists interact with driverless vehicles.

Volvo announced its plans to launch the XC90 SUV on South Australian roads in November 2015. Features like adaptive cruise control and pilot assist functions will keep the car within lanes and prevent them from running into cars in front of the autonomous vehicle. The challenge will be changing the habits of human operators as they share the road with AVs.

5. Conclusion

Beyond productivity gains, the ultimate return for investment for intelligent transportation solutions is a more livable city and better quality of life for all its citizens. Less gridlock, cleaner air, reliable mass transit: that's the kind of place where people want to live, work and shop—and it's attainable for any city with today's technologies.

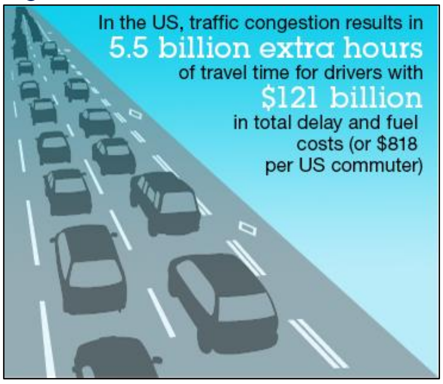


Figure 12: 2012 Urban Mobility Report Released with New Congestion Measures
Source: http://www.ibm.com/smarterplanet/us/en/traffic_congestion/article/traffic-management-and-prediction.html

Recommended Readings

Title	ITS e-Primer
Publisher	United States Department of Transportation: Intelligent Transportation Systems Joint Program Office
Website	https://www.pcb.its.dot.gov/ePrimer.aspx

Title	International Journal of Traffic and Transportation Engineering
Publisher	Scientific & Academic Publishing
e-ISSN	2325-0070
Website	http://journal.sapub.org/ijtte

A Title	Journal of Traffic and Transport Engineering
Copyright	Periodical Offices of Chang-an University
Production & Hosting	Elsevier B.V
Website	http://www.sciencedirect.com/science/journal/20957564

Publications which are in the holdings of the National Library or Public Libraries are denoted by [call number] at the end of each reference. Please check the library's online catalogue to confirm the availability.

References

Aerospace Engineering. (2015, March 26). Big Data in Aerospace.
Retrieved October 2, 2015 from
http://aerospaceengineeringblog.com/big-data-in-aerospace/

Amsterdam Smart City (ASC). (n.d.). The Digital Road Authority - IJburg.
Retrieved October 2, 2015 from
http://amsterdamsmartcity.com/projects/detail/id/75/slug/the-digital-road-authority-ijburg

Amsterdam Smart City (ASC). (n.d.). Smart Traffic Management.
Retrieved October 2, 2015 from
http://amsterdamsmartcity.com/projects/detail/id/58/slug/smart-traffic-management

Brown, P. M. (n.d.). Autonomous Vehicles: A thought leadership review of how the UK can achieve a fully autonomous future.
Retrieved October 2, 2015 from
http://www.theiet.org/sectors/transport/themes/autonomous-vehicles/index.cfm

Goh, T. W., & Fan, S. L. (2014). Drivers of Labour Productivity Trends in Singapore.
Retrieved October 2, 2015 from
https://www.mti.gov.sg/ResearchRoom/SiteAssets/Pages/Economic-Survey-of-Singapore-2014/FA_AES2014.pdf

Goodall, W., Fishman, T., Simon, D., & Perricos, C. (2015, March). Transport in Digital Age: Disruptive Trends for Smart Mobility.
Retrieved October 2, 2015 from
http://www2.deloitte.com/content/dam/Deloitte/uk/Documents/bps/deloitte-uk-transport-digital-age.pdf

Hanson, B. (n.d.). ITS ePrimer - Module 9: Supporting ITS Technologies.
Retrieved October 2, 2015 from
https://www.pcb.its.dot.gov/eprimer/module9.aspx

IBM. (n.d.). Traffic Management for a Smarter Planet.
Retrieved October 2, 2015 from
http://www.ibm.com/smarterplanet/us/en/traffic_congestion/article/traffic-management-and-prediction.html

Irish Times. (2014, March 31). Traffic flow improved by big data analytics used to predict bus arrival and transit times.
Retrieved October 2, 2015 from
http://www.irishtimes.com/sponsored/ibm/traffic-flow-improved-by-big-data-analytics-used-to-predict-bus-arrival-and-transit-times-1.1741922

