

TECHNOLOGY PLAYBOOK FOR THE CLEANING INDUSTRY



**Environmental Management
Association of Singapore**

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INTRODUCTION

1.1 Purpose and Scope

This technology playbook serves as a comprehensive strategic guide tailored for the cleaning industry in Singapore. Its overarching objective is to **empower businesses to harness the latest technological advancements**, thereby optimising operational efficiency, elevating service quality, and promoting sustainable practices. In an era where the cleaning industry is experiencing rapid transformation, this playbook offers a detailed roadmap that encompasses everything from assessing current processes and setting goals to exploring diverse technology solutions, learning from real-world case studies, and leveraging available support mechanisms.

1.2 Background and Motivation

The cleaning industry in Singapore plays a vital role in maintaining the cleanliness and hygiene of the city-state's infrastructure, public spaces, and buildings. However, it faces significant challenges, including acute labour shortages, intense competition, and the need to meet increasingly stringent environmental and hygiene standards. Simultaneously, initiatives by the Singapore government, such as the Smart Nation Initiative and the Green Plan 2030, present numerous opportunities for the industry to embrace technology and drive innovation.

This playbook has been developed in response to these challenges and opportunities, aiming to help cleaning businesses thrive in a constantly evolving landscape.





1.3 How to Use this Playbook

The playbook is structured in a clear and practical format, designed to guide technology adoption in the cleaning industry. Each chapter covers a specific area, offering detailed insights, practical advice, and real-world examples. To get the most value, readers are encouraged to start with Chapter 2, which outlines the current industry landscape and highlights key challenges and opportunities.

Chapter 4 then introduces various technology solutions, grouped by function and potential impact. Chapter 5 presents case studies showcasing how other businesses have implemented these technologies successfully. Additional sections address peer learning, regulatory requirements, and sustainability considerations.

The playbook concludes with a summary of key takeaways and a call to action to support continued progress in technology adoption.

2. Current Landscape in Singapore

Industry Overview & Key Challenges

The cleaning industry in Singapore is a diverse and dynamic sector, consisting of a wide range of businesses, from small local enterprises to large multinational corporations. These businesses offer an array of services, including commercial, residential, and industrial cleaning, waste management, and pest control. The industry is highly competitive, with businesses vying for contracts across various sectors such as commercial real estate, healthcare, education, and hospitality.

2.1 Key Challenges

Labour Shortage

One of the most pressing issues facing the cleaning industry in Singapore is the severe shortage of labour. An ageing workforce and competition for talent from other sectors make it difficult for businesses to recruit and retain skilled cleaners. This has led to increased labour costs and operational inefficiencies.

Fragmented Tech Adoption

Despite the growing importance of technology, many cleaning businesses in Singapore struggle with fragmented technology adoption. Lack of awareness, limited resources, and the complexity of integrating different technology solutions prevent businesses from fully capitalizing on the benefits of technology, such as improved productivity, cost reduction, and enhanced service quality.

Rising Hygiene Standards

In the post - COVID-19 era, there is a heightened demand for high - quality cleaning and hygiene services. Customers now expect businesses to adhere to strict hygiene standards, which require the use of advanced cleaning technologies and techniques. Meeting these standards can be challenging, especially for smaller cleaning businesses with limited resources.

Increasing Competition

The cleaning industry in Singapore is highly competitive, with numerous businesses competing for the same contracts. This has led to price pressure and the need for businesses to differentiate themselves through technology, innovation, and superior service.

2. Current Landscape in Singapore

Opportunities

Opportunity Area	Description	Business Advantage
Government Grants and Incentives	Various government schemes in Singapore support technology adoption and sustainable practices. These include grants for energy-efficient retrofits, digital transformation, and innovation in cleaning solutions.	Helps offset technology costs and strengthens competitive positioning.
Growth in Integrated Facility Management (IFM)	Rising demand for IFM services combining cleaning, maintenance, and other support functions creates new market opportunities for cleaning businesses.	Enables business expansion and delivery of more comprehensive services.
Advancements in Technology	Emerging solutions such as autonomous cleaning robots, IoT sensors, and analytics platforms are reshaping the industry.	Drives productivity, reduces operational costs, and improves service delivery.
Increasing Awareness of Sustainability	Growing demand for environmentally responsible services encourages adoption of green cleaning practices, waste reduction, and energy conservation	Enhances brand reputation and meets evolving client expectations.

2. Current Landscape in Singapore

Industry Segmentation

Segment	Key Characteristics	Strategic Focus
Small Enterprises (<50 employees)	<ul style="list-style-type: none">- Operate on limited budgets with minimal investment in technology- Often focus on niche markets (e.g., small businesses, salons, retail)- Operations are typically personalised and run by close-knit teams- Limited marketing and brand recognition- Workforce may lack deep technical knowledge	<ul style="list-style-type: none">- Adopt low-cost, high-impact tools (e.g., mobile apps for task tracking)- Use basic IoT for inventory tracking to manage supplies effectively- Implement simple cloud-based analytics to monitor task completion and customer feedback- Focus on real-time communication and operational visibility through lightweight solutions
Medium Enterprises (50–200 employees)	<ul style="list-style-type: none">- Partial progress in digitalisation with challenges in system integration- Actively expanding into larger-scale or specialised services- More structured organisationally than small firms- Need to balance tech investment with profitability- Face increasing customer expectations	<ul style="list-style-type: none">- Deploy scalable tools such as semi-autonomous cleaning robots (e.g., LionsBot R3)- Leverage analytics for route optimisation and resource efficiency- Implement cloud-based communication platforms to streamline multi-site operations- Use data insights to reduce labour costs and enhance cleaning performance
Large Enterprises (>200 employees)	<ul style="list-style-type: none">- Operate with fragmented tech ecosystems (siloeed systems for different functions)- Manage large-scale or regional/national operations- Must meet regulatory, client, and sustainability demands- Pressured to standardise and ensure system interoperability across operations	<ul style="list-style-type: none">- Build integrated AIoT ecosystems to unify operations and enable real-time monitoring (e.g., Eco Campus model)- Shift to outcome-based contracting (OBC) to align service quality with client expectations- Invest in enterprise-wide data analytics to guide strategic decisions on resourcing, expansion, and tech adoption- Focus on high-level interoperability and process standardization

