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National Environment Agency

Manpower Study of the Environmental Services Industry

Industry Transformation Efforts Report (Waste Management Sector)

December 2021

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Executive Summary

The National Environment Agency (“NEA”) and Workforce Singapore (“WSG”) has commissioned KPMG Services Pte Ltd (“KPMG Singapore”) to conduct an Environmental Services Industry Manpower Study (“Study”). The Cleaning and Waste Management sectors have been integrated within the Environmental Services Industry Transformation Map (ES ITM) to transform the Industry. The Study will address the manpower challenges of the Industry, evaluate the success of ES ITM initiatives, and propose recommendations for key areas of workforce transformation. The Industry Transformation Report forms the second of seven reports in this Study; it provides an assessment of the impact of Industry Transformation on the workforce.

Current State of Industry

The Waste Management Industry is critical to safeguarding public health and is categorised into three broad categories – collection, material recovery, and treatment and disposal." NEA is responsible for planning, developing, and administering Singapore's solid waste and hazardous waste management services.

1. Introduction

1.1 Study Overview

The National Environment Agency ("NEA") and Workforce Singapore ("WSG") have commissioned KPMG Services Pte Ltd ("KPMG Singapore") to conduct an Environmental Services Industry Manpower Study ("Study"). This report explores the impact of transformation efforts across all job roles, challenges faced at the organisation-level as well as by the employees, and analysis of potential challenges and opportunities at the desired transformation. The Impact of Industry Transformation report forms the second of seven reports in this Study.

The scope of the Study involves the gathering and analysis of information about the Industry. This includes its current state, impact of ES ITM initiatives, skills and training needs, career and wage progression pathways, future manpower demand and supply projections, and the recommendations to support the overall manpower development plans for the Environmental Services Industry from 2020 to 2035.

The Industry Transformation report presents a preliminary summary of the impact of transformation efforts across all job roles from 2017-2021. The information contained in this report is a consolidation of data and observations gathered from the data validation survey, stakeholder interviews, focus group discussions and desktop research.

2. Overview of the Waste Management Industry

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2.1 Overview of the Waste Management Sector

2.1.1 What it is

As global population increases together with urbanisation and affluence, Waste has inevitably been a growing concern for countries and must be addressed through careful multidisciplinary approach involving technology providers, service providers, government, and waste generators. When unmanaged appropriately, it poses a threat to both public health and the environment. The term 'Waste Management' is used to describe various activities and actions taken to manage and dispose waste to build sustainable and liveable cities.

At present, Environmental Services ITM rely heavily on 12 strategies across four pillars which are **Technology & Innovation, Jobs & Skills, Productivity, and Internationalisation.** As Singapore's population continues to grow, demand for waste management services will increase. In meeting this increasing demand, the waste management sector is facing significant manpower challenges; particularly in attracting and retaining local workers to a sector that is viewed unfavourably in the social domain. The ES Industry Transformation Map (ITM) focusses on four main areas of technology and innovation, jobs and skills, productivity and standards, and internationlisation. In the later sections, more in-depth explanations of the ES ITM will be provided.

The purpose of this paper is to provide an analysis on how Waste Management Sector's transformation efforts, through these years, have an impact on the current job roles and the potential emerging job roles that can co-exist with new technology. Challenges faced by employees and at the organisation-level will also be identified. In addition, strategies to maximise employment of older workers will be discussed in this paper in relation to Singapore's aging population.

2.1.2 Analysis of Key Transformation Efforts

The launch of the **Environmental Services Industry Transformation Map (ES ITM)** on December 2017, unveiled the strategies and initiatives to ensure a professional ecosystem with sustainable infrastructure of services and solutions will help achieve our Zero Waste vision and a clean and liveable Singapore. Partnering with various Government agencies, industry, unions and other stakeholders, NEA worked to establish 33 initiatives across 12 strategies to transform the ES Industry. Some strategies involved are firstly, growing capabilities and spurring innovations to promote Technology & Innovation. Secondly, ensuring sustainable manpower supply to achieve enhancements in Jobs & Skills. Thirdly, drive Productivity through strengthening procurement practices and establishing benchmarking indicators. Finally, promote internationalisation by enhancing global market access and build scale to offer integrated solutions.

ES ITM is broadly grouped into four categories as reflected in Figure 2:

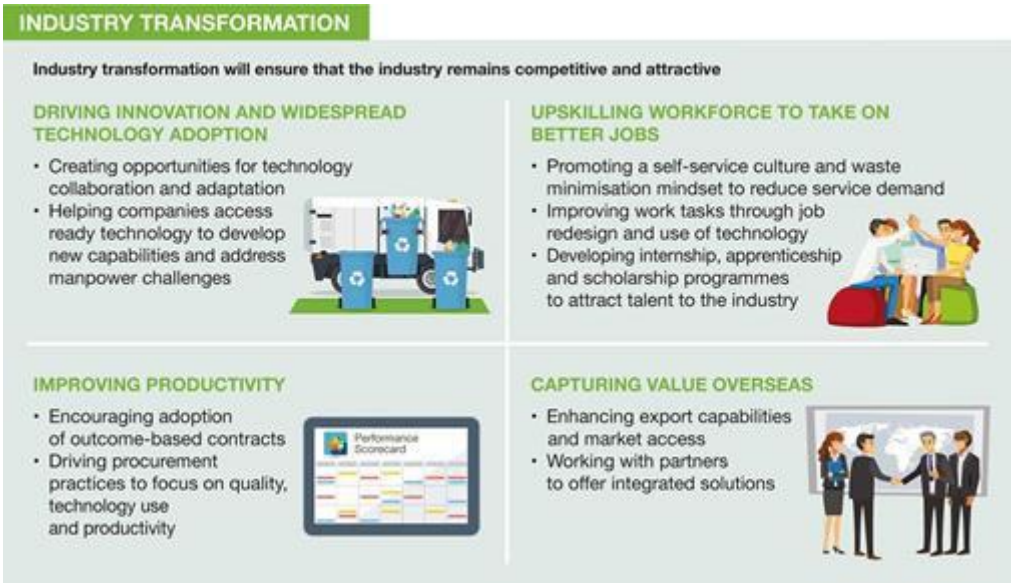

Figure 1: ES Industry Map Transformation

With these initiatives put in place, we can expect by 2035, about 30,000 people from the sector to benefit from higher-value jobs through technology adoption and skills upgrading. In the following paragraphs, we have highlighted some areas which have had great traction in the sector.

Figure 2: Side loader with a robotic lifting arm attached to the side of the truck

In the area of Job and Skills, changes in job roles have emerging. The role of a Waste and Recyclables Collection Trunk Driver has become more manpower-lean through the introduction of a Side loader which is an idea supported by the Singapore Economic Development Board (EDB)[1]. Collection around blocks can now be completed by a single truck driver from the comfort of his trunk cabin as compared to a two- men collection crew running from one recycling bin to the next previously. This has effectively helped waste management firms like 800 Super Waste Management to improve the working conditions of its staff by being less labour intensive throughout Singapore.

Similarly, to boost the Productivity of Jewel Changi Airport, robots were developed by Lionsbot International to help with waste collection. These robots help transport waste carts around Jewel Changi Airport, allowing Waste and Recyclables Collection Attendants to complete other more crucial tasks.

In Technology and Innovation, NEA launched the **Productivity Solutions Grant (PSG)** to raise the operational efficiency and productivity of the ES Industry through technology adoption. Due to COVID-19, the grant cap was increased from $250,000 to $350,000 and funding support has increased from up to 50 per cent to up to 80 percent.

[1]https://www.towardszerowaste.gov.sg/zero-waste-masterplan/chapter5/

NEA introduced **Regulatory Sandbox Projects** to encourage innovation in Singapore's Environmental Services Industry through the creation of an environment where it is conducive to trial and experiment. This allows the regulator to assess the impact of new solutions before implementing them on the premises. commercial properties. The Singapore Power Group Partnered with Gardens by the Bay (GBB) and Mursun Pte. Ltd. to pilot a Micro Auto Gasification System (MAGS) for onsite waste to energy treatment.

The **INCUBATE** programme was launched by NEA in partnership with progressive premise owners in 2017 to provide 18 partners the opportunity to create technologies for the ES industry, conduct trials and implement these technologies in INCUBATE partners' premises. The main recipients benefiting from these programmes are the big players such as Sembcorp, 800 Super Waste Management, Alba and Keppel, Wah & Hua and Tay Paper.

Beyond ES ITM initiatives, NEA has also been constructing infrastructure and collaborating with organisations to transform the sector. NEA is developing the Integrated Waste Management Facility (IWMF) to help Singapore meet its future waste management needs. IWMF will be a state-of-the-art flagship facility where innovative solutions are developed to convert waste to clean energy and for resource recovery. This will be Singapore's first integrated facility to treat incinerable waste. In addition, IWMF's automated Recovery Facility will consolidate all recyclables to achieve greater economies of scale and realise its vision towards zero waste. These efforts are part of Singapore's Zero Waste Masterplan to be a sustainable economy with an emphasis on embracing the circular economy paradigm.

Pneumatic waste management system was introduced as part of the HDB Greenprint, the Pneumatic Waste Conveyance System (PWCS) was developed to ease the operations and improve efficiency of waste collection. Through a vacuum-type underground pipe network, the automated waste collection system collects the household waste. This is then transported through underground pipes to a sealed container, which is periodically collected by trucks for disposal. Therefore, the waste is not exposed throughout the transfer process, reducing odour and pest problems. PWCS will offer a cleaner and more liveable environment with increased productivity.

Instead of placing separate bin centres at each location, the district can share a central bin centre, which can be located away from residents' homes. By implementing district- level PWCS (DPWCS), this can be achieved and additionally, refuse truck traffic within the district will be reduced. A high-level representation of the DPWCS in new estates.

In recent years, Service Providers see the importance of incorporating new innovations into their businesses. In the case of STREAM, a key industry player in the Waste Management sector, they have pioneered new developments in pneumatic solid waste transport technology over the years. Full Vacuum System was one of the developments by STREAM which routes waste from chutes to Central Waste Handling Facilities (CWHF) while filtering out fine particles and odour before the waste is released into the environment. Automated Waste Collection System also help dispose waste via chutes and loading stations and transports it via underground pipes. Envipure, which specialises in odour abatement and waste-water treatment is another example who uses advanced activated sludge treatment technology to reduce carbon footprint and increase energy efficient.

Outreach is important to encourage adoption and change behaviours. Sembcorp, which is an energy and urban development company involved in numerous sustainable initiatives has been an active advocate and has organized events to raise awareness and interest among students on recycling. Their Recycling-Made-Easy mobile application offers a range of features including educational elements and doorstep collection services. To spur participation, users will be rewarded with every successful collection of recyclables. Sembcorp also partnered with Energy Market Authority (EMA) In 2018 to organise Energy Challenge where ~180 students from ITEs, Polytechnics and universities participated in it.

These key transformation efforts contributed by government agencies and organisations will yield long term results and enable the sector to strive, improve its image and efficiently use its resources. Scale remains the biggest challenge for this sector as the number of small providers which have a headcount of 50 and below make up 98% of the entire sector. Capability building initiatives are described in section 5.1.2 on Career Progression and Internationalisation in section 7.1.4.

