

Dangerous goods regulating system in Singapore

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2010

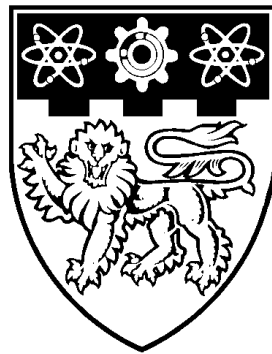
Cui, Y. (2010). Dangerous Goods Regulating System in Singapore. Final year project report, Nanyang Technological University.

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DANGEROUS GOODS REGULATING SYSTEM IN SINGAPORE

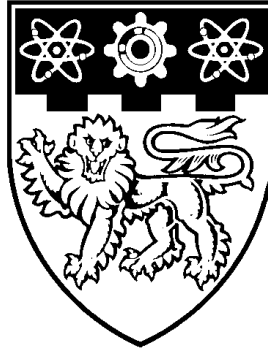


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2010

DANGEROUS GOODS REGULATING SYSTEM IN SINGAPORE



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

2010

SUMMARY

Dangerous Goods (DG), as its name states, can lead to serious consequences if improperly managed. Hence, a sound regulating system needs to be established to safeguard the handling of DG. In Singapore, many international and national rules and regulations have been implemented in the industry. Moreover, supportive initiatives have also been launched by various DG agencies to improve the DG regulating system in Singapore.

This report covers various literature reviews done in order to understand the DG regulating system in Singapore. The results from surveys and interviews with both industrial companies and regulatory bodies provide the different perceptions towards several DG issues in the regulating system.

The research shows that there are controversial opinions towards the integration of DG regulating system between the industrial companies and the regulating agencies. Some of industry companies are looking for a unified system with one DG agency in charge to reduce the confusions that exist in current system, on the other hand, the regulatory bodies have their own reasons to retain the multiple-agency system in Singapore while they are trying to improve and divide the responsibilities among each agency clearly.

Moreover, a common message from the industrial interviewees is that the effectiveness of communication between the industry and the regulating agencies needs to be improved and enhanced. The agencies shall keep the companies informed timely about the updated information about DG such as web portal function updates and regulation updates.

Since the 2006 study conducted by Mr. Rajkumar about DG logistics system in Singapore, the DG system has been strengthened along the years. The comparison shows an improvement especially in the compliance status of various DG initiatives by the companies. However, there is still a gap between Singapore and Europe as mentioned by some of the interviewees, and further developments and measures are warranted in the years ahead.

ACKNOWLEDGEMENT

I would like to express my sincere appreciation to the following people and organisations.

- Associate Professor Wong Yiik Diew for his valuable suggestions and instructions during the year's research study.
- My collaborators Huang Min and Zheng Yanchao for their cooperation and support.
- Mr. Tan Kia Tang from Ministry of Manpower for providing the SCIC guidebooks, relevant DG acts and potential contact person.
- Singapore Chemistry Industry Council for providing me copy of guidebook and relevant web links.
- Mr. Hu Wing Ko from PSA for the information provided on the PSA classes.
- Mr. Uwe Jacobsen for providing the DG information and potential contact person.
- Mr. Zhang Hongzhou for providing the piracy report.
- All the interviewees, Mr. Michael Foong from DHL, Dr. Roland Lim Yan Guan from SIMTech, Mr. Heng Keng Liang, Mr. Kwok Shun Yung and Ms. Alice Seto from Singapore Civil Defence Force, Mr. Ryan Lim from Schenker Pte Ltd, Mr. Tan Kia Tang from MOM, Mr. Michael Tang from Dangerous Goods Management Pte Ltd, Mr. Mohamed Salleh from LTH Logistics Ltd Pte, Mr. Uwe Jacobsen from Leschaco Ltd Pte, Mr. Terence Koh and Mr. Ooi Tiat Jin from SCIC, Mr. Martinn Ho from National Environmental Agency, Mr. Hu Wing Ko from PSA, and Mr. Razali from MPA for their patient explanation on the DG issues discussed in the report.
- All the survey respondents for their kindness in filling the questionnaire.

This report could not have been done without the above.

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LIST OF ABBREVIATIONS

AAR	Association of American Railroads
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
ADN	European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
BAM	Bundesanstalt für Materialforschung und -prüfung
BS	British Standards
BSI	British Standards Institute
CERT	Company Emergency Response Team
CFR	Code of Federal Regulations
CODAP	Code for Construction of Unfired Pressure Vessels
COTIF	Convention concerning International Carriage by Rail
CP	Code of Practice
CRP	Centre for Radiation Protection
CSC	International Safety Convention for Safe Containers
DG	Dangerous Goods
DGL	Dangerous Goods List
DGR	Dangerous Goods Regulations
DHL	Dalsy, Hillblom and Lynn
DOT	Department of Transportation
ECOSOC	United Nations Economic and Social Council
EHS	Employee Health and Safety
FRA	US Federal Railroad Administration
GGR	Dangerous Goods Procedural Rules
GHS	United Nations Globally Harmonised System of Classification and Labelling of Chemicals
GPS	Global Positioning System
HARTS	Harbour Craft Transponder System
HazMat	Hazardous Material
HNS	Hazardous and Noxious Substance
HSA	Health Science Authority
HTDP	Hazardous Material Transport Driver Permit
HTVTS	HazMat Transportation Vehicle Tracking System

IATA	International Air Transport Association
ICC	International Chamber of Commerce
ICGB	International Cargo Gear Bureau
IICL	Institute of International Container Lessors
IMB	International Maritime Bureau
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organisation
ISO	International Organisation of Standardisation
IT	Information Technology
LTA	Land Transport Authority
MAHB	Major Accident Hazards Bureau
MARPOL	International Convention for the Prevention of Pollution from Ships
MARS	Major Accidents Reporting System
MFAG	Medical First Aid Guide
MHA	Ministry of Home Affairs
MITRA	Monitoring and Intervention for the Transportation of Dangerous Goods
MOH	Ministry of Health
MOM	Ministry of Manpower
MPA	Maritime and Port Authority of Singapore
MSDS	Material Safety Data Sheet
NA CWC	National Authority, Chemical Weapons Convention
NEA	National Environmental Agency
NTSB	National Transportation Safety Board
OTIF	Intergovernmental Organisation for International Carriage by Rail
PCD	Pollution Control Department
RID	Regulations concerning the International Carriage of Dangerous Goods by Rail
SC	Singapore Customs
SCDF	Singapore Civil Defence Force
SCIC	Singapore Chemical Industry Council
SDS	Safety Data Sheets
SIMTech	Singapore Institute of Manufacturing Technology
SLA	Singapore Logistics Association
SOLAS	Safety of Life at Sea
SPF	Singapore Police Force
SPRING	Standards Productivity and Innovation Board

SS	Singapore Standard
TC	Transport Canada
TDG	Transport of Dangerous Goods
UN	United Nations
UNRTDG	United Nations Recommendations on the Transport of Dangerous Goods
US	United States
VTIS	Vessel Traffic Information System
WSH	Workplace Safety and Health
WSHA	Workplace Safety and Health Act

CHAPTER 1 INTRODUCTION

1.1 Background

Dangerous goods (DG), also called hazardous materials (HazMat), are radioactive, flammable, explosive or toxic substances and organisms in solid, liquid or gas forms (Wikipedia, 2009a) that can cause danger both to the public and environment. As a result, there are a number of regulations covering safe transportation, storage and packaging of DG such as International Maritime Dangerous Goods (IMDG) Code and Maritime and Port Authority of Singapore (Dangerous Goods, Petroleum and Explosives) Regulations.

Globally, DG is heavily regulated especially in Europe as it concerns the health and safety of the residents as well as the environmental issues. Moreover, DG can also become a terrorist weapon which could cause more dangerous situations and disastrous consequences.

In Singapore, DG carriers can be seen frequently on the roads with special signs indicating the specific class of DG on board. Since there is limited geographical space in Singapore, even the approved DG vehicles transportation routes cannot avoid the closeness to the residents and central district areas. The approved routes can be found in Appendix A (Rajkumar, 2006). Furthermore, research shows an increase in frequency of accident occurrences took place from the beginning of 20th century to 2004 in transportation of DG in Europe and North America regions (Planas et al., 2008). Singapore is also exposed to similar threats from DG transportation and storage as its small land space yet relative frequent DG transportation. The hub-and-spoke system that the port of Singapore has adopted requires an enduring safe and secure transition of cargoes including DG which shall become a competitive advantage of Singapore port compared with the others. Therefore, the importance of a well-managed DG system is enormous. In order to safeguard the process of transport, storage and carriage of DG, several agencies in Singapore are launching initiatives including various regulations and applied technologies to help the industry to build up a strong DG logistics chain. At the same time, the industrial companies are also paying good attention to the handling process of DG.

1.2 Objectives and Scope

The objectives of this study are to identify critical issues for DG regulating system in Singapore through a thorough literature review, and to gauge the usefulness and compliance status of dangerous goods regulations by assessing the logistics industry's perceptions on the current regulation system for DG transport in Singapore.

The research is under the context of Singapore with focus on transportation and logistics of DG. Relevant regulations and supporting activities are to be reviewed and profiled; the compliance status and usefulness of regulations, as well as the future trends shall be obtained from interviews and survey.

1.3 Methodology

Primary data for this study were collected through interviews and surveys. Logistics companies in Singapore which are involved in DG transportation or handling were contacted. Interviews were conducted with DG professionals in the logistics companies and DG agencies. Survey questionnaires were posted to DG logistics companies in Singapore. Survey questions were designed in accordance to the objectives of this study. Online survey links were also administered on the survey targets. Sample survey questionnaire is included in Appendix B.

Literature reviews of various resources such as databases, journals, books and internet are for secondary data collection. Secondary data are important to generate supportive evidences and comparison references for this research study.

1.4 Organisation of Report

The report includes 5 chapters which are shown in Figure 1.1.

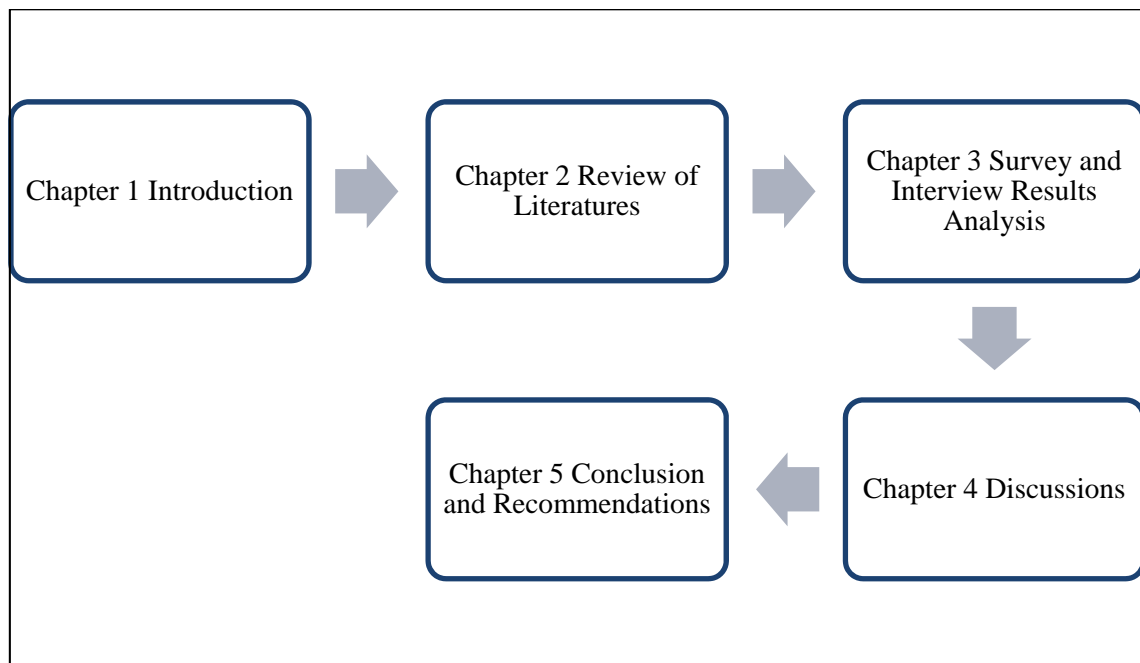


Figure 1.1 Structure of Report

CHAPTER 2 REVIEW OF LITERATURE

The information gathered through various literature reviews are organised in this chapter in order to understand DG regulating system in Singapore, and thus to identify the critical issues existing in the system.

2.1 Definitions

DG is classified by United Nations Recommendations on the Transport of Dangerous Goods (UNRTDG, UN Orange Book) into 9 classes according to the different properties and inherent hazards. The classes and respected labels can be found in Appendices C and D, respectively (Wikipedia, 2009a).

Additional labels are included in IMDG Code and International Air Transport Association (IATA) Dangerous Goods Regulations (DGR); these labels can be found in Appendix E.

Furthermore, UNRTDG has established 3 packaging groups based on the severity of danger of DG. Each packing group products are required to be packaged according to certain procedures described in UNRTDG. The 3 packing groups represent (SCIC, 2006a):

- Packing Group I - higher danger
- Packing Group II - medium danger
- Packing Group III - lower danger

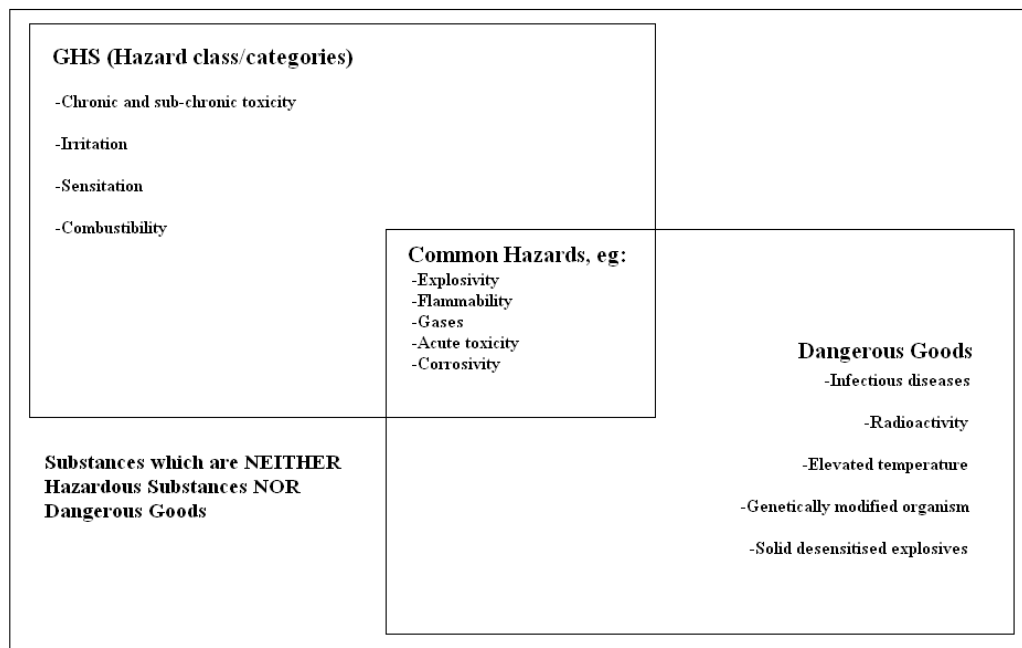
Whereas DG class classifies hazardous products into relatively broader categories, UN number is dedicated to one kind of product or products with similar properties. UN number is of 4-digit ranging from UN0001 to UN3500 which are assigned by United Nations Committee of Experts on the Transport of Dangerous Goods (TDG). The list of numbers is also published on UNRTDG (Wikipedia, 2009d). Hence, dangerous substances of the same DG class may have different UN numbers.

There is another system for classifying chemicals which is the UN Globally Harmonised System for Classification and Labelling of Chemicals (GHS). Singapore has committed to adopt GHS classifications by 2008 deadline imposed by UN (SPRING, 2009). The classes and labels are included in Appendix F (Wikipedia, 2009b).

The relationship between GHS and UNRTDG hazard classification is summarised in Figure 2.1, and the key differences between GHS and UNRTDG are elaborated as following by Singapore Chemical Industrial Council (SCIC) (SCIC, 2006b).

- The GHS covers both acute and chronic hazards

- The GHS provides information on the hazardous properties of chemicals and preventive measures of handling such chemicals throughout their lifecycle (i.e. production, transport, sale, use and disposal).
- The GHS communication elements are not intended for the transportation of HAZMAT and DG. Consequently, the labels for the GHS (i.e. the workplace/precautionary and consumer label) are different from those for HAZMAT and DG. The GHS communication elements also address a wider target audience ranging from workers, consumers to transporters.



Source: (SCIC, 2006b)

Figure 2.1 Relationship between the GHS and UNRTDG Hazard Classifications

2.2 DG Accidents and Incidents

DG accidents require specialised management system as the nature of DG implies that accidents of DG can give rise to great dangers.

2.2.1 DG Accidents and Incidents Statistics

Table 2.1 shows the summary statistics for a sample of 1,932 DG accidents that occurred between the beginning of the 20th century and July 2004 (Planas et al., 2008).

The research also reported that most of the accidents occurred on the roads and most took place in developed countries by virtue of wider applications.

Table 2.1 Statistics of DG Accidents (1901-Jul. 2004)

Type of DG accidents		Percentage out of the 1,932 accidents studied
Accidents occurred in the last 20 years		78%
Accidents occurred in the last 10 years		37%
Accidents occurred on roads		63%
Accidents categorised by results	Releases	78%
	Fires	28%
	Explosions	14%
	Gas clouds	6%
Accidents due to collisions		74%

Source: (Planas et al., 2008)

2.2.1.1 Terrorist and piracy attacks

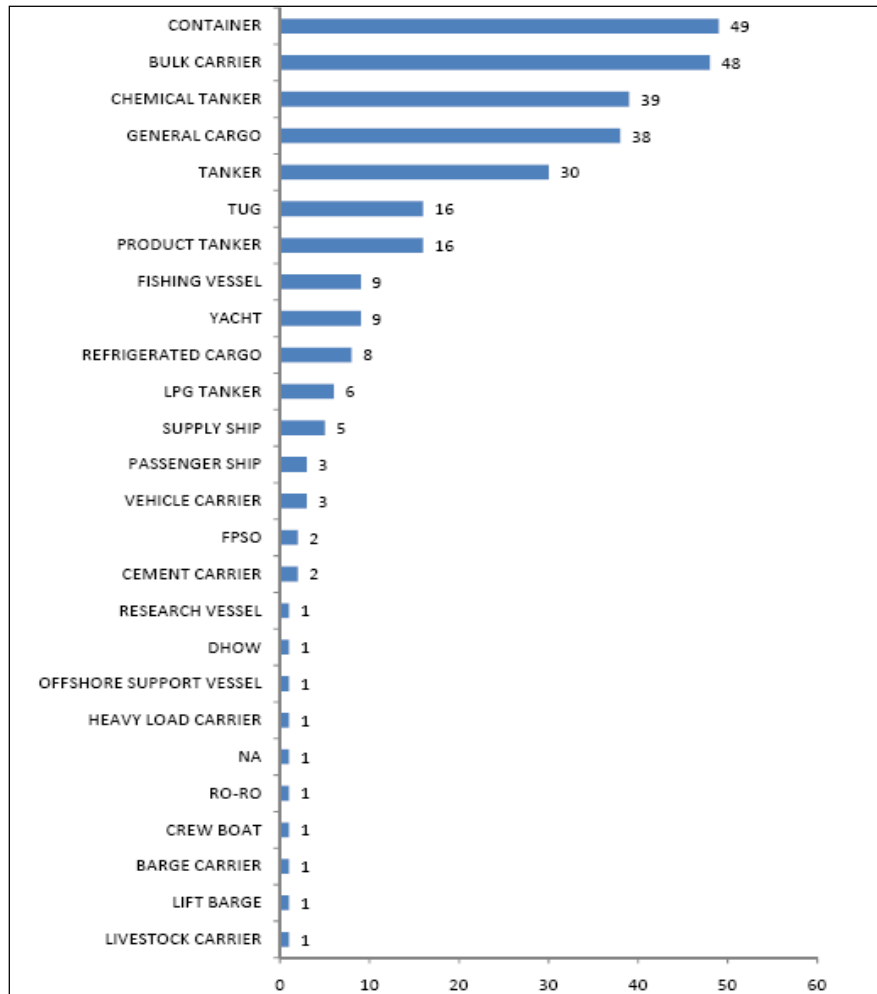
Terrorist can make use of hazardous materials to execute the attacks. Table 2.2 shows a list of terrorism actions involving hazardous materials in recent years (Milazzo et al., 2009).