3. Goals and Objectives | Defining Clear Goals

- 1. Improve Operational Efficiency:** The primary goal of technology adoption in the cleaning industry is to enhance operational efficiency. This can be achieved by streamlining processes, reducing manual tasks, and optimising resource allocation. For example, mobile apps for task management enable cleaners to receive assignments, track progress, and communicate with supervisors in real-time, reducing administrative time and effort.
- 2. Enhance Service Quality:** Another crucial goal is to improve service quality. Technologies such as IoT sensors and data analytics can be used to monitor the cleanliness of facilities, identify areas that need attention, and ensure consistent high - standard cleaning services. Customer management systems also help businesses understand customer needs and preferences, allowing them to tailor their services accordingly.
- 3. Reduce Costs:** Technology can help cleaning businesses cut costs by automating tasks, reducing waste, and improving resource efficiency. Autonomous cleaning robots, for instance, can reduce the need for manual labour, resulting in significant cost savings. IoT sensors can monitor the usage of cleaning supplies, preventing overstocking and reducing waste.
- 4. Meet Sustainability Goals:** With the increasing focus on sustainability in Singapore, cleaning businesses should aim to adopt technologies and practices that minimize their environmental impact. This includes using eco - friendly cleaning products, implementing energy - efficient technologies, and reducing waste generation. Meeting sustainability goals not only contributes to a greener future but also enhances a business's reputation and competitiveness.

3. Goals and Objectives | Aligning with National Priorities



The **Smart Nation Initiative** in Singapore represents a far - reaching and comprehensive vision aimed at leveraging technology to transform every aspect of national life, with the cleaning industry being no exception. This initiative is deeply rooted in the government's commitment to enhancing the quality of life for citizens, boosting economic competitiveness, and improving the efficiency of public services.

At its core, the Smart Nation Initiative emphasizes the collection, analysis, and utilization of data to drive informed decision - making and create more intelligent systems. In the cleaning industry, this translates into a multitude of opportunities. For instance, the integration of Internet of Things (IoT) sensors throughout various facilities can generate a wealth of data on factors such as occupancy levels, waste generation patterns, and equipment usage. This data can be harnessed to optimize cleaning schedules, ensuring that resources are deployed precisely when and where they are needed.

Moreover, the Smart Nation Initiative promotes the development and adoption of digital platforms that facilitate seamless communication and collaboration between different stakeholders. Cleaning businesses can benefit from this by using cloud-based platforms to centralize their operations. These platforms enable real-time sharing of information among cleaners, supervisors, and clients. For example, a cleaning supervisor can use a cloud-based platform to assign tasks to cleaners, who can then update the status of those tasks in real-time. This not only improves operational efficiency but also enhances transparency, as clients can access up - to - date information about the progress of cleaning services.

The Smart Nation Initiative also encourages innovation in technology. Singaporean cleaning businesses are incentivized to explore and develop new solutions that can address the unique challenges of the industry. This could include the creation of advanced cleaning robots with enhanced navigation and cleaning capabilities, or the development of artificial intelligence - driven analytics tools that can predict maintenance needs for cleaning equipment more accurately. By aligning with the Smart Nation Initiative, cleaning businesses in Singapore can position themselves as leaders in technological innovation, contributing to the overall growth and development of the nation's digital economy.

Note:

For further guidance on Smart Nation Initiative, please refer to: - <https://www.smartnation.gov.sg/>

3. Goals and Objectives | Aligning with National Priorities



Be a Part of the Green Plan

The **Green Plan 2030** is a cornerstone of Singapore's long - term strategy for achieving sustainable development. It sets out ambitious goals and targets aimed at reducing the country's environmental impact, transitioning to a low - carbon economy, and building a more resilient and sustainable future. The cleaning industry has a significant role to play in realizing these objectives.

One of the key focuses of the Green Plan 2030 is reducing carbon emissions. Cleaning businesses can contribute to this by adopting energy - efficient technologies. For example, the use of battery - powered or electric cleaning equipment, such as floor scrubbers and vacuum cleaners, can significantly reduce greenhouse gas emissions compared to traditional fossil - fuel - powered counterparts. Additionally, implementing smart energy management systems that optimize the use of electricity in cleaning operations, such as scheduling equipment usage during off - peak hours, can further reduce energy consumption and carbon footprints.

Water conservation is another crucial aspect of the Green Plan 2030. In the cleaning industry, this can be achieved through the use of water - saving technologies and practices. For instance, high - pressure, low - flow nozzles on cleaning equipment can reduce water usage without sacrificing cleaning effectiveness. Smart sensors can also be used to detect when cleaning is required, ensuring that water is only used when necessary. This not only conserves a precious resource but also reduces the burden on Singapore's water treatment and supply infrastructure.

