Industry 4.0
Transforming Singapore’sWarehouses
The fourth industrial revolution or Industry 4.0 is transforming the way storage and logistics functions are being set-up.

Today, machines with artificial intelligence (A.I.) capabilities that run autonomously, learn and adapt, collect and analyse data, communicate and propose decisions, are increasingly being adopted as part of the supply chain process.

However, as demands to incorporate Industry 4.0 initiatives such as the Internet of Things (IoT), robotics and A.I. into the logistics business grow, older developments may face some infrastructure constraints as the setting up of smart interconnected facilities will require higher building specifications (e.g. higher floor-loading capacity, higher electrical loading and fibre optic infrastructure) to cope with the higher electrical demands and wireless connectivity.

In light of this, how can logistics service providers (LSPs), end-users and warehouse landlords/owners gear up their brick-and-mortar facilities to meet the demands of the digital economy? This paper discusses some possible options.
Gearing up for Industry 4.0

Industry 4.0 is altering supply chains and raising customer expectations on speed, accuracy and visibility of inventory information across the globe.

Essentially, the supply chain process entails managing the activities of various stakeholders (e.g. raw material suppliers, manufacturers and distributors) involved at different stages of a product’s development process, from its infancy to the last mile delivery of the finished good to the consumer, using the most cost-effective and streamlined approach. This supply chain management process – whereby logistics is only one of the components – is complex and often challenged by unexpected delivery delays, inventory management issues, manpower constraints and cost concerns.

Notwithstanding, by harnessing the power of technology and the internet, different aspects of the product development process which were treated as separate functions previously, can now be linked up to form a seamless digital integrated supply chain network starting from the product’s research and development stage to the last-mile delivery of the finished goods to consumers. This led to improved agility and visibility.

In Singapore, some LSPs, end-users and warehouse landlords/owners have already joined the Industry 4.0 bandwagon.

One of the forerunners is the YCH Group which announced in December 2012 the development of a new state-of-the-art supply chain facility on a 6.5 ha site in Jurong West. Costing more than SGD 200 million, Supply Chain City was officially launched in September 2017. The Green Mark Platinum certified facility features the FUSIONARIS patented system which combines five floors of ramp-up warehouse covering a total area of 800,000 sq ft and a 50-m automated storage and retrieval system (ASRS) supplied by SSI Schaefer occupying a land area of 110,000 sq ft.

Key Highlights of Supply Chain City

<table>
<thead>
<tr>
<th>Address</th>
<th>8 Bulim Avenue, Singapore 648166</th>
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</thead>
<tbody>
<tr>
<td>Total Cost</td>
<td>More than SGD 200 million</td>
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<tr>
<td>Land Area</td>
<td>6.5 ha</td>
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<tr>
<td>Gross Floor Area</td>
<td>Approximate 2 million sq ft</td>
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<tr>
<td>Warehouse System</td>
<td>FUSIONARIS: FUSION of Automated Storage and Retrieval System (ASRS) and Ramp up Integrated Solution</td>
</tr>
<tr>
<td></td>
<td>• Patented system designed for scalability and operations around the clock, 24-7 for 365 days.</td>
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<tr>
<td></td>
<td>• Features a 50-metre ASRS occupying 110,000 sq ft of land to move 66,624 pallets which without the ASRS would have required 700,000 sq ft of built-up space.</td>
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<tr>
<td></td>
<td>• Five-storey ramp-up warehouse covering 800,000 sq ft of 50-metre height with total of 120 loading bays.</td>
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<tr>
<td></td>
<td>• Total throughput of 450 pallets per hour, reducing the retrieval of a pallet from 3.5 minutes (210 seconds) to 10 seconds, resulting in 95% improvement in efficiency.</td>
</tr>
<tr>
<td></td>
<td>• State-of-the-art supply chain management technologies and equipment.</td>
</tr>
<tr>
<td>Others</td>
<td>• BCA Green Mark Platinum certified</td>
</tr>
<tr>
<td></td>
<td>• 500,000 sq ft of modular office space, shared facilities and common areas</td>
</tr>
</tbody>
</table>

Source: YCH Group press release (22 September 2017)
More recently, Cache Logistics Trust developed and leased a customised facility for DHL Supply Chain Singapore’s Advanced Regional Centre which opened in 2016, while LOGOS and Yang Kee Logistics jointly completed the development of the Yang Kee Integrated Logistics Hub featuring a new automated container depot in 3Q 2018.

Earlier in 2018, local supermarket chain NTUC Fairprice unveiled its new AutoStore, an automated system using robotics to maximise storage space, optimise manpower and boost productivity, at its High-Tech Distribution Centre facility within FairPrice Hub at Joo Koon to support its online grocery business.

