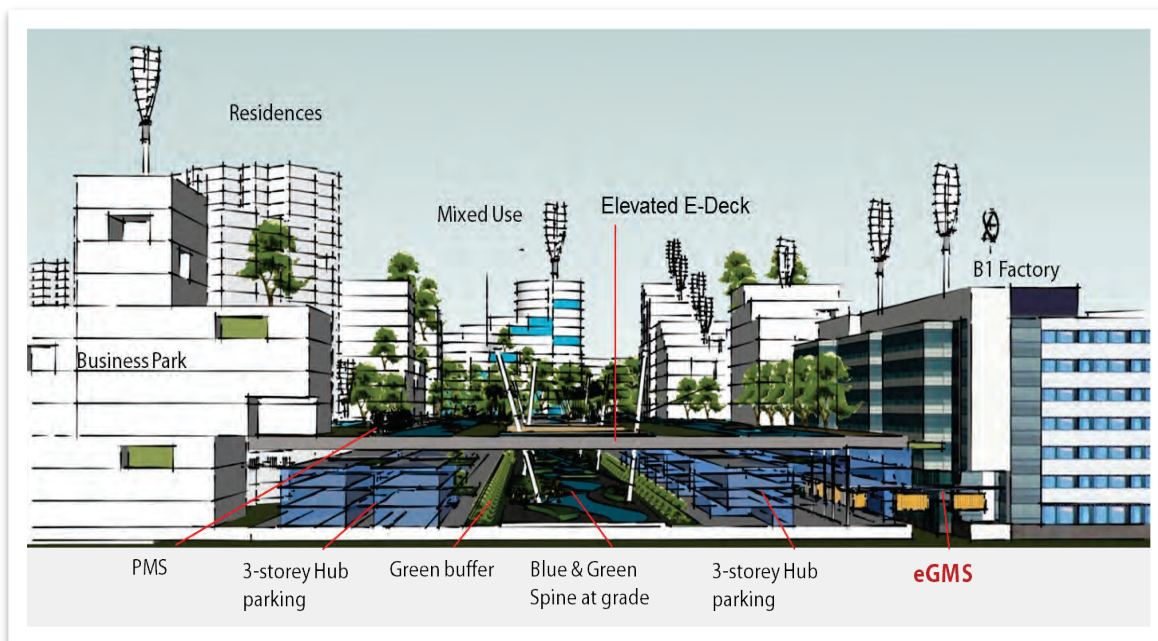


Land Use Intensification in Singapore – An Innovative Warehousing Concept as a Game Changer in Logistics

Volume 13-Nov-IR



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Land Use Intensification In Singapore – An Innovative Warehousing Concept as a Game Changer in Logistics

PRESENTED AT



Logistics Services and Infrastructure – Changing The Paradigm

13 NOVEMBER 2013

SINGAPORE

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Introduction

Singapore, as a small island state of 716 sq km of land and population of 5.4 million, faces a challenge of land scarcity – an essential factor in logistics. Business and industry compete for this limited land resource. As Singapore grows, the demands on the limited land resource will follow suit. It is therefore imperative to make strategic shifts towards higher value-added and more land-efficient economic activities, and to come up with more productive and innovative ways of land use to ensure the sustainable development of Singapore. Industrial land use, which accounts about 18% of the total land use, is an area where the government and researchers are looking for land use intensification opportunities.¹

Besides land, labour is yet another limited resource for Singapore. The logistics sector in many industries is often observed with a fairly uneven level of automation, which has a continued reliance on non-skilled/semi-skilled labour. Although the city has an increasingly well-educated workforce, relying on guest labour from the region is unsustainable in the long run. Therefore, finding innovative solutions to more efficiently utilize the labour resource is a key concern for many stakeholders.

One solution to enhance land and labour utilization in the city's development is to design for greater sharing of common facilities in industrial parks.² The idea is to establishing a shared multi-use facility within an integrated industrial complex that leverages on full automation to provide centralized, consolidated freight handling services for multiple enterprises.

Objectives

The concept of a consolidated shared warehouse is conceived out of two considerations. First, the need to innovate supply chain practice and the desire to further optimize current freights/goods handling processes. Second, the need to balance a liveable, urban environment while continuing to grow a resource-scarce mature economy.

The first consideration is borne out of Singapore's attempt to further strengthen its value proposition as a major import-export hub within the region. In order to do this, a re-examination of individual supply chain links and Singapore's role within the criss-cross of these international supply chains is critical. Any mechanism that serves to integrate supply chains beyond the firm level is expected to increase manufacturing productivity as a whole. This, in economics terminology, is referred to as incentivizing a positive externality beyond any one stakeholder's sphere of influence.

¹ NUS-JTC I³ Center. Dec 31, 2012. Available: <http://www.sde.nus.edu.sg/nus-jtc/researchthrusts/PlanningAndDesign.htm>. Accessed on Oct 31, 2013.

² Fu, G., & Wong, F. 2010. On maximizing value from land as a scarce resource. Singapore Ministry of Finance, Economic Strategies Subcommittee Recommendations.

Externality as an economic concept refers to a cost or benefit – resulting from one stakeholder’s activity – that will affect the welfare of other stakeholders who did not choose to incur that cost or benefit.³ For one enterprise, by integrating its supply chain with other enterprises, the total land use will be reduced, and saved land could be used for other purposes – a concept also known as opportunity cost. Integrated transportation among different enterprises will decrease the total number of shipments and vehicles required. Therefore the total traffic flow on the road will be reduced, resulting in less congestion and harmful emissions. These benefits increase marginal private benefits (MPB), shifting to a new market equilibrium where marginal social benefits (MSB) occur, resulting in gains for the whole society (illustrated in Figure 1).

Approached from the other end, individually operated supply chains with each enterprise maintaining its own warehouse will incur unobservable negative externalities. The wasted idle land in the less-than-full warehouses incurs land opportunity cost, and the sophisticated transportation network where each enterprise sends out its own vehicles will add to congestion and air pollution. Such intangible costs are not recognized by a company itself, resulting in an inefficient resource allocation at Q_2 , while the desired market optimal is Q_1 where marginal social cost (MSC) meets MSB (illustrated in Figure 2).

