A study of warehouse management system in Singapore

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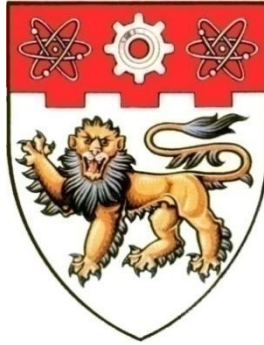2010

https://hdl.handle.net/10356/90972

Nanyang Technological University

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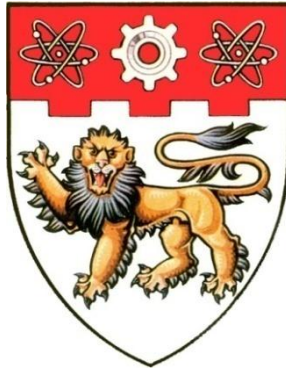
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A STUDY OF WAREHOUSE MANAGEMENT SYSTEM IN SINGAPORE

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A Research Project presented to the Nanyang Technological University
in partial fulfilment of the requirements for the
Degree of Bachelor of Science in Maritime Studies

2010

SUMMARY

In order to maintain/enhance Singapore's competitiveness as the world's leading logistics hub, this study examines the general use of Warehouse Management System (WMS) in the warehousing sector, with the aim of providing constructive recommendations. This research project was carried out by collecting survey data and conducting interviews with industry working professionals in the data consolidation and analysis phase. The findings indicate that:

- The small scale of WMS implementation in Singapore logistics industry is attributed to the substantial representation of small players. Thus, continued funding support from government is desirable in achieving full WMS adoption. Furthermore, merging of small players to become bigger players, together with proper control measures in place, might be beneficial to Singapore.

- Average level of warehouse sophistication lies between *rudimentary locator* and *advanced locator*, hence there is huge potential for improvement. There are significant differences in warehouse sophistication level between small and medium-large warehouses. Therefore, the small players have extra miles to go in catching up with more sophisticated industry practices.

- Generally speaking, WMS used in Singapore are strong in *number of functionalities*, *technology contents* and *ability to fit into warehouse operations*. However, they are weak in ability to *integrate and support warehouse automation*. As warehouses evolve towards automation, WMS developers can turn such weakness into business opportunity. On the other hand, warehouses should be prudent in choosing WMS packages.

- The deployment status of most WMS capabilities is slightly lesser than perceived usefulness. Furthermore, most extended capabilities are rated to have low deployment status and usefulness. Thus, there is enormous room for WMS to further develop and play a stronger role in increasing operational efficiency and productivity in the warehouses.

- The future R&D needs for WMS focuses on customer satisfaction, since warehousing itself is a service sector. Therefore, R&D needs for *visibility*, *event management* and *performance management* fall under high-importance, high-urgency activities.

ACKNOWLEDGEMENTS

First and foremost, I would like to credit my final year project supervisor, Dr Wong Yiik Diew, Associate Professor, School of Civil and Environmental Engineering (CEE), Nanyang Technological University (NTU), for my fruitful and unforgettable research experience. With extensive expertise and knowledge in research, he has been constantly giving generous support and guidance to my research project.

I want to thank my final year project collaborators, Cui Yifang and Zheng Yanchao, for their constant support and co-operation throughout the whole research project.

I am thankful to all staff in the Transportation Lab, CEE, NTU for their generous help to the data collection process of my project, especially the survey questionnaire dispatching stage.

I also would like to thank Mr Lim Kong Meng, Senior Assistant Director of library, NTU for his patient guidance on the effective use of library database resources.

I am sincerely grateful to the following academic professionals and/or industrial experts for their time spent on sharing valuable knowledge:

- Dr Jasmine, Lam Siu Lee, Assistant Professor of NTU

- Mr Ng Kah Yong, Representative of DST Lines

- Mr Ramachandran Pillai Sreekumar, Warehousing Manager of Ryder Asia

- Dr Roland Lim, Research Scientist of Singapore Institute of Manufacturing Technology (SIMTech);

- Mr Abdul Hamid, Warehousing Manager of GKE Warehousing and Logistics;

- Mr Eric Chan, Senior Warehousing Manager of Poh Tiong Choon Logistics;

- Mr Eric Lee, Deputy General Manager of THT Logistics;

- Mr Chan Hsien Hung, Assistant Logistics Director of Yang Kee Logistics;

- Mr Danny Kong, Logistics Engineer of Yang Kee Logistics

Last but not least, I would like express my appreciation to all the survey respondents (see Appendix B) for their participation and help.

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ASRS	Automated Storage and Retrieval Systems
3PL	Third Party Logistics
CDP	Capability Development Programme
DC	Distribution Centre
EDB	Economic Development Board of Singapore
EDI	Electronic Date Interchange
ERP	Enterprise Resource Planning
FMCG	Fast Moving Consumer Goods
GDP	Gross Domestic Product
GST	Goods and Services Tax
IT	Information Technology
JIT	Just In Time
Mgmt	Management
QA	Quality Assurance
R&D	Research and Development
RF	Radio Frequency
SC	Singapore Customs
SIMTech	Singapore Institute of Manufacturing Technology
SKU	Stock Keeping Unit
SLA	Singapore Logistics Association
SME	Small and Medium Enterprises
WMS	Warehouse Management System
ZG	Zero-GST

CHAPTER 1 INTRODUCTION

This chapter comprises three parts including brief introduction to the background of warehousing sector, objectives of this study as well as scope and tasks to be accomplished.

1.1 Background

A warehouse is "a commercial building for buffering and storage of goods, or an intermediate area for storing of raw materials or products until they are needed for production or consumption" (Chua & Teo, 2008). Warehousing, being an essential component of logistics, is a key aspect of modern supply chains and plays a critical role in the success or failure of businesses today (Frazelle, 2002a). If one takes a closer look at the detailed breakdown of the operating cost of a particular company, warehousing contributes to about 20% of logistics costs (Kearney, 2004). The substantial amount being tied up in warehousing resources prompted many companies to implement Just-In-Time (JIT) system which is "an inventory strategy that strives to improve a business's return on investment by reducing in-process inventory and associated carrying costs" (Wikipedia, 2010). However, the lean manufacturing concept has been proved to be impossible to realise the total elimination of a warehouse, mainly due to short lead time tolerance by customers, needs for holding of safety stock, further consolidation process at destination, etc.

Due to globalisation, the increase in complexity of supply chain has also increased the complexity of the roles played by a warehouse. Generally speaking, the traditional distribution warehouse which is mainly for storage and buffering of products has evolved to the production warehouse which can be seen as cross-docking points (where goods are moved directly from inward to outward vehicles without being put away into inventory), value-added service centres (e.g. pricing and labelling goods for customers), production postponement points (configuring or assembling goods specifically to customer demand so that a smaller range of generic products can be held in inventory), return goods handling centres (for reverse logistics of packaging, faulty goods or end-of-life goods) and many other miscellaneous activities, such as

service and repair centres (Maltz & DeHoratius, 2004).

The evolving role of warehouse has exerted significant impacts on the evolvement of Warehouse Management System (WMS). A WMS is a database driven IT tool used to improve the efficiency of the warehouse by coordinating warehouse activities and to maintain accurate inventory by recording warehouse transactions (Shiau & Lee, 2009). To quote Mr Danny Kong of Yang Kee Logistics, "WMS is an integral part of any supply chain". Proper and effective use of WMS can greatly increase the efficiency and productivity of a warehouse, thus helping to achieve warehousing cost reduction of the company. Through the general use of WMS in the logistics industry, one can also get a clear picture on the development of the warehousing sector.

In 2007, a World Bank report ranked Singapore as the top logistics hub in the world, above big players like the Netherland, Germany, China and Japan (EDB, 2009c). Recently, Asia Pacific Wine Hub announced the opening of its storage facilities in Singapore. Stocks and wine collections are stored in more than 100,000-square-feet of humidity, light and temperature controlled storage space where excellent inventory and warehouse management is essential (EDB, 2009a). In order to maintain its competitiveness in logistics industry, Singapore should not overlook the strategic importance of warehousing in which WMS has always been the passion of researchers on its constant improvement.

1.2 Objectives

This research project is aimed at studying WMS adopted in Singapore logistics industry as a whole. Through the current scale of implementation, perceived barriers for adoption, general evaluation of WMS, extent of use of WMS capabilities as well as desired R&D needs, this report aspires to provide conclusions and recommendations on warehousing sector, so as to enhance Singapore's competitiveness as a leading logistics hub.

1.3 Scope and Tasks

The scope and tasks of the research project include finding out the scale of implementation of WMS and perceived barriers for adoption, evaluating the strengths and weaknesses of WMS currently adopted by the industry as a whole, examining usefulness versus deployment status of current WMS capabilities and interpreting future R&D needs on desired WMS capabilities. A survey (see Appendix A) was conducted targeting logistics companies which were engaged in warehouse operations, both operating and not operating WMS, in Singapore.

CHAPTER 2   LITERATURE REVIEW

This Chapter collects relevant past literatures, which starts with background information about warehousing sector in the context of Singapore, followed by three sections covering evolution of warehouse, evaluation of WMS, and WMS capabilities.

2.1 Background Information

This section introduces some background information, facts and statistics of the logistics industry in Singapore, with focus on the sub-sector of warehousing and storage. Subsequently, a brief overview of this section is given.

2.1.1 Overview of the Logistics Industry in Singapore

As aforesaid, Singapore is a worldwide recognised leading logistics hub renowned for its world-class infrastructure and global connectivity. Among the top 25 third party logistics companies (3PLs), 21 have already established offices in Singapore, and most of them have set Singapore as regional headquarters. Apart from big players in logistics, leading companies across all industries have chosen to be based in Singapore to leverage on its excellent infrastructure and connectivity. Some examples include Hewlett Packard, LVMH, Numonyx, Roche Diagnostics and Schering-Plough (EDB, 2009b). Table 2.1 shows the statistics of Singapore logistics industry from year 2003 to 2007.

Table 2.1 Logistics Industry Statistics for Singapore in Year 2003 - 2007

Indicators	2003	2004	2005	2006	2007
No. of Establishments	5,694	5,815	5,478	5,772	5,371
No. of Workers	63,147	64,377	64,796	67,503	72,199
Operating Receipts ($m)	23,496	25,096	31,587	42,662	67,097
Value-added ($m)	4,897	5,575	6,359	7,589	9,417
GDP Contribution (%)	3.05	3.05	3.19	3.44	3.79

Source : Department of Statistics & SPRING Singapore
Notes : Industry cluster as defined by SPRING

The annual number of establishments has been remaining steady; the number of workers and GDP contribution have been increasing stably; operating receipts and value-added have been increasing abruptly especially from year 2006 to 2007 (SPRING, 2009a).

2.1.2 Overview of the Sub-sector of Warehousing and Storage

Generally speaking, the warehousing sector includes warehouses, specialised storage facilities and value-added logistics providers, in all of which WMS plays an important role in their daily operation and performance. Warehousing business can be categorised into the following (EnterpriseOne, 2010b):

- General warehouses;

- Value-added logistics providers offering warehousing services;

- Cold storage/low-temperature warehouse (e.g. for food, biological materials, etc); and

- Specialised storage services such as warehouses for class cargo.

As compared to other sub-sectors like freight & logistics, shipping & ship-related services, etc, warehousing sector is the second lowest contributor to the industry's operating receipts and has the following attributes (EnterpriseOne, 2010b):

- Highest profitability ratio;

- Second lowest number of establishments;

- Third highest value added per worker;

- Fourth lowest average annual remuneration per employee; and

- Lowest number of workers (see Table 2.2).

Table 2.3 shows the breakdown of main types of business cost in warehousing sector for the case of Singapore. Manpower cost contributes the most to the business cost among all types. One can also see that cargo handling cost takes up a substantial portion (12.5%) of the business cost. Thus, the warehousing sector should place emphasis on the efficiency and productivity of cargo handling such as by making effective use of WMS, especially within the warehouse

space.

Table 2.2 Warehousing Sector Statistics for Singapore in Year 2006

Indicators	Figures
Number of Establishments	334
Number of Workers	6,264
Operating Receipts	S$1.6 billion
Operating Expenditure	S$1.3 billion
Operating Surplus	S$557 million
Value Added	S$876 million
Profitability Ratio (%)	34%
Average Annual Remuneration per Employee	S$43,400

Source: (EnterpriseOne, 2010b)

Table 2.3 Breakdown of Business Cost in Warehousing Sector for Singapore

Main Types of Cost	% of Cost (2006)
Remuneration of Employees	21.3%
Depreciation	14.8%
Rental of Offices & Other Premises	14.5%
Cargo Handling, Port & Airport Charges	12.5%
Sub-contracted Work	8.6%
Government Taxes & Fees	3.9%
Admin Charges	3.3%
Utilities	3.1%

Source: (EnterpriseOne, 2010b)

2.1.3 Regulatory Requirements on the Use of WMS

In Singapore, all imports of liquors and tobacco (including cigarettes) must be stored in a licensed warehouse. A licensed warehouse is "a designated area approved and licensed by the Singapore Customs (SC) for storing imported dutiable goods, namely liquor, tobacco, motor vehicles and petroleum, with the Duty and GST payable suspended" (SingaporeCustoms, 2010a) . On the other hand, imported non-dutiable goods can be stored in a Zero-GST (ZG) warehouse pending re-export. A ZG warehouse is "a designated area approved by SC for storing imported non-dutiable goods with GST suspended" (SingaporeCustoms, 2010b). Both licensed

warehouse and Zero-GST warehouse require a stringent application procedure and payment of annual licence fee. Specifically, operation of a WMS is compulsory for running a licensed or Zero-GST warehouse as indicated in the application questionnaire for licensed premises applicants under the section of Systems Transparency and Accountability (see Appendix F).

