Fast & furious: The race is on for the future of mobility

Autonomous vehicles – the engineering behind AVs & other technology enablers

AI challenges in mobility

25th edition
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Technology will help our cities foster equitable growth when we talk about equality and environmental responsibility—all these can only be achieved by embracing new technologies and pursuing new industries.

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How automakers can survive the self-driving era

Outlook of Malaysia’s battery industry ecosystem

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Mobility futures: challenges and opportunities

Mobility reflects advancement of civilisation; contributing significantly to the economy, shaping political dynamics, mapping urban demographics and inculcating values.

Hopefuly the new year brings about glad tidings to all. This will be the first edition of the magazine for this year and we thought that we would like to focus on the future of mobility.

In 2010, when we embarked on a joint National Technology Foresight Project with the Ministry of Science Technology and Innovation, we stated that technology development for the next 10 years will be in support of the following themes—mobility, sustainability, modularity, safety and security—and the passing of time has reinforced this intent.

Mobility has been an important driving force for human development throughout history. It has allowed movement of people, circulation of capital and commodities, in part, this has led to the advancement of transportation and communication technologies, systems of governance, surveillance and vice versa.

Mobility reflects advancement of civilisation; contributing significantly to the economy, shaping political dynamics, mapping urban demographics and inculcating values. Today, in the era of the Fourth Industrial Revolution, ‘mobility’ is often associated with and expected to be sustainable, smart, safe and seamless.

In Malaysia, conversations related to mobility have been wide ranging, from public transport, rail infrastructure, environmental concerns to the new national car project. This reflects its importance to our national development. As we face rapid urbanisation with a growing number of citizens living in the city—creating sustainable transportation solutions pose one of the greatest challenges facing cities today while ensuring the vital flow of people, goods and services is as fluid as possible.

However, there are also enormous opportunities presented by sustainable mobility—from vehicle modernisation to infrastructure upgrades, autonomous cars and solar roadways, among others. Ride-sharing, car-pooling, public transportation, riding and walking
are options to overcome traffic problems and consumers can now opt to own or share their mode of transport. And while reducing congestion and fostering faster, greener, and cheaper transportation options, we are also promoting a healthier lifestyle! Meanwhile, the internet of things, big data analytics, sensors and augmented reality are among technologies that enable the integration of systems and connectedness of services—providing a seamless mobility solution that smoothens door-to-door travel.

As you can see, mobility related topics are in abundance and we would not be able to cover all. However, this time around, we're compiling discussions on mobility to touch on the shifts across the automotive industry, as well as the impact of the Fourth Industrial Revolution in respect to mobility. In this issue, our very own Dr. Raslan shares his insights on current MIGHT initiatives in mobility and smart city development whereas Zakwan peeks into the New National Car Project (NNCP) that is expected to open up more opportunities for Malaysia to acquire and showcase our engineering capabilities.

There are also further insights and viewpoints from experts and researchers. Quite expansively, they deliberate on issues ranging from future trends, challenges and opportunities. These discussions are grounded in smart mobility, technology advancement in automotive, business model shifts, and technology solutions from Industry 4.0 to address mobility issues and challenges around smart cities.

As usual, I sincerely hope the magazine provides you with some food for thought as you think up your future plan. Do tell us what you think, comments are encouraged and welcomed.

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Adopted from WEF, Arthur D. Little, MIGHT
In person with...

Dr. Raslan Ahmad
Senior Vice President, Malaysian Industry-Government Group for High Technology (MIGHT)

Dr Raslan Ahmad is currently a Senior Vice President of Malaysian Industry-Government Group for High Technology (MIGHT). Raslan gathers a highly-dynamic background in key development areas namely smart cities, renewal energy and Industry 4.0. At MIGHT, one of the key initiatives under his leadership involves the establishment of Malaysia Smart Cities Alliances (MSCA). The program is designed as an advocacy platform for key stakeholder engagement to create greater awareness on smart city technologies, applications, policies and best practices. Significantly, this collaborative-effort ensures that smart city development across Malaysia is aligned with the objectives of Sustainable Development Goals (SDGs) driven by industry best practices.

Designing the Future City

Sustainable urban mobility plan – the micro battles

What challenges and opportunities do we have in front of us in designing future cities? MITI recently published Industry 4ward – Malaysia National Policy on Industry 4.0. In short, the action plan outlines the government’s commitment to capture Malaysia’s Industry 4.0 interests to ensure the country is well prepared for the next technology upheaval. All of us need to, in a word, mobilise.

Largely, we are very concerned about what consequences Industry 4.0 can have in relation to our cities. In turn, we are looking into how these two aspects—city planning and Industry 4.0—will play out and more importantly, how fast and pervasive emerging trends will determine the country’s future and urbanisation.

Urbanisation is unavoidable as technology keeps evolving. At the moment, the size of the world’s population is growing rapidly and the majority of it—about 66% will be living in urban areas by 2050; and Malaysia’s urbanisation rate is among the fastest in East Asia. Today, the convergence of various technologies, cloud computing, robotics and AI, for example, are pushing new innovation out. As a result of this, our economy, social and community norms ought to change too.

Does this pose a threat to our social and economic health? It does, and in a few years, it would make a telling argument to see how far these new technologies would change our lives, and in the context of designing future cities, one of the major issues we are facing at the moment is transportation and how our mobility habits will relatively change. It is a matter of leveraging on the convergence of various technologies in respect to our social, economic and environmental vitality.

I think everybody acknowledges the need to...
adopt a new way of transportation and mobility to ensure the movement of people, goods and services is smooth. One important thing to note here is, mobility drives economic wealth and improves social connectivity. Most importantly, we need to make sure, every action we take meets the mobility objective of our society members from every walk of life. Now, we are seeing more and more discussions taking place regarding Transit Oriented Development (TOD), 3C model (compact, connected, and coordinated), door to door, seamless delivery, and of course, our rail project is helping too. As a result, our mobility agenda is becoming critical in many ways.

Speaking of future mobility and the automotive industry, we don’t have many choices but to adopt new approaches. These approaches need to be Uber-connected and employ a sharing model. To a great degree, vehicles of tomorrow constitute what emerging trends making way at present are pointing to, for example, we are seeing various testing series and pilots of autonomous vehicles that are lightweight and battery powered. Similarly, our Prime Minister recently mooted the idea of a New National Car Project (NNCP) to take local car manufacturers forward, where in a few years, we need to be able to produce autonomous semi-electric and full-electric vehicles to compete. These advancements are also a timely response to our commitment in handling climate change issue. As a country, we need to lower our carbon emissions by 40% for the development to be sustainable. But the question that begs asking is this; how do we achieve this without adopting and deploying new technology?

This brings us to Industry 4.0. As I mentioned earlier, some of us are very sceptical, others on the flipside are more objective and optimistic, and some quarters take this wait and see stance, but the reality is—the enabling technologies have reached our doors in many ways and sooner or later, they will change how we move about.

Solving urban mobility issues with Industry 4.0 technologies

Here’s one caveat. We are famous as users of technology, but we are not famous as contributors of technology. Should we remain like this forever, we are going to put a strain on the economy, and it is our next generation who will pay for our oversight if we don’t act proactively now.

To justify my point, we can clearly see at the global level, emerging mobility and smart city technologies are going mainstream. At the end of the day, this rapid reorganisation will change our economy, industries and cities. Therefore, I think, we have enough reasons to convince us why we need to embrace the Industry 4.0 to design the future of our cities.

As you are well aware, many of the formidable challenges around economic, social and urban constraints we are facing today can be resolved through Industry 4.0 technologies. But the real issue is, how do we adopt new technologies that can improve our cities in terms of sustainability, mobility, economic vitality and equality?

This is the issue that we need to debate—perhaps put more thoughts and inputs around our forward directions. To be effective, we need to consult and solicit feedback from all key stakeholder groups, not just from the government ecosystem, but more importantly the industry, communities, businesses and academia.

This is because we need everybody to work together to mobilise the agenda. We need to be united to push our agenda together. Again, let’s go back to one familiar target in relation to SDG number 11, toward sustainable cities and communities. Technology will help our cities foster equitable growth when we talk about equality and environmental responsibility—all these can only be achieved by embracing new technologies and pursuing new industries.

Early last year, when we hosted the World Urban Forum, a lot of the discussions centred around the adoption of new urban agendas and how these goals can be realised. Surely we cannot run away from technology and its correlation with the economy, as well as its significance to the well-being of our society.

I would like to highlight some examples here, in particular, how the World Economic Forum identifies potential Industry 4.0 technologies that can be deployed and adopted in realising some of our smart city agendas. To solve all of our urbanisation problems today and design liveable, sustainable cities, we need to adopt a far more strategic approach, of which technology is only one part. This is why we need a holistic and integrated approach to be coordinated. It requires involvement from all key stakeholders to achieve the goals when we are talking about smart planning and construction, among other things.

This is no longer just a dream. The technologies enabling these “forward changes” in mobility have arrived. In response, we need to make it a reality to allow our cities to thrive in the future. And to deal with these challenges, we need to do a reality check on the ground.

Using all these 11 enabling technologies that have been identified as Industry 4.0, I think we should take it positively. It is no longer a choice we can pass over. It is high time we start adopting and deploying new technological solutions whether we like it or not to usher in future sustainable cities and communities. Of these, certainly, they have to be inclusive, sustainable, resilient, safe and liveable for our cities to have any chance of success in the future.
In person with...  

Mohd Zakwan Mohd Zabidi  
Senior Vice President, Malaysian Industry-Government Group for High Technology (MIGHT)

ZAKWAN ZABIDI is a Senior Vice President at Malaysian Industry-Government Group for High Technology (MIGHT). Zakwan currently leads the development of industry-led New National Car Project (NNCP) by mobilising joint-efforts across various ministries, agencies, industries and academia. Zakwan lifts leadership at MIGHT with his management experience and knowledge acquired over 20 years across a broad range of high-tech industries. In his capacity, Zakwan strengthens MIGHT’s best practices in project management and planning. To date, Zakwan has played a key role in a number of MIGHT’s programs and initiatives involving national blueprints, strategic roadmaps, innovation models and frameworks, policy and strategy development, foresight, technology audit and business strategy development.

READY, SET, GO!

After 150 years, what’s next?

Car companies have recently been telling us what the car of 2020 will be like: autonomous is one word used, electric is another, and it will be connected to the internet too. Sounds exciting? The directions being proposed are a very good starting point to look even further and this begs us asking the question: what would the car of 2050 look like?

For a start, will there even be cars in 2050? Will an invention that will be 150 years old by then get replaced by something better? Would environmental concerns kill it? Would people become tired of getting behind the wheel as recent studies suggest? One plausible answer seems to be “maybe”, but the reality is that, an automotive is a convenient and flexible means of transportation. It fulfils the people’s need to move around freely and independently. And if done right, the automotive sector can be a sustainable and safe means of transportation.

In the past, automakers compete to come up with the most attractive and appealing cars. Now however, automakers are competing to introduce new breakthrough technologies. The Consumer Electronics Show (CES) has been the showcase of consumer technology innovation since 1967. This year’s CES, held in Las Vegas has been named one of USA Today’s 10 Best automotive shows. CES has now been the centre stage for companies to show off concept vehicles that encapsulate the future of car technology.

The disruption of connected, autonomous, shared, electric and lightweight vehicles is one of the many changes the industry is undergoing. We will see more changes in the next ten years than we did in the last 15. Nobody can really foresee, in details, the future of the automotive industry but four predictions from industry analysts say a little bit about where we are heading.
Just to give you a scenario, by 2030, 15% of the vehicles sold could be fully autonomous. As of now, no autonomous car has yet to be sold commercially. By 2030, electric cars will be 25% of new cars sold in urban areas. This is an increase over less than 1% sold globally now. By 2030 more than 25% of cars will be on shared mobility platforms and by 2025, all cars will be connected to the internet.