2.1.3 Analysis of Other Government Transformation Initiatives

Section 2.1.2 describes the programmes under the 4 pillars of ES ITM which includes Technology & Innovation, Jobs & Skills, Productivity, and Internationalism. This section describes other initiatives which have contributed significantly to the sector and work in tandem to support Singapore in achieving its sustainability goals.

The **Extended Producer Responsibility (EPR) system** is a policy approach where under which producers have been given significant responsibility for the treatment or disposal of post- consumer products. One of the aims when introducing EPR is to give producers an incentive to change product design in environmentally safe methods.

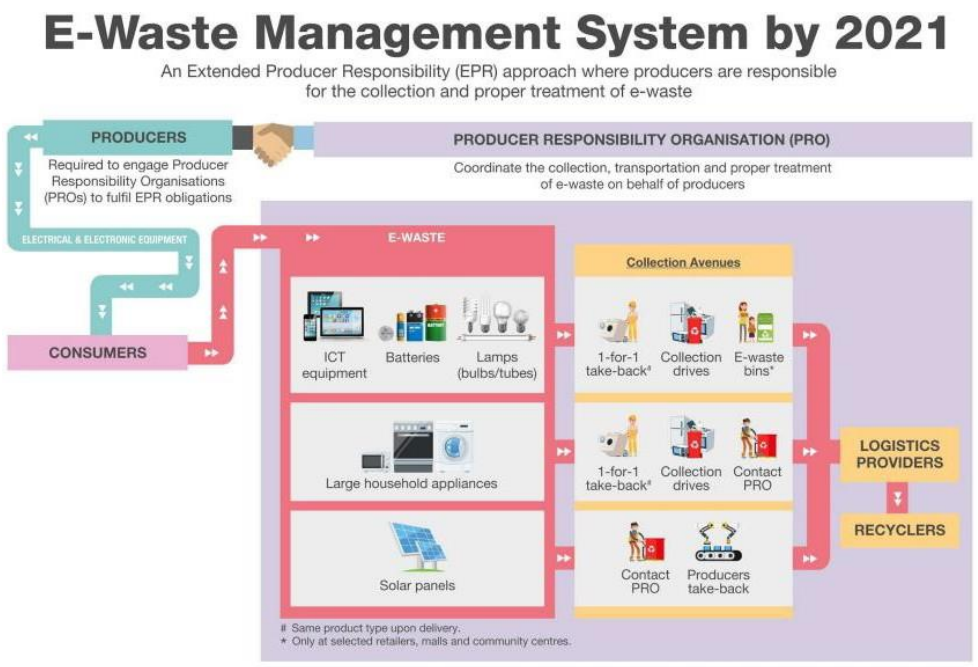

Figure 3: NEA Diagram on EPR

At present, Singapore recognises the relevance of EPR but has only applied this approach in a limited manner. For instance, Singapore has an existing energy label scheme, but it only shows the consumption of energy which is displayed on air-conditioners, fridges, and televisions. Ways to close the loopholes to advance with time can be through setting a legislation where end- users are not allowed to dispose their e-waste in general waste streams due to its toxicity Licensed e-waste recycler or a PRS operator should be engaged instead to ensure proper collection and handling of e-waste. In comparison, EU member countries have divided e-waste into various categories such as batteries, hazardous waste, and tyres. It would be insightful to match the relevant schemes in each category into Singapore's product classes context to maximises its usefulness.

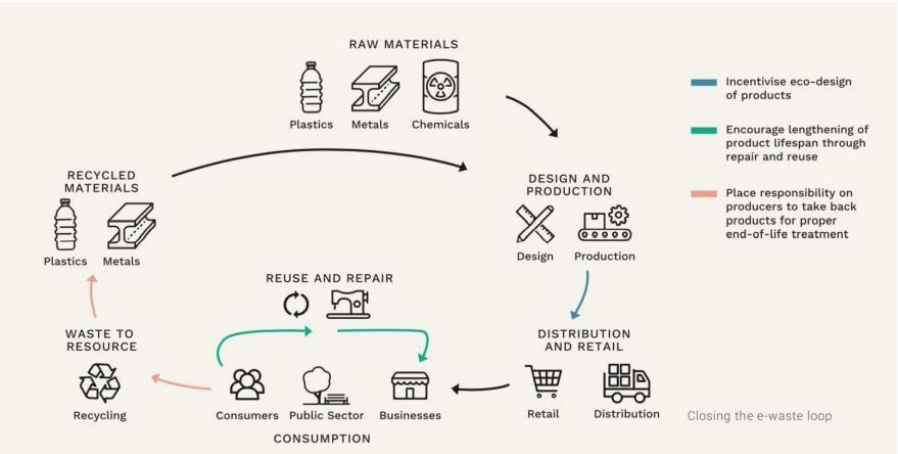

Figure 4: Closing the waste loop

To implement an effective EPR framework that is appropriate in Singapore context, it would be prudent to learn from EU best practices. Learning from EU's successes and failures would essentially reduce the risks of implementing the EPR scheme in Singapore. This is also relevant in the context of Singapore's shift to the Circular Economy approach.

Resource Sustainability Act (RSA) as of July 2020, requires companies to mandatorily report on their packing consumption where annual data must be reported on the amount of packaging they consumed. However, as with Eco-labels, the constricting nature of these schemes may result in an undesirable efficiency impact. The largely manual approach currently in use to comply with the new requirements requires technology innovation to capture real-time data at collection.

Another scheme, known as the **Deposit Refund Scheme (DRS),** which is targeted to roll out in 2022 in multiple phases by NEA, is intended to encourage recycling of packaging such as plastic bottles and aluminum cans. This scheme is not exactly new to everyone. Back in 2019, Singapore launched the **'Recycle n Save' programme** where 50 vending machines were deployed in various supermarkets island wide as a pilot programme.

However, the participation rates have gradually fallen despite initial enthusiasm. In order to see higher pick up rates in the upcoming DRS, Singapore can research further on the governance and administration models that has been used by countries such as Norway, Sweden and Germany. These countries were able to successfully achieve a high recycling rate of 80% of beverage containers[2]. Having a proper framework would therefore lead to improvement in DRS deployment. Likewise, in a latest e-waste collection and recycling programme by 800 Super Waste Management and Alba, locals are encouraged to recycle and are rewarded with points in the STEP-UP application on mobile devices. To make it more accessible for individuals, there are various drop off points around the island and doorstep collection for bulky items inclusive of a small fee.

Throughout EU member countries, a range of schemes have been deployed especially in tackling concerns over usage of plastics bags and batteries such as the **Advanced Disposal Fees (ADF).** Under this scheme, different fees are charged according to the type of materials which producers used in their packaging. For example, fees for plastics and composite packaging materials tend to be pricier as compared to packaging materials like paper, glass and metals. This may be an approach which Singapore can implement in the near future to encourage usage reduction of these materials.

[2] The Challenges of raising Singapore's recycling rate, CNA

The **Green Public Procurement (GPP)** is a term used to describe Green Purchasing. This aims to encourage the sector by providing incentives to develop sustainable technology and products. Since the public sector has a significant share of a country's purchasing power, it influences producers to adopt sustainable practises to gain revenues. In Europe, GPP policies focuses on eco-labelling such as German Blue Angel and The Nordic Swan. These environmental schemes to guide consumers in purchasing goods and services which are environmentally friendly and result in lesser social footprints.

Similarly, in Singapore, we have the Singapore Green Label, Energy Label, Water Efficiency Label and BCA Green Mark Scheme for construction and building products which are successful to a certain extent. The key difference between Singapore and the EU is that in addition to the Eco-labels criteria, EU has many polices put in place to support it. However, in Singapore, the Eco-labels are the main guiding principles behind GPP. This would mean it is not as comprehensive. If the purpose of GPP is to benefit its Circular Economy, defining green procurement will be essential to make clear its objective.

It is worth mentioning that across the EU member states, GPP is not uniformly implemented, usually a more unique and customised framework is required and that would be a learning for Singapore as we would also need to customise our requirements to suit our country requirements. Nevertheless, there is a lot of insights which Singapore can learn from the EU to make better and appropriate decisions.

The **PW Mark** was announced by Prime Minister Lee Hsien Loong at the National Day Rally speech on 29 August 2021. The PW Mark is an accreditation of companies who comply with the Progressive Wage guidelines. The Waste Management sector will benefit from the scheme when it is launched for the sector in 2022 and the value to the workers is the uplift of wages across all operational job levels. The Workfare Income Supplement Scheme which was launched to support almost half a million lower wage workers (Workfare recipients) will be increased as well from S$850 million to S$1.1 billion. The minimum age for one to qualify for the Workfare scheme will also be lowered to 30 instead of 35 to help younger lower wage workers.

3. Impact of ES ITM on Job Roles

3.1 Impact of ES ITM on Job Roles

3.1.1 Impact on Most Prevalent Job Roles
3.1.2 Roles at Risk of Redundancy
3.1.3 Extent of Impact on Job Roles
3.1.4 Demand for Existing Roles
3.1.5 Demand for Emerging Roles
3.1.6 Pace of Change

3.1 Impact of ES ITM on Job Roles

3.1.1 Impact on Most Prevalent Job Roles

The labour-intensive nature of work in Environmental Services (ES) industry suffers from an image problem. The Waste Management sector consisting of 450 companies is often viewed as low-skilled and low-tech. It is often over-looked by young job seekers due to the lack of career prospects.

But this will soon change. The emergence of the circular economy will facilitate opportunities to raise the attractiveness of the ES industry. It will drive the need for a competent and skilled workforce to manage the innovative technology and attract a younger workforce who are inclined towards the sustainability agenda. A brand-new image will evolve, and the manual work associated with waste collection and sorting and treatment will be augmented by technology, making the work environment more amenable.

Sector transformation through innovation is crucial to improving productivity in the waste management sector. This section highlights extensive adoption of technology across the value-chain segments and their associated implications on job roles requirements. As part of Singapore's Zero Waste Nation strategy, efforts such as Pneumatic Waste Conveyance Systems and Single-Chute Based separation system has effectively relieved the heavy reliance the sector currently places on manpower especially for the waste collection sub-sector which has experienced a leaner manpower in its operations. In the years to come, we would expect to see the demand of new emerging roles to replace or work in conjunction with existing roles that are still relevant and essential.

Given that hiring locals for recycling has been a challenge, Wah & Hua shared that they believe equipment and technology will play a role and are planning to replace the manual sorting with technology. To complement the use of technology, they will be recruiting operational staff such as operators and technicians who can handle and operate the equipment efficiently. In addition, there are plans to conduct R&D inhouse and collaborating with a local IT programming vendor to train robots for use on site. Moving forward, intention to hire more young graduates(technicians)who can handle and operate the process and technology more efficiently.

Productivity being one of the focal points in the Environmental Services ITM, requires Singapore to benchmark progress across the years. Upskilling employees with more efficient processes can uplift productivity and reduce reliance on manpower. As an example, with the advent of autonomous refuse trucks to collect and dispose waste, the reduction in manual resources would reflect a huge uplift in productivity. In figure 6, all key areas of the waste management cycle are reliant on manual labour currently so the introduction of the Extended Producer Responsibility (EPR) system, the Resource Sustainability Act and the Deposit Refund Scheme with new technology enablers presents opportunities to optimise labour to bring about significant productivity gains.

