TLI – Asia Pacific White Papers Series

Performance Measurement in Humanitarian Organizations

A TLI-AP – SCI Joint Study on Humanitarian Logistics

Volume 13-Nov-HL

A Collaboration Between

THE LOGISTICS INSTITUTE ASIA PACIFIC

NUS National University of Singapore

Georgia Institute of Technology

PERFORMANCE MEASUREMENT IN HUMANITARIAN ORGANIZATIONS

A TLI-AP – SCI Joint Study on Humanitarian Logistics

Qing Lu

Mark Goh

Robert de Souza

CONTENTS

EXECUTIVE SUMMARY

This white paper is based on a research project on Key Performance Indicators (KPIs) for Save the Children International (SCI)'s logistics operations with the funding support from UPS Foundation. Having operations in countries with different levels of capability, SCI intends to develop generic KPIs applicable to countries in different contexts. The key research question of the study is how to develop the relevant KPIs.

This study demonstrates how the Supply Chain Operations Reference (SCOR) framework and its associated performance attributes can be adapted to the humanitarian supply chain. With the support of SCI and other humanitarian relief organizations (HROs), we are able to map the generic supply chain processes of humanitarian organizations and develop a set of twenty-four KPIs for HROs to measure and monitor their supply chain performances effectively. These metrics cover the key elements of quality, time, and cost in humanitarian supply chains, and assist humanitarian organizations to measure their performances in terms of agility, responsiveness, reliability, and cost effectiveness along the whole supply chain processes. More importantly, from these metrics, organizations are able to benchmark internally against previous periods, externally with other humanitarian organizations, and set objectives with quantifiable goals, all of which support continuous improvement. It will enable humanitarian organizations to provide timely aid and efficient use of donor funds for value.

The validation of the draft KPIs with HROs shows the importance of these KPIs as well as the difficulty in their implementation. Only five KPIs (percentage of orders delivered in full, percentage of orders delivered in time, current on hand inventories, sourcing cycle time, and current purchase order cycle time) of the original twenty-four can be easily implemented in most HROs based on their existing procedures and practices. Based on the existing procedures of HROs, we suggest the automation of goods ordering, receiving and delivery in their logistics operations, which could improve documentation accuracy and reduce the workload of the logistics staff. We expect that automation would facilitate the implementation of eight more KPIs (three KPIs on documentation accuracy, three KPIs on order cycle time, perfect condition, and in stock percentage) on supply chain reliability and responsiveness. However, even after the automation, there are still eleven KPIs that are difficult to implement, including most KPIs on the supply chain cost. The weakness in cost measuring exists in most HROs. They need to improve by integrating their internal procedures across other operations functions such as Finance, Awards Management and distribution activities, for more effective measurement of their supply chain performances, especially in the supply chain cost estimation. Using organizational Monitoring, Evaluation, Accountability & Learning (MEAL) systems could support this process.

Further work can be done to implement a logistics management system to automate the supply chain processes with real-time dashboards for better supply chain visibility. HROs could also test these KPIs in a logistics heavy country, i.e., a country with large investment and spending in humanitarian logistics, to evaluate the importance and implementation difficulty of these KPIs in such a country. It is possible to find some KPI variations between logistics heavy and light countries. For example, pre-

qualification, contracting, and framework agreement would be more applicable in logistics heavy countries with high logistics demands. The automation of the delivery process would also be more applicable to logistics heavy countries. This will result in a comprehensive set of performance measurement metrics that is able to facilitate continuous improvement in the end-to-end supply chain processes of humanitarian organizations.

1. INTRODUCTION

Global disasters have been increasing in diversity, frequency and severity for the past decades [1]. To mitigate the effect of such disasters, humanitarian relief organizations (HROs) across the world are busy saving lives and helping surviving victims in disaster-prone areas where the poor infrastructure makes humanitarian logistics critical. Today, there is a strong demand for greater effectiveness and efficiency in humanitarian logistics operations as almost 60-80% of the expenses incurred in humanitarian operations are due to logistics activities [2].