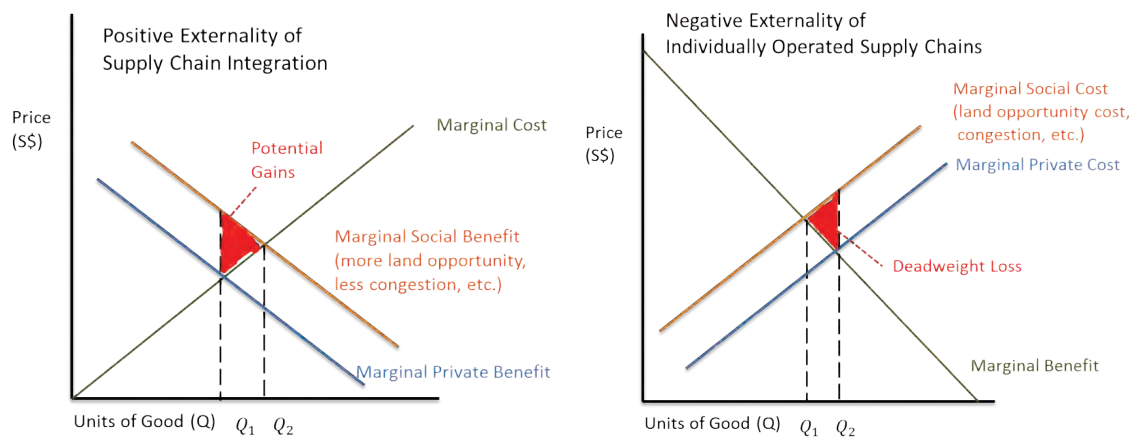


Figure 1: Positive externality of supply chain integration **Figure 2: Negative externality of individually operated supply chains**

The second consideration is driven by the desire to balance economic growth with urban liveability. Traffic congestion, air and noise pollution, rising density and space constraints are part of the multitude of problems that arise from an ever closer proximity between places where people work and live.

The automated consolidated warehouse concept aims to provide a game changer solution that can address Singapore’s supply chain challenges and catalyze innovative thinking in integrated warehousing and logistics.

³ Ranaiefar, F., & Regan, A. 2011. Freight-transportation externalities. In *Logistics Operations and Management: Concepts and Models* (pp. 333-357): Elsevier, Waltham, USA.

Singapore's Logistics Challenges

The context of a densely populated urban city exerts great challenges on logistics and material handling management in Singapore. One such challenge is how to improve operational efficiency in a highly compact city area, and the other is how to maintain and develop the nation's logistic competitiveness under the limited factor constraints. Innovative solutions as discussed below address these challenges and may facilitate consistent business growth of Singapore's logistics sector.

Operational efficiency

Often, it is said that much of the efficiency gained in high-tech international container shipping is lost in the last mile, where local conditions often chip away time and costs (operational efficiency) saved previously. The highly congested urban transportation networks cause delays for goods delivery to customers. The sheer variation of infrastructure such as site docking and queuing facilities and internal driveways often stand in the way of a quick-in quick-out delivery process. The inefficient operations result in greater costs overheads in last mile delivery. It is estimated that the unit cost of the last-mile logistics usually amounts to between 13% to 75% of the total logistics cost, which is a much higher contribution than other logistics legs in the whole logistics process.⁴

Land use limitation

Without the luxury of an immediate hinterland to expand into, Singapore, as a city that also functions as a nation-state, has to juggle its competing land uses. In an urban zero sum game, factories, warehouses, highways and local roads cannot become larger without taking away land to be potentially used for housing precincts, parks, and other public amenities (the challenge of opportunity costs). After two decades of fairly successful intensifying industrial land on the ground, there is now a limiting factor as to how high the industrial facilities can be built. The solution is to look further in-depth into the very industrial processes, such as logistics, that can further be enhanced through the use of shared resources, faster transfers, less visible movement, and industry co-location.

An Innovative Solution – eGMS

The estate-wide Goods Mover System (eGMS) is conceptualized as a centralized, consolidated facility—sitting within an industrial estate—that serves as the main receiving, storage, and distribution mechanisms for all industrial goods whether to/from the port or to /from individual industrial developments in the estate. It is aimed at greater infrastructural effectiveness and fostering positive externalities.

⁴ Van de Klundert, J., & Otten, B. 2011. Improving ltl truck load utilization on line. *European Journal of Operational Research* 210(2), 336-343.