I personally believe that these are conservative predictions. Consumers are expecting changes to happen much faster and sooner. Firstly, consumers are expecting a more relaxing and safer drive. Today more than 90% of accidents are consequences of human errors. Distracted driving has been one of the significant causes. Death rates on Malaysian roads is the third highest globally, more than China and India. Based on this statistics, against the estimated population of 30 million Malaysians, about 7,000 to 8,000 people in the country die on the road every year. As cars have more control over the driving, accidents and fatality can be reduced and so does insurance premium.

Secondly, consumers also want more a productive and connected drive. For example, in the US, a driver spends on average one hour per day driving. People living in Kuala Lumpur spend about 53 minutes stuck in the traffic every day based on a recent study by BCG. Autonomous vehicles could free up as much as 50 minutes a day for consumers, who will be able to spend traveling time working, relaxing, or accessing entertainment. The time saved by commuting every day might add up globally to a mind-blowing one billion hours. It could also create a large pool of values—potentially generating global digital-media revenues for every additional minute people spend on their mobile while in a car.

Thirdly, consumers want more choices and convenience. Some people don’t want to give up driving completely. What they want is the option to decide when to drive and when to let the car take over.

Finally, consumers are asking for more efficiency without comprising excitement. Batteries are getting better and cheaper. According to McKinsey, from 2010 to 2016, battery pack prices fell roughly 80% from $1,000/kWh to $227/kWh and the estimated range for many electric vehicles has increased significantly.

The New National Car Project

The announcement of the New National Car Project (NNCP) by Prime Minister Tun Dr Mahathir during the 24th Nikkei Conference at the Future of Asia last year provides an opportunity for Malaysian based companies to be at the forefront of the global automotive industry evolution. The NNCP is an opportunity for Malaysia to acquire and showcase our engineering capabilities. More importantly, the project will also strengthen and complement other sectors, such as supply chain and other new frontiers. In the process, we will also able to nurture a pool of young and talented workforce with the highest level of competencies, masters of new technologies with the ability to help Malaysia adapt to the Fourth Industrial Revolution’s challenges that lie ahead.

The effort to introduce a high-tech automotive manufacturing platform will provide opportunities for local companies and entrepreneurs to explore new businesses as well as enhance knowledge in various engineering areas such as computer programming, mechanical, electrical and electronics through technology transfer.

The New National Car Project is not about what we have now but it is more about preparing the future of our manufacturing sector. As the future is not predetermined, it depends on what we do today. In the face of every great challenge, there is always a choice. The choice we have to make today is a collective one. Everyone includes the government, industry, academia, research institutions and NGO has a role to play.

The disruption in the automotive industry is changing as we speak and will come whether we like or not. These changes will impact how we’ll travel, use our cars, what new services will be offered, and which players will make up the evolving automotive ecosystem. The New National Car Project is an opportunity to shape and develop a new ecosystem to ensure a scalable and sustainable model is in place to gear us up for success in the next economic landscape.

NNCP potential impact in the next 10 years

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<tr>
<td>New suppliers/vendors</td>
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<tr>
<td>Skilled workers (manpower)</td>
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<td>Over 4000 components</td>
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<td>(R&amp;D development)</td>
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Source: MIGHT, 2018
Why focus on smart mobility: 
Future trends, challenges and opportunities
The wave of change that will be led by the Fourth Industrial Revolution (4IR) is now firmly in sight. As such, we need to be prepared in order to stay relevant. In its entirety, 4IR brings together the rise of digital platforms and automation that will turn around business landscapes, industrial development and governance.

To bring the nation up to speed with the latest technological changes breaking ground, myForesight® recently highlighted four critical future trends related to the development of sustainable cities. Balancing a vast array of interests, these four trends are evolving at breakneck speed and soon, these forces will exert a significant impact to current developments led by emerging trends namely urbanisation, smart cities, digital society, Internet of Things (IoT), new business models and innovation in transport and climate change.

**Urbanisation & smart cities**

IoT, Artificial Intelligence (AI), robotics and process automation are transforming everything from the career path the next generation will opt for to where a large section of the world’s demographics chooses to live.

The global population will increase to 9.6 billion by 2050 and the majority of the population will grow in cities, with an estimated 66% of the global population living in urban areas by 2050. The implementation of smart cities will further advance digitisation and the deployment of new technologies in transportation. Based on a recent study by myForesight®, 75% of Malaysians are currently living in urban areas. At present, Malaysia’s urbanisation rate comes in at about 4%, and is among the fastest growing in East Asia.

**Digital society & Internet of Things (IoT)**

In today’s digital society, IoT is inextricably linked to other technology domains such as big data, smart cities and mobile apps. Based on Business Insider’s recent Intelligence IoT report, it was projected that there would be 34 billion devices connected to the internet by 2020, up from 10 billion in 2015, representing a 28% five-year compound annual growth rate (CAGR). Malaysia was then ranked 31st as the most tech ready country with approximately 150% mobile phone penetration.

**New business models & innovation in transportation**

Innovative new business models are offering various means to bridge current gaps in infrastructure and urbanisation issues. New ideas are pushing the envelope—integrating innovative practices to improvise the transportation system. Seamless multimodal transportation technologies enable consumers to get from one location to another via multiple, connected modes of transportation on a single fixed price charged on a single payment system.

Based on the United Nations’ World Urbanization Prospects, World Business Council for Sustainable Development, passengers’ travel distance is expected to double by 2050—over 70 trillion kilometres per year. An estimated 11 million people travel by train and buses in Kuala Lumpur every day, according to the Land Public Transport Commission (SPAD). In another development, it was estimated that around 60,000 Malaysian citizens have registered as ride-hailing services’ drivers, with dense concentration in Klang Valley & Penang.

Approximately 78% of commuters use smartphones while using public transport. Transportation and land use patterns are inevitably linked, especially in urban areas. Transit-oriented development (TOD) is a “3C” model for development—compact, connected, and coordinated; and this has a direct impact on urban mobility and the economy. TOD reduces travel time, congestion and emissions, while directly expanding access to different areas of the city and thus stimulating a host of economic activities.

**Climate change**

Climate change poses a threat to the environment and mankind in general. The issue is a compelling factor pressing for urgent reduction in carbon emission and pollution—yet these are the consequences of global warming that we are currently experiencing. Cities are responsible for 75% of the world’s carbon emissions. Changes in temperature, intense storms and sea-level rises may transform infrastructural design, operations and maintenance in the near future.

To cope, emissions of greenhouse gases worldwide will have to be cut by 50% by 2050. This is in line with the rise of automation and mechanisation being ushered by 4IR. Emerging digital technologies and services will influence future transportation in cities such as big data, electronic payment, Artificial Intelligence (AI), shared mobility, position-based information, intelligent transportation system, embedded technologies, cloud computing and multimodal transportation solutions. For instance, AI is defined as the ability of a computer program or machine to think, learn and make decisions. Deep learning technology—a technique for implementing machine learning, is expected to be the largest and the fastest-growing technology in the automotive AI market. It is currently being used in voice recognition, voice search, recommendation engines, sentiment analysis, image recognition and motion detection in autonomous vehicles.
The progression in automotive

We need to take strides to keep our awareness up to date with current technological advancements in the automotive sector. Hence, we cannot deny the sustainability of efficient energy sources to power up our vehicles. And that’s exactly what electrification brings to the mobility industry. As viable alternatives, hybrid and Battery Electric Vehicles (BEV) are seemingly competent modes of future smart mobility. Apart from that, the efficiency of the transportation means of the future will be aided by digitally-enabled platforms via information sharing models between Vehicle-to-Vehicle (V2V) and Vehicle-to-Grid (V2G). Another good model is the sharing model where car sharing, ride sharing and car-pooling will be a viable business opportunity that fits consumers’ future requirements. A new broad spectrum of autonomous vehicles presents the next level of mobility solutions by incorporating efficiency and convenience. Significantly, light weight design will play a crucial role in terms of energy and cost efficiency.

The progression of smart mobility

Much has been said about smart mobility. Smart mobility in cities is expected to be intelligent transportation. Based on Intelligent Transport finding, at present, the top five smart mobility cities are Singapore, Barcelona, London, San Francisco and Oslo.

In Singapore, sensors were installed throughout the city to accumulate large amounts of data to monitor mobility-related activities such as parking, traffic and cleanliness. Barcelona for one has many smart solutions to keep its population moving freely, including smart parking and traffic systems to monitor congestion. The city has also invested in clean transportation with its growing fleet of hybrid buses and bikes.

Meanwhile, London is using smart technologies to help tackle congestion and make parking simpler. It has also invested heavily in other transportation technologies, renewing its buses and metro fleets with new, cleaner and more efficient technologies. Similarly, San Francisco has embarked on smart ticketing to streamline public transport processes and smart parking.

Oslo recently introduced smart traffic measures by implementing license plate detectors to calculate accurate congestion in the city and it is also currently building 37 miles of bike lanes. The city has a pipeline of smart mobility implementation actions to improve carbon emissions. This includes a sweeping ban of cars in the city centre by 2019. To manage the transition, Oslo aims to redraw its entire transportation network by 2020 and cut fuel emissions by 50% and be 95% climate neutral by 2030.

Nevertheless, the global interests of the four trends highlighted above clearly demonstrate that the development of smart mobility is gaining a fresh life. This will lead to the increasing awareness on the importance of smart mobility—a prerequisite for smart city applications, i.e. seamless transportation. While it is clear there are a lot of opportunities and advantages in pursuing smart mobility agendas, some issues and challenges still linger and need to be carefully addressed as described in the diagram.

Ultimately, the future of smart mobility lies in connecting the dots between autonomous driving, connectivity, e-mobility and shared services.

In response to growing trends and indicators, MIGHT has established the National Mobility Initiative to focus on smart mobility efforts which give emphasis on key automotive (the new national car project), rail and shipping development areas. Collaborations with various high-tech industries and relevant experts are made possible through MIGHT Interest Groups (MIGs) which serves as a platform to provide an opportunity to work closely with the key stakeholder groups earlier strategic stage of the industry’s planning and development process. Being explicit about investment objectives and criteria; The MIGs provide members the opportunity to voice out their input and suggest potential solutions to cultivate stimulating dialogue between key decision makers.

In addition, MIGHT will also co-develop new technology solutions through a range of pitching, incubation and development avenues to create a flexible, responsive and agile regulatory framework. This will be carried out proactively to minimize unnecessary obstacles that may impede the uptake of new technologies. Further, to help Malaysia’s private sector outperform the competition, the government needs to be effective in playing multiple roles. These roles constitute timely implementation as an enabler, incubator and collaborator to bring about new technologies that can benefit both Malaysian businesses and their target markets. Finally, a Special Purpose Vehicle (SPV) will be designed to enable incubation and accelerate the delivery of initiatives to capture objectives that the National Mobility Initiative outlines.
Fast and furious: A race for the future of mobility

As a Senior Analyst at Lux Research, Chris covers the technologies and companies disrupting the global energy and transportation industries. As a leader of Lux’s mobility coverage, Chris works to develop a view of how technology innovation is impacting the future of mobility. His research focuses on energy storage technologies, electrified and connected vehicles, autonomous driving, and other mobility-related innovations. Chris holds a B.S. and M.S. in Mechanical Engineering from Purdue University.
I can’t think of a more interesting time to be covering innovative technologies in the mobility space. Falling battery costs are powering the electric vehicle revolution, leading automakers to plan for zero emission vehicles at scales never seen before. The promise of self-driving vehicles is no longer a distant future, as the first iterations are hitting roads today. With a few apps on my phone I can arrange travel to any corner of the world.

The prospects for future mobility will be determined by choices of consumer as well as the playing field that’s set by government policymakers. Consumer have more and better mobility options than ever – and will make their choices based predominantly on speed and cost. Governments look at rising global population and increasing urbanization and look for transportation systems that can able to handle a high density of passengers, while a global push to limit the impacts of climate means this transportation systems need to have low emissions. In the face of these four mobility needs – fast, affordable, passenger dense, and clean – what will define the future of mobility?