2.1.4 Government Assistance on the Adoption of WMS

The most relevant funding support for adoption of WMS provided by Singapore government to SMEs is the Logistics Capability Development Programme (Logistics CDP) which aims to help the logistics industry to improve the quality of their services and adopt global best practices (EnterpriseOne, 2010a). Table 2.4 shows the basic information about this funding support programme. Small and Medium Enterprises (SMEs) can apply to the financial aid scheme if they intend to implement a WMS before the programme expires in 2011.

Table 2.4 Logistics Capability Development Programme (Logistics CDP)

Lead Agency	SPRING Singapore
Launch Date	8 December 2006
Funds Allotted to the Programme	S$10 million
Duration of Programme	5 years
Target Number of SMEs Supported	200

Source: (EnterpriseOne, 2010a)

Projects supported by Logistics CDP include Capabilities Upgrading Projects, Process Improvement Projects, Service Development Projects, Certification Projects, and Strategic Alliance Projects. Implementation of WMS falls under the category of Process Improvement Projects which cover adoption of industry best practices, implementation of IT applications or improvement of workflow processes.

2.1.5 Structure of Background Information

Figure 2.1 shows the flow of thoughts on how the big picture of logistics industry of Singapore

affects this research project, and vice-versa how this research project contributes to enhance Singapore's competitiveness by providing conclusions and recommendations afterwards.

```
┌─────────────────────────────────────────────────────────┐
│ Logistics Industry of Singapore                         │
│                                                          │
│  •   World's top logistics hub                          │
│  •   Providing world-class logistics and supply chain    │
│      solution in Asia                                    │
│  •   Contributing 3.79% to Singapore's GDP in year 2007 │
└─────────────────────────────────────────────────────────┘
                          ↕
┌─────────────────────────────────────────────────────────┐
│ Warehousing Sub-sector                                  │
│                                                          │
│  •   Highest profitability ratio                        │
│  •   Second lowest number of establishments             │
│  •   Third highest value added per worker               │
│  •   Fourth lowest average annual remuneration per       │
│      employee                                            │
│  •   Lowest number of workers                           │
└─────────────────────────────────────────────────────────┘
                          ↕
┌─────────────────────────────────────────────────────────┐
│ Warehouse Management System                             │
│                                                          │
│  •   Compulsory for licensed and Zero-GST warehouses    │
│  •   Government funding support available under          │
│      Logistics CDP                                       │
└─────────────────────────────────────────────────────────┘
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Figure 2.1 Flow of Background Information

In the past, there have been some researches done on the use of IT in Singapore, and some have investigated more specifically into the use of IT in warehouses. The usage of IT and the types depend on various factors such as the capacity of warehouse, targeted market, IT literacy in the management, and the number of IT employees (Nanang, Pokharel, & Jiao, 2003). However, there is a lack of in-depth study specifically on the use of WMS in the context of Singapore logistics industry.

2.2 Importance of Warehouse

Warehouse portrays two critical functions (Lambert & Stock, 1993):

- Time utility: "Value created or added to a product by making something available at the right time";

- Place utility: "Value created or added to a product by making something available at the right place".

In addition, contributions of warehouse to businesses include (Lambert, Stock, & Ellram, 1998):

a) Achieving transportation economies (e.g. combine shipment, full-container load);

b) Achieving production economies (e.g. make-to-stock production policy);

c) Taking advantage of quality purchase discounts and forward buys;

d) Supporting the firm's customer service policies;

e) Meeting changing market conditions and uncertainties (e.g. seasonality, demand fluctuations, competition);

f) Overcoming the time and space differences that exist between producers and customers;

g) Accomplishing least total cost logistics commensurate with a desired level of customer service;

h) Supporting the just-in-time programmes of suppliers and customers;

i) Providing customers with a mix of products instead of a single product on each order (i.e. consolidation);

j) Providing temporary storage of material to be disposed or recycled (i.e. reverse logistics);

k) Providing a buffer location for trans-shipments (i.e. direct delivery, cross-docking).

Some gaps between industrial practices and academic researches include:

a) Not all new picking methods have been studied and the optimal combinations of layout, storage assignment, order clustering, order release method, picker routing and order accumulation have been addressed to a minor extent only (de Koster, Le-Duc, & Roodbergen, 2007);

b) 80% of order-picking systems are using low-level, picker-to-parts order-picking system; however, more focus has been placed on high-level picking system and Automated Storage

and Retrieval Systems (ASRS) (de Koster et al., 2007);

c) Despite the importance of warehouse design, a systematic approach for warehouse designing is still lacking (Baker & Canessa, 2009);

d) More research is needed on strategic design problems (technical feasibility, design objective) and on the integration of various models and methods in order to develop a systematic design methodology, instead of local optimisation (Rouwenhorst et al., 2000);

e) Multiple-level warehousing is popular in the manufacturing and service sections; little research work has been done for multi-level warehouse layout problems (Onut, Tuzkaya, & Doga, 2008).

2.2 Evolution of Warehouse

The evolution of warehouse has been mentioned by a lot of literatures on warehousing and storage of goods. First of all, the evolution started with the changing role of warehousing in the supply chain. Conventionally, a warehouse is used to hold safety inventory in response to the volatile market demand and supply (Christopher & Towill, 2001). Warehouse can also be a place where further consolidation or assembly of goods are done. In addition to these traditional inventory holding roles, warehouse has evolved to a value-added service point where key product customisation activities are executed, e.g. packaging, labelling, marking, pricing, and returns processing (Frazelle, 2002b).

Secondly, level of warehouse sophistication in terms of adoption of technologies and complexity in performing activities has also been evolving. Internally, this can be attributed to the changing role of warehousing in logistics; externally, it can also be explained by the extraordinarily fast movement of technologies nowadays. Warehouse development level can be broken down into five levels (see Figure 2.2), from the simplest to the most sophisticated (Klappich, 2009c).

As illustrated in Figure 2.2, *Storeroom* is the most basic level of sophistication in warehousing

which involves manual process, minimal use of technology and very low complexity in operations. *Rudimentary Locator* is the second level of WMS which involves minimal complexity, typically with basic needs for product receiving, put-away, storage, picking, etc. *Advanced Locator* is the third level of WMS which involves increasing complexity in operating and managing warehouse activities and improving warehouse task execution performance. *Added Intelligence* is the fourth level of WMS which involves larger physical facilities, more staff in operations, increasing value-added services, and higher complexity in the process. *Automated* is the highest level of WMS where "automation is intrinsically woven into the warehouse processes"
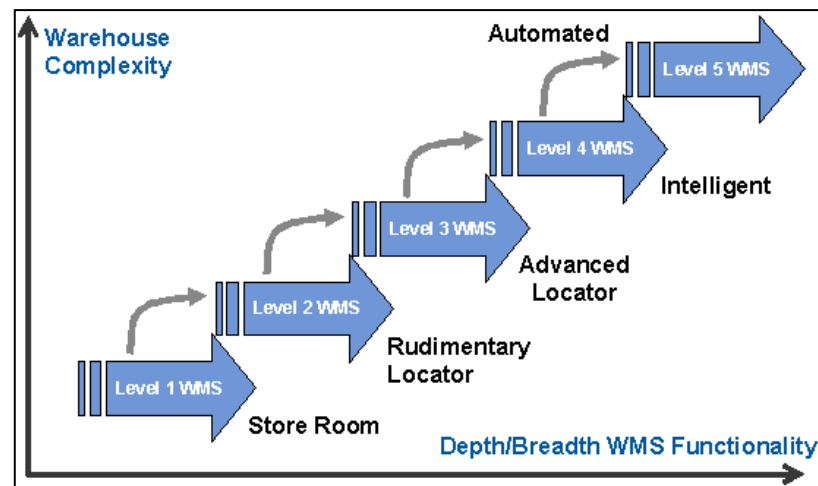
Source: (Klappich, 2009c)

Figure 2.2 Warehouse Stratification-Level Model Comparison Model

It is believed that the evolution of warehouse directly triggers the evolution of WMS. With the increasing complexity in warehouse operations and management from level 1 to level 5 (as shown in Figure 2.2), there is demand for more capabilities (see Table 2.5). A WMS is barely needed in a Storeroom, but starts to be a necessity when a Storeroom moves to a Rudimentary Locator where basic product locating capabilities are used. Core capabilities become significant for an Advanced Locator. Moving to Added Intelligence, it starts to require extended capabilities while maintaining strong core capabilities. Automated level places less emphasis on the core capabilities but more on integration with automation (Klappich, 2009b).

Table2.5 Warehouse Stratification Model

Impact	Storeroom	Rudimentary Locator	Advanced Locator	Added Intelligence	Automated
People	Inventory management and control are secondary processes for users in storeroom-type environments, which is typical of this level.	Limited WMS user knowledge and skills still focus on day-to-day execution of receiving and put-away.	Increased WMS user knowledge and skills, but still primarily focused on process execution; increased demand and use of RF for operators.	Advanced user knowledge/skills; focus moves more to warehouse productivity/efficiency/throughput, resource/asset utilization and optimizing warehouse activities; need for decision support and extended WMS capabilities.	Emphasize shifts from primarily user knowledge and skills focused to designing and managing the warehouse around automation.
Process	Primarily manual processes with minimal use of technology (ERP); very low complexity; inventory stored in single location in support of some other function like sales or customer service and support.	Minimal complexity, typically have rudimentary needs for product locating for put-away and picking; pallet storage with minimal split pallet picking; focus on simple storage and retrieval.	Increasing warehouse complexity with more receiving/put-away, pick/pack/ship and inventory management options and requirements; focus on improving warehouse task execution performance.	Tend to be larger physical facilities, more employees operational/back office, more products and transactions, and more complex processes like light assembly or kitting. High-level complexity, labor and transaction volume requires more-robust decision support to optimize operations.	Warehouse and automation design drives warehouse automation processes and capabilities. While limited automation can be used in previous levels, these types of facilities are highly automated, and the automation is intrinsically woven into the warehouse processes.