The Green Plan 2030 also emphasizes waste reduction and recycling. Cleaning businesses can play a vital role in this area by implementing waste management strategies that focus on minimizing waste generation and maximizing recycling. This could involve using reusable cleaning materials, such as microfiber cloths and mop heads, instead of disposable ones. Additionally, businesses can separate and recycle waste generated during cleaning operations, such as paper, plastic, and metal. By aligning with the Green Plan 2030, cleaning businesses can not only meet regulatory requirements but also enhance their reputation as environmentally responsible organizations, which can be a significant competitive advantage in the market.

Note:

For further guidance on Green Plan 2030, please refer to: - <https://www.greenplan.gov.sg/>

3. Goals and Objectives | Mapping Technologies to Green Mark 2021 and Green Plan Goals

By aligning with BCA's **Green Mark 2021** framework, cleaning service providers can better position themselves as preferred partners for building owners seeking to achieve or maintain certification. This strategic alignment enhances credibility, ensures compliance with national sustainability benchmarks, and increases competitiveness in securing contracts for green-certified buildings

Technology	Green Mark Category	Green Plan Impact
IoT Occupancy Sensors	Smart Building Systems	Reduces energy waste
Water-efficient Cleaning Tools	Water Efficiency	Supports water conservation
Autonomous Robots	Energy Efficiency, Ops Management	Reduces Labor-related emissions
AI-Driven HVAC Optimisation	Energy Performance	Lowers carbon foot print
Smart Waste Monitoring	Waste Management	Promotes circular economy

Note:

For more details on Green Mark 2021, please refer to: - <https://www1.bca.gov.sg/>

4. Technology Solutions

Cloud-based platforms serve as the digital backbone for cleaning operations, centralizing data from multiple job sites. They enable real-time management of cleaning schedules, task assignments, employee records, and inventory levels. High-speed internet and secure data centers ensure seamless communication between the back-office and field workers, allowing for instant data sharing and access to critical information. This infrastructure supports the integration of other digital tools, facilitating a more coordinated and efficient approach to cleaning business management.

Possible Use Cases

- 1. Multi-site Cleaning Operations:** A cleaning company with contracts across dozens of commercial buildings in Singapore uses a cloud-based platform. Managers can log in from anywhere and view the real-time status of cleaning tasks at each building. They can easily adjust schedules if a client requests an urgent cleaning, assign additional staff to a busy location, and monitor inventory levels of cleaning supplies across all sites. For example, if one building runs low on floor cleaner, the manager can quickly arrange for a restock from a central warehouse.
- 2. Remote Team Collaboration:** During a large-scale event cleaning project, such as a music festival, the cleaning supervisor can use the cloud-based system to communicate with the cleaning teams on-site. Workers can upload photos of completed areas, report any issues, and receive updated instructions in real-time. The supervisor, who may be off-site, can manage the entire operation, ensuring that all cleaning tasks are completed on time and to the required standard.

Benefits

- **Enhanced Flexibility**
- **Improved Data Security**
- **Cost - Efficiency**



4. Technology Solutions

Mobile-enabled task management apps and communication tools are designed to streamline cleaning operations in the field. Supervisors can assign tasks directly to cleaners' mobile devices, specifying details like location, scope of work, and required cleaning products. Cleaners can use these apps to update task statuses, upload before - and - after photos for quality verification, and communicate with supervisors in real-time. GPS tracking features allow supervisors to monitor the location and progress of workers, ensuring efficient task completion.

Possible Use Cases

- 1. Commercial Building Cleaning:** In a large office complex, the cleaning supervisor uses a mobile task management app to assign daily cleaning tasks to a team of 30 cleaners. Each cleaner receives a detailed list of areas to clean, such as restrooms, corridors, and meeting rooms, along with specific instructions. As the cleaners complete each task, they mark it as done in the app and upload photos. The supervisor can then quickly review the work and address any issues immediately, such as a missed spot or an unclean area.
- 2. Emergency Cleaning Response:** When a client reports a sudden spill or mess in a retail store, the supervisor can use the app to quickly dispatch the nearest available cleaner. The cleaner receives the task notification on their mobile device, along with the location and details of the emergency. They can then navigate directly to the site using the app's GPS-integrated map and update the supervisor on their estimated arrival time and progress of the cleaning.

Benefits

- **Increased Productivity**
- **Improved Quality Control**
- **Enhanced Communication**



Mobile-enabled Task Management and Communication

4. Technology Solutions

The Internet of Things (IoT) in the cleaning industry involves the use of sensors and connected devices to monitor various aspects of cleaning operations. Occupancy sensors detect human presence in areas like restrooms, lobbies, and offices, triggering automated cleaning schedules based on usage patterns. Smart waste bins use sensors to monitor fill levels and send alerts when they need emptying, optimising waste collection routes. Sensors on cleaning equipment track performance metrics such as motor temperature, vibration, and usage hours, enabling predictive maintenance to prevent breakdowns.

Possible Use Cases

- 1. Public Facility Cleaning:** In a busy airport terminal, occupancy sensors in restrooms detect the number of users at different times of the day. Based on this data, the IoT-enabled cleaning system automatically schedules more frequent cleanings during peak travel hours, ensuring that restrooms remain clean and hygienic for passengers. Smart waste bins in the terminal notify the waste management team when they are nearly full, allowing for efficient and timely collection.
- 2. Industrial Equipment Maintenance:** A manufacturing plant uses IoT sensors on its floor - cleaning equipment, such as automated scrubbers. The sensors continuously monitor the equipment's motor performance, brush wear, and battery life. When the sensors detect that a component is approaching the end of its lifespan or is showing signs of malfunction, the system sends an alert to the maintenance team, who can then schedule preventive maintenance to avoid unexpected breakdowns during production hours.