To improve humanitarian logistics operations, performance measurement is the first step. Moreover, despite its significance, performance measures and measurement systems have not been widely developed and systematically implemented in the relief chain [3]. In addition to the common problems in the non-profit sector such as performance criteria ambiguity [4], the inherently unique characteristics of the disaster relief environment make relief chain performance measurement even more challenging.

This paper attempts to address this research gap and develop a set of key performance indicators (KPIs) which could be used by HROs in their logistics operations at the country level. We develop a performance measurement framework for the supply chain processes with reference to the Supply Chain Operations Reference (SCOR) model and its associated performance metrics. With the support from SCI, we were able to map a generic relief chain and develop a performance measurement framework. Twenty-four KPIs are proposed based on SCOR, which are then validated by both SCI and other international HROs joining the study.

The rest of the paper is organized as follows. Section 2 reviews the context of humanitarian logistics in the literature as well as some tools for performance measurement in both commercial and humanitarian world. Section 3 discusses the research methodology, and explains the reasons for using SCOR model in this study. Section 4 presents the reference framework and the measurement metrics by performance attributes. Section 5 reports the KPI validation process as well as the results and recommendations. Section 6 concludes the paper.

2. PERFORMANCE MEASUREMENT IN COMMERCIAL AND HUMANITARIAN LOGISTICS

Humanitarian logistics is the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials as well as related information, from point of origin to point of consumption for the purpose of meeting the end beneficiary's requirements [5]. The similarity in humanitarian and commercial logistics is that both include activities such as preparation, planning, procurement, transportation, storage, tracking, and customs clearance, but there are also many differences in objective, demand and supply pattern, flow type, lead time, stakeholders, operation environments. These differences are summarized in Table 1 with brief notes.

Topic	Commercial SCM	Humanitarian SCM
Main objective	Maximize profit	Save lives and help beneficiaries
Demand pattern	Fairly stable and can be predicted with forecasting techniques	Irregular with respect to quantity, time and place. Demand is estimated within the first hours of response
Supply pattern	Mostly predictable	Cash is donated for procurement. Unsolicited donations and in-kind donations need sorting, prioritizing to decrease bottlenecks
Flow type	Commercial products	Resources like evacuation vehicles, people, shelter, food, hygiene kits, etc.
Lead time	Mostly predetermined	Approximately zero lead time, demand is needed immediately
Delivery network structure	Established techniques to find the number and locations of warehouses, distribution centres	*Ad hoc* distribution facilities or demand nodes, dynamic network structure
Inventory control	Safety stocks for certain service levels can be found easily when demand and supply pattern is given	Unpredictable demand pattern makes inventory control challenging. Pre-positioned inventories are usually insufficient
Technology and information systems	Highly developed technology is used with commercial software packages	Less technology is used, few software packages that can record and track logistics data. Data network is non-existent
Performance measurement method	Based on standard supply chain metrics	Time to respond the disaster, fill rate, percentage of demand supplied fully, meeting donor expectation
Equipments and vehicles	Ordinary trucks, vehicles and fork-lifts	Robust equipment are needed to be mounted and demounted easily
Human resources	Commercial SCM is now a respected career path (Thomas, 2003)	High employee-turnover, based on voluntary staff, harsh physical and psychological environment
Stakeholders	Shareholders, customers and suppliers	Donors, governments, military, NGOs, beneficiaries, United Nations, etc.

Table 1: Commercial vs. humanitarian supply chain [6]

2.1 Performance measurement in commercial supply chain

Performance measurement is defined as an activity that is performed by managers to attain predefined company goals [7]. It affects strategic, tactical, and operational planning and control which is vital in setting objectives, evaluating performance and more importantly determining the future courses of action for the entire supply chain [8]. Performance measurement can be examined at three levels: individual performance metrics, sets of performance metrics (system or framework), and the relationship between the system and the environment [9].