Technology	Use whatever capabilities provided by ERP, or perform manually.	Need a real WMS with basic product locating capabilities but minimally use core WMS capabilities. Even with reduced cost for RF activities often paper-based. Most ERP offer acceptable WMS capabilities.	Need richer locator capabilities; greater feature depth across core WMS capabilities, and need more feature options and configuration, particularly in pick/pack/ship.	Need strong core WMS, but emphasis shifts to extended WMS capabilities like task interleaving, labor management, dock scheduling and yard management. Having an adaptable application architecture is more important at this level to allow the WMS to adapt to process changes during and after implementation.	Highly automated facilities are often designed and built by engineering or material-handling firms that specialize in automated warehouses, and the emphasis in WMS is less on the core WMS features, and more on integration with automation.

Source: (Klappich, 2009b)

2.3 Evaluation of WMS

Since this research project aims to conduct a general evaluation of WMS in Singapore, proper evaluation criteria are to be set up in order to do a comprehensive examination. This sub-section presents six past studies on the evaluation of WMS, followed by a conclusion paragraph which summarises the evaluation criteria.

2.3.1 Historical Evaluation Criteria

A WMS serves to record accurate information, coordinate various tasks, and maximise warehouse performance. There are many studies on the selection of a WMS package. Different studies set their evaluation criteria differently.

- In *The Practitioner's Definitive Guide: Warehouse Practices (Chua & Teo, 2008),* evaluation criteria for WMS include the following important features (see Table 2.6):

Table 2.6 Important Features of WMS

a) Flexibility	h) Inventory reports and throughput statistics
b) Product conversion/Value-added activities	
c) Speed of RF processing	i) Report writer
d) Cycle-counting/Stock take	j) Monitoring of activities
e) Cross-docking	k) Multiple warehouse
f) Invoicing	l) Online enquiry/Self-service menu
g) Performance reports	m) Audit trail
	n) Interface

Source: (Chua & Teo, 2008)

- In *World-Class Warehousing and Material Handling (Frazelle, 2002b)*, WMS can be evaluated functionally as well as technologically. Criteria for both functional evaluation and technical evaluation include the following (see Table 2.7):

Table 2.7 WMS Functional Evaluation and Technical Evaluation

WMS functional evaluation	WMS technical evaluation
a) Receiving	a) Data architecture
b) Put-away	b) Development tools
c) Replenishment	c) Data collection technology
d) Picking	d) Technical platform
e) Shipping	e) Database technology
f) Slotting	f) User interface
g) Counting	g) Response time
h) Work measurement	h) Scalability
	i) Modification

Source: (Frazelle, 2002b)

- In *Starting Up A World-Class DC (Miesemer, 2001)*, a WMS evaluation worksheet (see Table 2.8) is used for selection.

Table 2.8 WMS Evaluation Worksheet Summary

a) General requirement (e.g. RF unit response time, task interleaving)	j) Cycle count and physical inventory
b) Receiving	k) Labour management
c) Put-away	l) Yard management and dock scheduling
d) Replenishment to forward reserve or pick locations	m) Light manufacturing, co-pack support
e) Picking	n) Activity based costing
f) Shipping/order details	o) Metrics (performance measurement)
g) Inventory management	p) EDI
h) QA	q) Pallet management
i) Warehouse management	r) Reports and inquiries
	s) Technology

Source: (Miesemer, 2001)

- In *Warehouse Management Systems: Best of Breed or ERP (Klappich, 2009c)*, it is argued that companies must develop a selection methodology that places integration and a single-vendor solution in the proper context with numerous other important evaluation criteria which include company, product, community, service and support. However, this report shall only focus on the product itself. The evaluation criteria for product include the following (see Table 2.9):

Table 2.9 Product Evaluation

a) Viability	f) Usability
b) Functionality depth	g) Adaptability
c) Functionality breath	h) Integration
d) Agility	i) Vertical industry specialisation
e) Technology	

Source: (Klappich, 2009c)

- In *Stratifying WMS: A Multilevel View (Klappich, 2009b)*, when evaluating WMS, the paper emphasises on the following (see Table 2.10):

Table 2.10 WMS Critical Characteristics

a) Functionality b) Technical architecture c) Scalability d) End-user support	e) Productivity/throughput enhancing capabilities (for example, work and labour management, analytics, dock scheduling) f) Integration and support for warehouse automation

Source: (Klappich, 2009b)

- In *Warehouse Management Systems (WMS) Software Listing* (see Appendix C), competitor analysis for CatalystCommand WMS (by Catalyst International) is conducted against 4 criteria (see Figure 2.3).
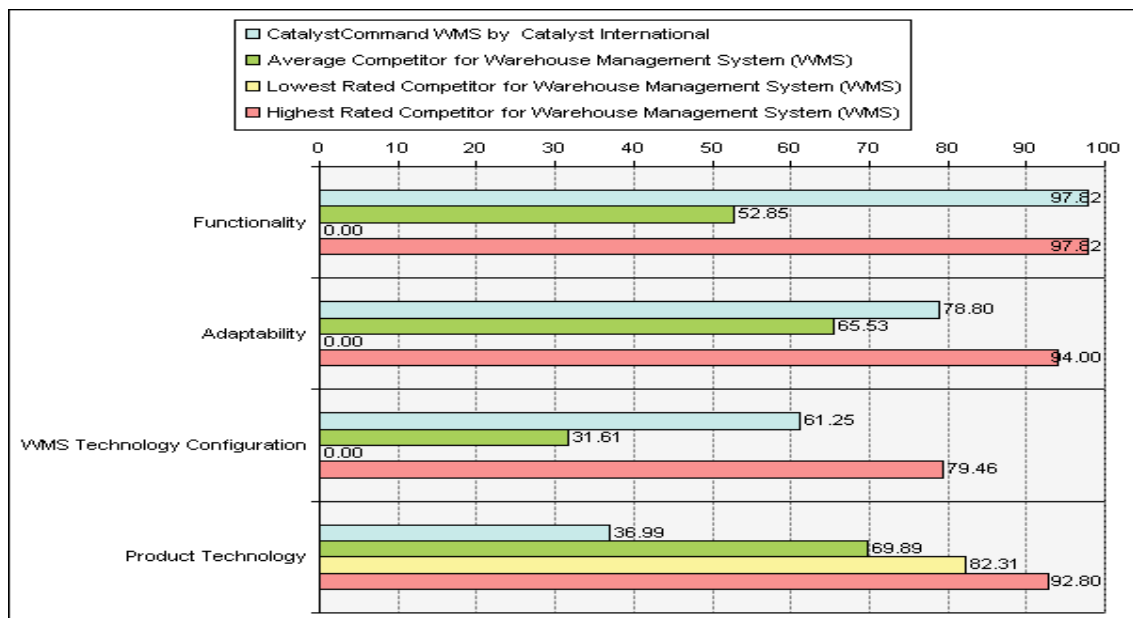
Source: ("Warehouse Management Systems (WMS) Software Listing," 2009)

Figure 2.3 Warehouse Management System (WMS) Main Modules

2.3.2 Consolidation of Evaluation Criteria

After combining similar criteria in the 6 aforementioned studies into one category, a frequency test was conducted and the most mentioned criteria for WMS evaluation were selected to be used in survey questionnaire as follows:

a) Functionalities;

b) Technology contents;

c) Adaptability;

d) Integration and support for warehouse automation.

2.4 WMS Capabilities

Figure 2.4 lists a comprehensive inventory of the functionalities as well as categorisations. When a company is considering buying or developing a WMS, it is not enough to only focus on the WMS core capabilities. The extended WMS capabilities, when properly utilised, are the key to differentiate warehouse performance of the company. However, it is absolutely not correct to blindly buy as many functionalities as possible. There are two common pitfalls when implementing a WMS. The warehousing of a company might have developed to a certain stage, but the existing WMS capabilities are not sufficient to perform the activities effectively. Conversely, company might tend to over-buy WMS capabilities while there is not a real need. Neither unfilled needs nor excessive customisation is desirable when evaluating and adopting WMS.
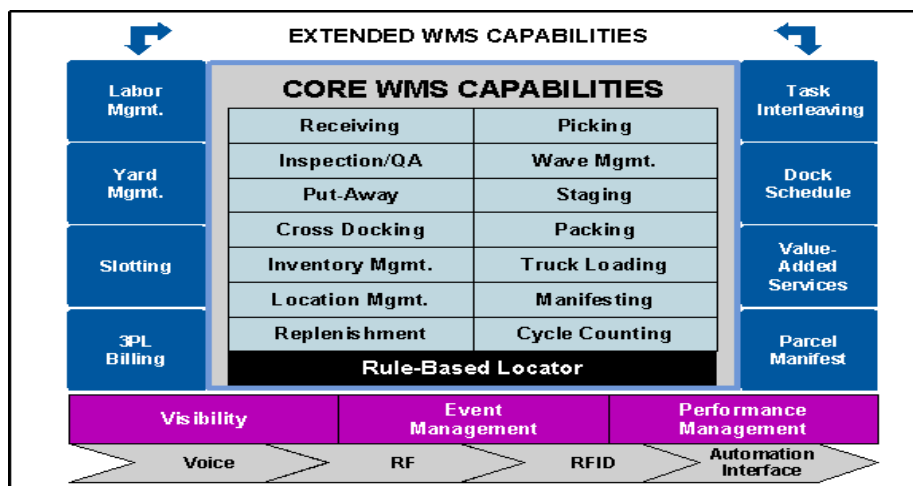
Source: (Klappich, 2009b)

Figure 2.4 WMS Capabilities Ecosystem

A WMS capability framework (see Figure 2.5) can be developed, by further categorising the functionalities so that the evolution of warehouse could be included into the overall picture. As the sophistication level of warehouse increase, WMS capabilities required are also evolving, from basic core capabilities which ensure the smooth flow of main warehouse activities to strong core capabilities which shift emphasis to the management of the warehouse. Extended WMS capabilities are for warehouse at the added intelligence level to aid in operating and managing complex activities more effectively. The emergent capabilities have drifted away from taking care of daily activities in the warehouse, but rather they tend to oversee the warehouse operations from a macro perspective.

Basic Core Capabilities
- Receiving
- Inspection/AQ
- Put-Away
- Cross Docking
- Picking
- Staging
- Packing
- Truck Loading

Strong Core Capabilities
- Inventory Mgmt
- Location Mgmt
- Replenishment
- Wave Mgmt
- Manifesting
- Cycle Counting

Extended Capabilities
- Labour Mgmt
- Yard Mgmt
- Slotting
- 3PL Billing
- Task Interleaving
- Dock Scheduling
- Value-Added Services
- Automation Interface

Important Features
- Visibility
- Event Mgmt
- Performance Mgmt

Figure 2.5 WMS Capability Framework

CHAPTER 3 METHODOLOGY

The topic for this project was chosen under the big topic of "Transportation and Logistics in Singapore". Figures 3.1 outlines the methodology and activities that were applied throughout the research project. At the starting stage of the study, several interviews were conducted in order to understand the industry better and identify current critical issues. Professionals involved in critical issues identification included Dr Jasmine Lam Siu Lee, Assistant Professor of NTU; Mr Ng Kah Yong, Representative of DST Lines; Mr Ramachandran Pillai Sreekumar, Warehousing Manager of Ryder Asia; Dr Roland Lim, Research Scientist of Singapore Institute of Manufacturing Technology (SIMTech).

Figure 3.1 Activity Flowchart of Research Project

A 5-page questionnaire (see Appendix A) was constructed after pilot-testing it with industry

experts Mr. Jonathan Yue of Procter & Gamble and Mr. Ramachandran Pillai Sreekumar of Ryder Asia. Both of them offered valuable feedbacks on the survey questions, especially the first question of part II regarding the sophistication level of the warehouse in terms of adoption of tech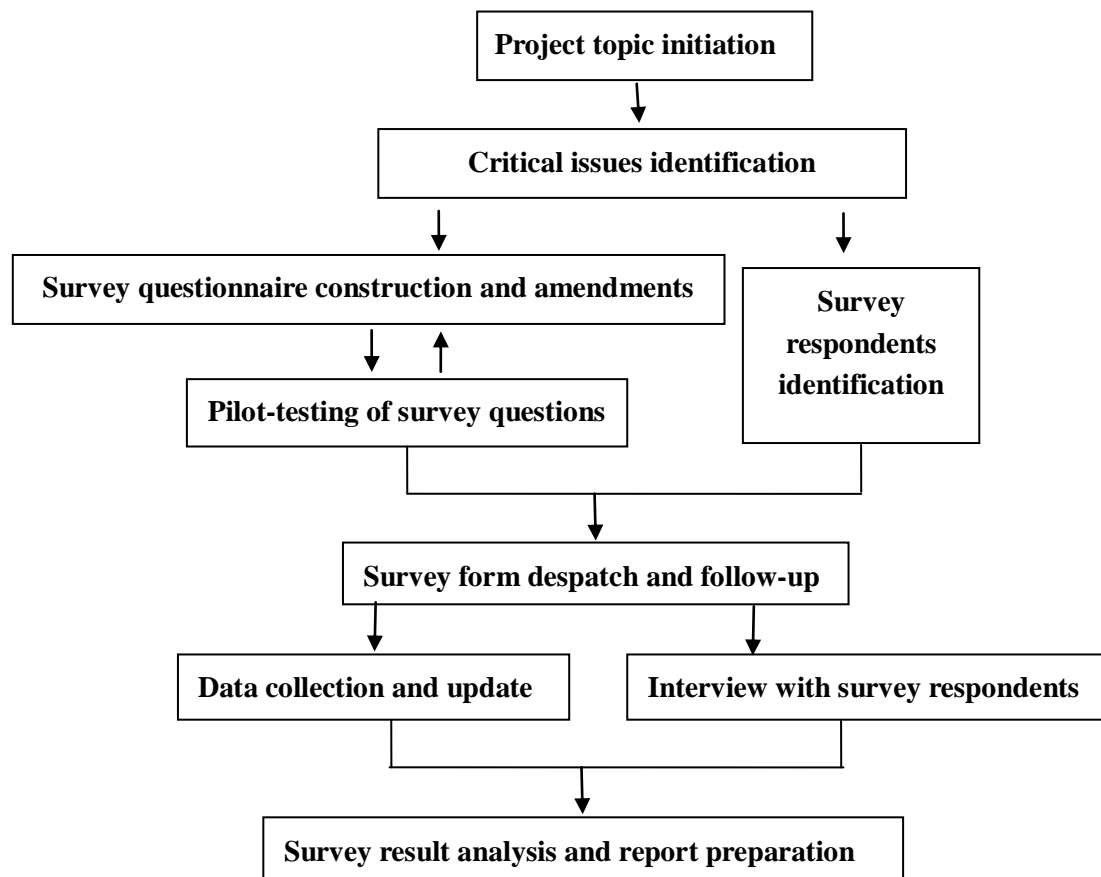nologies and complexity in performing warehouse activities. The survey was developed to consist of a brief introduction to the current research project and three parts respectively on company information (4 questions), Warehouse Management System (WMS) (Section A: 4 questions, Section B: 3 questions) and feedbacks (2 questions). The questions were designed to contain status and decision questions, numerical questions on ranking, and textual questions for responses not listed in the options.

The data base of target survey respondents was obtained from Singapore Logistics Association (SLA) website (SLA, 2010) which provides a list of its current members with their contact information (company address, telephone, fax, E-mail, website, services, representatives, date of admission). Preliminary selection of target companies was based on information on SLA website and selecting companies indicated as providing warehousing service. After generating a preliminary list of potential companies, survey questionnaires were sent out to an initial batch of 36 companies, attention to representatives indicated on SLA website. One survey was soon received, which turned out to be unfilled with a statement "We have no warehouse facilities" (three similar cases in total which rendered the 3 survey responses invalid for data analysis). It was then realised that companies which provide warehousing service do not necessarily operate their own warehouses; instead they work with external parties who own warehouse space. Most of remaining companies on the list were then contacted through telephone call to find out whether the company is engaged in warehouse operation and the name of the person in charge of the warehouse, unless the information was already clearly stated on the website. Another 151 sets of survey forms were sent out in 4 batches (see Table 3.1 for detailed breakdown), which brought the total number of survey form sent out to 187 sets, with each containing a questionnaire together with a self-addressed postage-paid envelop. In addition, as some companies expressed preference for soft copy, another 8 sets of questionnaire were sent out through E-mail.

Table 3.1 Survey Response Breakdown

Category			Date of Despatch	Number of Survey Forms	Number of Respondents	Percentage (%)
Pilot Tests			3rd and 9th November 2009	2	2	1.0
Hard Copy	Batch Number	1	9th December 2009	36	5	2.6
		2	13th December 2009	35	1	0.5
		3	15th December 2009	11	6	3.1
		4	22nd December 2009	49	3	1.5
		5	30th December 2009	54	10	5.1
Soft Copy			Throughout December 2009	8	1	0.5
Total				195	28	14.4