4. Technology Solutions

Robotics and automation technologies in the cleaning industry involve the use of autonomous machines and software-driven systems to perform cleaning tasks and manage back-office operations. Autonomous cleaning robots are designed to handle tasks like floor scrubbing, window cleaning, and toilet cleaning with precision and efficiency. They use sensors and advanced navigation systems to operate in various environments without constant human supervision. Automation also extends to administrative processes, such as invoicing, payroll, and inventory management, reducing manual labor and increasing operational speed.

Possible Use Cases

- 1. Large-scale Floor Cleaning:** A shopping mall uses autonomous floor - cleaning robots to clean its expansive corridors and open areas overnight. These robots are programmed to follow specific routes, avoiding obstacles and cleaning the floors thoroughly. They can operate continuously for several hours, covering a large area in a short time, and are able to return to their charging stations when the battery is low.
- 2. Back-Office Process Automation:** A medium-sized cleaning company implements an automated invoicing system. The system integrates with the company's task management software, automatically generating invoices based on completed cleaning jobs, the services provided, and the agreed-upon rates. It then sends these invoices to clients via email, reducing the time and effort spent on manual invoicing and minimizing the chances of errors.

Benefits

- **Labor Savings**
- **Consistent Quality**
- **Improved Efficiency**



**Robotics and
Automation
Technologies**

4. Technology Solutions

Data analytics and business intelligence tools in the cleaning industry collect, analyze, and interpret data from multiple sources, such as IoT sensors, mobile task management apps, customer feedback, and equipment performance records. Advanced analytics algorithms identify patterns, trends, and insights within this data, which are then presented through intuitive dashboards and reports. These insights enable managers to make data-driven decisions regarding cleaning operations, resource allocation, service quality improvement, and cost-reduction strategies.

Possible Use Cases

- 1. Performance Analysis and Improvement:** A cleaning service provider analyzes data from its mobile task management app to evaluate the productivity of its cleaning teams. By looking at factors such as the time taken to complete different types of tasks, the number of tasks completed per day, and the quality ratings provided by clients, the company can identify areas where teams are excelling and areas that need improvement. Based on these insights, they can provide additional training to underperforming teams or adjust task assignments to optimize productivity.
- 2. Cost-Benefit Analysis:** A large-scale cleaning contractor analyzes data on the cost of cleaning supplies, labor expenses, and equipment maintenance across its various contracts. By comparing the costs associated with different cleaning methods, products, and service levels, the company can determine the most cost-effective approach. For example, it may find that using a particular brand of eco-friendly cleaning product, although more expensive upfront, reduces the need for re-cleaning and improves customer satisfaction, resulting in overall cost savings.

Benefits

- **Informed Decision-Making**
- **Proactive Problem-Solving**
- **Competitive Advantage**



**Data Analytics
and Business
Intelligence**

4. Technology Solutions


AI-powered optimization and decision-making in the cleaning industry leverage artificial intelligence algorithms and machine learning models to analyze complex data sets and make intelligent decisions. These technologies can optimize cleaning routes by considering factors like traffic conditions, task locations, and time constraints. AI can predict cleaning needs based on historical data, occupancy patterns, and other variables, enabling proactive scheduling and resource allocation. AI-driven chatbots are also used to handle customer inquiries, providing instant and accurate responses to improve customer service.

Possible Use Cases

- 1. Route Optimization for Cleaning Fleets:** A cleaning company with a fleet of vehicles used for waste collection and equipment transportation uses an AI-based route optimization system. The system takes into account real-time traffic data, the location of each collection point, and the capacity of the vehicles. It then calculates the most efficient routes for the drivers, reducing travel time, fuel consumption, and labor costs. For example, during peak traffic hours, the AI system may suggest alternative routes to ensure timely waste collection.
- 2. Predictive Cleaning Scheduling:** A commercial cleaning service provider uses AI to predict the cleaning needs of its clients. By analyzing historical data on office occupancy, foot traffic patterns, and the type of activities taking place in different areas of a building, the AI model can predict when certain areas will require cleaning. Based on these predictions, the company can schedule cleaning tasks in advance, ensuring that the spaces are clean and presentable when needed, without over- or under- cleaning.

Benefits

- **Operational Efficiency**
- **Enhanced Customer Experience**
- **Strategic Planning**



**AI-powered
Optimization and
Decision-making**

4. Technology Solutions

Digital training and skills development platforms in the cleaning industry offer online courses, video tutorials, interactive simulations, and assessment tools to train cleaning staff. These platforms provide a convenient and flexible way for workers to learn new cleaning techniques, safety procedures, and how to operate new cleaning equipment. They also allow companies to track employee progress, ensure consistent training across the workforce, and provide certifications upon completion of training modules.

Possible Use Cases

- 1. Onboarding New Employees:** A cleaning company uses a digital training platform to onboard new cleaners. New hires can access a series of online courses that cover basic cleaning techniques, safety protocols, and company policies. Through interactive simulations, they can practice using different types of cleaning equipment in a virtual environment before working on actual job sites. The platform tracks their progress, and once they complete all the required modules and pass the assessments, they receive a certification indicating they are ready to start work.
- 2. Updating Skills for Existing Staff:** When the company introduces a new type of eco - friendly cleaning product, it uses the digital training platform to train its existing staff. Workers can watch video tutorials on how to use the product safely and effectively, and then take quizzes to test their knowledge. The platform also allows for discussion forums where employees can ask questions and share their experiences, facilitating a collaborative learning environment.



