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Towards Logistics 4.0 – Preparing for the next stage of logistics in Hong Kong

Implementation Manual

Contents

Editorial Board and Disclaimer

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1 Executive Summary

The term *Logistics 4.0* is focusing not only on the logistical processes in the shipping and manufacturing sector, it embraces technological use cases enhancing the full value-creation process from the initial order to delivering a valuable product to the customer. A successful transformation requires the solutions, realized through technologies, to be aligned with both, the focus on the unique situation of the organisation as well as with its culture and specific qualifications. The goal of Logistics 4.0, of becoming more flexible in the interaction with stakeholders and their shifting demands, is required in the current situation while increasing resistance against unplanned disruptions.

The Reader's Guide gives an overview over the whole Implementation Manual. The Implementation Manual condenses and gives context for organisations facing Logistics 4.0 challenges, connecting the Logistics 4.0 questionnaire with the Roadmap based on use cases as well as perspective from the assessed shipping and manufacturing companies. The focus is set on transitioning from a Level of -2 to reaching Level L1: Visibility as the main target for the full industry. This is followed by the functional enablers – a perspective on how Logistics 4.0 projects can be structured with its unique requirements and additionally the Logistics 4.0 implementation teams and capability building represent a proven method to successfully implement interwoven, interdisciplinary projects. The Technology landscape gives an overview of the different tools that support the full transformation process as well as being specifically useful for the use cases. The technologies cover the areas of collecting, transferring, analyzing, processing and output of data and actions which are required for a Logistics 4.0 adoption. The Vendor landscape shows a collection of identified suppliers who, divided into four categories, can help with their specific expertise and are driving Logistics 4.0 adoption forward. Ultimately, the Recommendations for HK Logistics 4.0 give out six suggestions. The first three were deducted from the assessed companies in Hong Kong and represent a general recommendation directed to companies active in the logistics sector. They focus on a digitalisation strategy joined with a vision of the company, put an emphasis on collecting data, on LEAN principles to continuously optimize operations as well as a general goal of increasing flexibility when it comes to creating a competitive advantage. Three further recommendations are given as an industry-wide possibility to support SMEs in their Logistics 4.0 transformation journey.

This document is a guideline for every shipping and manufacturing company to implement Logistics 4.0 by combining the current state of the sector, aiming at a stepwise approach to attain higher levels of digital maturity, as well as a perspective on the market overall and the available solution providers.

2 Introduction – Project Background

2.1 Motivation

The global pandemic, chip crisis, disrupted logistics networks and increasing compliance requirements pose unforeseeable challenges to global enterprises. Uncertainties and delays in global supply chains accumulate while consumer expectations on what can be done online and what can be delivered on short notice are steadily increasing. The resources that are not scarce or insufficient to meet the customer demand cannot be miraculously generated through digitalisation and connectivity in global value networks. Still, digital capabilities help companies to create comprehensive transparency and react faster and better in uncertain and dynamic environments. The term *Logistics 4.0* describes the impact of Industry 4.0 on logistics and the interaction of Industry 4.0 technologies and paradigms with the cross-functional and inter-company functions and processes of logistics.

The digital connectivity and close integration of processes, assets, and entities in the supply chain, such as producers, vendors, warehouses, transportation companies, distribution centers, retailers and customers offers great potential for all stakeholders. Companies that continue to build their digital capabilities in logistics can, for example, minimize their costs through stronger collaboration, transparency about the status quo, increased automation, and higher efficiency of processes. On the other hand, companies have the opportunity to enhance customer satisfaction through increased delivery reliability, quality, flexibility and can explore growth opportunities through new digital business models.

2.2 Project Scope

To help HKSMEs companies to implement Logistics 4.0 and build stronger digital capabilities in the area of logistics, the Hong Kong Shippers' Council, together with the Hong Kong Productivity Council (HKPC) and international partners, initiated the project "Towards Logistics 4.0 - Preparing for The Next Stage of Logistics in Hong Kong".

During the three major project phases from 2019 to 2022, more than 100 HKSMEs companies of the Shippers Council were surveyed on their logistics services and processes. In total, assessments with 22 selected pilot companies that fall into the categories of manufacturing companies with trading activities, trading companies without manufacturing activities, sea freight forwarder companies as well as cross border logistics companies were conducted to determine the status quo of logistics processes. Based on the gained insights, extensive roadmaps were developed to support companies in shaping the transformation to Logistics 4.0 and taking steps towards value addition Furthermore, international

conferences and seminars were held to share insights on the value, application fields and business model innovations of Logistics 4.0.

2.3 Introduction of Entities

Shippers Council

The Hong Kong Shippers Council was established in 1967. The council consists of 15 trade associations and serves to protect and promote the interests of Hong Kong exporters and importers, traders and manufacturers in any issues relating to the transportation of merchandise by sea, land, and air. The Shippers Council represents Hong Kong shippers globally and shapes the regulatory environment on issues relating to the shipping and transportation of goods on a local, regional, and global level together with other regional and international organisation.

Hong Kong Productivity Council (HKPC)

The Hong Kong Productivity Council (HKPC), established in 1967, is a multidisciplinary organisation, which is tasked to promote productivity excellence in the Hong Kong industry sector and assist Hong Kong enterprises through the introduction of advanced technologies and innovative service offerings. HKPC focuses on topics such as IoT, big data analytics, AI, robotics, digital manufacturing, etc., to help companies to increase competitiveness in local and international markets, improve productivity, and reduce operating costs.

Fraunhofer IPT

The Fraunhofer society is a German research organisation and the largest organisation of applied research in Europe. Fraunhofer IPT, located in Aachen, is part of the largest cluster of production technology institutes in Europe. This cluster is formed together with renowned institutes at the RWTH Aachen Campus and is conducting research on providing connected, adaptive production solutions in Industry 4.0 for companies of all sizes.

INC Invention Center

INC Invention Center is a spin-off of Fraunhofer IPT and bundles know-how from various Fraunhofer and research institutes. It is headquartered at RWTH Aachen Campus and offers professional consulting and implementation services by helping companies become leading innovators through profound expertise in the fields of Industry 4.0, AI in production, sustainability as well as innovation and technology management.

In the project at hand, INC Invention Center as implementation agent was responsible for conducting the cross-industry survey of companies as well as the assessments of the selected pilot companies

together with the HKPC. Based on this, INC developed roadmaps to provide Hong Kong companies with actionable recommendations for their transformation to Logistics 4.0.

3 Introduction to Logistics 4.0 & Industry 4.0

3.1 Industry 4.0

Industry 4.0 is hailed as the fourth industrial revolution and constitutes a fundamental transformation of industrial value creation through the emergence of flexible, highly dynamic, and globally connected value networks. For companies, the vision of industry 4.0 is to transform into a learning, agile enterprise that can adapt to volatile markets and dynamic environments and respond quickly to changing conditions. Industry 4.0 goes beyond automation as it enables the transmission, processing, and use of mass data.

For enterprises, Industry 4.0 offers new opportunities to find value and capture it. Either companies can increase growth and revenue by introducing data-based business models, developing smart products, or offering data-driven services. On the other hand, costs can be reduced by increasing efficiency and flexibility, saving time, or improving quality of products and services. Hence, Industry 4.0 is not an end in itself, but enables companies to grow or improve operations supported by modern information and communication technology (ICT).

Technology Enablers of Industry 4.0

From a technology perspective, the revolutionary aspect lies in the ability of multimodal ad-hoc networking for communication and information exchange of people and cyber-physical systems in real-time. Data consistency along the value chain is enabled by the so-called “single source of truth” concept, which essentially describes the practice of structuring data and information in a redundance-free manner to circumvent contradicting data sets and ensure a reliable basis for data analytics applications. The integration of modern sensor technologies and ICT in physical assets, the interconnection of people, systems, and devices via the Internet of Things (IoT), analytics capabilities, and a variety of assistance systems to provide data-based insights to users are the main technology enablers and central contributors to bringing intelligence to the full value chain.

3.2 Logistics 4.0

The connection of people and cyber-physical systems for the communication and exchange of data as well as the progression of the internet from an information source to the Internet of Things and Services also have significant consequences for the logistics sector. The technological enablers of Industry 4.0 offer great potential in terms of transparency, speed, flexibility, and manageability of logistics processes and are transforming the logistics sector toward the next stage of evolution: Logistics 4.0.

For logistics, digitalisation enables an interactive flexibilization of business models, processes, and partner networks. In a narrower sense, Logistics 4.0 encompasses the linking and integration of logistics processes inside and outside companies and production facilities along the entire value chain to create decentralized and real-time logistics networks. Ultimately, Logistics 4.0 is not only about creating a digital supply chain for individual companies, but also about connecting various value and supply chains of global company networks.

All elements and entities in the network, such as IT systems, humans, assets, and goods are connected via the internet and can communicate with each other. Humans can for example send data to the network via smartphones or tablets and materials or goods can be equipped with beacons to send data about their location or condition. Other elements are, for example, IoT devices with an inherent intelligence to autonomously perform tasks of different complexity, such as handheld devices, cameras, detectors, or self-navigating vehicles.

Benefits of Logistics 4.0

The goals of Logistics 4.0 are inter-company optimization and automation of material flows and resource utilization in both inbound and outbound logistics. Companies that are building more digital capabilities in the context of logistics can create significant competitive advantages by reducing their costs and at the same time increasing customer satisfaction by improving service quality and minimizing delivery errors. Among other things, Logistics 4.0 creates value for companies in terms of:

Name	Description
Delivery reliability, quality, and flexibility	Delivery reliability is enabled through end-to-end tracking of items and assets, prediction of bottlenecks and delays and identification of risks. Higher quality of goods and services is achieved through condition monitoring of goods and monitoring of processes in real time. Flexibility can be increased based on capabilities to adapt to dynamic environments and suggest alternative routes or scenarios.
Increased transparency	The integration of entities and logistics processes along the entire supply chain creates comprehensive transparency and thus facilitates supply chain management and supports decision-making.
Automation of processes	Progressing digitalisation and connection also facilitates partly or full automation. For example, processes or workflows can be supported or even fully automated by using robotic process automation (RPA), or cargo itself could become intelligent and organize its own transport autonomously.
Enhanced collaboration	The connection of entities in the supply chain enables a higher division of labor and efficient collaboration with partners, suppliers, and customers.
New services & business models	The extensive collection of data throughout the supply chain enables data-driven and platform-based business models with new types of revenue models and new ways of service provision to the customer, such as SaaS models (Software as a Service).

Table 1: Value of Logistics 4.0

Evolution from Logistics 1.0 to Logistics 4.0

Figure 1: Evolution of Logistics

Due to the lack of digital technologies, traditional logistics is less efficient, highly manual, and requires centralized and complex planning. Typical characteristics are paper-based documentation, manual input, and transfer of data between IT systems, scanning of documents and constantly making phone calls to update the latest cargo status. These characteristics illustrate the procedures of traditional logistics and reflect the current status quo of many companies.

The evolutionary stages from Logistics 1.0 to Logistics 4.0 over the course from the 19th to the 21st century can be described as follows:

Stage	Logistics 1.0: "Local logistics"	Logistics 2.0: "Region centric logistics"	Logistics 3.0: "Global logistics"	Logistics 4.0: "Interconnected global logistics"
Content	Mechanization of transport from animal force to the operation and utilization of railways and own vehicles.	Higher complexity for logistics due to a growing logistics sector and routes focusing on inter- and intra-regional clusters and large-scale utilization of equipment (e.g., trucks, ships, aircraft).	Strong involvement of 3rd party logistics service providers, as companies inevitably do not have a fleet available everywhere and in sufficient numbers. Transport remains an intermediate step in the client's business process.	Independent automated control of logistics across the entire business process of companies and collaboration between logistic enterprises - logistic customer service as a priority.

Table 2: Evolutionary stages of Logistics

3.3 Challenges and Opportunities of Logistics 4.0 for Hong Kong

Observed challenges in Logistics 4.0 for Hong Kong SMEs

During the visits of the selected pilot companies, various challenges in the general context of logistics and for the introduction of Logistics 4.0 were observed:

Independent introduction of Logistics 4.0

SMEs often do not have the skills themselves to introduce Logistics 4.0, especially in shipping. Manufacturing companies have to some extend already established teams who have built digital production applications and are now also working on logistics 4.0 applications. Most IT staff is focused on commercial IT systems like ERPs or very specific IT solutions to digitalize individual processes. In this context, operational and business model improvements are left behind. Here, more knowledge on IoT applications and a more process-oriented thinking need to be promoted.

Standardization of interfaces

Interfaces are not standardized. Every new vendor and value partner has to be integrated, which often requires considerable effort or may not be even possible due to technologic or organisational constraints. If time and costs do not bring sufficient savings, integration may not be worth it.

Utilization of classic and manual communication methods

Many customers are still used to make use of e-mail or even fax/telephone for communication. Companies see themselves confronted with the question why they should digitalize if their customers do not insist to do so or even lack the capabilities to work together through new digital means. However, a generation shift at customers can quickly turn this around from API integration being not desired to being absolutely mandatory for maintaining business relationships. Thus, it is recommendable for companies to act proactively and already encourage their customers to benefit from the utilization of digital solutions and digital integration today.