In summary, a total of 195 sets (187 hard copies, 8 soft copies) of survey forms were sent out and 28 responses (including the 2 pilot tests and 3 invalid responses) were received with 7 respondents indicating willingness to have interview sessions, which gave a response rate of 14.4%. The 3 invalid responses were excluded from analysis, and the effective response rate was thus 12.8%.

The low response rate can be considered reasonable as other researches done in Singapore logistics industry also showed more or less similar response rates (Nanang et al., 2003). The low response rate might also be attributed to the fact that the survey of this research project was done in December when many working people were on leave. Some interview dates were also postponed due to Lunar New Year public holidays in middle February. It is recommended that future research projects conducting surveys try to avoid these periods to possibly achieve a higher response rate.

Interviews were conducted from time to time throughout the data collection and update process, in order to gather in-depth information about the topic. Interview questions were drafted out and E-mailed to the survey respondents before the interview. The interview process was recorded by manual type into a laptop. A copy of interview summary was E-mailed to the interviewee(s) to verify the accuracy of the recorded information. Some interviewees reverted with the amended version, and some acknowledged in agreement with the recorded information (see Appendix E).

CHAPTER 4   SAMPLE CHARACTERISTICS AND ANALYSIS

This chapter consists of two parts, i.e. sample characteristics and survey result analysis, respectively. Each part is further divided into sub-parts to facilitate data analysis.

4.1 Sample Characteristics

This section presents survey response sample profiles by business activities, type of companies and number of employees respectively. The analysis sample comprised a total of 25 respondents.

4.1.1 Company Profiles by Business Activities

Respondents were asked to indicate the main activities and services of their companies in Part 1 of survey questionnaire. Table 4.1 shows the distribution of activities. Almost all (96%) companies are engaged in warehousing service, with the exception of companies where warehousing is only an internal unit serving the upstream business. More than half of the companies (54%) are engaged in a comprehensive suite of business activities and services including warehousing, land, air and ocean freight, transportation and logistics. There are a couple of companies indicating their presence in other service sectors, e.g. container yard and services, shipping agency, etc (see Appendix G).

Table 4.1 Companies by Business Activities

Business Activities	Number of companies (n=25)	Percentage (%)*
Warehousing	24	96
Land freight, transportation and logistics	22	88
Air freight, transportation and logistics	14	56
Ocean freight, transportation and logistics	16	64
Others	6	24

Percentages do not add up to 100% as respondents could indicate several activities.

4.1.2 Type of the Companies

Respondents were asked to indicate the type of their companies in Part 1 of the survey questionnaire. The survey results are as follows:

• 5 (20%) are local branches of multinational companies (MNCs);

• 5 (20%) are regional headquarters of multinational companies (MNCs);

• 15 (60%) are local operating companies.

4.1.3 Company Profiles by Employee Size

The 25 respondent companies vary in size in terms of number of employees (see Figure 4.1), with the smallest having 6 employees and the largest having more than 1000.
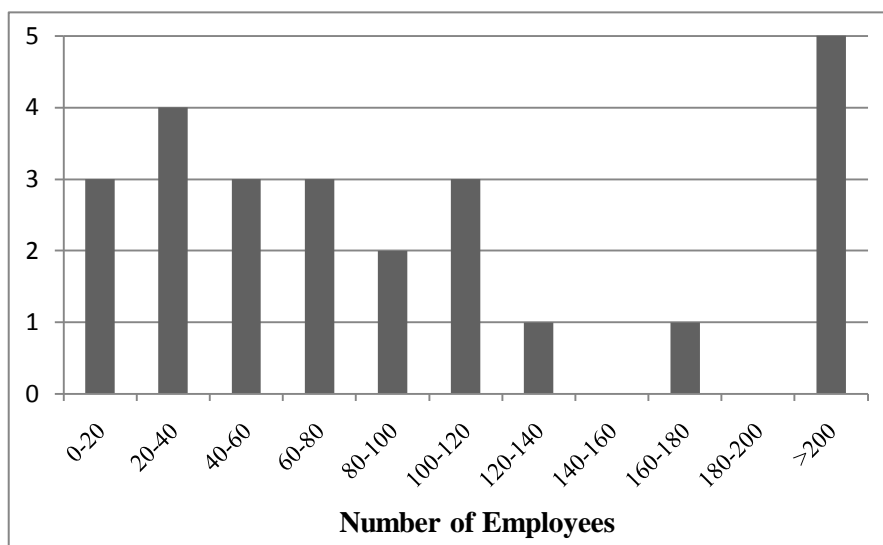
Figure 4.1 Distribution of Companies by Number of Employees

Figure 4.1 shows the distribution of companies by size. In the current research, the number of employees is taken as the indicator of organisational size and it is assumed that organisations with fewer than 100 employees are small and those with 100 or more employees are medium-large. Only two size categories are used due to limited sample size. The same categorisation method was also used in Foo's study on Culture, productivity and structure: a Singapore study (Foo, 1992). A total of 15 companies (60%) falls under the category of small

warehouse, while 10 companies (40%) are medium-large warehouse. The numbers of employees in small warehouses are quite evenly distributed in every interval (a spread of 20 employees in one interval). However, medium-large warehouses seem to be dominated by big players with employee size exceeding 200.

4.2 Survey Result Analysis

This section analyses on survey results and discusses mainly on the following five areas: implementation of WMS and barriers of WMS adoption, level of warehouse sophistication, evaluation of WMS, WMS capabilities and R&D needs.

4.2.1 Implementation of WMS and Barriers of WMS Adoption

Overall, 16 companies (64%) out of the total 25 respondents operate a WMS. The percentage is considered small as compared to a study on the use of Information Technology in warehouses conducted in 2003 in Singapore, where the implementation level of WMS reached 80% and WMS was ranked the second widely-used IT tool after computer (Nanang et al., 2003). Apparently, there is some interesting gap between the two survey findings since the level of WMS implementation would have gone even higher than 80% over the years in between the two studies (see Table 4.2).

Table 4.2 Level of WMS Adoption is Year 2003 and 2010

Year	Sample Size	Number of Adopters	Level of WMS Adoption
2003	15	12	80%
2010	25	16	64%

Under the current research study, working professionals of the logistics industry expressed difficulty in providing a percentage on the overall level of WMS implementation in warehouses. Warehousing is a customer-driven service industry, and the implementation of WMS largely depends on the products that the warehouse stores and the sector that the company serves.

Quoting Mr. Eric Chan of Poh Tiong Choon Logistics which primary handles petrochemical products, "As far as my contacts are concerned, nearly all of the warehouses, being big or small, are all using WMS, but not sure the extent of use. The petrochemical industry is very unique, and it requires the information that a WMS can provide, for example, customer requirements, regulatory requirements, etc." WMS becomes a must for warehouses storing dangerous goods, cold storage goods, etc.

Table 4.3 Profile of Respondent Companies

Variables	Adopters (n=16)		Non-adopters (n=9)	
	Number	Percentage (%)	Number	Percentage (%)
Level of warehouse sophistication				
Storeroom	1	6.2	2	22.2
Rudimentary locator	3	18.8	6	66.7
Advanced locator	5	31.3	1	11.1
Added intelligence	5	31.3	0	0
Automated	2	12.4	0	0
Type of companies				
MNC - local branch	2	12.5	3	33.3
MNC - regional headquarter	5	31.3	0	0
Local operating company	9	56.2	6	66.7
Number of employees				
0-20	1	6.3	2	22.2
20-40	2	12.5	2	22.2
40-60	2	12.5	1	11.1
60-80	2	12.5	1	11.1
80-100	1	6.3	1	11.1
100-200	4	25	1	11.1
200 and above	4	25	1	11.1

Table 4.3 compares the profiles of WMS adopters and non-adopters, in terms of level of warehouse sophistication, type of companies, and number of employees. Figure 4.2 presents the graphical comparison between WMS adopters and non-adopters, from which one can see that in terms of number of employees, frequency of adopters and non-adopters tends to be more negatively correlated. However, as for level of warehouse sophistication and type of companies, frequency of adopters and non-adopters are positively correlated for some parts. Therefore, number of employees is considered an important factor affecting WMS adoption due to the

totally different behaviour of the two curves. With reference to the aforementioned fact that the current research receives a much lower rate of WMS adoption as compared to a study done in 2003 (see Table 4.2), the reason could be the sample of the current study covers a comprehensive range of companies with different number of employees, including a significant component of small warehouses.
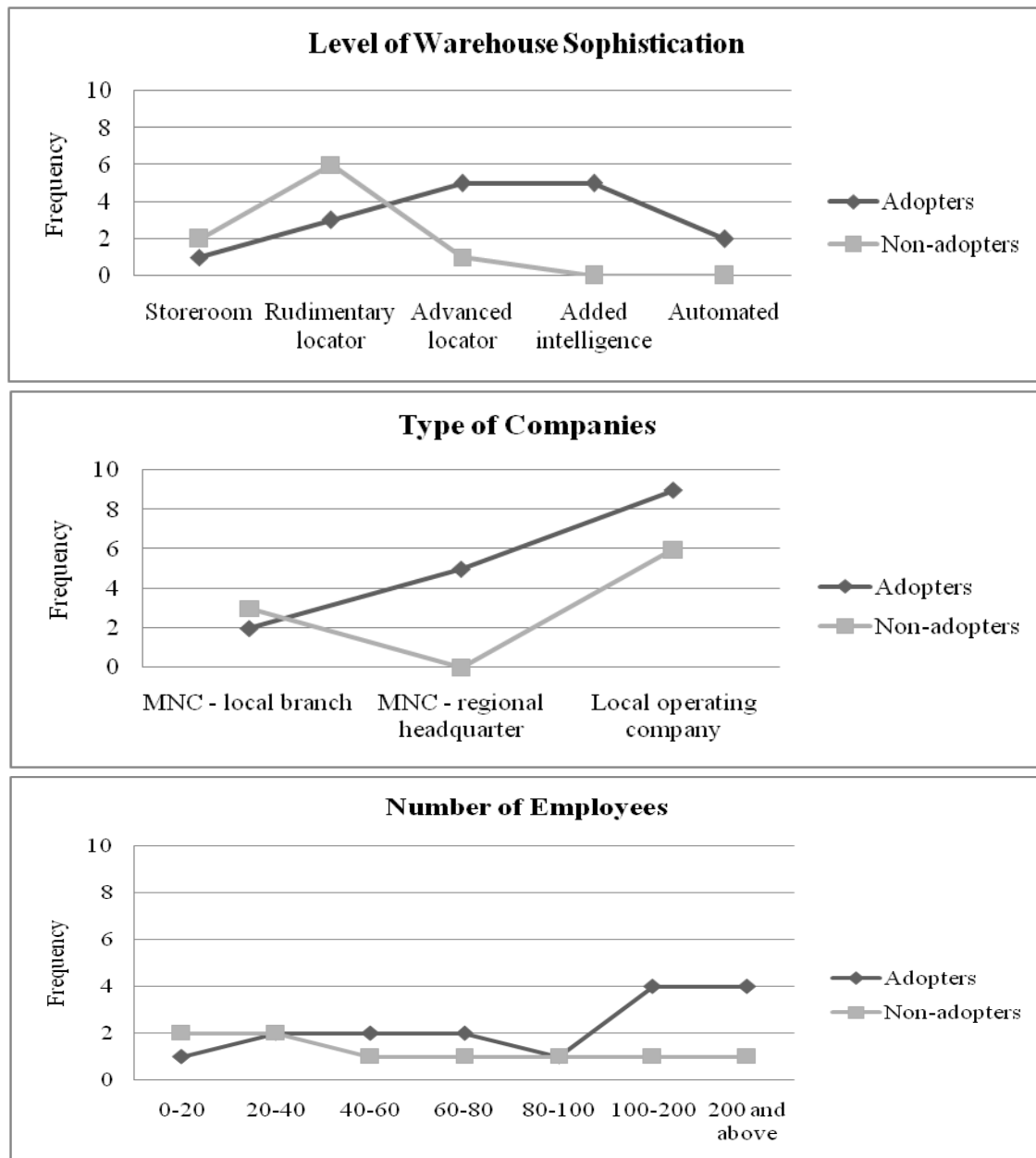

Figure 4.2 Comparison of WMS Adopters and Non-adopters

Table 4.4 Barriers of WMS Adoption

Barriers of WMS Adoption	Mean of ratings*	Standard deviation	Rank
High start-up cost	1.56	0.88	1
Large-scale initial set-up and system resources	2.00	0.93	2
On-going difficulty in running a data-intensive system	3.25	0.89	3

*Mean of rating with 1= most important, 2= second most important and so on.

WMS, being a modern system which can bring tremendous benefits to users, is yet to be well implemented in the industry. Table 4.4 lists the prominent barriers for WMS implementation and respective rating by survey respondents. The number 1 reason for not adopting WMS is because of the *high start-up cost*, followed by *large-scale initial set-up and system resources* and *on-going difficulty in running a data-intensive system*. Several interviewees shared the same point of view that high start-up and maintenance costs are the major hindrance to WMS implementation especially for small warehouses (see Appendix E). Mr. Eric Lee of THT Logistics estimated that a simple stand-alone WMS could easily cost from 20,000 to 40,000 SGD and this does not include the additional charge for system customisation.

4.2.2 Level of Sophistication of Warehouse

As explained in Chapter 2, there are 5 levels of warehouse sophistication in terms of adoption of technologies and complexity in performing warehouse activities, namely *storeroom*, *rudimentary locator*, *advanced locator*, *added intelligence* and *automated*. Figure 4.3 presents the distribution of companies by level of warehouse sophistication.
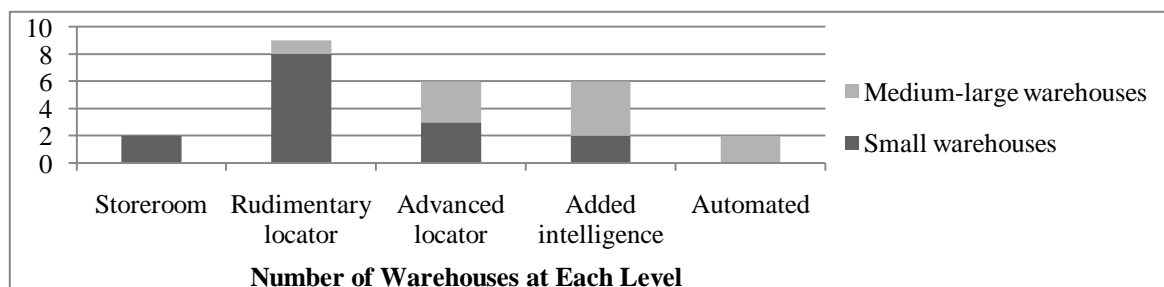

Figure 4.3 Distribution of Companies by Level of Warehouse Sophistication

To facilitate the data analysis process, the five levels are assigned numerical values from 1 to 5, with *storeroom* being 1 and *automated* being 5. Calculating the mean score of sophistication level (see Table 4.5) gives a value of 2.88 which shows that the average sophistication level of warehouse in Singapore is between level 2 (rudimentary locator) and level 3 (advanced locator). This survey finding is consistent with Mr. Hamid's (of GKE Warehousing and Logistics) sentiment towards this issue. During the interview, he indicated that in the context of Singapore logistics industry, most warehouses are between level 2 and level 3, and very few warehouses can go to level 4 and above. Mr. Eric Chan of Poh Tiong Choon Logistics believed that the sophistication level of a warehouse largely depends on the kinds of goods it stores and customers it serves. He said that most warehouses storing general cargoes are only at level 2 while in the petrochemical industry, he was confident to say that "most of the warehouses are at least at level 4 and the top players surely have gone to level 5". Generally speaking, petrochemical warehouses are more sophisticated than general warehouse, due to more 'demanding' customers and more stringent regulations on petrochemical cargoes.

Table 4.5 Level of Sophistication

Level of Sophistication	All (n=25)		Small (n=15)		Medium-large (n=10)		*p*-value (2-tailed Test)