4. Technology Solutions

Cybersecurity and data protection technologies in the cleaning industry are focused on safeguarding sensitive information, including customer data, employee records, and business operations data. This involves implementing measures such as firewalls, encryption, intrusion detection systems, and regular security audits. Employee training on cybersecurity best practices, such as creating strong passwords and avoiding phishing scams, is also crucial to prevent data breaches and protect the company's digital assets.

Possible Use Cases

- 1. Protecting Customer Information:** A cleaning company that services high-profile corporate clients stores sensitive customer information, such as access codes to secure buildings and details of special cleaning requirements. To protect this data, the company uses encryption to scramble the information during storage and transmission. Firewalls are installed to block unauthorized access to its internal network, and intrusion detection systems monitor for any suspicious activity. Regular security audits are conducted to identify and address any potential vulnerabilities.
- 2. Securing Business Operations Data:** The company's internal systems contain data on cleaning schedules, employee payroll, and inventory management. To prevent data loss or unauthorized access, the company backs up its data regularly and stores the backups in a secure off-site location. Multi-factor authentication is implemented for employees to access these systems, adding an extra layer of security. In case of a security incident, the company has an incident response plan in place to quickly address the issue and minimize the impact on its operations.

Benefits

- **Reputation Protection**
- **Legal Compliance**
- **Business Continuity**



4. Technology Solutions

Augmented Reality (AR) and Virtual Reality (VR) technologies are emerging as valuable tools in the cleaning industry. AR can be used to provide real-time information overlays on physical environments. For example, cleaners can use AR-enabled devices to view detailed cleaning instructions, safety guidelines, or location-specific information directly on the area they are cleaning. VR, on the other hand, is useful for training purposes. It creates immersive virtual environments where cleaners can practice complex cleaning tasks, learn safety procedures, and familiarize themselves with new equipment in a risk-free setting.

Possible Use Cases

- 1. AR-Guided Cleaning:** In a large hospital, cleaners use AR-enabled smart glasses. When they approach a patient room for cleaning, the glasses display step-by-step cleaning procedures, highlighting areas that require special attention, such as high-touch surfaces that need extra disinfection. The AR system can also show the location of cleaning supplies within the hospital, reducing the time spent searching for equipment.
- 2. VR-Based Training:** A cleaning company uses VR technology to train its employees on handling hazardous waste. Trainees wear VR headsets and enter a virtual environment that simulates a hazardous waste cleanup site. They learn how to properly wear personal protective equipment, handle contaminated materials, and follow safety protocols in a realistic but safe setting. This type of training allows employees to make mistakes and learn from them without any real-world risks.

Benefits

- **Improved Training Effectiveness**
- **Enhanced OTJ Efficiency**

**Augmented Reality
(AR) and Virtual
Reality (VR)**

An illustration on a light blue background showing various pieces of technology. At the top left is a VR headset. To its right is a hand holding a smartphone displaying a drone with the word 'ARMS' on its side. Below these are a VR headset with a blue display, a yellow and black game controller, and a white drone. At the bottom, a hand points at a smartphone displaying a 'WINDY WEATHER' forecast, and another hand holds a smartphone with a floor plan. The text 'Augmented Reality (AR) and Virtual Reality (VR)' is written in bold black font at the bottom right.

4. Technology Solutions

5G technology offers ultra high-speed, low-latency communication that can revolutionize the cleaning industry. It enables seamless and real-time connectivity between various devices and systems involved in cleaning operations. This includes connecting autonomous cleaning robots, IoT sensors, mobile devices of cleaning staff, and back - office management systems. With 5G, data can be transmitted instantaneously, allowing for more precise control and monitoring of cleaning tasks, as well as faster decision-making based on real-time data analysis.

Possible Use Cases

- 1. Autonomous Robot Fleets:** In a large industrial park or a vast commercial complex, a fleet of autonomous cleaning robots can be deployed. These robots are connected via 5G to a central control system. The high-speed and low-latency connection of 5G allows the robots to receive real-time updates on their cleaning routes, adjust to sudden changes in the environment (such as the appearance of obstacles), and communicate with each other to optimize their collective cleaning efforts. For example, if one robot detects a spill that requires immediate attention, it can quickly notify other nearby robots to assist or adjust their routes to avoid the area until it's cleaned.
- 2. Remote Monitoring and Management:** Cleaning supervisors can use 5G-enabled devices to remotely monitor multiple cleaning sites in real-time. They can view live video feeds from cameras installed in buildings, check the status of IoT sensors (such as occupancy sensors in restrooms or fill-level sensors in waste bins), and communicate with cleaning staff on-site. In case of an emergency, like a malfunction in a cleaning machine, the supervisor can remotely diagnose the problem using data transmitted over 5G and provide instructions to the staff on how to fix it, minimizing downtime.

Benefits

- **Increased Operational Speed**
- **Enhanced Precision and Control**
- **Scalability**



5. Government Intervention and Support

The Singapore government plays a pivotal role in shaping the cleaning industry's technological landscape through policy - making and regulatory frameworks. To encourage the adoption of advanced cleaning technologies, the government formulates regulations that set standards for cleanliness and hygiene in various sectors, such as healthcare, hospitality, and public facilities. These regulations often implicitly or explicitly incentivize the use of technologies like IoT-driven monitoring systems to ensure compliance. For example, in hospitals, regulations may require the use of sensors to monitor and maintain specific hygiene levels in patient rooms and operating theaters. This not only improves the quality of healthcare but also drives the demand for relevant cleaning technologies.