Table 2.2 Terrorist Attacks Involving DG

Date (DD/MM/YYYY)	Place	Event	Consequences
12/11/2003	Nassiriya (Iraq)	Explosion of a truck loaded with explosives – Domino effect: explosion of the warehouse storing explosives	28 fatalities
16/07/2005	Mussayeb (Iraq)	Explosion of a road-tanker loaded with Liquefied Pure Gas (LPG)	60 fatalities and 82 injured
20/02/2007	Taji (Iraq)	Explosion of a road-tanker loaded with chlorine	6 fatalities and 140 intoxicated
17/03/2007	Al Anbar (Iraq)	3 suicide attacks with trucks loaded with chlorine dirty bomb	2 fatalities and 350 intoxicated
16/05/2007	Abu Saydah (Iraq)	Explosion of a road-tanker loaded with chlorine	45 fatalities and 65 injured

Source: (Milazzo et al., 2009)

From International Chamber of Commerce (ICC) International Maritime Bureau (IMB)'s annual report on *Piracy and Armed Robbery against Ships*, the reported types of vessel attacked during the year 2008 are shown in Figure 2.2. From this information, one can notice that vessels such as chemical tankers and LPG tankers that carry DG-related cargoes account for a substantial portion.



Source: (IMB, 2009)

Figure 2.2 Types of Vessels Attacked in 2008

In order to pay special attention to the vehicles carrying DG, companies importing or exporting DG must make a declaration to Singapore regulatory bodies such as Singapore Civil Defence Force (SCDF) and National Environmental Agency (NEA). Vehicles carrying DG are also installed with Global Positioning System (GPS) for a real-time monitoring. However, Mr. Jacobsen, managing director from Leschaco Pte Ltd, had raised his concern that no terrorists would ever declare DG if they were to import any of such materials for terrorist acts (Jacobsen, 2010). Thus, fighting against terrorism is a complex and difficult task.

2.2.1.2 DG incidents by mode

The majority of DG incidents occurred on the roads, in particular highways. Table 2.3 shows 5-year figures for DG incidents by mode reported by United States (US) Department of Transportation (DOT).

Table 2.3 DG Incidents by Mode in US (2004-2008)

Mode/Year	2004	2005	2006	2007	2008	Total
Air	993	1,655	2,411	1,555	1,277	7,891
Highway	13,071	13,461	17,157	16,904	14,781	75,374
Rail	765	745	704	750	750	3,714
Water	17	69	68	61	98	313
Total	14,846	15,930	20,340	19,270	16,906	87,292

Source: (DOT, 2009b)

2.2.1.3 DG incidents by cause

There could be several causes in each accident. Over 40 kinds of causes are identified by US DOT for DG incidents. The top 10 causes which led to the highest number of incidents in 2008 are shown in Table 2.4.

Table 2.4 Top 10 causes for DG incidents in US in 2008

Causes	Number of Incidents in 2008
Human error	2,507
Dropped from vehicles	2,039
Loose closure, component, or device	1,921
Forklift accident	1,338
Improper Preparation for Transportation	1,290
Cause Not Reported	1,246
Defective Component or Device	1,240
Inadequate Preparation for Transportation	1,055
Impact with Sharp or Protruding Object (e.g., nails)	956
Inadequate Blocking and Bracing	917

Source: (DOT, 2009a)

Causes such as human error, dropped from vehicles, and cause not reported stay in the top reasons for DG incidents through the years which indicate some critical aspects that need to be worked on.

On 21st March, 2006, there was a huge explosion onboard the 68,363DWT M/V Hyundai Fortune in the area of Gulf of Aden. The cause of the explosion was commonly agreed as the fireworks reactions in the containers (Wikipedia, 2009c). The fireworks may not have been declared and labelled as DG by the shipper and thus the cargo may not been properly stored by the ship's crew (Horton, 2007). The insurance market was predicting to lose about \$250 million over the incident (Insurance Times, 2006) which is "one of the biggest and most complex claims cases the marine insurance market has experienced" (Stuart, 2006). Hence, the declaration and correct labelling of DG are vital for preventing DG incidents. As Karl Lumbers, UK P&I club's

loss prevention director said, “quite simply, the more people that follow the International Maritime Dangerous Goods Code, the fewer the incidents and the less chaos and disruption to people’s lives” (Stuart, 2006).

2.2.1.4 DG accidents/incidents in Singapore

Singapore is a city state which implies that the potential danger caused by DG accidents can be very significant towards the residents and public properties. From the feedback of Mr. Lance Foong, a DG air freight expert from Dalsey, Hillblom and Lynn (DHL), he stated that Singapore’s small geographical area and dense population can be an impediment to developing DG logistics chain and “there are not too many places where we can site a specialised warehouse for hazardous materials without endangering residents” (Foong, 2009).

During the interview with Mr. Heng Keng Liang, Licensing Team Leader from Singapore Civil Defence Force, he mentioned that the total number of DG accidents or incidents is confined to only single digit annually in Singapore (Heng, 2009). Mr. Heng also added that the DG licenses for the DG-carrying vehicle or drivers would be suspended once any incident occurred, but this does not discourage the logistics companies to report the incidents to the government agencies because nowadays the media become more fast and open, and the number of cases that are not reported to the authorities should be minimal.

Mr. Ryan Lim from Schenker Singapore Pte Ltd explained that for small incidents, under Ministry of Manpower (MOM)’s Workplace Safety and Health (WSH) requirements, if the employees got injured from handling DG and took more than 3 days, medical leave, the case must be reported to MOM and relevant parties (Lim, 2009).

2.2.1.5 Cost of DG incidents

The contrast of DG incidents and non-DG incidents can be found in Table 2.5. It shows that motor carrier DG incidents result in higher cost and longer traffic delay compared with non-DG incidents.

2.2.2 DG Accidents/Incidents Management System

DG accidents/incidents management system involves analysing past information, take necessary precautions to prevent DG incidents and after accidents actions to minimise loss, and rescue the injured.

Table 2.5 Comparative Costs of Hazmat and Non-hazmat Motor Carrier Accidents/Incidents

Type of accident/ incident events	Average cost (in US\$)	Average traffic delay
Non-hazmat events	340,000	2 hours
All hazmat events	414,000	N/A
Hazmat events with spill/release	536,000	5 hours
Hazmat events with fire	1,200,000	8 hours
Hazmat events with explosion	2,100,000	12 hours

Source: (Erkut et al., 2007)

The Major Accident Hazards Bureau (MAHB) of the European Commission analyses the cases reported to the Major Accidents Reporting System (MARS) database to study past accidents. The objective is to learn lessons from past accidents in order to minimise recurrence and to mitigate the consequences of the accidents (Sales et al., 2008).

Monitoring and Intervention for the Transportation of Dangerous Goods (MITRA) project carried in Europe is primarily designed to satisfy civil security needs in European countries which integrates satellite navigation systems, telecommunications networks, geographic information systems, risk-knowledge databases and risk-propagation models in a single system. MITRA system provides great help to regional civil security centres make fast and safe decisions to optimise the resources allocated to handle the accidents. The functions of MITRA system are summarised in Appendix G.

Milazzo et al. (2009), in the report entitled “Risk Management of Terrorist Attacks in the Transport of Hazardous Materials Using Dynamic Geoevents”, explained that terrorist attacks involving hazardous materials require a dynamic risk management which applies a systematic and structured methodology that permits an exhaustive analysis of the attacks. The risk management system can be divided into the following phases (Milazzo et al., 2009):

- Characterization of the areas considered potential targets for terrorist actions;
- Definition of the characteristics of the area (manufacturing site and/or characterised by transport of dangerous substances);
- Qualitative study (identification of potential targets and incidental scenarios);
- Quantitative study of the incidental scenarios;
- Management of terrorist actions.

2.3 Problems with DG Transportation and Logistics System

Inadequate awareness and preparation for potential DG incidents threats is one problem pointed out by Planas et al. (2008) which would result in the following human, economic and environmental consequences:

- Lack of adequate precautions, intervention procedures and schemes;
- Lack of specific protection equipment;
- Exposure of first rescue teams and civilian populations to unknown hazards;
- Late and incorrect information provided to civilian populations;
- Loss of lives, both in civilian populations and civil security intervention forces (especially the first intervention teams).

Unreported accidents/incidents are another problem. This can cause inaccurate incident data which prevents precise analysis of information for future references. It is said that in US from 2006 to 2008, 1,199 serious hazardous materials spills on roads, rails, airstrips and waterways, were not reported to the government agencies, out of 1,403 reported ones, resulting in incomplete data for investigators to identify the unsafe carriers or containers (Eisler, 2009).

It is believed that DG transport and logistics system is a heavily regulated system. The news article *Hazmat Regulation Must Maintain Safety without Unnecessary Burdens to Commerce* mentioned that a balance needs to be achieved in DG transportation policy between making sure that appropriate safeguards are in place and being careful that no unnecessary burden is brought to the workhorse industries of the economy. On one side, risks of DG transport need to be mitigated and on the other side, an effective functioning system needs to be maintained (US Fed News, 2009).

2.4 DG Regulating System in Singapore

DG regulating system in Singapore is discussed under 2 main categories. One is primary activities which refer to the international and national rules and regulations that Singapore DG industry is adopting. The other category is supportive activities which are initiatives developed by DG agencies in Singapore to support primary activities, such as web portals for DG declaration and vehicle tracking devices.

2.4.1 Primary Activities

International and national rules, regulations and standards from literature reviews are summarised and discussed in the following sections.

2.4.1.1 International rules and regulations

International rules and regulations play a reference role in setting the national rules and regulations in Singapore. Table 2.6 shows a list of international regulations, standards, organisations, and area of application associated with carriage of DG.

Table 2.6 International Regulations, Standards, Organisations and Area of Application

Area of Application	Organisation	Regulations and Standards
Global	<ul style="list-style-type: none"> • International Air Transport Association (IATA) • International Maritime Organisation (IMO) • International Cargo Gear Bureau (ICGB) • Institute of International Container Lessors (IICL) • International Organisation of Standardisation (ISO) • International Union of Railways • International (European) Railway approval and country registration 	<ul style="list-style-type: none"> • IATA Dangerous Goods Regulations (DGR) • International Maritime Dangerous Goods (IMDG) Code • The International Convention for the Prevention of Pollution from Ships (MARPOL) • European Agreement on International Transport of Dangerous Goods by Road (ADR) • European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) • United Nations Model Regulations on the Transport of Dangerous Goods (UNTDG) • International Safety Convention for Safe Containers (CSC) • Rules on International Transport of Dangerous Goods by Rail (RID)
US	<ul style="list-style-type: none"> • US Department of Transport (DOT) • Association of American Railroads (AAR) • American Society of Mechanical Engineers (ASME) • American Society for Testing Materials (ASTM) • US Federal Railroad Administration (FRA) 	<ul style="list-style-type: none"> • US DOT specification for regulated liquids and gases (DOT 51) • 49 Code of Federal Regulations (CFR)
Britain	<ul style="list-style-type: none"> • British Standards Institution (BSI) 	<ul style="list-style-type: none"> • British Standards (BS)
France	<ul style="list-style-type: none"> • Syndicat National de la Chaudronnerie, de la Tôlerie 	<ul style="list-style-type: none"> • French Code for Construction of Unfired Pressure Vessels (CODAP)
Germany	<ul style="list-style-type: none"> • Bundesanstalt für Materialforschung und -prüfung (BAM) 	<ul style="list-style-type: none"> • BAM Dangerous Goods Procedural Rules (BAM-GGR)
Canada	<ul style="list-style-type: none"> • Transport Canada (TC) 	<ul style="list-style-type: none"> • Transportation of Dangerous Goods Regulations • Transportation of Dangerous Goods Act

Source: (SCIC, 2006a), (SNCT, 2007), (BAM, 2008), (TC, 2010)

It is appeared that DG is heavily regulated, especially in European countries, in order to prevent any disastrous incidents which can cause life and properties loss. Mr. Jacobsen from Leschaco Pte Ltd, who is from Germany, explained that Europe is a much connected community where countries are linked by railways, roads and waterways, and a well-regulated DG system can ensure safe transportation and handling of DG (Jacobsen, 2010).

Among the regulations listed in Table 2.6, the most commonly-complied international rules are the six listed in Table 2.7.

Table 2.7 Six Commonly-Complied International Rules

International Rules and Regulations	Area of Application
i. United Nations Model Regulations on the Transport of Dangerous Goods (UNTDG)	Road/Rail/Air/Sea/Inland Waterways
ii. European Agreement on International Transport of Dangerous Goods by Road (ADR)	Road
iii. Rules on International Transport of Dangerous Goods by Rail (RID)	Rail
iv. International Air Transport Association (IATA) Dangerous Goods Regulations (DGR)	Air
v. International Maritime Dangerous Goods (IMDG) Code	Sea
vi. European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN)	Inland Waterways

i. United Nations Model Regulations on the Transport of Dangerous Goods (UNTDG)

UNTDG, also referred to as “Orange Book”, was prepared by the Sub-Committee of Experts on the Transport of Dangerous Goods of the United Nations Economic and Social Council (ECOSOC). The first version was formulated in 1956 (Wikipedia, 2009e). The “Orange Book” can be viewed as a set of model regulations that apply throughout most of the world to road, rail, sea, air, and inland waterway transport. One of the key points in the book established by ECOSOC is the Dangerous Goods List (DGL) (Lowe, 2005).

The UN Recommendations on the Transport of Dangerous Goods address the following main areas:

- List of dangerous goods most commonly carried and their identification and classification;
- Consignment procedures: labelling, marking, and transport documents;
- Standards for packagings, test procedures, and certification;
- Standards for multimodal tank-containers, test procedures and certification.

These recommendations contain all basic provisions for the safe carriage of DG which are also subject to additional requirements at national level of different countries (ECOSOC, 2007).

ii. European Agreement on International Transport of Dangerous Goods by Road (ADR)

ADR which stands for *Accord européen relatif au transport international des marchandises dangereuses par route* (a French Publication) governs transnational transport of DG and was first launched in 1957 by United Nations' Economic Commission for Europe. ADR 2009 is the restructured version of the former ADR after a set of new amendments were introduced (Wikipedia, 2009b).

iii. Rules on International Transport of Dangerous Goods by Rail (RID)

RID, which is under Convention concerning International Carriage by Rail (COTIF), was developed by Intergovernmental Organisation for International Carriage by Rail (OTIF) (OTIF, 2009).

iv. International Air Transport Association (IATA) Dangerous Goods Regulations (DGR)

IATA DGR is the only user manual for transporting dangerous goods by air and is used by more than 200 airlines internationally. DGR, which is updated annually, covers a comprehensive DG list, labelling requirements, packing requirements, training guidelines and up-to-date information on shipping forms (ASC, 2008).

v. International Maritime Dangerous Goods (IMDG) Code

IMDG Code was developed by International Maritime Organisation (IMO) since 1960s for the transport of DG by sea covering matters such as packing, container traffic and stowage. IMDG Code is a uniform international code which is contained in Safety of Life at Sea (SOLAS) (IMO 2006).

vi. European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN)

ADN was established in 2000 and came into force in 2008. The aims of ADN are (UNECE, 2009b):

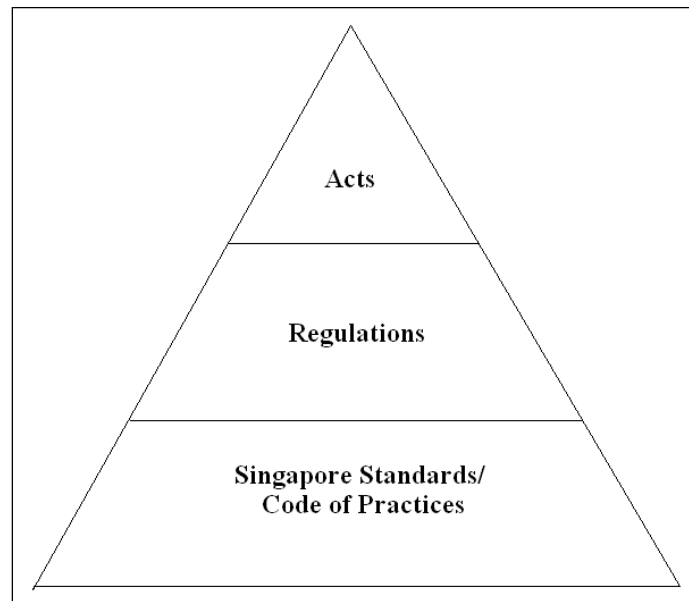
- Ensuring a high level of safety of international carriage of dangerous goods by inland waterways;
- Contributing effectively to the protection of the environment, by preventing any pollution resulting from accidents or incidents during such carriage;
- Facilitating transport operations and promoting international trade in dangerous goods.

2.4.1.2 National rules and regulations

In Singapore, the regulatory framework for DG handling is set up through Acts, Regulations, Singapore Standards and Codes of Practices by respective government agencies. Generally, Acts stipulate the main legal requirements; Regulations provide detailed requirements with

regards to environmental protection and safety of workers; and Singapore Standards and Code of Practices give guidance on implementation of Acts and Regulations (SCIC, 2006b). The regulatory framework is shown in Figure 2.3.

The national Acts, Regulations and Standards formulated by relevant parties are summarised in Table 2.8.



Source: (SCIC, 2006b)

Figure 2.3 DG Regulatory Framework in Singapore

2.4.2 Supportive Activities

Supportive Activities are referring to the initiatives launched by DG agencies for supporting primary activities. This study has an objective of identifying technology initiatives as the fundamental supportive activities. Technologies that are currently adopted by DG agencies in Singapore can be classified into the following 2 categories which are technologies for DG declaration and technologies for vehicle tracking.