Missing proactive approach towards driving Logistics 4.0 implementation

Consumer-facing companies innovate faster and adapt to changing market demand more rapidly. Individualization and connection to platforms like Amazon, Taobao, T-Malls, JD.com drives internal digital capabilities. For many, this is a big challenge at the beginning, but once they have achieved it, it helps drive the overall digitisation of the company. Observations in industry show that many companies stop at that point and digitalisation is driven to exactly the point where it's needed to interoperate with platforms and rarely further. However, companies should take the opportunity to analyse what additional benefits could be achieved by improving their digital maturity and in which areas further action should be taken to, e.g., streamline operations, optimize processes, or develop data-driven business models for leverage competitive advantage.

Opportunities of Logistics 4.0 for companies in the GBA and ASEAN region

The opportunities of Logistics 4.0 for companies in the GBA and ASEAN region are divided into two groups and highlight below:

First, companies who do business in the GBA and ASEAN region to serve global customers with manufactured goods from the GBA or ASEAN region and then deliver to customers globally. Here, Logistics 4.0 can create business opportunities with regards to two main aspects:

1. With higher volatilities in supply chains and increasing compliance regulations imposed by governments worldwide, transparency and real-time tracking of shipments become clear unique selling points (USPs). Currently, many global customers (e.g., in Europe, the Americas, Middle East) make daily phone calls to ask suppliers about the exact position of their expected deliveries, e.g., whether it is on the ship, way, or how long it will still take. Providing this information in a digital form facilitates quicker and more adequate reactions. Thus, it saves costs for customers as the whole planning process from procurement over production to delivery can be adapted to the current situation.

2. In addition, the mentioned compliance requirements both in terms of CO_2 footprint and documentation of quality parameters can be significantly improved by automatic documentation and including features that allow a tracing of the full supply chain. For example, the capability to collect data on goods vibration to find the root cause for quality defects before the component is shipped to the customer or localization to determine the exact position of shipments can lead to a competitive advantage and are already being demanded by customers around the world.

The development of these capabilities throughout companies in the supply chain is only progressing slowly. But, eventually, every supply chain's tier will need to be able to handle this.

Secondly, for companies who are serving the GBA and ASEAN consumer markets, Logistics 4.0 can also create business opportunities with regards to two aspects:

1. Customers in these markets are already acquainted to very fast deliveries and tracking of deliveries through apps like Amazon, T-Malls, Taobao or others. To satisfy these requirements, companies anyway have to build the infrastructure to connect to these platforms and shouldn't stop once they reached that milestone. Instead, they should use the newly acquired knowledge and skills to optimize their own internal processes and further develop their business models to differentiate from competition, e.g., via customer segmentation into those who prefer more simple and cheaper services and those who are willing to pay more for higher value services based on the analysis of customer data.

2. Besides the right pricing, flexibilization, speed and customization are the most important customer demands in this market. Companies should pursue business model innovation to offer matching goods and services that satisfy these demands. Here, logistics plays an integral role, as the more customization can be done in logistics, the more efficient the production can still be. Huge manufacturing organisations usually have complex defined processes for changes and bringing flexibility in any processes likes logistics has a long decision-making process due to the dependencies inside the organisation. This is a key advantage of SMEs over big enterprises who can adapt faster.

4 Reader's Guide

In this document, we introduce the Implementation Manual. This manual starts out with an exemplary, but fictive, Logistics company located in Hong Kong, which is facing similar challenges to the assessed companies. This is followed by a stepwise approach of the previously mentioned company implementing use cases based on the results of the Logistics 4.0 questionnaire. Connecting the dimension with the roadmap as well as giving context to the decisions that arise. Starting out with the lowest potential level of -2. After multiple steps of moving towards the final level L4 of Logistics 4.0, the previously mentioned use cases are then put into context for a successful implementation. The Functional Enablers are divided into two categories, first more context is given on how Logistics 4.0 projects can be run and the complexity that arises. Additionally, this is followed by an overview of the Teams and roles that were helpful to bring complex projects to a successful implementation as well as the required knowledge and qualification that is expected of the workforce. The Technology Landscape shows ten different technologies that have a strong impact on the Logistics 4.0 functionality and can help to facilitate and support the transformation of Logistics companies. The Vendor Landscape gives an overview of different suppliers who, like the technologies, are at the forefront of influencing the direction of where Logistics 4.0 is moving to. They are categorized into Sales and Planning, Transportation, Warehousing and Goods Management. Finally, the Recommendations for HK Logistics 4.0 conclude this document by giving out suggestions for individual SMEs as well as industry wide suggestions for the logistics sector in Hong Kong.

5 Implementation Manual

Exemplary company

Best Value Services HK Trading Ltd. (BVSHK) at a glance:

Revenue	120 Million HKD
Products & Services	Shipping & logistics services
Employees	370
White collar	250
Markets	Hong Kong, China, Vietnam

Best Value Services HK Trading Ltd. was founded in 1982 in Hong Kong by Andrew Chow, starting out with logistics services with his garage as storage and a pickup truck offering services to friends and families. Slowly transitioned away from the B2C business with local logistics solutions and into the B2B business. Here BVSHK company established itself as a global freight solution provider as international trade of China, ASEAN, Australia, North America, and Europe increased.

Headquartered in Hong Kong with facilities throughout South-east Asia and trading offices in London and California, BVSHK has made steps on the international market.

But while growth rates were stable for the last years reaching an annual revenue of around 120 million HKD, the increased usage of online platforms has resulted in an increase of e-commerce demand – shifting from high quantity orders from the B2B sector towards handling of B2C logistics processes and offering logistics services to multiple (mostly local) SMEs. As currently BVSHK has only established services for one local manufacturer, they are aiming to enhance their capabilities to offer services to the B2C market, back to the initial roots of the company.

Mr. Chow retired last year and handed over the company to his son Leo Chow, who identified a new direction for the company. Amid the dynamic global situation, Mr. Leo Chow wants to implement various modernization measures to face new global challenges ranging from political instability, the ongoing pandemic as well as increased resource prices and the continued property cost increases.

Locations:

The headquarter of BVSHK is in Hong Kong with its main warehouse of 30,000 m². Additionally, there are three warehouses in China and one in Vietnam (recently acquired), each around 10,000 m² in size.

Services:

BVSHK is providing warehousing, distribution, picking and packing services, which includes transportation, individual services and reverse logistics services. For the freight forwarding and distribution business, multi-modal solutions as well as customs clearances are part of the portfolio.

Employees:

With 370 employees in three different countries with 120 employees in Hong Kong, 140 in China and the remaining 110 employees in Vietnam. The qualifications of the white-collar employees can be considered market-average whereas those of the blue-collar employees vary based on seasonal requirements.

Revenues & costs:

The revenue of approximately 120 Million HKD was realized two years ago, with the current challenges resulting in a decrease in revenue while costs for all logistics related processes has increased.

Customers:

BVSHKs current customers are mostly manufacturers in China that require international freight solutions (mostly ocean freight and some air freight). The main customers in Hong Kong are consumer appliances manufacturers using the storage, picking, and packaging services of BVSHK which works with local delivery companies.

To start out the transition towards Logistics 4.0, Leo used the “Logistics 4.0 - Self-Assessment Questionnaire” to find out the current state of BVSHK. in all its Hong Kong and Vietnam facilities. The resulting Self-Assessment Scores show a diverse picture of different development stages of Logistics 4.0, where the Hong Kong location scored a 0,0 and the Vietnam location a -2,0 as they are at their start of digitalisation.

A Step one: Level -2 to 0: How to move towards Logistics 4.0

Leo, after taking over the company, wanted to visit the newly bought facility in Vietnam after having issues in getting correct information on their current status and development stage. The warehouse was just recently acquired to enhance and support the ASEAN market as well as moving into the healthcare market as that was the primary focus of the acquired company.

To find out the digitalisation status, Leo planned to use five days to assess the current state together with an interdisciplinary team from Honk Kong and local employees from all hierarchy levels.

As integration into the everyday business of BVSHK main facility in Hong Kong was the main goal, the target of reaching level 0 was set for the facility in Vietnam within the next two years.

To develop a roadmap and find out the required capabilities, Leo used the Logistics 4.0 - Self-Assessment Questionnaire to document and discover facility's current state. The basic collection of data and their output (in IOT (Sensors & Output)) was completely manual and prone to errors. All information was documented on paper, printed out whenever information was needed to be taken away from the few workstations (e.g., work order, a picking list, checking for product's quantity, etc.).

Storage locations in the warehouses were not structured based on customer but just randomly in a more chaotic fashion and the content of the storage facility was documented in multiple books, each located at one of the aisles where removal from pieces were collected in written form to keep the inventory levels up to date. There were a lot of errors and checking the inventory at the end of the fiscal year caused a lot of headaches among the employees and management.

Sadly, the company's state was found to still be relatively low with a final score of Self-Assessment Score of -2.

To transition out of this state and reach level 0, the facility should start a transformation process. Connecting the Self-Assessment Questionnaire with the roadmap for the matching industry can help to develop a customized and specific roadmap for every company to reach the higher maturity levels.

Dimension	Dimension Score
Data-driven Business Models	-2,0
Smart Services & Processes	-2,0
Smart Supply Chain & Operations	-2,0
Information Technology	-2,0
IoT	-2,0
Strategy & Organisation	-2,0
Culture & Mindset	-2,0
Self-Assessment Score	
-2,0	

To start the development of a roadmap, the results from the questionnaire were combined with the Logistics 4.0 roadmap. For the first dimension of Data-driven Business Models, the sales and IT departments were invited to brainstorm towards creating a formalized business model using business model canvas. The business model canvas is a framework for the visualization and structuring of business models, which covers all important aspects and supports new business model development. The current business situation was rough due to reduced operations in the core business and a new assessment of demand and changes had to be performed. This resulted in the definition of market requirements, identification of different customer groups with their specific demands, development of new pricing models and processes to adapt towards changes in the future to refine and reiterate on the needs of internal and external stakeholders. To drive this change, additional capabilities of the internal IT systems were defined which will be needed in the dimensions of Information Technology and IOT (Sensors & Output).

For the dimensions Smart Services & Processes customers had to manually call or write emails and inquire possible changes to their orders. This resulted in numerous errors as this information required to respond to the customer was not available readily to the sales department. They had to contact all relevant departments, causing additional work and inefficiencies. Additionally, the services offered by external solution providers (like priority shipping, managing import / export manifests, customs clearing and other services) were not documented and made available for internal use. To overcome this, consulting the roadmap in both the Smart services and Smart Processes dimensions, Leo and his team developed the goal to have all product and order related information available digitally and in a defined process relating to all offered services. To reach the required capabilities both a Customer Relationship Management (CRM) system and an Order Management System (OMS) were put on the roadmap.

The Dimension Smart Supply Chain & Operations was based on non-standardized, local spreadsheet files that were exchanged by email, both for internal communication as well as with suppliers. Consulting the roadmap, Leo's team first defined method for standardization of processes and templates to track and manage information relating to all logistical processes, then followed up by establishing requirements to manage the information storage and flow in matching IT systems referring to the dimensions Smart Supply Chain & Operations of the roadmap. Two different requirements were defined relating to a Supplier Relationship Management (SRM) and a Warehouse Management System (WMS) to manage the newly defined standardized input, output, and storage of information. As the current disruptions in the market from a wide range of sources are ongoing and unpredictable, a higher degree of details relating to internal as well as external information is required to keep the business processes running and be able to accurately accommodate disruptions and make

conscious decisions and communicate them to all affected parties. This does not only lead to the processes themselves being delayed but if contracts were signed and services were guaranteed a financial loss can occur, caused by higher costs or in the long term by unsatisfied and not returning customers. To facilitate the collection and exchange of information, standardization of management of information through RPA, in case API or EDI integration is not possible, can help to transfer information into the specific information systems without requiring manual intervention of the workforce.

For the two dimensions Information Technology and IOT (Sensors & Output) from the Questionnaire, a joined dimension is mentioned in the roadmap called Smart Technologies. Here the joined dimension defines the input possibilities of information into the dedicated documents first and later into the matching information technology systems. The required infrastructure needs to be managed and capable to process the information as well as having the possibility to output the information for the specific user, customer, supplier, process, or other action (e.g., automatic trigger of information of delayed orders to be send to customers, adjustments of storage locations information, etc.).

As all goods in the Vietnam location of BVSHK were unstructured, information was collected manually on paper, copy pasted to isolated spreadsheet files and only exchanged on a case-by-case basis, Leo and his team assessed the requirements to move to a digital form of connecting all incoming items with an internally managed SKU as a unique reference number available to all parties in the systems for material and inventory handling. The collection of this data is aimed at scanning barcodes at each station along the process to create a digital interface for every corresponding IT system (SRM, WMS, CRM, OMS, etc). To be capable to achieve this, the basic collection of data (e.g., storage location and parameters of the location, supplier information, package weight, quantity of items, size, etc.) must be integrated into each specific IT solution to be able to monitor levels and track their process states. To reach the higher logistics maturity level of 0, a requirement analysis was conducted by BVSHK for all planned software solutions resulting in a targeted growth of the supporting resources while the new software solutions for the departments are implemented and fully aligned.

The planned additional functionalities and management of targeted solution levels require the Vietnam location to adapt its Strategy & Organisation according to the new requirements. The definition and alignment of all company goals regarding digitalisation was pushed and defined. One thing to consider in the definition of the strategy of a company is, that even though outside parties can make certain steps easier or harder (e.g., based on their openness to share information) the general strategic goal of implementing new technologies and sharing information should be driven by internal forces and in alignment with the digital strategy.