Moreover, the government regularly reviews and updates existing regulations to accommodate emerging technologies. In the case of autonomous cleaning robots, the government may develop guidelines regarding their safe operation in public spaces, ensuring that they do not pose a risk to pedestrians or other users. These regulatory efforts create a stable and predictable environment for cleaning companies to invest in and implement new technologies.



Policy - Making and Regulatory Frameworks

5. Government Intervention and Support

This factsheet summarizes key financial assistance programs and initiatives available to help cleaning companies modernize operations, adopt digital technologies, and improve workforce sustainability. It also includes relevant technological insights and strategy enhancements derived from comparative industry references to support sustainable transformation and ESG readiness.

Grant Scheme	Description	Link
Environmental Services Productivity Solutions Grant (ES PSG)	Provides up to 50% funding support, capped at S\$200,000 per company, to adopt technology and equipment that enhance productivity in cleaning, waste management, and pest control operations.	Link
Enterprise Development Grant (EDG)	Provides up to 50% co-funding (up to 70% for sustainability projects until Mar 2026) for upgrading, innovation, and productivity improvements.	Link
Energy Efficiency Fund (NEA)	Provides up to 50% co-funding for energy-efficient technologies (e.g., LED lighting, high-efficiency motors). Applicable to SMEs undertaking retrofit projects.	Link
IMDA Advanced Digital Solutions (ADS)	Supports sector-specific digital solutions (e.g., smart facility monitoring, IoT-based systems) that improve operational resilience and sustainability.	Link
SkillsFuture Enterprise Credit (SFEC)	Offers up to S\$10,000 in credits to offset 90% of out-of-pocket expenses for workforce transformation or enterprise capability projects, including job redesign and digital adoption.	Link

Workforce Development Support	Description	Link
Environmental Services Job Redesign	Offers up to 90% salary support for companies adopting redesigned job roles under WSG's Career Conversion Programme.	Link
Jobs Transformation Map (JTM)	Provides guidance on emerging job roles, necessary skills, and upskilling pathways in the cleaning sector.	Link

5. Government Intervention and Support

Financial Incentives and Grants

Singapore’s financial incentives and grants provide a clear pathway for cleaning companies to adopt cutting-edge technologies, enhance sustainability, and remain competitive. By aligning with schemes like PSG, EDG, and ES ITM 2025, firms can reduce costs, improve operational efficiency, and tap into emerging opportunities in green innovation. Proactive collaboration with government agencies and tech partners will be key to maximizing these benefits and driving long-term growth.

Grant/ Incentive	Objective
Productivity Solutions Grant (PSG)	PSG supports SMEs in adopting pre-approved technologies like cloud-based management systems and IoT sensors. From 2023, the funding cap for SMEs is S\$30,000, covering up to 50% of qualifying costs . More details on NEA’s website (nea.gov.sg).
Enterprise Development Grant (EDG)	EDG funds business transformation projects, such as AI-powered scheduling systems and robotics adoption. For sustainability-related projects, funding support is increased to 70% until March 2026. More details on ES’s website (enterprisesg.gov.sg).
Enterprise Financing Scheme – Green (EFS-Green)	Loans of up to S\$50 million are available for eco-friendly equipment and renewable energy systems. Repayment terms are flexible. More details on ES’s website (enterprisesg.gov.sg).
SkillsFuture Enterprise Credit (SFEC)	SFEC provides S\$10,000 in credits to offset 90% of training costs for tech-driven roles. Credits must be used by June 30, 2025. More details on ES’s website (enterprisesg.gov.sg).
Company Training Committee (CTC)	CTC offers credits to offset up to 90% of costs for customized training programs in the cleaning industry. Credit amounts are based on eligible expenses, subject to a cap. Approved training proposals are required, and credits must be used within a government - set time frame. More details on e2i’s website (e2i.com.sg/ctc).

5. Government Intervention and Support

Promoting Industry Collaboration and Knowledge Sharing

The government actively promotes industry collaboration and knowledge sharing to accelerate technological adoption in the cleaning sector. It organizes industry-wide events, conferences, and seminars where cleaning companies, technology providers, and researchers can come together to share ideas, showcase new technologies, and discuss potential collaborations. These platforms create opportunities for cleaning companies to learn about the latest technological trends, understand how other firms are implementing new solutions, and explore partnerships for technology development and adoption.

Furthermore, the government may establish industry-led committees or task forces focused on specific technological areas relevant to the cleaning industry. These groups work together to identify challenges, develop solutions, and share best practices. For example, a committee on the adoption of AI in cleaning can bring together experts from different fields to discuss how AI can be effectively applied in the industry and how to overcome common barriers. Through these collaborative efforts, the government helps to foster a culture of innovation and continuous improvement within the cleaning industry.

By implementing these intervention and support measures, the Singaporean government plays a crucial role in facilitating the cleaning industry's technological transformation. This support not only benefits individual cleaning companies but also contributes to the overall growth and competitiveness of the industry, setting the stage for a more efficient, sustainable, and technologically-advanced cleaning sector.

Note:

For further guidance on industry and knowledge platform, please refer to:

- <https://www.cleanenvirosummit.gov.sg/>

6. Technology Classification by Readiness & Applicability

Technology Readiness Levels (TRLs) are a framework used to assess the maturity of a technology, ranging from conceptual research (TRL 1) to fully commercialized solutions (TRL 9). This playbook categorizes technologies into three tiers—Low, Medium, and High—to help businesses prioritize investments based on risk, scalability, and alignment with national goals.