Vahrenkamp and Siepermann [10] described performance metrics as consolidated quantitative data to measure operations and improvements, which provides a holistic view of the complex structures and interrelations in a system. It must be meaningful and relevant in order to aid management decisions and improve services. The design and development of performance metrics will thus have to be aligned with the supply chain strategy, where shared goals should be pursued and sub-optimization avoided [9, 11].

There are many works related to supply chain performance measurement with various approaches, different objectives and industrial settings [12]. The balance scorecard is a widely used framework on performance measurements by incorporating multiple relevant attributes together [13]. Bhagwat and Sharma [14] applied the balance score card to supply chain management, which provides a quantitative perspective of the dynamics of the distribution logistics chains by dashboards.

To measure the performance of a supply chain systematically, reference process models could be valuable tools [15]. A reference process model represents specific ordering of work activities across time and place, including clearly identified inputs and outputs [16]. It improves the speed and efficiency of modeling because of knowledge reuse and shared understanding through a common language. The most three reference process models to represent the upstream and downstream processes of a supply chain are Global Supply Chain Forum (GSCF), the Process Classification Framework by American Productivity & Quality Center (APQC), and Supply Chain Operations Reference (SCOR).

GSCF is built on eight key business processes which are customer relationship management, supplier relationship management, customer service management, demand management, order fulfillment, product development and commercialization, manufacturing flow management, and returns management [17]. The main critical linkage in this supply chain is the customer relationship management and supplier relationship management process. Each process in GSCF is managed by a cross-functional team and will interface with key customers and suppliers. This framework is more suitable for organizations that have a clear boundary between the business units.

APQC's Process Classification Framework is a high-level, generic enterprise model that will encourage business and other organizations to see their business processes from a cross-industry viewpoint instead of a functional viewpoint. It has identified 12 high-level functional categories and contains over 1000 process elements. Though it can be implemented in any organizations, it is more suitable to manufacturing companies.

SCOR is developed by the Supply Chain Council (SCC) to evaluate the overall effectiveness of a supply chain. It is a reference process model for supply chain management, which provides a framework that links business process, metrics, best practices and technology features into an integrated structure. SCOR is the most common model to describe supply chains using a common set of definitions, and can be used in various types of organizations. The model spans from a supplier's suppliers to a customer's customers. It describes the business activities required to satisfy customer demand and provides a basis on how to improve business processes. It uses benchmark and best practice data to prioritize the supply chain activities, quantify potential benefit of specific process improvement, and determine financial justifications [18].

SCOR integrates the business concept of process re-engineering, benchmarking, and measurement into its framework [19]. It covers all customer interactions (order entry through paid invoice), all physical material transactions (supplier's suppliers to customer's customers, including equipment, supplies, spare parts, bulk products, software, etc.) and all market interactions (from the understanding of aggregate demand to the fulfillment of each order). It does not attempt to describe every business process or activity. Figure 1 shows the entire supply chain's operation using SCOR processes.

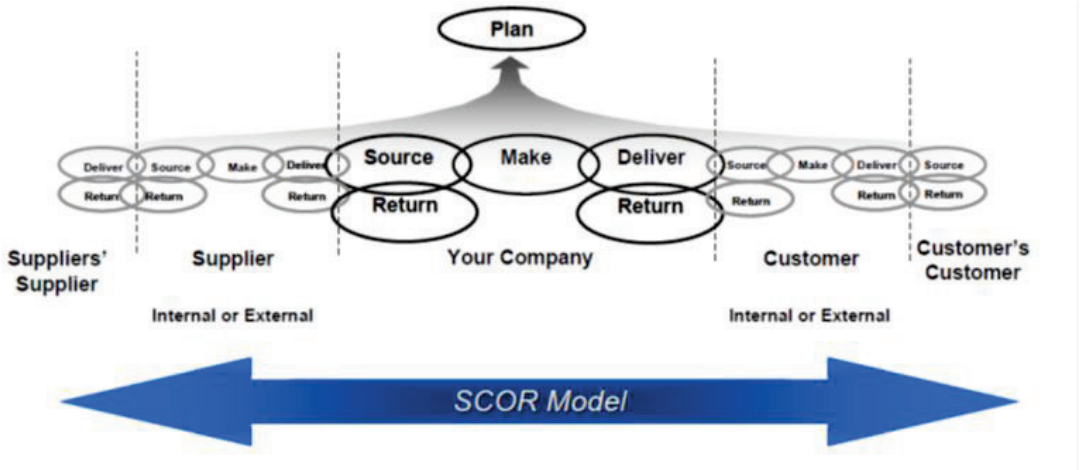

Figure 1: Depiction of end-to-end supply chain by SCOR [20]