This approach can be supported by both strategic and operational decisions that aim at more standardization and follow a defined procedure. For this, strategic meetings should be conducted to create a vision as well as goals for the company to align the goal of reaching a higher maturity level. To follow a standard operation procedure, ISO 9001 was followed to align the company with its customer's goals as well as the internal perspective to follow the PDCA (Plan, Do, Check, Act) cycle. To realize consistency in the growth of the IT infrastructure and capabilities, a basic IT governance was introduced, further following the roadmap Dimension of Strategy and organisation.

Lastly, the dimension of Culture & Mindset revealed a lack of knowledge about the capabilities of newly thought after solutions, their usage as well as their alignment with the newly defined processes. As knowledge was not shared throughout the company, a loss of employees with years of experience has previously caused disruptions and the inability to fully reach the customer's expectations. This can lead to problems when key personal is not available and can decrease efficiency in how processes are dealt with. To advance in this dimension, Leo consulted the roadmap and created an educational process with guidelines for new solutions, specifying their usefulness and requirement of adhering to them. Knowledge of the departments and employees was collected according to the roadmap and formalized as well as enriched with the new capabilities and processes. As an overarching topic a perspective that is often forgotten is the focus on the lean 5s principles. These support in driving a continuous improvement mindset called Sort, Set, Shine, Standardize and Sustain. The general focus of these five principles aims at reducing anything that is unnecessary (a waste), decrease variation and variance as well as focus on increasing productivity. This concept can be applied in all areas of a company, be it business processes, material, or information flow. For the warehouse in Vietnam location of BVSHK specific goals could be to reduce operational costs, increase inventory turnover and ease material handling for employees.

B Step two: Level 0 to L1: Visibility – What is happening?

For the BVSHK main location in HK, the self-assessment resulted in a Score of zero.

This score represents a company that has already reached the foundation condition of Logistics 4.0 by holistically finishing the development and implementation of "Systemization and Computerization" which belong to Logistics 3.0 as well as the Logistics 4.0 – Connectivity - Foundation Condition.

Dimension	Dimension Score
Data-driven Business Models	0,3
Smart Services & Processes	0,3
Smart Supply Chain & Operations	0,3
Information Technology	0,0
IoT	0,0
Strategy & Organisation	0,3
Culture & Mindset	0,3
Self-Assessment Score	
0,0	

To move further in the transformation process and understand the potential future state of BVSHK, Leo tried to understand the next step to fully reach a self-assessment score of **1,0**. Reaching this state is not an easy task as gaining holistic Logistics 4.0 Visibility and being able to answer the question "what is happening?" can be a challenging task.

Based on the evaluation, the lowest identified score(s) of all Dimensions should be focused. For BVSHK, a holistic advancement is required. However, for other companies, more diverse dimension scores are likely results of the self-assessment.

For the dimension Data-driven Business Models BVSHK has a target to enable a broad range of possibilities to allow its customers to access their order status in multiple variants through an online platform, a mobile app as well as being automatically forwarded to the matching responsible server contact. Currently, the accessibility of information for customers is still difficult. At the same time, customers cannot request additional services based on their individual requirements through the online platform. To see how to reach maturity level L1, the roadmap suggests to continuously analyze the market structure and enable customers to digitally interact with services supplied by BVSHK at their own accord.

For the dimension Smart Services & Processes the score of 0,3 in the self-assessment and checking in the roadmap leads to the suggestion to create a digital interface as well as automatic internal as well as external notifications in case of deviations from the planned processes relating to a specific customer. This requires a standardization of automatic triggers based on the supplied services as well as the possibility of the customer to request his specific requirements, based on the roadmap and dimension of Smart Services. Another suggestion is to implement a Customer Relationship Management (CRM) system and Order Management System (OMS) to supply the needed capabilities.

For the dimension Smart Supply Chain & Operations the resulting score is 0,3. Here, Leo should focus on both dimensions of the roadmap Smart Supply Chain and Smart Operations. For the Smart Supply chain, he can check “Get information automatically from logistics partners” and “Digital IT system integration of providers (EDIs/APIs)” while for the dimension Smart Operations the general aim is to integrate the collection of data inside department specific IT systems. The management of internal material flow, storage locations, asset management and picking processes can be managed by a dedicated system, like a warehouse management system (WMS). This system must allow the integration of different sources of information and should supply APIs for further integration into different information systems throughout the organisation.

To integrate **EDI/API** the first step is to understand and prioritize the different potential partners and processes that can be integrated. This can be done considering different aspects, for example the importance of the data that could be collected, the current tasks required to manually input and transfer it, their value to other supply chain partners and/or the value it would provide to the customer.

For the dimension **Information Technology** and **IoT**, Leo assesses BVSHK’s state as a **maturity level 0**. The recently introduced basic ERP (Enterprise Resource Planning) and department specific information systems all allow processes to be managed digitally, resulting in a score of 0. But Leo is uncertain on where to continue from there. After checking the roadmap, the next steps should be “Connectivity of IT systems to develop single source of truth” and “Measures to collect real-time data” to reach level **L**1. For these steps, first, to realize a single source of truth, all previously mentioned digital IT systems (WMS, OMS, CRM, etc.), have to be connected and integrated with each other to eliminate multiple variants of information stored in separated databases (e.g., orders, specifications, customer information, etc.) following the roadmaps dimension of Smart Technologies. To achieve this, Leo is aiming to have a unique identifier for every asset of BVSHK that will be used as a reference in each system. He can now also check the vendor landscape to get information on solution providers. It is important to understand here, that the isolated handling of spreadsheet files which can be shared by email or instant messenger services led to information silos. As all changes to these documents are not fed back to the information systems where an order, not updated version of the information will exist in a database, thereby working against a centrally connected single source of truth.

The second use case aims at a possibility to collect real-time data. As currently data is entered manually at various steps at BVSHK in different departments, the target is now to check how specific use cases can enable a digital input for all relevant process steps into the associating information systems based on printed tags (e.g. printed bar codes) with SKU specific reference numbers connected to a centrally managed unique identifier of the product joined with an infrastructure to collect process states

enabling tack and trace throughout the organisation. The tag can be attached to every item itself or be followed on carrier level or on a batch level, where the removal of every unit still has to be documented. A different solution away from the optical technology would be to move towards RFID-based tracking. The infrastructure for this, consisting of RFID-tags (also called RFID-transponders) with location-based RFID Sensors requires a higher initial investment cost but enables faster scanning in bulk and unlike optical based systems, doesn't require line of sight. The locations where the scanners should be located is based on the value-stream of every company itself. For BVSHK in HK, Leo decided to use a QR-Code based system as the goal is to have item-level traceability for all parts and the investment cost is relatively low. Scanners are available for all employees and each step from inbound receiving join with the confirmation of matching parts, then moving the parts into the corresponding storage location by scanning the code of the sorted location as well as item barcode. After an incoming order, the corresponding picking location is known to the operator who will then scan the storage location, the part to be sent transporting it to the packing station. After another scan there, the outgoing part is given to the logistics provider. Through this integration, a discrete tracking at defined points is realized to get information on every process start, end as well as duration. Through RFID a more holistic perspective is possible, joined with continuous monitoring of locations, but the investment cost of this solution was not feasible for Leo.

For the dimension of Strategy & Organisation BVSHK is evaluated as 0,3 based on the current lack of interaction of interdisciplinary departmental work and company-wide digital strategy development. As internal, department specific limitations are more understood the usage of external providers and consultants is moving to a higher priority where the main value creation of BVSHK is not affected. To reach a higher level, the goal, after consulting the roadmap, is to define a digital strategy that is both aligned with the goals of the company as well as the heads of all the departments. The second focus is to use cross-functional teams, which, after checking the qualifications of all employees, are established to steer the new Logistics 4.0 projects and their implementation. To make sure both use cases do not contradict each other, a balanced approach of developing a strategy with a vision that is aligned with business targets and departmental KPIs is leading a joined development process forward.

For the last dimension of the questionnaire Culture & Mindset, Leo and his team assess the score to be 0,3. This results in the initiative to develop an easily accessible system to support data-driven decision-making as well as the documentation of knowledge to offer it to other departments or third parties.

C Step three: Level L1 to L2: Transparency – Why does it happen?

After achieving level L1 in BVSHK Hong Kong and identifying the potential future state of BVSHK, Leo tried to understand the next step after reaching a full self-assessment score of 1,0 of Visibility. Reaching the next state of Transparency requires an understanding of context of the previously gathered sources of information, by not only being able to see what is currently happening, but by additionally being able to answer the question of "Why does it happen?" to reach the maturity level L2 of Transparency. The highest scored small and medium enterprises in the assessment in the shipping, trading and manufacturing sector in Hong Kong have reached level L2.

The previously created visibility into different departments and outside sources of the dimension Data-driven Business Model has to be further enhanced with capabilities to not only analyze the status quo of internal and external sources of information but automatic adjustments made based on the results from the insights gained. This can result in dynamic price adjustments based on an optimization of services available to the customers as well as adjustments in the market that influence the services offered. To reach this level, a continuous iteration of innovation processes and a continuous monitoring of customer related information (target group, value proposition, revenue model and value chain) have to be implemented. Furthermore, the roadmap suggests to enhance the usage of data analytics as well as allowing more accessibility towards services and the order status for customers.

For the dimension Smart Services & Processes reaching level L2 Transparency requires the implementation of analytics to process the available data into useable information that is supplied to the customers and enables them to make conscious decisions on their triggered processes. Events relating their service are not only displayed to them but additionally enhanced with cause-and effect relationships. Checking the Roadmap, Leo discovered that the data gathered from outside sources has to be collected, enriched and processed to support forecasting and start internal as well as external interaction towards process adjustments based on it.

To reach the maturity level Transparency, the dimension of Smart Supply Chain & Operations requires gathering information from the full value network, including internal and external data to enable cause and effect analysis. This will enable the realization of a basic digital supply chain twin to analyze the current state of the supply chain of and operations in BVSHK. The information gathered this way has to be output towards the employees and be customized based on the context required. To realize this, after checking the roadmap, it is suggested to establish the previously mentioned supply chain twin as well as optimize storage location-based decisions through the newly processed data.

For the dimension of Information Technology, after the basics and management of data related infrastructure have been established, the remaining development process aims at identifying

correlations between historic data and the currently running processes enhanced by data analytics. Checking the dimension of IoT, the level of Transparency is reached when sensor-based inputs are supplying real-time information from all process related parameters (as in GPS locations, in-house locations, remote management capabilities, etc.) as well as interacting with the environment and value related tasks, as in manipulation of assets (transporting, sorting a shelf, etc.). In the roadmap Leo finds the required infrastructure to create a single source of truth as well as the required computing capabilities to process data and generate real-time insights about cause and effect relationships.

To reach the maturity level of Transparency, the dimension Strategy & Organisation requires the establishment of interdisciplinary target systems, that are tracked by defined KPIs (Key Performance Indicators). These KPIs are derived from the strategic goals of the company and should help to drive actions and make the progress and success of digital initiatives visible and measurable. For the implementation of digital initiatives, interdisciplinary and agile teams should be formed, who are supported by external experts for topics where the internal expertise is not sufficient. To reach this highest level of Transparency in the Dimension of Strategy & Organisation, the roadmap suggests to set up continuous improvement teams to iteratively solve the dynamically occurring problems, document and enhance the workforce by enhancing their capabilities to manage the skillset required to handle these tasks and understand how to manage the amount of data that has to be handled and used adequately. These tasks have to be supported by an implementation of data governance throughout the full organisation to guarantee consistency of data acquired and used to make choices.

The dimension of Culture & Mindset at Transparency aims at how data is collected, formalized and used by every single employee. Employees have to understand data and build trust in data to support decision-making. Furthermore, employees should be willing to collaborate to solve interdisciplinary problems, which can be supported by digital tools such as a digital knowledge base or collaborative platforms for efficient communication and exchange of data. In the roadmap, the use cases focus on promoting a culture for agile working as well as an encouragement to focus on data-driven decisions.

D Step four: Level L2 to L4: Predictability & Adaptability – What will happen & How can an autonomous reaction succeed?

The maturity level L3 of Predictability relates to the capability to predicting future states and develop scenarios to further enhance data-driven decision making. As the maturity level L4 of Adaptability, where decision making is further enhanced from the previous level and is still a research subject with limited use cases available, levels L3 and L4 will be listed together in this implementation step. Based on the questionnaire, the maturity levels L3 & L4 can only be reached in the dimension of Smart Supply Chain & Operations:

- For Predictability, after establishing a basic digital supply chain twin as well as multiple IoT solutions displaying current, context related information, the context is enhanced by further information as well as the prediction of future scenarios. Examples for this can be gathered from the roadmap, e.g., Predictive warehouse analytics that supports higher fulfillment potentials of orders by using current and historical data, or a Digital transportation twin with AI based forecasting to more accurately monitor and manage logistics networks with higher enhancement of simulations and thereby created predictions.
- Adaptability can further enhance systems to autonomously use and optimize operational processes where the role of the employee shifts towards an advisory function. For these use cases, the roadmap lists Self-optimizing transportation digital twin as well as digital twin of warehouse facility, where almost a state of a lights-out-factory is reached.

After consulting the questionnaire and the chapter 3 - Roadmap for the logistics industry, Leo is a bit unsure on how to approach the use cases and where to start with their implementation. To successfully carry out Logistics 4.0 projects, a combination of factors can facilitate them which will be further expended upon in the next chapter.