Technology Readiness Level (TRL) Classification

TRL	Maturity	Type of Technologies
Low (1–3)	<i>Conceptual/Prototype</i>	<ul style="list-style-type: none">- AI-powered contamination detection- Predictive analytics for waste streams
Medium (4–6)	<i>Piloted/Validated</i>	<ul style="list-style-type: none">- IoT-enabled waste management systems- Semi-autonomous floor scrubbers
High (7–9)	<i>Commercially Scalable</i>	<ul style="list-style-type: none">- Autonomous cleaning robots- Cloud-based workforce management platforms

Note:

For further details on Technology Readiness Level (TRL), please refer to:

- <https://www.a-star.edu.sg>

Why TRLs Matter

1. Risk Mitigation:

- Low TRL technologies (e.g., AI prototypes) require partnerships with research institutions like Temasek Polytechnic.
- High TRL solutions (e.g., autonomous robots) offer immediate ROI but demand workforce retraining.

2. Alignment with Enterprise Clusters:

- **SMEs:** Prioritize High TRL tools (e.g., mobile apps) for quick wins.
- **Large Enterprises:** Invest in Medium TRL systems (e.g., IoT analytics) for scalability.

3. Sustainability Integration:

- Medium TRL technologies (e.g., waterless cleaning systems) advance Green Plan 2030 goals.

6. Readiness Assessment Framework

To ensure systematic and effective adoption of technologies, businesses must evaluate their readiness across five critical dimensions. This framework is anchored to case studies, tools, and national standards explicitly cited in this playbook:






Dimensions for Assessment

No	Dimensions	Key Questions
1	Technological Infrastructure	<ul style="list-style-type: none">- What existing systems are in place (e.g., manual vs. digital workflows)?- Are there gaps in connectivity (e.g., lack of IoT-enabled devices)?
2	Workforce Competency	<ul style="list-style-type: none">- What is the digital literacy level of employees?- Are training programs aligned with WSQ standards?
3	Financial Capacity	<ul style="list-style-type: none">- What budget is allocated for technology adoption?- Are government grants (e.g., NEA 3R Fund) being utilized?
4	Regulatory Alignment	<ul style="list-style-type: none">- Do technologies comply with SG Clean Quality Mark or NEA guidelines?- Are data practices aligned with IMDA's Cybersecurity Act?
5	Sustainability Goals	<ul style="list-style-type: none">- Are technologies reducing carbon/water footprints (e.g., solar robots)?- How do outcomes align with Singapore's Green Plan 2030?



6. EMAS Technology Adoption Readiness Scorecard



Assessment Dimensions

Dimension	Criteria	Self-Assessment (1-5)	Priority Level	Action Items
Technological Infrastructure	Existing IT systems, IoT/automation tools, interoperability of platforms.		 High	Audit workflows; deploy IoT sensors; upgrade legacy systems.
Workforce Competency	Staff digital literacy, training alignment with WSQ standards.		 Medium	Enroll teams in WSQ courses; train on mobile apps/robotics.
Financial Capacity	Budget allocation, grant utilization (NEA/IMDA), ROI analysis.		 High	Apply for NEA 3R Fund; budget for IMDA ADS grants.
Regulatory Alignment	Compliance with SG Clean, NEA standards, WSQ certification.		 High	Conduct SG Clean audits; adopt WSQ training modules.
Sustainability Goals	Carbon/water reduction, energy efficiency, alignment with Green Plan 2030.		 Medium	Pilot solar robots; track metrics via AIoT dashboards.

Scoring Guidelines

- **1-2 (Low)**: Immediate action required.
- **3 (Moderate)**: Address gaps using playbook tools.
- **4-5 (High)**: Ready for next phase.


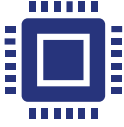



Priority Key

-  **High**: Critical for immediate adoption (e.g., grants, compliance).
-  **Medium**: Important but phased (e.g., sustainability).

6. Key Performance Indicators (KPIs) & Efficiency Measurement

To ensure technology adoption delivers measurable value, businesses must track specific, playbook-aligned KPIs that validate efficiency, sustainability, and compliance.

KPIs by Technology

	 Mobile Solutions	 IoT Sensors	 Robotics	 AIoT Platforms	 Outcome-Based Contracting
Core KPIs	<ul style="list-style-type: none"> - Task completion rate - Avg. response time 	<ul style="list-style-type: none"> - Occupancy accuracy - Predictive maintenance alerts 	<ul style="list-style-type: none"> - Labor hours saved - Error rate per 1,000 tasks 	<ul style="list-style-type: none"> - Energy consumption (kWh) - Cleanliness score 	<ul style="list-style-type: none"> - Water saved (liters/month) - Compliance audit score
How to Measure	Use real-time dashboards (e.g., Zoho Creator) to track daily task logs.	Deploy analytics tools (e.g., Power BI) to monitor sensor data trends.	Conduct time-motion studies and compare pre/post-robot deployment data.	Use ETIH@TP's AIoT dashboard for real-time facility analytics.	Generate OBC reports with platforms like SAP Fieldglass.

7. Future Outlook and Challenges

Technological Advancements on the Horizon

The future of the cleaning industry is poised to be shaped by several emerging technological trends. One area of significant potential is the further development of artificial intelligence (AI) and machine learning algorithms. Currently, AI is used for basic route optimization and task prediction, but in the future, it could reach a level of sophistication where it can anticipate complex cleaning needs based on a multitude of factors such as weather patterns, building usage trends, and even social events in the vicinity. For example, an AI system might predict that a heavy rainstorm will lead to increased dirt and mud in the entrance areas of office buildings, and automatically adjust cleaning schedules and allocate additional resources in advance.