SCOR features four level of supply chain management. Level 1 is the point at which a company establishes its competitive objectives. It focuses on five areas of supply chain such as plan, source, make, deliver, and return. Level 2 defines 26 core process categories that are possible components of a supply chain. Level 3 provides a company with more detailed information from Level 2 process categories to set a successful goal for its supply chain improvement, and Level 4 is industry-specific for a company to define for its areas of improvement.

The corresponding performance attributes in SCOR model are reliability, responsiveness, agility, costs, and asset management. SCOR defines reliability as the performance of supply chain in delivering, correct product as the correct time, in the correct condition and quantity, with the correct documentation, and to the correct customer. Responsiveness refers to the speed at which a supply

chain provides products to the customer, and agility is the ability of a supply chain in responding to market changes.

2.2 Development of performance measurement in humanitarian organization

Performance measurement is crucial in the humanitarian sector as there are numerous agencies competing for donor funding and higher demands for accountability of donors, media and the public [21]. Developing the right performance measurements can assist a humanitarian organization measure the impacts of disasters, enhance preparedness and as a result alleviate the impact of such disasters, and ultimately efficiently manage donor funds to maximize assistance to the beneficiaries [3].

Most of the early work on humanitarian performance measurement focused on measuring outcome attributes [22]. For example, the balanced scorecard approach, originally developed by Kaplan and Norton [13], has been expanded into the humanitarian area by pioneering works with several organizations which include UWSENE, Duke Children's Hospital and New Profit Inc. [21].

While most performance measurement frameworks in humanitarian organization are borrowed from commercial world, Henderson et al. [23] argued that many commercial performance metrics do not apply for humanitarian organizations. For example, the "bottom line" measurement of profit or loss does are not applicable to the humanitarian organization. Four steps were suggested to measure output and outcome attributes, identifying the organization's mission, developing qualitative requirement for indicators and measurements, developing primary indicators and measurements, and implementing the new performance measurement system [23].

Davidson [24] proposed a framework of four performance indicators, namely, appeal coverage, donation to delivery time, financial efficiency, and assessment accuracy. The study also noticed that performance measurement in HROs is challenging because they are not accustomed to such practices.

Beamon and Balcik [3] proposed a performance measurement framework for humanitarian organization after comparing the differences between commercial and humanitarian organizations in areas such as revenues, goals, stakeholders and performance measurement. They proposed a three-part framework performance measurement system focusing on resource performance metrics, output performance metrics, and flexibility metrics.

In summary, performance measurement in humanitarian organizations is less established in comparison to the commercial world. While there are some well-known generic frameworks for commercial firms such as the SCOR model and the Balanced Scorecard, there is not any universally accepted performance measurement framework in humanitarian organizations and it is difficult to develop appropriate metrics [25]. Moreover, many humanitarian organizations do not have appropriate performance measurement metrics, and those that do tend to make the mistake of employing too many metrics [26], which stretches their resources in data tracking and maintenance. Another challenge often faced by humanitarian organizations is the lack of data and system to capture

information. Additionally, data gathering varies from country to country and there is no consistency in data definition, which creates difficulty in the development of a proper performance management framework.

3. RESEARCH METHODOLOGY

The objective of the study is to develop a performance measurement framework for supply chain processes in humanitarian organizations, and recommend key measurement metrics using an appropriate supply chain tool. The study is conducted in the following stages.