6 Functional Enablers

To realize successful implementation of Logistics 4.0 on a bigger scale, a multitude of approaches are capable to realize a positive outcome. Starting out with a general structure of L4.0 projects, to the general capabilities required in the workforce to overarching perspectives will be shown below.

A How to structure and run a Logistics 4.0 project & standardize

Each use case represents a unique project – the uniqueness does not come from the use case itself but from the unique current situation of the company where it should be implemented to generate new value.

To start with, the complexity of the implementation requires a more agile approach compared to classical projects that could be structured following a stage-gate model. This requires a change in mentality when approaching these projects. It might be required, after every step, to start from the beginning (1) again when certain understandings have been developed or an approach was not fruitful.

As a general starting point the Ideation step (1) has to be performed. Here the current challenge has to be precisely identified and what value should be generated to overcome it. Following this, the Hypothesis (2) should be created to understand how the identified problem could potentially be solved with a matching use case from the given roadmap. As the mentioned use cases are generic a matching solution for the company has to be identified.

But how can it be assessed if a specific solution would solve the identified problem? For this, steps three (3) and four (4) have to be taken next. Exploration (3) stands for an evaluation of the hypothesis from step (2) and step four (4) Pilot is the realization of the use case from the hypothesis. These two steps (3 & 4) are approached in a Plan-Do-Check-Act cycle that will be repeated until either a new Ideation (1) is started from a previously unidentified approach, or an iterative approach can be realized to successfully create a pilot that will bring the value to the implementing company. As a final step, Scaling (5) is the roll-out of a full-fledged solution based on the hypothesized use case and realization of the previously mentioned value for the company.

Use cases can have different development stages. If they are still in the very early stages and not integrated into running processes they are part of R&D projects (I). As soon as the use case comes closer to a functional stage with an observable output they are demonstrators (II). Before the market launch, a use case can be piloted (III) in an authentic environment, such as testing the integration into a running production process. In the final step, the use case is rolled-out and fully integrated into productive use (IV).

Depending on the parameters of the use case (requirements of APIs, documents, standard operating procedures, manufacturers landscape) and the previously explained stages of the use case, a standardized approach to implement use cases can help to increase the success of implementation as well as the acceptance among employees. Use cases in the stages I & II can be supported by demonstration factories. These facilities are designed to exhibit and prove the feasibility of the application in a realistic and authentic context where the surrounding is developed based on real, but isolated, workflows. The environment for the use case might not be able to be fully scalable, but it is important that the flow of information from sensors to connecting the data sources to the performance of analytics is realistic. Another important factor is from the demonstrator stage onwards, that the system is automated in the same fashion as the fully market-ready use case. The insights generated by a demonstrator can help to validate the technical feasibility and the added value of the tested use case as well derive learnings about potential upcoming challenges for the integration and roll-out and standardization of the use-case.

Standardization focusses on managing the complexity of the usage of technologies applied. The integration aims at assessing the required compliance as well as IT-Security challenges and infrastructure requirements. The stabilization step demonstrates the real-world application dealing with maintaining functionality and understanding the means that are required to keep the use case running. To facilitate this a demonstration factory can help to support the development of a wide range of solutions and confirm the value it might bring to the industry before moving towards a piloted implementation.

B Logistics 4.0 Implementation teams & capability building

The successful implementation of use cases is not only dependent on a matching infrastructure and the correct structure of the project, but a big part of an effective integration is based on the people involved in this process.

The composition of the team that is running the project is fundamental to bring the implementation to a successful conclusion. As cross-functional teams are required due to the interdisciplinary nature of Logistics 4.0, correctly defined roles with the matching domain knowledge help to involve the right parties into a project. To start with, a Product Owner is chosen to own the KPIs that are the target of the implementation. This role aligns the goals with the strategic vision of the company and is the person accountable to answer project related questions to the “What?” and “Why?”.

The Project Manager, as the second in command, should have knowledge on leading the cross-functional teams. The prioritization of the tasks to be completed and answering the question of “How?” is his job. An important role that needs to be involved due to the previously mentioned

complexity of the cross-functional and interdisciplinary nature of the L4.0 projects is a Coach, or Translator. This role is necessary to help with alignment and mediation between all involved participants by having knowledge across multiple domains. The Project Manager is not required to be an expert in every domain, but should have a good understanding across all related disciplines. This person can be from a central unit of the company or an external consultant, supporting with an outside perspective and an impartial approach towards the project. The infrastructure perspective is provided by two additional roles. The first role involves the IT Team which has to deal with deriving requirements for the IT infrastructure for a full rollout scaling as well as providing a suitable infrastructure for the pilot, and to keep it from interfering with outside systems; Secondly the Data Team to enhance the infrastructure by monitoring data related tasks. The data quality requirements have to be met by comparing with historical and other sources of data, as well as keeping check on the currently gathered data and aligning with the next team, the Domain Team, to correlate the data with hypothesis. The second role is for the Domain Team to cover multiple domains, ranging from understanding the requirements and views from daily operations of the use case as well as representing the automation and process perspective, depending on the use case requirements. It is fundamental to have the domain knowledge for correlations and cause-and-effect analysis, but as multiple parties with different fields of expertise are part of the project, the value of the Coach or Translator cannot be understated to balance and mediate between occurring disagreements and misunderstandings.

As the different roles and teams require specific knowledge to understand the tasks at hand and their roles, a certain qualification of the whole workforce is required. In the questionnaire as well as the roadmap the dimension of Culture & Mindset is one of the key success factors. One of the main pitfalls of Logistics 4.0 projects is not involving the people that have to make choices as well as the ones who will have to work with the use case every day. To help with the alignment and understanding, a capability-building program can facilitate to enhance the understanding of these roles and the significance when it comes to the strategic as well as operative implications. For the management and decision-makers it is important to understand how to create, manage and implement a digital transformation program and deal with change management. For the engineers and operators, digital literacy, the basics of Logistics 4.0 with its technologies, and data-driven approach can give a more hands-on understanding. This approach can be further supported by supplementing it with authentic and real-life learning experiences such as demonstrators or even a demonstration factory that shows use cases in an authentic manufacturing environment to make the added value and impact of Industry 4.0 applications directly visible and tangible for training participants.

7 Technology Landscape

There has been a rapid increase in the use of technologies to increase resiliency of the supply chain and boost productivity. Based on the Logistics 4.0 Navigator, the technologies can be categorized based on the enablers layer that help to implement a certain use case from the roadmap.

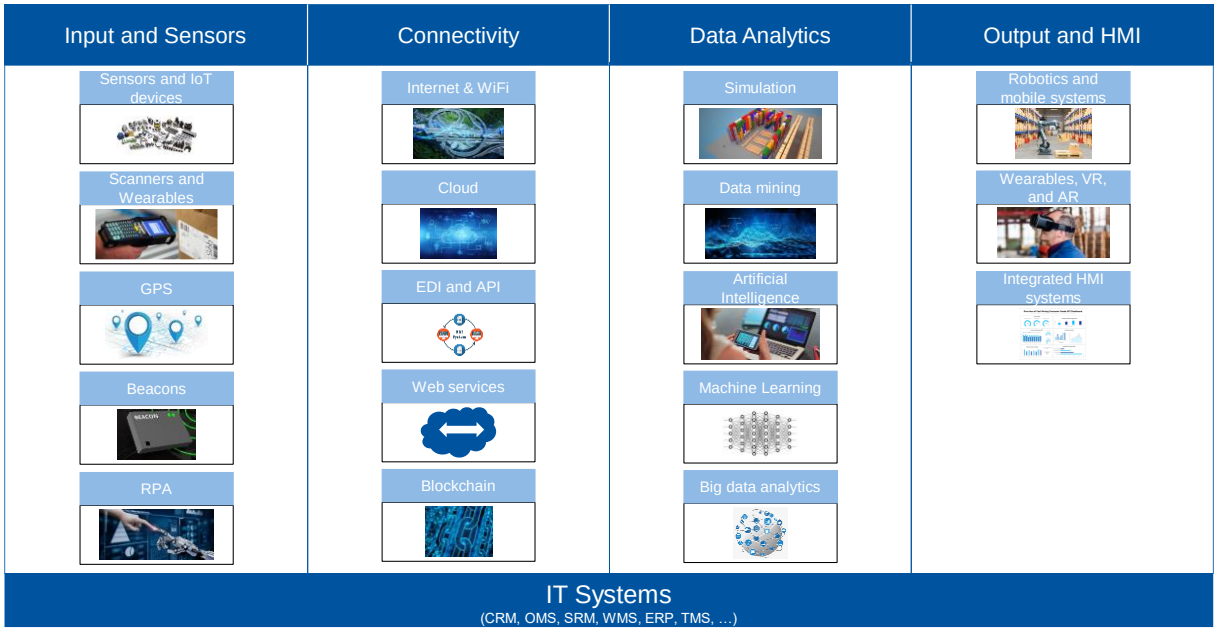


Figure 2: Technology Landscape

The above image shows the technologies that can be implemented throughout the logistics processes and classified according to their relevant application areas. The following technologies are revolutionizing how logistics processes today work:

1. Input and Sensors

Sensors

Data-driven decisions is a topic of focus for logistics 4.0 and therefore collecting the right amount and right quality of data by using sensor technology is of utmost importance. IoT helps to track goods and assets and transfers this data over the internet. IoT devices find many applications in the logistics environment, e.g., secure tracking of expensive products, worker assistance, mobile devices and wearables, inventory tracking using barcodes and scanners, and AGVs.

Scanners and wearables

Use of marker technologies (e.g., barcodes, QR codes, RFID tags and reads) or high-resolution cameras are used to identify materials in the processes of the supply chain. The information gathered through these scanners can be transmitted to the required IT system thus avoiding any manual updating of process step completion.

GPS

With the advancement in mobile technologies, GPS helps transportation and logistics businesses to locate and track fleet of vehicles in the transportation network. With GPS tracking, vehicle speeds and routes can be tracked in real-time and reroute the vehicles in the fleet in case required.

Beacons

Beacons are transmitters that use wireless connection to signal the location of the items. Beacons can be used for asset tracking (e.g., pallets, containers, lids, …) and thus serve a solution for a crucial challenge in warehousing. The times and throughput can be calculated based on the tracked activities.

RPA

Robotic Process Automation can boost supply chain management efficiency. It is a relatively easy technology which can automate repetitive and time-consuming tasks. RPA uses software robots to extract data from one software system and paste it into another. RPA can work together with chatbots and mobile applications. It can be used to provide automated notifications to the customers regarding the status of the orders and delays to enhance customer experience.

2. Connectivity

Internet and WiFi

5G provides high speed data transfers at low latency and more reliability. 5G allows for more robust connections between IoT devices and the network and therefore plays an important role for Logistics 4.0. It is possible to transfer the generated data in real-time using 5G technology and when analyzed, provides supply chain visibility.

Cloud

Supply chains need a single source of truth to coordinate shared processes and predict bottlenecks. With cloud technology every acting partner in the supply chain can be connected and remote information can be made available to multiple partners, so that they can access the data easily from anywhere. In combination with IoT devices and geoanalytics, it is possible to monitor delivery networks and prioritize shipments. Cloud computing enables efficient logistics and data management and supports in data storage.

EDI and API

Electronic Data Exchange (EDI) facilitates the exchange of information between businesses. Documents are transferred between partners directly. No manual creation, printing/sending/faxing/e-mailing of e.g. orders, order confirmations, delivery notes or similar documents, which are agreed to be processed via EDI, are needed. EDI automates the information flow in a standardized format between companies. It removes time lags of manual data processing (e.g. document creation), data

transfer (e.g. mail), and inputting back to the partner system (e.g. typing). Various sources of relevant external data for demand forecasting (and more advanced techniques such as demand sensing) can be found and can be integrated in real-time via APIs. Such APIs can be documented in a standard format to ease integration.

Web services

Web services is a method of communication of electronic devices through internet. In case of logistics, through the integration of internet with business processes, web services offer automating interactions through collaborative commerce. With this technology, new applications can be built to solve business problems.

Blockchain

Blockchain has potential applications in logistics functions that can enhance supply chain transparency and traceability as well as ensure security and authenticity of goods. Blockchain based monitoring of carriers and suppliers creates trust between the parties. Blockchain provides secure and encrypted platform to exchange data and documents and detect any frauds that may occur during payment transactions.

3. Data Analytics

Simulation

Simulation in logistics is used to develop models of the facilities and network to investigate the effects of changes in the current operations. It provides the dynamic details for expansion and redesign of the current elements of a supply chain network.

Data Mining

Data mining is the process of using raw data points to convert it into useful information. The role of data mining in logistics and supply chain is to reduce complexity of the process and create visibility in the operations. Data mining includes techniques of data modeling to sort through large databases using business intelligence tools and identify relevant trends and patterns. For growing businesses this helps in generating key metrics and reports in actionable form.

Artificial Intelligence

With the advancement of AI, the potential of using data has been enhanced for decision making. AI in logistics have positively made the robots intelligent to identify and sort the goods in warehouses and enhance the workflow. AI powered demand prediction and accurate forecasting tools support human to make decisions and meet customer needs. Real-time optimization of transportation routes and warehouse activities can be enabled using AI.

Machine Learning

The volatility faced by logistics providers make it difficult to manage problem free operation. Machine learning models provide great insights from large data sets that can make the supply chains more resilient and reduce the uncertainties. Machine learning has great potential in improving issues related to demand prediction, resiliency to disruptions, sustainability of supply chain costs, route optimization, frauds.