Figure 5: Value-chain for Waste Management

3.1.2 Roles at Risk of Redundancy

Occupations within an Industry can be categorised according to the level of competency required and importance to the business. Based on these criteria, the following categories may be observed:

Critical: Jobs requiring a high competency in specialised technology and skills that are critical to long-term business success (high competency level and essential to the business)

Core: Jobs which require a lower competency in technology and skills but are important to the delivery of products and services (low competency level and essential to the business)

Functional experts: Jobs which require a specific competency in technology and skills which support business operations (Specific competencies and less essential to the business)

Non-core: Jobs which require minimal competency in technology and skills, and are not focused on strategic direction (low competency requirements and less essential to the business)

Non-Core category comprises of roles which do not possess high competency level in specialised technology. Such roles are often at risk of redundancy since competencies can be easily substituted by automation. The concept of automation has offered an alternative to the traditional approach. Automation calls upon other technology such as AI and machine learning to automate various tasks. For instance, service providers use a software to create invoice without the need of manual writing for every single transaction. This reduces the need for admin support and handles one of the most time-consuming tasks internally. It is also argued that such transformation will reduce human errors which can potentially cause major consequences. Furthermore, Toxic Industrial Waste Collectors (TIWCs) are required to keep track of the TIW collected and disposed of. Over the years, larger TIWCs such as Veolia and Environmental Solution Asia are observed to have adopted IT systems to keep track of their waste across locations without a need to create a manual hardcopy at every location.

In essence, roles that are of less importance to the business and require little to a low level of competency will face the challenge of elimination.

The domain knowledge held by employees in the Critical category such as the Research and Development job level are important to the Sector. Employees at this level possess an advanced understanding of Waste Management and a specialised knowledge of the job scope they are in. Employees at the Management level tend to have worked within the Sector for an extended period. These employees leverage on their experiences to forecast operational requirements (i.e. manpower forecasts) and conduct business development work. The knowledge possessed by Research and Development and technical expertise gained by Management employees is unlikely to be substituted by technology in the next few years and are hence considered key occupation jobs and competencies which are non-substitutable by technology.

Out of the categories identified within the Manpower Study, occupations within the Critical and Core Categories were identified as key occupations due to the importance of these roles for the sustainability of the Waste Management Sector and competency requirements which have a low likelihood of substitution by technology. Within these two criteria, the study considered the value of the work provided and the specialised knowledge possessed by the key occupation job levels which are critical to the sector.

Similar to the situation in France where digital transition is also being experimented in the sector as it parallels Singapore's profile of the sector which is hugely manual and a workforce which is resistant to the use of digitalisation, leading to a very uneven adoption across the SMEs. However, in Singapore, given the slowing growth of the workforce and increased availability of government grants, more Service Providers are committing to the use of digitalisation and adoption of new tools. They are aware that they will be faced with the risk of extermination if they do not transform their business and their workforce.

3.1.3 Demand for Existing Roles

Career levels referenced throughout this paper are defined as follows according to SkillsFuture Singapore (SSG).

As seen below, these are the 3 tracks under Waste Management sector such as Waste Collection, Materials Recovery and Treatment and Disposal. We will analyse the degree of impact on job roles in these categories when key notable trends like AI, Data Analytics and Automation takes place in the near future.

	Waste Collection				Materials Recovery			Treatment and Disposal		
Trends/Job Families	Waste and Recyclables Collection Attendant	Weighbridge Operator	Mechanical Operator/Waste and Recyclables Collection Truck Driver	Operations Director/ General Manager	Waste Recycling Sorter	Waste Recycling Machine Operator	Operations Director/ General Manager	Waste Treatment Worker/ Waste Disposal Worker	Waste Treatment Executive /Waste Disposal Executive	Operations Director/ General Manager
Autonomous Vehicles	▶	▶	▼	▶	▲	▼	▶	▲	▶	▶
Wireless Sensor	▼	▼	▲	▶	▼	▲	▶	▼	▲	▶
RFID	▲	▶	▲	▶	▲	▶	▶	▲	▲	▶
Artificial Intelligence (AI)	▼	▲	▼	▲	▼	▲	▶	▼	▲	▶
Big Data and Data Analytics	▶	▲	▲	▲	▶	▲	▲	▶	▲	▲
Outsourcing	▼	▼	▼	▲	▼	▼	▲	▼	▼	▲
Sustainability	▶	▲	▼	▲	▶	▲	▲	▶	▲	▲

Figure 6: Demand for Existing Roles

▼ Skill redundancy or threat of job loss ▲ Opportunity for skill adjacency, wage progression or increase in mobility demand ▶ Nominal or minimal impact

The **Mechanical Operator/Waste and Recyclables Collection Truck Driver** carries out operational duties using mechanical motorised vehicles in accordance with the assigned schedules. He/she pulls and manage heavy equipment and objects, estimates the weight load to ensure compliance with load limitations, sweeps roads and roadsides while operating a mechanical and motorised vehicle. With the introduction to Automated Vehicles, such roles may be at risk of redundancy since the number of truck drivers required will be significantly reduced. Additionally, with sensor-equipped bins, demand for existing roles such as **Waste Collection Attendant** would fall with reduced collection trips.

For the **Waste Treatment Executive**, there is an opportunity for skills expansion when new emerging areas such as Wireless Sensor and RFID, AI and Data Analytics are adopted. This will improve efficiency of resources and uplift the skills of **Drivers** in the use of these technologies in their daily routine. There is an opportunity for skill adjacency here as well as the type and profile of skilled resources with advanced knowledge of technology may come from outside the sector and augment the growth in the sector.

As for **Operations Director/General Manager** role, their primary job scope includes deciding the overall direction of the organisation within the guidelines set up by the board of directors or a similar governing body. Since this role requires deep understanding of processes, he/she will face nominal or little impact when new technologies emerge. They will continue to strategise and direct operational activities in the light of new trends such as sustainability. With detailed data now available in real-time, the incumbent will be able to analyse trends and develop action plans to address gaps and shortfalls.

In developing the new skills, the skill framework for Environmental Services should be taken reviewed. Technical Skills & Competencies (TSC) measured through proficiency levels (level 1 to level 6)[3] in the areas of Hazardous Material Management, Waste Collection Management, Waste Disposal Management, Waste Material Loading and Unloading Administration, Waste Sorting Management etc. should be appropriately augmented.

In a research conducted by OECD, it is estimated that 14% of jobs are at high risk of automation[4]. Despite this, in 2012-2019, employment grew in all OECD countries. This proves that at a higher risk of automation does not necessarily mean association with lower employment growth. Despite the increase in productivity, automation promotes employment growth. However, the degree of automation does impact the level of employment growth. For instance, occupations at higher risk of automation (6%) are seen to face a lower level of employment growth as compared to in occupations at low risk (18%). Lower skill workers are concentrated in high- risk occupations since 2012 and the low growth has not led to a drop in the employment rate for this group of workers.

Globally, there is much evidence of redesigned and emerging roles in the sector. In the City of Rotterdam, a total of 150 wireless sensors was installed in collection bins around the City to monitor the fill levels. The trial has been a huge success and the number of collection days has been reduced by 20% with an optimum fill level of 70%. A European Commission study has also proven that smart waste collection can reduce collection costs by up to 40% with its decrease in fuel consumption and air pollution. The success of the use of such technology is the training of the workforce. Existing Truck Drivers need to have the skills to read the sensors installed in the bins and navigate the applications to provide real-time support for clearance and other tasks. This dynamic routing allows drivers to efficiently plan their routes to save time.

[3] Overview of Technical Skills & Competencies (TSC), SkillsFuture Singapore
[4] Future of work, OECD

Figure 7: Wireless Sensors in collection containers

In Singapore, some game changing pilots have been trailed with good results. 800 Super Waste Management introduced a Side Loader to carry out collection around blocks with a single truck driver. This reduces the headcount by one third as it no longer requires a two-men collection crew running from one recycling bin to the next. The truck driver can undertake the refuse collection whilst stationed in his truck. This further improves the working conditions of its staff as the unsanitary odour of working in such environments is much reduced. At SembWaste, a Smart Waste Collection System (SWCS) was introduced. This system leverages sensor technology to detect the capacity of waste in compactor bins and uses this information to allow truck drivers to plan vehicle routing to optimise resources. This improves productivity.

Going forward, automation will likely be accelerated with a consequent reduction on the reliance on manual labour which will affect the demand of existing roles that undertake manual work. Change must be embraced for this segment of the workforce where reskilling and upskilling protects jobs at risk.

3.1.4 Demand for Emerging Roles

Technology is constantly improving and introduction to new job roles naturally occur but emerge gradually. To efficiently allocate resources such as training and innovation, we can categorise the roles under Short term and Long term to determine which job roles should be invested first.

In the short term, perhaps in the next 2-5 years, roles such as **Waste Remote Monitoring Executive, Smart Waste Collection Administrator and RFID/Sensor Technician** may be in greater demand due to emerging technology.

In the case of **Waste Collector Truck Driver**, which is at risk of redundancy, a Smart Waste Collection Administrator role can be created to operate Claw Controllers to pick up discards. This Administrator will operate his tasks within his truck rather than undertake the manual collection and transfer which is a time-consuming activity. The use of sensor-equipped bins will enable dynamic routing and increase the efficiency of route collection. Such technology will improve the working environment and will uplift the skills of the workforce.

For the **RFID/Sensor Technician** role, the use of QR codes and barcodes will enable the workers to view the percentage level of waste in each bin within the comfort of their trucks or control room. When the amount of waste has reached a certain level, for example filled to an 80% level, **Waste Remote Monitoring Executives** can send out the **Smart Waste Collector Administrator** to the location where waste is required to be cleared. Such an approach would greatly increase productivity level of workers and allow the administrators to have the responsibility to plan their routes as they maneuver around the island.

Piloting of programs can be done in non-mature estates to observe its outcome and performance. For instance, the new developing Tengah estate will be a good starting point as it focuses on being future-ready with all its eco-green initiatives. If successful, further discussion can take place to develop the pilots further. To evolve claw control system, we can automate the process to encourage separation of waste into its different categories such as recyclables and non-recyclables.

When we look beyond (long term), roles such as **Sustainability Specialist, AI Recycling Sorting Operator and Biofuel Production Specialist** will not necessarily be required now since such technology are more sophisticated and require a longer duration (~10years) to be matured. For instance, having a side loader as mentioned earlier is a recent upgrade. Entire change towards automation will not be possible overnight but must be introduced in phases.

The pace of change is expected to be rapid due to trends taking place concurrently. In the ES industry, there is an increase in consumer demand and expectations as Singaporeans have high standards towards public hygiene. With a better educated workforce, searching for a pipeline of workers in this sector is a challenge and there is also the intense competition with other industries for manpower. If job roles are not redesigned, it will be difficult to attract new entrants due to its nature of work.

Emerging job roles with interesting job descriptions together with unique role titles could potentially captivate local workers. With the increasing concerns of COVID-19 and the higher standards expected for hygiene and sanitation, specialisation and better compensation will be the levers for employment in this sector. Improved employment legislation and policies will spur interest from locals and accompanied by grants for new technology adoption, transformation would be accelerated.