Koslow, T. (2015, September 1). Spanish Maker 3D Prints Working Model of Boeing 787 Jet Engine.
Retrieved October 2, 2015 from
http://3dprintingindustry.com/2015/09/01/spanish-maker-3d-prints-working-model-of-boeing-787-jet-engine/

LaBrecque, S. (2014, December 5). 10 things we learned about technology and sustainable urban transport.
Retrieved October 2, 2015 from
http://www.theguardian.com/sustainable-business/2014/dec/05/sustainable-transport-urban-technology-debate-city-clean

Land Transport Authority of Singapore. (2015, January 12). Intelligent Transport System. Retrieved October 2, 2015 from
http://www.lta.gov.sg/content/ltaweb/en/roads-and-motoring/managing-traffic-and-congestion/intelligent-transport-systems.html

Land Transport Authority. (2015, March 11). More Commuters Satisfied with Public Transport in 2014, but More Needs to be Done. Retrieved October 2, 2015 from
http://www.lta.gov.sg/apps/news/page.aspx?c=2&id=ec883090-d0c2-4b68-b5cc-37950debae74

Marr, B. (2015, May 27). How Big Data And The Internet Of Things Improve Public Transport In London.
Retrieved October 2, 2015 from
http://www.forbes.com/sites/bernardmarr/2015/05/27/how-big-data-and-the-internet-of-things-improve-public-transport-in-london/

Ministry of Trade and Industry. (n.n.). Economic Survey of Singapore Second Quarter 2014. Retrieved October 2, 2015 from
https://www.mti.gov.sg/ResearchRoom/SiteAssets/Pages/Economic-Survey-of-Singapore-Second-Quarter-2014/BA_2Q14.pdf

Moore, O. (2015, April 27). Toronto to use big data to help reduce traffic congestion.
Retrieved October 2, 2015 from
http://www.theglobeandmail.com/news/toronto/toronto-to-use-big-data-to-help-reduce-traffic-congestion/article23829404/

Rail Safety Standards Board. (2015). Research, development and innovation quarterly summary Q4 2014-2015.
Retrieved October 2, 2015 from
http://www.rssb.co.uk/Library/research-development-and-innovation/2015-05-quarterly-summary-research-development-innovation-2015-q4.pdf

Research Centre for Integrated Transport Innovation (rCITI). (n.d.). GoGet Carshare.
Retrieved October 2, 2015 from
http://www.rciti.unsw.edu.au/goget-carshare

Schmahl, A. (2014, March 31). Future Disruptions In Transportation -- 2014 And Beyond.
Retrieved October 2, 2015 from
http://www.forbes.com/sites/boozandcompany/2014/03/31/future-disruptions-in-transportation-2014-and-beyond/

Sheppard, P. (n.d.). Autonomous Vehicles: A Railway Perspective.
Retrieved October 2, 2015 from
http://www.theiet.org/sectors/transport/resources/av-railway.cfm

Stevens, A. (n.d.). Autonomous Vehicles: A Road Transport Perspective.
Retrieved October 2, 2015 from
http://www.theiet.org/sectors/transport/resources/autonomous-vehicles.cfm

Taylor, J. (2015, June 23). The free-flowing driverless vision for Sydney in 50 years.
Retrieved October 2, 2015 from
http://m.dailytelegraph.com.au/newslocal/city-east/the-free-flowing-driverless-vision-for-sydney-in-50-years/story-fngr8h22-1227409818086

Transportation Policy Research Centre, Texas A&M Transportation Institute. (n.d.). New Approaches to Transportation Management (Task 1). Retrieved October 2, 2015 from
http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/TTI-2014-7.pdf

University of New South Wales. (n.d.). Transport engineering.
Retrieved October 2, 2015 from
http://www.engineering.unsw.edu.au/civil-engineering/transport-engineering

Valich, T. (2015, May 8). Big Data in Planes: New P&W GTF Engine Telemetry to Generate 10GB/s.
Retrieved October 2, 2015 from
http://www.vrworld.com/2015/05/08/big-data-in-planes-new-pw-gtf-engine-telemetry-to-generate-10gbs/

Wagner, J., Goodin, G., Baker, T., Maddox, J., & Pourteau, C. (2014, February). Revolutionizing Our Roadways The Challenges and Benefits of Making Automated Vehicles a Reality.
Retrieved October 2, 2015 from
http://d2dtl5nnlpfr0r.cloudfront.net/swutc.tamu.edu/publications/technicalreports/600451-00029-2.1.pdf