First is the selection of reference process model. Based on our literature review and discussion with relief professionals from HROs, we decided to adopt SCOR as the core reference model. SCOR has been around since 1996 and is a comprehensive framework that links business process, metrics, best practices and technology into a single structure in the commercial world. In the context of SCI, it needs a generic and flexible tool to support its on-going consolidation process in its various country branches. The overall operation processes in these branches are adequately covered by SCOR.

In the second stage we develop a KPI framework as generic measurement on humanitarian supply chain. A mapping of existing supply chain processes in SCI is conducted against the generic process framework in SCOR. As there are three generic levels in SCOR, the mapping was done at the three levels respectively. In this stage, the researchers also screened through all performance metrics from Level 1 to Level 3 to identify metrics relevant to logistics activities. This stage is to develop a KPI framework for further study based on agreed four humanitarian logistics attributes, widely adopted by HROs which aim for “value for money”, agility (flexibility & adaptability), cost, responsiveness, and quality (reliability). Selection and adaption of suitable metrics was carried out through a two-pronged process of elimination and identification. The methods used are literature review and applying practical experience in commercial supply chain as well as the feedback from SCI. The research team would also compare existing KPI’s used on other HRO’s if this data is accessible. During the process, primary focus is given to high impact areas that are closely linked to HRO’s focus on “value for money” and potential to deliver tangible benefits to its operation. A generic supply chain process and an initial set of KPIs are proposed at the end of this stage.

In the third stage, we focus on the validation of the draft KPIs with other HROs through face-to-face or telephone interviews with field, regional and head quarter logisticians to get their feedback and opinion on the validity, availability and quality of input data. Researchers are expected to propose a number of critical KPIs for SCI then.

In order to validate the proposed KPI’s it is necessary to understand if the current operation systems (i.e. procedures, reports, tools and forms) are available and capable of capturing the data and also with what degree of integrity and quality. We would differentiate the KPIs into two groups, KPIs that

are measurable now and should be implemented, and KPIs not measureable now and could only be implemented in the future.

The validation process with the other HROs was conducted through our HRO contacts. Survey questionnaires were sent out and received seven valid responses. It covers both large and small international HROs, and both religious and secular HROs.

4. PROPOSED FRAMEWORK

To develop a set of logistics performance indicators, we use both performance attributes and logistics processes developed above as classification dimensions. The five performance attributes – reliability, responsiveness, agility, cost, and asset management in original SCOR model were carefully evaluated. In the context of humanitarian logistics, all these attributes except for the asset attribute are important. Reliability or quality is a key requirement of any supply chain. Measuring the reliability of logistics processes and products is the way to improve these processes. Responsiveness or timeliness is related to the response time of the supply chain, one key aspect in humanitarian operations. Cost is the measure of logistics financial performance, and all the three are widely used in literature [12]. Agility or the chain response to demand surge is one critical aspect in emergency relief operations. Only asset management is less important as HROs are normally asset-light without manufacturing facilities or other high- value fixed assets. SCI also views performance attributes related to reliability, responsiveness, agility, and cost as relevant in achieving its objective of achieving “value for money”. We thus adopt four performance attributes from SCOR model, reliability, responsiveness, agility, and cost.

On logistics processes, we similar adopt SCOR processes based the context of humanitarian operations. We take SCI (and other similar international HROs) as the focal company in our analysis and focus on supply chain processes under its control. The delivery processes at the ground level are thus not covered. In order to make the performance measurement framework manageable, considering the complexity of the humanitarian supply chain, the generic catalog of indicators or KPIs is structured in a hierarchy of three levels, in consistent to the SCOR model [20].

At Level 1, original SCOR Level 1 processes are plan, source, make, deliver and return. In the context of humanitarian operations, HROs normally do not manufacture humanitarian goods and collect return relief items. We thus remove make and return processes and add store to highlight the storing process in relief operations. Processes in Level 1 of the framework are plan, source, store, and deliver. Here plan includes activities to balance the demand and supply in developing best plans to meet sourcing, inventory and delivery requirement. Source includes activities to source and procure and services in meeting demands. Store includes activities to receive and inspect goods as well as to store and dispatch stocked goods. Delivery includes activities related to the management of received goods as well as the delivery of goods from the HRO.