Disruptive innovations in technologies enabling new forms of mobility are few and far between

History shows that mobility innovation can be painfully slow, with fundamental changes happening only infrequently. The first vehicle with wheels – a chariot – was invented roughly five thousand years ago, but was only 150 years ago we started to see new propulsion technologies like on the steam engine. Since the rise of the automobile 100 years ago, the same basic design with an internal combustion engine has remained dominant (though of course cost and efficiency have dramatically improved), only recently being challenged by electric vehicles.

It would, however, be a mistake to say nothing has changed in mobility – it’s just the fundamental innovation hasn’t been in the basic hardware configuration, but in new business models that have been enabled by new technologies. For instance, the first automobiles were unreliable and prohibitively expensive; since few could afford a car in these early days, taxi services sprang up, allowing users to take advantage of the speed and convenience of cars without having to pay the high upfront costs. After the assembly line drove down costs with Ford’s Model T in 1913, rental services began to appear – lower cost, driven by tech innovation, allowed a business to buy a large fleet of vehicles and rent them to drivers.

More recently, digital transformation has leads to further innovations in mobility business models. Even in the early days of the internet – just five years after it became publicly accessible – MapQuest emerged as an alternative to conventional maps. When the internet went mobile in the mid-2000s, companies like Uber and Grab soon emerged, connecting consumers that need to get somewhere with drivers willing to use their cars as a taxi.

The future of mobility will feature sharing-based business models powered by autonomous vehicles

What new technologies will emerge from there that transform the way we move? The answer from our perspective is clear: Autonomy. Self-driving cars continue to steadily move toward reality as improved sensors, increasing investments and testing, and maturing software algorithms have resulted in millions of miles traveled by autonomous vehicles. The innovation activity that we track reflects the growing pace of progress: In 2013, just 272 patents were filed related to vehicle autonomy; through the first 10 months of 2018 that number already reached 2,930. The number of miles traveled by self-driving vehicles is growing exponentially, collecting a body of data that will be used to improve performance, and increased production scale is driving down the costs of key components.

That’s not to say we are going to see self-driving cars deployed at scale in the near-term future. Today’s pilots remain limited to tightly controlled areas, restricting the types of environments and conditions they are exposed to. Despite advances, many components still prohibitively expensive: The lidar sensor systems that are likely required to enable fully autonomous driving still add more than $10,000 to the cost of a vehicle. Even with this limited...
and expensive deployment, there have been high-profile failures, such as the lidar-equipped Uber vehicle which struck and killed a pedestrian in a scenario which the sensor should have been capable of avoiding a crash. Given the distance still to go, we believe a realistic timeline for fully autonomous cars the early 2030s in a best-case scenario.

Autonomy alone won’t revolutionize transportation, but rather as we’ve seen with advances from rental fleets to Uber, it will be the business models built around it that define the future of mobility. Ride-hailing apps have already found impressive market traction, and are displacing conventional taxis in cities around the world. Consider New York City, where iconic yellow cabs now lose out to ride-hailing apps which provide 65% more rides than taxis. Users are opting to use them for both convenience and cost – sharing your location allows drivers to pick up users exactly where they are, while more efficient utilization allows them to provide lower costs compared to conventional taxis.

The largest portion of costs for these rides are the drivers themselves, who account for 50% to 70% of the cost of a ride. Self-driving cars that are able to pick up users and drive them to their destination, with no drivers involved, could drive down the costs of shared mobility enough to displace car ownership not only in large city centers, but in the suburbs surrounding them, as well as in smaller cities. Once again, this improvement in technology will lead to business model innovations that use lower cost to enable new ways of interacting with consumers – just as the cost reduction from the assembly line lead to rental fleets a century ago. In this future, consumers may have the option to purchase a subscription to a fleet of autonomous taxis, at a lower price than owning a car, leaving car ownership as a mere luxury – and enabling mobility as a service.

With a clear vision and the right execution, new entrants can own the future of mobility

Many players in the automotive value chain share a similar vision and pursuing these types of projects. In the past several years, there has been a proliferation of autonomous vehicle taxi service pilots across the globe. Ford is laying out the groundwork for its own service. Daimler announced a partnership with Bosch for self-driving vehicles in California next year. Toyota invested $500 million in Uber to develop a self-driving fleet using its Sienna minivans, and Waymo is partnering with Fiat Chrysler to use as many as 62,000 of its minivans for AV car service. Large companies aren’t the only ones jumping in the mix, as several start-ups are attempting to build their own services. For example, Milo established a one-year autonomous shuttle service pilot that operates on private roads in Arlington, Texas’s entertainment district. In 2016, nuTonomy implemented an autonomous taxi service pilot in Singapore (Aptiv later acquired the startup for $450 million in 2017), and EasyMile started offering an electric-powered automated shuttle bus called EZ10 for fixed-route and on-demand transportation environments.

But despite all this alignment on the future potential of self-driving taxis, it’s not clear what the best companies to operate these services will be. Automakers are moving aggressively as they see these services as both a threat to their conventional business and opportunity for expansion, but they lack a user base for mobility services, or experience in building one, and aren’t familiar with operating fleets or managing subscription services. Existing ride-hailing companies have the advantage of data from millions of rides and existing network of riders, but aren’t equipped to build their own vehicles with self-driving technology, and mostly don’t have expertise in fleet management either (leaving their drivers responsible for operating and maintaining their vehicles). A likely outcome may resemble that of Didi Chuxing, the Chinese ride-hailing company which is partnering with automakers to design vehicles for sharing – combining the hardware expertise of automakers and software platform of the largest ride-hailing company in the world. We will see more experimentation in years to come, and creation of new and sometimes-surprising partnerships as players compete to put together the right formula.

I really like cars. Watching them race, fixing them up, or going to car shows to see new ones remains a favorite hobby of mine. Still, when I think about the future of mobility, I can’t help but imagine a day, perhaps soon, where I don’t own one. Thinking back to the four characteristics of that will drive future transportation choices – fast, affordable, passenger dense, and environmentally friendly – I believe an autonomous taxi fleet would be an effective complement to existing public transportation and provide the final push to transform mobility from a product to a service.
Arij van Berkel leads Lux Research’s Energy Transition program. This program provides strategic insights in the landscape of energy supply to mobility, residences and industry. Before joining Lux, Arij worked for Shell and TNO, the Dutch applied research organization. At TNO he worked on a variety of technologies including food preservation, emission reduction and biomass conversion. He was also closely involved in shaping the European innovation ecosystem. His last position there was to be P&L responsible for TNO’s chemicals innovation portfolio and for liaising with the Dutch and EU governments on innovation policy. Arij holds a Ph.D. from Eindhoven University.
The end of combustion

The industrial revolution taught people to effectively harness the power of energy stored in fuels through combustion. Before the steam engine, mobility was powered by human and animal power, and wind. Today, most mobility is powered by some form of combustion. Developments in combustion have been tremendous over the past 150 years and engines are now much cleaner. Just in the past 20 years, the NOx emissions of diesel cars have decreased from an average 0.5 g/km to below 0.08 g/km. Similar order of magnitude reductions have been achieved for particulate emissions.

However, despite these developments, emission reduction of combustion has failed to keep pace with the sheer scale of deployment. As more vehicles hit the road, the combined air pollution caused by so many individual “fires” burning on our roads became unsustainable. While car manufacturers keep adding 5% to 15% in costs to every next generation internal combustion vehicles by adding end-of-pipe emission reduction equipment, the pressure on governments to take these same vehicles off the road keeps mounting.

The era of combustion is drawing to an end after a success story of nearly two centuries, the disadvantages of combustion are catching up with it, while alternatives such as electric or hydrogen vehicles are warming up to take over.

Other cars are not the answer

The automotive powertrain will thus transform to some sort of electric drive train. Initially, we’ll see more petrol and diesel hybrid powertrains, and gradually full battery electric and hydrogen or natural gas hybrid electric will take over. We estimate that by 2030 at least 50% of new car sales will have an electric powertrain. Still, this development will only change one type of cars for other cars. It doesn’t fundamentally change the way mobility is organized.

Cities continue to grow; more than 60% of the world’s population will live in a city by 2050. Cities will then account for more than 75% of the world’s energy consumption and since they have a high population density, cities will not easily be self-sufficient in renewable energy. They need to import energy and food from the surrounding area to sustain their population.

A city’s high population density is one of its attractions. The intensity of human interaction in the city accelerates economic activity and makes them prosperous. However, a high population density does also cause problems. Besides air quality issues, cities also must deal with congestion, continually aging infrastructure, safety issues, scarcity of land, volume and timing of energy supply and acquiring and managing the data to address all of the aforementioned issues. Just changing the way cars are powered effectively only addresses the issue of air quality. To address the other issues and thus enable further growth of cities more fundamental changes to mobility are required.

New technology will help cities to reduce energy demand, while solving the pressing issues mentioned above. Lux Research analyzed all technologies that are currently being developed to assess their potential contribution to solving the problems plaguing cities. It turns out that the impact of electric vehicles is limited. Much more impactful technologies are:

• New train and train-like systems. These are high density, electric, modes of transportation that are very effective at solving issues of safety, energy (they are much more efficient per passenger-kilometer) and congestion. Innovations in train technology make these systems more flexible and increase the density (number of passenger movements per kilometer of infrastructure). Digital innovations in the management and safety of the system play a major role, as well as innovations in the drivetrain that enable more stops with higher average speed between stops.

• New lighter modes of transportation for the last mile. By far the most influential development for mobility in the city is the development of new and light transportation modes for short distances. Most cities have recently implemented bike sharing schemes to facilitate short distance mobility (e.g. from a train station to your final destination). New vehicles will make these schemes increasingly convenient to use. Examples of these new vehicles are (in order of appearance): electric bikes, electric scooters, small autonomous electric vehicles, and eventually electric autonomous flying taxis. The latter will likely first appear in the shape of electric delivery drones and then evolve to also carry passengers.

• V2X connectivity. As vehicles of any kind become electrified, they will also become more connected to the city infrastructure. The main, and primary, connection will probably be connecting electric vehicles to the power grid bi-directionally. This way the grid can serve to charge
the vehicles, and the vehicles can provide temporary storage and load management to the power grid. Other connections to the infrastructure will follow, with vehicles negotiating parking spots before arrival and routing of autonomous vehicles to optimize traffic flow and to present travelers with as many competing options as possible.

- **Digital technology enables a fully integrated mobility system.** Smart buildings have knowledge of the calendars and plans of their occupants. They know when people need transportation and where it needs to take them. Integrating this data in a larger city management system enables an overall optimization of transportation in the city on all aspects: costs, energy use, management of the power grid, predictability of travel time, speed and number of options to choose from.

The city of the future will evolve to become one coherent technological system that caters for the needs of its inhabitants, including mobility. In the smart city, data will enable predictions of mobility needs ahead of time and providers of mobility services can dispatch resources to the places where they are most needed. Your commuter train will be longer on Mondays and shorter on Wednesday because the train operators knows how many people will be on it.

**Mobility and energy form a symbiosis in the city**

Most movements of people and goods in the city of the future will be powered by electricity. Between 40% and 70% of that energy will likely be supplied through batteries. The rest will be consumed by grid-connected systems such as trains. The city transportation system is thus also the largest variable load on the power grid. Moreover, the load is not only variable in time, but also in location. Battery powered vehicles can support the grid in certain areas, such as residential areas during the day when solar power is generated but not used. New business models, modeled after virtual power plants allow mobility service providers to earn revenues by moving both people and energy storage around. Those companies will provide ride sharing services to people and, at the same time, energy storage sharing services to the power grid. This will decrease the cost of energy and the cost of transportation in the city.

The challenge for cities today is to provide good regulatory frameworks to expedite these developments. A well-balanced approach must coordinate promoting near-zero-energy buildings and new modes of transportation (e.g. electric scooters) while stimulating ride sharing and regulating car emissions. Timing is the key to a smooth and successful transition while continuously optimizing the system on both energy and mobility.

In the short term, natural gas could fulfill most needs for clean fuel. In the longer-term hydrogen will likely play a role in addition to battery electric vehicles.

