

International Conference on Railway Engineering (ICRE) 2023
“Sustainable Railway - Green Technology and Social Diversity & Inclusion”
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Sustainable and Smart Railway

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Greeting

Distinguished guests, fellow railway professionals, ladies and gentlemen, Good Morning. It is my great pleasure to welcome you all to the “International Conference on Railway Engineering 2023”.

The theme of this Conference is sustainable railway, and its association with green technology, social diversity and inclusion. I am going to share with you some local development, the global technological advancement and my future visions on railway.

Introduction

Talking of sustainable railway, what is your perception on this photo?

If you are a practitioner of “Chinese Palmistry”, you may consider that these trains on the palm are running on lines that are called the “life line”, “head line”, and “love line”.

To me, the lines on the palm symbolize connectivity of railway. Railway lines actually connect different areas, cities and countries; commuting people to work, students to schools, and let families meet those they loved. Railway is the backbone of modern society connecting area and people.

To many believers of palmistry, palm lines could show ones’ future. Nonetheless, the railway profession here is definitely more than a fortune teller. We construct railway, creating new railway lines. With our expertise and knowledge, we could work together enhancing train connectivity, improve ride experiences and achieve a more “sustainable railway”.

Sustainable Development

So, what are the elements to develop sustainability in railway?

In the broadest sense, sustainability refers to the ability of maintaining or supporting a process continuously over time. The key notion is to fulfill the needs of current generations without compromising the needs of future generations, while striking a balance between economic growth, environmental conservation and social well-being.

To make it more precise, the United Nations has established 17 Sustainable Development Goals (SDGS) to promote sustainable development in a holistic and integrated manner.

For the railway industry, 4 key elements of UN's Sustainable Development goals are especially relevant, and they are "Connectivity", "Environmental Conservation", "Reliable Service for Every Users" and "Inclusion & Diversity".

Let me explain how these elements works together, and our current development and vision in building a sustainable railway.

Connectivity

Achievements in railway industry in the past decade

Let first talk about Connectivity. Railway infrastructure built by engineers has enabled not only efficient transportation, but also fostered closer connections between communities around the world. The connectivity factor has played a significant role in improving the accessibility and mobility of people, goods, and services. According to the statistics published by International Association of Public Transport (UITP) in May 2022, the total length of metro infrastructure worldwide is around 17,221 km, the majority of them are in the Asia Pacific. ¹ Approximately 3,300km of new metro infrastructure was put in revenue service between 2018 and 2020.

The development of high-speed railway networks has also been very impressive in the last decade, providing a new level of connectivity between cities and region. As of 2021, the total length of commercially operated high-speed railway networks in the world has reached 58,839 km, which is about 190% increase in the total length when compared to 2011. This has enabled people to travel longer distances in shorter amount of time,

¹ The International Association of Public Transport (UITP) | Statistic Brief for World Metro Figures 2021 issued in May 2022 <https://cms.uitp.org/wp/wp-content/uploads/2022/05/Statistics-Brief-Metro-Figures-2021-web.pdf>

opening up new opportunities for business and leisure.²

China is a significant contributor to the development of the high-speed rail network, now having the largest high-speed rail network worldwide. The passenger volume of high-speed rail in 2019 saw a 265% increase from that of 2010.³ This highlights the positive impact that railway infrastructure has had on improving connectivity and accessibility for people.

In Hong Kong, we have also made significant leap forward in the railway industry by completing five major railway projects in the past decades. These projects include the South Island Line, Kwun Tong Line Extension, Island Line Western Extension, Sha Tin and Central Link, and the High-Speed Rail. Collectively, there was a 20 % increase in the total length of Hong Kong railway network in 2015. Completion of the new metro lines has significantly enhanced connection of all districts in Hong Kong, while the High-Speed Rail system has opened up new opportunities for cultural, economic, and social exchange with cities in particular those in Greater Bay Area in Mainland China.

Apart from the movement of people, railways have played a significant role in transporting goods to support international trade. In 2022, the Chinese railway operator CR Express launched a freight train from Xi'an in China to Duisburg in Germany, which is the first fixed schedule train to run between China and Europe.⁴ This train journeyed around 10,000 km one way passing through multiple countries to reach Germany.

Thank you for the railway engineers for making these remarkable achievements possible and enabling us to enjoy the benefits of sustainable, efficient transportation and closer relationship between Asia and Europe.

Shape the future railways in Hong Kong/ GBA

In Hong Kong, our railway engineers continue to work on several ongoing railway projects that aim to further improve the transportation infrastructure and connectivity of the city. These projects include the Northern Link connecting the Tuen Ma Line and the East Rail Line, Tung Chung Line Extension, Oyster Bay Station and Tuen Mun South Extension.