4.1 Organisation-Wide Challenges in Implementing Workforce Transformation

4.1.1 HR Practices
4.1.2 Technology Adoption and Digitalisation
4.1.3 Legislation and Policies
4.1.4 Infrastructure
4.1.5 Service Contracts

4.1 Organisation-Wide Challenges in Implementing Workforce Transformation

4.1.1 : HR Practices

At an organisation-level, implementing workforce transformation can be complex due to challenges such as attracting talents, changing perception towards re-trainings and job re-design. With Singapore's limited pool of local and highly trained staff, many of whom prefer to work with MNCs rather than in these industries.

Attracting new entrants & mid-career switches

Enterprise Singapore's Local Enterprise and Association Development (LEAD) programme supports WMRAS and EMAS in initiatives that build up their core capabilities to better support sector transformation in their subsectors. To create pipelines to draw new talents into the sector, internship opportunities are created for students to provide them the platform and opportunity to kick-start their career in this sector.

In November 2020, Hong Kah North Grassroots Organisation partnered with the Waste Management and Recycling Association of Singapore (WMRAS) to hold a job fair as part of its Go Green Movement. The job fair aims to promote careers in the environmental services sector for those who may have been impacted by the economic downturn due to COVID-19. The fair offered more than 350 job vacancies in estimated 20 organisations.

Apart from attracting new entrants, the Professional Conversion Programme (PCP) was launched on 1 November 2020. WMRAS was appointed as Programme Manager by WSG, to equip mid-career jobseekers with skills to take up roles within the Waste Management sector. Some examples include HR management, leadership, project management and operations etc. The PCP consists of facilitated training and structured on-the-job training provided by participating employers over a period of up to 3 months.

Feedback from qualitative interviews and the Visioning Workshop indicate that salaries are crucial to improving the attractiveness of the Sector to local talent. Similarly, results from the survey indicate that poor pay and benefits were believed to be the top reason behind job seekers' negative perception of the Sector. However, faced with pricing pressure, rising operating costs and resultantly thinning profit margins, Service Providers struggle to leverage this crucial component of the Employee Value Proposition to build a stronger pipeline of manpower.

Muhamad Nasri Bin Sahari, a 32 y/o Malaysian, joined 800 Super Waste Management company a truck driver. With a diploma in Emergency Response, he worked in the Singapore Civil Defence unit previously and saw a 10%-15% increase in salary when he decided to move over due to family commitments. Money was a key consideration for him

and although some of his family members were not too supportive given the type of sector he was moving into; he was not perturbed and saw the potential and stability which would benefit him.

During an interview session with Sembwaste, it was also noted that some of the blue-collar workers in other countries are paid as much as a white-collar worker because they contribute to the society the same way as others. For example, a plumber in Scandinavia earns more than an accountant. Moving forward, a deeper discussion on the philosophy of pay for such essential workers is fundamental to adjustments in pay and benefits to make it more attractive to entice locals into this sector.

Workers' attitudes to skills upgrading

Motivating individuals to undergo new skills trainings are often seen as a challenge as mindsets are difficult to change but it is necessary to achieve a more capable workforce. Thus, with appropriate guidance, incentives and relevant information, workers can make well informed decisions for themselves.

One way would be using real life examples of success stories of how automation has changed and benefited the way one works. Rewarding workers could be another way by allowing them to take time off to attend trainings. This workforce displaying a disinterest may also be due to a lack of awareness of what is available, a lack of support from their employers or the strongly held perception that operators are not required to hold any form of waste management qualifications. Job roles are changing due to environmental pressures and government policy, with the likelihood that demands for new skills will evolve for employees in areas such as recycling and waste-to-energy initiatives. Nevertheless, organisations need to recognise and be mindful that promoting these approaches will take time to see its positive effects.

Job Re-design

This is an attempt to re-evaluate job responsibilities and work environments to improve workers' performance and safety by simplifying processes through new technological solutions. Therefore, redesigning of jobs will lead to greater productivity and job satisfaction level.

According to the types of job re-designing as shown below, reassigning of roles and responsibilities should begin first by determining which job scope needs to be further expanded, modified, or removed. Apart from reviewing job tasks, it is also necessary to take into consideration the needs of workers with disabilities to better cater to their needs and empower them to perform their roles optimally.

Work processes are required to change to effectively redesign the job. Process redesign may be in the form of introducing new technological systems, reallocation of resources and/or challenging existing norms in the service provider to identify areas for improvement.

Another area could be making changes in work arrangements. For instance, to encourage older workers in the workforce, implementing flexible working arrangements like staggered hours can be carried out. In addition, displaying a flowchart of the tasks required to be completed or through colour coding can effectively benefit employees especially older workers in remembering the steps; subsequently perform impeccably.

Figure 8: Types of Job Redesign

The 4D Job Redesign Framework designed by Workforce Singapore (WSG) helps to guide cleaning companies which are embarking on a journey to redesign jobs through four simple steps namely Discover, Diagnose, Design and Deliver.

Waste Management Providers will first need to **Discover** by identify problem areas across key aspects such as people, process, environment, and technology to come out with an effective job redesign solution. Once this step is completed, we can move on to the **Diagnose** stage by defining problem statements or the areas of inefficiencies. This includes determining the root cause of the issue as well as the key objective. **Design** step would mean adopting pre-fitted solutions or relevant job redesign techniques. Companies can use these pre-fitted solutions alongside with process redesign and technology. For instance, for Multi-Skilled Cleaners, as part of job redesigning, some area of work will be enriched. They will be required to learn how to operate appropriate ride-on machinery and/or equipment with supplies as directed. At the final step of **Deliver**, implementation of job redesign initiative will take place together with evaluation of outcome. A human capital transformation plan will be developed, and outcome measurements can be done so through productivity indicators.

In addition, complementing with the 4D framework, Job redesign techniques can be utilized through Enlargement, Enrichment, Reconfiguration and Job Simplification respectively[5].

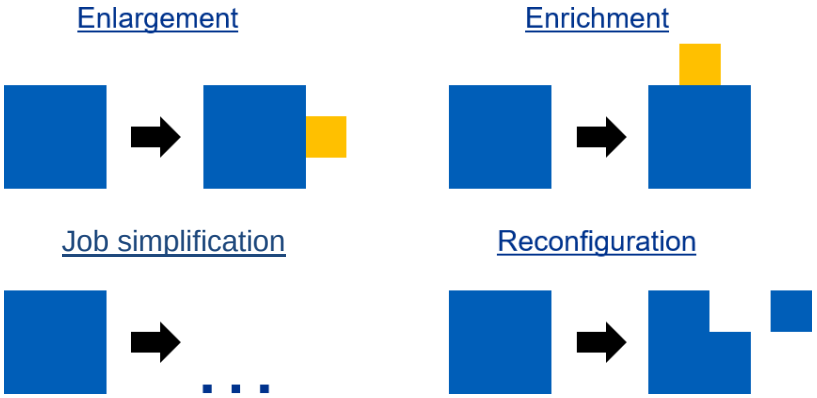

Figure 9: Job Redesign Techniques

Enlargement involves retaining the original scope of a job amidst of introducing a new set of tasks for the same job grade. This can be used to fill any gaps left behind by an eliminated job to reduce down-time or to accommodate changes in technology and skills requirements through amalgamating existing tasks into current roles or creating new tasks. Hence, increase value-added work, task variety, employee engagement and job satisfaction.

Enrichment, unlike Enlargement involves retaining the original job scope but introduces a value-added component that comes from a higher job level. With this additional value-added component, it will require increased responsibility and accountability; and provides new opportunities for building skillsets and enable effective succession planning.

Reshuffling of tasks to achieve a different set of objectives can be done so with **Reconfiguration**. Identification of gaps in terms of efficiency and effectiveness of a job need to be evaluated together with a full review of existing scope of a job; to integrate recommended solutions to close these gaps. Thus, such valued added work will bring about increase task focus and variety.

Lastly, **Job Simplification** takes place where identified tasks and/or jobs are deemed as redundant. Streamlining roles of personnel will help to minimise redundancies and unnecessary duplication of task to reduce work fatigue and job monotony.

WSG'S Career Conversion Programme supports job re-design by providing opportunities for individuals to upskill while enterprises embark on their business transformation journeys. This 3-month programme comprises of a structured OJT and facilitated training in:

- Robotics & Automation
- Incident & Accident Investigation

[5] Job Redesign Methods, Workforce Singapore

- Customer Management (Supervise Service Operations)
- Apply Emotional Competence to Manage Self and Team at the Workplace

Under the Productivity Solutions Grant (PSG-JR), companies can implement JR initiatives with support from pre-approved JR Consultants. Through this transformation, quality of jobs can be enhanced by making jobs more productive and attractive for locals and lastly, drive business growth further.

The Waste Management Career Conversion Programme aims to equip mid-career PMET jobseekers with the necessary competencies to take on roles such as HR, Marketing, Project Management, Operations within the industry.

Therefore, with these concise and easy-to-digest framework and techniques coupled with programme, it will address service providers' concern of sourcing for guidance when it comes to redesigning jobs to transform the workforce in becoming more efficient and productive.

4.1.2 : Technology Adoption and Digitalisation

It is important for the Waste Management Sector in Singapore to have an increased focus on the adoption of relevant technology. The use of technology is a key enabler in alleviating the manpower challenges faced in the Waste Management Sector by transforming businesses processes, standardising waste management performance, and enhancing the overall image of the Waste Management Sector. Through the provision of grants and incentives, the government is encouraging the adoption of new technology and digitalisation. These grants and incentives make it less onerous on the Service Provider as opportunities to pilot then scale becomes more attractive for the organisation

The Infocomm Media Development Authority (IMDA) in partnership with NEA developed the **Environmental Services Industry Digital Plan (IDP)** for the Waste Management and Cleaning Management sectors within the Environmental Services Industry. The intent of the plan was to guide SMEs in this sector on their digital transformation effort.

SMEs can use IDP to assess their digital readiness and identify key skill gaps to support their digitalisation. Under this plan, Digital Roadmap (Training) developed by SSG, Ngee Ann Polytechnic and the Institute for Technical Education provides the sector workforce with the necessary skills to adopt digital solutions and be ready for changes that comes along with this transformation. IDP will also be regularly updated whenever new technologies are introduced to ensure its relevance as the sector progresses.

Figure 10: Key Components of the Environmental Services IDP

As seen above, the Digital Roadmap provides a reference on solutions relevant for SMEs in Environment Services industry across 3 stages:

- Stage 1: Getting Digital Economy Ready *(Digital Operations, Optimised Resources)*
- Stage 2: Growing in the Digital Economy (Integrated Sensing, Dynamic Response)
- Stage 3: Leaping Ahead *(Autonomous Operations, Intelligent Business)*

Following through the steps (Step 1 to Step 4), SMEs can reap the full benefits of going digital by engaging the digital project management services (Step 5) to support their implementation solutions. Through business process re-engineering and job redesign, SMEs will therefore yield a more sustainable digitalisation outcome.

The above steps also guide businesses to decide on the suitable training programmes that their employees will be taking to upgrade their digital skills. This training is also aligned to the digital skills and competencies of the Skills Framework for Environmental Services. Please see section 5.1.3 on the use of the IDP for acquisition of knowledge and skills.