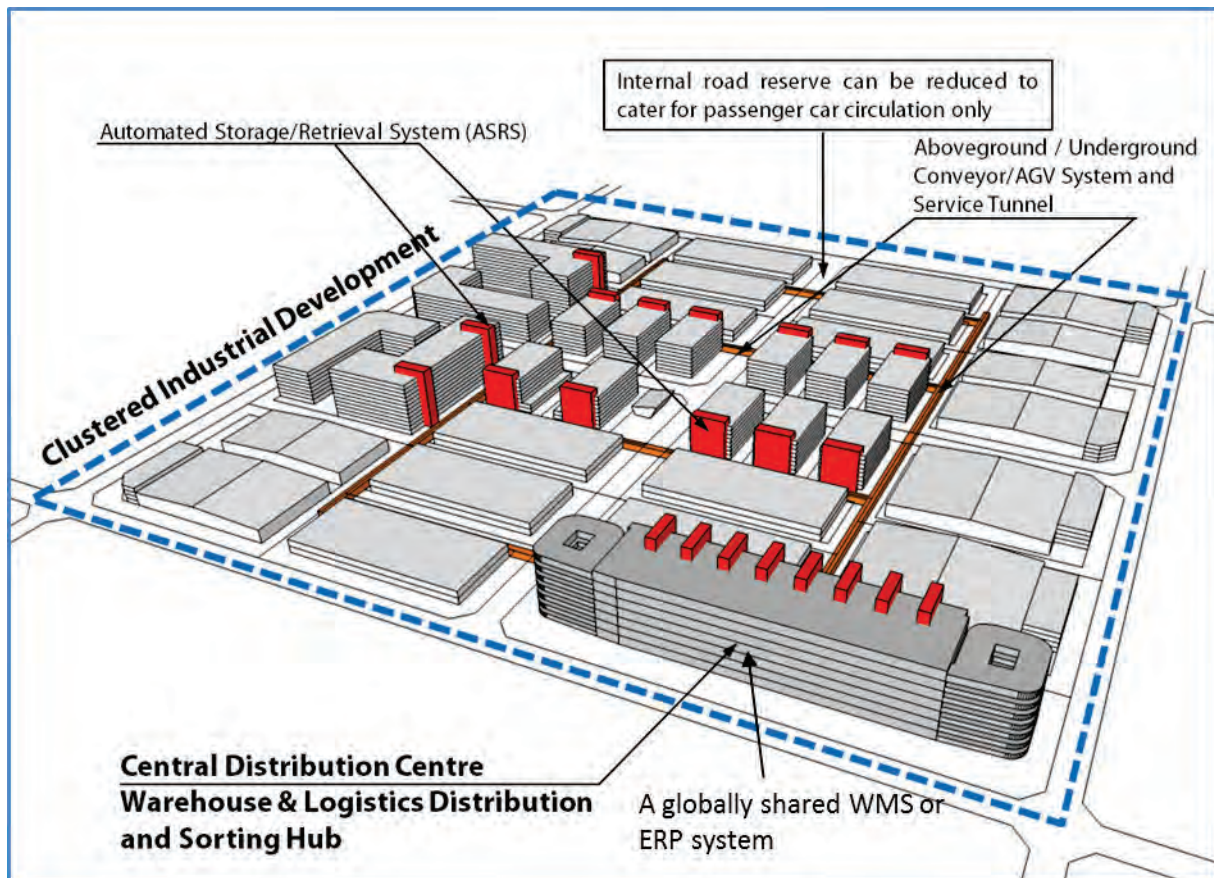


Figure 3: Illustration of eGMS concept

In essence, the eGMS allows each industrial development or cluster to “outsource” all aspects of its goods movement activity, from the large driveways and parking lots required for container trucks, to the loading/unloading docks which feed the products into the packing/unpacking area, to the warehousing elements required to store excess products or intermediary inputs. By placing all these facilities within a centralized distribution center (CDC) that serves a certain industrial precinct, trucks no longer have to make multiple drop-offs to different destinations. A “milk run” via automated links to co-located facilities within a cluster alleviates the last mile inefficiencies, by moving as many commodities above or below ground to and from the consolidation center.

The automated distribution system (either by conveyor or automated guided vehicles (AGV)) will break bulk, sort and distribute goods from the CDC. This time saving, cost definite innovation is a prime investment decision.

Rather than having general stakeholders with competing interests to manage this facility, a single third-party logistics (3PL) operator could potentially run the entire CDC system and distribution network, and charge every user a subscription fee, or even operate efficiently on a novel gain share business model with all parties of interest.

Complementing the solution, a globally shared warehouse management system (WMS) or enterprise resource planning (ERP) system will be advantageous to coordinate orders and service requests. It is

envisioned that inter-firm supply chain management could be centered on the consolidated warehouse, whereby individual firms are able to view at one glance information on stock from various stockists, and adjust their orders accordingly. All orders can be placed through the shared WMS system and distributed by the consolidated shared warehouse.

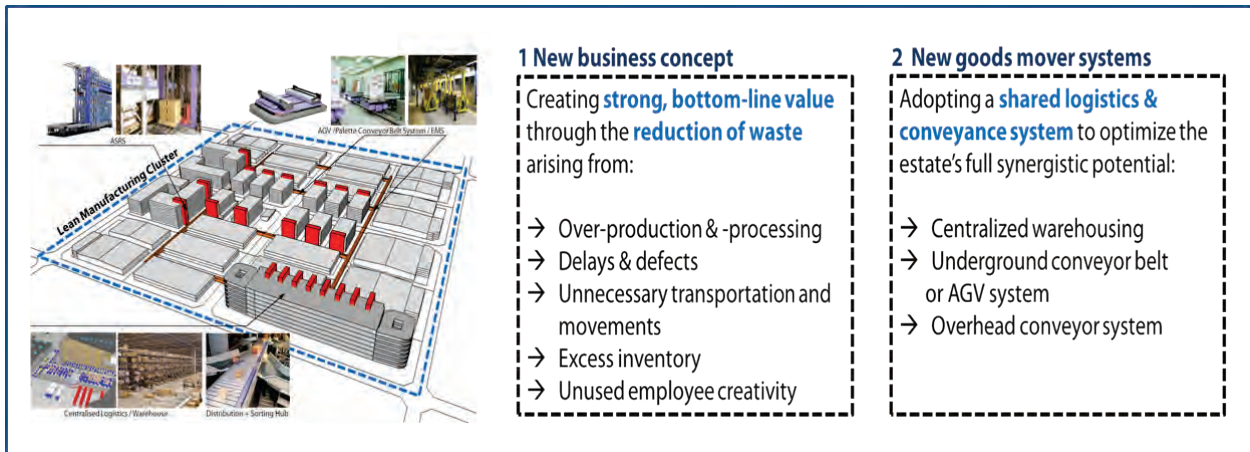


Figure 4: eGMS design overview

A highlight of this innovative design is illustrated in Figure 5 and Figure 6. Goods are moved between the centralized warehouse and each industrial enterprise within the region by an automated system either through aboveground conveyer belts or underground tunnels, optimizing the ground land use that would have been dedicated to driveways and docks. With a significant amount of industrial traffic taken off the road, traffic loads are expected to be lighter and multi-year road-widening projects could eventually cease. The reduction in interaction between pedestrian, commuter traffic and industrial traffic will also reduce the probability of accidents, which will benefit the society as a whole. The MPB curve shifts closer to the MSB curve through such innovative concept (illustrated in Figure 7).