2.4.2.1 Technologies for DG declaration

With the development of Information Technology (IT), online channels for submission of goods manifest become very common. In Singapore, a number of agencies have come out with their own IT for DG transporters to declare the cargo information such as type of DG and weight. Table 2.9 shows 4 web portals that have been used for online declaration of DG in Singapore.

2.4.2.2 Technologies for vehicle tracking

Vehicle tracking is considered an important element in DG management in terms of security issues and emergency handling plans. Threats of terrorism have brought more concerns on the

security issues in transportation, while vehicle tracking system strengthens the ability to tackle chemical and biological threats. With vehicle tracking, after-accident actions can be applied immediately to the scene of accidents for fire fighting, rescue or ambulance services.

Table 2.8 Singapore National Acts, Regulations and Standards

	Regulations	Agency
Acts	• Workplace Safety and Health Act	MOM
	• Environmental Pollution Control Act	NEA/Ministry of Environment and Water Resources (MEWR)
	• Environmental Public Health Act	
	• Hazardous Waste (Control of Import, Export and Transit) Act	
	• Fire Safety Act	SCDF
	• Poisons Act	Health Science Authority (HAS)/MOH
	• Radiation Protection Act	
	• Arms and Explosives Act	Singapore Police Force (SPF)
	• Explosives Substances Act	Ministry of Home Affairs (MHA)
Regulations	• Strategic Goods (Control) Act	Singapore Customs (SC)
	• Chemical Weapons (Prohibition) Act	
	• Road Traffic Act	Land Transport Authority (LTA)
	• WSH (General Provision) Regulations 2006	MOM
	• WSH (Registration of Factories) Regulations 2006	
	• WSH (First Aid) Regulations 2006	
	• WSH (Incident Reporting) Regulations 2006	
	• WSH (Risk Management) Regulations 2006	
	• Environmental Pollution (Hazardous Substances) Control Regulations	NEA
	• Environmental Public Health (Toxic Industrial Waste) Regulations	
	• Fire Safety (Petroleum Flammable Materials) Regulations 2005	SCDF
	• Radiation Protection (Ionising Radiation) Regulations 2001	Health Science Authority (HAS)/Ministry of Health (MOH)
	• Radiation Protection (Transport of Radioactive Materials) Regulations 2001	
	• Prevention of Pollution of the Sea (Reporting of Pollution Incidents) Regulations	MPA
	• Strategic Goods (Control) Regulations 2004	SC

Source: (SCIC, 2006a), (SCIC, 2006b)

Table 2.9 Singapore National Acts, Regulations and Standards (Continued)

Singapore Standards/ Code of Practices	<ul style="list-style-type: none"> • SS CP 32: 1985: Code of Practice for the Transportation and Storage of Pesticides • SS CP 61: 1994 Packaging And Containers For Hazardous Substances • SS CP 78: 1999 Code of Practice for the Distribution of Hazardous Chemicals • SS CP 92: 2002 Code of Practice for Manual Handling • SS CP 98: 2003 Preparation and Use of Material Safety Data Sheets (MSDS) • SS 506: 2006 Occupational Safety and Health (OSH) Management System • SS 532: 2007 Singapore Standard Code of Practice for the Storage of Flammable Liquids SS 586: 2008 Hazard Communication for Hazardous Chemicals and Dangerous Goods 	SPRING Singapore
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Source: (SCIC, 2006a), (SCIC, 2006b)

Table 2.9 Web Portals for DG Declaration

Web Portal	Agency
Marinet	Maritime and Port Authority of Singapore (MPA)
Tradenet	Singapore Civil Defence Force (SCDF)
Portnet	PSA
JP-Online	Jurong Port

i. Vessel Traffic Information System (VTIS)

VTIS was established by MPA for vessel tracking within the Singapore Strait and Singapore port waters. As these water areas are considered as one of the busiest in the world, VTIS is critical for the safe and efficient navigation of ships (MPA, 2009d).

ii. Harbour Craft Transponder System (HARTS)

HARTS is a technology developed by MPA which enables the automatic identification of all powered harbour and pleasure craft plying in Singapore waters and allows the security agencies to focus on any craft without an identification tag (MPA, 2009b).

iii. HazMat Transportation Vehicle Tracking System (HTVTS)

HTVTS was launched by SCDF which requires vehicles' compliance to the regulated DG transportation routes and times. It also allows enforcement officers to conduct regular field checks efficiently (ADRC, 2008).

HTVTS comprises two phases (Mapinfo, 2005):

- a. Phase one involves the tracking of all local and foreign vehicles carrying bulk petroleum and toxic material.
- b. Phase two involves the installation of an immobiliser which can remotely stop vehicles from entering exclusion zones.

SCDF implemented Phase 1 HTVTS with effect from 1 July 2005. Vehicles, both locally registered and foreign registered vehicles entering into Singapore, are installed with tracking devices (SCDF, 2005b).

2.4.2.3 Other Supportive Activities

The connection between the governmental agencies and the industry is usually through third party such as SCIC. SCIC gets feedbacks from the industry from time to time via conferences or surveys. SCIC also helps the governmental bodies to effectively implement the national rules and regulations among the industrial companies.

Responsible care is an initiative originated from Canada and was introduced to Singapore by SCIC in 1990. Various programmes such as training workshops, best practices sharing seminars are conducted annually to advocate Responsible Care in the industry. Now, Responsible Care becomes a global recognised project adopted and practised in 53 countries around the world. The list of countries is listed in Appendix H (SCIC, 2009a).

2.4.3 DG Stakeholders in Singapore

In Singapore, there are several agencies that are involved in regulating DG transport and logistics. Each agency taps on different aspects of DG transportation but overlapping may still occur. Mr. Foong from DHL proposed a one agency system similar to US's National Transportation Safety Board (NTSB) so that suppliers and customers need only consult one single body for DG matters that cut across all transportation modes and warehousing (Foong, 2009). Mr. Ryan Lim from Schenker Singapore Pte Ltd and Mr. Mohamed Salleh from LTH Logistics (S) Pte Ltd also aspire to have an integrated DG regulatory body in Singapore for time saving and consultancy convenience.

Similar concept was also brought up during the interview with Dr. Roland Lim Yan Guan, the research scientist from planning and operations management at Singapore Institute of Manufacturing Technology (SIMTech). The idea is called single-point clearance and declaration which means when ships come to the port, there is only one system for the master or the ship agent to contact for operation purposes such as cargo declaration, documents submission, piloting schedule and berthing schedule, etc (Lim, 2009).

However, this may not be realised in the near future as the integration of agencies is a complex and time-consuming process. Mr. Heng from SCDF found the integration to be difficult to implement at least within the near term (Heng, 2009). Mr. Martinn Ho, former DG engineer from NEA said that the integration issues has been in discussion for a few years, however, there are constraints of different agencies being specialised in different areas of DG, for example, NEA is specialised in environmental protection and prevention of pollution aspects, while SCDF is specialised in emergency response activities and fire safety aspects, thus, it would be more efficient for different agencies to be in charge of the different areas of DG (Ho, 2010). This issue is further discussed in the Chapter 3.

Agencies involved in regulating DG transport and logistics and their regulatory areas are listed in Table 2.10.

Table 2.10 Singapore DG Agencies and Their Regulatory Areas

Agencies	Regulatory Area
i. Maritime Port Authority of Singapore (MPA)	Movement of DG to Singapore via Singapore waters
ii. Port of Singapore Authority (PSA)	Movement of DG through port terminals
iii. National Environmental Agency (NEA)	Import, storage and transportation of scheduled hazardous substances in Singapore
iv. Singapore Civil Defence Force (SCDF)	Import, storage and transportation of petroleum and flammable material in Singapore
v. Health Science Authority (HSA)	Transportation of radioactive material
vi. Singapore Police Force (SPF)	Transportation and storage of explosives & pyrotechnics within Singapore arms & explosive branch
vii. Ministry of Manpower (MOM)	Workplace safety and health
viii. Singapore Customs (SC)	Handling of chemicals with chemical weapons content
ix. Land Transport Authority (LTA)	Loadability and road limit
x. SPRING Singapore	Local Standards

Source: (SCIC, 2006a) and others

i. Maritime and Port Authority of Singapore (MPA)

MPA is mainly involved in regulating ocean-freight DG transport and logistics. Mr. Razali, port chemist from MPA explained that before adopting international DG Class 1-9 as regulated in the IMDG Code, MPA was using MPA Class 1, 2 and 3 to classify DG. After ratifying IMDG Code, MPA Class 1, 2 and 3 transformed to PSA Group 1, 2 and 3 for the ease of handling of DG at port terminals. Moreover, importers and exporters of DG through port of Singapore need

to declare the DG manifest to MPA 12 hours prior to the arrival or departure of ships (Razali, 2010). MPA requires original certificates for DG clearance to be onboard Singapore ships. Appendix I contains a list of DG documents which are exacted from the *Certificates, Documents and Publications Required to Be Carried on Board Different Types of Singapore Ships 2009* (MPA, 2009a).

ii. PSA

PSA identifies and classifies chemicals into 3 DG Groups based on IMO class, namely (SCIC, 2006a):

- PSA Group 1 (storable and non-storable)
- PSA Group 2 (storable and non-storable)
- PSA Group 3 (storable)

Based on the above, PSA regulates the movements of DG arrivals at terminals, and consignees of the cargo shall need to act according to the following (SCIC, 2006a):

- Group 1S-Group I DG recommended for storage and unstuffing at Godown
- Group 1D-Group II Direct loading and unloading
- Group 2S-Group II DG recommended for storage and unstuffing at Godown
- Group 2A-Group II DG recommended for storage at DG Yard only
- Group 2B-Group II DG recommended for storage at DG Yard only
- Group 2C-Group II DG recommended for storage at DG Yard only
- Group 2F-Group II DG recommended for storage at DG Yard only

Mr. Hu Wing Ko explained that after shipping lines' declaration of DG via PORTNET^a DG Declaration (PM4) in Portnet is approved by MPA, PSA shall classify the cargo into respective PSA Groups for the purpose of safe management at terminals (Hu, 2010).

Mr. Jacobsen from Leschaco Pte Ltd raised an issue that, under SCDF regulations, DGs are not allowed to be transported in the city area after office hours; on the other hand, PSA is working on 24/7 basis and requires DG to be transported out of port area even when the cargo arrives after office hour, and this would create a dilemma for the consignees. In this case, consignees need to inform SCDF in advance about the issue and obtain a special approval for the occasion (Jacobsen, 2010). Thus, the coordination and harmonisation between the agencies may need to be improved, although DG contributes only small percentage of the total cargo handled by ports in Singapore.

PSA's Chemcare project was introduced in 1999 (Pillai, 2005) which provides value-added services and facilitates the movement of dangerous goods through PSA terminals. PSA also offers consulting service to the customers regarding local regulations on dangerous goods.

Chemcare consists of the following services (PSA, 2009):

- Fumigation
- DG Reworking
- DG Labelling
- Pre-shipment Inspection
- Storage and Monitoring of special DG
- DG Training

iii. National Environmental Agency (NEA)

NEA's Pollution Control Department (PCD) is responsible for air and water pollution control, and hazardous substances and toxic industrial wastes control. Moreover, PCD controls the import, use, storage and transportation of hazardous substances, and ensures the safe handling, treatment and disposal of toxic industrial wastes (NEA, 2002).

iv. Singapore Civil Defence Force (SCDF)

According to Mr. Kwok Shun Yung (Kwok, 2009), the hazmat captain from SCDF, SCDF's Hazmat Department was originally Chemical & Toxic Material Section which was first established in 1989, and subsequently became the Hazmat Department in 2007.

Under SCDF's act and regulation, the following products are licensable (SCIC, 2006a):

- Petroleum
- Class 0-Liquified petroleum gas
- Class I-Liquid petroleum with a flash point below 23 degree C
- Class II-Liquid petroleum with a flash point between 23 degree C and 61 degree C
- Flammable materials
- Class III petroleum having a flash point of at least 61 degree C but not more than 93 degree C

Moreover, SCDF issues Hazardous Material Transport Driver Permit (HTDP) to drivers who transport licensable products. Vehicles transporting DG also need to be fixed with tracking system and monitored by SCDF depending on specific quantity (SCIC, 2006a).

The inspection checklists for i) Bulk transportation (prime mover, trailer and road tankers), ii) Package transportation (prime mover and trailer), iii) Package transportation (Vehicles constructed to carry goods) and iv) Package transportation (Vehicles), as well as the approved inspection bodies are included in Appendix J-N, which are provided courtesy of Ms. Alice Seto from SCDF (Seto, 2009).

v. Ministry of Manpower (MOM)

MOM focuses on the safety and health of personnel with regards to DG transport and logistics. Hence, MOM emphasises on an excellent framework for ensuring a safe environment and preventing DG hazards. MOM established a Compliance Assistance Checklist for flammable hazardous substances. The checklist is shown in Appendix O.

MOM also sets up the Guideline on Prevention and Control of Chemical Hazards which states the rules for control measures, personal protection, emergency planning and first aid procedures as well as education and training, etc. (MOM, 2002).

vi. Health Science Authority (HSA)

The Centre for Radiation Protection (CRP) under HSA is the controlling authority for use of ionising and non-ionising radiation in Singapore. CRP issues license to qualified personnel who handle radioactive material. Agents importing radioactive materials for sale or re-exporting also need to provide detailed accounting information to CRP each month (SCIC, 2006a).

vii. Singapore Police Force (SPF)

SPF is mainly in charge of the explosives, i.e. DG Class 1. Arms and Explosives Act formulated by SPF regulates the manufacture, use, transport, import, export and possession of arms, explosives and explosive prototypes in Singapore under Chapter 13 of the Act (Enterprise One, 2009).

viii. Singapore Customs (SC)

National Authority, Chemical Weapons Convention (NA CWC), set up under Singapore Customs, controls transfer of strategic goods. A valid permit is required by Singapore Customs for (SCIC, 2006a):

- Export goods specified in Part II of the Schedule of the Chemical Weapons Prohibition Act
- Export document in which any technology specified in Part II of the Schedule
- Tranship goods specified in Part II of the Schedule

ix. Land Transport Authority (LTA)

LTA regulates the road users' behaviour on a whole, and the mission is to maintain law and order and to ensure the laden weight of the vehicles is within the licensed limit.

x. SPRING Singapore

SPRING is the national standards and accreditation body which develops and promotes internationally-recognised standards such as GHS in order to enhance competitiveness and to facilitate trade in Singapore. SS 586 is one of most recent standards that SPRING drew up to promote GHS in the industry.

xi. Singapore Chemical Industrial Council

SCIC, although not considered a regulation-formulating agency, also plays an importance role in incorporating the various regulatory agencies and industrial companies together to improve the DG system in Singapore. Some of SCIC's publications include *Guidebook on Transport & Handling of Dangerous Goods*, *Guidebook on Warehousing & Storage of Hazardous Materials & Dangerous Goods*, *Guidebook on the Globally Harmonised System of Classification and Labelling of Chemicals*.

xii. Jurong Port

Jurong Port is an important party involved in ports of Singapore activities. Jurong Port also actively supports the regulatory bodies to smoothen the procedures for vessels coming into Singapore ports. JP-Online is a web portal for declaration of goods which was developed by Jurong Port. The portal has been updated so that shipping companies can enjoy expanded facilities on JP-Online with a three-way DG information exchange among MPA, PSA and Jurong Port. This streamlines the DG approval process and enhances the Inter-Terminal Haulage transfers of DG containers between PSA and Jurong Port. Thus, customers can shortcut the applications of DG directly via JP-Online without having to go through Marinet in advance, as is the practice earlier on (Jurong Port, 2009).

The main regulatory bodies regulating DG are Singapore Civil Defence Force, National Environmental Agency and Singapore Police Force. Their responsibilities (by DG classes) according to Mr. Heng from SCDF are shown in Table 2.11.

Table 2.11 DG Classes Responsibility by Various Agencies

NEA	SCDF	SPF	No specific agency
Class 2.3 Class 6 Class 7 Class 8	Class 2.1 Class 3 Class 4	Class 1 Class 5	Class 2.2 Class 9

The roles and functions of the national primary activities and supportive activities can be grouped into the following categories.

2.4.3.1 General rules and regulations

General rule and regulations cover DG transport and handling on a general basis. The following are a few examples.

- i. The Maritime and Port Authority of Singapore (Dangerous Goods, Petroleum and Explosives) Regulations 2005

With this regulation, the Maritime and Port Authority of Singapore (MPA) change the previous MPA DG grouping system class I, II and III and to the IMO 1-9 classes and UN numbers. The Maritime and Port Authority of Singapore (Dangerous Goods, Petroleum and Explosives) Regulations 2005 were gazetted on 11 January 2005 and came into effect on 31 January 2005 (MPA, 2005).

- ii. Maritime and Port Authority of Singapore (Dangerous Goods, Petroleum and Explosives) (Amendment) Regulations, 2007

Maritime and Port Authority of Singapore (Dangerous Goods, Petroleum and Explosives) (Amendment) Regulations 2007 introduced several amendments to the 2005 version and the latest version came into force on 1 Jan 2008. The amended legislation incorporates the latest amendments to the IMDG Code 2006 Edition, which also has become mandatory by 1 Jan 08 (MPA, 2007).

- iii. SS 532: 2007 Singapore Standard Code of Practice for the Storage of Flammable Liquids
SS 532 was launched by Standards Productivity and Innovation Board (SPRING) Singapore which provides companies and owners of flammable storage facilities a more comprehensive set of guidelines for the safe storage of flammable liquids. SS 532 replaces SS Code of Practice (CP) 40: 1987 Storage of Flammable and Combustible Liquids. SS532 is adopted by the Singapore Civil Defense Force (SCDF) for full compliance by companies for the design of the storage area for flammable liquids (SPRING, 2007).

2.4.3.2 Declaration of DG

Declaration of DG involves importers, exporters, carriers etc. to declaring the cargo to DG agencies via web portals.

MPA has set up Procedures for DG Declaration for the ship owner, agent or master of vessels carrying dangerous goods to declare DG via Portnet, JP-Online or Marinet which are 3 online

web portals for cargo declaration. The Procedures for DG Declaration also include some special requirements for certain types of DG and certain weight of DG (MPA, 2009c).

PM4 Declaration was set up by Jurong Port which stipulates that Dangerous Goods (DGs) exported, imported, and transshipped through Jurong Port are subject to prior approval by the port or relevant competent authorities (Jurong Port, 2008b). This rule can also be found in General Rules and Regulations for Jurong Port Section 7 (Jurong Port, 2008a).

2.4.3.3 Classification and labelling of DG

Classification and labelling of DG in Singapore incorporates the international rules into the national standards. The international classification standard adopted by many countries in the world is UN Globally Harmonised System of Classification and Labelling of Chemicals (GHS) which is referred to as the “Purple Book”. It addresses classification of chemicals and proposes harmonised hazard communication through labels and safety data sheets (SDS). GHS also provides a basis for harmonisation of rules and regulations on chemicals at national, regional and worldwide level (UNECE, 2009a).

The implementation status of GHS is summarised by GHS sub-committee under UN. A total of 67 countries in the world including Singapore have adopted or amended their national regulations to reflect the provisions of the GHS (UNECE, 2009c). The list of 67 countries is shown in Appendix P.