	Mean score*	Standard deviation	Mean score	Standard deviation	Mean score	Standard deviation	
	2.88	1.13	2.33	0.90	3.70	0.95	0.002**

*Mean score in scale of 5: 1 = storeroom; 2 = rudimentary locator; 3 = advanced locator; 4 = added intelligence; 5 = automated.

**Statistically significant difference between group means at α=0.05.

Besides types of warehouses, warehouse size is another factor affecting its sophistication level. Statistics (see Table 4.5) shows that mean level of sophistication is 2.33 for small warehouses and 3.70 for medium-large warehouses. Despite small sample size, level of warehouse sophistication does not display non-normality distribution (see Figure 4.4). Statistically significant difference in level of sophistication was found between small and medium-large warehouses using *t*-Test. Figure 4.3 gives a graphical profile on the relationship between warehouse size and sophistication level. As the sophistication level goes up, there is a gradual reduction in the proportion of small warehouses and rise in the proportion of medium-large
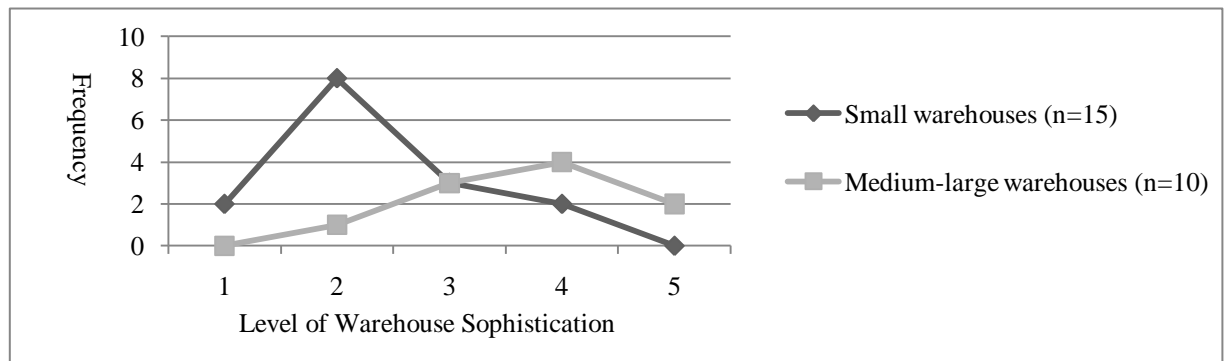
warehouses.

Figure 4.4 Frequency Profile of Level of Warehouse Sophistication

4.2.3 WMS Evaluation

Generally speaking, WMS implemented in Singapore logistics industry have medium to high number of functionalities, medium technology contents, medium to high adaptability to fit into warehouse operations, low to medium ability to integrate and support for warehouse automation (see Table 4.6).

Table 4.6 Evaluation of Warehouse Management System (WMS)

Evaluation Criteria	All (n=16)		Small (n=8)		Medium-large (n=8)		Gap**	Percentage
	Mean score*	Standard deviation	Mean score	Standard deviation	Mean score	Standard deviation		
Number of functionalities	2.25	0.58	2.00	0	2.50	0.76	- 0.50	- 20%
Technology contents	2.06	0.77	1.63	0.52	2.50	0.76	- 0.87	- 34.8%
Adaptability	2.19	0.75	2.13	0.64	2.25	0.88	- 0.12	- 0.53%
Integration and support for warehouse automation	1.81	0.75	1.63	0.52	2.00	0.93	- 0.37	- 18.5%

*Mean score in scale of 3: 1 = low; 2 = medium; 3 = high.

**Difference between mean score of small and medium-large warehouses.

It is worth noting that *integration and support for warehouse automation* only gives a mean

score of 1.81 with standard deviation of 0.75. This result is closely related to the aforementioned discussion on the sophistication level of warehouse. The industry average sophistication level is in between level 2 (rudimentary locator) to level 3 (advanced locator), which falls far short of warehouse automation.

Looking at small and medium-large warehouses separately, one can observe that WMS used in the latter are more advanced than the former in every evaluation criterion, although to a different extent. Table 4.6 compares the characteristics of WMS adopted in small and medium-large warehouses using gap analysis. A notably large gap was found in *technology contents* of WMS operated in small and medium-large warehouses. Table 4.6 shows a mean score of 1.63 for small warehouses and a mean score of 2.50 for medium-large warehouses, with a gap of -0.87 which accounts for a significant percentage of -34.8%. As compared to *technology contents*, difference between small and medium-large warehouses in other evaluation criteria is not as significant.

4.2.4 WMS Capabilities

Table 4.7 compares the usefulness and deployment status of WMS capabilities using gap analysis. Figure 4.5 is a scatter-plot diagram of WMS capabilities lying in the 2-dimension of usefulness and deployment status. No single capability falls under the high-usefulness, low-deployment status and high-deployment status, low-usefulness quadrants. However, interestingly there is no capability lying above the diagonal line. This means that WMS capabilities are, to a minimal extent, being under-deployed in the system despite their perceived usefulness, except the three capabilities located at the point of intersection (namely *task interleaving*, *dock schedule*, *automation interface*). This indicates that there is still room to increase the extent of use of WMS capabilities to catch up with their perceived usefulness. Especially, capabilities with relatively larger gaps between usefulness and deployment status include *3PL billing*, *value-added services*, and *slotting*.

Table 4.7 WMS Capabilities

Capabilities	Usefulness		Deployment status		Gap**	Percentage
	Mean score*	Standard deviation	Mean score	Standard deviation		
Core capabilities	2.77	0.44	2.64	0.50	0.13	4.92
Labour management	1.70	0.90	1.60	0.80	0.10	6.25
Yard management	1.80	0.70	1.70	0.60	0.10	5.88
Slotting	1.77	0.73	1.64	0.74	0.13	7.93
3PL billing	2.40	0.80	2.20	0.80	0.20	9.09
Task interleaving	2.00	1.00	2.00	1.00	0.00	0.00
Dock schedule	2.00	1.00	2.00	1.00	0.00	0.00
Value-added services	1.85	0.69	1.71	0.61	0.14	8.19
Automation interface	2.00	1.00	2.00	1.00	0.00	0.00

*Mean score in scale of 3: 1 = low; 2 = medium; 3 = high.

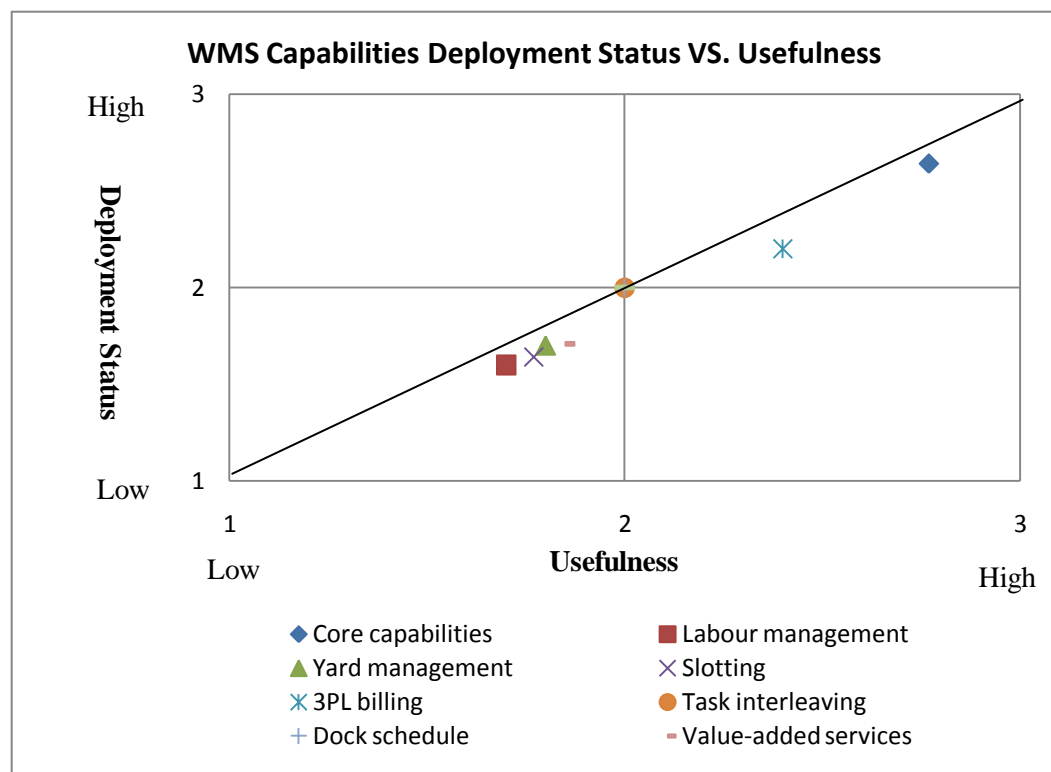**Difference between mean score of usefulness and deployment status of WMS capabilities.

Figure 4.5 WMS Capabilities Deployment Status VS. Usefulness

Apparently, both level of implementation and usefulness are substantially higher for core capabilities than for extended capabilities (with the exception of *3PL billing*). Figure 4.5 shows

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that only *core capabilities* and *3PL billing* lie under the high-usefulness, high-deployment status quadrant. As mentioned in Chapter 2, extended WMS capabilities are for warehouses at the added intelligence level to aid in operating and managing complex activities more effectively. Mr. Hamid confirmed that currently most warehouses in Singapore would mainly require core capabilities but place less emphasis on extended capabilities, the reason being that most warehouses are still not up to the sophistication level of requiring the support of extended capabilities.
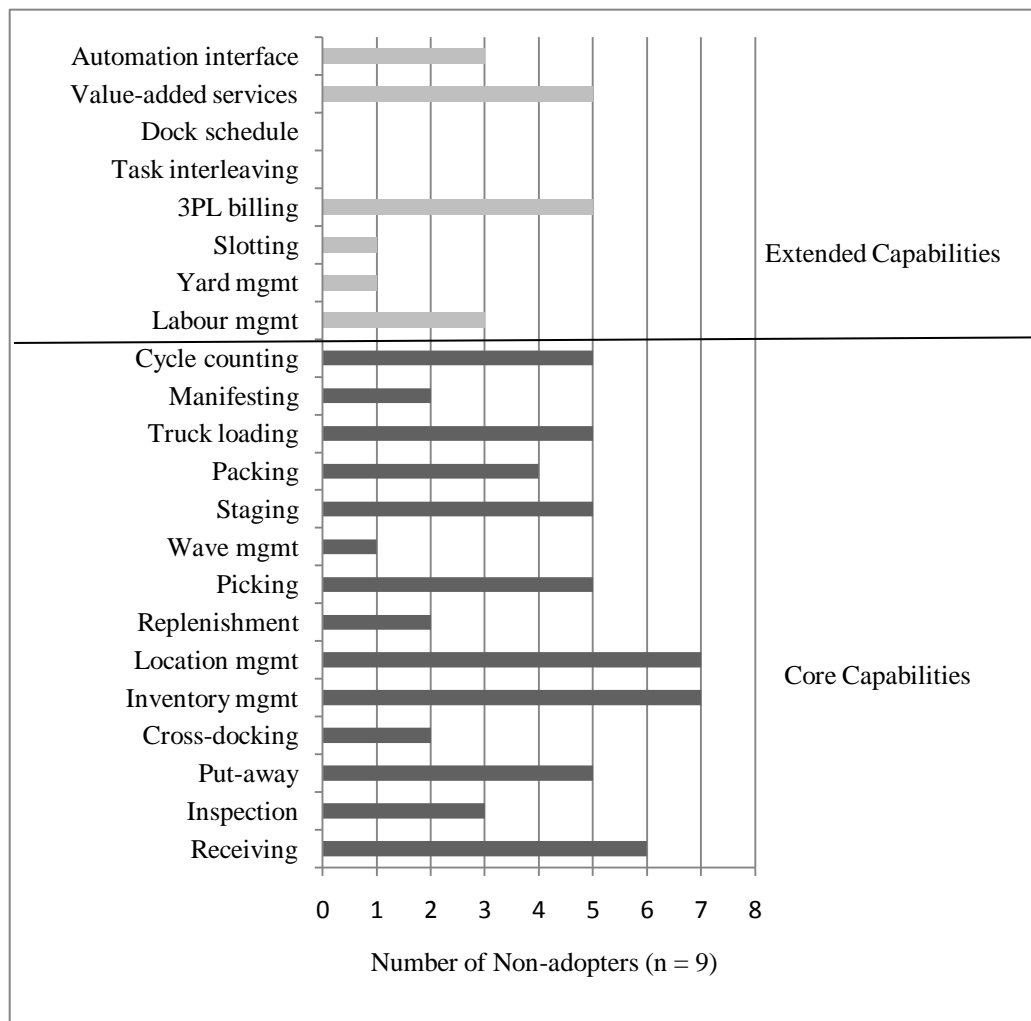

Figure 4.6 Profile of Desirable WMS Capabilities by Non-adopters

Figure 4.6 profiles the desirable WMS capabilities by non-adopters. The top-ranked capabilities, namely *location management*, *inventory management*, *receiving* are all core capabilities. One can observe that core capabilities are more desired than extended capabilities. However, high

desirability is also observed for some certain extended capabilities like *3PL billing* and *value-added services*.

4.2.5 R&D Needs for WMS

Table 4.8 compares the importance and urgency of R&D needs for WMS using gap analysis. Interestingly, all the R&D needs fall under the high-importance, high-urgency quadrant (see Figure 4.7). However, all the points lie below the diagonal line, which means that the R&D needs, to a small extent, are more important but slightly less urgent. The largest gap between importance and urgency among all R&D needs is *performance management* where its importance exceeds urgency significantly

Table 4.8 R&D Needs for WMS

R&D Needs	Importance		Urgency		Gap**	Percentage
	Mean score*	Standard deviation	Mean score	Standard deviation		
Visibility	2.73	0.59	2.56	0.51	0.17	6.64
Event management	2.27	0.71	2.25	0.58	0.02	0.89
Performance management	2.8	0.42	2.5	0.73	0.30	12.00

*Mean score in scale of 3: 1 = low; 2 = medium; 3 = high.

**Difference in mean score between importance and urgency of R&D needs.
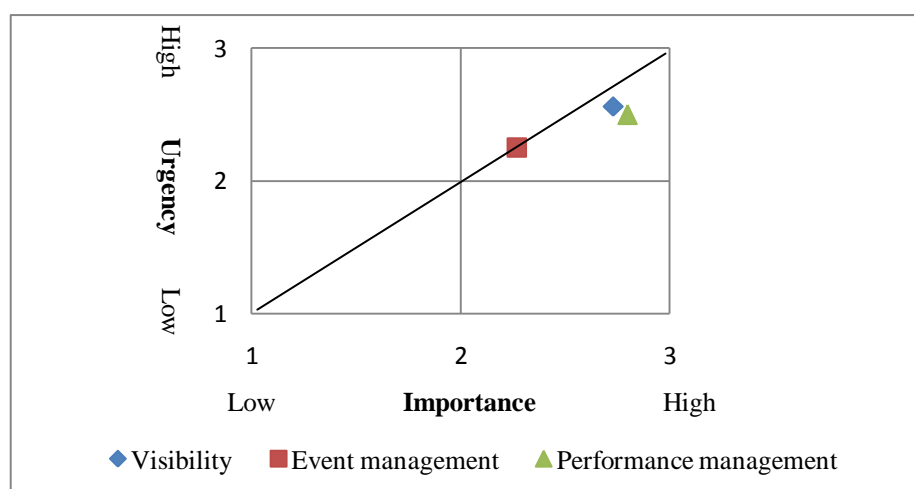

Figure 4.7 R&D Needs for WMS

CHAPTER 5   CONCLUSIONS AND RECOMMENDATIONS

This chapter ends the report by making conclusions based on the survey results and providing recommendations accordingly.

5.1 Adoption of WMS

According to survey results, 64% of the warehouses in Singapore logistics industry have adopted WMS. Though it was described as an under-estimated figure by industrial professionals, it is considered a small scale of implementation for a leading logistics hub like Singapore. Graphical comparison was done between small and medium-large warehouses in terms of level of warehouse sophistication, type of companies, and number of employees, among which number of employees was found to be the affecting factor for WMS adoption. Thus, it is concluded that the notably large representation of small players (in terms of number of employees) hinders the full implementation of WMS in the warehousing sector. Among the reasons for non-adopters in not operating WMS, *high start-up cost* was ranked the top one. Several working professionals also voiced consensus with this survey finding during interviews.

Funding support from government to the logistics industry is available to develop new logistics capabilities, and deploy IT for resource planning and data interchange under Logistics Capability Development Programme (Logistics CDP) (SPRING, 2009b). Continuous government support and more specifically tailor-made financial aid scheme on the implementation of WMS are necessary.

However, the adoption of WMS does not make big business sense to some small players due to low operational volume, as according to one survey respondent and several interviewees. Therefore, aggregation of warehouse space by the merge of small players might be seen in the decade to come, which could lead to larger operational scale and the requirement for WMS. Smaller warehouses shall merge and become big players in the market. At the enterprise level, the advantage of centralisation of warehouse space is that warehouses can leverage on large

scale of operation to enjoy economies of scale and have more resources to offer to the customers. Especially, Singapore being a geographically small country does not impose significant impacts on the inbound and outbound transportation cost for warehouse centralisation. Rather, there would be cost saving on facility set-ups. At the national level, warehouse centralisation could further enhance Singapore's competitiveness as a leading logistics hub. Big players with greater extent of WMS usage can largely increase warehouse operational efficiency and productivity. However, Mr Chan Hsien Hung of Yang Kee Logistics also expressed his concern towards this phenomenon that monopolists have strong bargaining power to dominate market price. Proper control measures should be in place to prevent this potential danger.

5.2 Level of Warehouse Sophistication

There is enormous room for improvement on the level of warehouse sophistication, especially for small warehouses. The average level of warehouse sophistication is only 2.88, according to survey results. It is between *rudimentary locator* and *advanced locator*, which is considered sub-standard for a world-class logistics centre. Survey results also show significant difference in sophistication level between small (mean score = 2.33) and medium-large (mean score = 3.70) warehouses, with p-value (2-tailed test) of 0.002 at $\alpha = 0.5$. A recent study has found that most SMEs in Singapore do not effectively innovate to create value for themselves and their stakeholders, and only 21% of SMEs successfully apply innovation management tools (Mok, 2010). It is desirable for small warehouses, especially general cargo warehouses to catch up with the average standard. Level of warehouse sophistication is closely related to the extent of WMS usage, which directly affects the efficiency and productivity of warehouse operations.