Big data analytics

To gain transparency, the supply chain uses the enormous amount of data sets generated by the flow of goods, the weather and traffic conditions, location. Customers demand digital services for more speed and responsiveness. Online sales and customer interactions provide large amounts of data which can be further processes to develop new strategies. Enterprise systems contain historical data which can be used for optimizing operations. The data from these sources paired with AI can be utilized to create a supply chain digital twin to enable complete visibility and further use analytics to predict risk scenarios.

4. Output and HMI

Robotics and mobile systems

Robotics and automation have been existing in the industry since a while. Robots are now autonomous – intelligent machines that are capable of performing tasks without human control. Autonomous vehicles, mobile robots and drones find important use cases in warehousing and logistics. Robots and Cobots are used in warehouse facilities for material handling activities like picking, sorting, and packaging of goods. AGVs provide flexibility for transportation of material, whereas drones are suitable for inventory check and last mile delivery.

Wearables, Virtual Reality (VR) and Augmented Reality (AR)

Wearables are devices used to continuously guide and support employee and provide additional contextual information is provided, e.g., exoskeletons can be used to accomplish processes that are not possible ergonomically or mobile devices like smart watches and glasses provide added information for performing non-conventional tasks. Virtual reality simulates a real-life environment that replaces the real-life world with a virtual one. This simulated virtual world can be used to create learning opportunities and trainings for employees in a warehouse setting. For optimization of warehouse space, AR provides a digital and interactive method using 3D warehouse layout. AR also finds use case in order picking to locate and extract products.

Integrated HMI systems

Station-based assistance systems (e.g., control rooms and line displays, pick by light, lean working stations) at defined stations can support with relevant information or with simplifying complex tasks. A control room provides a central overview for planning and control of entire supply chain. Line displays provide visualization of important KPIs for decision-making. Pick by light system makes the parts to be picked easily visible. Lean working stations, for e.g., in packaging, make the packing items and materials easily accessible to the operators and improve their efficiency.

5. IT Systems

IT systems provide the digital support for performing the logistics related function in the internal and external chain. The commonly used IT systems include Customer Relationship Management System (CRM), Order Management System (OMS), Supplier Relationship Management System (SRM), Enterprise Resource Management System (ERP), Warehouse Management System (WMS), and Transportation Management System (WMS).

These are few applications how these technologies are helping in created a transparent, automated and connected logistics network. These technologies have large potential for many innovative use cases to transform how the logistics processes work today. They drive customer expectations but at the same time create new business opportunities.

8 Vendor Landscape

The graphics illustrate a collection of vendors that were identified to provide digital solutions for driving Logistics 4.0. These vendors were categorized into four areas of operation: Sales and planning, transportation, warehousing, and goods management. For example, Blue Yonder, Project 44, Epicor, BluJay, and Manhattan Associates provide solutions in various areas and can support complete digitalisation. HKSMEs could take these global vendors as a benchmark and good practice for local digital solutions for driving Logistics 4.0.

A. Sales and Planning

Remi provides a platform to drive proactive business decision making for pricing and supply chain using data and machine learning. The AI-based demand forecasting platform uses an algorithmic approach for supply chain and sales forecasting that relies on historical sales and encompasses external data streams like promotional behavior, weather, and global events to accurately predict the future.

Ui Path provides end to end automation through their platform and one of their main solutions is Robotic Process Automation (RPA) that take up tedious tasks. The software robots can handle data from any source (desktop, web, Citrix and other virtual desktop interfaces (VDI), text-based data, email, IT, and human) and can integrate with various platforms (SAP, Salesforce, Oracle, Microsoft, Google, ServiceNow, …). These robots have AI capabilities and can understand conversations and make decisions.

With personal sales assistance, the sales system interaction can be automated, and the CRM interaction can be conducted by the Chyme bot. It has a built-in AI that enables a conversational interaction that is context-aware making the user experience more productive.

IBM API Connect helps managing the API ecosystem across multiple clouds which is important for digital transformation and provides visibility on the application environment and to create an IT ecosystem.

Kinaxis can transform sales and operation planning by enabling cross-function collaboration between sales, finance, demand and supply planning and operations. The platform provides a real-time view of supply chain health and key business metrics.

Inform provides a comprehensive demand planning tool which is add-on software for an ERP system. It is an AI-supported multi-dimensional planning tool that optimizes planning quality and improves planning reliability.

With the BlueYonder solution, the planning potential can be improved to fill the gap between demand and supply. It helps to create demand scenarios to analyze the supply chain constraints and makes decisions based on them.

Modata creates forecasts based on real-time data and analyzes team performance based on historical data to spot risks and avoid any surprises. Industry benchmarking is also a valuable feature in Modata platform to identify improvement areas and make investment decisions.

B. Transportation

With Transmetrics, companies can optimize complex transport networks with a linehaul planning AI tool and automated scheduling functionality. It suggests the most optimal network plan to reduce costs and increase profitability.

Epicor provides a distribution ERP solution for small to midmarket enterprises operating locally and globally to efficiently plan, assemble, ship, and deliver goods to the customer.

The transportation management solution from BlueYonder make it possible to achieve real-time visibility across the transport network. Companies can integrate suppliers and initiate carrier collaboration to manage inbound and outbound logistics.

BluJay provides a solution for shippers and freight forwarders to master a frictionless supply chain and transportation network. With a SaaS TMS solution one can get a real-time overview of drivers, the fleet and manage shipping load.

AnyLogistix supply chain network design helps in finding optimal locations for new facilities (distribution centers, warehouses, and production sites), defining the flows between them, and balancing costs.

Cargonexx provides algorithm-based route planning by taking into consideration the affecting factors like loading time, waiting times, driving time and distance to plan tours efficiently.

For shippers, logistics providers and carriers, **Project44** act as a single source of truth platform for air, rail, road and air transportation channels by giving real-time information on the movement of cargos.

Llamasoft, a Coupa company, provides a solution for supply chain disruption and accelerates supply chain digitalisation by supporting in implementation of a supply chain digital twin.

C. Warehousing

Companies can optimize warehouse operations in real-time to increase efficiency by leveraging machine learning by implementing the BlueYonder warehouse tasking solution.

The Digital yard management platform from PINC uses an IoT sensors network to gain inventory visibility and automates data collection, workflow processes and scheduling by integrating the existing systems.

AnyLogic provides warehouse simulation software for designing and optimizing warehouse layouts to meet dynamic operational needs.

MotionMiners uses motion mining techniques to analyze intralogistics activities from incoming goods to storage, picking and dispatch. It uses mobile sensors to collect raw data which is analyzed in the cloud using machine learning.

Omnichain provides a complete warehouse management solution to manage inventory levels and product flow across all warehouses in the network.

Companies can improve logistics processes with scanners, RFID readers and wearables with smart autoID solution offered by FEIG in the areas of incoming and outgoing shipments, picking and packaging and for E-Kanban and refill control.

Manhattan Associates provides a wide range of supply chain solutions. With the intelligent cloud-based warehouse management system, all core functions of a warehouse can be conducted efficiently.

Solvice provides an AI-based optimization solution for workforce and logistics. Picking path optimization manages picking activities by sequencing them in the perfect route throughout the warehouse by integrating real-time positioning.

D. Goods Management

Jungheinrich provides automated guided vehicles and advanced forklifts to bring in flexibility in the warehouse. The AGVs can be connected to the WMS or ERP system and optimize the workflow.

CAJA robots provide workstations for picking, replenishment and robots for lifting and picking that can be integrated with the WMS system using APIs

The automation units from Boston Dynamics are capable for carrying out tasks like truck unloading, depalletizing.

Honeywell products like mobile computer, barcode scanners, printers, voice direction and RFID systems help distribution centers, transportation and logistics organisations to increase productivity of the warehouse operators.

Kargo optimizes the inbound and outbound flows using computer vision to visually inspect freight and facility operations in real-time.

The voice and light systems by Dematic for order fulfilment improves order accuracy through easy-to-learn and easy-to-follow instructions and thus customer satisfaction.

Remotely operated forklifts by Phantom Auto gives the operator the flexibility to drive remotely and more efficiently.

Zebra helps to be well-connected to all the resources and assets in warehouse operations and thus gain visibility.

9 Best Practices

A. DHL

DHL is part of the world's leading logistics company Deutsche Post DHL Group operating in over 220 countries and territories worldwide. This leading international logistics company aims to digitalize its logistics operation has defined 'Strategy 2025 - Delivering excellence in a digital world' and plans to invest EUR 2 billion cumulatively till 2025 in digitalisation to improve employee experience as well as increase operational excellence with a yearly run rate benefit of at least EUR 1.5 billion by FY2025.

According to DHL, Logistics 4.0 is a prerequisite for Industry 4.0. To create an intelligent logistics system, networking, automation and real-time communication are the key factors.

Creating transparency is the crucial aspect of Logistics 4.0 which can be gained through collecting real-time data that leads to automated triggers, increased efficiency and reduction of risks. For multinational companies to visualize their full network from their immediate suppliers to n^{th} tier supplier, DHL has launched its Resilience360 Transparency Portal. Resilience360 risk assessment solution helps them identify possible problems that could have an impact on their supply chain, whether from natural disasters, regulatory issues or political upheavals.

DHL transport network optimizer refines transportation operations and optimize inter-related variables to create an end-to-end supply chain. It is a planning tool that harness big data and advanced analytics from shipment.

The DHL Supply Chain Asia Pacific has introduced Digital Twin Warehouse. This digital twin aims at reducing aisle congestions, creating alert system, temperature monitoring, indoor traffic visibility, real-time operational data capturing and analytics, and enhancing material handling equipment safety.

Robotic process automation is used by DHL in their transportation solutions to handle administrative and back-office processes such as sending transaction-related emails, invoicing carriers and retrieving proof of deliveries.

DHL Supply Chain has established a lighthouse site at their Beringe warehouse facility in Netherlands. This smart warehouse is used to establish best practice and pilot new technologies and use cases before they are rolled out globally. The technologies used are:

- Robotic picking cell with vision technology
- High throughput outbound sorting conveyors
- Automated master data collection through sensors
- Smart scanners
- Vision picking system
- Pick and place bots
- Automated print and apply outbound sorter
- Automated storage and retrieval systems
- Integrated transport control tower

B. Kuehne+Nagel

Kuehne+Nagel provides sea, air and road logistics solutions and connect 106 countries through their network. It is the No. 1 Sea freight forwarder worldwide that is determined to provide innovative and sustainable logistics solutions. To drive digitalisation in logistics, Kuehne+Nagel invests in research and technologies to support their customers. To make global supply chains more transparent, Kuehne+Nagel is determined to integrate latest technologies in their products and services.

Technologies that Kuehne+Nagel currently use are:

- Application Programming Interfaces (APIs) to integrate with customer systems
- Big Data and predictive analytics to make better decisions and for risk management
- Machine Learning and Artificial Intelligence to recognize patterns for quality management
- Internet of Things (IoT) to get real-time data during transportation
- Blockchain technology for secure exchange of data between partners

Air freight digital solutions under eTouch, Kuehne+Nagel's digital transformation initiative, transforms the interactions internally, with suppliers and with customers. The manual data entry of customer specifications in the transportation management system has been replaced by automated processing of shipment requests through EDI integration, myKN (Kuehne+Nagel's online platform) and shipment data wallet. Automated routing and pricing through carrier API integration is a project in the development phase under the digital transformation initiative.

The myKN online tool provides customers with complete control of their shipment. The customizable dashboard offers customers the flexibility to choose optimal route for the shipment, find competitive quotes and create bookings. Customers have real-time insight into costs, identify bottlenecks and optimize their logistics plan.

Real-time intelligence on entire supply chain network is critical to overcome global challenges. Kuehne+Nagel partnered with Chorus to implement new sensors and orchestration technology to understand where good are located, where they are needed, what state they are in, and how they are used. Kuehne+Nagel will integrate this technology in their service offering, eTrucknow to provide the road logistics customers enhanced visibility.

C. DB Schenker

One of the world's leading global logistics providers DB Schenker supports industry and trade in the global exchange of goods through land transport, worldwide air and ocean freight, contract logistics and supply chain management. DB Schenker is driving their innovation and digitalisation to build future of global goods and information flows. They aim to deliver most innovative services and solutions by providing digital services to their customers. DB Schenker is actively developing analytics to develop a data-driven company culture.

To conduct state of the art research, DB Schenker collaborated with Fraunhofer IML in Dortmund and founded DB Schenker Enterprise Lab for Logistics and Digitisation to develop prototypes and conduct field test.

A digital twin of DB Schenker warehouse has been implemented by capturing all the processes. This digital twin can simulate the functions of the contract logistics warehouse. Another successful project of DB Schenker Enterprise Lab is a decision support tool for efficient truck loading. DB Schenker captures performance KPIs and promote employee involvement in optimization process through gamification. Other major topics for research are 3D printing and use of drones for logistics processes.

DB Schenker has introduced the Connect 4.0 platform for customers to get quotations, booking and tracking of shipments for land, air, and water freight, all through a single platform.

In the contract logistics facility Red Lion operated by DB Schenker in Singapore, use of autonomous vehicles and customized robots for inbound and outbound air freight is implemented to speed the logistics process. Use of WMS system and pick by light system has reduced the lead times by 40%.

DB Schenker uses AGVs with laser technology and high-resolution cameras at their specific warehouses in Germany to transport goods from A to B. DB Schenker implemented its first autonomous mobile robot in Pardubice. This robot scans the QR codes of the transport material and carry it across the warehouse to the predefined location.