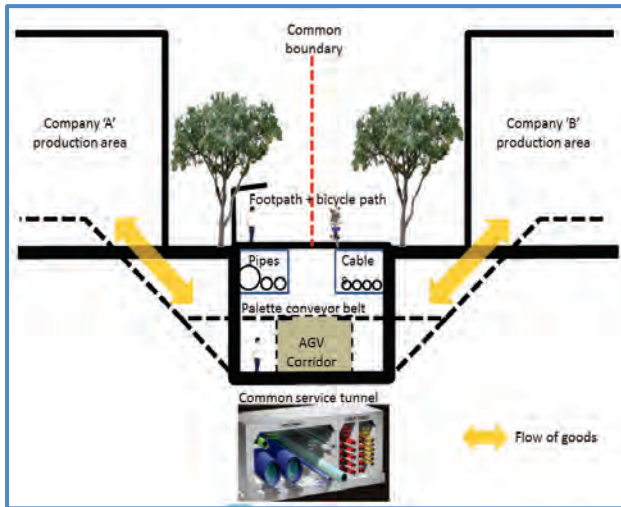


Figure 5: Underground distribution operation of the automated distribution system

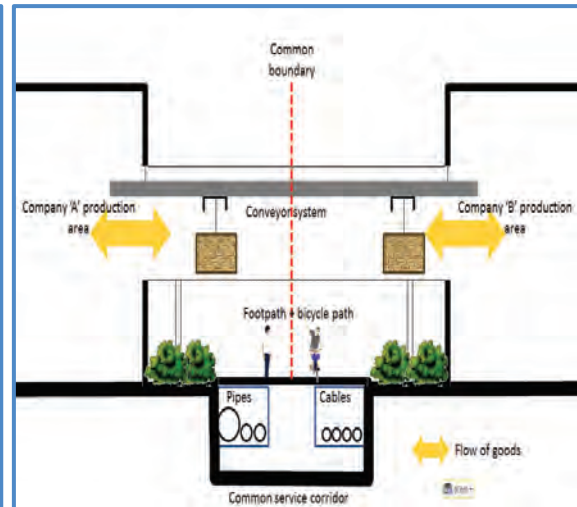


Figure 6: Aboveground distribution operation of the automated distribution system

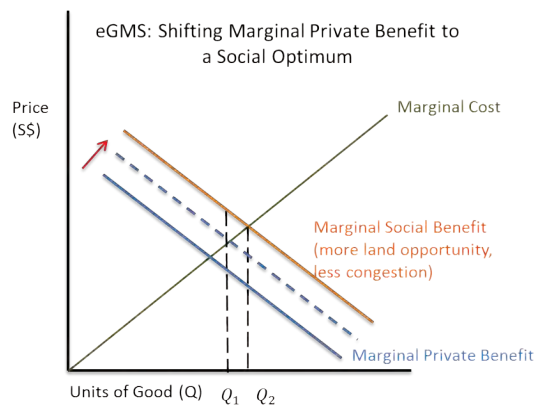
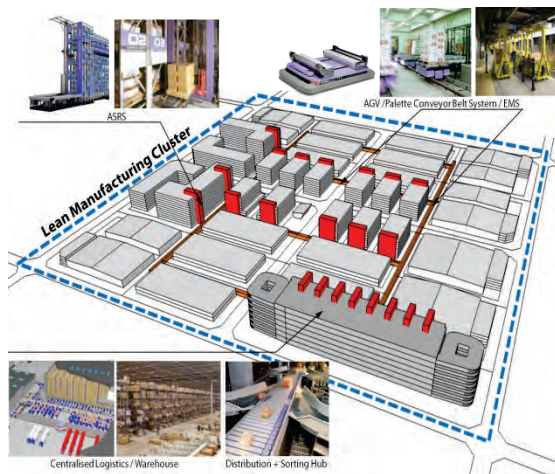


Figure 7: Increased marginal private benefit by eGMS

In summary, the eGMS concept is projected to bring benefits to various stakeholders within and outside the industrial park, as shown in Figure 8.



Projected Benefits

WITHIN INDUSTRIAL PARK CORRIDOR
Reduction of land take by 20-30% due to shared logistics system.
Free up the surface land for more productive uses due to reduction of land taken up by roads and aboveground developments.
Reduction in production lead times due to production line integration (e.g. vendor management, purchasing systems).
Reduction of trips generated & manpower required by companies due to physical clustering & automated conveyance, thereby also reducing industrial traffic going into new residential estates.
Reduction of production unpredictability due to assurance of supply arrival.

Figure 8: Projected benefits of eGMS within an industrial estate

Source: JTC presentation. May 22, 2013. Integrated underground eGMS network.

After setting up an industrial estate as aforementioned, one advancement is linking this industrial estate and some other similar industrial estates to ports/airports, via an effective underground goods moving system. This development is anticipated to change the landscape of Singapore’s logistics operations and enhance Singapore’s role as a critical and competitive import-export hub in the Asia Pacific region. An illustration of this integrated linkage to Tuas Port is shown in Figure 9.

Integrated Underground Goods Moving System from Industrial Estates to Tuas Port

Envisioned as

A future goods mover corridor that allows direct goods movement from various industrial estates to Tuas Port bypassing surface roads.

Tapping on

Strategic developments such as 2-west and underground rock caverns as central goods distribution centres for industrial parks in the western and northwestern region.



Projected Benefits

FROM INDUSTRIAL ESTATES TO PORT
Improve traffic conditions within the road networks serving the western / north-eastern region.
Free up surface land for more productive uses due to reduction of land taken up by roads and buildings.
Provide efficient transportation and logistical solutions for industrial developments, i.e. quicker delivery time, higher throughputs, reduction of labour through automation.
Allow for targeted measures to contain any H&S impact of hazardous industrial traffic.