KPIs at this level would contain indicators that reflect the overall performance of the HRO. These first level indicators will show the result of the efficiency of the HRO along the supply chain, and the combined use of these indicators will help understand the overall logistics performance of the HRO in reliability, responsiveness, agility, and logistics costs. The list of KPIs we adopted at this level is presented in Table 2.

SCOR Metrics	SCOR #	Performance Attribute	Description	Formula
Perfect order fulfilment	RL 1.1	Reliability	The percentage of orders meeting delivery performance with complete and accurate documentation and no delivery damage.	[Total perfect orders] / [Total number of orders] x 100% Note: an order is perfect if the individual items making up that order are all perfect.
Order fulfillment cycle time	RS 1.1	Responsiveness	The average actual cycle time consistently achieved to fulfill customer orders. For each individual order, this cycle time starts from the order receipt and ends with customer acceptance of the order.	[Total actual cycle times for all orders delivered] / [Total number of orders delivered]
Upside supply chain flexibility	AG 1.1	Agility	The number of days required to achieve an unplanned sustainable 100% increase in quantities delivered. Note: the 100% is a general benchmark in the context of humanitarian logistics (Original SCOR uses 20%),	Total elapsed days between the occurrence of the unplanned event and the achievement of sustained plan, source, make, deliver and return performance.
Supply chain management cost	CO 1.1	Supply chain costs	The costs associated with operating the supply chain.	The sum of the costs associated with the Level 2 processes to plan, source, store, and deliver.

Table 2: Proposed SCOR metrics at Level 1 for humanitarian organizations

At Level 2, Processes plan and source are further breakdown into four sub-processes, P1 (plan source), P2 (plan store), P3 (plan delivery), and P4 (plan for good-in-kind (GIK)1); S1 (source for goods going to be stored), S2 (source for goods going for immediate distribution), S3 (source for GIK going to be stored), and S4 (source for GIK going for immediate distribution). A SCOR Level 2 model is presented in Figure 2.

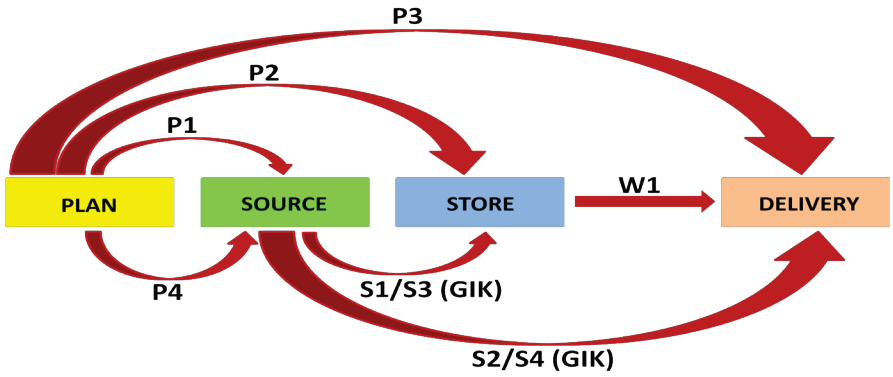

Figure 2: SCOR Level 2 model for SCI's supply chain

[1] Good-in-kind is goods given by donors directly.

KPIs at Level 2 provide more detailed measures for each combination of performance attribute and logistics processes. Most KPIs we adopted at Level 2 are closely related to KPIs we adopted at Level 1. For example, KPIs "sourcing cycle time", "assembly cycle time", and "delivery fulfillment cycle time" are closely related to Level 1 KPI "order fulfillment cycle time" to measure the chain responsiveness at three different processes. Only KPI "supply chain risk mitigation cost" are not directly associated to any Level 1 KPIs. The list of KPIs we adopted at this level is presented in Table 3.