Under the ES ITM Initiative, NEA launched the **Productivity Solutions Grant (PSG)** to raise the operational efficiency and productivity of the ES Industry through technology adoption. Due to COVID-19, the grant cap was increased from $250,000 to $350,000 and funding support has increased from up to 50 per cent to up to 80 percent.

The **INCUBATE** programme was launched by NEA under the ES ITM initiative in partnership with progressive premises owners in 2017 to provide 18 partners the opportunity to create technologies for the ES industry, conduct trials and implement these technologies in INCUBATE partners' premises. Some solutions created were smart compactors and the use of in-sink grinders. Premise owners involved in this programme include Heartbeat@Bedok, Centre for Healthcare Assistive & Robotics Technology, NTU, NUS, SIT, Ngee Ann Poly, Changi Airport Group and Pan Pacific Hotels Group. Through these innovations, it helps to lessen and removeworkers' pain points. With food waste recycling machines being trial tested, it will potentially close the food waste loop, resulting in cost savings which will divert some of this waste away from our only landfill.

NEA introduced **Regulatory Sandbox Projects** under the ES ITM initiative to encourage innovation in Singapore's Environmental Services Industry through the creation of an environment where it is conducive to trial and experiment. This allows the regulator to assess the impact of new solutions before implementing them on the premises. commercial properties. The Singapore Power Group Partnered with Gardens by the Bay (GBB) and Mursun Pte. Ltd. to pilot a Micro Auto Gasification System (MAGS) for onsite waste to energy treatment. This trial took place between May 2019 and May 2021. This is one of the green solutions to reduce Singapore's garbage output and address landfill space limitations. Waste can be converted into thermal energy to heat water at F&B outlets in GBB; while converting some into solid carbon material used for horticultural R&D purposes.

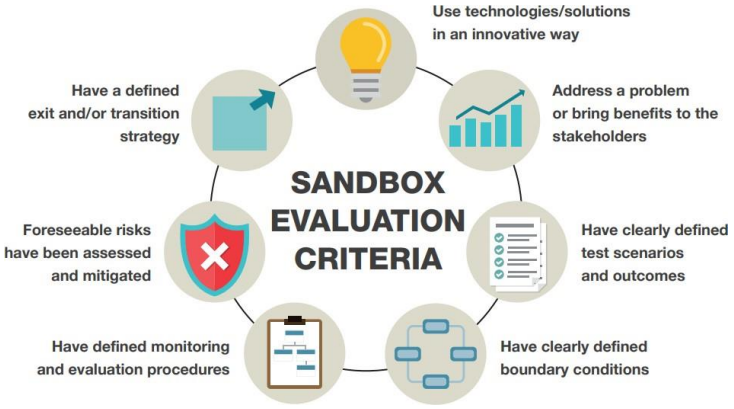

Figure 11: Regulatory Sandbox Infographic

There are several big players who are investing in technology such as Sembcorp, 800 Super Waste Management, Alba and Keppel. Others include Wah & Hua who partnered with Alba and Tay Paper for recycling.

To position Singapore as the technology centre of excellence, the government has put in place various other schemes and grants to encourage locally developed waste management solutions. The Enterprise Development Grant (EDG) is provided by Enterprise Singapore to fund organisation's projects by up to 70% of the cost to encourage them to upgrade their business, innovate or even venture aboard. EDB also incentivises organisations who engage in R&D capabilities and technologies. Finally, a $45 million funding programme known as the Closing The Waste Loop (CTWL) R&D initiative was also set aside by NEA to support R&D activities that looks at improving current key processes in the area of plastics, e- waste and incineration ash.

With businesses integrating sustainability into their business models in ways that benefit both the environment and the economy, it is crucial for the government to collaborate with them as these redesigned business models will create new, good economic opportunities and jobs for the future economy. The biggest challenge for this sector is to onboard the smaller firms which are voluminous in this sector. This group do not invest in technology as their concern is survivability and have funding limitations. Grants and other financial support would help these smaller Service Providers and encourage the adoption of new technologies and stay competitive.

Grants for the lease of some pre-selected technologies is a way to allow Service Providers to quickly adopt and try out and integrate these new technologies into their current processes. One relevant example is SamurAITM, a waste sorting robot which is available through lease on a monthly subscription plan. It was launched by Veolia Group in France with a Canadian recycling equipment manufacturer Machinex. Such robots serve to modernise and automate sorting recyclables out from general waste.

Figure 12: SamurAITM waste sorting robot

4.1.3 : Legislation and Policies

The government has been actively involved in the transformation of the Waste Management Sector. Over the years, the following schemes and legislations have been introduced by the government.

The launch of **Zero Waste Masterplan**[6] in 2019 maps out Singapore's key strategies to build a sustainable, resource-efficient, and climate-resilient nation. As the global community shifts to a low-carbon economy to ensure a sustainable future of production and consumption since resources are being consumed much faster than they are being replenished, Singapore is doing its part by following three key principles. Firstly, to treat economic development, environmental protection, and social inclusion as of equal importance. Secondly, involvement of all stakeholders to achieve the optimal outcome. Lastly, plan and strategize while taking a long-term view. With an integrated approach, we can achieve better synergies and resource efficiencies. These principles will ultimately guide our waste management policies and will continue to do so as we face environmental challenges such as climate change and a growing global waste problem.

To secure a green, liveable and sustainable home for generations of Singaporeans to come, the Republic will step up to drive its sustainability by setting, ambitious and concrete targets under a new initiative called the **Singapore Green Plan 2030**[7] .

Under the **Resource Sustainability Act**[8] as of 2019**,** the owners of large commercial and industrial premises are required to design a separate space and allocate on-site food waste treatment systems in their plans from 2021. Secondly, commercial, and industrial food waste generators are required to segregate their food waste for treatment from 2024.

Under the **Mandatory Packaging Reporting**[9] introduced by NEA, the producers of packaged products, such as brand owners, manufacturers and importers, as well as retailers such as supermarkets, to submit packaging report and 3R plans from 2022. Companies are required to provide information on the types of packaging material (e.g. plastic, paper, metal, glass), packaging form (e.g. carrier bags, bottles) and the corresponding weights.

In 2022, Singapore is planning to legislate the **Deposit Refund Scheme for Beverage Containers**[10]**.** Further, a pilot is being undertaken for the **E-Waste Management System** to promote and ease the process of recycling electrical and electronic waste among the consumers. This will likely be included in legislation in the near term. On 17 August 2021, NEA launched a S$3 billion **multicurrency medium-term note programme**[11] and a green bond framework to finance the development of sustainable waste management infrastructure.

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[6] Zero Waste Masterplan

[7] Straits times- Green Plan 2030

[8] Resource Sustainability Act

[9] Singapore-packaging-agreement

[10] CNA - e-waste management system

[11] Programme to finance sustainable waste

On the workforce aspect, MOM has announced that the **Progressive Wage Model** will be introduced for the Waste Management Sector in 2022 and this will provide a clear pathway for workers to earn higher wages and enjoy career progression as they upgrade and become more productive. The **Dependency Ratio Ceiling (DRC)** for foreign workers in the service industry was reduced from 40% to 35% since January 2021 and this has impacted the pipeline of workers required in the sector.

4.1.4 : Infrastructure

Infrastructure limitation is one of the key challenges faced among Service Providers, hindering the adoption of technology. Service Providers often attributed the low technology adoption to the current infrastructural limitations on accessibility. For example, Service Providers commented on the lack of spacing between landed residential areas for side loader vehicles to access. For instance, instead of demanding one bin for each landed property, having a central bin for each estate area eases the waste collection process and eliminates the issues arising due to infrastructure. In addition, Service Providers stated that rental cost forms substantive part of the business cost. Hence, waiving the cost expenses could possibly encourage more Service Providers especially smaller firms to adopt technology. It was suggested that consultations be undertaken by Building Architects and WMRAS as the representative body to explore how technology can be optimised especially in the construct of new premises.

The Pneumatic Waste Conveyance System (PWCS) provides a solution to tackle these issues. PWCS is an automated waste collection system which uses air suction to move waste from individual buildings through a network of pipes to a central location for collection. This removes the need for manual collection. Since it involves an enclosed system, it reduces odour and pest problems and provides a cleaner and more livable environment.

Figure 13: Illustration of a Pneumatic Waste Conveyance System

To tackle the issue of truck traffic within the district during collection, implementation of district-level PWCS was introduced where district will share a common central bin centre instead of various bin centres at individual development. HDB had already introduced this in new estates such as Tampines North, Punggol North, Bidadari and the upcoming Tengah. With this, it will benefit and serve approximately 4,000 residential DUs.

Through these efforts, the Government aims to mitigate future challenges that the waste collection sector will face due to increasing manpower shortages and an ageing workforce. Singapore's sixth, Waste To Energy (WTE) plant known as the The TuasOne WTE plant was created to raise resource efficiency. It was built to meet part of our waste incineration needs for the next 25 years, the plant will take up on 4.8 ha of land and have the capacity to incinerate 3,600 tonnes of waste per day. This can lead to cost savings for organisation since they will be able to have a greater capacity to focus on other areas that increase efficiency.

Figure 14: Artist's impression of TuasOne Waste-to-Energy plant

The introduction of a strong digital and network infrastructure such as 5G will support further improvements in urban infrastructure. This must be complemented with a set of common operating standards and protocols to ensure interoperability. A strong infrastructural foundation will encourage sector transformation and will place Singapore in a better position to tap into potential new technologies.

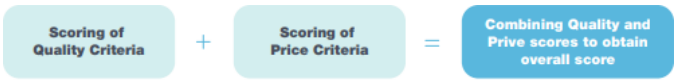
4.1.5 : Service Contracts

For the waste management sector, weightage is used for the collection of refuse as well as type of material for disposal. Price is heavily weighted for selection with limited weightage is assigned for quality and use of technology.

In Singapore, NEA advocates a fairer distribution of Price-Quality (PQ) ratio. Through the Price-Quality method, different weightages are allocated to various quantitative aspects. The evaluation criteria are divided into three components namely Eligibility Critical Criteria, Price criteria and Quality Criteria[12].

To participate in government tenders, Service Providers must meet the **Eligibility/Critical criteria** which is the achievement of two consecutive 'Clean Mark Silver/Gold Awards' by NEA under the 'Enhanced Clean Mark Accreditation Scheme' (EAS). In addition, they must be able to meet a certain financial grading and attend the compulsory site or briefing (if any) to participate in the tender. These criteria ensure that Service Providers have the capabilities to bid and deliver high standards.

A PQ ratio of 40:60 is recommended and can be readjusted according to the Service Buyer's priority on how important the dimension of quality is to the contracts. Thus, a higher-weighted quality component would essentially drive Service Providers to propose better solutions to meet buyer's needs. This is then translated to the overall score for the bid, based on the combined scores from the Quality and Price components.