Figure 9: Projected benefits of linking industrial estates to port

Source: JTC presentation. May 22, 2013. Integrated underground eGMS network.

Costs and Benefits for the Industry at Large

From a supply chain perspective, removing industrial goods movement from the main ground transport arteries into a centralized and consolidated system will generate better efficiency and increase seamless flows within a production network and value chain setting. According to many research studies, consolidation of industrial activity to centralized warehouse/logistics will generate greater agglomerative effects for the economy. The principle behind such an intervention is to introduce an intermediate storage and handling point that allows for several levels of optimization: consolidation of goods flows, optimization of warehouse operations, and economies of scale for support activities such as security, and insurance.

More specifically, there are five major benefits for an industrial enterprise to join a shared warehouse initiative:

1. **Reduction in investment and risk.** By shifting storage and logistics activities to the shared warehouse (which typically is run by a 3PL service provider), industrial enterprises will reduce the investment in its own logistics capacity and operations. Saved investment and efforts can be used to focus on the enterprises' core business activities, such as research & development, and manufacturing.
2. **Reduction in transportation cost.** Being responsible for goods handling, the centralized shared warehouse service can include consolidation of smaller shipments into full vehicle loads to manufacturers and external customers. This will contribute to a cheaper per-unit transportation cost due to economies of scale.
3. **Reduction in inventory holding cost.** By integrating all the private warehouses of clustered enterprises, space that would previously be idle in one warehouse can be used for products of another tenant now. This is especially useful for products with seasonality of demands or supply. Therefore, the total storage space of all enterprises will be reduced, leading to a cheaper per-unit storage cost. In addition, the shared common pool of labour, goods handling equipment, insurance, and other resources will help reduce the unit inventory holding cost.
4. **Improved efficiency.** With good knowledge and experience, specialized 3PLs can provide the services that greatly improve the efficiency of a company's business processes in inventory, distribution, and transportation. According to a survey study that took responses of over 2300 supply chain executives worldwide in 2013, more than half of the surveyed companies agreed that "use of 3PLs has led to year-to-year incremental benefits", and about 75% of them observed significant improvement in order fill rate and order accuracy.⁵
5. **Capacity flexibility.** By subscribing for space and service from the shared warehouse, an enterprise will be able to flexibly adjust its warehousing needs based on demand, and add short-term or long-term capability quickly and easily.

⁵ C. John Langley Jr. The state of logistics outsourcing 2013, annual survey sponsored by Capgemini US.

It is also worthy of note that adopting a shared warehouse concept, the clustered enterprises will indirectly contribute to the society and the environment. Land saved from warehouse space could be developed for other uses, helping to create a live-work-play balanced urban environment in Singapore. Through the transportation consolidation at the shared warehouse, there will be fewer vehicles needed and less traffic on the road. This will reduce the road congestion, exhaust emission and noise pollution in the city. These external benefits are likely to contribute to growing trends amongst modern enterprises of establishing corporate social responsibility.

However, clustered enterprises require a favourable value proposition to participate, due to the cost incurred to relocate their sites to the designated area. Incentive mechanisms should be developed by the government to motivate industry participation. Such incentives could be motivated through government subsidies, favourable regulations, or lower tax for the internally involved stakeholders. For both the industrial entities and the government, a careful analysis of the trade-off between public and local costs is necessary to correct the perceived “market failure” in the logistics sector (“Market failure” is defined as a situation where demand and supply does not match and the market fails to deliver an efficient or optimal allocation of resources).

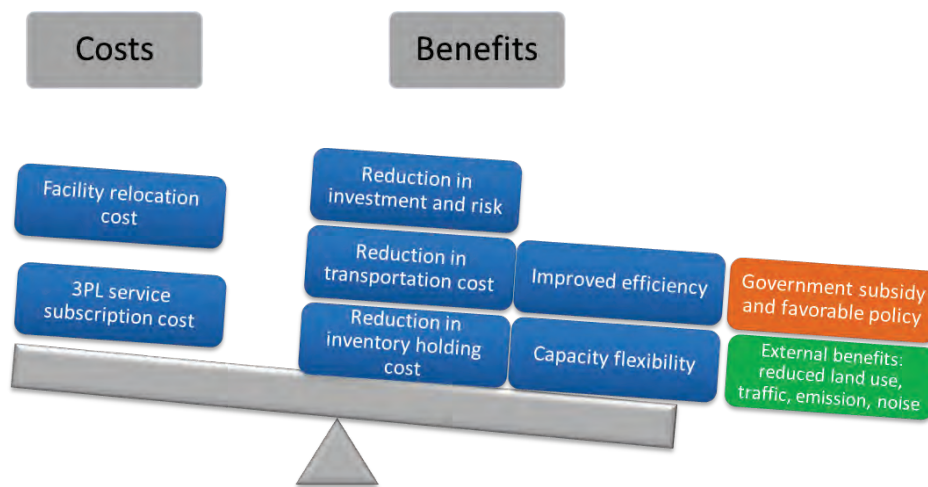


Figure 10: Costs and benefits of the consolidated shared warehouse for an industrial enterprise

Key Issues for Stakeholders

In summary, this land intensification strategy can be defined in the Figure 11, in terms of what the incentive is, who is involved, why they should participate, and where this concept is rooted.