5.3 Evaluation of WMS Adopted in Singapore

It is of great importance for WMS developers to understand the current WMS being used in the industry and desired needs of users. Among all evaluation criteria, *integration and support for*

warehouse automation receives the lowest mean score of 1.81. This is in line with the level of warehouse sophistication in Singapore. Being the weakness of WMS, *integration and support for warehouse automation* might be the potential opportunity for WMS developers to exploit as the warehousing sector grows stronger. Furthermore, relatively large gap was found in *technology contents* of small warehouses (mean score = 1.63) and medium-large warehouses (mean score = 2.50) using gap analysis. If small warehouses do merge, enhancement of *technology contents* would be greatly desired. However, WMS adopted in Singapore are generally strong in *number of functionalities*, *technology contents* and *ability to fit into warehouse operations*.

There are hundreds of WMS packages available in the market. Asia, together with Latin America and Eastern Europe are among the emerging markets that WMS providers target to penetrate (Klappich, 2009a), of which Singapore is definitely a hot spot. Companies are reminded to be prudent in choosing WMS packages case by case. It is recommended that Singapore Logistics Association renders necessary assistance to warehouses by providing general training or guidelines in selecting WMS.

5.4 Usage of WMS in Singapore

Interestingly, among all capabilities (except *task interleaving*, *dock schedule*, *automation interface*), their deployment status is slightly, if not significantly, lower than perceived usefulness, especially *3PL billing*, *value-added services*, and *slotting*. The warehousing sector is strongly recommended to increase the extent of use of those capabilities that are not yet effectively utilised.

Furthermore, both usefulness and deployment status are higher for core capabilities and *3PL billing* than other extended capabilities. There is huge room for extended capabilities, especially *labour management*, *slotting*, *yard management*, *value-added services* to be customised to fit into warehouse operations.

In conclusion, warehouses should be encouraged to make full use of WMS capabilities, especially extended capabilities which can increase warehouse operation efficiency to a higher level.

5.5 R&D Needs for WMS

The R&D needs for *visibility*, *event management* and *performance management* are all classified as high-importance and high-urgency, although *performance management* is perceived to be relatively more important than urgent as compared to the other two R&D needs. Especially, the importance and urgency for *visibility* and *performance management* R&D needs are slightly higher than *event management*. As pointed out by several working professionals during interviews, warehousing is a customer-driven service. It is a trend that nowadays customers are becoming more demanding. Thus, R&D needs for WMS are targeted to enhance customer service and increase customer satisfaction.

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APPENDIX A: QUESTIONNAIRE

Survey of Warehouse Management System in Singapore

I am Huang Min from Nanyang Technological University (NTU), School of Civil and Environmental Engineering, Maritime Studies programme. I would like to seek your kind help in completing the survey form attached.

The objective of this survey is to investigate how the industry perceives current Warehouse Management System (WMS) in order to evaluate its strengths and weaknesses, to examine the usefulness of current WMS capabilities as well as to interpret future desired WMS capabilities. The survey is applicable to logistics companies which are engaged in warehousing operation in Singapore.

The survey consists of 3 parts which would take you about **10-15 minutes** to answer all the questions.

Part 1: Information about Organisation

Part 2: Warehouse Management System in Singapore

    Section A: For Companies Using WMS

    Section B: For Companies Not Using WMS

Part 3: Feedbacks

All information will be kept confidential and only aggregated results will be released.

Please fill this survey form by **a personnel experienced in warehousing field** and use the **postage-paid envelop** attached with the survey questionnaire to mail back.

Please feel free to contact me if there is any enquiry regarding the project. I can be contacted as follow:

Investigator: Ms Huang Min
Phone: +65 9715-6330
E-mail: min.huang@pmail.ntu.edu.sg

Supervisor: Associate Professor Wong Yiik Diew
Phone: +65 6790-5250
E-mail: cydwong@ntu.edu.sg

Thank you very much for your time and effort!

Part 1   Information about Organisation

1.   Please indicate the full name of your Company:

     _____

2.   Main activities and services of your Company (please tick all that apply):

     □   Warehousing
     □   Land freight, transportation and logistics
     □   Air freight, transportation and logistics
     □   Ocean freight, transportation and logistics
     □   Other activities (please specify)   _____

3.   Type of the Company:

     □   Multinational corporation – local branch
     □   Multinational corporation – regional headquarter
     □   Local operating company

4.   Please indicate the number of employees of your Company in Singapore:

     _____

Part 2   Warehouse Management System in Singapore

5. Please indicate the <u>sophistication level of your warehouse</u> in terms of **adoption of technologies** and **complexity in performing warehouse activities**.

□ **Storeroom** *(manual process, minimal use of technology and very low complexity in operations)*

□ **Rudimentary locator** *(minimal complexity, basic needs for receiving, put-away, storage, picking, etc.)*

□ **Advanced locator** *(moderate complexity, good warehouse task execution performance)*

□ **Added intelligence** *(large physical facilities, many staff in operations, many value-added services)*

□ **Automated** *(automation is intrinsically woven into the warehouse processes)*

For companies using WMS, please answer Section A (Q6 – Q8). For companies not using WMS, please answer Section B (Q9 – Q10).

Section A (Q6 – Q8): For Companies Using WMS

6. Please evaluate the Warehouse Management System (WMS) that your Company is currently using according to the following criteria.

Criteria	Status		
	Low	**Medium**	**High**
Number of functionalities			
Technology contents			
Adaptability *(how well the WMS fits into the warehouse operations)*			
Integration and support for warehouse automation			
Others, please specify_____			

7. Please rate the <u>usefulness</u> and <u>deployment status</u> of the following *WMS capabilities* according to the situation of your Company.

WMS Capabilities	Usefulness			Deployment Status		
	Low	**Medium**	**High**	**Low**	**Medium**	**High**
Core capabilities *(e.g. receiving, storage, picking, shipping, cross docking)*						
Labour management						
Yard management						
Slotting						
3PL billing						
Task interleaving						
Dock schedule						
Value-added services						
Automation interface						
Others, please specify_____						

8. Please rate the <u>importance</u> and <u>urgency</u> of the following ***R&D needs*** for WMS in Singapore.

R&D Needs of WMS Capability	Importance			Urgency		
	Low	Medium	High	Low	Medium	High
Visibility *(e.g. current stock level, product locations, on-going activities etc.)*						
Event management *(the functionality that triggers specific actions based upon the occurrence of a specific event or combination of events)*						
Performance management *(the capability to evaluate performance, e.g. efficiency, utilisation, etc.)*						
Others, please specify_____						

Section B (Q9 – Q10): For Companies Not Using WMS

9. Please **rank** the reasons for which your Company is <u>not</u> using WMS.

Reasons	Ranking *(Rank among the reasons, with <u>1 being the most important</u>, 2 being the second most important and so on.)*
High start-up cost	
Large-scale initial set-up and system resources	
On-going difficulty in running a data-intensive system	
Better alternative, please specify_____	
Others, please specify_____	

10. If your Company is considering implementing WMS, what are the capabilities that you look for? (You can tick more than one.)

- □ Receiving
- □ Inspection
- □ Put-away
- □ Cross-docking
- □ Inventory management
- □ Location management
- □ Replenishment
- □ Picking

- □ Wave management
- □ Staging
- □ Packing
- □ Truck loading
- □ Manifesting
- □ Cycle counting
- □ Labour management
- □ Yard management

- □ Slotting
- □ 3PL billing
- □ Task interleaving
- □ Dock schedule
- □ Value-added services
- □ Automation interface
- □ Visibility
- □ Event management
- □ Performance management

Part 3   Feedbacks

11. Would you be interested to have an interview session of 15-30 minutes?

□ Yes

□ No

If yes, please leave your contact information here:

Name: _____

Tel: _____

Email: _____

12. Would you be interested in having a copy of the summary findings of this research project?

□   Yes

□   No

-End of Survey-
Thank you very much for your time!

APPENDIX B: LIST OF PARTICIPATING COMPANIES

Addicon Logistics Management (S) Pte Ltd

Aerohub Logistics Pte Ltd

Applied Forwarding Pte Ltd

B H S Kinetic Pte Ltd

Freight Link Logistics Pte Ltd

Geometra Worldwide Movers Pte Ltd

Geosis Wilson (Singapore) Pte Ltd

GFS Forwarding Pte Ltd

GKE Warehousing & Logistics Pte Ltd

Henry Bath Singapore Pte Ltd

Lap Distribution Pte Ltd

Logwin Air + Ocean Singapore Pte Ltd

Michelle Art Transport Pte Ltd

Procter & Gamble Singapore Pte Ltd

Penanshin (PSA KD) Pte Ltd

Poh Tiong Choon Logistics Limited

Ryder Ascent Logistics Pte Ltd

Schenker Singapore (Pte) Ltd

SH Cogent Logistics Pte Ltd

Singapore Post Limited

THT Logistics Pte Ltd

Transware Distribution Services Pte Ltd

Tri-Net Logistics (Singapore) Pte Ltd

Yang Kee Logistics Pte Ltd

Yusen Air & Sea Services (S) Pte Ltd

APPENDIX C: WMS SOFTWARE LISTING

- CatalystCommand WMS (by Catalyst International)

- Geode WMS (by Sage)

- Infor SCM Warehouse Management Enterprise (by Infor)

- ORION (by 3i Infotech)

- Accuplus (by Cadre Technologies, Inc)

- Avercast Trolling For Dollars (by Avercast)

- CoreWMS (by Software Technology & Consulting)

- E2e (by RedPrairie Corporation)

- Inconso WMS Suite (by Inconso AG)

- Logility Voyager Solutions Warehouse PRO (by Logility)

- QAD Enterprise Applications (by QAD)

- Skyway Direct Procurement Unification (by Skyway Software)

- Supply Chain Advantage (by HighJump Software)

- Synchronicity (by Radcliffe Inc)

- viad@t (by viastore sytems GmbH)

- WaerLinx (by Waer Systems Limited)

- Warehouse Under Control (by 4uLogistics)

- Service suite (by Ventyx)

Source: ("Warehouse Management Systems (WMS) Software Listing," 2009)

APPENDIX D: DEFINITIONS OF WMS CAPABILITIES

Receiving is the starting point of warehousing process thus it is important that one needs to get it right at all times. If anything goes wrong at this stage, the problem will transfers downstream ("garbage in garbage out").