**The digital electric era will replace the era of combustion**

Combustion has brought prosperity to the world but has now reached the limits of scalability. The world’s needs bigger, more scalable and flexible systems than combustion-based technology can provide. The mobility of the future will be powered by electricity and electric fuels. Electricity is a real-time energy and thus requires real-time management. Digital technology is indispensable to the future of technology. It is thus safe to say that the energy for the future of mobility is electricity, electric fuels and data.

Even when the mobility in the city is comfortable, affordable and fast, people and goods also need to move between cities and outside of cities. The situation there is very different. The benefits of the high population density do not exist, and mobility solutions need to be versatile, independent, long-range and flexible. Some of these requirements can be met by an elaborate train infrastructure that would be connected to the power grid. Most movements by truck, ship or plane however will still need fuel.
Traditional automotive industry stands at the brink of an unprecedented transformation in a century.

AVs need 5G technologies to mature to connect with the driving environment.

Car manufacturers are starting new companies to handle their emerging service-related businesses such as sharing, parking and charging.

Changing paradigms from automotive to mobility

Vivek Vaidya is an Associate Partner and Senior Vice President with the Frost & Sullivan Asia Pacific Intelligent Mobility Practice. Vivek Vaidya is an opinion maker, strategic thinker and compelling speaker. He has advised major automotive companies, transportation companies and governments on future scenarios and regulations, market & competitive strategies and strategic partnerships in his career spanning 20 years. He has strong personal relationships with CXO’s in the region. He is a preferred industry analyst for many business channels such as BBC, CNBC, Bloomberg, Channel NewsAsia, ET now etc. He has also spoken at various conferences across the world and quoted extensively in newspapers.
The automotive industry has flourished since Ford launched the Model T in 1908, making cars easily accessible to the masses. New models have continuously been launched and significant innovations, product upgrades, and styling changes have occurred. Car makers built up their own supplier bases, and created their own unique, vertically integrated distinct ecosystems. The industry never really faced any disruption. Today, the traditional automotive industry stands at the brink of a sweeping transformation that has not been witnessed in the last 100 years.

Although cars are among the most popular means of transportation, they pose several challenges. About 54% of the world’s population lives in cities. This concentration of people and their cars in urban areas has had unwanted consequences in the form of higher pollution, congestion and accidents. About 7 million deaths are attributed annually to poor air quality. Air pollution in cities also causes loss of productive time and contributes to spiraling healthcare costs. Simultaneously, congestion impacts the economy. It is estimated that, on average, a driver spends 50 hours annually stuck in traffic. This costs the global economy about 1% in terms of lost productivity. Compounding these problems are the unacceptable and, in most cases, avoidable 1 million fatalities caused by road accidents.

As cities continue to struggle with overburdened road networks and inadequate transportation infrastructure, the low utilization rate of cars imposes a further burden. Most cars, with the exception of taxis and shared cars, are driven only for 2.5-3 hours per day, and remain parked for the rest of the time. Again, although most cars have a seating capacity of 4-5 passengers, Frost & Sullivan research reveals that, globally, almost 60% of trips are made with the driver alone in the car.

Thus, the car industry had all the right elements in place for disruption in the near term.

Tesla, with its fresh and fearless approach to car making, has been at the vanguard of change. It conceptualized an all-electric, connected smart car that had the capability to evolve over a period of time. Even as most car makers were debating whether electric cars were feasible, Tesla, a complete industry outsider, whipped up a frenzy in the market with the launch of its all electric car. Against a backdrop where dealer discounts determined the quarterly performance of a brand, customers chose to pay and wait months for their Tesla to be delivered to their door step. They could buy the car online and receive delivery at home, without having to step outside to visit a dealership. Tesla’s car was revolutionary; it was more like a smartphone on wheels, always connected and with exotic features such as over-the-air (OTA) updates, which were completely new to the car industry. Current Tesla cars have several sensors embedded in them. On being activated by paid updates, they enhance the capabilities of the car through functions such as self-parking and fetch. An OTA update, sent in response to a potential safety hazard, results in the ground clearance increasing by a few millimeters, further highlighting the way in which Tesla has upturned the car industry. Such an occurrence in the conventional automotive industry, for instance, would have resulted in a recall. Tesla’s innovative, out-of-the-box way of doing business has certainly impacted traditional thinking among automotive players.

Tech titan Google doesn’t make cars but has created waves with its fully functional autonomous car. This concept was straight out of a science fiction movie and the world was overawed to see it leap off the screen and into a real world setting. Autonomous cars are, undoubtedly, going to cause the biggest disruption in the industry. There are several other technologies that will converge to convert autonomous cars into a reality. Autonomous vehicles will need 5G technologies in order connect to with the driving environment. They will also require a a slew of cameras, radars, and light detection and ranging (LiDARs) sensors, in addition to other types of sensors, to optimally analyze driving conditions. HD maps will be needed to precisely position the car in its surroundings. Rapid image processing technologies, machine learning and artificial intelligence for effective real-time driving decisions, and vehicle-to-vehicle and vehicle-to-infrastructure communication, technologies will also be critical for the successful real world deployment of autonomous vehicles. Most of these technologies have previously been beyond the core competencies of automakers.

Therefore, they are now looking to access these new technologies either by partnering or acquiring smaller companies and/or start-ups. So for the first time in a century, automotive supply chains are on the verge of being disrupted by smaller companies.

Ride hailing companies like Uber and Grab highlight another aspect of disruption and transformative thinking in the industry. Unlike Tesla and Google who have triggered technology-led disruption, Uber and Grab represent service-led innovation. The easy availability of a car on hire has eliminated the need for car users to own, maintain and park their cars, and has underlined the growing appeal of pay-per-use models in mobility. The software industry has made a similar transformation from product-based approaches—whether in terms of standard or customized product offerings—to software-as-a-service business models. Personal mobility is fast following the same path. It is speculated that when Uber eventually goes in for its maiden IPO, despite not having any real assets.
About

54% of the world’s population lives in cities. This concentration of people and their cars in urban areas has had unwanted consequences in the form of higher pollution, congestion and accidents.

Like factories, its market capitalization is likely to be higher than that of established automotive companies such as Ford.

Most industry respondents have taken notice and have started redefining their technology roadmaps and business strategies. Car manufacturers like Daimler and BMW have started new companies or divisions to handle their emerging service-related businesses such as sharing, parking and charging. Companies like Audi have demonstrated roadworthy Level 3 automated cars, underlining their commitment to autonomous vehicle development. GM and Ford are leveraging their competencies in connected car infrastructure to further build products and services that enhance the driving experience. GM and Toyota have also invested in or acquired ride hailing and car sharing companies like Lyft and Grab, respectively. Industry analysts view these as key strategies by traditional automakers to learn about new business models as well as launch new products and services on these platforms.

The high octane action witnessed by the automotive industry over the past few years is likely to continue for another decade or so. We, at Frost & Sullivan, believe that this will be a defining phase in the transformation of the automotive industry. Ultimately, it will not be so much as the survival of the fittest as the survival of the most adaptable. As the automotive industry evolves, companies who can change their narrow “automotive” way of thinking and rapidly adapt to a broader “mobility” way of thinking will survive and thrive.
Contents

- Car ownership, by contrast, will become less relevant as car-sharing services and platforms emerge.
- Until 2025, legislation is the main roadblock to autonomous driving.
- With the next wave of innovation, traditional automotive players could wind up in the passenger seat.

How automakers can survive the self-driving era

Kaushik co-leads A.T. Kearney’s Automotive practice for South East Asia, with extensive experience advising clients on mobility trends and implications, across autonomous vehicles, EVs, freight technology solutions. He advises private and public sector clients on strategic and policy imperatives arising out of the major disruptions in mobility, guiding their thinking on investment themes, partnership options, regulations and policies. Kaushik has done over 15+ consulting engagements on these topics across the world, and has authored thought pieces on several mobility topics.

Dr Hasan Shafi works with clients in Oil & Gas, Chemicals and other asset-intensive sectors. He specializes in strategy development and execution, large scale transformation, M&A, performance improvement and digital transformation. Hasan has also worked as a senior executive in the chemicals sector heading up Strategy and M&A functions. As a member of the firm’s global EPI practice, Hasan works closely with the A.T. Kearney Energy Transition Institute with a specific focus on the topic of Energy Transition in the region.

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Transportation as we know it would be impossible without the quantum leaps in technology that have taken place over the past centuries. It is undeniable that the next big thing will be autonomous driving. With this wave of innovation, traditional players in the automotive industry could wind up in the passenger seat, with new entrants sitting pretty behind the wheel.

For original equipment manufacturers to survive in this market, there are five key questions to answer:

1. How can OEMs match consumer needs with autonomous driving solutions, while overcoming skepticism about relinquishing control of the vehicle?
2. How will the market for autonomous driving develop and what will the associated product roadmaps look like?
3. How will government legislation keep pace with new technologies while also addressing questions of liability?
4. Which business models will win in the new industry?
5. What role will partner and competitor ecosystems play in autonomous driving?

To help answer these questions, A.T. Kearney conducted more than 150 interviews with executives at companies around the world who have a strong motivation to make autonomous driving an affordable reality for consumers and for businesses. Our findings reveal crucial insights along the five key questions:

**Consumer needs**

- The connected consumer prefers an individual lifestyle in a big city environment
- More urbanization results in intermodal mobility, services enabled by mobile devices provide consumers with more flexibility and time

**Market and product roadmaps**

- Changing consumer behavior causes a paradigm shift toward mobility as a service and a preference for lavish private transportation
- The market for autonomous driving grows to $560 billion by 2035
- The main product categories around autonomous driving include mobile apps, special equipment, autonomous cars, mobility services, and infrastructure
- Developed and mature markets, including Asian megacities, spearhead market development and a global rollout

**Insights**

- Revenues from autonomous driving and related services will double from 2030 to 2035
- Revenue from self driving vehicles will triple during this period
- The quantum leap in both technology and revenue will be a steady but rapid progression, finally transitioning to fully autonomous vehicles.
- After 2030, technologies like special equipment for autonomous driving will start to become a commodity.
**Legislation, technology, and liability**

- Until 2025, legislation is the main roadblock to autonomous driving
- The most pressing legal issue is accident liability
- Achieving economic savings is the primary reason to drive legislation

**Partner and competitor ecosystems**

- Existing players in the automotive industry collaborate with new entrants to offer value-added services
- Traditional OEMs have the first view on the consumer; the first OEM to build a value-added service network with partners wins the market

**Business models**

- Autonomous driving threatens the very existence of mid-level automakers as the market develops along three segments: premium, low-cost, and drones
- The industry splits in two—those that manufacture vehicles and those that provide consumer services

**Car-as-a-platform: new services**

- Vehicle enhancement and management
- Infotainment and communication
- Listening and viewing services
- In-car shopping
- News
- IPA
- Communication services
- Emergency services
- Health checks
- Concierge service
- Integration into car required
- Pay-as-you-drive
- On-demand performance boost
- Remote maintenance
- Parking place finder
- Parking services
- Travel planning and booking
- Journey management
- Mobility services
- Fleet management
- Car sharing
- Car-as-a-platform

Automotive OEMs need to rethink their value creation strategy towards a more collaborative approach
Implications for Malaysia

For Malaysia, we have identified key imperatives along 3 areas:

- **Launch pilots for autonomous concepts**
  Opportunity to partner with OEMs/suppliers on autonomous pilots across robo-taxis, buses, inter-modal shuttles, trucks (platooning). Important to embellish ‘smart city’ credentials and differentiation, and spur local innovation.

- **Identify new investment opportunities**
  Significant growth expected in autonomous/connectivity-linked areas – e.g. image sensors, actuators, ECUs, insurance, predictive maintenance.
  Opportunity to build understanding of ecosystem and pick future ‘winners’.

- **Unlock new service models**
  Significant undiscovered/untrialed margin pools in fleet management, financing, connectivity services.
  Opportunity to ‘pilot’ and ‘develop’ the service eco-system linked to autonomous cars.