The following are examples of national regulations stipulating the classification and labelling of DG.

i. Singapore Standard (SS) 586: 2008 Hazard Communication for Hazardous Chemicals and Dangerous Goods

SS 586 was established by SPRING Singapore to guide Singapore industry to implement GHS and to minimise the risks posed to human health and the environment when hazardous chemicals are being handled, transported or stored. SS 586 results from the revision of two earlier standards SS 286: 1984 on ‘Caution Labelling for Hazardous Substances’ and CP 98: 2003 on ‘Preparation and Use of Material Safety Data Sheets’ (MSDS) (SPRING, 2008). SS 586 comprises 3 parts and the detailed information is shown in Appendix Q.

ii. Poisons (Hazardous Substances) Rules 1986

The Poisons (Hazardous Substances) Rules 1986 stipulate that containers holding hazardous chemicals must be labelled according to approved Code of Labelling, such as the Singapore Standard (SS) 286 (Koh, 2000).

2.4.3.4 Licensing control

Licensing control of hazardous chemicals prevents unauthorised and unprofessional personnel from handling DG and ensures proper procedures are followed at all times in the handling process to prevent accidents and mitigate any adverse effects (Koh, 2000).

Poisons Act and Poisons (Hazardous Substances) Rules 1986 are legislation which controls the import, export, sale, storage, transportation and use of hazardous chemicals. These legislations state that Poisons Licence is required for wholesalers, distributors and users of hazardous chemicals.

2.4.3.5 Workplace safety and health

Employees who are working at companies that are involved in DG transportation and logistics are considered as critical roles for making sure the smooth physical flow of DG. Hence, it is important to protect the health and safety of the employees from potential incidents that could take place.

SCIC launched Responsibility Care Activities to promote 6 codes of management practices in the industry, one of which is Employee Health and Safety (EHS) Code of Management Practices. The main objective of the Code is to protect and promote the health and safety of people working at or visiting the workplace. It helps to identify and access hazards, prevent unsafe actions and conditions, and foster communication on health and safety issues in order to maintain and improve employee's health (SCIC, 2009b).

Another legislation developed by Ministry of Manpower (MOM) is the Workplace Safety and Health Act (WSHA) which came into effect in 2006. The WSHA Act cultivates good safety habits of individuals and advocates a strong safety culture in the workplaces (MOM, 2006b).

2.4.3.6 Emergency management

SCDF enacted the Fire Safety (Petroleum and Fire Safety) Regulations in 2005 which states that the storage of petroleum or flammable material more than 5,000 litres or 5,000 kg requires the establishment and maintenance of an in-house Company Emergency Response Team (CERT). The CERT must be competent in handling incidents in the event of fire, explosion, leakage or any other similar emergencies (SCDF, 2005a).

2.5 Conclusion

From the literature reviews, several conclusions are made with regards to DG regulating system in Singapore.

2.5.1 General System

With a number of international DG rules and regulations adopted, Singapore has gradually been improving the DG system and is catching up with European countries. Mr. Jacobsen agreed that Singapore has made great progress for the past decade especially under the aspect of warehousing for DG (Jacobsen, 2010).

In general, Singapore has established a relatively sound DG regulating system based on the various regulations and supportive activities promoted by several DG agencies. These regulations cover different aspects of DG transport and logistics which safeguard the DG transport chain within Singapore in air, land and ocean freight. As Mr. Foong from DHL has mentioned, Singapore enjoys a good reputation, good ratings internationally for quality, technology and extremely low corruption as well as good transportation infrastructure (Foong, 2009). These are important considerations in the management of DG because it gives confidence to customers that DGs are managed in an efficient and effective manner with full compliance to international DG regulations.

2.5.2 DG Incidents in Singapore

Internationally, DG accidents are most frequently taking place in developed countries, especially on high ways. The MAHB in Europe was established for DG accidents reporting and analysis on the collective DG incidents information. In Singapore, according to the interviewees, the accident rate is low compared with other developed countries. This may due to two reasons, one of which is that Singapore's limited landscape contributes to the relatively lower rate, but more importantly is that prevention measures have been well implemented and the regulation framework is well established so that possibility of accident occurrence is minimised. However, without an established accidents reporting system, the exact accidents data cannot be collected and analysed. Mr. Tang from DGM Pte Ltd said that the scale of DG incidents in Singapore was usually small (Tang, 2009) and Mr. Heng said the major cause of incidents was human negligence (Heng, 2009).

Furthermore, the emergency response programme is considered as critical for dealing with DG incidents. In Singapore, according to Mr. Kwok, there are 4 Hazmat stations located at Alexandra, Jurong Island, Tuas and Tampines (Kwok, 2009). The Hazmat stations together with fire fighting stations and CERT can form a strong emergency response team.

2.5.3 Primary Activities and Supporting Activities

Primary activities refer to the international and national regulations adopted and supporting activities refer to the other initiatives which strengthen the implementation of various

regulations. The supporting activities discussed in Chapter 2 mainly refer to the technologies used such vehicles tracking devices, other supportive initiatives are conferences and responsible care held and promoted by SCIC. The characteristics of these activities can be categorised as following.

- General rules and regulations
- Classification and labelling of DG
- Declaration of DG
- Emergency Management
- Licensing Control
- Health and safety of personnel

These categories of initiatives were surveyed by compliance status and usefulness, and the results are organised in Chapter 3.

2.5.4 DG Agencies in Singapore

Another important issue is that there are several DG agencies involved in DG agencies which may cause inconvenience for the DG handling parties such as manufacturers, carriers and storage providers. Although the agencies have make their roles and responsibilities relatively clear, as there are complexities in DG properties and different standards that each agency perceive, it may still lead to some grey area in the regulating system.

The perspectives of the industry towards this issue are further discussed in Chapter 3 by analysis of survey results. The scope of a compromise between the agencies and industry is explored in order to achieve an efficient DG system in Singapore.

CHAPTER 3 SURVEY AND INTERVIEW RESULTS AND ANALYSIS

Information of companies handling DG in Singapore was collected from Singapore Logistics Association (SLA) and other various channels. 120 survey questionnaires were mailed out to the companies, out of which only 14 filled questionnaires were received. Among the 14 filled questionnaires, 2 are considered not relevant as the respondent indicated “Not Applicable” for question 3 (indicating of DG class handled) in the questionnaire. The responding companies can be found in Appendix R.

Moreover, companies and DG agencies were also contacted through email requesting for interviews to discuss further on the DG issues covered by the study. In total, 12 personal communications were conducted, 5 are with DG agencies, 6 are industrial companies and 1 with a research institute. The summary of personal communications can be found in Appendix S.

3.1 Challenges of Primary Research

Primary research adopts the method of survey and interviews. Over 100 companies involving DG handling were contacted by emails or postal mails. On-line survey link was given in the email, and hardcopy of survey questionnaire with postage paid envelop were sent by postal mails. A total of 14 replies were received including 12 copies of hardcopy replies and 2 online replies. The response rate is only 11.7%.

The major difficulty is that the response rate is very low, thus, the survey results may not be representative of the overall opinions of the whole industry. Although there are about a hundred companies listed in SLA website associate with HazMat transportation, the companies may not be specialised in handling HazMat and thus may not be willing to reply. However, with the survey data, and coupled with several interviews with the industry companies and agencies, a stratified analysis is conducted in the following sections.

One challenge during the research is that it is difficult to find out the right person in charge to receive the questionnaire. SLA’s membership contact person is the representative from the company who may not be a DG expert; SCIC’s member list only gives the company name and website link, and companies’ websites seldom list departmental contact person’s information. NEA and SCIC were contacted for more information of the companies’ contacts but it was found out that such information cannot be released to third party. Some contacts were found from the electronic brochures of conferences regarding DG matters, whereby invited speakers from regulatory bodies and the industries were often listed. Some contacts were obtained by calling up the companies and requesting for contacts of the person in charge of DG.

Another challenge is that a couple of the questionnaires were not fully filled, especially for the double column questions. The respondents may not have understood the question's requirement and filled in only one column for each item. Moreover, some respondents tended to give moderate rating for all the items listed in one question. These would cause inaccuracy in the survey results.

The challenges for the interviews are that the interviewees may miss out some information on the spot during the interviews, and face to face interview opportunities with the agencies are generally difficult to obtain. Interviews with NEA, SCIC and PSA were conducted over telephone.

3.2 Company Profile

Various characteristics were provided by companies as according to the information collected from part 1 of the survey questionnaire.

The main activities of the respondent companies are shown in Figure 3.1. As for this question, companies are able to choose more than one choice, thus in order to further differentiate the companies, Figure 3.2 shows the number of companies involved in different types of activities. It is seen that half of the respondent companies are involved in only one of the logistics activities.

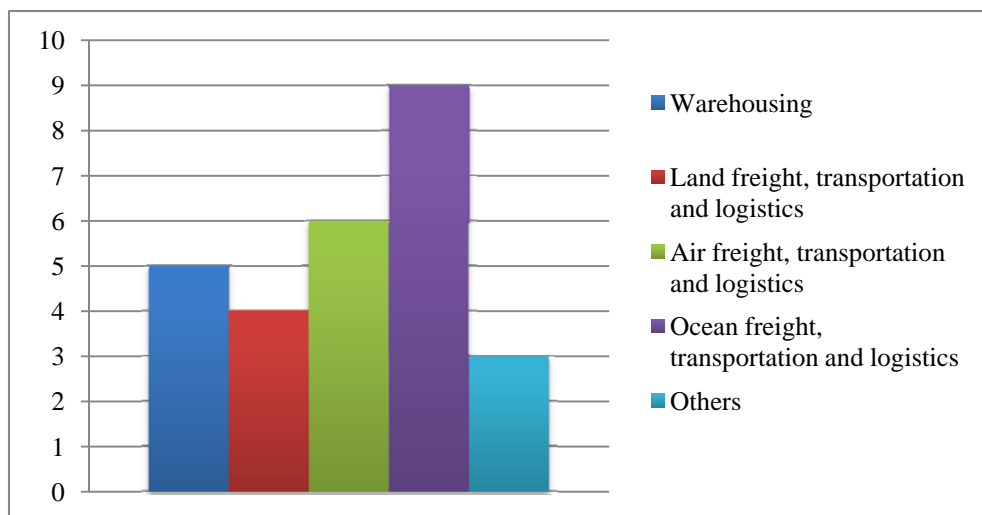


Figure 3.1 Main Activities of Companies

Classes of DG that the companies are handling are shown in Figure 3.3. The number of companies handling different number of classes of DG is shown in Figure 3.4. From Figure 3.3, class 3 and class 9, which are flammable liquids and miscellaneous substances and articles

respectively, are the most common classes handled by the companies. Moreover, Figure 3.4 also indicates that almost half of the respondent companies are handling all classes of DG cargoes.

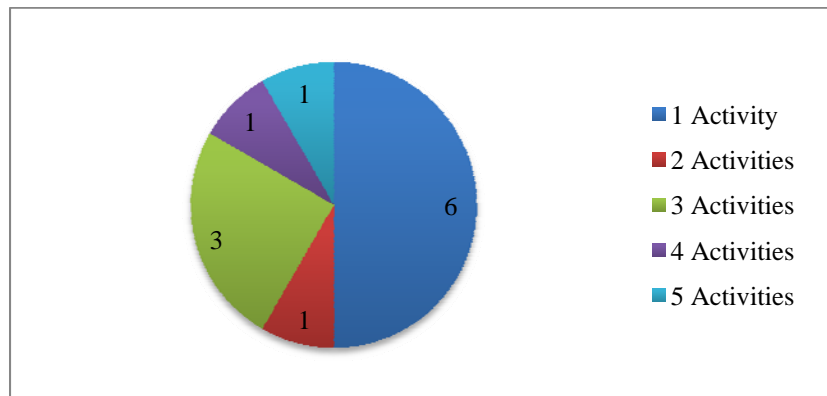


Figure 3.2 Number of Companies Involving in Different Numbers of Activities

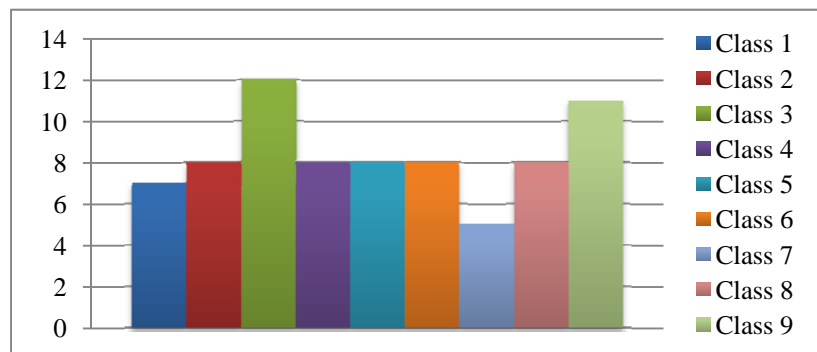


Figure 3.3 Classes of DG the Companies are Handling

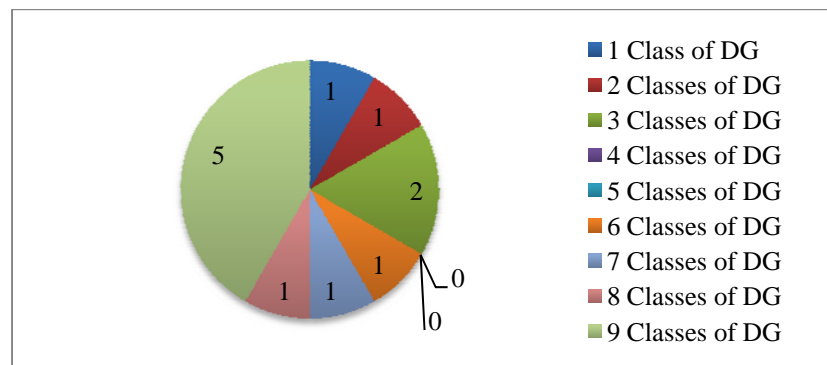


Figure 3.4 Number of Companies Handling Different Number of DG Classes

The types of the respondent companies are shown in Figure 3.5, of which half of the companies are local branches of multinational companies. From the information gathered during interviews with the industrial companies, the local branches are usually originated from Europe, for example, Schenker Pte Ltd and Leschaco Pte Ltd are from Germany, Germaxco Chemical Pte Ltd and Dangerous Goods Management Pte Ltd are from Netherlands.

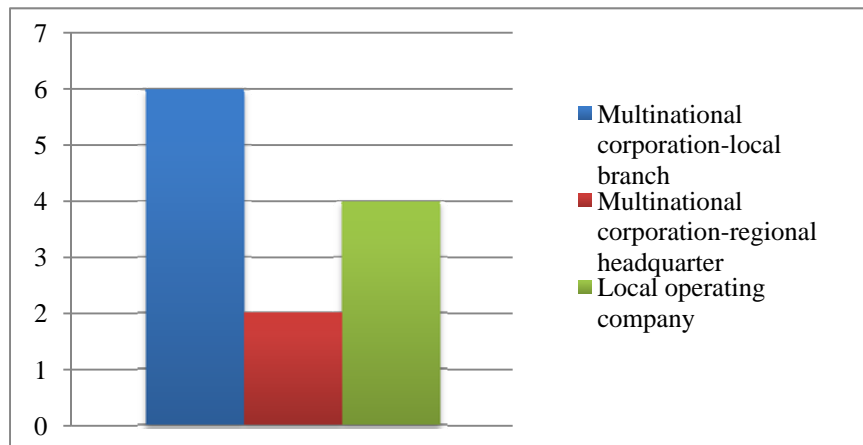


Figure 3.5 Types of Companies

Figure 3.6 shows the number of employees based in Singapore of the respondent companies. Most of the companies have less than 50 employees based in Singapore.

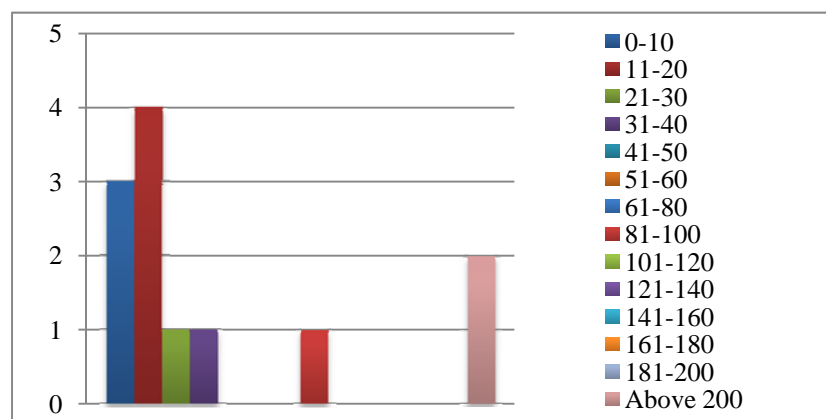


Figure 3.6 Number of Employees Based in Singapore

3.3 Survey Result

Part 2 of the questionnaire consists of 3 questions. The results for question 6 are shown in Figures 3.7-3.10.