Inspection/QA (Quality Assurance) is the process of ensuring any damages or discrepancies are clearly shown on the delivery order of the transporter to prevent any disputes of liability later.

Put-Away is a process of putting away the incoming goods to locations where they can be stored and tracked.

Cross Docking is the process of directly shipping out the incoming products without the needs to store them.

Inventory Management is "the direction and control of activities with the purpose of getting the right inventory in the right place at the right time in the right quantity in the right form at the right cost" (InventoryOps, 2009).

Location Management is the functionality that manages the status changes and the property of the location during the processes of inbound, outbound and storage.

Replenishment is the process of transferring cargo from the bulk storage area to the picking zone. WMS has the functionality to trigger a replenish task when the stock falls below certain level.

Picking is the process of picking goods from storage locations to fulfil customer orders. There have been a lot of literatures exploring optimal order picking algorithm.

Wave Management is the functionality that manages wave picking where orders from all zones are picked at the same time and later sorted and consolidated into individual orders.

Staging is the functionality that manages those activities (e.g. receiving, cross docking) that happen on staging area.

Packing involves the preparation of the goods for shipment.

Truck loading only happens when the delivery order is generated from the WMS after transporter arrives to collect the cargo.

Manifesting is the functionality that can produce a report (physical or electronic) that is sent to the carrier for billing purposes (InventoryOps, 2009).

Cycle Counting is an essential feature of WMS that incorporates cycle-counting as part of the warehouse activities.

Labour management ensures the optimisation of labour productivity and performance through better planning, staffing, and execution.

Yard management describes the function of managing the contents (inventory) of trailers parked outside the warehouse, or the empty trailers themselves. Yard management is generally associated with cross docking operations and may include the management of both inbound and outbound trailers.

Slotting describes the activities associated with optimizing product placement in pick locations in a warehouse. There are software packages designed just for slotting, and many WMS packages will also have slotting functionality. Slotting software will generally use item velocity (times picked), cube usage, and minimum pick face dimensions to determine best location.

3PL billing is activity-based billing which allows them to calculate billable fees based upon specific activities. For example, a 3PL can assign transaction fees for each receipt, and shipment transaction, as well as fees for storage and other value-added activities.

Task interleaving describes functionality that mixes dissimilar tasks such as picking and put-away to obtain maximum productivity. Used primarily in full-pallet-load operations, task interleaving will direct a lift truck operator to put away a pallet on his/her way to the next pick. In large warehouses this can greatly reduce travel time, not only increasing productivity, but also reducing wear on the lift trucks and saving on energy costs by reducing lift truck fuel consumption. Task interleaving is also used with cycle counting programs to coordinate a cycle

count with a picking or put-away task (Piasecki, 2006)

Dock schedule ensures efficient flow of dock activities by proper scheduling them.

Value-Added Services is a functionality that enables you to perform value-added services better by accommodating changing customer tastes and product requirements.

Automation interface refers to how well WMS connect and integrate with other software being used in the warehouse.

Visibility is a functionality that enables you to have a clear picture of the current stock level, product locations, on going activities and so on.

Event management is a functionality that triggers specific actions based upon the occurrence of a specific event or combination of events (InventoryOps, 2009).

Performance management is a capability that automatically generates performance evaluation benchmarks in terms of efficiency; utilisation based the data information recorded in the system.

APPENDIX E: INTERVIEW RECORDS

Interviewee: Mr Hamid of GKE Warehousing & Logistics

Date: 30th December 2009

Time: 1030am – 1130am

1. How is the trading of a warehouse like? What is the industry practice in Singapore?

    GKE Warehousing & Logistics chooses to own a certain volume of warehouse space to the extent that can meet the average market demand. When demand goes up in times of good economy, the company rents warehouse space from other warehouse operators taking into consideration on the facility, its location and the rental rates.

    This concept is largely similar to the industry practice in shipping. It is believe that both warehouse and ship are huge investment and are considered useless (not generating any revenue) unless they are put into use. Therefore, utilisation of the assets is important.

2. What do you think of the scale of implementation of WMS in the context of Singapore logistics industry? Up to now, the 6 survey responses showed that 50% of the companies are currently using WMS while the other 50% are not. Since the sample size is so small, what's your sentiment towards this issue?

     It is very difficult to give a figure on that.

3. In your opinion, what could be the factors affecting the decision of a company on whether to implement WMS?

    Customer requirements: Some customers would require monthly reports, real-time access to their cargo status, goods delivery report based on which they bill their customers, etc. In this case, a WMS becomes compulsory in getting the business.

    Do we really need it? Do we believe in WMS? (scale of operation, volume of transactions): It is important to balance the efforts involved in operating a WMS and the volume of transaction and scale of operation. If the time and cost spent in WMS can be justified by a

reasonable amount of transaction volume and operation scale. E.g. the transaction volume of GKE Warehousing & Logistics is more than 500 line items per day, which is considered substantial.

Cost: The high start-up and the maintenance costs are the major hindrance to the implementation of WMS, especially for small companies. The cost also depends on the number of users who have access to the system.

Need to standardise recording practice: A WMS becomes necessary especially when there is frequent manpower change in warehouse operation where different operation staff has a different set of practice in recording SKUs.

As for GKE, on-going difficulty in running a data-intensive system is not seen as a problem since the company has been using WMS for the past 10 years.

4. Of the 5 levels of warehouse sophistication i.e. storeroom, rudimentary locator, advanced locator, added intelligence, automated, which level do you think that most of the companies are at?

Mr. Hamid believes that in the context of logistics industry in Singapore, most companies are between level 2 (Rudimentary locator: *minimal complexity, basic needs for receiving, put-away, storage, picking, etc.*) and level 3 (Advanced locator: *moderate complexity, good warehouse task execution performance*), very few companies can go to level 4 (Added intelligence: *large physical facilities, many staff in operations, many value-added services*) and above.

Mr. Hamid suggests that companies at basic sophistication levels develop their own in-house systems whereas companies at more advanced sophistication levels purchase WMS packages available in the market. However, at the end of the day, the system being purchased from the market still belongs to WMS developers.

5. Some elaborations of survey questions:

Number of functionalities is indicated medium in the survey as the operation of the

warehouse mainly requires core capabilities. Both usefulness and deployment status for most extended capabilities are low.

Technology contents are indicated medium in the survey as there is only scanner technology involved. The company is expecting more technologies for example the SMS delivery update, however, customer base is still not big enough.

Mr. Hamid believes that R&D needs for WMS are not as that important and urgent because what WMS in the market offers is way beyond what the warehouse operation needs. However, he does place emphasis on the visibility capability as it is normally required by the customer to check current stock level, especially for those customers located overseas.

Conclusion:

Warehousing is very customer-oriented business. Therefore, everything about warehouse operation and WMS capabilities must be consistent with customer requirements.

Interviewee: Mr Eric Chan of Poh Tiong Choon Logistics

Date: 13 Jan 2010 (Wednesday)

Time: 15:00 – 16:30

1. What do you think of the scale of implementation of WMS in the context of Singapore logistics industry? Up to now, the 19 survey responses showed that around 63% of the companies are currently using WMS while the other 37% are not. Since the sample size is so small, what's your sentiment towards this issue?

A WMS can be easily bought over the shelf and they are readily available in the market.

"As far as my contacts are concerned, nearly all of the warehouses, being big or small, are all using WMS, but not sure the extent of use."

The petrochemical industry is very unique; it requires the information that a WMS can provide. For example, customers (big players in the energy industry) requirements,

regulatory requirements (dangerous goods)

80% of customisation was made to the US model WMS to suit for petrochemical warehouse at the time when the company bought the WMS, which cost around 1 million SGD.

2. In your opinion, what could be the factors affecting the decision of a company on whether to implement WMS?

Customer-driven: Requirements from customers keep changing, and special requirements (daily/monthly reports, billing, tracking) are not easy to track manually. Example: Nowadays, most customers require web-based live inventory portal for real-time tracking and a tool to commit their sales.

Globalisation: The supply chain becomes more complex, and the company has to move ahead of time. (Macro-view)

Scale of operation

Business volume

Revenue: Whether it makes business sense to invest in WMS when return margin is very low because a WMS is quite expensive. Example: a simple stand-alone WMS can easily cost 20-40,000 SGD.

3. Of the 5 levels of warehouse sophistication i.e. storeroom, rudimentary locator, advanced locator, added intelligence, automated, which level do you think that most of the companies are at?

"In the petrochemical industry, I am confident to say that most of the warehouses are at least at level 4 (added intelligence), and the top players surely have gone to level 5 (automated)."

Mr. Eric Chan believes that most warehouses storing general cargos are at level 2 (rudimentary locator).

Generally speaking, the petrochemical warehouses are more sophisticated than general