² International Union of Railways (UIC) | ATLAS High-Speed Rail 2022 (Updated as of Dec 2021)
<https://uic.org/IMG/pdf/uic-atlas-high-speed-2022.pdf>

³ UIC | HIGH SPEED TRAFFIC IN THE WORLD (Updated 1st September 2022)
https://uic.org/IMG/pdf/20220826_high-speed-traffic-in-the-world.pdf

⁴ <https://www.shiphub.co/xian-duisburg/>

Shaping the future railway system is a continuous process in Hong Kong. The planning of railways is crucial for creating future economic drivers and should always align with future urban development. Recently, the government have announced the development of the Northern Metropolis in Hong Kong, aiming to form the development framework named “Twins Cities, Three Circles” with Shenzhen. The 3 circles are the Shenzhen Bay quality development circle, Hong Kong-Shenzhen close interaction circle and the Mirs Bay/ Yan Chau Tong eco-recreation/ tourism circle. ⁵

In the Hong Kong Policy Address 2022, several new railways are proposed as part of our infrastructure development plan, aiming to strengthening the connectivity of the Northern Metropolis, facilitating the overall development of the Northern Metropolis, and development of new residential zones. It included the Hong Kong-Shenzhen Western Rail Link, Central Rail Link and TKO Line Southern Extension. ⁶

Environmental Conservation

Next, let’s consider environmental conservation. In response to climate change, the global community has pledged to reduce our carbon footprint. China aims to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060. Similarly, the Hong Kong government has been taking active steps towards improving air quality and developing Hong Kong into a smart city. The government has set the target of striving for carbon neutrality before 2050. The transportation sector accounts for approximately 20% of carbon emissions in Hong Kong. To contribute to this goal, we are prioritizing the promotion of electric and other alternative energy vehicles, as well as transitioning towards zero-carbon transportation.

Railway has been an important means of transportation and mass transit in Hong Kong due to its eco-friendly and efficient characteristics. According to the Strategic Studies on Railways and Major Roads beyond 2030 launched by the Hong Kong Government, many new railway projects will be initiated in the near future. These projects aim to establish a highly interconnected railway network that will stimulate and support future development of Hong Kong as well as reduce carbon emissions, provide cleaner air and achieve the goals of “Climate Change Action Plan 2030+”.

Some of you may still remember that, in the old days, smoke and sparks were emitted

⁵ Report of Northern Metropolis Development Strategy
<https://www.policyaddress.gov.hk/2021/eng/pdf/publications/Northern/Northern-Metropolis-Development-Strategy-Report.pdf>

⁶ Policy address 2022: <https://www.policyaddress.gov.hk/2022/en/p76.html>

from coal-burning steam powered train, and so we used to call train in Chinese as 火車, which is literally translated to English as fire car. To accommodate increasing road traffic during the 1960s, the Mass Transit Railway (MTR) with electrified trains was developed as a major public transport network, serving us in Hong Kong since 1979. The electrification of trains in Hong Kong has not only provided passengers with reliable, safe and efficient services, but has also eliminate the dust and dark particulates that were previously emitted from coal or diesel-powered trains.

New Zero-carbon Energy - Hydrogen

In the quest for a more sustainable railway system, the transportation industry has been striving to explore and use alternative energy sources to reduce carbon emissions. While electric and battery trains have seen significant advancements, concerns persist about the indirect emissions from electricity generation which are still not carbon free.

Green hydrogen, on the other hand, is now gaining prominence and is being developed in many countries as an alternative solution. This zero-emission energy carrier, produced by, for example, electrolyzing water using renewable energy sources, can power trains without any harmful byproducts. It is therefore regarded as a potential game changer in the near future.

Numerous countries worldwide have developed hydrogen roadmaps to outline their plan for implementing hydrogen technologies in various sectors. One of the key focuses in these roadmaps is the transportation sector.

For instance, the Mainland China, which is the largest hydrogen producer globally with an annual production of about 33 million tonnes, has revealed its hydrogen development vision in the 14th Five-Year Plan. According to the Long-Term Development Plan for Hydrogen Industry (2021-2035) announced in March 2022, China aims to produce 100,000 to 200,000 tonnes of renewable-based hydrogen annually and will have a fleet of 50,000 hydrogen-fueled vehicles by 2025. When this target is achieved, it is estimated that the country's carbon emission will be reduced by one to two million tonnes annually.

To keep pace with the rapid adoption of hydrogen as fuel source and help transit Hong Kong towards a carbon neutral city, our government has established an interdepartmental working group to oversee the implementation of hydrogen energy in Hong Kong. The hydrogen bus and heavy-duty vehicle trial scheme is regarded as an initial step towards achieving the Government's goal of promoting clean energy sources in the transportation

sector.

While hydrogen has primarily been associated with fuel cell vehicles, scientists, researchers and private investors have already spearheaded and been exploring potential uses apart from road applications.