SCOR Metrics	SCOR #	Performance Attribute & process	Description	Formula
Percentage orders delivered in full	RL 2.1	Reliability & delivery process	The percentage of orders which all of the items are received by customer in the quantities. It measures the quantity and quality of the delivery.	[Total number of orders delivered in full] / [Total number of orders] x 100%
Delivery performance to customer commit date	RL 2.2	Reliability & delivery process	The percentage of orders that are fulfilled on the customer's originally scheduled or committed date. It measures the timeliness of the delivery.	[Total number of orders delivered within scheduled date] / [Total number of orders] x 100%

Table 3a: Proposed SCOR metrics at Level 2 for humanitarian organizations

SCOR Metrics	SCOR #	Performance Attribute & process	Description	Formula
Documentation accuracy (compliance)	RL 2.3	Reliability & delivery process	The percentage of orders with accurate documentation supporting the order. The order will be considered to be accurate when documents related to: shipping, payment, compliance and other mandatory requirements are received in full, correct, and readily available when needed.	[Total number of orders delivered with accurate documentation] / [Total number of orders] x 100%
Perfect condition	RL 2.4	Reliability & delivery process	The percentage of orders delivered in an undamaged state that meets specification, have the correct configuration, are faultlessly installed and accepted by the customer.	[Total number of orders delivered in perfect condition] / [Total number of orders] x 100%
Sourcing cycle time	RS 2.1	Responsiveness & source process	The average time associated with sourcing processes. It gives an overall measurement on the sourcing process, starting from identifying the sources of supplies and ends at the supplier payments.	For all supply items ordered, the maximum value of ([The payment date] – [Date of informal sourcing request])
Assembly cycle time	RS 2.2	Responsiveness & store process	The average processing time between commencement of upstream processing and completion of all assembling process steps up to packaging and labeling operations. In the humanitarian context, it only covers the packaging and labeling operations for humanitarian kits.	[Total number of kits in active assembling] / [Average daily kits outputs]

Delivery fulfilment cycle time	RS 2.3	Responsiveness & delivery process	The average processing time associated with deliver processes.	[Total actual delivery cycle times for all orders delivered] / [Total number of orders delivered]
Upside source flexibility	AG 2.1	Agility & source process	The number of days required to achieve an unplanned sustainable 100% increase in quantity of supplies. Note: the 100% is a general benchmark in the context of humanitarian logistics.	For all supply items ordered, the maximum value of ([Receipt date of order in which quantity increases by 100%] – [PO date of order in which quantity increases by 100%])
Upside delivery flexibility	AG 2.3	Agility & delivery process	The number of days required to achieve an unplanned sustainable 100% increase in quantity delivered with the assumption of no other constraints.	For all delivery items, the maximum value of ([order delivery date in which quantity increases by 100%] – [The date of ordered items ready for delivery in which quantity increases by 100%])
Cost to plan	CO.2.1	Supply chain costs & plan process	The cost to manage the plan process.	The sum of all costs associated with the plan process such as plan to source, and plan to delivery.
Cost to source	CO.2.2	Supply chain costs & source process	The cost to manage the source process.	The sum of all cost related to sourcing cost such as material planning, planning procurement staff, supplier negotiation, bidding, and quotations.
Cost to deliver	CO.2.4	Supply chain costs & delivery process	The cost to manage the delivery process.	The sum of all costs associated with the delivery process such as outbound transportation costs.
Supply chain risk mitigation cost	CO.2.7	Supply chain costs & all processes	The cost associated with activities that are planned to mitigate supply chain risks.	The sum of the costs associated with supply chain risk mitigation activities in plan, source, and deliver processes.

Table 3b: Proposed SCOR metrics at Level 2 for humanitarian organizations (in continue)

In the model development at Level 3, the main supply process processes are mapped according to the SCOR processes while all administrative procedures are excluded and presented in Figure 3. Details of the last mile delivery processes are excluded as well. Furthermore, this supply chain workflow was mapped based on the assumption that SCI's financial aspects are stable and will not cause any impact on the processes.