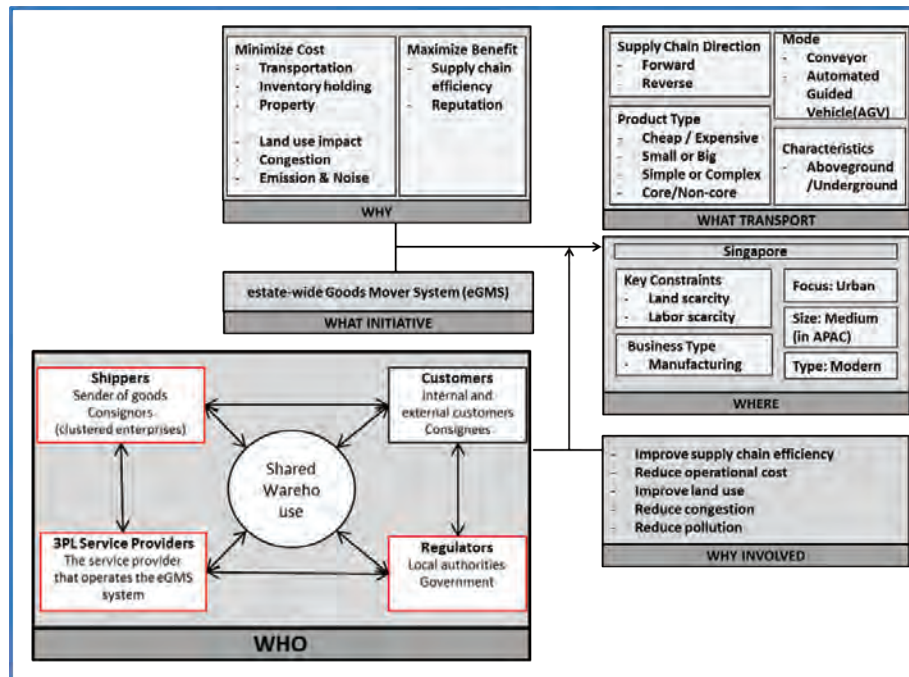


Figure 11: Summary of the eGMS initiative

Adapted: Quak (2011)⁶

It is anticipated that the automated consolidated warehouse concept is likely to have many implications both for the logistics industry and Singapore’s urban environment. To further assess the feasibility and potential success of this shared warehouse concept, some key issues should be taken into consideration by the different stakeholders. For example: the shippers who produce and send out products to customers, the freight transport operators who handle the goods storage and flow processes, especially the 3PL service provider who operates the shared warehouse system, and the authorities who regulate and administer the sector.

⁶ Quak, H. J. 2011. Urban freight transport: the challenge of sustainability, *City distribution and urban freight transport: multiple perspectives*: Edward Elgar, Cheltenham, UK.

Shippers

One key issue for the clustered shippers is the feasibility of integrating their supply chains into a centralized consolidation center and whether the consolidation center will satisfy their logistics needs. In the past few decades, consolidation centers have evolved to meet the changing customer requirements towards better support for goods movement. The various roles of a consolidation center in a supply chain could include: ⁷

- A make-bulk/ break-bulk consolidation terminal, which combines small quantities of several products into fewer larger assortments or de-aggregates large incoming loads for product mixing and creating consolidated outbound shipments.
- A cross-dock operation, which occasionally marries received products with other products with the same destination and ships them at the earliest opportunity without long-term storage.
- A transshipment node, where a shipment is taken out of one vehicle and then loaded onto another vehicle especially when there is a need to change transportation mode or vehicle type.
- An assembly facility, which performs the delayed manufacturing processes such as item-differentiation, packaging, labelling, and final assembly in order to better reflect the local market needs.
- A product fulfillment center, where ships products directly to final customers who usually place orders via an electronic medium such as the internet and the telephone.
- A returned goods depot, which handles the goods return process in reverse logistics operations.

A consolidation center often performs more than one of the above functions simultaneously. The role of a consolidation center can only be clearly defined based on the specific requirements from its customers.

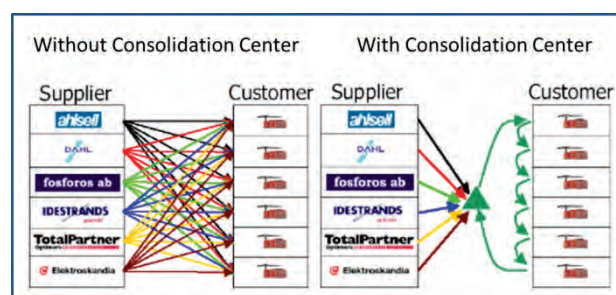


Figure 12: An example of consolidation center from Stockholm, Sweden

Adapted: Woodburn (2005)⁸

⁷ Higginson, J., & Bookbinder, J. 2005. Distribution centres in supply chain operations. In A. Langevin & D. Riopel (Eds.), *Logistics Systems: Design and Optimization* (pp. 67-91): Springer, US.

⁸ Woodburn, A. Jan 13-14, 2005. Overview of consolidation centers for urban and specialist use. Available: http://www.bestufs.net/download/Workshops/BESTUFS_II/London_Jan05/BESTUFS_London_Jan05_Woodburn_UoW.pdf. Accessed on Oct 31, 2013

Third Party Logistics Service Providers

Managing efficient goods flow for a complex consolidation center serving various customers is challenging for the 3PL service providers. Lessons can be learnt from successful cases, one of which is UTi’s shared distribution infrastructure for pharmaceutical industry in South Africa.

UTi’s shared distribution infrastructure – UTi Pharma case study

Modern supply chain distribution faces increasing challenges from growing market demands. This is especially true for the pharmaceutical industry where delivering the right medicine on time, in the right condition to the right place is closely related to a person’s health. The primary challenges for pharmaceutical distribution include: providing reliable service for different markets ranging from urban areas to remote rural areas; maintaining effective product flow from manufacturing sites through to patients; ensuring the quality of products that require particular cold storage and handling conditions; and avoiding trade in stolen, counterfeit, and expired pharmaceuticals that will lead to grey market trading.

To address those challenges, UTi has come up with an innovative direct distribution model with shared distribution infrastructure, which outpaces the traditional distribution model. In this new model, pharmaceutical manufacturers are jointly served by a shared distribution center that handles the goods flow from manufacturing to consumer markets.