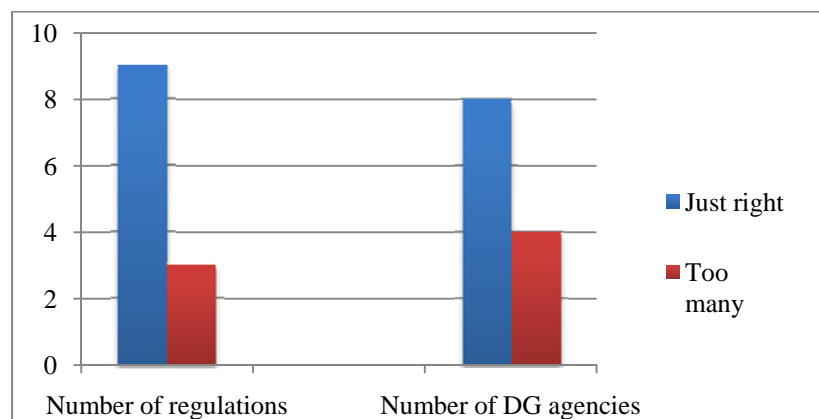


Figure 3.7 Number of Regulations and DG Agencies in Singapore

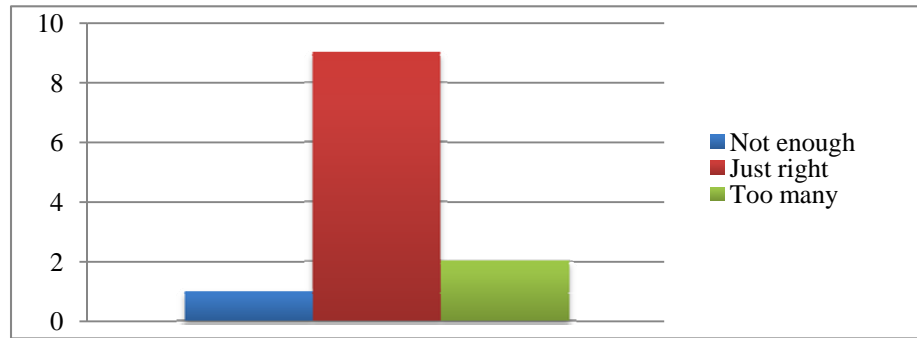


Figure 3.8 Number of Web Portals

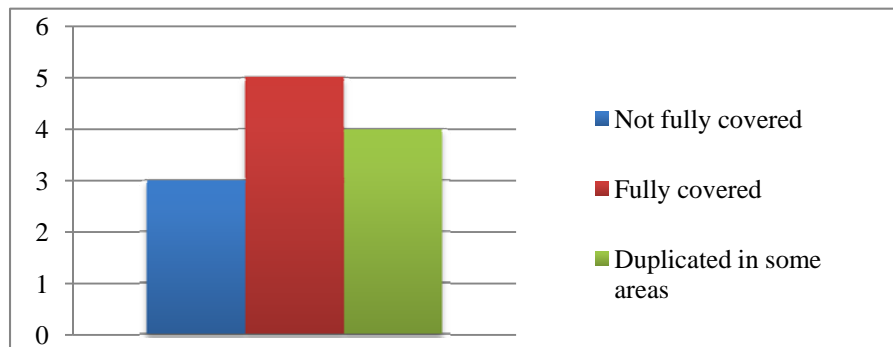


Figure 3.9 Coverage of Regulations

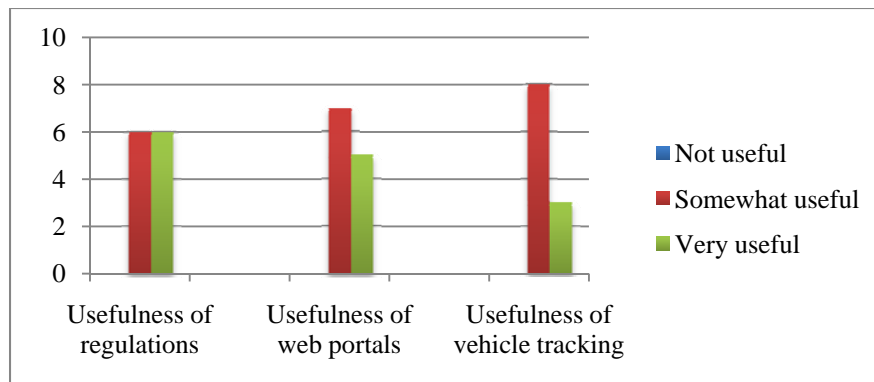


Figure 3.10 Usefulness of Regulations, Web Portals and Vehicle Tracking Devices

From Figure 3.7, one can see that about 1/3 of the respondent companies perceive the number of regulations and DG agencies as being too many while the majority of the respondents consider the numbers as being just right. Figure 3.8 shows that most of the respondents agree that the number of web portals for relevant DG documents submission is just right. The controversy of understanding and perceptions of the coverage of regulations are shown in Figure 3.9, and these aspects are discussed in the next section 3.4. On a general basis, DG regulations, web portals and vehicle tracking devices are considered as useful tools for DG logistics system in Singapore.

The result for question 7 is generated as shown in Table 3.1. It shows that compliance level exceeds usefulness level with a minor gap in between.

Table 3.1 Mean Ratings of Regulations Compliance and Usefulness

	Compliance*	Usefulness**	Gap
General DG rules	2.75	2.60	0.15
Classification and labelling of DG	2.75	2.60	0.15
Declaration of DG	2.67	2.50	0.17
Emergency management	2.67	2.40	0.27
Licensing control	2.67	2.60	0.07
Health and safety of personnel	2.69	2.60	0.09

* 1 being limited compliance; 2 being some compliance; 3 being substantial compliance.

** 1 being not useful; 2 being somewhat useful; 3 being very useful.

The mean ratings of importance and usefulness of the R&D needs are shown in Table 3.2 from which one can find the position for each R&D need in Figure 3.11.

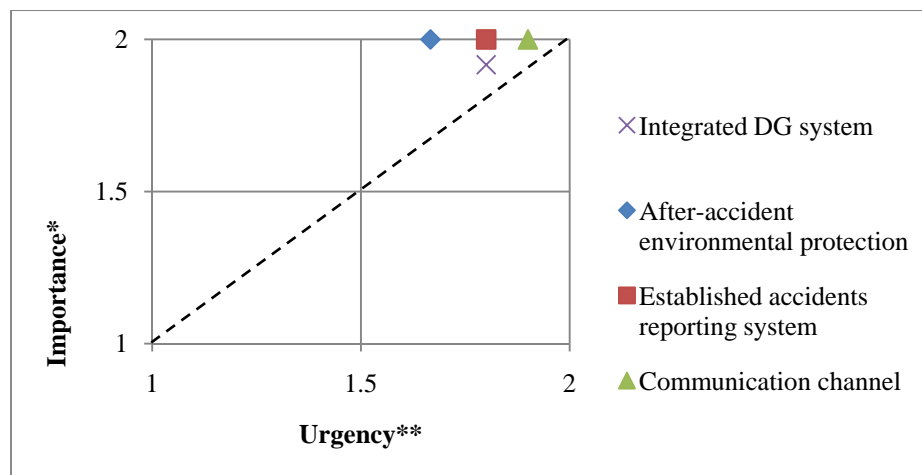
Table 3.2 Mean Ratings of Importance and Usefulness of R&D Needs

	Importance*	Urgency**
Integrated DG regulatory system	1.92	1.80
Regulations for after-accidents environmental protections	2.00	1.67
Established accidents reporting system	2.00	1.80
Communication channel between the regulatory body and the industry	2.00	1.90

* 1 being not important; 2 being important.

** 1 being not urgent; 2 being urgent.

The results for open answer questions including question 9 are summarised in Appendix T. The detailed result information for the survey can also be found in Appendix U.



* 1 being not important; 2 being important.

** 1 being not urgent; 2 being urgent.

Figure 3.11 Importance and Urgency of R&D Needs

3.4 Interview Results

Interviews are conducted with both regulatory bodies and industrial companies. The discussions can be categorised into the following aspects.

3.4.1 Number of Regulations and Agencies

Figure 3.7 shows that most of the respondents think that the number of regulations and agencies are just right, with about 1/3 of the respondents considering the agencies regulating DG being too many in Singapore. The answers for the question are dependent on personal perceptions and judgements which can lead to different explanations for this issue.

Mr. Salleh from LTH Logistics, who previously worked at SCDF mentioned during the interview that the diversification of the roles of different agencies could cause some delay in time and resources (Salleh, 2009). As different agencies may require different permits for DG carriage and storage, thus documents are to be submitted several times to each agency. However, if a single one-stop integrated agency is being practised, the DG handler's administration work would be greatly reduced, by having to submit only one set of document, and multiple permits may then be issued by the integrated DG regulating agency. Mr. Salleh also suggested that SCDF would be the proper agency to be the integrated agency in charge of DG issues, as SCDF possesses many qualified expertise in the HazMat department (Salleh, 2009).

Mr. Lim from Schenker Pte Ltd brought up similar opinions (Lim, 2009). Although the major DG regulating agencies are SCDF, NEA and SPF, there are also several other agencies regulating specific areas in DG as listed in Table 2.11. Mr. Foong from DHL referred to US DOT as a good example of being the only major agency regulating DG issues in US (Foong, 2009).

On the other hand, Mr. Jacobsen from Leschaco expressed his opinion that the number of agencies in Singapore is just right as the most frequently contacted agencies are SCDF, NEA and SPF which does cause a great inconvenience (Jacobsen, 2009).

Taking a further look at the respondents' answers on question 3 and question 6 in the questionnaire, the result is shown in Figures 3.12 and 3.13. In y-axis, "1" stands for "Just right" and "2" stands for "Too many". In x-axis, 1-9 stands for the number of DG classes handled by the respondent companies. The linear line is the trend line for the points. From Figures 3.12 and 3.13, the trend line in both figures has a negative gradient revealing a very weak negative correlation between the number of classes handled and number of regulations and agencies being perceived by the companies. Hence, one may conclude that the perceptions of each respondent depend on their own judgement over the choices given in the question.

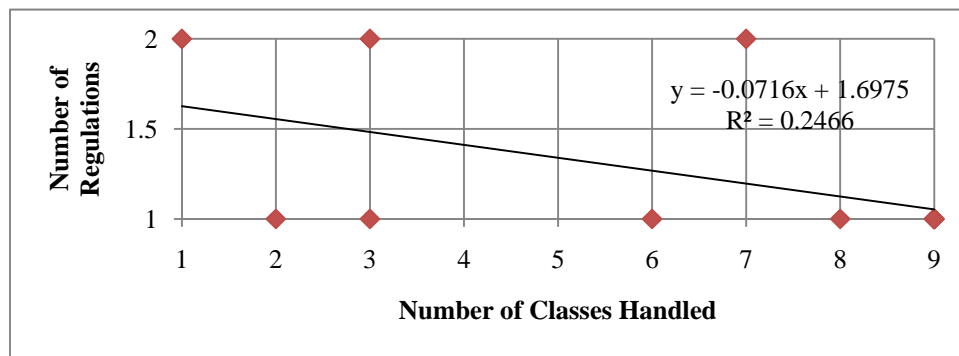


Figure 3.12 Relationship between Number of DG Classes Handled and Number of Regulations Perceived

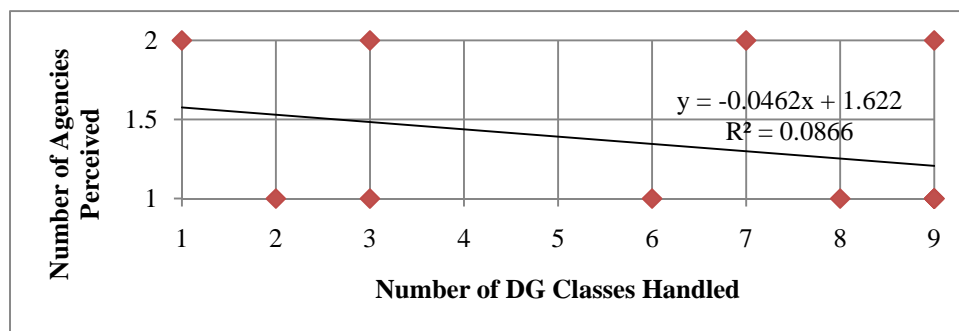


Figure 3.13 Relationship between Number of DG Classes Handled and Number of Agencies Perceived

From interview with the DG agencies, Mr. Heng from SCDF considered that the structure of DG regulating system in Singapore would remain relatively the same as it has been the practise of multi-agency approach for some years, with each agency being clear and familiar with their job and coverage of regulatory areas (Heng, 2009). Mr. Ho from NEA also mentioned that the issue of multi-agency practice has been in discussion for a couple of years already, but as each agency is specialised in different area of DG, it would be more effective and efficient for the agencies to retain their role and responsibility. Furthermore, Mr. Ho also stated that the regulatory bodies are also optimising their division of responsibilities in DG issues, for example, SCDF replaced NEA to supervise the toxic products carriage in Singapore after the establishment of HazMat group in SCDF, and SCDF has developed a more complete list of toxic products under supervision as well (Ho, 2010).

A compromise between the industry and the regulatory bodies needs to be achieved. As DG transportation and handling create potential danger to both societal and enterprise level, a more stringent regulating system shall be adopted in order to minimise any incidents. Both the

industry and regulatory bodies need to make efforts to improve the effectiveness of the system. The industry should understand the rationale behind the multi-agency practice and comply with the international and national regulations to achieve a safe and secure handling process of DG. The regulatory bodies need to continue improving and making clear their roles and responsibilities and enhance communications with the industry. Mr. Tang from Dangerous Goods Management Pte Ltd suggested that a comprehensive and informative web portal may be launched for personnel to access in order to learn the functions and roles of each agency (Tang, 2009). The web portal should be well-structured and updated regularly. The responsibilities and requirements of each relevant DG agency should be provided and relevant hyperlinks given for convenience of access by industrial companies.

3.4.2 Coverage of Regulations

The survey result reveals controversial perceptions among the respondents. It appears to depend on each respondent's personal experience at work.

Mr. Jacobsen thinks that the coverage of regulations in Singapore is not enough since there are still some grey areas which are not being clearly covered by regulations such as the oxidizer products. Mr. Jacobsen is from Germany and he considers that DG is more heavily regulated in Europe than in Singapore. Moreover, the difference between the regulating systems in Singapore and in Europe is that in Singapore, the regulating agencies play a more leading role in DG matters, whereas in Europe the regulating bodies give the industry companies more responsibilities in taking care of the DG matters. For example, in Singapore, the regulatory body requires the instalment of GPS system on vehicles carrying DG and keeps track of the location and routing of the vehicles in order to take necessary and immediate actions for emergencies. In Europe, the responsibility is on the companies to make sure the movement of vehicles carrying DG does not violate the regulations and does not put public and residents in threats and danger (Jacobsen, 2009).

The duplication of regulations is embodied in the documentation procedures. Mr. Salleh gave an example of applying for licences for DG carriage. Licences are required by designated agencies when DG is being transported passing through different customs; import, export and transport of DG through ports or land need separate declaration to different agencies to get required licenses (Salleh, 2009). It would be more convenient to establish a system where the company can declare DG for one time and all relevant parties would be informed through the system and thus issue required licenses and permits afterwards.

From the survey and interview, it shows that the regulations in Singapore still need to be improved. Feedbacks from the industry need to be collected from time to time to understand the gaps and loopholes existing in the system and grey areas that need further clarifications.

3.4.3 Usefulness of Web Portals and Vehicle Tracking Devices

Web portals and vehicle tracking devices are generally agreed as useful among the respondents. As discussed previously in Chapter 2, Mr. Jacobsen raised his concern that vehicle tracking devices are installed only on the registered vehicles carrying DG; the illegal importing of DG may not be tracked and can pose great threats to the society (Jacobsen, 2009).

Mr. Salleh from LTH Logistics Pte Ltd considered the vehicle tracking device as being very important in safeguarding the transportation of DG. Thus, LTH Logistics has established its own system to track their vehicles besides the GPS device installed by SCDF, and as a result, the company itself can access the position of the vehicles at all times.

The web portals are referred to the online system for submission of documentations as covered in the discussion in Chapter 2. Mr. Tang from Dangerous Goods Management Pte Ltd mentioned that the web portal should not just be for the submission of DG manifest and other documentations, but many other functions can be developed. One important function he suggested was for education and training, a simple structured web portal where even an amateur can surf the web portals to learn relevant information about DG (Tang, 2009).

Mr. Lim from Schenker Pte Ltd brought up another issue. The commonly used web portals like SCDF, NEA regularly update the websites' information and structures without giving in-time notice to the industrial companies. Thus companies may end up spending more time in getting familiar with the new functions in the websites. Mr. Lim suggested that the agencies could provide a list of updated functions in the web portals in order to keep the companies informed (Lim, 2009).

It is very critical that an effective communication channel between the industrial companies and the agencies be established. SCIC, which can be considered as principle association of the DG industry, holds conference a few times annually and invites personnel from both industry and agencies to come together to discuss the issues to improve the DG system in Singapore (Koh, 2010).

3.4.4 R&D Needs

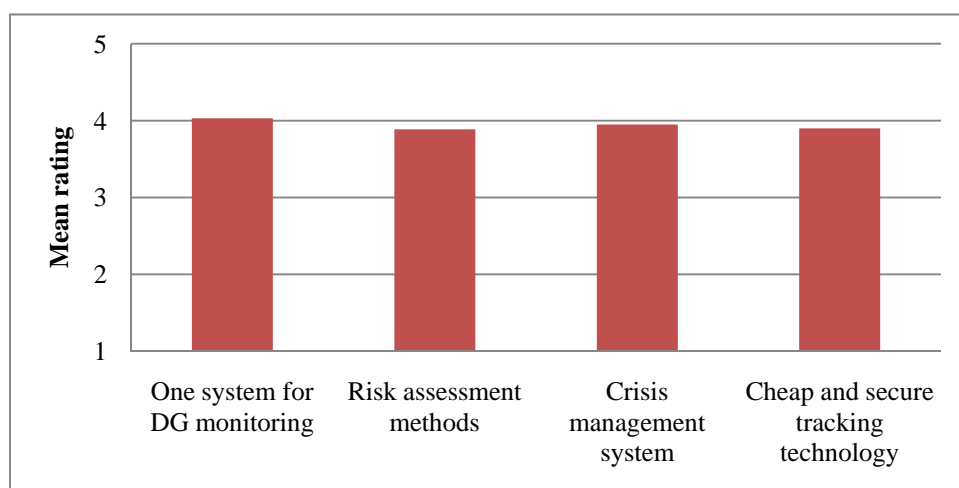
Figure 3.11 shows that all the four R&D needs are located in the first quadrant of the diagram. The respondents agree that the R&D needs are important, and the communication channel

between the industry and regulatory body for DG related information updates is rated the most urgent. As discussed in section 3.4.3, Mr. Lim stated that the provision of the updated information from the regulatory body would help the industrial companies to save time and cost (Lim, 2009).

Mr. Tang thinks that it is important to have a complete regulation for after-accidents environmental protections, as besides the safety of human beings, environmental pollution is also a potential consequence of DG accidents (Tang, 2009).

Mr. Heng from SCDF said there was not an accidents reporting system is not in place for 2 reasons, one being Singapore's limited geographical location has only few cases of DG accidents each year, the other reason is that companies handling DG are required to report to the regulatory bodies of any DG incidents (Heng, 2009). The major Accident Hazards Bureau (MAHB) in Europe collects DG accident information for analysis aimed at improving the DG system in Europe. Hence, it may also be helpful for Singapore to build up an electronic system that DG accidents and incidents information can be input and be analysed. However, the cost-effectiveness of such a system needs to be taken into considerations; the capital cost and expertise cost to set up the system and the usefulness of the system are yet to be studied.

The report *Analysis of Dangerous Goods Logistics in Singapore* studied four other R&D topics in 2006, and the survey result is shown in Figure 3.14. In y-axis, 1 stands for not important to 5 stands for critical. Figure 3.14 shows that R&D needs have a similar importance rated by the respondents where the issue of one system for DG monitoring has a slightly higher rating among the four (Rajkumar, 2006).



Source: (Rajkumar, 2006)

Figure 3.14 Mean Ratings for R&D Topics 2006

3.4.5 Cost of Compliance

Cost of compliance with the regulations was brought up to the interviewees during the interviews. Mr. Salleh stated that the cost for complying is high especially the infrastructure cost. For example, the cost for a normal warehouse transformed into specialised DG warehouse may cost around SGD 3 to 5 million (Salleh, 2009).

Mr. Lim considered that the training cost for the DG personnel is relatively high as every DG handler needs to take training courses at designated agency which cost about SGD300-500 per person. Moreover, the licence of personnel needs to be renewed every 2 years and more training courses may need to be taken to learn updated information about DG. However, the training courses are necessary to equip the employees with knowledge to handle DG safely. Mr. Lim said they also conduct in-house course or hands-on training to further coach their employees.