In this full report “The Next Generation of Automotive Sales: 2025 and Beyond”, we describe the forces shaping the autonomous driving market and what the market will ultimately look like. We also define the core questions facing incumbent OEMs and offer our recommendations on necessary preparations to compete in this market in terms of product structures, business models, and teams.
Business model shifts
How shared and integrated mobility models are challenging traditional car industry

By removing the driver, automation will lower commuting cost per mile by about 70%. And by creating a self-driving fleet, this will have far-reaching consequences for the entire industry and its value chain. Fleet operators can then make collective vehicle purchasing decisions, increase leverage over carmakers and remove the mediation Uber drivers currently provide to tilt the sector to their advantage. Currently, Audi, BMW, Ford, Google, General Motors, Tesla, Volkswagen and Volvo are the leading companies developing and testing autonomous cars.

Have you ever imagined what cars would look like in the future? Many sci-fi films that attempted such as Minority Report and I,Robot portrayed the future with elaborate footages of self-driving cars that drove in a coordinated manner, looked invariably the same and some even took to the sky. If we mapped this out across Maslow’s hierarchy of needs, cars of the future would sit at the apex of the pyramid.

The digital disruption has the potential to transform the automotive industry by providing new opportunities for smart autonomous cars. Now, cars can communicate, socialise and cooperate with other infrastructure and mobility apparatus. This includes other vehicles, traffic lights, mechanics, parking lots and dealers—thus enabling them to participate in a broad ‘system of systems’.

Going forward, car manufacturers need to adopt new business models to defend their ground by redesigning customer engagement and expectations. Advances in digital businesses and technologies are offering consumers new capabilities. The rapid reorganisation and the shift we are going to see in the future may constitute a new form of cars and a revamp of the whole mobility ecosystem.

Internal combustion engines are nonetheless an engineering marvel, channeling rapid-fire explosions to power a vehicle as it moves forward—and modern car designs have been deeply influenced by the strengths and weaknesses of internal combustion engines. To date, automotive companies have amassed great expertise in a broad range of sectors. By contrast, engines, transmissions, radiators, gas tanks and a lot of other auto parts would be rendered obsolete however when the next generation of cars in the future get powered by batteries and electric motors instead.

Automotive manufacturers generate a huge chunk of their revenue by selling automobiles and services that are directly related to the automotive business such as maintenance services. For many years, the automotive industry has gained competitive advantages through advances in the fields of mechanical and electrical engineering.

More precisely, improvements in value depend on being able to create cost-effective engines—provide and improve safety and key selling features such as auto braking, chassis control, multimedia systems equipped with connectivity functionalities and so on. A large number of analysts and executives in the automotive industry are convinced that this is going to change and the increase in value will be generated across the surrounding ecosystem. Unfortunately, the traditional hardware supply business model has reached its peak and is now tapering off.

Beyond the automotive industry

### Business models

<table>
<thead>
<tr>
<th>Country</th>
<th>Prepared for self-driving cars</th>
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<tbody>
<tr>
<td>India</td>
<td>49%</td>
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<tr>
<td>Malaysia</td>
<td>48%</td>
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<tr>
<td>China</td>
<td>46%</td>
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<td>Russia</td>
<td>32%</td>
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<tr>
<td>Colombia</td>
<td>32%</td>
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</tbody>
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Source: What The Future

### Who’s ready for self-driving cars?

- StreetScooter by Deutsche Post DHL Group
  - 60%-80% lower costs for maintenance and water
  - 16,000 tonnes of CO₂ saved
  - 100% ‘green’ electricity

Source: Deutsche Post DHL Group

### 3D printing

- Strati, the 3D printed car manufactured in only 45 hours
- 44 hours to print
- 4 days to build the whole car
- 4 less than main parts

Source: Red Bull
A shift to automation is expected through smart algorithms to improve efficiency, semi-automated parking functionality, and fully automated driving.

Carsharing models are likely to expand to include P2P and corporate on the same platform, as well as consolidation with other adjacent mobility services.

Consolidation in the market is likely, with OEMs playing an increasingly important role.

**FUTURE**

* A world that is...

- **~$0.30** Cost per Mile
  - A new age of accessible autonomy
  - Autonomous fleets managed by mobility providers
  - Emergence of autonomous vehicles
  - Lightweight materials
  - Shift in mobility preferences
  - Leads to fewer vehicles per household
  - A world of car sharing

**Cost per Mile**

- **~$0.65**

**Shared mobility** is the shared use of a vehicle, bicycle, or other mode of transportation that enables users to gain short-term access to transportation modes as-needed.

**Shared-platform**

- Finance: Growth in fleet financing in place of auto loans and leasing
- Insurance: Shifts from personal liability to catastrophic systems-failure insurance
- Media: Increase in consumption of multimedia and information due to time not driving
- Medical & legal: Reduction of costs for emergency medical services and related legal fees because of fewer accidents
- Public sector: Erosion of tax revenues related to property and fuel taxes, vehicle registration and traffic citations
- Retail: Increase in sales due to increased mobility of underserved segments (e.g. seniors)
- Telecom: Additional bandwidth requirements to meet increased demand for connectivity and reliability
- Technology: Emergence of autonomous drive operating system players
- Transportation: Substitution of demand for traditional taxis, limos, and rental vehicles with shared fleet vehicles

The future of mobility will be multi-modal, shared and zero emission. Thus, integrated shared mobility complementing traditional public transit such as bus + rail, will complete the ecosystem of services - a new category of private “public transport.”

- **32K** lives saved
- **40%-90%** decrease in emissions from automobiles
- **100B** hours of productivity gained back

**Shifts from personal liability to catastrophic systems-failure insurance**

- **Energy demand drops** as tailored vehicles enable more efficient and environmentally friendly powertrains.
- **Traffic jams** become a rarity as sensors govern distance between vehicles and manage traffic patterns.
- **Trip costs plummet** as the cost of commuting declines up to 70%, increasing accessible mobility.

**Number of vehicles on the road by 2050**

- **2.1 billions**
  - Electrification + Automation
  - Electrification + Automation + Sharing
  - 20th Century Technology
- **1,700 megatonnes**
- **700 megatonnes**
- **4,600 megatonnes**

**CO₂ Emissions by 2050**

- **0.5 billions**
- **2.1 billions**
- **2.1 billions**
- **40%-90%**

**70%**

Over 70% of Malaysia’s population will be urban by the year 2020

**70%**

ITDP described a superior scenario, whereby all urban transportation revolutions are accepted by citizens, including electrification, automation, and sharing.

**Source:** www.myforesight.my

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Autonomous vehicles: The technology's architecture, engineering and other technology enablers

The way in which human driven and automated vehicles interact will have major impacts on traffic flow dynamic and road safety.

Professor Nick Reed
Academy Director of Transport Research Laboratory (TRL), The Gateway Project, UK Smart Mobility
Decidedly, mutually reinforcing vehicle technology developments will have tremendous implications on mobility. As Prof. Nick Reed alluded to, the adoption of autonomous vehicles requires technology development that is not exclusive to autonomous vehicles. Balancing the technology development pursuit however involves larger agendas that have relevance to surrounding cities, infrastructure, people and the complete spectrum of the transportation ecosystem.

In the near future, road vehicles will be more than just transportation means. They communicate to provide an information dashboard for the passengers on board. New developments in mobility technology will promote a dramatic shift that will soon be embedded into next-generation vehicles. These vehicles will be equipped with the ability to respond to any dynamic conditions and surroundings changes. These types of vehicles are what we know today as autonomous vehicles.

The idea behind AVs attempts to minimise or eliminate the human element or errors in driving to increase road safety. At the same time, AVs enhance users’ networking and connectivity.

Thanks largely to technologies like GPS, sensors, monitoring system, interfaces such as on-machine, between machines and machine-to-cloud (or datacentre) systems that enable data to be processed as useful information, AVs are changing the car industry on its head. Common vehicle functionalities are being reimagined too—bringing more benefits to consumers and the transportation ecosystem as a whole.

In addition, autonomous vehicles will be able to communicate not just with voice and data networks, but also surrounding cars, drivers, and infrastructure. This creates higher accessibility for various groups who are unable to drive, such as the younger cohort, the elderly and the mobility impaired. Even those who may not be able or want to own a private car can move about freely.

### Benefits of autonomous vehicles

#### Road Safety
- Sense foot traffic before they even cross the street, as a result pedestrians’ safety gets significantly better.
- Reduce road accidents caused by driver errors, e.g. drunk driving or distracted drivers.

#### Convenient
- Cultivate higher productivity by improving multi-tasking. There are varying levels of automated vehicles, but more advanced levels only require the driver to monitor the drive to make sure it goes smoothly.
- Long road trips will become more convenient because the driver will be free to attend to their own activities during drives.
- Increase accessibility for people who are unable to drive.

#### Efficiency
- Save fuel – autonomous vehicles are more efficient, cutting travelling distances by automatically choosing the fastest route.
- Reduce the costs of taxis and delivery services.
- Reduce the demand of street parking.
How do autonomous vehicles operate?

In general, autonomous vehicles embed advanced technologies and computational systems to recognise changing and dynamic road conditions. The Society of Automobile Engineers (SAE) defines five levels of autonomous driving, as summarised below.

**Source**: SAE International – Levels of Driving Automation, National Highway Traffic Safety Administration (NHTSA)

**Levels 1-3 require a licensed driver**

**Levels 4 and 5 allow driverless operation, a perquisite for many anticipated benefits.**

**The 5 levels of autonomous driving**

- **Level 0** No Automation
  - In charge of all the driving
  - Can provide basic help, such as automatic emergency braking or lane keep support

- **Level 1** Driver Assistance
  - Must be always ready to take over within a specified period of time when the self-driving systems are unable to continue
  - Can take full control over steering, acceleration, and braking under certain conditions

- **Level 2** Partial Automation
  - Must stay fully alert even when vehicle assumes some basic driving tasks
  - Can automatically steer, accelerate, and brake in limited situations

- **Level 3** Conditional Automation
  - Must do all the driving, but with some basic help in some situations
  - Can assume all driving tasks under nearly all conditions without any driver attention

- **Level 4** Conditional Automation
  - Can be passenger who with notice, can take over driving when the self-driving systems are unable to continue
  - In charge of all the driving can operate in all environments without need for human intervention

- **Level 5** Full Automation
  - No human driver required steering wheel optional, everyone can be a passenger in an Level 5 vehicle
  - In charge of all the driving can operate in all environments without need for human intervention
  - Must do all the driving, but with some basic help in some situations
Autonomous vehicles’ technologies

Common readily available technologies that are yet to mature will soon enable vehicles to operate autonomously. As highlighted below, these technologies will be imbedded in autonomous vehicles’ operation in all environments without the need for human intervention.

**LiDAR - Light detection and ranging**
A rooftop ranging system comprised of 64 lasers paints a 360-degree picture of the car’s surroundings and is accurate to within 2 cm.

**GPS**
GPS is accurate to within 1.9 meters. With GPS covering the macro location of a vehicle, smaller on-deck cameras can recognise smaller details like red light, stop signs, and construction zones.

**Processor**
Reads data and regulates autonomous vehicles’ behaviour.

**Stereo vision**
Two windshield-mounted cameras build a real-time 3D image of the road ahead, spotting hazards like pedestrians and animals.

**Infrared camera**
Two infrared headlamps extend your vision at night without blinding other drivers. The signature of the infrared beam is detected by a camera, which displays an illuminated image on the dashboard.

**Radar**
An accident-prevention system that triggers alerts when it detects something in a car’s blind spot.

**Lane guidance**
Recognises lane markings and knows the difference between the road surface and boundary lines.
Cameras mounted behind the rear-view mirror recognise lane markings, spot contrast between road surfaces and boundary lines.

**Wheel encoder**
Wheel-mounted sensors measure the velocity of the car as it manoeuvres through traffic.

**Source**: https://www.greencarreports.com/news/1073264_can-driverless-cars-solve-distracted-driving-infographic-explains-it-all
Surely, every industry and business will be impacted by the impending transitions in autonomous vehicles’ technology. Below is a list of top automakers and their predictions.