Another promising frontier is the integration of nanotechnology into cleaning products and equipment. Nanoparticles can be engineered to have unique properties, such as enhanced antibacterial and self-cleaning capabilities. In the future, we could see the widespread use of surfaces coated with nanomaterials that repel dirt and stains, reducing the frequency of cleaning required. Additionally, nanoscale cleaning agents could be developed that are more effective at removing tough contaminants while being environmentally friendly.

The Internet of Things (IoT) is also expected to expand further, with more devices becoming connected. In the cleaning industry, this could lead to the development of smart buildings where every aspect of the cleaning process, from the operation of cleaning equipment to the monitoring of waste levels, is seamlessly integrated and controlled. For instance, a building's entire cleaning infrastructure could be managed through a single IoT-enabled platform, which coordinates the activities of autonomous cleaning robots, smart waste bins, and occupancy-based cleaning schedules.

7. Future Outlook and Challenges

Challenges in Adopting New Technologies

Despite the numerous benefits that new technologies offer, the cleaning industry faces several challenges when it comes to adoption. One of the major hurdles is the cost associated with implementing advanced technologies. Autonomous cleaning robots, for example, can be expensive to purchase and maintain, and the installation of IoT sensors and other digital infrastructure can require a significant upfront investment. Small- and medium-sized cleaning companies, in particular, may struggle to afford these costs, putting them at a competitive disadvantage compared to larger firms.

Another challenge is the issue of workforce readiness. Many cleaning workers may lack the necessary skills and knowledge to operate and maintain new technologies. Training employees to use advanced cleaning equipment, understand data analytics tools, or interact with AI-driven systems requires time, resources, and a commitment to continuous learning. There is also a risk of resistance to change from workers who may be accustomed to traditional cleaning methods and fear that new technologies will replace their jobs.

Interoperability is also a significant concern. As the cleaning industry adopts a variety of technologies from different vendors, ensuring that these systems can work together seamlessly becomes crucial. For example, a cleaning company may use a mobile task management app from one provider, an IoT-based monitoring system from another, and an AI-powered analytics tool from a third. Without proper interoperability, data may not flow smoothly between these systems, leading to inefficiencies and missed opportunities for optimization.

7. Future Outlook and Challenges

Opportunities for Growth and Innovation

Despite the challenges, the adoption of new technologies presents numerous opportunities for growth and innovation in the cleaning industry. By embracing digital marketing and online engagement tools, cleaning companies can reach new customers and expand their market share. For example, using social media platforms and search engine optimization (SEO) strategies, a local cleaning business can target specific customer segments and increase its visibility in the digital space.

Technologies also enable the development of new service models. For instance, companies can offer data - driven cleaning services, where they analyze data from IoT sensors and other sources to provide customized cleaning solutions based on a client's specific needs. This not only differentiates the company from its competitors but also allows for higher-value service offerings.

Collaboration between cleaning companies and technology providers is another avenue for growth. By working together, they can co - develop innovative solutions tailored to the unique requirements of the cleaning industry. For example, a cleaning company might partner with a robotics firm to design a new type of autonomous cleaning robot specifically for cleaning hard-to- reach areas in industrial facilities.

In conclusion, the future of the cleaning industry is filled with both promise and challenges. While the adoption of new technologies will require significant investment and effort, the potential rewards in terms of improved efficiency, enhanced service quality, and business growth are substantial. Cleaning companies that are able to navigate these challenges and embrace technological change will be well - positioned to thrive in the digital age.

8. CONCLUSION

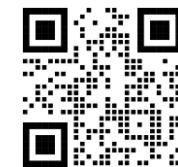
The cleaning industry in Singapore has undergone a remarkable transformation, propelled by a powerful combination of technological innovation and robust government support. Technologies such as cloud-based platforms, IoT-driven systems, and AI-powered solutions have streamlined operations, enhanced efficiency, and improved service quality. cloud-based platforms centralize data, enabling real-time management across multiple sites, while IoT sensors automate cleaning schedules based on occupancy, optimising resource allocation. AI and data analytics help in making informed decisions, predicting cleaning needs, and optimising routes, resulting in significant cost savings and increased productivity.

The Singaporean government has played a pivotal role in facilitating this transformation through various financial incentives, policies, and training initiatives. Grants like PSG, EDG, and those under ES ITM 2025 have made it more affordable for cleaning companies, especially SMEs, to adopt new technologies. Sector-specific incentives promote high-quality and sustainable practices, while skills-development programs ensure the workforce can adapt to technological changes. This support has not only reduced the financial barriers to innovation but also created a conducive environment for the industry's growth.

Despite the progress, the industry faces challenges in the future, such as high implementation costs for emerging technologies, potential workforce resistance, and interoperability issues. However, with the strong foundation established by existing technologies and government support, cleaning companies are well-equipped to overcome these hurdles. By continuing to leverage available resources, collaborating with technology providers, and investing in training, the industry can look forward to sustained growth, improved competitiveness, and a contribution to a cleaner, more sustainable Singapore.



[Click here to watch video.](#)



Industry peers who had successfully deployed sustainable technologies.

Source: IMDA, <https://youtu.be/ONDo4Zodq8Y>

9. Feedback and Suggestions

With the sector evolving rapidly, your expertise and perspectives are vital to refining this resource. We encourage industry professionals to share feedback, ensuring the roadmap remains practical, forward-thinking, and aligned with real-world needs.

To contribute your ideas: Visit the link or scan the QR code below.

Your input will help shape a resilient, tech-driven future for Singapore's cleaning industry. Join us in redefining excellence!



**EMAS Technology Playbook:
Share Your Contribution**

<https://forms.gle/jgNUyHSFQcMgEc5h8>

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