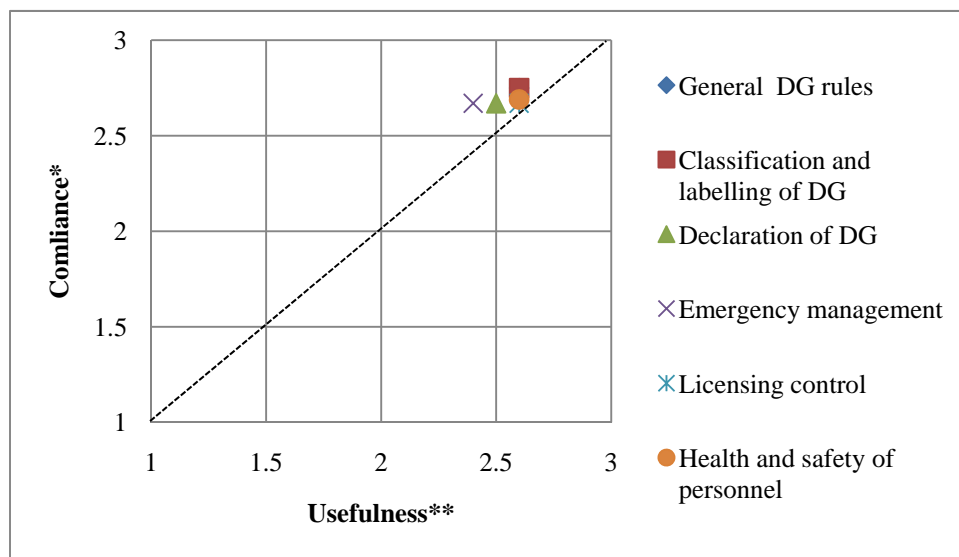
The compliance of regulations would usually give rise to the increase of cost born by the industrial companies. However, the effectiveness of the rules and regulations is more important apart from the cost because it is critical to make sure the process of handling DG is safe and proper.

CHAPTER 4 FINDINGS AND DISCUSSIONS

In this Chapter, gap analysis of the usefulness and deployment of regulations as well as the comparison between primary and secondary findings are conducted. A study on Singapore's DG logistics done by Mr. Thiraviam Vemburaj Rajkumar in 2006 provides the main comparison resource for the gap analysis to test the improvements of DG system in Singapore through the past few years.

4.1 Gap Analysis

Figure 4.1 (and Table 3.1) show a small positive gap between the compliance and usefulness of various kinds of regulations. In Figure 4.1, the dashed line stands for the balance between the compliance and usefulness. All the points are located above the line. The survey result shows that the compliance status of regulations is very high which mildly exceeds the usefulness of the regulations. Hence, this may indicate that in Singapore, the level of adoption and usefulness of the regulations are in balance.



* 1 being limited compliance; 2 being some compliance; 3 being substantial compliance.

** 1 being not useful; 2 being somewhat useful; 3 being very useful.

Figure 4.1 Usefulness and Compliance of Regulations

Table 4.1 shows the mean ratings of usefulness of web portals and vehicles tracking device which has been profiled earlier in Figure 3.10.

Table 4.1 Mean Rating of Usefulness of Web Portals and Vehicle Tracking Devices

Usefulness	Mean Rating (1: Not useful; 2: Somewhat useful; 3: Very useful)
Web portals	2.42
Vehicle tracking devices	2.27

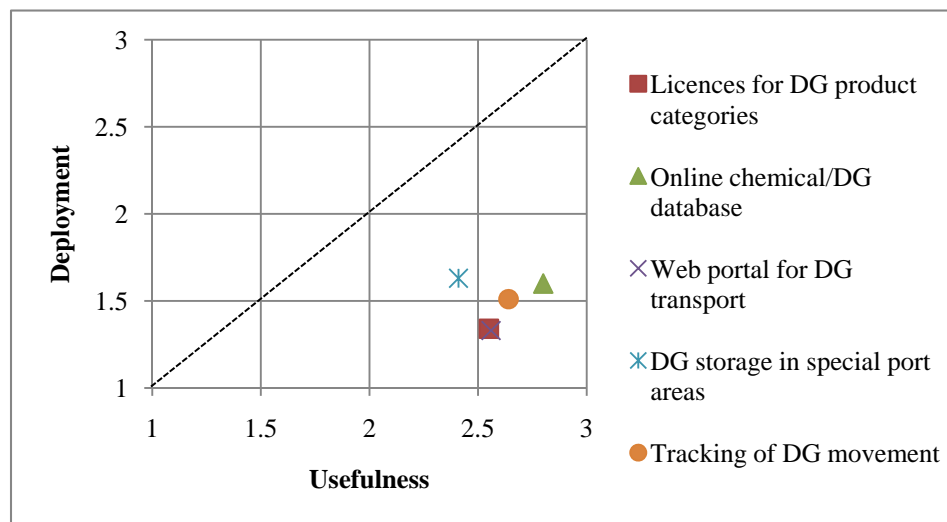
The 2006 study on DG logistics in Singapore produced the survey result summarised in Table 4.2 shows a much higher usefulness level than the deployment level back in 2006. The figures in Table 4.2 are also expressed graphically in Figure 4.2 for a clearer view.

Table 4.2 Mean Ratings of Technology Usefulness and Deployment

No	Type of technology	Usefulness*	Deployment**	Gap
1	Licences for DG product categories	2.55	1.34	1.21
2	Online chemical/DG database	2.80	1.60	1.20
3	Web portal for DG transport	2.56	1.33	1.23
4	DG storage in special port areas	2.41	1.63	0.78
5	Tracking of DG movement	2.64	1.51	1.13

*1 being not useful; 2 being somewhat useful; 3 being very useful

** 1 being not consider; 2 being to be introduced; 3 being currently used



Source: (Rajkumar, 2006)

Figure 4.2 Gap Analysis of Technology Usefulness and Deployment

By extracting similar items for 2006 and 2010 studies, Table 4.3 is summarised.

Table 4.3 Usefulness gap between 2006 and 2010

Item	Usefulness 2010	Usefulness 2006	Usefulness Gap
Licensing	2.6	2.55	0.05
Web portal	2.42	2.56	-0.14
Tracking devices	2.27	2.64	-0.37

Besides licensing, the usefulness for web portals and tracking devices is perceived to be lower in 2010 compared with 2006. This may be due to 2 reasons. One reason is because the survey is dependent on the respondents' perceptions and judgements, thus different respondents may result in different results. Secondly, the requirements of the respondents may increase. The companies pay more attention to the cost-effectiveness of the regulations and technologies and

their expectations increase as time advances. The improvements of the regulations and technologies may not have improved as much as their expectations.

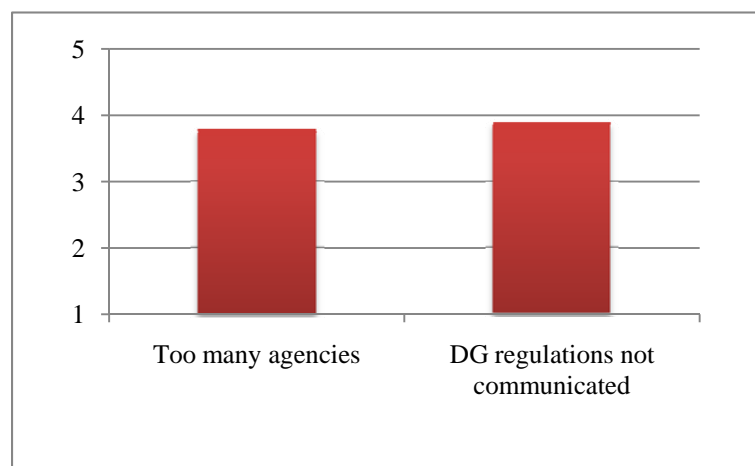
Moreover, the sample size of the study conducted in 2006 is bigger and may represent a more precise view.

In conclusion, from the trend in Figures 4.1 and 4.2, one may see that the industry has increased the compliance and deployment level for regulations and technologies from 2006 to 2010. However, as reliance on information technologies grows, the industry is expecting more advanced and cost-effective technologies and relevant regulations to be developed.

4.2 Primary and Secondary Findings

Chapters 2 and 3 cover the secondary and primary findings respectively which lead to the following discussions.

Secondary Findings--The regulations and regulatory bodies are summarised in Table 2.11 in Chapter 2, from which, one can see how regulated DG is in Singapore. Several agencies have launched various rules and regulations in order to make sure the DG system is in good order. Moreover, DG agencies play differentiated roles in the regulating system with three major regulatory bodies namely SCDF, NEA and SPF. Mr. Rajkumar in his previous research on DG logistics in Singapore pointed out that one of the weaknesses of DG system in Singapore is having too many agencies involved; another weakness is that regulation updates was not well communicated to the industry. The importance rating for each weakness by the survey respondents are shown in Figure 4.3. For y-axis, the scales stand for 1 being not important to 5 being critical. Thus, the two weaknesses were considered as very important in 2006.



Source: (Rajkumar, 2006)

Figure 4.3 Mean Rating of Weaknesses

Primary Findings--On the other hand, primary research shows that there are some messages from the industry which voice out the expectations for an integrated DG system containing one agency in charge. One integrated DG agency could help the industry to speed up the process of administration works; also the companies need to consult only one agency to solve various kinds of doubts and problems that they may encounter. The regulators, although aware of the demand from the industry, after several years discussions, decide to maintain the multi-agency system as the difficulties of transformation from multiple agencies to a single agency cannot be solved within a short time frame. The difficulty is that agencies employ personnel specialised in different areas of DG functions, for example, SCDF is specialised in safety of carriage of DG and emergency management, while NEA is specialised in the environmental protections and concerns. Mr. Salleh from LTH Logistics thus suggested that the expertise of different DG functions can be gathered at one specific agency (Salleh, 2009) so that the difficulty explained by the regulators can be solved. However, the reformation of the framework can be very complicated and time consuming. Since the current system has been practised for many years, the birth of a new structure in regulating DG may not be realised in the near future.

With regard to communications of regulations updates, the primary research shows the industry's perception in Figure 3.11. The communication channel between the industry and the regulatory bodies for DG information updates has the highest rating for both importance and urgency. This may imply that the communication between the industry and regulators is still a problem as compared to the study in 2006.

From the primary and secondary findings, one can see that the weaknesses with the regulating system still remain and may continue to exist. The problem is whether the seriousness has decreased or not. For the integrated agency issue, Figures 3.7 and 3.11 show that the industry is accepting the multiple-agency situations because two in three of the respondents are satisfied with the prevailing number of agencies in Singapore, and the importance and urgency is not as critical as the communication channel. Hence, this indicates that there are improvements for the past few years with the regulating system and the industry is getting familiar with each agency's roles and responsibilities.

However, an effective communication channel between the industry and the regulators is yet to be enhanced. SCIC as the intermediary should play a more active role in bridging the industry and the regulatory bodies. SCIC consists of members from both the DG companies and the government authorities to update the guidebooks published to provide instructions to the industry; SCIC should take this opportunity to establish a platform for the two parties to share their opinions and ideas. Moreover, regulators should take the initiative to provide updated

information and future trends to the DG companies in order to better prepared them about the changes.

4.3 Summary of Research Findings

In summarising primary and secondary findings from this study, the following points are listed to reflect the results from literature reviews, survey and interviews.

- DG under UNRTDG is classified into 9 classes by difference in properties and hazard. For each kind of dangerous product, a 4-digit UN number is given which stands for specific properties and relevant packaging requirements. Two well-known systems to classify chemical products are UNRTDG and GHS. GHS has different classification standards with UNRTDG as stated in Figure 2.1. According to Mr. Tan from MOM, the international organisations are planning to unify the classes so that a harmonised system can be achieved (Tan, 2009).
- Research shows that most DG related accidents took place in developed countries for the past century. The cost and time lost associated with DG accidents are higher than the normal accidents on the roads. Moreover, DG can be utilised by terrorist to cause severe danger to the society. In Singapore, DG accidents rate is considered very low by the interviewees, but as there is no established DG accident reporting system in Singapore, more information about DG incidents can be collected for further analysis.
- DG regulating system in Singapore is discussed under two categories: primary activities and supporting activities. The primary activities refer to the acts, regulations and standards set by international and national organisations. The supporting activities refer to the technologies and other initiatives for the purpose of implementing primary activities. The functions of these activities can be further classified into six categories which are general rules and regulations, declaration of DG, classification and labelling of DG, licensing control, workplace safety and health as well as emergency management.
- Most of the participating companies in the survey are involved in ocean freight, transportation and logistics and almost half of all the respondents are handling all 9 classes of DG. The most commonly handled class of DG is class 3 which is flammable liquids. The survey obtained the following results.
 - i. Most respondents agree that the number of regulations, regulatory agencies and web portals in Singapore are just right.

- ii. There is a controversial answer for the coverage of the regulations. One in four respondents thinks regulations does not fully cover all the DG issues; 41.7% of the respondents considers it is fully covered; and the rest 33.3% feels that there are duplications in some areas.
 - iii. Half of the participants rated somewhat useful on usefulness of the regulations while the other half rated very useful. Most of the participants think the web portals and the vehicle tracking devices are somewhat useful.
 - iv. The adoption level of the various categories of activities launched by relevant DG agencies has reached a balance with the usefulness level of these activities. There have been improvements of the DG system in Singapore over the past few years as contrasted to the usefulness level being higher than the deployment level in the study conducted in 2006.
 - v. The R&D needs proposed in the study are all considered as important and urgent by the respondents. The R&D needs include integrated DG regulatory system, regulation for after-accidents environmental protection, established accident-reporting system and communication channel between the regulatory body and the industry for relevant DG information updates. In the 2006 study, too many DG agencies and DG regulations update not well communicated were also rated as important weaknesses existing in Singapore.
- The interviews were conducted with both regulatory bodies and industrial companies. The interview results further complement the survey results from the two parties.
- i. The interviewees expressed their opinions towards the multiple-agency issue in Singapore. Interviewees who consider the number of agencies as too many have the main concern that there would be some repetition in the works to be done such as applying for licenses and submission of DG manifest, etc. Interviewees who consider the number of agencies as just right hold the point of view that the major DG regulating agencies are SCDF, NEA and SPF, and thus the situation does not cause any big problem. The agencies' perceptions on this issue are also discussed in Chapter 3. From the agencies' perspective, there would not be any major change with the current framework, but they would continue working on strengthening the structure, and making clear of each agencies' roles and responsibilities.
 - ii. In terms of coverage of regulations, interviewees have different perspectives. Some consider there are some grey areas that need further clarification by the agencies; some consider that there are duplications in the coverage of regulations and duplications in the responsibilities of the agencies. Moreover, as Mr. Jacobsen mentioned, comparing with Europe, Singapore

still needs to establish more regulations, especially some in-house practices. He suggested that Singapore should introduce to the industry mandatory appointment of a Dangerous Goods Safety Advisor, who would be trained and certified based on the local and international rules and regulations, like the EU practice (Jacobsen, 2010).

- iii. Interviewees suggested the web portals should include more educative information for amateur to learn about DG. Moreover, vehicle tracking devices are only installed on the licensed vehicles carrying DG, while other DG carriers without licence may still pose threats.
- iv. It is agreed that there is lack of effective communication channel in the DG system. The industry may not be aware of new updates with the regulations or functions on the web portals, as a result, some inconvenience would arise.
- v. The cost associated with the compliance of regulations and deployment of technologies is considered relatively high by the interviewees, for example, the infrastructure cost and training cost. However, the effectiveness, usefulness and safety seem to be more important than cost. Nevertheless, more cost-effective measures should be developed by the agencies and adopted by the industry.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

Based on the literature reviews, as well as the survey and interview results, discussion has been made in Chapter 4. In this chapter, conclusions and recommendations for this research study are given.

5.1 Reiteration of Objectives

The objectives of this study are to identify critical issues for DG regulating system under Singapore context through a thorough literature review; to survey and interview the industry and regulatory bodies on the critical issues identified in order to collect the views and perception from both parties; and based on the findings, to give the conclusions and recommendations.

5.2 Methodology

The response rate for the survey is quite low, hence a recommendation on future research is that the survey targets should be contacted in three procedures. Firstly, before sending out the questionnaire, companies should be contacted and informed about the survey, and relevant personnel in charge should be requested. Secondly, the questionnaire is to be sent out to the right person specialised in the area of study. Thirdly, for non-replies, additional emails or calls can be made to ensure they have received the questionnaire and due action is being taken.

Furthermore, more interviews with the industry experts and more face-to-face interviews with the regulatory bodies should be conducted for the future studies in order to get more personal opinions on the issue.

5.3 Research Findings

The major findings from this study on Singapore's DG regulating system are as follows.

First of all, Singapore has an established DG regulating system encompassing different initiatives and agencies. However, comparing with European system, there is still space for Singapore to further improve. One major finding is that the industry claims there are many DG agencies in Singapore to regulate the system which lead to confusions and time consumption. The industry wishes to have an integrated system to make transactions more effective and efficient such as when applying for various licences. Moreover, this can also help the companies to reduce consultation times with different agencies when enquiring for DG issues. Contrarily, DG agencies state that they have already recognised the need of the DG companies and had discussions for a few years over this issue. The agencies have decided to maintain multi-agency framework whereby each agency has DG professionals to deal with different kind of DG matters. Furthermore, there are only three major DG agencies namely SCDF, NEA and SPF,

and they are trying to make the division of roles among each agency more clearly for the convenience of the industrial companies. Within the near future, the DG agencies would still be exercising their respective responsibilities for relevant DG issues.

Secondly, one important and urgent demand from the industry is effective communication with the authorities. The updates on the web portals or regulations may not be communicated in time to the industry and thus causes inconvenience and delay. Previously, it is SCIC playing the role as bridge to gather the industry and agency personnel to come together to share opinions and suggestions several times each year. One key initiative should be to promote and enhance connection between the industry and the regulatory bodies to facilitate the process of exchange of information and points of views.

Thirdly, by comparing the study conducted in 2006 by Mr. Rajkumar on DG logistics system in Singapore and today's study. It is shown that companies' compliance level of the agencies' initiatives has increased which reflects the continuous efforts put in by both the companies and the agencies to improve DG system in Singapore.

5.4 Future Related DG Issues for Study

During the study, one potential area that can be further researched in future study on DG is the harmonisation of DG classification system at an international level. As there are two sets of chemical classification systems defined by UNRTDG and GHS respectively as mentioned in Chapter 2, international organisations do aspire and have intention to unify the classifications system so that there is less confusion. This would affect the national standards as many countries are complying with both UNRTDG and GHS. Moreover, Singapore port's unique classification discussed in Chapter 2 can also be studied in the future. The PSA Classes 1, 2 and 3 which only apply in Singapore port may cause misunderstanding by shipper and carriers of DG, especially if they are unfamiliar with the system.

This research study is mainly focused on the internal factors, meaning the national situation. Future research study on DG regulating system should include more external factors such as comparisons with the other country's DG system. The advantages and disadvantages of the each country's DG framework should be discussed in order to find the gaps. By analysing both internal and external environment, this would help to better position Singapore's DG regulating system and to improve the structure and content of the system, thereby reducing the gap between Singapore and the advanced countries and achieve a safer and more effective DG regulating system in Singapore.