Service buyers can adopt a point scoring system to assess the Quality Criteria. An example can be found below:

Example of Point Scoring System:

Point	Definition
5	Deployment proposal exceeds the requirement
4	Deployment proposal satisfies the requirement with some additional benefits
3	Deployment proposal satisfies the requirement
2	Deployment proposal satisfies the requirement with minor reservations
1	Deployment proposal satisfies the requirement with major reservations
0	Deployment proposal does not meet the requirement

Figure 15: Price-Quality Method

[12] Guide on tender evaluation for Outcome-based contracting, NEA

5. Employee-Level Challenges in Implementing Workforce Transformation

5.1 Employee-Level Challenges arising from Workforce Transformation

5.1.1 Mindset Shift

5.1.2 Career Progression

5.1.3 Technology Adoption and Digitalisation

5.1 Employee-Level Challenges arising from Workforce Transformation

5.1.1 : Mindset Shift

Mindset shift is crucial to inspire younger generations to join this sector and convince workers that it is not a low-skill sector. Many initiatives have been rolled out to integrate technology to current processes and systems.

Employees may also be resistant to transformation changes. Perhaps in their current tasks allocated to them, they are already accustomed to following a certain standard protocol. For instance, employees are accustomed to following through stages A, B, C in order but with automation and increased reliance on technology, employers may want employees to stop applying the standard protocol and use Stages X,Y,Z instead. Although such improvement in technology may make processes simpler but to employees it might be more complex for them to comprehend and apply.

Furthermore, the motivation behind attending such trainings and course may be lacking. Employees might find it taxing for themselves especially after long hours at work and the reduction of time they could possibly spend on leisure and lifestyle. Furthermore, employees also may not see an importance of having such trainings and question the need for revamping and upskilling themselves when they are already comfortable with how they approach their tasks.

In essence, organisations need to paint the bigger picture to encourage employees to participate. Monetary rewards must commensurate with the knowledge and skills acquired so that the interest level amongst the workforce will increase. A consideration is to use a flexible system of a tiered certification pathway where the acquisition of knowledge and skills across defined levels of proficiency will result in an uplift of wages. Please refer to section 5.1.2 on a more specific elaboration in career progression.

Efforts to award employees in this sector can be used to show how the sector has evolved and increased educational flexibility to provide opportunities to those interested. In 2018, Republic Polytechnic launched a Part-Time Diploma in Applied Science (Environmental Services and Management). This is a Work-Study programme (WSPs) providing opportunities for participants to deepen their skills and knowledge to dive into a career in ES industry. E.g. Hazardous Waste Specialist.

SSG also introduced a study award to encourage early to mid-career Singaporeans to develop and deepen their skills in key sectors to gain relevant working experience in these sectors. Singaporeans can learn robust skillsets to increase competencies. To illustrate, Specialist Diploma in Environment & Water Technology (PAJ) will include learning about how contaminated wastewater is treated and how it is being reused as drinking water. Advance

environment-care such as environmental management system and cutting-edge technology such as the membrane technology in water treatment will be taught as well.

As such, apprenticeship and scholarship programmes like NEA-Industry Scholarship programme serve as a method to attract and retain talent especially at the levels of Associate Professionals and Technicians (APT) and Professional, Managers and Executives (PME).

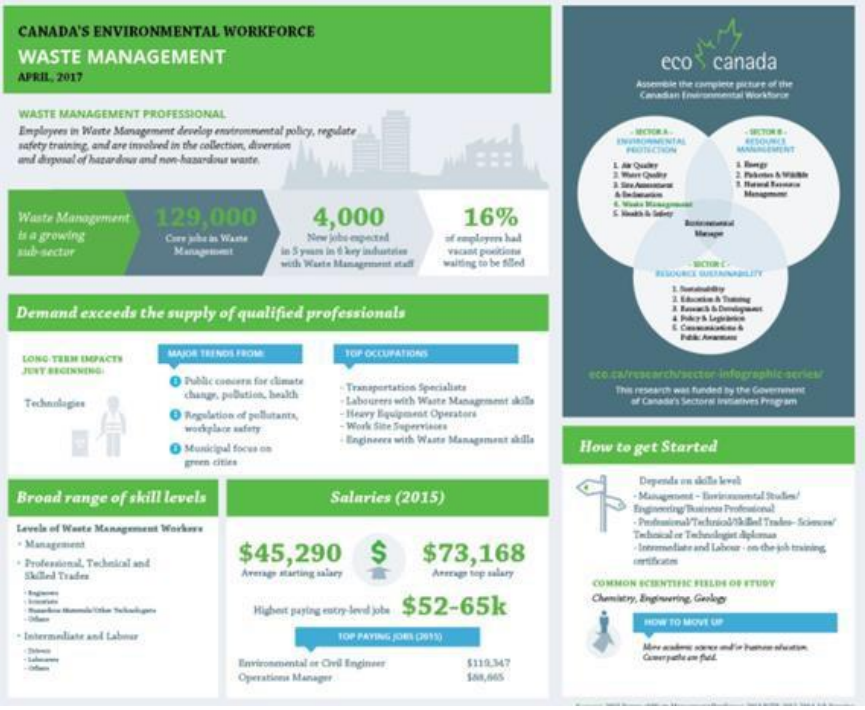


Figure 16: Overview of Canada's Environmental Workforce

Eco-Canada which has a range of new positions currently available however the percentage of unfilled positions is increasing with demand exceeding supply. If we look at trends in our current environment, this phenomenon will be reality in Singapore in the medium term when technology matures so it is important to broaden and widen the skillsets of employees in Waste Management and rebrand new occupation names to shift mindsets.

In promoting the shift in mindset, some companies in the Waste Management sector in Singapore has progressively rebranded itself into a sector requiring highly skilled individuals. At local SME Biomax Green Pte Ltd, advanced biotechnology was leveraged by a dedicated team of professionals to develop innovative solutions that refine and diversify the company's services and offerings. These solutions help to convert organic waste into high-grade organic fertiliser using digesters and enzymes. Besides, the company also employs a qualified team of sales and operations managers to engage and manage projects arising from local and international clients. Such roles may entice local qualified professionals to join the compelling sector.

5.1.2 Career Progression

To progress into the respective roles, skills upgrading is necessary to enhance employee capabilities to prepare them to perform more complex tasks and stay relevant in the workforce. To align these skill developments with career progression, a career progression roadmap must be designed to present possible career options within the sector. These career options should then be clearly articulated and translated to suitable training and wages. To address an employee's challenge of staying relevant in the sector and to be able to apply their learnings, job redesign can be initiated.

Through job redesign, employers can create higher quality jobs to tackle concerns which employees may have in terms of the potential career progression this sector offers. Incorporating more lateral pathways across waste management value chains can provide a sense of career development for the employees. Integrate roles across multiple value chains will further enable workers to deepen their understanding of the Waste Management sector.

Implementation of Tiered Certification Pathway can also help establish career pathways for employees based on the accumulation of skills and experience towards operational management or other specialised roles. Accreditation for Waste Management professionals may be formally established within a tiered accreditation system. These credentials may include proof of technical knowledge and skills, experience pre-requisites and the passing of a certification exam. For instance, a Waste Collection Attendant will be required to take on 4 critical technical skills (e.g. learning to manage tools and equipment and managing incidents) coupled with 7 generic skills (e.g. service orientation, digital literacy, sense making). These are done in conjunction with 21 technical skills before one can move on to the next tier.

Currently, it is mandatory for all General Waste Collectors (GWCs), Toxic Waste Industrial Collectors (TIWC) and General Waste Disposal Facilities (GWDF) to hold a license from NEA in order to collect certain types of waste and dispose them accordingly and all waste collection drivers and crew, and operators must be certified. Requirements to fulfill core and elective modules only apply to employees who are currently in the general waste collectors' business. The courses offered by WMRAS are as follows:

Module 1: Carry Out Waste Collection in Accordance to Assigned Schedule
Module 2: Operate Waste Collection Vehicles to Collect Waste
Module 3: Carry out Collection of Sludge and Greasy Waste

An interesting example is the transformation of the TIWC sector is the project undertaken by Veolia South East Asia[13]. They developed an instrumental programme for Showa Denko HD Singapore, a player in the microelectronics industry which in Singapore produces about 29% of the hard disk media sold globally. The programme developed by Veolia provides a total and holistic water and wastewater management solutions for the microelectronics industry. It reduces energy consumption and provides higher savings with the latest technology.

[13] Showa Denko: Ultra-Pure Water, Reclaim Water and Wastewater Management | Veolia South East Asia

The benefits for the client included reduced energy usage of 600 kWh per day and a saving of 1,064 kWh per day, continuity of operations: operations interruptions have been rectified within 1 to 2 hours with no disruption caused to client's production, heavy emphasis on preventive maintenance work and health & safety and high quality and volume water production with a multi-utility project. This is illustrated in the figure below.

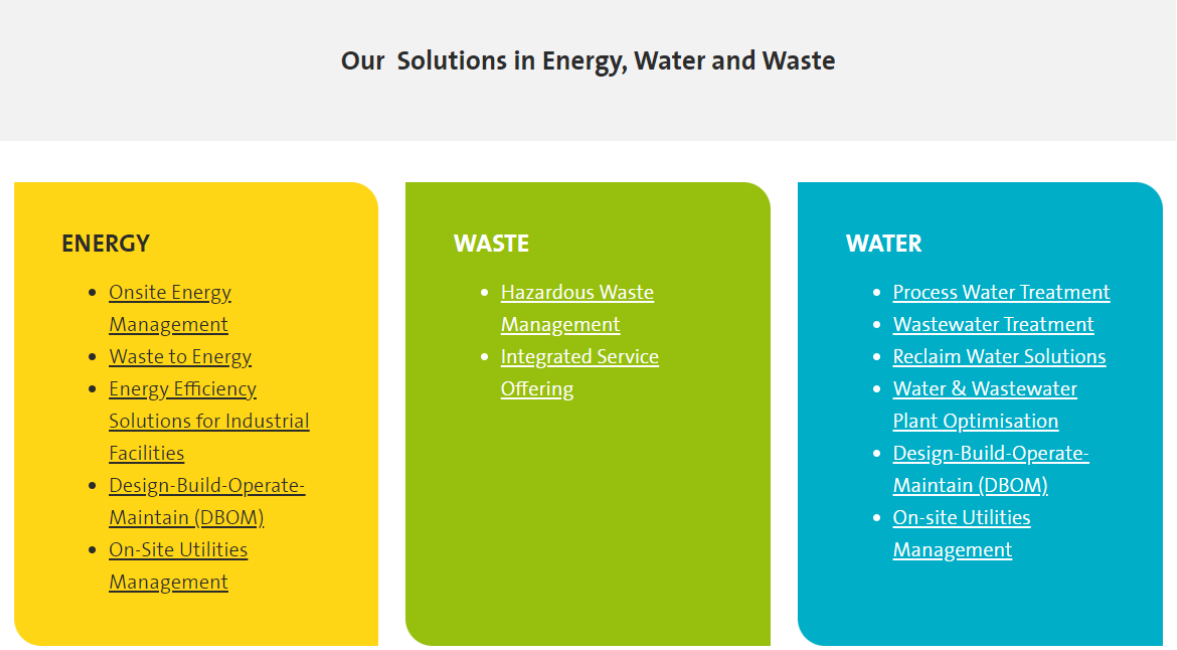


Figure 17: Veolia's Solutions in Technology

The skill sets in Veolia has evolved over the years from Waste Collection which it no longer does (although there are still field workers who are hired to load waste in the plants but these include the foreign workforce) to advanced automation and technology which hires largely local residents for roles such as process, mechanical and chemical engineers for their laboratories. They tend to be younger in their thirties or forties and some over sixties are hired on a contract basis to support the team. All training is all conducted on-the-job at the plants.