Yusen Logistics Singapore Pte Ltd also embarked on the development of a new warehouse on its existing site at No. 30 Tuas Avenue 13 as part of its future proofing strategy. Expected to be operational by 2019, the new three-storey ramp-up warehouse designed and built by Boustead Projects, will offer seamless process integration with the existing building. It will have about 215,000 sq ft of storage area, 36 loading bays and a rooftop parking area of around 86,000 sq ft for up to 100 trailers. And to transform the conventional warehouse operation to a smart data driven logistics operation, advanced robotic, radio-frequency identification (RFID), vision recognition system and autonomous technology will be installed and integrated with Swisslog Autostore, an automated ultra-high-density storage and robotic order-picking technology. ¹

Indeed, as illustrated above, there is no one-size-fit-all solution for those looking to automate their warehouses. While storage and automation solutions providers such as SSI Schaefer and Swisslog offer a wide range of options including Automated Guided Vehicles (AGV), automated picking systems and the ASRS, the desired solution will hinge on a myriad of factors and considerations. These include the volume and type of goods handled, funding and costs involved, manpower capability, the suitability of the existing facility and whether there are alternative space solutions, land availability (for those looking at greenfield developments) as well as the business strategy of the LSP/end-user going forward.

The above, in turn, will have a bearing on the LSP/end-user’s real estate requirements. In the following section, we discuss three possible real estate outcomes for LSPs and end-users looking to embrace Industry 4.0, the key considerations for each option, as well as how warehouse landlords/owners can gear up their facilities to meet the needs of Industry 4.0.

Examples of Smart Warehouse Features

Advance Surveillance Systems
- Video monitoring
- Remote gate entry/exit control solutions
- Cyber security systems

Green Warehouse Solutions
- Smart LED lighting
- Solar panels
- Rainwater collection
- Automated power controls

Warehouse Management Systems (WMS)
- Automated real-time inventory tracking, control and order processing
- Automated preventive maintenance scheduling

Warehouse Automation and Robotics
- Automated Storage & Retrieval Systems (ASRS)
- Automated picking tools (e.g. sorters, robotic arms)
- Automated Guided Vehicles (AGVs)
- Collaborative Robots (Cobots)

Vision Technologies
- Intelligent cameras/sensors
- Barcode scanners
- Vision guided robots

Full Network Connectivity
- Core IT Infrastructure
- WiFi connectivity
- Cloud storage

Source: JLL Research
Options for Consideration

Option 1: Upgrade/Automate Existing Warehouses
Smart facilities with machines and cyber connected systems will require higher building specifications such as higher floor-loading capacity, higher electrical loading and fibre optic infrastructure.

While changes to the physical shell of existing developments are limited, upgrading the power supply and making buildings fibre-ready are quick and easy fixes that LSPs/end-users considering automating their warehouse operations and warehouse landlords/owners can undertake to enhance the specifications of their existing facilities.

Upgrading the building’s incoming electrical supply usually takes about 6-9 months. This may be undertaken by the landlord or tenant. In cases where the LSP initiated the power upgrading work, a cost sharing arrangement will usually be worked out with the landlord.

As most buildings are already fibre-enabled, implementation of IoT technology should not pose any major issue.

However, due to the physical building constraints in some of these existing premises, customisation of storage and automation solutions may be required and likely at a price premium.

In addition, the facility’s physical limitations such as the existing floor-to-ceiling height and floor-loading capacity may render it unsuitable for implementing more advance warehouse automation solutions which may impede or slow down the LSP/end-user’s plans to gear up their business operations for Industry 4.0. For instance, we understand there may be minimum floor-to-ceiling height requirements to accommodate an ASRS for generic palletised cargo in order to maximise the storage volume and Return on Investment (“ROI”).

Key Advantages/Opportunities

LSP/End-User Perspective
- Fastest and least costly option compared to relocation or redevelopment
- Opportunity to reduce operational costs with better efficiency

Warehouse Landlords/Owner Perspective
- Quick and easy way to improve building’s specifications
- Faster and less costly than redevelopment
- Improve marketability in the short-term

Key Challenges/Threats

- Physical building/space limitations
- Price premium for customisation of storage and automation solutions
- Impede/slow-down long-term plans to embrace Industry 4.0
- Physical building limitations remain e.g. floor-to-ceiling height, floor-loading capacity
- Risk of functional obsolescence in the longer term

Source: JLL Research
Option 2: Relocate to an Existing Warehouse with Higher Specifications

Due to the physical limitations of existing premises, some LSPs/end-users may seek alternative warehouse premises with higher specification – either through acquisition or lease – that can better accommodate their plans for Industry 4.0. This reinforces the need for warehouse landlords to proactively review the relevance of their existing property portfolio and explore upgrades to the specifications of their existing buildings to improve marketability as discussed in Option 1.