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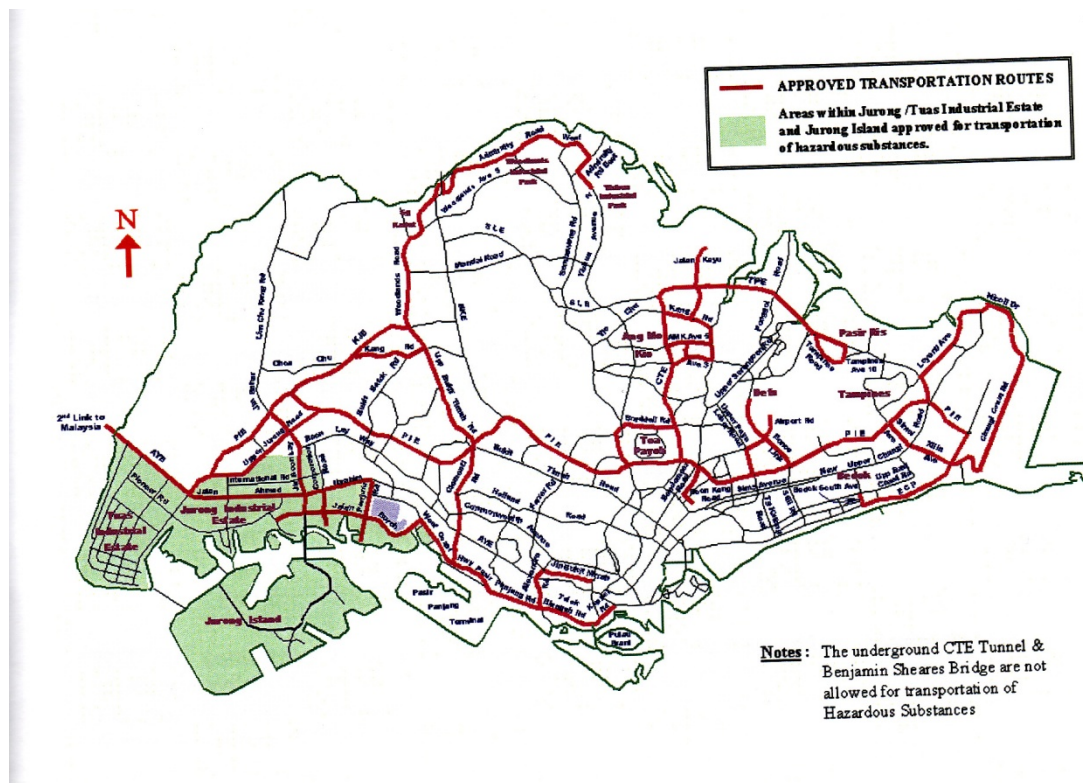
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APPENDIX A Approved Transportation Route of DG



Source: (Rajkumar, 2006)

APPENDIX B Sample Questionnaire

Survey of Dangerous Goods Regulating System in Singapore

Questionnaire

I am Yifang and from Nanyang Technological University, 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 the dangerous goods regulating system in Singapore in order to assess Singapore's strength, weakness, problems and gaps in the regulatory framework. The survey is applicable to companies engaged directly or indirectly in dangerous goods (or hazardous cargo) logistics industry 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: Dangerous Goods Regulating System in Singapore

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 dangerous goods field and use the **postage-paid envelop** attached with the survey questionnaire to mail back.

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

Investigators: Ms Cui Yifang

Phone: +65-83178671

Email: cuiy0003@ntu.edu.sg

Supervisor: Associate Professor Wong Yiik Diew

Phone: +65-6790-5250

Email: 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. Which classes of DG does your Company handle? (Please tick **all that apply**)

- | | | |
|----------------------------------|----------------------------------|---|
| <input type="checkbox"/> Class 1 | <input type="checkbox"/> Class 5 | <input type="checkbox"/> Class 9 |
| <input type="checkbox"/> Class 2 | <input type="checkbox"/> Class 6 | <input type="checkbox"/> Not Applicable |
| <input type="checkbox"/> Class 3 | <input type="checkbox"/> Class 7 | |
| <input type="checkbox"/> Class 4 | <input type="checkbox"/> Class 8 | |

4. Type of the Company:

- ☐ Multinational corporation – local branch
☐ Multinational corporation – regional headquarter
☐ Local operating company

5. Number of employees based in Singapore of your Company:

- | | | |
|----------------------------------|------------------------------------|------------------------------------|
| <input type="checkbox"/> 0 – 10 | <input type="checkbox"/> 51 – 60 | <input type="checkbox"/> 141 – 160 |
| <input type="checkbox"/> 11 – 20 | <input type="checkbox"/> 61 – 80 | <input type="checkbox"/> 161 – 180 |
| <input type="checkbox"/> 21 – 30 | <input type="checkbox"/> 81 – 100 | <input type="checkbox"/> 181 – 200 |
| <input type="checkbox"/> 31 – 40 | <input type="checkbox"/> 101 – 120 | <input type="checkbox"/> Above 200 |
| <input type="checkbox"/> 41 – 50 | <input type="checkbox"/> 121 – 140 | |

Part 2 Dangerous Goods Regulating System in Singapore

6. Please rate the following criteria for dangerous goods regulation system in Singapore? (DG=dangerous goods)

Criteria	Rating		
	Just right	Too many	
Number of regulations that are required to be complied with			
Number of agencies involved in regulating DG logistics	Just right	Too many	
Number of web portals for relevant DG document submission	Not enough	Just right	Too many
Coverage of regulations on DG related issues	Not fully covered	Fully covered	Duplicated in some areas
Usefulness of regulations on a general basis	Not useful	Somewhat useful	Very useful
Usefulness of web portals for relevant DG document submission	Not useful	Somewhat useful	Very useful
Usefulness of vehicle tracking devices (e.g. HTVTS, VTIS etc.)	Not useful	Somewhat useful	Very useful

7. Please indicate the compliance status & usefulness for the following categories of regulations according to your company's situation. Please rate with regard to dangerous goods regulating system in Singapore. (DG=dangerous goods)

Categories of regulations	Compliance status			Usefulness		
	Limited compliance	Some compliance	Substantial compliance	Not useful	Somewhat useful	Very useful
General DG carriage rules (e.g. IMDG, IATA and ADR etc.)						
Classification and labelling of DG						
Declaration of DG						
Emergency management						
Licensing control						
Health and safety of personnel						
Others, please specify _____						

8. Please rate the importance and urgency of the following R & D needs for dangerous goods regulation system in Singapore. (DG=dangerous goods)

DG R&D needs	Importance		Urgency	
	Not important	Important	Not urgent	Urgent
Integrated DG regulatory system (e.g. 1 DG agency, 1 web portal for document submission and information sharing etc.)				
Regulations for after-accidents environmental protections				
Established accidents reporting system				
Communication channel between the regulatory body and the industry for DG related information updates				
Others, please specify_____				

9. Please offer your suggestions or recommendations for improving the DG regulatory framework in Singapore?

Part 3 Feedbacks

10. 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: _____

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

☐ Yes

☐ No

-End of survey-

Thank you!

APPENDIX C UN DG Classifications

Class 1: Explosives

Division 1.1: substances and articles which have a mass explosion hazard

Division 1.2: substances and articles which have a projection hazard but not a mass explosion hazard

Division 1.3: substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard

Division 1.4: substances and articles which present no significant hazard

Division 1.5: very insensitive substances which have a mass explosion hazard

Division 1.6: extremely insensitive articles which do not have a mass explosion hazard

Class 2: Gases

Class 2.1: flammable gases

Class 2.2: non-flammable, non-toxic gases

Class 2.3: toxic gases

Class 3: Flammable liquids

Class 4: Flammable solids; substances liable to spontaneous combustion; substances which, in contact with water, emit flammable gases

Class 4.1: flammable solids, self-reactive substances and desensitised explosives

Class 4.2: substances liable to spontaneous combustion

Class 4.3: substances which, in contact with water, emit flammable gases

Class 5: Oxidizing substances and organic peroxides

Class 5.1: oxidizing substances

Class 5.2: organic peroxides

Class 6: Toxic and infectious substances

Class 6.1: toxic substances





Class 6.2: infectious substances






Class 7: Radioactive material




Class 8: Corrosive substances

Class 9: Miscellaneous dangerous substances and articles

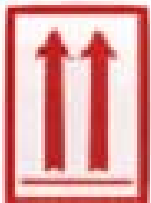





APPENDIX D DG Labels

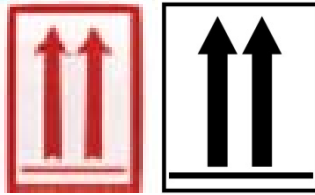
<p>Class 1 Explosives Division 1.1-1.6</p>	
<p>Class 2 Compressed, Liquefied or Dissolved Gases under Pressure Division 2.1 Flammable Gases</p>	
<p>Division 2.2 Non-Flammable Gases / Non-Toxic Gases</p>	
<p>Division 2.3 Toxic Gases</p>	

<p>Class 3 Flammable Liquids</p>	
<p>Class 4 Flammable Solids or Substances Division 4.1- 4.3</p>	
<p>Class 5 Oxidising Substances (agents) and Organic Peroxides Division 5.1- 5.2</p>	
<p>Class 6 Toxic and Infectious Substances Division 6.1- Toxic Substances</p>	
<p>Division 6.2- Infectious Substance</p>	

<p>Class 7 Radioactive Substances</p>	
<p>Class 8 Corrosives</p>	
<p>Class 9 Miscellaneous dangerous substances and articles</p>	

APPENDIX E IMDG and IATA Labels

<p>IMDG Label</p>	<div data-bbox="496 338 839 539">   </div> <p>Orientation Label</p> <div data-bbox="478 613 715 819">  </div> <p>Elevated Temperature Mark</p> <div data-bbox="477 889 805 1117"> <p>DANGER</p>  <p>THIS UNIT IS UNDER FUMIGATION WITH (fumigant name) APPLIED ON <small>(Bezeichnung des Schädlingsbekämpfungsmittels)</small></p> <p>{ date } { time } <small>(Datum und Zeitpunkt eintragen)</small></p> <p>DO NOT ENTER</p> </div> <p>Fumigation Warning Sign</p> <div data-bbox="489 1191 842 1415">  <p>MARINE POLLUTANT</p> </div> <p>Marine Pollutant Mark</p>
<p>IATA Label</p>	<div data-bbox="489 1503 644 1671">  </div> <p>keep away from heat</p> <p>Keep Away From Heat</p>



Orientation Label



Magnetised Material



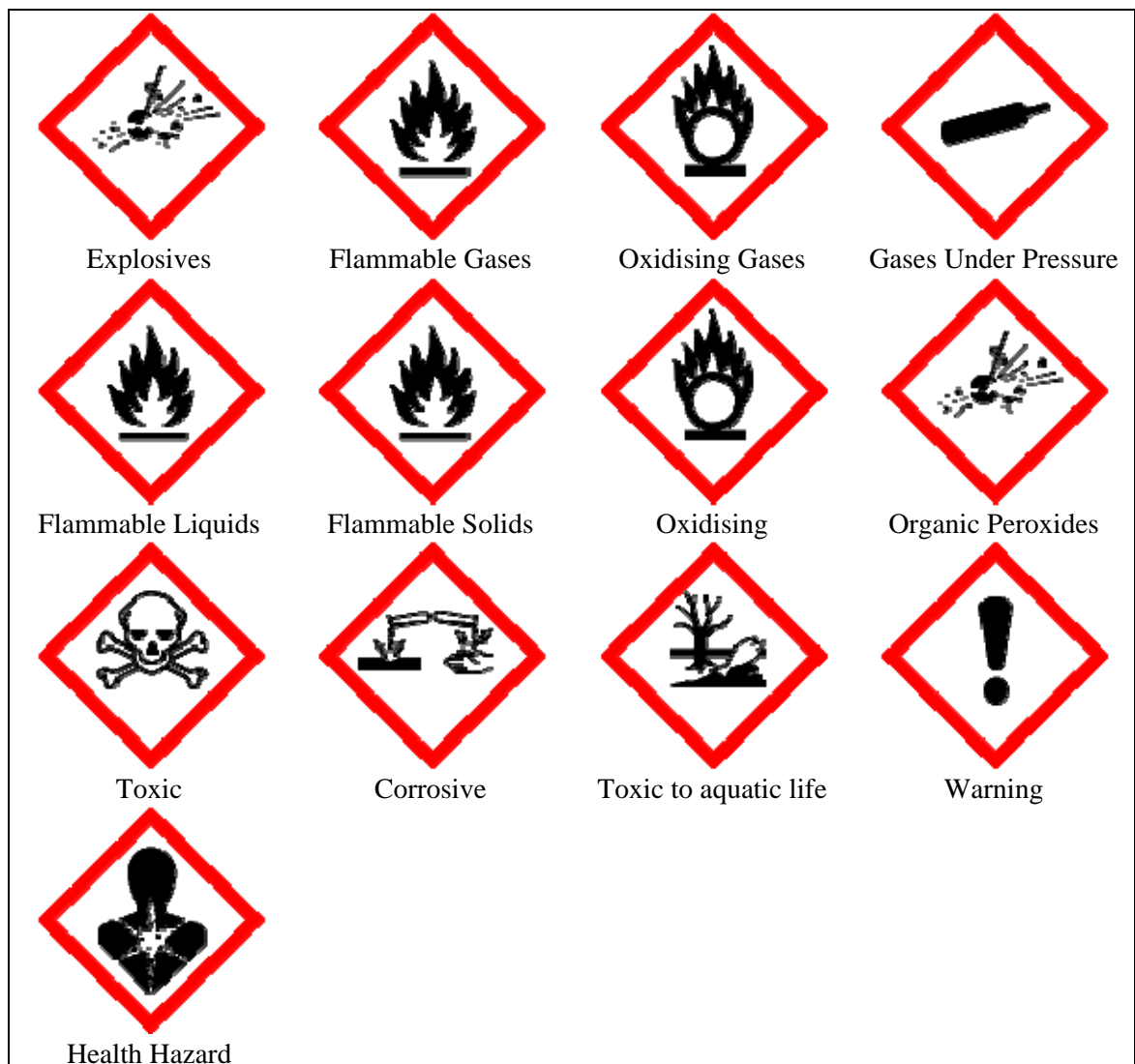
Cargo Aircraft Only



Cryogenic Liquids

Source: (SCIC, 2006b)

APPENDIX F GHS Labels



Source:(SCIC, 2006b)

APPENDIX G MITRA Functions

MITRA functions	Details
Real-time knowledge of the location of DG circulating within a given area	<ul style="list-style-type: none"> • Current vehicle position • Cargo identification, characteristics and status (nature of the transported products) • Potential risks and hazards posed by the vehicle and goods, and the particular precautions required
Information about the area around the vehicle	<ul style="list-style-type: none"> • Occurrence of extraordinary events • Geographical and physical characteristics of the areas the vehicle has to or might cross • Large human populations in the vicinity • Presence of social infrastructure (hospitals, schools, stadiums, etc.) • Presence of other vehicles transporting dangerous goods in the vicinity
Information to react immediately with precise knowledge of the situation and subsequent risks	<ul style="list-style-type: none"> • The last known position of the vehicle, the precise identification of the cargo and the intervention procedures applicable to this cargo. • Indications of the specific precautions to be taken, as well as the intervention schemes most suited to the type of accident • Estimation of the effects of the accident and its impact on the surrounding area (perimeters potentially affected)

Source: (Planas et al., 2008)

APPENDIX H List of Countries Adopted and Practiced Responsible Care

Argentina	Hungary	Portugal
Australia	India	Russia
Austria	Indonesia	Singapore
Belgium	Ireland	Slovak Republic
Brazil	Israel	Slovenia
Bulgaria	Italy	South Africa
Canada	Japan	South Korea
Chile	Latvia	Spain
Colombia	Lithuania	Sweden
Czech Republic	Malaysia	Switzerland
Denmark	Mexico	Taiwan, ROC
Ecuador	Morocco	Thailand
Estonia	Netherlands	Turkey
Finland	New Zealand	United Kingdom
France	Norway	United States
Germany	Peru	Uruguay
Greece	Philippines	Venezuela
Hong Kong SAR	Poland	

Source: (SCIC, 2009a)

APPENDIX I Documents Required onboard the Ships

Section	Documents
Section 1: For All Ships on International Voyages 1.2 Document and Drawings	Document of Compliance with the Special Requirements for Ships Carrying Dangerous Goods
	Dangerous Goods Manifest or Stowage Plan
	Cargo Information and appropriate Shipping Documents
Section 1: For All Ships on International Voyages 1.3 Publications	Relevant Sections of the International Maritime Dangerous Goods (IMDG) Code
Section 3: For Cargo Ships (<i>In addition to the Certificates, Documents and Publications in Section 1</i>) 3.3 Publications	International Maritime Dangerous Goods (IMDG) Code
	Medical First Aid Guide (MFAG)
Section 5: For Ships Carrying Noxious Liquid Chemical Substances in Bulk (<i>In addition to Certificate, Documents and Publications in 1 and 3.1</i>) 5.1 Certificate	International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk
Section 5: For Ships Carrying Noxious Liquid Chemical Substances in Bulk (<i>In addition to Certificate, Documents and Publications in 1 and 3.1</i>) 5.2 Documents	Pollution Incident Emergency Plan for Hazardous and Noxious Substance (HNS)
Section 6: For Chemical Tankers 6.1 Certificates	Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk
	International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk
Section 8: For Miscellaneous Craft 8.1 Certificates and Documents	Certificate of Fitness for the Transportation and Handling of Limited Amounts of Hazardous and Liquid Noxious Substances in Bulk

APPENDIX J Inspection Checklist for Bulk Transportation

Prime mover and trailer (bulk tank, ISO tank)

Road tanker (single entity lorry)

* Transport of petroleum and flammable materials in bulk means transport of petroleum and flammable materials in container more than 250 litres water capacity.

(A)	Documents Requirements
1	Professional Engineer's certificate
2	Manufacturer's report (new application)
3	One copy of tanker drawing endorsed by PE (new application)
4	Hydrostatic test report (once every 5 years)
5	Radiographic test report (once every 10 years)
6	Test certificate issued by LTA (road worthiness)
7	Test report (once every 5 years) for ISO tank or BLC
8	Transport Emergency Response Plan
9	Hazardous Materials Transport Driver Permit
(B)	Technical Requirements
1	Exhaust system in order (must be in front)
2	Fire shield at rear of cabin provided & in order
3	Battery cut off
4	Discharge faucets
5	Emergency cut off for tanker
6	Emergency Information Panel according to Singapore Standard/ Code of Practice provided on 3 sides
7	Warning sign " Danger, Highly Flammable" according to Petroleum & Flammable Material Regulations display at the back of the vehicle
	Bumper (heavy duty steel) 15 cm from tank
8	Earthing strap touching the ground
9	Metal conduits for all wirings in good condition
10	Manhole covers in order
11	Coaming satisfactory and projected at least 25 mm above manhole covers
12	Pressure , level & temperature gauges provided
13	Safety & hydrostatic relief valves provided
14	Proper battery compartment
15	Vehicle is equipped with one 9 kg dry powder fire extinguisher and <ul style="list-style-type: none"> i) 1 x 1 kg dry chemical fire extinguisher , or ii) 1 x 2.3 kg dry carbon dioxide fire extinguisher

Source: (Seto, 2009)

APPENDIX K Inspection Checklist for Package Transportation I

Prime mover and trailer (trucking container containing petroleum or Flammable materials in package, examples drums, bottles, pallets etc)

* Transport of petroleum and flammable materials in package means transport of any petroleum or any flammable materials in one or more containers of less than 250 litres water capacity.