DB Schenker uses machine learning and data mining technologies as well as prescriptive and predictive analytics in the area of demand forecasting and network and capacity planning to identify optimization potential and cost-saving opportunities.

D. WIP Transparency

Continental is a Germany-based leading automotive supplier with 400 locations in 60 countries worldwide. To make their intralogistics process flows dynamic and data-driven, Continental had a goal of creating a smart factory. Continental collaborated with Kinexon to implement their real-time locating system (RTLS) for precise real-time tracking of all associated with material and production flow. Kinexon provides software for process automation, intelligent analysis, and integration of data sources.

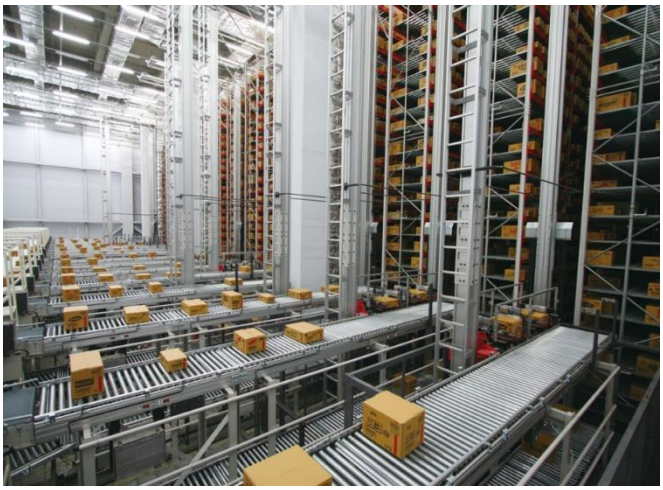
Continental faced certain challenges:

- Stock levels on the shopfloor in both production processes and assembly lines were not visible for line feeders and in the warehouse. This resulted in blocked paths and inefficient feeding.
- Additionally, to the unknown amount of bound capital in high stock levels, this caused high search times as well as long idle and waiting times at the lines while resulting in inaccurate planning and material usage.
- Defined waiting times of certain assembly parts needed special and temporary storage locations which resulted in complications in confirming the validation of the storage conditions.

The RTLS system from Kinexon provided the following solution:

- Tags for live tracking of pallets were added to the carrier systems and a traffic light system was implemented to indicate the locations that required feeding.
- Different tags were added to carriers to track their location. A Machine Learning algorithm was implemented to optimize delivery times as well as predict resource usage.
- Based on the special storage requirements, the tags were enhanced to integrate time measurement to record and trigger the ERP system when a defined threshold was reached to resume the production process.

E. Dark Warehouse



A dark warehouse is a fully automated warehouse operated by networked robots, without the intervention of any humans. This is a futuristic concept which means that the warehouse can function even if the lights are out. Today the warehouse managers have to be prepared to react towards any uncertainties emerging due to changing markets and customer requirements. But in the future, the dark warehouse will be intelligent, and the machines will not just perform monotonous, standardized tasks, but also make their own decisions based on the intelligence they gain through their ability to collect and analyse data.

In this fully automated warehouse, robotics will play a key role. However, robots as we know today, will require more flexibility to adapt to process. High use of cobots, autonomous mobile robots (AMR), automated guided vehicles (AGV), drones can be imagined in such a warehouse facility. They need to be equipped with sensors and cameras to understand their surrounding making them smarter. However, to make correct decisions, the intelligence required for the robots will be parted through advancement of artificial intelligence (AI).

The robots and the mobile systems need to be fed with very precise real-time data and need high computing power to perform real-time analytics which can be realized through the high potential of the 5G network and the power of cloud computing. All the mobile systems should be networked to exchange data and therefore need to communicate with each other continuously.

For the automated warehouse to function smoothly, a strong foundation in terms of use of right IT systems and efficient planning is necessary. Humans will still have a role of managing these systems.

The efforts for building a dark warehouse are immense and still needs some technological advancements. That said, fully automated and connected warehouse is considered to be the future and it is not very far away. A lot of research and attempts at achieving this autonomous state has brought partial success to some large organisations.

The Germany-based automotive OEM Mercedes-Benz, e.g., uses state of the art technology at its Mercedes-Benz Global Logistics Center in Germersheim. There is extensive use of automated material-handling systems such as AGVs, storage and retrieval systems.

Another Germany-based automotive manufacturer Audi is using augmented reality to plan complex logistics processes and uses AGVs directly connected to the production planning process for material transport for customized products.

The Bavarian automotive manufacturer BMW launched “Autonomous and Connected Logistics” research project supported by the Bavarian Ministry of Economic Affairs, Regional Development and Energy. By creating a 5G testbed at Dingolfing site, various logistics use cases are currently being implemented.

10 Recommendations for Logistics 4.0 Implementation in Hong Kong

To facilitate the Logistics 4.0 introduction and to take the next steps, recommendations were deducted for individual SMEs as well as for the overall setting of shipping and logistics companies in Hong Kong.

A Recommendations for individual SMEs

#1: Build a clear vision of your Unique Selling Point (USP) in the face of digitalisation and proactively build digital capabilities to keep up with global players. Ensure a minimal standard of digitalisation capabilities exist, at the very least traceability and enough integration into transport providers' and customers' systems to provide live updates.

Companies should create a clear picture of what their USP is in the face of digitalisation. Logistics 4.0 is more than being able to make incremental improvements for logistics processes. It is about having a strategy on how to leverage digitalisation in logistics to eventually establish new business models. Many of the visited SMEs have the advantage of offering supreme services to customers but do lack some of the features which big players have, such as tracking and tracing to follow shipments in real-time. Soon such capabilities will be crucial for company success and required by customers. Consequently, SMEs should take a proactive approach towards building appropriate digital capabilities to prepare for the requirements of tomorrow's customers. We strongly recommend using the enclosed roadmaps in the maturity protocols to aim at least for a 1i level within the next 2-3 years as a basis. This should definitely include traceability of shipments, inventory and orders, and seamless IT integration with transport providers and warehouses or terminals. However, this is not a distinguishing factor but a mere minimal requirement for staying competitive in the face of changing supply chain management processes globally. In addition to this we strongly recommend each company to identify what can set them apart from large providers as an SME and capitalize on this in a digital way. The potential to quickly customize services and react in a flexible way are the strongest factors here, but also these actions will in the near future universally be required to be mapped in a digital way.

Steps for implementation - #1:

1.	**Future market requirements**	Understand the future market requirements for the logistics sector and the potentials of digitalisation as well as the requirements for your business sector (Chapter 3 "Introduction to Logistics 4.0 & Industry 4.0" and chapter 6 "Key Insights for the shipping/manufacturing and trading industry", Maturity Level Protocols)
2.	**Core competences and business model**	Conduct a workshop to define the core competences of your company and your current business model, i.e., who are your target customers, how do you generate value for customers and through which standardized services and channels do you deliver it. **Relevant use-cases and initiatives in the roadmaps** **Data driven business models (-2 to -1)** - *Define service offerings and define revenue streams* **Smart services (-2 to - 1)** - *Define standards for provision of services* - *Establish information channel for customer communication*

3.	**Desired USP**	Conduct a workshop to define how digitalisation can enhance the current business model and can create a USP for your company based on your core competences in order to serve the future market requirements identified in step 1. **Relevant use-cases and initiatives in roadmaps** **Data driven business models (-1 to 0)** - *Develop a business model and offer services to the customer digitally*
4.	**Build basic digitalisation capabilities**	To build a good foundation for further digitisation, ensure basic digital capabilities by implementing all initiatives and use-cases in the roadmap of your industry to reach level 0. **Relevant use-cases and initiatives in the roadmaps** - *All dimensions including use cases & initiatives from level -2 to 0*
5.	**Supplier & customer integration**	Establish supplier and customer integration: Establish integration into transport providers' and customers' IT systems to provide live updates and enable better collaboration. First, appropriate data sharing agreements with customers and suppliers are needed. Many big transport providers directly provide API (preferred) or EDI services which can be licensed as a customer, but which do require the technical skills to perform the integration by oneself. For those who do not provide such services it would make sense to pool together with other SMEs to define one format and agree with the provider. As frequently this skill would not be available in-house, next, for the actual integration an integration partner is needed (e.g., ERP customizer, contract software developer) to connect specific interfaces used by suppliers & customers for data exchange. **Relevant use-cases and initiatives in roadmap for the shipping industry** **Smart Supply Chain (0 to L1)** - *Automated information from logistics partners and suppliers regularly* **Smart technologies (0 to L1)** - *Connectivity of IT systems and avoid workaround solutions* **Relevant use cases and initiatives in roadmap for the manufacturing and trading industry** **Smart Supply Chain (0 to L1)** - *Get information automatically from logistics providers* - *Digital IT system integration of providers (EDIs/APIs)* **Smart technologies (0 to L1)** - *Software to establish domain-specific single source of truth architecture*
6.	**Traceability capabilities**	Establish traceability capabilities to retrace the path of goods, get real-time updates on their current location and provide customers with that information at any time. The next steps are: - Define process steps and relevant information for traceability - Derive requirements for additional data that is needed (e.g. for sensor retrofitting) - Determine a suitable identification system for goods (e.g., barcodes on boxes, RFID tags) - Implement the solution at all relevant stations in the intralogistics and logistics system (e.g., barcode scanners, RFID scanners) - Make sure traceability data is fed back to the connected IT system (e.g., ERP) and provided to customers on demand (e.g., customer portal) **Relevant use-cases and initiatives in roadmap for the shipping industry** **Data driven business models (0 to L1)** - *Offer customers the possibility to interact with services at any time* **Smart services (0 to L1)** - *Platform for customers to track shipment status and automated alerts* **Smart Supply Chain (0 to L1)** - *Track and trace system for downstream supply* - *Supply chain control tower - dashboard for visualizing order status* **Smart Operations (0 to L1)** - *Digital dashboards to display orders at work stations* - *Digital shadow of warehouse to monitor flow of orders* **Smart technologies (0 to L1)** - *Implement measures to collect real-time data* **Relevant use-cases and initiatives in roadmap for the shipping industry** **Data driven business models (0 to L1)** - *Enable customers to interact with services at any time* **Smart services (0 to L1)** - *Automatic notifications for customers / alerting functions* **Smart Operations (0 to L1)** - *Enhance track & trace capabilities*

		Smart technologies (0 to L1) - *Infrastructure for collecting times, levels, material flow*

#2: Start collecting operational data by adding at least a minimal IoT implementation and implement LEAN principles to continuously optimize processes and contribute to a better planning.

Companies are currently mostly planning based on experience. The utilization of many resources, such as a share of the workforce or production capacity depends on expected orders on a given day. However, accurate forecasting of irregular or even sudden customer requests or events cannot be made by definition. Still, a first step towards more accurate planning is to start acquiring data about processes and historic demand and using that to analyze what gaps can be identified, what buffers are potentially there, and which overloads could or couldn't be managed in the past. In this context, LEAN principles can be applied and supported by data collection and digital tools to continuously optimize and eliminate small wastes while ensuring resilience to adapt to any changes. To do so, at the least a basic IoT system comprising of scanners to read item positions, take times for each process, and linking actions to orders should be introduced where not available. People need to be trained to take a look at KPI in real time on e.g., KPI dashboards or wearables to optimize their and their teams' performance.

Steps for implementation - #2:

1.	**Basic IoT system**	Implement a basic system of IoT devices at relevant places on the shopfloor or in the warehouse to enable data collection at various points. The next steps are: - Map relevant processes and material flows in the operations (warehouse, inbound and outbound transport, commissioning etc.) in the as-is state (e.g., value stream map) - Identify relevant data points that should be recorded in order to track efficiency (e.g., process, waiting and transport times, goods locations not only in storage, but in processing, operator movement times, …) - Decide at which points in the processes data should be recorded (e.g., when putting on forklift or trolley) - Analyze which of the desired data points are already available and where gaps exist and what simple technology solutions can fix this. Avoid human data input where possible (e.g., by installing scanners in fixed positions where material has to pass by on a conveyor), and prefer simple solutions (barcodes, etc.) over complex ones (indoor GPS, active RFID, …) unless the requirements impose a need for more advanced technology - Implement suitable IoT solutions where data is not yet available to record the desired data points (e.g., barcode scanners, hand terminals, retrofit sensors) **Relevant use-cases and initiatives in roadmap for the shipping industry** **Smart Operations (L1 to L2)** - *Use of IoT devices for worker assistance* **Relevant use-cases and initiatives in roadmap for the manufacturing & trading industry** **Smart Operations (0 to L1)** - *Prepare digital lean data collection with digital resources*
2.	**Process and historic demand data**	Acquire data about processes and historic demand to enable deeper analysis for continuous optimization. The next steps are: - Refer to the mapped value streams and required data points from step 1 - Analyze which data points are still missing that cannot be recorded through IoT devices - Determine the best way to collect the missing information (e.g., integration of isolated IT systems / PLCs, virtual sensors)