cargo warehouses.

Customer is the driving force, and petrochemical players are more "demanding".

The regulatory framework for petrochemical cargo is more stringent as well.

A warehouse depends very much on what kind of goods it stores and what kind of customer it serves. Example: WMS used in a warehouse storing Fast Moving Consumer Goods (FMCG) is very complicated due to fast-in-fast-out nature.

4. Other questions will be more of elaborating the survey questions that have been answered. (Just in case, please the survey response attached.)

    Qn 6 –Buying a WMS is like buying a car, depending on what your applications are. Small players are suggested to develop their own in-house WMS

    Qn 8 (R&D) – the flexibility to change information as needed without affecting the historical data, considering the warehousing billing is very dynamic.

Interviewee: Mr Eric Lee of THT Logistics

Date: 5th February 2010

Time: 1045am – 1115am

1. What do you think of the scale of implementation of WMS in the context of Singapore logistics industry? Up to now, the 24 survey responses showed that around 62.5% of the companies are currently using WMS while the other 37.5% are not. Since the sample size is so small, what's your sentiment towards this issue?

    Depending on what kind of companies you conducted the survey in the logistics industry, the needs of WMS varies especially for SME. WMS is widely used by warehouse and freight service provider and not too common for local transport companies.

    Companies whose core businesses are warehousing is highly likely to implement a WMS.

2. In your opinion, for a warehouse what could be the hindrances of implementing WMS?

   Costing of WMS software, Software license and customized for specific use is generally high to implement as it easily cost above $100,000, excluding additional features e.g. scanner, wireless device, server, firewall etc… which is necessary during the set-up.

   Whether to implement WMS largely depends on the kinds of cargo handled. If those cargoes are not possible to be handled by human hand (e.g. petrochemical, cold-stored goods), naturally warehouse automation becomes necessary, where WMS will be required.

3. Of the 5 levels of warehouse sophistication i.e. storeroom, rudimentary locator, advanced locator, added intelligence, automated, which level do you think that most of the companies are at?

   Mosty up to first 4 in your list.

4. Survey result shows that there is great disparity in technology contents in WMS between small and medium-large warehouses (mean for small warehouse: 1.63; mean for medium-large warehouses: 2.43; T test: 0.04). What do you think of this finding and the possible reasons behind?

   The business that the companies are engaged in matters more than the size of the warehouse.

Interviewees: Mr Chan Hsien Hung and Mr Danny Kong of Yang Kee Logistics

Date: 9th March 2010

Time: 10am-11am

1. Overall, 16 companies (64%) out of the total 25 respondents operate a WMS. Since the sample size is quite small, what is your sentiment towards the implementation level of WMS in the logistics industry of Singapore?

WMS, as an integral part of logistics industry plays a crucial role in the warehousing sector.

The survey result on scale of implementation of WMS (64%) may have underestimated the actual implementation level due to the limited sample size.

Nearly all major players operate a WMS, but small players may not necessarily need a WMS.

2. Does Singapore Government play any role in the implementation of WMS? Is there financial aid scheme of any kind in place? Or are there any government regulations on WMS adoption?

    Spring Singapore provides funding support for Logistics Capability Development Programme   .

    In Questionnaire for Application of Licensed Premises from Singapore Customs, there is a question on WMS (see Appendix F). It is mandatory for the warehouse operator to manage the bonded cargos using a WMS system. The WMS system will keep track of the cargo and its location.

3. Survey results show that level of sophistication of WMS in Singapore logistics industry is between *Rudimentary Locator* and *Advanced Locator* (see explanation in survey form), which is still considered sub-standard for a leading logistics hub like Singapore. Centralisation of warehouse space may be seen in decade to come, where scale of operation will be much larger and WMS will become much more desired. We will see disappearance of small warehouses which in turn merge stronger into big players in the market. What's your opinion toward this issue? Will merge of small players help to enhance Singapore's competitiveness?

    Disappearance of small players is possible due to inability to sustain their business since customers are becoming more demanding.

    Danger of centralisation of warehouse space is the monopoly situation where major players have strong bargaining power and dominate the market and price.

    The advantage of centralisation of warehouse space is that there will be more resources to

offer to the customers and leverage on large scale of operation to enjoy economies of scale.

4. Interestingly, a notably large gap was found in technology contents of WMS between small and medium-large warehouses. What could be the reasons behind? How do those technology contents help in achieving warehouse productivity and efficiency?

    Medium-large warehouses are more investment capability to technologies than small warehouses.

    Unlike medium-large warehouses, not all small warehouses have in-house IT department in charge of use of technology in the warehouse.

    Customer requirements for medium-large warehouses may be more stringent, which requires the   necessary technology contents in place.

    Reduction of manpower.

    Reduction of   human error; increase in inventory management accuracy

    Time saving

5. Other suggestions to enhance Singapore's competitiveness in the warehousing sector:

    Education: There should be more training and re-training of logistics professionals.

    Grants: High cost in investing in systems and technologies remain No.1 problem.

    Publicity: Proper publicity should be in place to boost the image and to promote the industry.

    Blue-corner workers are more and more difficult to recruit. If total automation of warehouse could be made possible, this problem won't exist.

APPENDIX F: QUESIONNAIRE FOR APPLICATION OF LICENSED PREMISES

SINGAPORE CUSTOMS - Schemes Promotion & Administration Branch

APPLICATION OF LICENSED PREMISES

Dear Customer,

Please complete the below questionnaire. Your cooperation is required for us to accurately assess your application.

Thank you.

1   BUSINESS ACTIVITIES

1.1 Describe your company business activities and corporate profile/history. How long has your company been in these business activities? Is your company affiliated to any other companies (e.g. parent-subsidiary relationships, etc.)? Provide a copy of the ACRA Business Profile of your company.

1.2   Who are your potential and existing customers? What types of goods would be stored in the proposed licensed premises? Are there any controlled or dangerous goods?

1.3 What is the experience of your company in providing storage/warehousing/logistics services, knowledge on customs procedures, etc.? Please indicate the services provided, such as permit declaration, clearance of goods through checkpoints, transportation, storage/warehousing, etc.

1.4 Please highlight any achievements (awarded by government agencies, non-governmental organizations or trade/business associations, etc.) which your company has achieved during the years of your operations.

1.5 Has your company participated in any Singapore Customs (SC) or IRAS tax-suspension schemes (e.g. Licensed Warehouse, ZGS Warehouse, Major Exporter Schemes, Third Party Logistics Schemes, etc.).

2   STANDARD OPERATING PROCEDURES & SEGREGATION OF DUTIES

2.1 Please provide the SOPs for the processes as follows:
- (a)   Handling of in-bound and out-bound tax-suspended goods;
- (b)   Audit / Stock checks;
- (c)   Reporting of stock discrepancies;

(d)   Any other procedures relating to the handling/movements and storage of tax-suspended goods; and

(e)   Business Continuity Plan / Disaster Recovery Plan (which ensure the continuity of critical business functions in your company).

2.2 Provide a copy of the (a) Company Organizational Chart and (b) Operations/Logistics Department Organizational Chart. The chart should show the full names and responsibilities of each of the staff involved in the operations of the licensed premises.

2.3 Does your company have a regular training programme and what types of training courses does your staff need to attend?

2.4 Is your company ISO certified? If so, state which processes that are ISO certified and provide a copy of the ISO certifications.

2.5 Highlight what other accreditations (e.g STP, TAPA, RCAR, ISPS Code, CP-PAT, etc.) which your company has achieved? Provide a copy of each of the certification.

3   SYSTEMS TRANSPARENCY & ACCOUNTABILITY

3.1 Briefly describe the warehouse management system (WMS) / inventory system used by your company in tracking and accounting for the movements of tax-suspended goods in your licensed premises? Is the WMS / inventory system purchased off-the-shelf and customized, or developed in-house?

3.2 Briefly explain the security policy on the system access-control for individual users.

3.3 How often does your company backup data? How are accidental data loss detected and highlighted?

4   ADOPTION OF SECURITY MEASURES

4.1 Briefly describe the security measures at the proposed licensed premises, e.g. security guard, alarm system, close circuit TV, screening of personnel etc. Highlight company's Security Management Plan or Risk Assessment Plan (if any).

Name of Respondent:
Designation[1]:
Name of Company (with endorsement):

Date:

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[1]   This application is to be completed/endorsed by personnel holding an appointment of Manager and above.

APPENDIX G: SUMMARY OF RESPONDENT-SPECIFIED 'OTHER' RESPONSES

Part 1	Information about Organisation

2. Main activities and services of your Company (please tick all that apply):

- Postponement and localisation
- FMCG products
- Bulk cargo handling, packaging, home delivery services
- Projects (transportation for events)
- Container yard and services
- Shipping agency

Part 2	Warehouse Management System in Singapore

6. Please evaluate the Warehouse Management System (WMS) that your Company is currently using according to the following criteria.

- Supporting value-added services (medium)
- No backend support

7. Please rate the <u>usefulness</u> and <u>deployment status</u> of the following **WMS capabilities** according to the situation of your Company.

- Documentation (usefulness: medium, deployment status: medium)

8. Please rate the <u>importance</u> and <u>urgency</u> of the following **R&D needs** for WMS in Singapore.

- RFID (importance: medium, urgency: medium)

9. Please **rank** the reasons for which your Company is <u>not</u> using WMS.

- Better alternative: manual tracking
- Operation model does not require the need for a WMS
- Low number of SKUs