From a cost and time perspective, relocating to a higher specification warehouse will typically be faster and cheaper than demolishing and reconstructing a brand new facility. However, disruptions to existing business operations can be expected and the search for a suitable alternative warehouse may take longer than envisaged.

For example, some older buildings with shorter land tenures may make a less compelling case for investing in costly automation systems which usually require a longer ROI of 10 years or more. In some cases, the LSP/end-user may still need to enhance the building’s electrical supply which may take about 6-9 months or more, and work out the cost sharing arrangement with the landlord for the upgrading work.

However, as some warehouse landlords/owners are less receptive towards offering extended rent free periods beyond the typical market practice of 1-3 months, the LSPs/end-users may be required to pay rents for any extended fit-out period.

LSPs/end-users leasing their premises should also take into consideration the flexibility of the leases (e.g. option to terminate in full/partial the lease term or floor area and option for temporary expansion subject to availability of space within the property during peak business periods) and opportunities for future space expansion (e.g. Right of First Refusal (ROFR) for any space availabilities within the property for any future expansion).

However, there is less certainty on the real estate cost for those renting their premises, with rents and lease terms subject to market dynamics and negotiations.

Other considerations include the suitability of the space for the targeted type of goods to be handled, as well as the time required to source for and install the software and hardware for the warehouse automation which can be very costly.

Last but not least, without a custom-built development, the LSP/end-user still runs the risk of ending up with a less-than-ideal facility in terms of location and building attributes.

Key Advantages/Opportunities

- Faster than redevelopment
- Less costly than leasing from a customised development
- Able to see the actual space, and assess the suitability of the neighbouring operations and environment

Key Challenges/Threats

- Search for a suitable alternative property may take longer than expected
- Disruption to existing business operations
- Physical building limitations may still exist e.g. may still need to upgrade building’s power supply
- Less certainty on the real estate cost if leasing the premises
- Risk of settling for a less-than-ideal facility

Source: JLL Research
Option 3: Tear Down and Rebuild/Greenfield Developments

Given the limitations of the earlier two options, demolishing and redeveloping their existing facilities or custom-building a brand new facility incorporating latest advance warehouse management systems may well be the most ideal solution for LSPs/end-users with a longer term business strategy in mind. Likewise, warehouse landlords with functionally obsolete facilities could consider redevelopment if the planning parameters such as the gross plot ratio and locational attributes (i.e. surrounding uses) permits.

Typically, it takes about 24-30 months to design, construct and fit out a new warehouse facility. However, a longer lead time may be required for the installation of more complex automation infrastructure.

In undertaking the redevelopment, there is merit in designing a versatile facility that can be modified in the future. Incorporating modular mechanical and electrical (M&E) systems for instance, will allow for future expansion due to the adoption of Industry 4.0 initiatives by occupiers. Examples include spare risers to run M&E cables, expansion provision in the electrical room to accommodate future increase in power requirements and having designated areas for additional water tanks and air-conditioning compressors.

The new building can also be constructed with a floor-loading capacity that is above the current requirement, to allow for the flexibility to add more floors (if the gross floor area has not been maximised) when needed.

LSPs/end-users looking for a purpose-built facility can also partner or enter into build-to-lease arrangements with warehouse landlords. However, for those looking to adopt advanced automation systems such as the ASRS into their warehouse operations, it is advisable to appoint an experienced storage and automation solutions provider upfront so that requirements like the floor-to-ceiling height for the ASRS can be incorporated into the building design.

Landlords should also take into consideration the flexibility of the space/design of the facility to cater to the needs of different types of tenants/goods so as to improve the marketability of the development.

Both LSPs and landlords developing their facilities can also take advantage of the Green Mark Gross Floor Area Incentive Scheme 3 which aims to encourage the development of buildings with higher tier Green Mark ratings (i.e. Green Mark Platinum or Green Mark GoldPlus). The incorporation of green features in the warehouse design such as energy efficient LED lighting, efficient air-conditioning systems and installing solar panels will translate into energy and water savings that can offset some of the building operating costs arising from the implementation of Industry 4.0 initiatives (e.g. higher power usage).