### Patent analysis

The race to capture higher R&D in autonomous vehicle technology has long begun around the world. Car manufacturers in particular must accelerate their evolution to compete with other tech companies to contend as pioneers in autonomous vehicle technologies. Dispersed innovation activities being undertaken currently are not just from a select group of automakers. It involves big non-automotive tech companies such as Google and Apple that have vested interests in the growth of the technology too.

Patent data is collected based on each company’s top 5 areas of interests. The results indicate 3 key areas that have been explored most in AVs’ research:

- Engineering element & machine function
- Controlling and computing system
- Vehicle structure and characteristics

Results also indicated that conjoint control, gearing, controlling and sensing systems are the sub-areas that most companies find most reflective of the engineering elements and machine functions of AVs apart from controlling and computing systems, vehicle structure and characteristics areas.
Undoubtedly, AVs bring benefits that span outside current transportation systems and norms. The technologies being developed to allow autonomous driving can change the whole ecosystem toward a safer, convenient and efficient traffic system.

With a clear understanding on the capability of AVs, innovation activities can be carried out with much higher exploratory objectives. In other words, the predictions published by major automakers and tech companies described the intense aspiration of a new-end market built around mobility. Currently, these companies are racing toward creating the ideal technologies to fit the vision. With the help and introduction of advanced technologies, the predictions carved out carry an exponential industry weight. Partly, these predictions offer a look into the possibilities and opportunities that could play out to be a reality in the not-so-distant future.

References:
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Over the past 5 years, Artificial Intelligence (AI) has moved up the ranks from science fiction into real world applications. Significantly, AI has taken the automotive industry by storm in driving the development of level-4 and level-5 autonomous vehicles (AVs). AVs are being tested rigorously all over the world. AVs (sometimes also referred to as self-driving cars or driverless cars) are vehicles that use a combination of sensors, cameras, radars and artificial intelligence (AI) to drive between destinations without a human driver. To qualify as a full AV, a vehicle must be able to navigate without human intervention to a predetermined destination across routes that have not been adapted for its use.

So far, SAE International has developed a framework that’s gaining widespread recognition across the industry and thus AV concepts have been broadly adapted. The definitions and levels are laid out in the SAE J3016 diagram below.
**Autonomous driving - levels of automation, cost, timing**

Here is a guide to the 7 challenges when it comes to realising AVs:

1. **Socio-economic challenges**

   Increasingly autonomous transportation of people and goods will have major ramifications for employment and job skill requirements. In November 2018, Tun Dr. Mahathir in his speech at the Asia-Pacific Economic Cooperation summit in Papua New Guinea highlighted that policies were needed to protect the losers from a shift toward a technology-driven economy. Unfortunately, this includes replacing the job of drivers in today’s economy. Perhaps, in the scenario where a ride-hailing company no longer needs drivers for its AVs, the livelihood of drivers employed in today’s sharing economy will be highly jeopardised. Foreseeably, one viable solution is to retrain and reskill them. However, the concept of transitioning current workforce to new jobs is easier said than done. It requires a major mind-set overhaul to fully comprehend the intricate nature of the future of work.

2. **Technology maturity**

   By using a neural network, (a subset of AI that requires a massive amount of computational power) it is both critical yet imprudent to safety whereby the detection accuracy of the network needs to be much higher than that of today’s internet speed. The system needs to operate flawlessly irrespective of weather conditions, visibility or road conditions. However, to achieve this level of game-changing performance, a neural network needs to be trained based on representative datasets that include samples of all possible driving, weather, and situational conditions. In practice, this translates into large petabytes of training data.

   However, AI is not completely fool-proof. It can still be tricked. For example, adversarial images or pictures engineered to fool machine-vision software, can be used to undermine or even crash self-driving cars. To illustrate, a 45 mph sign sticker applied to a stop sign could possibly confuse a machine vision and crash the car. In 2017, a neural network trained by Google to identify everyday objects was tricked into thinking that a 3D-printed turtle was a gun. In response, Waymo’s engineers said that they were building redundancy into their system to address these fatal possibilities. All this adds up to a long list of concerns around the commercial timeline and feasibility of self-driving cars, which includes hacking, ransomware and privacy breaches. A
similar challenge recently surfaced when Volvo opened up about a problem they were facing to recognise the unique movement of kangaroos in Australia—a major animal-related accident cause in Australia.

AVs depend on AI for their capability. Here are 3 levels of AI adopted from McKinsey:

- **Narrow AI**
  The lowest level of AI with existing software that automates and performs common human activities.

- **General AI/Human level AI**
  The capability to understand its environment and to act accordingly.

- **Super AI**
  The highest level of AI. AI becomes much better than the human brain in practically every field.

AVs’ adoption requires large-scale re-purposing of urban space such as parking areas and traffic lanes. However, other challenges in relation to legislation, cyber-risks, liability, infrastructure and technology appear to slow down AVs’ commercialisation rate.

### 4 Autonomous ecosystem and urbanisation

As future AVs become safer and more efficient, they will rely on high-bandwidth mobile networks to wirelessly share and receive data from each other. Self-driving vehicles currently operate by collecting data from an array of sensors which is then interpreted by various algorithms. There is however a limit to AVs’ capability and the information collected by these sensors at present. To illustrate, AVs cannot see vehicles outside their field of vision or become aware of impending traffic occurring miles down the road. The main challenge is to overcome this vision constraint. That said, the solution involves constant access and interpretation of data collected by thousands of surrounding vehicles and other infrastructure. When the cars evolve further from hardware units into end-to-end software platforms, the wide range of IT systems equipped across AVs make them vulnerable to cyber attacks. Cybersecurity issues in AVs can be caused by data hacking, system hacking and data privacy. In view of this, Tesla previously implemented a policy to force owners of its AVs to give up rights over vehicle data. Conversely, ownership of data now falls in the hands of the the manufacturer. Here, we can see how data is becoming an increasingly valuable source for manufacturers to advance their machine learning capability. A recent study revealed that one possible threat looms concerning AVs’ security. When connected, AVs are vulnerable to various forms of unscrupulous exploits. And in the worst case scenario depicted by the study, AVs could even be manipulated to plan a bomb attack by unsuspecting terrorists.

Currently, 4G network is fast enough for most tasks, such as sharing status updates and requesting rides. However, it lacks the speed to equip AVs with human-like reflexes that could well have prevented the fatal Uber self-driving car crash. 5G’s low latency and safety characteristics will play well in the evolution of AVs, enabling smart vehicles to communicate with each other, and creating opportunities for connected AVs. An AV operated via a cloud-based, autonomous driving system must be able to stop, accelerate and turn when told to do so. Any network latency or loss in signal coverage preventing the message from being delivered could result in catastrophic consequences. However, wireless operators believe that AVs still have a significant way to go before they come into service, despite ongoing pilots and trials. According to a Gartner analyst, Will Hahn, 5G will be essential to the development and use of AVs, with two important caveats, the network must be truly 5G, and the vehicle must be truly autonomous. Apparently, both are still very unlikely in the near future.
The industry needs to determine the types of data that can be shared and how it will be anonymised. This will likely necessitate government supervision to ensure compliance and implementation ethics. Deploying a common identity layer and identity authentication protocol that enable trustworthy interoperability and secure connectivity between all entities will help to cover the groundwork as far as public policy is concerned.

For this to happen, stakeholders engaged with developing AV systems, components, infrastructure or complete AVs must participate in both standardisation activities and interoperability testing in order to make sure that a basic level of trust can be established for each and every device that’s adopted in AV communication.

There’s a common notion that when more AVs make their way on the road, there will be fewer accidents. This implies that there will be fewer liability claims. However, the ongoing debates making rounds all over the world now seek to find answers regarding who should get insured. Is it the driver, the car manufacturer or the programmer? Today, a lot of the liability falls with the driver, but in a world where the vehicle is completely in control, it doesn’t make sense to peg any sort of liability to the passengers. Before any common agreement can be reached on the predicament, let’s not forget that there are other data privacy regulatory issues to consider too.

According to the Global Driverless Vehicle Survey 2018 by Baker McKenzie, respondents of the survey were not aware of any laws or regulations in Malaysia that relate specifically to driverless vehicles. There are no prescribed standards or approval processes for driverless cars in Malaysia. This calls on the attention of the Ministry of Transport (MOT), the principal regulatory authority in Malaysia that oversees the Road Transport Department (RTD) to look into the maturing technology trend.

Meanwhile, a KMPG Report on Autonomous Vehicles Readiness Index (AVRI) published in January 2018 assessed the 4 pillars of country openness and AV preparedness. Saliently, the report stressed why policymakers need to anticipate the adoption of AVs now.
Inevitably, ethical considerations need to touch on how AVs decide who gets killed in the unfortunate event of a collision. However, a recent study by MIT Media Lab suggested that AVs would most probably kill the person who is less reactive. More than 2 million people in over 200 countries took part in the survey. The survey represented an updated version of the famous “trolley problem” often used in philosophical thought experiments. In the experiment, study subjects were told to imagine a trolley heading down a track and to think about the various possibilities—like whether diverting the train to kill more people is better than leaving the situation to happen in an attempt to understand ethical decision making. And while the results varied widely between different groups, scientists found a number of common beliefs between them.

Three main elements appeared as priority in decision making in crashes;

- Cars should favour fewer people to die rather than more,
- Older people are killed rather than younger ones,
- Humans are favoured over animals.

However, the degree to which they agreed with the above considerations varied among different groups and countries. The survey also found that people tended to believe that cars should favour law-abiding citizens over those who don’t. However, machine algorithms do not have the ability to consider a person’s family ties, profession, fame, criminal record, gender, age or any other factors.

Self-driving cars will ultimately change the way we commute and work. In the 19-page study entitled “autonomous vehicles and the future of urban tourism”, researchers Scott Cohen and Debbie Hopkins argued how the deployment of privately owned and shared autonomous cars will disrupt nearly every actor in the tourism world, including car rental companies, hotels, restaurants, bars, and even brothels. While we are free from the task of driving, unintended consequences suggest a mobile red light district in the future will affect societal values.
As Malaysia weighs how to formulate a regulatory structure around AVs, the country is currently revising its National Automotive Policy (NAP) to include a review of electric vehicles (EVs) and AVs. Although AI brings a lot of tangible benefits, we should fully comprehend where AI is lacking at the moment to make informed decisions. Similarly, the rise of e-commerce and emerging technological shifts have driven many large brick-and-mortar retailers out of business. Unless they’re able to adapt, gas stations and convenience stores could be left to the same fate too.

There is a reasonable expectation that AVs will perform the same or better in all aspects than their conventional counterparts. However, it seems that current regulations are still behind the technology development and sometimes hinder the development and testing of AV technologies.

In order to overcome the challenges associated with autonomous driving, it is crucial that key AV stakeholders (governments, technology/telecom players, suppliers, automotive councils and academic institutions) work side by side to implement a commercially viable business model that facilitates the deployment and adoption of AVs. A key point to consider here is that technology rarely arrives ‘perfectly formed’. Waiting for it to do so usually results in being left behind. Instead, it makes great economic sense to get involved now amid the uncertainty to find and build applicable solutions.

In the long run, driverless cars will help us reduce accidents, save time spent on commuting and make more people mobile.

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1. https://singularityhub.com
15. https://www.academia.edu/3766376/Autonomous_vehicles_and_the_future_of_urban_tourism
Industry 4.0 and smart city integration from the perspective of mobility
Currently, various technology trends are disrupting the mobility ecosystem in many ways. It could probably unravel beyond what many technology experts in mobility foresee. This turbulent flow will cut across manufacturers, auto retailers, insurance sectors, financial institutions and go up to regulators. In many ways, this will induce organizations that have vested interests in the transportation sector to evolve their business and operational model to stay ahead of the game and remain competitive as the future for mobility unfolds (Deloitte).

Information technology will be a key driver of innovation in mobility, allowing smarter and more flexible solutions. As projected, there will be 34 billion devices connected to the internet by 2020, up from 10 billion in 2015 (Business Insider).