Upskilling has been the key driver for the waste management sector so that in the future, career progression pathways will and must tie together with the required skill sets for the next job. This will create greater earning opportunities for the employee. As such, a series of possible career progression opportunities focusing on vertical movements and rotational opportunities across department with horizontal movements by career levels will enable the employees to take up additional skillsets. Performance indicators should also be transparent to empower employees to be responsible for their own individual learning. Therefore, they can stay motivated and look forward to opportunities to further hone their skills.

One example can be seen in the case of Muhammad Sharizam Bin Hairulnizam, a 26-year-old Singaporean, who is a diploma holder in security management before he had joined 800 Super Waste Management. He was the head of security operations in his previous company and shifted to this company as Operations Executive because his father was an employee there and came to know about the opening for Operations Executive. Working in a "less glamourous" industry was not his concern and instead was convinced since it is an essential service and thus,

recently started his master's program in Environmental Safety. Hence, good performance together with a positive attitude to learn, there are opportunities for promotion/further studies.

Apart from this, 800 Super Waste Management provides internal training and courses to guide workers to reach the next level in their career pathway.

It can be tremendously difficult to encourage employees to upskill because of the fear instilled in them due to a lack of confidence to meet the expectation of employers. However, job redesign and offering career progression will the boost confidence of employees in the sector and reduce the concerns an employee might have when the sector progresses into a more digitised environment.

5.1.3 : Technology Adoption

Globally, most of the firms are moving towards automation and technology and Veolia is one amongst them. The introduction of software packages enabled them to report, monitor and track effectively and efficiently. Veolia strongly believes that automation can never be a replacement of human. Hence, it is necessary that efforts are put in place to assist employees to utilize technology to its full potential in a shorter period of time; since one of the major challenges which Waste Management sector faces, is the ability to attract locals due to their lack of confidence in acquiring the requisite knowledge and skills in digitalisation.

Technology Proficiency Level

Dividing employees based on their individual's technology proficiency level will be useful in allowing organisations to develop more personalised training modules to cater to certain group of workers who require more time to pick up new skillsets. Trainings offered should also be based on an employee's job grades. For instance, all operational employees will be required to learn how to operate new machineries while employees at the management level who are advanced digital users will be offered more complex subjects such as using data analytics tools.

It is also not a surprise that employees may resent the organisation's decision to integrate new technology into their processes or systems since they are so used to a workflow, they can undertake the work without much preparation. However, with more user-friendly innovation, it can encourage workers to adopt and use technology comfortably.

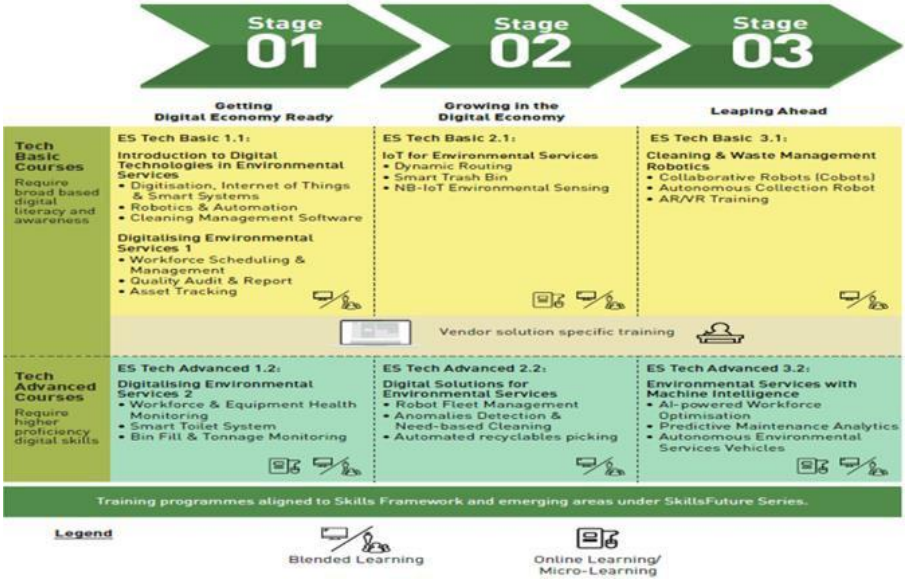


Figure 18: Basic and Advanced Technology courses

Above are the programmes that are identified under the Environmental Services Industry Digital These were designed by IMDA and NEA. Completion of these programmes will enhance an employee's technology proficiency level making them work more efficiently and drive the organisation's productivity level. The Introduction to Digital Technologies in ES course is catered for new entrants and existing practitioners. Coaching provided by ITE will allow participants to acquire foundational understanding and insights to the digital solutions trends in the ES industry. With hands-on activities, it provides participants the opportunity to perform tasks using new robotics and automation.

Platform to understand more details

Often, employees are keen in upgrading their skillsets but are not able to access the opportunities if these are not made available to them. To increase the accessibility to these courses, employees can now self-assess their digital readiness on their own using a self-assessment checklist. Individuals can also seek assistance from a business advisor at an SME Centres. For employees who are at looking at advanced digital advisory, principal consultants at the SME Digital Tech Hub will be able to advise them.

With sufficient information of course availability, together with courses that suits one's need, this will result in a reduction of jobs mismatch and support the individual's potential making the workforce in the sector highly efficient.

In an interview with an employee from 800 Super Waste Management, it was revealed that normal working hours per day is 12 hours from 7am to 7pm, and they are paid one day salary even if they complete the tasks assigned or the routes planned earlier. This would essentially mean employees will be keener to adopt technology that allows them to complete their tasks more efficiently resulting in shorter working hours. If monetary rewards are included in the acquisition of knowledge and skills, then this will add impetus to the employees to acquire the new skillsets.

With sufficient information of course availability, together with courses that suits one's need, this will result in the reduction of mismatch of jobs and supports the development of an individual's potential making the workforce in the sector highly efficient.

6.1 Challenges and Opportunities in Maximising Employment of Older Workers

Asia-Pacific (APAC) is the fastest aging region in the world, with an expected increase of 200 million elderly people (aged 65 and above) between now and 2030 contributed by the increased in life expectancy and a decline in fertility rates. In particular, Singapore has the highest life expectancy at birth (84.8 years) and healthy life expectancy at birth (74.2 years) in the world[13] . With societal aging, this has serious implications on the workforce.

In Singapore, this challenge is coupled with the decline in labour productivity. With projected retirement and re-employment age raising from to 65 and 70 respectively by 2030[14], Government and organisations must join efforts to plan for a future, where older workers represent an increasing proportion of the workforce, from minimising the challenges that organisations may potentially face to providing more opportunities for older workers to upskill and meet expectations. This would enable our older workers to thrive in the future economy and keep Singapore competitive and adaptable despite its maturing workforce.

Additionally, in a survey conducted by the Ministry of Manpower (MOM) on the impact of COVID-19 on the labour market, we notice that the employment rate for older workers aged 65 & over continued to increase, from 27.6% in 2019 to 28.5% in 2020, reflecting sustained efforts to raise their employability and higher demand for essential services like cleaning, waste management and security amid the COVID-19 outbreak.

Particularly in the Waste Management sector where the percentage of older workers of 55 years and above make up 38% of the workforce, programmes to digitalise the workforce must be appropriately planned out so that Singapore can continue to benefit from their contribution even as it transitions into a new economy where the proliferation of technology will drive the sector.

Challenges

Maximising employment of older workers is often seen as a challenge due to reasons such as productivity loss, resistance to change and slow adoption of technology. Such risks can potentially cause rising fiscal burden for companies. Thus, many hold stereotypical views of older workers, detrimental to age-diverse workplace.

Older workers may present challenges related to higher healthcare needs and this in turn may lead to productivity loss from sickness absenteeism. Sickness absenteeism per employee is estimated to increase by 89 percent from 2016 to 2030 due to the aging workforce. However, in today's context, many processes are now automated and older workers who are resistant to change may find themselves excluded from the new ways of doing things.

[14]Source: 'The Burden of Disease of Singapore, 1990-2017', Institute of Health Metrics and Evaluation and the Ministry of Health
[15]Source: '2020 Labour Force survey findings, Ministry of Manpower Statistics

The Singapore government is highly cognisant of this and have mounted campaigns to support the seniors in this endeavour. There will be more outreach efforts to help seniors go digital by partnering with companies as well as enhancing training programmes and schemes. To date, more than 100,000 seniors have benefitted from digital skills training conducted by the SG Digital office since it was launched in June 2020[15]. 200 roving counters will be set up in the community in addition to the 47 community hubs already present.

Further, lower-income seniors will be able to enjoy affordable mobile access for a longer period. The current scheme offers eligible seniors a basic smartphone with co-payment starting from S$20 bundled with a S$5 monthly mobile plan that offers 5GB of data for one year.

The increase of hawker stalls offering e-payments now numbered 60% which encourages the customers to use digital methods of payment. Seniors who are regular consumers at hawker stalls must learn this method of payment settlement to continue to enjoy their favourite foods.

At the formal set up of enterprises and offices, the fundamental change in attitudes of employers towards older workers is a critical component of maintaining longevity of the workforce. Employers must be fully persuaded about the potential value-add that older workers can offer to their organisation. Through our visioning workshop, it was mentioned by services buyers that older workers take time to adapt to the new practices and changes since they may lag in capturing and remembering certain things. Hence, trainings and guides must be devised in such way that it is easier for them to understand and capture the details properly such as using pictorial guides.

Opportunities

To create inclusive and dynamic workforce, some key areas to maximise the employment of older workers are:

- Redesigning jobs to raise productivity and workplace longevity
- Personalised career planning sessions
- Provide more part-time re-employment opportunities
- Restructure medical benefits provided by employers (Hospital, Insurance schemes, Medisave)
- Tap on various grants to create age-friendly workplaces

Senior Worker Support Package was introduced in February 2020. In this package, Senior Worker Early Adopter Grant and Part-time Re-employment Grant can be used to support employers in implementing key recommendations by the Tripartite Workgroup. Under the Senior Worker Early Adopter Grant, it provides funding support of up to $125,000 to progressive employers who are willing and able to raise higher internal retirement and re-employment above the prevailing statutory ages. Therefore, to promote the employment of older workers.

[15] 3 September 2021, Infocomm Media Development Authority

To match appropriate jobs to older workers, it will be useful to gain insights regarding their interests and health conditions through individual career planning sessions to customise and find suitable jobs for them. To further support part-time opportunities for our older workers, the Part-time Re-employment Grant is introduced where it provides up to $125,000 to employers who are committed to a re-employment policy. Under this policy, employers will offer part-time re-employment opportunities to eligibly senior workers who request for it. Such arrangement will benefit seniors who prefer less manual work and motivate them to stay in the workforce.

Furthermore, in 2019, it was announced that the Central Provident Fund (CPF) contribution rates for older workers will rise to enhance older workers' financial security. This is clearly a move by the Government to encourage seniors to stay relevant and encourage them to continue to contribute to the workforce. Older workers (>50) also tend to stay longer (6-10 years) and are more dedicated to the work compared to the younger workers (30-40) as mentioned during the stakeholder interview.