Going into the sea, the Norwegian recently launched the world's first vessel powered by liquid hydrogen in 2021. Up in the sky, "Airbus", has recently announced its plans to introduce the world's first zero-emission commercial aircraft to market that runs solely on hydrogen by 2035.

How about the hydrogen application to the track? Being the backbone of modern transport, the "railway" will not be missed for sure.

Hydrogen-powered trains have gained significant momentum in recent years. The world's first hydrogen tramcar was invented in 2015 in the Mainland China, and the technology has been put into commercial operation in Tangshan since 2017.

Subsequently, Germany introduced the world's first hydrogen-powered train in 2018. The train has travelled over 200,000km and can travel up to 1,175km without refueling. Later in 2019, the Chinese rail manufacturer "CRRC" further introduced a modern hydrogen tram demonstration line in Foshan Gaoming, capable of traveling 100km on 20kg of hydrogen and refueling in only 15 minutes. Japan also recently unveiled its first hydrogen-powered train in 2022, which can travel up to 140 kilometers at a top speed of 100 km/h. The train is currently undergoing testing with plans for commencing commercial operations in 2030.

Given the success of hydrogen-powered train projects worldwide, could this technology be viable for Hong Kong? I believe there are several key considerations.

Firstly, the availability of hydrogen must be assessed.

Hong Kong's unique geographic location provides an advantage for collaboration with the Greater Bay Area (GBA) to establish the hydrogen supply chain. The Guangdong Province can supply ample hydrogen and delivered to Hong Kong within 2 hours via tube trailers. As for Towngas, its 3,600 km extensive piping network in Hong Kong is already capable of delivering town gas with about 50% of hydrogen in its composition at present. This gives us a head start in exploring the future hydrogen pipeline transmission.

However, these supply options are not green hydrogen, leading to our second

consideration on environmental impact. Although hydrogen fuel cell trains emit zero carbon, the production of hydrogen can still contribute to global warming if it is not sourced from renewable sources. Therefore, we must assess the carbon footprint of hydrogen train as compared to electrified train to determine if the case is justifiable.

Irrespective of whether hydrogen is used, we must bear in mind that hydrogen is a highly flammable gas, and safety must be carefully assessed before considering its application as a fuel in a densely packed and populated city like Hong Kong.

Hydrogen has unique physical characteristics that make it particularly flammable. When released into air, it can be ignited and burn easily with even a small spark or static discharge. The minimum ignition energy of hydrogen is 0.02 millijoules, which is a very low energy level as compared to 0.24 millijoules for gasoline vapour (about 12 times higher). Hydrogen also has a very broad flammability range, being 4 % to 74 % concentration in air as compared to 1.4 % to 7.6% for gasoline vapour.

In addition, as a major portion of rail network in Hong Kong is underground (or in tunnels), and this does not help disperse leaked hydrogen readily.

Nevertheless, we must keep an open mind and consider all options in pursuing a sustainable railway system. By prudently weighing the risks and benefits, we can determine the optimum development mode for hydrogen-powered trains in Hong Kong, ultimately leading to a more sustainable and greener mass transportation.

Reliable Service for Every Users

And then, how about reliability of service. Railways are widely recognized as a safe and reliable form of transportation globally. A report from the European Commission 2019 revealed that the risk of death for a passenger train within the EU is approximately 0.09 fatalities per billion train kilometers. This is almost one-third the risk for bus and coach passengers and approximately 28 times less than for car occupants.⁷

In order to maintain continuous reliability and ensure safe services in the railway industry, advanced maintenance techniques leveraging technology have become a key enabler. The industry has started to shift towards digital maintenance practice, such as the implementation of real-time remote condition monitoring system for in-service train. These systems monitor the pantograph and rail track geometry using IoT technology,

⁷ The International Railway Safety Council and European Commission | Statistic for fatality risk of passenger using different mode of transport 2019 <https://international-railway-safety-council.com/safety-statistics/>

allowing for the collection and analysis of enormous amounts of data in real-time, making it possible to detect minor changes and to predict failures well in advance.

In Hong Kong, the EMSD has collaborated with MTRCL to develop a real-time “Train-borne Railway Infrastructure Inspection System” on a passenger train. It is the world’s first train-borne high-speed scanning system to detect & predict tunnel infrastructure defects including concrete spalling, crack, water seepage and trackside equipment displacement using operation train running at 80km/h. The system applies advance technologies, such as 4th Generation LiDAR with SLAM, AI Stereo Computer Vision, Dual-band Infrared Imaging and 5G Edge Computing. Using AI analytics for the big data collected, predictive maintenance can be achieved, and is able to minimize unexpected failures that cause services delays. This project received a Silver medal at the 48th International Exhibition of Inventions of Geneva.