		- Where possible, manual input of data (e.g., input in terminal by operator) should be prevented to increase accuracy and reduce non-value-adding activities - Start comprehensive acquisition of data about processes and historic demand from different sources (e.g., from IoT devices, PLCs, IT systems) - - Analyze for potentials of improvement and apply Lean principles in the next step **Relevant use-cases and initiatives in roadmap for the shipping industry** **Smart Technologies (0 to L1)** - *Connectivity of IT systems and avoid workaround solutions* - *Implement measures to collect real-time data* **Relevant use-cases and initiatives in roadmap for the manufacturing & trading industry** **Smart technologies (0 to L1)** - *Software to establish domain-specific single source of truth architecture* - *Infrastructure for collecting times, levels, material flow*
3.	**Lean principles for optimization**	Analyze collected data for improvement potentials and apply Lean principles to continuously optimize processes and eliminate small wastes. The next steps are: - Analyze data for optimization potentials (e.g., high waiting times, process bottlenecks, balancing of transports, storages and where appropriate lines) - Define relevant parameters that will be shown to operators to support their decision-making - Visualize parameters for operators in a way that optimization potentials can easily be identified (e.g., dashboards, smart watches) and countermeasures be derived - Set up cross-functional teams to drive continuous improvement (KAIZEN) across the company **Relevant use-cases and initiatives in roadmap for the shipping industry** **Smart operations (0 to L1)** - *Digital dashboards to display orders at work stations* **Strategy and organisation (0 to L1)** - *Set up continuous improvement teams (KAIZEN)* **Relevant use-cases and initiatives in roadmap for the manufacturing and trading industry** **Smart operations (0 to L1)** - *Prepare digital lean data collection with digital resources* **Strategy and organisation (0 to L1)** - *Set up continuous improvement teams (KAIZEN)*
4.	**Improved planning**	Establish an integrated planning system to manage all planning related data in one system and update planning dynamically (e.g., production plan, shipment delivery) based on the current setting with the overall goal to reduce lead time and save costs. The next steps are: - Assess the availability of relevant data sources and document necessary system interfaces to get planning data from different systems - Select or develop a suitable IT solution and integrate relevant systems for real-time parameter input - Migrate stepwise from the old planning process to the new process and implement defined rules in the advanced planning & scheduling tool - Create schedule visibility for all relevant stakeholders (e.g., production, warehouse, maintenance, external suppliers) so everybody follows the same schedule - Continuously optimize the planning process and refine rules based on feedback from stakeholders and measured KPIs **Relevant use-cases and initiatives in the roadmaps** **Smart supply chain (o to L1)** - *Advanced planning and scheduling*
5.	**Employee training**	Establish a training program to enable employees to use the benefits of new integrated systems and data as a basis for better decision-making. The next steps are: - Develop a concept for a training program to educate employees for the newly introduced systems, devices and processes, e.g., how to use new IT systems like the planning system, read and understand KPI dashboards for lean process optimization or use IoT devices like barcode scanners

		- Define learning programs for different stakeholders in your company (e.g., management level, white collars, blue collars) and find suitable partners to deliver the training content - Launch the program and periodically train employees, implement job rotation and test employee skills regularly to ensure the sustainable application of new devices and systems and data-based optimization of processes - Continuously promote a working culture that is beneficial in an environment of logistics 4.0 and industry 4.0, e.g., promote agile working, data-driven decision-making, collaboration between departments and the usage of available IT systems **Relevant use-cases and initiatives in the roadmaps** **Strategy and organisation (L1 to L2)** - *Develop qualification of employees to handle and process data* **Culture and mindset (0 to L2)** - *Promote knowledge transfer between departments* - *Promote acceptance and usage of data and IT systems* - *Promote agile working culture* - *Establish culture of data-driven decision making*

#3: Flexibility and speed create a competitive advantage for SMEs. Only perform partial automation of processes to handle repetitive and error-prone processes while maintaining flexibility.

Flexibility and speed are key distinguishing factors of SMEs. Observations show that many companies strive for a higher degree of automation, as this often enables savings, e.g. of labor costs. However, a higher degree of automation comes along with a loss of flexibility. Therefore, we recommended to analyze the potential of digitalisation to improve indirect operations (planning, documentation, especially data entry into own or suppliers' systems) while keeping certain steps (flexibility to choose supplier or transport provider, adjustment to customers' business process, etc.) manual to maintain flexibility. Where a direct integration with suppliers is not possible, for example, bridging technologies like robotic process automation (RPA) can help to reduce repetitive and error prone manual tasks while enabling to quickly adapt processes as the supplier network changes.

Steps for implementation - #3:

1.	**Flexibility versus Automation analysis**	First systemize all processes which are considered to be automated, i.e., making a clear process description including all relevant special cases in writing. - If not yet available, write down process descriptions for each relevant process step which should be automated. - Check for deviations in the process depending on customer, order type etc. and map those as well – automation (whether physical or RPA) does not allow for flexible handling unless programmed in. - Check the business perspective – adaption of an automated process to a new customer requirement can be time-consuming and costly. Where are your (office or operations) processes always streamlined, what is often done different for certain customers, where are rush handlings etc. needed due to business requirements? - Automation needs all relevant information flows automated as well. Where are paper-based or special case handlings in your process? These would need to be eliminated before automation. - Cost analysis: how many man hours (including rework due to mistakes) go into a certain process step per day? Would automating this process step mean one worker less is needed in the office or operations, or would it only create a buffer?

2.	**Analysis of automation potentials for commercial and office processes**	Commercial and office processes can be automated using RPA if they are fully repetitive or if the only decisions follow a clear logic (e.g., the location of a specific field for data depending on the customer portal. Processes with a lot of copy/pasting, retrieving information from web portals, etc. are good candidates for RPA. - RPA is always the second best option to a direct replacement of the process with an actual IT integration using EDI or APIs. Check whether this would be possible with a suitable effort first. - Try to slice the process into smaller pieces and don't aim for a 100% solution especially if there are several exceptions. Maybe only pre-filling half a form can save half the time of your clerk, but the other half requires some thinking and anyway would need to be double-checked. Focus on the purely repetitive tasks first. - Align with an engineering partner on the creation of RPA "robots" (software automation programs) - As a next step, some more flexible processes can be automated using advanced RPA including AI components. Only start with these once you have tapped the potential of classic automation as this is significantly more effort and involves higher skills in the company. **Relevant use-cases and initiatives in the roadmaps** **Smart Processes (-2 to L1)** - *Define standards for overarching processes and support them digitally* - *Implement IT systems to support processes (e.g., CRM, OMS)* **Smart Operations (-2 to L1)** - *Define the operational procedure for internal processes*
3.	**Analysis of automation potential for operations processes**	Operations processes can be automated with various technologies, including automated handling (smart conveyors, AGVs, autonomous forklifts, AS/RS, …). Each physical automation comes with the same restrictions as a digital one (the automation system does exactly what is defined in the process and is not able to dynamically handle exceptional cases unless told so), plus physical restrictions (Size of physical elements like conveyors, grippers, etc.). Thus, care should be taken that automation is done where it saves costs in the long run and not where the cost of re-tooling and changes in the end becomes higher. - Check which physical processes take most time from your workers. Is the actual physical process the most time consuming part? Or is it things like documentation, information retrieval, work preparation which can be handled with the recommendations 1 and 2? - If automation would make sense, standardize surroundings in a flexible way. Are there standard packaging sizes etc.? These can help simplify the automation - Work with an engineering partner to put the automation in place - Make sure to avoid creating very inflexible settings which cannot be changed anymore. Modular automation which still allows for human intervention is often best. **Relevant use-cases and initiatives in the roadmaps** **Smart Processes (-2 to L1)** - *Define standards for overarching processes and support them digitally* **Smart Operations (-2 to L1)** - *Define the operational procedure for internal processes*

Furthermore, the following recommendations are given for the overarching ecosystem of shipping and logistics companies in Hong Kong to advance the development of Logistics 4.0. These can help to drive forward the whole industry as some SMEs may not have the opportunity and resources to pursue certain actions on their own.

B Industry-wide recommendations to support SMEs in applying Logistics 4.0

#1: Set up a central training program and talent attraction campaigns to enable SMEs to build digital capabilities on their own.

SMEs should build capabilities to digitalize their operations by themselves. This poses a challenge to many, and it is difficult to find the right talent with the necessary skillset to drive the digital agenda. Experience from other sectors has shown that there is great added value in setting up central training programs to educate the existing workforce, who already have the necessary domain knowledge and a good understanding of the company, in digital topics as well. Partners, vendors, and experts, such as the Hong Kong Productivity Council, are still needed to implement major upgrades and new technologies. However, continuous training for employees is an important factor for the successful introduction of Logistics 4.0 and enables SMEs to independently introduce and use small digital use cases that lead to more flexibility and transparency.

Steps for implementation - #1:

1.	**Requirements for Logistics 4.0**	Understand and map the future market requirements as well as the potentials of digitalisation for the logistics sector in Hong Kong. Furthermore, understand the requirements for Hong Kong SMEs with regards to technology implementation, the right mindset and organisation in order to move towards logistics 4.0 to derive relevant contents for a comprehensive training program. **Relevant chapters - Implementation Manual** - *Chapter 3: Introduction to Logistics 4.0 and Industry 4.0* - *Chapter 6: Functional Enablers* - *Chapter 7: Technology Landscape* - *Chapter 10: Recommendations for Logistics 4.0 Implementation in Hong Kong*
2.	**Status quo and needs of local SMEs**	Understand and map the current status, needs and challenges of Hong Kong SMEs with regards to the implementation of Logistics 4.0 to derive focus topics for the training program and to best meet the needs of the local industry. **Relevant chapters - Implementation Manual** - *Chapter 3: Introduction to Logistics 4.0 and Industry 4.0* - *Chapter 10: Recommendations for Logistics 4.0 Implementation in Hong Kong* **Relevant chapters - Maturity Level Protocols** - *Chapter 6: Key insights for the manufacturing and trading / shipping industry*
3.	**Implementation partners**	Get in touch with partners and experts, like the Hong Kong Productivity Council, who have experience in setting up and delivering industry training programs in order to ensure the right scoping and high quality of contents for a comprehensive program.
4.	**Training programs**	Develop training programs for the stakeholders of the training program across different hierarchy levels and functions (e.g. management, white collars, blue collars). For an optimal development for the local industry, define the training contents in workshops together with 2-3 representative pilot companies.
5.	**Launch training program**	Launch the training program and deliver the trainings to local companies together with the chosen implementation partner. In a first round, deliver the trainings to the pilot companies for last refinements. Subsequently, open the program to other Hong Kong SMEs.

#2: Define industry-wide standards for data exchange to avoid manual and error-prone copy & paste activities.

Observations in practice have shown that many activities revolve around the manual transfer and copying of data between IT systems and tools, e.g., in the handling and planning of orders. Manual and repetitive tasks are error-prone and take time, and once an error has been made, it takes time to find and correct it. To enable extensive and efficient data exchange between stakeholders in the value chain and facilitate the integration of new systems, industry-wide standards for data exchange formats should be defined by a representative committee.

Steps for implementation - #2:

1.	**Establish industry group on data standardization**	Establish steering group and implementation group from different companies in different positions in the value chain (traders/manufacturers, forwarders, warehouse operators, terminal operators, shipping lines, local IT providers, government agencies -e.g., customs, …)
2.	**Define relevant messages**	Define for which messages a digital standard makes sense – e.g., transport order, bill of lading, etc.
3.	**Screen standards used by other jurisdictions/markets**	Are there already digital standards in use or even standardized which can be used or adapted for use in Hong Kong?
4.	**Define digital standard**	Define the message format standard in a digital form as well as an API for exchange of the relevant information
5.	**Provide reference implementations**	To make the standards usable, reference implementations should be provided in various formats. These can be (coarse) libraries in common enterprise programming languages (Java, C#,…) web frameworks (Ruby on Rails, Javascript) and – as these are still commonly used – Excel macros.

#3: Develop and promote deployment of easy-to-use software for SMEs for easy integration of relevant supply chain data.

Software should be available for quick implementation in SMEs, which already integrates all relevant adapters to major suppliers and is compatible with the standardized formats that are used in industry. Most of the current IT solutions depend on companies having an IT department to customize software according to the companies' requirements, which is often challenging for SMEs. A software solution with simplified functionalities to only take over most parts of the job, which is in turn able to connect to most APIs and easy to deploy without the need for a big internal IT team and easy to configure could create a lot of value in terms of operating in a standardized way between SMEs and relevant big players who have defined APIs for data integration.

Steps for implementation - #3:

1.	**Develop local vendor ecosystem and showcases**	Establish center (e.g., in HKPC) where vendors can show their solutions and gather requirements from the council members.
2.	**Utilize grant schemes to develop simple solutions for identified requriements**	Where possible, incenitvize vendors to provide solutions for industry-wide requirements.

3.	**Provide access to specialists for deployment and customization**	As SMEs often lack skills or resources for own deployment or customization, develop programs to support SMEs with relevant expertise and technical manpower when needed.

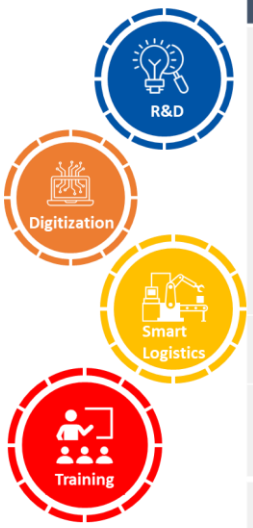
To summarize, SMEs have great potential to thrive in the digital world that is brought up by Logistics 4.0, if they focus on their core competences, which are speed, flexibility and being closer to the customer while keeping in mind what the future hygiene factors are. This is having digital capabilities which allow for real-time tracking of shipments, getting documentation done automatically, prevent human mistakes with the aid of digital tools and enable to track and optimize processes internally.