All in all, despite the challenges presented, many methods are put in place to maximise the employment of our older workers. As Singapore is facing an aging population, it would certainly be a pity not to proactively harness the potential and strength of older workers.

7.1 Opportunities and Outlook for the Sector

7.1.1 : Technology & Innovation

2025 VISION: High degree of automation & innovation

To achieve the desired transformation of the Waste Management Sector, respective stakeholders are required to work collaboratively to manage the challenges faced and these include relevance of job roles, maximising employment of older workers, poor sector image, mindset and culture, and finally receptance to the use of technology.

From our analysis, Europe is clearly more advanced in terms of technology, recycling policies and overall deployment as compared to Singapore's Circular Economy journey to date since we are only gradually stepping up as described in the recent Zero Waste Management Master Plan. Singapore should consistently adopt methods which has been proven to be successful in Europe where possible and in aspects which are similar since some approaches are only better reflected in other ASEAN countries.

In a report conducted by World Bank in 2018[16], it is projected that with rapid urbanisation together with population growth and economic growth, global waste will increase significantly by 70% over the next 30 years. This equals a staggering 3.40 billion of waste generated annually. If left unresolved, waste will affect the livelihood of everyone around the world. The longer-term effect is the impact on the climate for subsequent generations. Innovative technology will transform the way waste is being managed and, in the process, uplift the skills required for the sector, protecting jobs which are at risk of redundancy.

In Singapore, innovative practices have been identified in the Regulatory Sandbox and INCUBATE programmes as well as projects undertaken with the Productivity Solutions Grant (PSG) launched by NEA under ES ITM. Details can be found in section 4.1.2.

[16]https://www.worldbank.org/en/events/2017/09/25/opportunities-and-challenges-of-urbanization

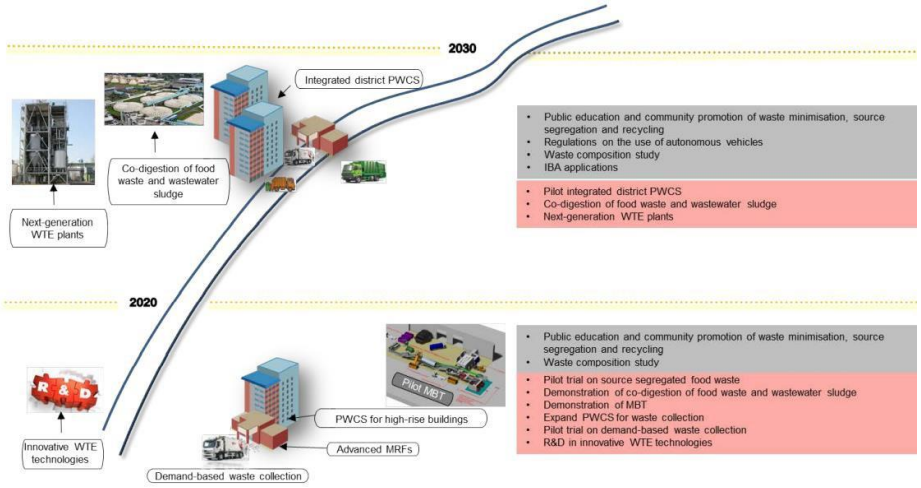


Figure 19: Proposed Technology Roadmap on Waste Management

To realise the 2030 vision, a Waste Management Technology Roadmap was established describing the RDD&D pathways. This roadmap addresses the technology options for various areas like collection, sorting, recycling, and treatment to meet the desired goals[17]. The roadmap must be reviewed and adjusted to external factors such as technology advancement, changes in policies, waste conditions and public expectations.

There is ongoing dialogue on programmes which the government is keen to provide in grants and subsidies. Sector-wide service standards and accreditation to incentivise service providers with good sector practices and processes have been launched. Wages, skills uplift and digitisation considerations are also been addressed within government and interventions have been or will be created to address these gaps.

[17] Waste Management Technology Roadmap, NCCS

7.1.2 : Jobs & Skills

2025 VISION: Skilled and manpower-lean workforce

It is crucial to maintain the relevance of current and emerging job roles. Continuous effort to understand the demand and emergence of certain job roles will provide insights on the re-design of suitable jobs and thus, improve skill capabilities of workers. When supplemented with the use of appropriate technology, it will bring out exponential changes impacting efficiency and effectiveness.

Poor sector image would only aggravate the manpower shortage situation in Waste Management sector. There is a strong stigma associated with this sector as both workers themselves and general public view these jobs to be of low skilled; dirty and dangerous.

Public campaigns and roadshows can act as gateways to re-brand the sector to attract younger talent by highlighting the emerging roles and new technologies. For example, NEA together with WSG can work with Institutes of Higher Learning (IHLs) to attract younger generation to the sector by increasing internship opportunities. To improve the perception of such industries, sector wide appreciation events were organised to recognise ES professionals for their commitment and excellence in their work. Within the Service Providers establishments, more progressive efforts have involved monthly team sessions where lunch or dinner was served (pre COVID-19) or packet lunches or dinners distributed as well as bursary and scholarships for individuals as well as their children.

With the reduction in foreign workers' quota, attracting a younger generation of Singaporeans becomes critical. In an interview with Lendlease, it was mentioned that redesigning of job scope would greatly increase the standards and give a better reflection of a sector that embraces technology. Programmes to guide the transition would be helpful for Service Providers and Buyers as the case studies of organisations who have valiantly adopted technology into their processes can furnish learning lessons to support the acceleration of its use in the sector.

In achieving a manpower-lean workforce, technology is clearly a lever, however maintaining and increasing the workforce to meet ongoing demand is a combination of hiring across the population from the older workers to ex-convicts, women and those with disabilities. The programmes for the latter two have been undertaken intermittently with some employers but the strategy going forward should be more collaborative where training is provided prior to these individuals going on site.

7.1.3 : Productivity

2025 VISION: Best in class with productive enterprises

Productivity and Technology & Innovation are pillars which Singapore could possibly work on to upgrade further. Singapore has always positioned herself as one with exceptional sustained economic performance and business-oriented nation, a result of decades of committed economic policy. Given how Singapore's workforce already comprises of many highly skilled foreigners, we could provide more opportunities for locals to take up positions that match their capability. Sector webinars and workshops can be held to raise Service Buyer's awareness on the benefits of technology adoption and awarding contracts to Service Providers who utilise technology can enhance productivity.

In the recent 2021 Budget debate, Deputy Prime Minister Mr. Heng See Keat mentioned that raising productivity through transforming the way firms works is the only way to continuously enhance the lives and jobs of Singaporeans. Seeing this importance of enhancing productivity, $24 billion is set aside for business and worker transformation to be ultitise in the next 3 years.

It is essential to not only maximise workers' competencies but also drive technology to gain competitive advantage through continuous effort to be open to international capital and technology. Venturing into new technologies which are unique and exceptional in its innovation or adapting technology from other frontiers can help provide the visibility and economic and financial benefits for both Singapore and the enterprise.

Addressing all considerations of technology, jobs and productivity together is the nucleus of the change. While much technology experimentation is already in progress, scale is often the biggest impediment to the transformation. To achieve this, ease of access to the use of the technology available and affordability is central to the transition strategy. The final outcomes are enhanced productivity where fewer workers are required and new jobs and skills with a different profile of workers and this will ultimately allow expectations for higher wages, better benefits to be paid to the qualified workers in this sector.

7.1.4 : Internationalisation

2025 VISION: Environmental services companies with a global footprint

Given that Singapore has a small economy, it is necessary to support our SMEs international expansion. To do so, it is crucial to organise networking sessions to cultivate stronger ties and connect with foreign companies. For example, the Building and Construction Authority (BCA) has always been supporting Singapore construction firms in their internationalisation since 1999 through multiple measures and bilateral collaborations. Best practices can thus be referenced to inform and inspire the development of local solutions.

Figure 20: BCA organising networking sessions

Besides working on improvement in Waste Management sector in Singapore, Singapore also sees the importance of working with other countries to drive sustainability and manage climate changes. With the collective effort of Singapore company Keppel Infrastructure Holdings Pte Ltd, and China Harbour Engineering Company Limited, Keppel Seghers Hong Kong Limited and Zhen Hua Engineering Co. Ltd, a total of S$5.3 billion was spent to build and operate Hong Kong's first IWMF to treat wastewater in the Waste-To-Energy (WTE) plant and landscape irrigation in mechanical treatment plant. Therefore, market access can be achieved, new technology capabilities can be shared, and possible project collaborations can be achieved among countries to offer integrated solutions.

In an interview sharing session, Wah & Hua, a manufacturing company, shared that 90% of their employees are working as collectors. Wah & Hua is acquired by a company in India (they are Singapore-registered company and started a landfill business in India and have expanded services to other countries like UK and Vietnam and the next acquisition is Switzerland).

In the area of internationalisation, Wah & Hua is working with ESG and Infra Asia to identify potential countries to expand their business. They had drafted out plans on energy conversion, but Covid-19 halted their plans which led to newer ideas on green energy driven by the fact that they were burning contaminated recyclable materials. Wah & Hua is an attractive profile to showcase as it expands its business model beyond the traditional areas of township collection, incineration, or recycling.

NEA regularly organises international platforms and events namely, the CleanEnviro Summit Singapore, with the purpose of connecting local companies with an international audience by showcasing products, services, and innovative solutions. In-depth discussions, roundtables and sharing of best practices also take place. The success of this event can be reflected from the participation numbers collected. In the last event, over 24,000 visitors from more than 120 countries and regions and over 1,100 participating companies were engaged in the event.

7.1.5 : Culture of Citizenry

Transforming the sector also requires the involvement of Citizens. Government agencies can implement legislations and credit system for recycling. Rewards-based recycling programmes can draw participation rates. For instance, smart recycling bins can be set up around heartland areas to provide citizens the convenience to drop off recyclables. A unique QR code on user's device can be used to scan the credits awarded. These credits can therefore be exchange for online shopping and grocery vouchers. Such engagements with citizens can also be seen in Nigeria where eTrash2Cash created waste collection centres across vulnerable communities. Rewards are given in the form of cash earnings where users can have the options to redeem earnings instantly or save it over time to access better social care services.

Figure 21: Drop off points for recyclables

In a new e-waste collection and recycling programme undertaken by 800 Super Waste Management and Alba, locals are encouraged to recycle and are rewarded with points in the STEP-UP application on their mobile devices. To make it more accessible for individuals, there are various drop off points around the island and doorstep collection for bulky items for a small fee.

The transformation of this sector requires collaboration with service providers and grassroot organisations in partnership with government agencies, equipment and technology providers, Service Buyers and associations. While we strive to continue to achieve world class attitudes towards waste disposal and segregation at the citizenry level, the accompanying practices of technology use, governance and skill qualification must move in tandem to enable us to achieve the outcomes for the desired state of the sector.

8. Conclusion

8.1 Conclusion

By 2035, the sector aims to be competitive and attractive. In achieving these goals, it is important to note that recommendations are encouraged to be viewed collectively and adopted through different phases (short and long term) for sector transformation to be successful. Tracking of performance should be implemented and consistent to identify the necessary changes/approaches to take. With concerted efforts from various sector stakeholders such as service providers, employees themselves and the Government, the transformation journey can be a triumph as we envision the future waste management sector to be vibrant, sustainable, and professional.

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