Another real-time remote condition monitoring project that the EMSD takes lead is the “Tramway Derailment and Collision Prevention System”. It is the world first double-deck tram borne real-time detection, alert and positioning system with LiDARs and GNSS to prevent derailment and collision due to foreign objects in track groove. The system applies change detection and multi-level objects detection deep learning model, and can provide accurate long-range real-time detection up to 60m with 99% system accuracy. This allows driver to have sufficient time to react and to stop at safe distance, thus, enhancing tram safety. This project received a Gold medal and a special prize – Thailand Award for the Best International Invention & Innovation” at the 48th International Exhibition of Inventions of Geneva.

The aforementioned awards have given a testimony to the EMSD's commitment to excellence, and to our colleagues’ tireless efforts in making our railway systems safer and more reliable.

On the other hands, robotics and automation allow faster maintenance execution. In Japan, a prototype VR-controlled robot has been deployed to clean and maintain the railway infrastructure. The robot can reach 10m above the ground and lift up to 40kg at a time. While it may look as though the robot operates autonomously, it is controlled by engineers through VR headsets and remote controls. This helps carry out the maintenance work at high-risk locations.⁸

⁸ Giant Robot to fix railways in Japan <https://www.iotworldtoday.com/robotics/giant-robot-to-fix-railways-in-japan>

Furthermore, robotic train inspection became a new trend across the globe. They could perform train bottom condition inspection⁹ that serve as good partners for future railway maintenance engineers.

The next-generation automation technology will continue to reduce the impact of human error and human limitations on railroad operations, improving safety and efficiency.

Inclusion & Diversity

Next, we come to Inclusion and Diversity. The society has the general consensus that Diversity and Inclusion are becoming important aspects for sustainable development. Diversity is the presence of differences that may include race, gender, religion, sexual orientation, ethnicity, nationality, socioeconomic status, language, disability, age, religious commitment, or political perspective. Inclusion is an outcome to ensure that those diverse individuals should not be alienated but welcomed.

In today's railway network, can we be more considerate and attentive in our designs for stations, asset and rolling stock to create an environment that supports all people and promotes safety and peace of mind? Can we provide assistance proactively, such as sufficient lifts and accessible means for the elderly, pregnant and passengers with access needs?

A culture that supports people in need throughout society should be nurtured, and this can be achieved by enhancing station facilities to implement real barrier-free access.

For instance, in the past, passengers in wheelchairs are required to seek assistance from the station staff for boarding and disembarking from trains using portable ramp. How about narrowing the platform gaps by installing comb-shaped materials to facilitate those passengers who prefer to get off the train unaided?¹⁰

We have priority queues for lift, how about extending the priority queues for getting on trains?¹¹

In Singapore, they established Dementia Go-To Points. It serves as “safe-return” points for public to bring persons with dementia who may appear lost or are unable to identify

& <https://www.youtube.com/watch?v=j0wsHvLvmxs&t=69s>

⁹ Train Maintenance & Bottom Inspection Robot <https://railway-news.com/videos/shenhao-technology-train-bottom-inspection-robot-chinese/> & https://www.youtube.com/watch?v=MV5_eOpWp38

¹⁰ JR East Group Integrated Report 2022 https://www.jreast.co.jp/e/environment/pdf_2022/all.pdf

¹¹ Land Transport Authority in Singapore | An Inclusive Public Transport System https://www.lta.gov.sg/content/ltagov/en/getting_around/public_transport/a_better_public_transport_experience

themselves or their way home. The station staff are trained to help the commuter reunite with their family. Also, there are big sized “Find Your Way” symbols at strategic locations at different exits placed on floor and column to assist people with dementia and elderly to get to their destination easier.¹¹ Can we refer to these innovative examples to make the railway network more people-friendly and enhance the livelihood of millions of people worldwide?

Closing

In closing, I wish to emphasize the crucial role we play in driving a sustainable railway. While palmistry may predict our destiny, our actions and attitudes shape our future. The future of railway lies in our hands. With advanced technologies available today, we are empowered and obliged to make positive impacts on the environment and society. We gather here today because we recognize that sustainability is not merely a policy or a direction, but a necessity for the future of our people. It is imperative that we equip ourselves with the knowledge and skills to shape the future of the railway industry. The keys to achieving a sustainable railway are Connectivity, Environmental Conservation, Reliable Service for Every Users and Inclusion & Diversity. Coincidentally, these four elements of sustainable railway are the same as the name of this conference today “I-C-R-E”. By embracing these elements, we will create a sustainable railway to benefit all in the community. While we have made huge progress in the past, we should keep the momentum towards sustainable railway. I would like to take the opportunity to encourage all railway practitioners to move forward towards a brighter and more sustainable future.

Thank you for letting me being a part of this event, and I look forward to seeing the progress we will make together towards a more sustainable railway. I wish you all enjoy the events in the coming days.

Thank you.