(A)	Documents Requirements
1	Test certificate issued by LTA (road worthiness)
2	Hazardous Materials Transport Driver Permit
3	Transport Emergency Response Plan
(B)	Technical Requirements
1	Exhaust pipe directed downwards and adequate shrouding (metal cover) to be provided
2	Warning sign “ Danger, Highly Flammable “ according to Petroleum & Flammable Material Regulations display at the back of the vehicle
3	Fire shield at rear of cabin provided & in order
4	Battery cut off
5	Earthing strap touching the ground
6	Warning labels according Singapore Standard/ Code of Practice provided at 3 sides
7	Metal conduits for all wirings in good condition
8	Proper battery compartment
9	Vehicle is equipped with one 9 kg dry powder fire extinguisher and <ul style="list-style-type: none"> i) 1 x 1 kg dry chemical fire extinguisher , or ii) 1 x 2.3 kg dry carbon dioxide fire extinguisher

Source: (Seto, 2009)

APPENDIX L Inspection Checklist for Package Transportation II

Vehicles constructed to carry goods (e.g. lorries, pick-ups)

* Transport of petroleum and flammable materials in package means transport of any petroleum or any flammable materials in one or more containers of less than 250 litres water capacity.

* Vehicles use for transport of flammable gases must not have a roof covering.

(A)	Documents Requirements
1	Transport Emergency Response Plan
2	Test certificate issued by LTA (road worthiness)
3	Hazardous Materials Transport Driver Permit
	Supplier's authorization letter (for LPG dealers only)
(B)	Technical Requirements
4	Platform of the vehicle is lined with timber or is timber constructed so as to minimize contact between the metal parts of the platform and any container
5	Protective railings lining the platform of the vehicle are at least 1 m in height in order to secure any container and to prevent such container from falling off the vehicle when the vehicle is in motion
6	Glass at the back of the driver cabin, if any is of wired glass or toughened or safety of not less than 6 mm in thickness so as to act as a fire resisting shield
7	Battery is covered with appropriate insulation material to prevent electrical spark emanating there from igniting any flammable vapour from any container
8	Exhaust pipe is extended at least 150 mm outwards away from the vehicle tail box or is directed downward to keep vehicle exhaust away from any container
9	Warning sign " Danger, Highly Flammable " according to Petroleum & Flammable Material Regulations display at the back of the vehicle
10	Warning labels according Singapore Standard/ Code of Practice provided at 3 sides
11	Vehicle is equipped with one 9 kg dry powder fire extinguisher and <ul style="list-style-type: none"> i) 1 x 1 kg dry chemical fire extinguisher , or ii) 1 x 2.3 kg dry carbon dioxide fire extinguisher

Source: (Seto, 2009)

APPENDIX M Inspection Checklist for Package Transportation III

Vehicles (e.g. Van or box up vehicle)

* Transport of petroleum and flammable materials in package means transport of any petroleum or any flammable materials in one or more containers of less than 250 litres water capacity.

(A)	Documents Requirements
1	Transport Emergency Response Plan
2	Test certificate issued by LTA (road worthiness)
3	Hazardous Materials Transport Driver Permit
(B)	Technical Requirements
4	Adequate ventilation on top and bottom (louvers) / exhaust fan
5	Battery is covered with appropriate insulation material to prevent electrical spark emanating there from igniting any flammable vapour from any container
6	Exhaust pipe is extended at least 150 mm outwards away from the vehicle tail box or is directed downward to keep vehicle exhaust away from any container
7	Warning sign “ Danger, Highly flammable “ according to Singapore Standard/ Code of Practice display at the back of the vehicle
8	Warning labels according Singapore Standard/ Code of Practice provided at 3 sides
9	Vehicle is equipped with one 9 kg dry powder fire extinguisher and <ul style="list-style-type: none"> i) 1 x 1 kg dry chemical fire extinguisher , or ii) 1 x 2.3 kg dry carbon dioxide fire extinguisher

Source: (Seto, 2009)

APPENDIX N Approved Inspection Bodies

No.	Inspection bodies approved to carry inspection on vehicles and approved agent for installation of tracking device, horns and blinkers, orange vehicle number plate	Annex E	Annex F	Annex G	Annex H	Installation of Tracking Device etc
1	ABS Consulting	yes	yes			
2	Germanisher Lloyd	yes	yes			
3	Bureau Veritas	yes	yes			
4	VICOM LTD	yes	yes	yes	yes	
5	Comfort Automotive Services			yes	yes	
6	Comfort Delgro Engineering Pte Ltd			yes	yes	
7	JIC Inspection Services Pte Ltd	yes	yes	yes	yes	
8	STA Inspection Pte Ltd			yes	yes	
9	Astrata (Asia Pacific) Pte Ltd					yes

Source: (Seto, 2009)

APPENDIX O Compliance Assistance Checklist (Flammable Hazardous Substances)

Safe Work Procedures		Yes	No
1	SWPs are developed for work with flammable substances.		
2	SWPs are developed for isolation, depressurisation or purging of pressurised flammable gases/vapours.		
Risk Assessment		Yes	No
3	Risk assessment has been conducted and documented.		
4	Risk assessment has address fire and/or explosion risks		
5	Records of risk assessment are kept for at least 3 years.		
6	Risk assessments are reviewed at least: <ul style="list-style-type: none"> Once every 3 years or When there are changes or When someone gets hurt 		
Rish Control Measures		Yes	No
7	All reasonably practical steps are taken to keep ignition sources separate from flammables.		
8	All reasonably practical steps are taken to prevent fire/explosions <ul style="list-style-type: none"> Enclosure Remove/prevent accumulation of flammables Exclusion/effective enclosure of ignition sources Use of flame-proof equipment etc. 		
9	The plant is constructed to withstand pressures of explosion.		
10	The spread and effects of overpressures are restricted by these appliances in the plant: <ul style="list-style-type: none"> Chokes, baffles, vents, blast walls etc. 		
Permit-to-Work System		Yes	No
11	A permit-to-work system is implemented for hot works.		
12	The permit-to-work system includes measures to ensure safe hot work operations.		
13	A competent person is appointed in certifying PTW for hot work.		
Mitigation Measures		Yes	No
14	A means of extinguishing fire is provided and readily available.		
15	A means of extinguishing fire is adequate, suitable and regularly maintained.		
16	Goods, articles and substances in a factory are stored, stacked or placed so as to not interfere with the efficient functioning of sprinkler systems or other fire-fighting equipment.		
17	A clear passageway is maintained for escape in a fire. <ul style="list-style-type: none"> No obstruction from contents in any room 		
18	All fire exits are easily opened from the inside.		
19	Fire exits are marked clearly.		
20	Everyone in the workplace is familiar with emergency procedures in the		

	event of a fire.		
21	Effective fire warning devices are available.		
22	Fire alarms are maintained and tested at least once a month.		
Information and Training		Yes	No
23	There is a competent person in charge of managing hazardous substances.		
24	There are adequate warning notices (in languages understood by all) at entrances and locations where flammables are used.		
25	All persons potentially exposed to flammables are warned of the hazards and precautions.		
26	All flammables are kept, stored, handled, or disposed of in a safe manner.		
27	All containers for flammables are affixed with warning labels.		
28	The warning labels are easily understood by all at work in the factory.		
29	The warning labels have hazards warnings and precautions in it.		
30	Safety Data Sheets (SDSs) are made available in the office and the process areas. Workers are aware of the locations of the SDSs.		
31	Workers are informed and warned of the specific hazards as stated in the SDS.		

Source: (MOM, 2006a)

APPENDIX P GHS Implementation Status (Country List)

Argentina	Finland	Malaysia	Senegal
Australia	France	Malta	Serbia
Austria	Gambia	Mauritius	Singapore
Belgium	Germany	Mexico	Slovakia
Bolivia	Greece	Myanmar	Slovenia
Brazil	Hungary	Netherlands	South Africa
Brunei	Iceland	New Zealand	Spain
Darussalam	Indonesia	Nigeria	Sweden
Bulgaria	Ireland	Norway	Switzerland
Cambodia	Italy	Paraguay	Thailand
Canada	Japan	Peru	United Kingdom
Chile	Lao People's	Philippines	United States of
China	Democratic	Poland	America
Colombia	Republic	Portugal	Uruguay
Cyprus	Latvia	Republic of	Viet Nam
Czech Republic	Liechtenstein	Korea	Zambia
Denmark	Lithuania	Romania	
Ecuador	Luxembourg	Russian	
Estonia	Madagascar	Federation	

Source: (UNECE, 2009c)

APPENDIX Q SS586

Part 1	Transport and Storage of Dangerous Goods	Set out the guidelines on the DG communication and labelling of hazardous chemicals and dangerous goods for transportation by road in Singapore. It also provides guidelines for the emergency information panel to be used for bulk storage of dangerous goods in the workplace to convey relevant information to the emergency responders for combating an emergency at the work place.
Part 2	Globally Harmonised System of Classification and Labelling of Chemicals – Singapore's adaptations	Provide guidance for the implementation of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) in Singapore. It is based on the United Nations (UN) GHS that provides for the global harmonisation of rules and regulations on the classification and labelling of chemicals as well as communication about chemicals, which include the preparation of Safety Data Sheets (SDS)
Part 3	Preparation of Safety Data Sheets (SDS)	

Source: SPRING (2008)

APPENDIX R Survey Respondent Companies

Anshin Logistics Pte Ltd
Atlas Logistics (Far East) Pte Ltd
Belm Meyer Specialty Chemical LLP
Dangerous Goods International Singapore Pte Ltd
Dangerous Goods Management (Singapore) Pte Ltd
DG Packaging Pte Ltd
Elite International Logistics Singapore Pte Ltd
Germarco Chemcargo Management Pte Ltd
Hazel Wrights Logistics Pte Ltd
Leschaco Pte Ltd
LTH Logistics (Singapore) Pte Ltd
Macoline (S) Pte Ltd
Mitsui Phenols Singapore Pte Ltd
Schenker Singapore Pte Ltd

APPENDIX S Personal Communication Summary

Date (DD/MM/YYYY)	Interviewee	Organisation	Remarks
15/10/2009	Lim Yan Guan	SIMTech	
12/10/2009	Heng Keng Liang Kwok Shun Yung Alice Seto	SCDF	
15/10/2009	Lance Foong	DHL	Email Communication
02/11/2009	Ryan Lim	Schenker Pte Ltd	
12/11/2009	Tan Kia Tang	MOM	
29/12/2009	Michael Tang	DGM Pte Ltd	
31/12/2009	Mohamed Salleh	LTH Logistics Pte Ltd	
05/01/2010	Uwe Jacobsen	Leschaco Pte Ltd	
06/01/2010	Martinn Ho	NEA	Telephone Interview
09/01/2010	Terence Koh	SCIC	Telephone Interview
14/01/2010	Hu Wing Ko	PSA	Telephone Interview
19/04/2010	Razali	MPA	Telephone Interview

APPENDIX T Open Question Results Summary

Question	Answer
Question 2: Other activities	DG packaging
	Sales and marketing
	Value added service, i.e. tank container operation
	DG packaging, declaration, course, sale of packaging material
Question 7: Others	Responsible Care
Question 9	Currently, we have too many agencies regulating DG. Perhaps consider a uniform authority like SCDF to be responsible for all DG licensing. They are the ones who approves the Emergency Response Plan for on-site and transport. Also mitigating the incidents when they occurred. Why not we consolidate the resources to one agency, SCDF will be appropriate. Today, it is so complicating and some authorities are lacking knowledge too.
	Notification list for website updates.
	Similar to the EU Directive 96/35/CE, Singapore should introduce to the industry mandatory appointment of a DG Safety Advisor, who'd be trained and certified based on local and international rules and regulations.
	More visibility of DG related issues, online or hardcopy.
	Regularly updates, uniform class classification.

APPENDIX U Survey Result Summary

Part 1 Information about Organisation		
Main activities	Number	Percentage
Warehousing	5	42%
Land freight, transportation and logistics	4	33%
Air freight, transportation and logistics	6	50%
Ocean freight, transportation and logistics	9	75%
Other activities	3	25%
Classes of DG handled	Number	Percentage
Class 1	7	58%
Class 2	8	67%
Class 3	12	100%
Class 4	8	67%
Class 5	8	67%
Class 6	8	67%
Class 7	5	42%
Class 8	8	67%
Class 9	11	92%
Type of company	Number	Percentage
Multinational corporation-local branch	6	50%
Multinational corporation-regional headquarter	2	17%
Local operating company	4	33%
Number of employees based in Singapore	Number	Percentage
0-10	3	25%
11-20	4	33%
21-30	1	8.3%
31-40	1	8.3%
41-50	0	0%
51-60	0	0%
61-80	0	0%
81-100	1	8.3%
101-120	0	0%
121-140	0	0%
141-160	0	0%
161-180	0	0%
181-200	0	0%
Above 200	2	16.7%

Part 2 DG Regulating System in Singapore: Criteria of DG Regulating System		
Number of regulations	Number	Percentage
• Just right	9	75%
• Too many	3	25%
• Mean (1: Just right; 2: Too many)	1.25	
• Standard Deviation	0.45	
• Sample Variance	0.20	
Number of agencies	Number	Percentage
• Just right	8	67%
• Too many	4	33%
• Mean (1: Just right; 2: Too many)	1.33	
• Standard Deviation	0.49	
• Sample Variance	0.24	
Number of web portals	Number	Percentage
• Not enough	1	8.3%
• Just right	9	75%
• Too many	2	1.7%
• Mean (1: Not enough; 2: Just right; 3: Too many)	2.08	
• Standard Deviation	0.51	
• Sample Variance	0.27	
Coverage of regulations	Number	Percentage
• Not enough	3	25%
• Just right	5	42%
• Duplicated in some areas	4	33%
• Mean (1: Not enough; 2: Just right; 3: Duplicated)	2.08	
• Standard Deviation	0.79	
• Sample Variance	0.63	
Usefulness of regulations	Number	Percentage
• Not useful	0	0%
• Somewhat useful	6	50%
• Very useful	6	50%
• Mean (1: Not; 2: Somewhat; 3: Very useful)	2.5	
• Standard Deviation	0.52	
• Sample Variance	0.27	
Usefulness of web portals	Number	Percentage
• Not useful	0	0%
• Somewhat useful	7	58%
• Very useful	5	42%
• Mean (1: Not; 2: Somewhat; 3: Very useful)	2.42	
• Standard Deviation	0.51	
• Sample Variance	0.27	
Usefulness of vehicle tracking devices	Number	Percentage
• Not useful	0	0%
• Somewhat useful	8	67%
• Very useful	3	25%
• Mean (1: Not; 2: Somewhat; 3: Very useful)	2.27	
• Standard Deviation	0.47	
• Sample Variance	0.22	

Part 2 DG Regulating System in Singapore: Compliance and Usefulness of Initiatives		
General DG carriage rules	Number	Percentage
• Limited compliance	0	0%
• Some compliance	3	25%
• Substantial compliance	9	75%
• Not useful	0	0%
• Somewhat useful	4	33%
• Very useful	6	50%
	Compliance	Usefulness
• Mean (1: Limited/Not; 2: Some; 3: Substantial/Very)	2.75	2.6
• Standard Deviation	0.45	0.52
• Sample Variance	0.20	0.27
Classification and labelling of DG	Number	Percentage
• Limited compliance	0	0%
• Some compliance	3	25%
• Substantial compliance	9	75%
• Not useful	0	0
• Somewhat useful	4	33%
• Very useful	6	50%
	Compliance	Usefulness
• Mean (1: Limited/Not; 2: Some; 3: Substantial/Very)	2.75	2.60
• Standard Deviation	0.45	0.52
• Sample Variance	0.20	0.27
Declaration of DG	Number	Percentage
• Limited compliance	1	8.3%
• Some compliance	2	16.7%
• Substantial compliance	9	75%
• Not useful	0	0%
• Somewhat useful	5	41.7%
• Very useful	5	41.7%
	Compliance	Usefulness
• Mean (1: Limited/Not; 2: Some; 3: Substantial/Very)	2.67	2.5
• Standard Deviation	0.65	0.53
• Sample Variance	0.42	0.28
Emergency management	Number	Percentage
• Limited compliance	0	0%
• Some compliance	4	33%
• Substantial compliance	8	67%
• Not useful	1	8.3%
• Somewhat useful	4	33%
• Very useful	5	41.7%
	Compliance	Usefulness
• Mean (1: Limited/Not; 2: Some; 3: Substantial/Very)	2.67	2.4
• Standard Deviation	0.49	0.70
• Sample Variance	0.24	0.49

Part 2 DG Regulating System in Singapore: Compliance and Usefulness of Initiatives (Continued)		
Licensing control	Number	Percentage
• Limited compliance	0	0%
• Some compliance	4	33%
• Substantial compliance	8	67%
• Not useful	0	0%
• Somewhat useful	4	33%
• Very useful	6	50%
	Compliance	Usefulness
• Mean (1: Limited/Not; 2: Some; 3: Substantial/Very)	2.67	2.6
• Standard Deviation	0.49	0.52
• Sample Variance	0.24	0.27
Health and safety of personnel	Number	Percentage
• Limited compliance	0	0%
• Some compliance	3	25%
• Substantial compliance	9	75%
• Not useful	0	0
• Somewhat useful	4	33%
• Very useful	6	50%
	Compliance	Usefulness
• Mean (1: Limited/Not; 2: Some; 3: Substantial/Very)	2.75	2.60
• Standard Deviation	0.45	0.52
• Sample Variance	0.20	0.27

Part 2 DG Regulating System in Singapore: Importance and Urgency of R&D Needs		
Integrated DG system	Number	Percentage
• Not important	1	8.3%
• Important	11	91.7%
• Not urgent	2	16.7%
• Urgent	8	67%
	Importance	Urgency
• Mean (1: Not important/urgent 2: Important/urgent)	1.92	1.8
• Standard Deviation	0.29	0.42
• Sample Variance	0.08	0.18
Classification and labelling of DG	Number	Percentage
• Limited compliance	0	0%
• Substantial compliance	12	100%
• Not useful	3	25%
• Very useful	6	50%
	Importance	Urgency
• Mean (1: Not important/urgent 2: Important/urgent)	2.0	1.67
• Standard Deviation	0	0.5
• Sample Variance	0	0.25
Declaration of DG	Number	Percentage
• Some compliance	0	0%
• Substantial compliance	12	100%
• Not useful	2	16.7%
• Very useful	8	67%
	Importance	Urgency
• Mean (1: Not important/urgent 2: Important/urgent)	2.0	1.8
• Standard Deviation	0	0.42
• Sample Variance	0	0.18
Emergency management	Number	Percentage
• Limited compliance	0	0%
• Substantial compliance	11	91.7%
• Not useful	1	8.3%
• Very useful	10	83.3%
	Importance	Urgency
• Mean (1: Not important/urgent 2: Important/urgent)	2.0	1.9
• Standard Deviation	0	0.32
• Sample Variance	0	0.1