As such, the mobility sector will grow more prominent with recent Industry 4.0 development gaining traction alongside other smart city initiatives. Therefore, this article aims to further the discussion on Industry 4.0 and smart city integration from the context of mobility and how positive Industry 4.0 development can be leveraged for smart city initiatives. Industry 4.0 refers to smart manufacturing activities or better known as the place where new products and technologies are manufactured. Meanwhile, smart city is a platform where these products and technologies get deployed.

To delve deeper, the authors would like to refer to cases based on examples with reference to Malaysia’s automotive industry and the aforementioned trends. Figure 1 shows the overall mobility ecosystem and the cluster involved.

**Mobility at a glance**

Figure 1: Mobility Ecosystem
Market driven smart city

According to the statistics, 75% of Malaysians live in urban areas. The country’s urbanization rate is about 4% a year on average—amongst the fastest in East Asia (Urbanice Malaysia & World Bank). This indicates that mobility is highly intense at city level compared to rural areas. Whereas, Figure 2 shows the local landscape with regard to smart city implementation that encompasses various focus areas such as water, waste, energy and mobility.

The transportation sector in Malaysia consumes 35% of total energy and produces nearly 50 million metric tons (Mt) of CO2 in 2015. This contributes heavily toward pollution and the environmental challenges the country is currently facing (Malaysia Stocktaking Report on Sustainable Transport and Climate Change, GIZ) as 85.2% of the transportation emission source is from road transport. In the Malacca State Greenhouse Gas Emission Inventory Report 2013 prepared by Malacca Green Technology Corporation (MGTC) & ICLEI Local Governments for Sustainability; it indicated that on-road petrol cars had the highest share of GHG Emission in the city which stood at 58.7%. At the city level, there were a number of issues and challenges highlighted and these issues were closely related to mobility such as traffic congestion, safety, security, limited parking space, navigation and comfort ability.

Kuala Lumpur citizens spend approx. 270 to 500 million hours stuck in traffic (RM 5.51 Billion productivity lost/year) - Smart Cities Asia

Approx. only 60% of highlighted cities implementing smart initiatives as highlighted in the blue colour

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<tr>
<th>City (Population)</th>
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<th>City (Population)</th>
<th>Date as cities</th>
<th>City (Population)</th>
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<td>Georgetown</td>
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<td>Kuching</td>
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<td>Bandar Melaka</td>
<td>15 April 2003</td>
<td>Kuala Terengganu</td>
<td>1 January 2008</td>
</tr>
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</table>

Figure 2: Smart city initiatives at various cities in Malaysia
Understanding the issues and challenges at hand, the technologies forcing to go mainstream seek to address current industry constraints. Driven by nascent market needs and incoming trends, new technological solutions identified will lead to an unprecedented transformation of the mobility ecosystem. Subsequently, this will provide answers for the conundrum regarding why car manufacturers produce their cars equipped with the latest sophisticated technology features. It is done to fulfill specific objectives to resolve future market needs as well as to live up to consumer expectations. Figure 3 shows samples of how cars sporting the latest technology features provide solutions for the issues faced by consumers and describes an accurate equation between a technology push and market pull.

Therefore, we can see how the linkages between Industry 4.0 manufacturing and smart city interact. At ground level, the application platform concentrates on how car users experience and benefit from smart city features. Despite a low portion of car usage in rural areas, geographically, it represents a different set of challenges and mobility requirements. Therefore, car automakers must embrace Industry 4.0 in smart manufacturing to produce products that the evolving market wants.

In addition, car manufacturers need to factor in usability considerations and equip their cars with features that offer flexibility for areas that lack smart facilities. This makes Industry 4.0 an access gate for manufacturers to streamline their production line facilities and operations with state-of-the-art technologies (Flexis).

Although not every manufacturer has the luxury of a complete facility with Industry 4.0 features, on average, most manufacturers have already embraced the basic principles of Industry 4.0. According to Bosch, with the adoption of smart and connected lines, the company recorded a 25% increase in output for its automatic braking system (ABS) and electronic stability programs. Moreover, smart city implementation will further push digitization and deployment of new technologies in the mobility sector.

Currently, there are a host of Industry 4.0 technologies advancing the manufacturing sector namely 3D Printing, Artificial Intelligence, Robotics & Automation & Virtual Reality.

Some of the technologies being developed for smart city applications include big data and cloud storage. Saliently, this will complement technology development in the mobility sector as described in Figure 4.

**Figure 3** Sample of technology solutions in addressing market requirements
Finally, this article aims to form a view of the interrelation between a technology push and market demand by studying a few key examples of Industry 4.0 and smart city applications from the aspect of mobility. Besides, there are plenty of Industry 4.0 opportunities from other sectors that can be link to smart city application spanning ICT, waste, water and energy etc. However, as technology transforms mobility, the factors that we should collectively consider require a holistic examination to tailor suitable solutions in diverse cross-cut sectors.

### References:
1. The Future of Mobility, Deloitte University Press, 2015
2. Estimated Internet-Connected Device Installed Base Global, Business Insider 2015
4. National Physical Plan 2010, JPBD
6. Malaysia among Most Urbanized Countries in East Asia, World Bank Group 2015
7. Malaysia Stocktaking Report on Sustainable Transport and Climate Change (Data, Policy and Monitoring), ASEAN-German Technical Cooperation, Energy Efficiency and Climate Change Mitigation in the Land Transport Sector
Outlook of Malaysia’s battery industry ecosystem

The battery industry is poised to become a leading power source for mobility. The trends taking hold show an increasing effort to address battery lifecycle and discharge time. Moving forward, batteries need to be decomposed in the correct way.
This article seeks to further a public discussion on the outlook of Malaysia’s Energy Storage System (ESS), in particular, the electrochemical technology or better known as battery. In the last couple of years, an increased emphasis on the localization of battery manufacturing has paved the way for the industry’s value acceleration. The effort was aimed at capturing a growing demand in the energy and transportation sectors. Thus, the proliferation of studies and analyses conducted in recent years on the cost structures, battery value chain and industry trends emerging provide vital inputs at the intersection of future ESS industry development.

The first law of thermodynamics indicates that the energy can be converted from one form to another form and it cannot be created nor destroyed. Therefore, energy can exist in various forms including mechanical, thermal, electrical, fluid, chemical, solar, nuclear, sound and it is available to be stored in many methods by using specific technology of Energy Storage System (ESS) as shown in Figure 1.

According to the Joint Working Group on Chemical Energy Research of German, Energy Storage System (ESS) is defined as a device or system that is able to take up a certain amount of energy in a controlled manner via the charging process, and contain this energy over period of time relevant to the specific context (storage) and distribute the energy over a period of time in a controlled manner via the discharging process.

**Basic operations**

In general, there are five ESS technology categories namely chemical, electrical, thermal, electrochemical and mechanical as shown in Figure 1. As highlighted in the red box, electrochemical ESS or battery consists of two sub-types; classic batteries and flow batteries.

![Figure 1: Taxonomy of Energy Storage System (European Association for Storage of Energy)](image-url)

Technically, a battery consists of 3 main elements: positive electrode, negative electrode & electrolyte i.e. the chemical solution. Materials used for negative and positive electrodes are different and it largely depends on product development as presented in Table 1 for the Lithium type.
<table>
<thead>
<tr>
<th>Cathode</th>
<th>Anode</th>
<th>Manufacturers</th>
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*Table 1: Lithium ion subcategory characteristics (IRENA 2015)*

During the operation, the electron moves from the negative electrode to the positive electrode via the electrochemical process and thus produces the electrical energy in a process known as discharging. As the power decreases, once the battery is connected to the charger, the electron will be forced to move back from the positive electrode to the negative electrode in a process known as charging. Eventually, through repeated charging and discharging, battery materials deteriorate as the battery units deplete.

**Industry trends**

The trend taking hold in the battery industry shows an increasing effort to address battery lifecycle and improve battery discharge time as shown in Figure 2. The results are reflective of most industry players’ interests that centre around innovation activities in improving battery life cycle, discharge time and size. There are less takers however in the areas of storage capacity and efficiency. Nowadays, there are many options available that come in various material types, packaging and sizes including cylinder, button cell, prismatic, polymer sheet depending on the intended application.
The battery market & manufacturing

Based on the Organisation for Economic Co-operation and Development (OECD), manufacturing of ESS is classified as a medium high-technology industry under the Electrical Machinery and Apparatus category [8]. Here, Figure 3 shows the industry’s local value chain and Figure 4 shows its global key players.

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<tr>
<th>Anodes</th>
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<th>Electrolyte solutions</th>
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<tr>
<td>• Tomyama Pure Chemical</td>
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<td>• Cheil Industries (Samsung)</td>
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<td>Electrolyte</td>
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<td>• Kanto Denka Kogyo</td>
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<td>• Stella Chemifa</td>
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<tr>
<td>• Morta Chemicals</td>
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<tr>
<td>End-product makers</td>
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<tr>
<td>• Consumer Electronics</td>
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<td>• Automotive OEMs</td>
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<tr>
<td>• Stationary Applications</td>
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<tr>
<td>Cell manufacturing</td>
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<tr>
<td>Cell production including electrode manufacturing, assembly process and electrical formation.</td>
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<tr>
<td>Electrode Manufacturing Sturry Mixing &gt; Coating &gt; Evaporating &gt; Compressing &gt; Slitting</td>
<td></td>
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<tr>
<td>Assembly Process &gt; Drying &gt; Tab Welding &gt; Stacking &gt; Packaging &gt; Filling</td>
<td></td>
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<tr>
<td>Electrical Formation &gt; Final Storage &amp; Testing</td>
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<td>Retailer &amp; integration</td>
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<td>Stationary</td>
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<tr>
<td>• RE battery</td>
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<tr>
<td>• Telco tower</td>
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<tr>
<td>• Outdoor street lighting</td>
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<tr>
<td>• Charging station</td>
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<tr>
<td>• Home appliance</td>
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<tr>
<td>Module assembler</td>
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<tr>
<td>Module production. Activities involved in module customization, cell configuration and electronic management.</td>
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</tbody>
</table>

Based on the Organisation for Economic Co-operation and Development (OECD), manufacturing of ESS is classified as a medium high-technology industry under the Electrical Machinery and Apparatus category [8]. Here, Figure 3 shows the industry’s local value chain and Figure 4 shows its global key players.
ESS is a key growth motor for the mobility sector. At present, batteries are widely utilized across residential, industrial, commercial and transportation applications. For example, in residential and commercial applications, batteries are used in electronic devices such as laptops, smart phones and tablets. Meanwhile, in an industrial setting, batteries are used to power instrument controllers, radio communication devices and etc. Further, in the transportation sector, batteries are used to provide a source of energy to power electric vehicles (EVs) such as buses, scooters and cars. Figure 5 zooms in on leading countries’ statistical evolution in relation to EVs whereas figure 6 shows the increasing global demand for EV batteries that’s illustrated by an upward trajectory through to 2035.

In addition, figure 7 shows a preliminary analysis of domestic EVs' value proposition.

For the Malaysian battery market, all product owners, local manufacturers, importers and retailers involved in battery re-packaging activities need to comply with Malaysia’s Battery Safety Regulation underlined by the Ministry of Domestic Trade and Consumer Affairs (KPDNHEP) and SIRIM.

Product tests outlined by the agencies touch various areas in relation to durability. These areas cover examinations such as over charging, over discharging, crushing, nail penetration and external short circuit via a set of rigorous testing. In addition, transportation standard safety testing (UN/DOT38.3) includes altitude simulation, thermal test, external short circuit test, impact test and force discharge tests.

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**Figure 5: Evolution of the global electric car stock, 2010-2016**

Notes: The electric car stock shown here is primarily estimated on the basis of cumulative sales since 2005. When available, stock numbers from official national statistics have been used, provided good consistency with sales evolutions.


**Figure 6: Global EV battery demand**

EV sales of 18 million cars would require battery production to increase threefold.