11 Funding support for the Industry to Migrate L4.0 Step by Step

HKSAR Government provides different funding programmes to the Hong Kong industry aiming to increase the added value, productivity and competitiveness of our economic activities. HKSAR Government hopes that, through the funding, Hong Kong companies could be encouraged and assisted to upgrade their technological level and introduce innovative ideas to their businesses.

A. Matching The Right Program and Applying for HKSAR Government Funding

HKSMEs could utilize the HKSAR Government funding scheme to implement Logistics 4.0 by combining the current state of the sector, aiming at a stepwise approach to attain higher levels of digital maturity, and a perspective on the market overall and the available solution providers. Some attractive funding scheme is grouped into four categories – Research and Development(R&D), Digitalisation, Smart Logistics and Training and shown below for your reference. For details, please visit the websites of Innovation and Technology Commission or HKPC for the latest information.



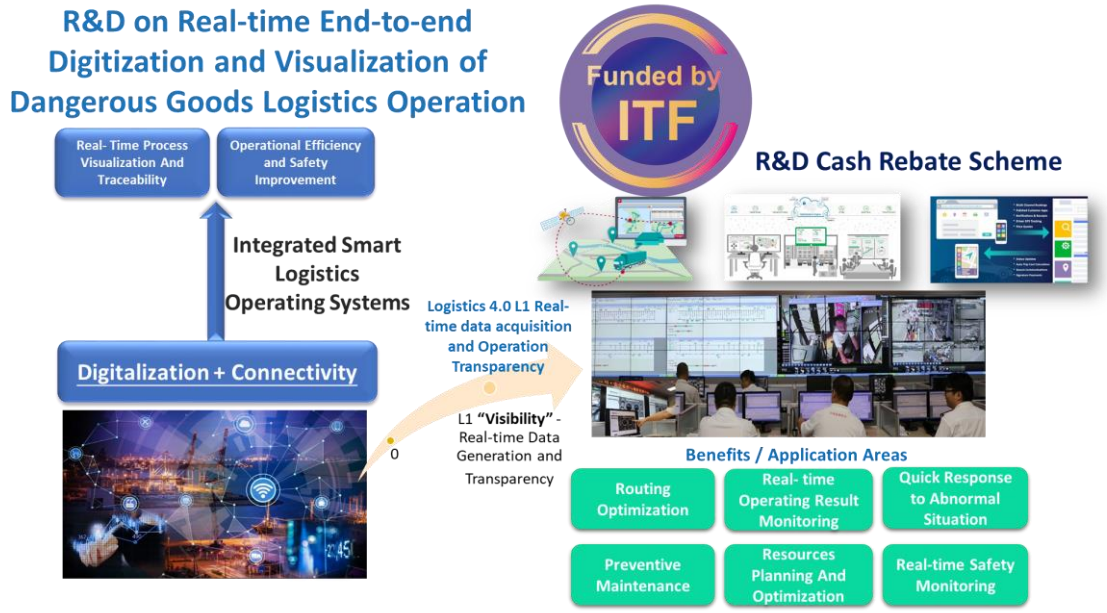
Category	Funding Scheme	Paired Form Ent.:Gov.	The upper limit of the enterprise's cumulative funding approval
R&D	Enterprise Support Scheme (ESS) π	1:1	HK$10,000,000 /Enterprise Application (No cumulative upper limit)
	R&D Cash Rebate Scheme π	6:4	No application limit (HK$30,000,000 above items are approved by the Legislative Council)
	Partnership Research Programme (PRP) π	1:1	No application limit (HK$50,000,000 above items are approved by the Legislative Council)
	Innovation and Technology Support Programme(Platform & Seed) π	At least 10%Industry Sponsorship (Platform)	Seed projects: Maximum Funding Support: HK$2.8 million undertaken by R&D Centres1; HK$1.4 million undertaken by other applicants.
Digitization	Technology Voucher Programme(TVP) π	1:3	6 Projects - HK$600,000
Smart Logistics	Pilot Subsidy Scheme for Third-party Logistics Service Providers Transport and Housing Bureau	1:1	4 Projects- HK$1,000,000
Training	Reindustrialisation and Technology Training Programme (RTTP) π	1:2	No application limit (Each company is subject to a funding ceiling of HK$ 500,000 in each financial year)

* Information is for reference only and enterprises must meet the relevant requirements of the Scheme before submitting applications.

Starting with the Research and Development(R&D), there are four funding schemes from the Innovation and Technology Fund (ITF), administered by the Innovation and Technology Commission. The Enterprise Support Scheme(ESS) is launched in 2015, aiming to provide funding support for local companies to conduct in-house research and development (R&D) work with a view to encouraging the private sector to invest in R&D. The Intellectual Property Rights Ownership would be the recipient company and not mandatory for the benefit sharing of commercialised R&D results. The R&D Cash Rebate Scheme(CRS) aims to encourage more research and development (R&D) investment in the private sector and encourage local enterprises to establish stronger partnership with designated local

public research institutes. It can provide 40% cash rebate of the local enterprises' eligible expenditure contributed to ITF projects and Partnership projects as undertaken by designated local public research institutes i.e. HKPC. For the Partnership Research Programme (PRP), it aims to support applied research and development (R&D) projects undertaken by R&D Centres or designated local public research institutes in collaboration with companies. The maximum project duration is 36 months which is a bit longer than the other R&D funding schemes. Besides, the Intellectual Property (IP) Rights will be owned by the company if it contributes at least 50% of the total project cost. The Innovation and Technology Support Programme (ITSP) (Platform & Seed) aims to support applied research and development (R&D) projects undertaken by R&D Centres or designated local public research institutes with a view to transferring the R&D results to local industries. The industry sponsorship of this funding scheme is relatively low, comparing with the other R&D funding schemes, even not mandatory for the seed projects. But, the applications for the funding once a year, 3 month durations.

Taking the R&D Cash Rebate Scheme(CRS) as an example, a turn-key R&D logistics 4.0 project aims to transform the operation of a local dangerous goods logistics company from the traditional operation to smart logistics operation step by step. It is a partnership project; the R&D works are conducted by a designated local public research institution – HKPC.



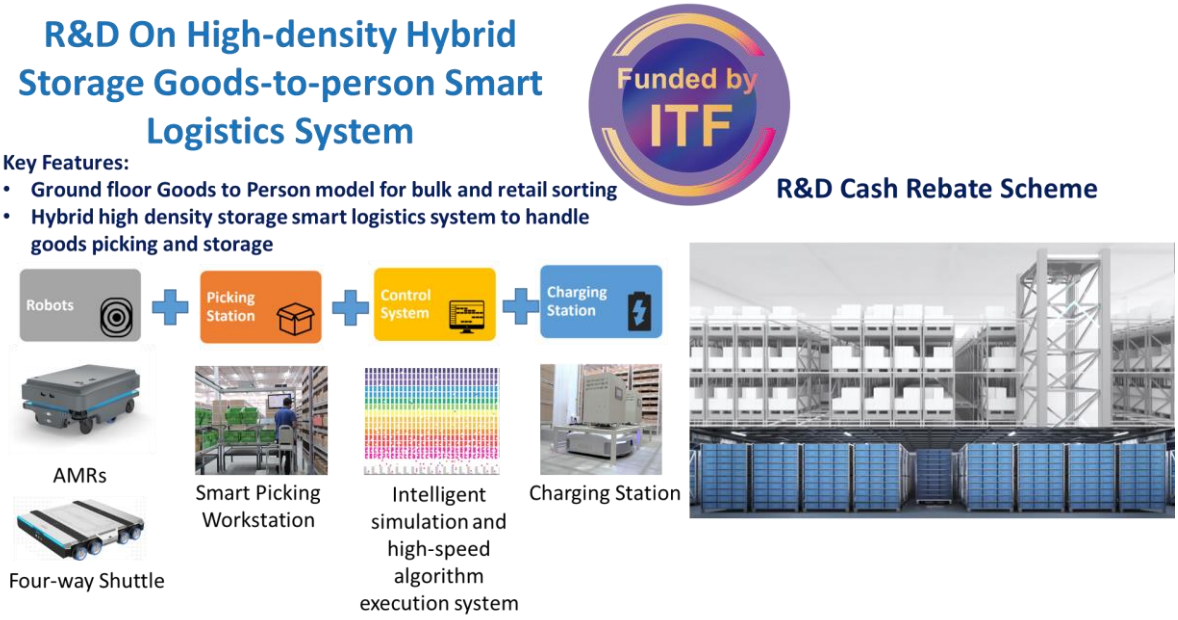
The objectives of this project are:

1. Operational efficiency and effectiveness improvement
2. Real- time process visualization and traceability

The project outcomes are:

1. Costs and resources optimization
2. Safety measures and control enhancement

Another R&D Cash Rebate Scheme(CRS) partnership project is a turn-key R&D logistics 4.0 project for a local logistics company transforming the business model from Business to Business(B2B) to Business to Customer(B2C) e-commerce fulfillment service. The R&D project is to develop a High-Density Storage Goods to Person Smart Logistics System in order to deal with the dramatic increase on the throughput of the Business to Customer (B2C) orders.



This R&D project could provide the following benefits for the company through “Digitalisation + Connectivity”

1. Improve inbound and outbound throughput
2. Improve order fulfilment accuracy
3. Improve order processing data accuracy and traceability
4. Reduce labour and operational costs
5. Optimize warehouse space

For the digitalisation category, the Technology Voucher Programme(TVP) aims to subsidie local company and organisations on the use of technology service and solutions to improve productivity, or upgrade or transform the business processes. As mentioned in the chapter 10, companies should first create a clear picture of what their Unique Selling Point (USP) is in the face of digitalisation. Then, the companies should follow the steps for implementation #1 to leverage digitalisation in logistics to eventually establish new business models. The TVP could subsidise the use/upgrade of the technology service and solutions.

For the smart logistics category, the Pilot Subsidy Scheme for Third-party Logistics Service Providers encourage the HKSMEs to adopt the latest technology of logistics sector for enhancing efficiency and productivity. As mentioned in the recommendation #2 for individual SMEs of chapter 10, the HKSMEs can utilize this funding scheme to implement a basic system of IoT devices at relevant places on the shopfloor or in the warehouse to collect real-time operational data such as the Warehouse/Distribution Center Management System, Real-time Location System and Transportation Management System (TMS). The HKSEMs could follow the steps for implementation #2 in chapter 10 to determine the steps for the implementation of the basic digital systems towards Logistics 4.0.

Lastly, in the training category, RTTP aims to subsidise local company to train their staff in advanced technologies, especially those related to “Industry 4.0”. It supports two types of training courses: public courses are open to the public for enrolment and applications for course registration should be submitted by course providers. Tailor-made courses are designed for a particular enterprise (or enterprises) and the course proposals should be submitted by the enterprise concerned as part of the training grant application.

The HKSMEs could join the public course or submit a tailor –made courses to train up the right talent with the necessary skillset to drive the digital agenda of the company. To do so, HKSMEs should start with understanding and mapping the future market requirements of Logistics, which could be get in touch with partners and experts, like HKPC or VTC to look for any suitable public course that meeting the requirements. Moreover, the company could set up and delivering tailor –made training programs in order to ensure the right scoping and high quality of contents for a comprehensive program with the partners and experts. The detail steps for setting up a central training program could refer to the Industry-wide recommendations #1 in Chapter 10.

Sources Useful sources for vendors and use cases

A. Sales and Planning
   1. https://www.remi.ai/demandforecasting
   2. https://www.uipath.com/product/robots
   3. https://chymebot.com/sales-assistant/
   4. https://www.kinaxis.com/en/solutions/sales-and-operations-planning
   5. https://blueyonder.com/solutions/demand-planning
   6. https://www.inform-software.com/supply-chain-management/demand-planning
   7. https://www.mo-data.com/sales-forecasting/
   8. https://www.ibm.com/cloud/api-connect

B. Transportation
   1. https://www.transmetrics.ai/
   2. https://www.epicor.com/en/industry-productivity-solutions/distribution/
   3. https://blueyonder.com/solutions/transportation-management
   4. https://www.anylogistix.com/business-challenges/supply-chain-network-design-software/
   5. https://www.blujaysolutions.com/solutions-for-shippers/
   6. https://www.project44.com/for-logistics-providers
   7. https://www.coupa.com/solutions/supply-chain-resiliency
   8. https://www.cargonexx.com/tourenplanung

C. Warehousing
   1. https://blueyonder.com/solutions/warehouse-tasking
   2. https://www.pinc.com/
   3. https://www.anylogic.com/warehouse-operations/
   4. https://www.motionminers.com/en/logistics/
   5. https://www.omnichains.com/platform#warehouse-inventory-management
   6. https://www.feig-logistik.de/en/
   7. https://www.manh.com/de-de/produkt/manhattan-active-warehouse-management
   8. https://www.solvice.io/solutions/picking-path-optimization

D. Goods Management
   1. https://www.logisnextamericas.com/en/jungheinrich
   2. https://cajarobotics.com/
   3. https://www.bostondynamics.com/solutions/warehouse-automation
   4. https://sps.honeywell.com/us/en
   5. https://mykargo.com/
   6. https://www.dematic.com/en/products/products-overview/voice-and-lights/
   7. https://phantom.auto/solutions/remotely-operated-forklifts
   8. https://www.zebra.com/de/de/solutions/industry/transportation-logistics/warehouse.html