Examples of Green Warehouses in Singapore

<table>
<thead>
<tr>
<th>Name of Warehouse</th>
<th>Green Mark Certification</th>
<th>Examples of Green Features</th>
<th>Estimated Annual Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>CWT Mega Integrated Logistics Hub (47 Jalan Buroh)</td>
<td>Platinum</td>
<td>• Energy efficient LED lighting system</td>
<td>• Energy: 8.82 mil kWh/yr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Energy efficient chilled water plant</td>
<td>• Water: 28,047 m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Solar Photovoltaic (PV) of 539kWp that offsets 5% of the annual energy consumption</td>
<td>• ETTV*: 29.96 W/m²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Extensive use of Green Concrete with recycled aggregates</td>
<td></td>
</tr>
<tr>
<td>JTC Logistics Hub</td>
<td>Platinum</td>
<td>• Optimised building form and space planning to minimise direct solar exposure of air conditioned spaces</td>
<td>• Energy: 3.38 mil kWh/yr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Optimising daylighting and control glare through design of light shelves (internal &amp; external)</td>
<td>• Water: 13,498 m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• ETTV: 25.28 W/m²</td>
</tr>
<tr>
<td>LOGOS-Yang Kee Warehouse</td>
<td>Platinum</td>
<td>• High efficient LED lighting</td>
<td>• Energy: 1.77 mil kWh/yr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Efficient air-conditioning system</td>
<td>• Water: 19,847 m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Extensive use of environmentally friendly products</td>
<td>• ETTV: 36.65 W/m²</td>
</tr>
<tr>
<td>Panalpina Warehouse</td>
<td>Platinum</td>
<td>• High efficient LED lighting</td>
<td>• Energy: 2.61 mil kWh/yr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Efficient use of thermal insulated panel walls</td>
<td>• Water: 69,300 m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Extensive use of environmentally friendly products</td>
<td>• ETTV: 19.5 W/m²</td>
</tr>
</tbody>
</table>

*Envelope Thermal Transfer Value
Source: Building and Construction Authority, JLL Research, January 2019

3 For more information, please go to https://www.bca.gov.sg/GreenMark/gmgfa.html
However, the high capital investment outlay involved in developing a purpose-built warehouse with advanced automated systems could be a major barrier to entry, especially for smaller players, as it may not be easy to get the buy-in from top management, unless it is a top-down directive to automate the company’s warehouse operations or redevelop the property.

In addition, in instances where the current site is deemed unsuitable for redevelopment, sourcing and securing a suitable alternative land plot will take time. Due consideration must also be given to the required funding for the land and building cost, as well as for the warehouse automation software and hardware.

### Key Advantages/Opportunities

<table>
<thead>
<tr>
<th>LSP/End-User Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Opportunity to have a customised state-of-the-art facility with latest advanced warehouse automation systems and with future business growth in mind</td>
</tr>
</tbody>
</table>

### Key Challenges/Threats

<table>
<thead>
<tr>
<th>Warehouse Landlords/Owner Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Slowest and most costly option compared to upgrading the specifications of existing buildings and relocation</td>
</tr>
<tr>
<td>• May be difficult to convince top management</td>
</tr>
<tr>
<td>• May need to source for alternative sites if current site is deemed unsuitable</td>
</tr>
<tr>
<td>• Funding considerations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LSP/End-User Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Opportunity to redevelop and refresh existing property portfolio</td>
</tr>
<tr>
<td>• Improve marketability as Industry 4.0 gains traction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Warehouse Landlords/Owner Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Getting management support to redevelop aging warehouses</td>
</tr>
<tr>
<td>• Funding considerations</td>
</tr>
<tr>
<td>• Developing customised build-to-lease facility for specific end-users may limit flexibility to lease it to other types of end-users should the master lessee leaves at the end of the lease term</td>
</tr>
</tbody>
</table>

Source: JLL Research
Conclusion

The fourth industrial revolution is real and will continue to transform the logistics landscape, including the accompanying brick-and-mortar. For LSPs/end-users and warehouse landlords/owners participating in this digital logistics journey, the following are some key considerations to bear in mind:

**Begin with the end in mind**

Before jumping on the Industry 4.0 bandwagon, take time to establish and understand the end objectives. This could range from improving warehouse productivity, reducing the reliance on manpower, and automating just a part of the business process or the entire warehouse operations.

**Think long term**

For those looking to redevelop or custom-build their own state-of-the-art facilities with advanced warehouse automation systems, understand that this is a long-term investment due to the high capital outlay. The approach to automation – which is usually a 10 to 20-year decision – can be complex and costly if not well planned and defined. As such, any successful implementation of automation requires a strategic alignment with the organisation.¹

**Engage the experts early**

LSPs and landlords should pro-actively evaluate the suitability of their existing facilities and upgrade or rebuild where necessary to cater to the digital economy so as to stay in or ahead of the competition.

As there is no one-size-fit-all solution, and to ensure the most efficient automated warehouse design, we would advise end-users/LSPs and warehouse landlords/owners to engage the services of real estate consultants and/or storage and automation solutions providers upfront, for advice on customising the warehouse operations and incorporate any requirements into the real estate facility design.

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