**Figure 7: Preliminary analysis on the battery as one of the segment in electric vehicle industry**

<table>
<thead>
<tr>
<th>Value chain</th>
<th>Local context</th>
</tr>
</thead>
<tbody>
<tr>
<td>EV components manufacturer</td>
<td>1. Nissan</td>
</tr>
<tr>
<td>2. Renault</td>
<td>5. Deftech Sdn Bhd</td>
</tr>
<tr>
<td>3. Scomi Engineering</td>
<td>6. TESLA (import)</td>
</tr>
<tr>
<td>EV assembler</td>
<td>1. Go auto</td>
</tr>
<tr>
<td>2. Eclimo (EV Bike)</td>
<td>8. Deftech Sdn Bhd</td>
</tr>
<tr>
<td>3. COMOS</td>
<td>9. AMDAC Sdn Bhd</td>
</tr>
<tr>
<td>4. Nissan</td>
<td>(EV Bus)</td>
</tr>
<tr>
<td>5. Renault</td>
<td></td>
</tr>
<tr>
<td>6. Scomi Engineering</td>
<td></td>
</tr>
<tr>
<td>(EV Bus)</td>
<td></td>
</tr>
<tr>
<td>Energy generation</td>
<td>Utility Companies</td>
</tr>
<tr>
<td>1. TNB</td>
<td>4. IPPs</td>
</tr>
<tr>
<td>2. Sabah energy corporation</td>
<td></td>
</tr>
<tr>
<td>Energy transmission &amp; distribution</td>
<td>Utility Companies</td>
</tr>
<tr>
<td>2. Sabah energy corporation</td>
<td></td>
</tr>
<tr>
<td>Energy storage (battery) management</td>
<td>1. Eclimo</td>
</tr>
<tr>
<td>2. Malaysia Automotive Institute (MAI)</td>
<td>5. Microvast</td>
</tr>
<tr>
<td>3. AMREC SIRIM</td>
<td>6. Renewcell Sdn Bhd</td>
</tr>
<tr>
<td>EV charging infrastructure station</td>
<td>1. MGTC in collaboration with TESLA</td>
</tr>
<tr>
<td>2. PETRONAS</td>
<td>5. COMOS in collaboration with MGTC &amp; MAI Treelektrik</td>
</tr>
<tr>
<td>Dagangan Berhad in collaboration with TNBES &amp; MGTC (In Progress-60)</td>
<td></td>
</tr>
<tr>
<td>Infrastructure services, operation &amp; maintenance</td>
<td>1. Eclimo</td>
</tr>
<tr>
<td>2. COMOS</td>
<td>5. ABB Malaysia</td>
</tr>
<tr>
<td>3. EV Connection Sdn Bhd</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. First Energy Network Sdn Bhd</td>
</tr>
<tr>
<td></td>
<td>5. ABB Malaysia</td>
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</tbody>
</table>
In the future, new battery technologies will offer significantly better performance in terms of physical size, capacity, quicker charging time, safety and costs. Moving forward, batteries need to be decomposed in the correct way. Batteries consist hazardous materials that can pose negative impact and risks toward the environment. The country can therefore provide more opportunities for the battery industry by increasing effort to promote local manufacturing of batteries. However, the agenda boils down to a few key challenges, for example, economy of scale to attract the industry’s key players to manufacture in Malaysia. On the other hand, as a battery manufacturer, Malaysia needs to factor in the added responsibility of managing waste from battery usage and end-of-life properly.

Forward integration along with a fitting policy are what the industry needs to address the usage of locally made batteries. In many cases, Malaysia can enhance its capability by promoting local resources and know-how in battery-manufacturing processes and critically, batteries’ terminal integration.

In short, the race to the future of the battery industry has already begun. This is the overall picture of the progress and opportunities of Malaysia’s battery industry. To ease the barriers of growth, the industry requires more support from various government departments and private stakeholders to accelerate its development.

References:
1. European Energy Storage Technology Development Roadmap 2017
2. Battery Storage for Renewables: Market Status and Technology Outlook, IRENA 2015
3. Electricity Storage and Renewables: Cost and Markets to 2030, IRENA 2017
myForesight® book club

What Are Your Blind Spots?
Conquering the 5 Misconceptions that Hold Leaders Back

Uncover your blind spots and reset your leadership approach for long-lasting success in any business.

Far too many business leaders today are using outdated practices to engage and motivate their people and they’re failing miserably. Truly resilient, thriving organizations are those that are purpose driven and focus on more than pure profits. Purpose, or an underlying company philosophy, not only drives strategic change, but also encourages customer loyalty and employee engagement. In order to succeed, leaders must be willing to discard old ways of thinking and detrimental business habits and recognize their blind spots.

Authors Jim Haudan and Rich Berens identify the five most common leadership blind spots that hamper success: Purpose, Story, Engagement, Trust, and Truth. They take you straight into the board room of well-known leadership teams to illustrate how these blind spots play out and the impact they have on organizations. You’ll learn how to identify and overcome your own blind spots and embrace positive, forward-thinking new practices.

What Are Your Blind Spots equips you with the tools needed for a personal leadership reset. You’ll discover how to increase engagement, productivity, and growth in your own organization. This is an invaluable guide for executives, managers, team leaders, and human resource professionals looking for an effective way to engage and motivate employees at every level of an organization.

The Big Nine:
How the Tech Titans and Their Thinking Machines Could Warp Humanity

A call-to-arms about the broken nature of artificial intelligence, and the powerful corporations that are turning the human-machine relationship on its head.

We like to think that we are in control of the future of “artificial” intelligence. The reality, though, is that we—the everyday people whose data powers AI—aren’t actually in control of anything. When, for example, we speak with Alexa, we contribute that data to a system we can’t see and have no input into—one largely free from regulation or oversight. The big nine corporations—Amazon, Google, Facebook, Tencent, Baidu, Alibaba, Microsoft, IBM and Apple—are the new gods of AI and are short-changing our futures to reap immediate financial gain.

In this book, Amy Webb reveals the pervasive, invisible ways in which the foundations of AI—the people working on the system, their motivations, the technology itself—is broken. Within our lifetimes, AI will, by design, begin to behave unpredictably, thinking and acting in ways which defy human logic. The big nine corporations may be inadvertently building and enabling vast arrays of intelligent systems that don’t share our motivations, desires, or hopes for the future of humanity.

Much more than a passionate, human-centered call-to-arms, this book delivers a strategy for changing course, and provides a path for liberating us from algorithmic decision-makers and powerful corporations.
Screening future scenarios to champion greater integrity

**MIGHT. Cyberjaya**
16th and 17th October 2018

Recently, on the 16th and 17th of October 2018, myForesight® conducted a scenario planning workshop with the National Centre for Governance, Integrity and Anti-Corruption (GIACC). In effect, the use of MIGHT’s flagship program to create alternative stories about the future strengthens GIACC’s outgoing strategy to foster greater national integrity.

By creating plausible scenarios around the nation’s governance and business practices, the workshop is a significant effort to support Malaysia’s renewed integrity cause. To advance the organisation’s internal capacity on Foresight knowledge, objectively, the assistance provided by myForesight® was structured to improve the agency’s ability to measure integrity development along Malaysia’s next National Corruption Plan that will run through from 2019 to 2023.

In response to the concern raised by Y.A.B Prime Minister Tun Dr. Mahathir Mohamad where the premier recently remarked, “The government commitment is to achieve the principle of wanting Malaysia to be known for integrity and not corruption”.

Following this, the agency has published the National Corruption Plan 2019 - 2023 and will be rolling out a pipeline of programs to implement a joint-action that maps across to Malaysia’s public and private sectors.

Ultimately, by applying the lens of plausible future scenarios, the agency sees the greatest impact in areas that will generate tangible results to improve the nation’s integrity.

University of Malaya’s Faculty of Science visit to myForesight®

**MIGHT. Cyberjaya**
23rd November 2018

On the 23rd of November 2018, myForesight® received a study visit from the Department of Science and Technology Studies, Faculty of Science, University Malaya.

A total of 13 third-year ‘Policy and Management of Science and Technology’ students took part in the visit. The students spent half a day in MIGHT’s Cyberjaya main office and experienced first-hand, the dynamic roles myForesight® plays as one of the key think-tank agencies that provides crucial input to national Science, Technology and Innovation (STI) agenda.

Significantly, the students received coaching in the valuable skills and exposure on a potential career prospect in the field of foresight. The students also observed how varied and elaborate the work myForesight® does in foresight techniques, tools and processes in the interest of policy-making to boost the nation’s high-technology industry pursuit.

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**myForesight® in the news**

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MPC Foresight management retreat

At Malaysian Productivity Council’s (MPC) recent management retreat, myForesight® Directors, Rushdi Abdul Rahim, and Mohd Nurul Azammi Mohd Nudri were invited to share what action government agencies need to carry out an effective long horizon planning exercise.

In addition to a brief introduction on foresight, saliently, Mr. Rushdi Abdul Rahim and Mr. Mohd Nurul Azammi Mohd Nudri discussed at length the importance of measuring and managing the total impact of an uncertain future using scenarios. Apart from stressing that scenario planning can avoid the dangers of linear, one dimensional thinking, both myForesight® representatives took turns to accommodate a host of questions posed by the turn-up with regard to planning #beterfutures. The event took place on the 29th of November 2018 at MPC’s office in Petaling Jaya.

Projek Sarjana Muda 2 (PSM II) final year paper presentation

On the 2nd of December 2018, the second leg of Universiti Tun Hussein Onn’s (UTHM) ForesightClub final paper presentation took place at Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia. The program involved 23 pre-selected students from UTHM’s Faculty of Technology Management and Business.

A definitive follow up, initially, the first leg got the program off the ground with the introduction of a ‘Future Deck’ to assist and stimulate the students’ thinking on selected research topics for their final year project.

In brief, a ‘Future Deck’ is a compilation of megatrends with supporting keywords, facts and figures classified under five perspectives – social, technology, economic, environment, politics and values.

Leveraging on the countless hours of conducting training and consulting myForesight® has borne out, the collaboration mapped out a simple framework to measure these megatrends to help the students develop their research findings.

All of this is done with the aim to encourage young Malaysian entrepreneurs to pursue opportunities in various emerging technology fields. Contributing time and experience to the cause were myForesight’s senior research analysts, Nadia Sullivan and Mohd Hasan Mohd Saaid, who formed a panel of moderators in judging the students’ ideas.

Last but not least, the outreach program is another joint-effort by MIGHT and a local university partner to provide an outlook on all-round foresight tools and applications to stretch the nation’s foresight ambition holistically.
YOUR NEXT BIG IDEA
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Consuming, deciphering, and acting on all available information is impossible. There’s simply too much of it. Lux provides unbiased, fact-based expert opinions about:

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- When is the best time for you to act.

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SilTerra

Defining Tomorrow in Malaysia Today

Incorporated in 1995 as a semiconductor manufacturer in line with then Malaysian Prime Minister Mahathir Mohamad’s Second Industrial Master Plan, SilTerra has been ranked 16th globally by Gartner in the category of pure-play foundries.

SilTerra has since then built its base from CMOS logic, RF and HV technologies to more advanced emerging fields such as silicon and bio-photonics, silicon nano-wire, MEMS, pMUT and advanced power. This has helped customers develop new device categories and products such as:

- photonic waveguides
- bio-sensors
- micro-mirrors
- high efficiency power devices
- fingerprint sensors

These are targeted at emerging markets such as automotive, life sciences, IOT as well as consumer, communications and data center segments with a customer base that includes global tech giants such as Broadcom, LG, Sony and Qualcomm who provide chips to brand names like Amazon and Google. One California-based customer was recently acquired for US$1.2 billion after successfully launching their DNA Sequencing Chip.

Being a top 5 E&E exporter in Malaysia and leading innovator is the result of years of developing local talent at universities and nurturing strategic partnerships with organizations like imec, the leading nanoelectronics research institute based in Leuven, Belgium.

“Through SilTerra’s own transformation, we have been able to collaborate with emerging companies around the world to develop their dreams into innovative new products. SilTerra is now looking forward to stepping up its role in Malaysia and playing our part in developing a vibrant high-tech ecosystem for the nation,” said CEO Firdaus Abdullah.

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Send your feedback and get in touch with us at foresight@might.org.my

Website: www.myforesight.my

We look forward to hearing from you.

myForesight® team