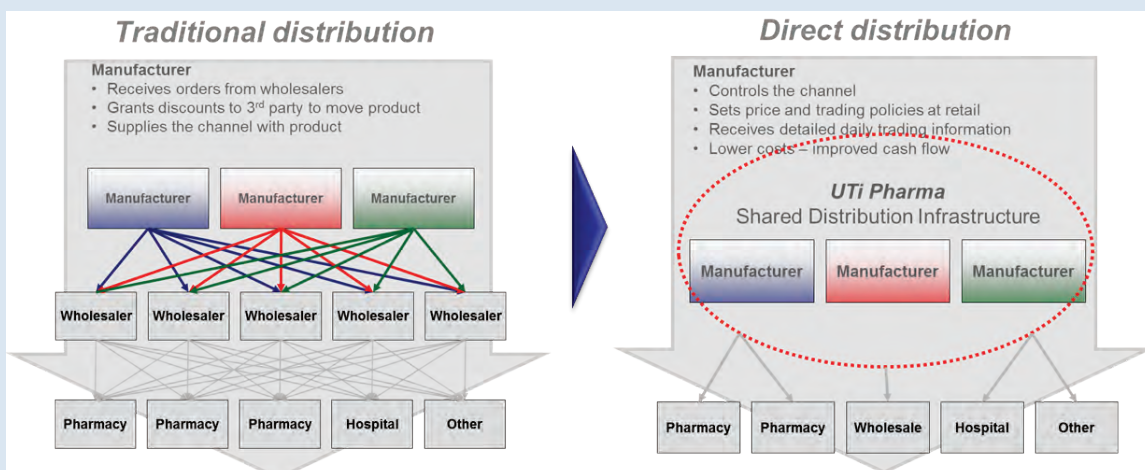


Figure 13: UTi’s new distribution model for pharmaceutical industry

As service provider, UTi offers facilities, systems, fleet of vehicles, expertise, integrity, technology, innovation and dedicated people to deliver quality and cost-effective distribution to consumer market. Various services are provided within the shared distribution center to cover the end-to-end order-to-cash cycle, including finished goods warehousing, order picking and packing and delivery supported by automation and sophisticated technology.

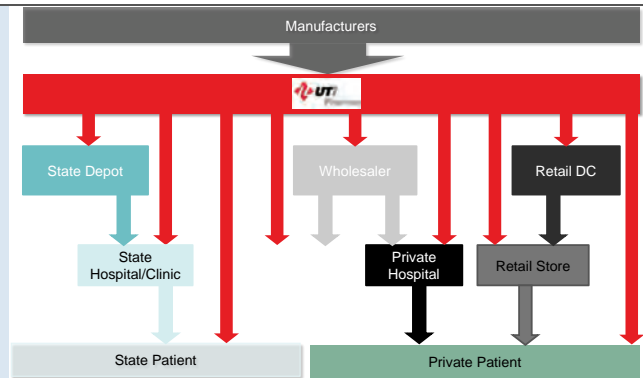


Figure 14: UTi's pharma distribution network

An advanced information system is used to provide full visibility in stock status, credit limits, sales data and facilitate tracking of invoicing and customer data and product batches. In addition, the shared distribution center accommodates online and electronic ordering facilities and maintains 24/7 emergency medication service for pharmaceutical dispensers and patients.



Figure 15: UTi's shared distribution center

UTi's shared distribution solution brings various benefits for manufactures and end customers:

- Provides guaranteed product quality and information transparency for all manufacturers, as well as dispensers and patients.
- Eliminates intermediate distribution parties and reduces costs due to duplication waste of distribution resources.
- Puts responsibility on UTi for ensuring effective manufacturer control of the distribution process and brand integrity.
- Reduces grey market trading through full audit trail supported by validated systems.
- Drives accuracy, efficiency and effectiveness by sophisticated technology which reduces paper usage and risk of human error.



Currently this distribution model is applied in South Africa, where a shared distribution facility combines over 40 pharmaceutical (including seven of the world's top ten), diagnostics and consumer manufacturers in the same distribution network for the same geographical markets. This is an innovative business model where competing manufacturers collaborate with each other to leverage economies of scale and reduce costs of finished products, warehousing, and distribution.

It can be seen that this distribution model of active collaboration of pharmaceutical manufacturers has the potential for expansion in other markets and industries. In the Singapore context, further investigation will be needed about whether clustering manufacturers geographically and linking them via automation will generate further benefits, and whether further savings could be leveraged from above or below ground goods handling.

Acknowledgement: we would like to express our appreciation to Uti for sharing this case study with us. Diagrams and insights in this case study are referred from "UTi Phama case study write-up" by UTi, Nov 2013.

Regulators

Clustering is one of the key drivers for regional economic growth and the development of clusters in various types of industries has been a focus for many government programs across the globe. A cluster refers to a group of firms from the same or related industries located geographically close to each other or even physically co-located.⁹ Typically, participants in a cluster include a set of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions who compete but also cooperate.

A cluster benefits the participating companies by providing them with an integrated economically scaled resource and capabilities.¹⁰ Firstly, companies will reduce the search and information costs, because they can source from the common pool of human capital, products, services, and extensive market, technical, and competitive information within the cluster, instead of pursuing external resources or developing their own capabilities. Additional benefits can be achieved through joint logistics, bulk handling, and brand recognition. Moreover, companies benefit from knowledge spillovers from competing co-located firms, public research institutions, suppliers and customers. The gained knowledge will stimulate innovations that better fits market needs through cooperative research and competitive striving.¹¹

Clustering helps cities and countries direct their economic development and recruiting efforts. It also encourages communities to refocus efforts on existing industries. Strong domestic clusters will appeal

⁹ Bell, G. G. 2005. Clusters, networks, and firm innovativeness. *Strategic Management Journal*, 26(3), 287-295.

¹⁰ He, J., & Fallah, M. H. 2011. The typology of technology clusters and its evolution—Evidence from the hi-tech industries. *Technological Forecasting and Social Change*, 78(6), 945-952.

¹¹ Maine, E. M., Shapiro, D. M., & Vining, A. R. 2010. The role of clustering in the growth of new technology-based firms. *Small Business Economics*, 34(2), 127-146.

to foreign investment. The eGMS could operate at the heart of such clusters (as illustrated in Figure 16).

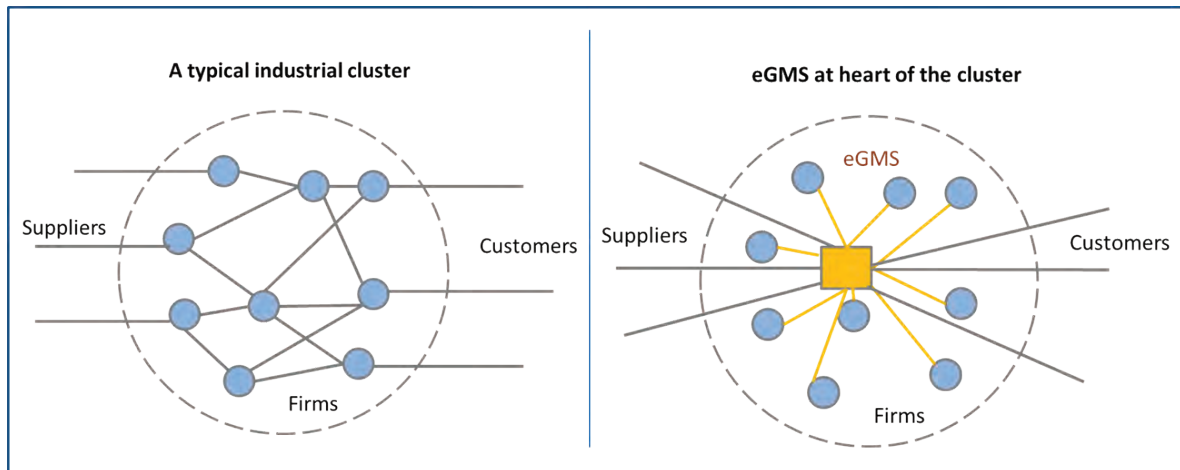
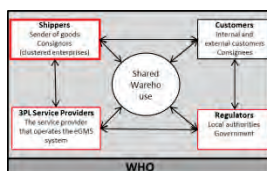


Figure 16: The eGMS could operate at the heart of a cluster

Adapted from the Marshallian cluster concept from: He et al. 2011. ¹²

It is challenging to develop a greenfield cluster, but appropriate policy interventions can facilitate such development. As clusters are different from one another, understanding the drivers for the performance of individual clusters is essential to help propose appropriate cluster policy interventions.

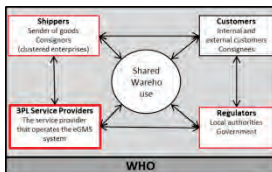
Problems for discussion with stakeholders



Shippers Perspective

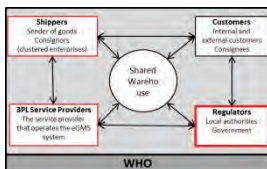
- (1) What does it take to be a participant in this advanced shared warehouse concept? What trade-offs are necessary and what incentives are expected from legislation and in turn from the selected service provider?
- (2) What are the major characteristics of common product/material flow handling? What special requirements need to be taken care of in the consolidation process (such as refrigerated products, off-spec cargo)?

¹² Ibid Page 14 note 9.



Third Party Logistics Service Providers Perspective

- (1) What is the responsibility for the consolidated warehouse? What kinds of services are essential for the success of this shared warehouse concept?
- (2) As a 3PL service provider, where is the cost-benefit tipping point? What specific capabilities are necessary for managing such a system?
- (3) How should one measure performance efficiency (both allocative and technical) and how will this impact productivity?
- (4) Serving multiple customers simultaneously within one network increases the system complexity and uncertainty across stakeholders. How is reliable and consistent service maintained in this scenario?
- (5) Data security and harmonization is important to establish the cooperation among different companies sharing the logistics system. How would one secure physical and data flow through innovative operation process design and an integrated information system?



Regulators Perspective

- (1) Is this shared warehouse concept worthwhile investing?
What assessments are needed to evaluate the feasibility of this concept?
- (2) To promote the shared warehouse concept, what policies and financial support can be provided to attract industry participation?
- (3) How to evaluate the impact of these policies and support (such as subsidies) on other enterprises that are outside the shared facility estate?
How to minimize the effects of such intervention on market efficiency?

Conclusion

A key factor in the success of this innovative warehouse concept is whether it will add value to existing manufacturing activities by increasing productivity, and concurrently reducing negative externalities as well as enforcing positive externalities. A cost-benefits analysis for participants at firm and cluster levels may be necessary.

Once implemented, this innovative warehousing concept will restructure the logistics industry and its current business and operating models. The effects of such a restructuring exercise remain to be investigated and promoted through case studies and exploring best practices.

The consolidation of all logistics flows into a consolidated shared warehouse can bring about the risk of a single point of failure. Special precautions need to be designed to preempt operational failure, since this form of freight logistics is different from the existing forms of urban transportation. A simulation study may be necessary.

Additional policy levers in the pricing of industrial land, the channelling of demand for industrial land into space (i.e. multi-tenanted factories), the repositioning of industrial land for core manufacturing activities only (and no goods handling ancillary activities) and the move towards encouraging shared facilities as the new planning paradigm for industrial parks in Singapore will factor in the market receptivity of this innovative shared warehousing incentive. A system dynamics study might be applied.

It is postulated that this consolidated shared warehouse concept should be expanded beyond one industrial estate for economic impact. Strong government leadership and financial backing will be required, as well as the buy-in of early adopters within the logistics sector. The Logistics Institute-Asia Pacific intends to study, with industry participation, the trade-offs and feasibility of this novel land intensification strategy and scrutinize its implications on the congested urban environment in the region.



A Collaboration Between



The Logistics Institute – Asia Pacific

National University of Singapore

21 Heng Mui Keng Terrace, #04-01, Singapore 119613

Tel: (65) 6516 4842 · Fax: (65) 6775 3391

Email: tlihead@nus.edu.sg · URL: www.tliap.nus.edu.sg