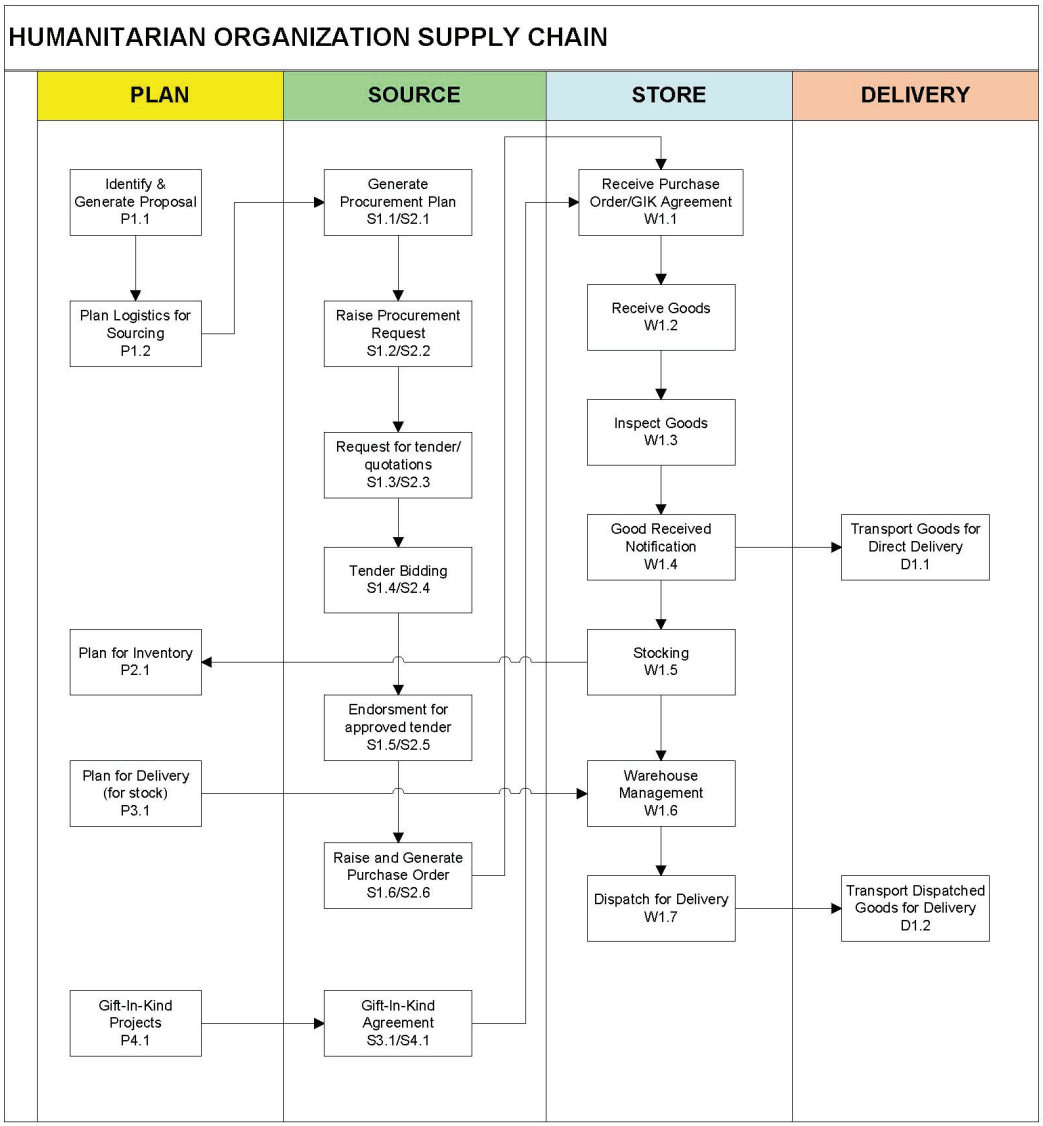

Figure 3: SCOR Level 3 model for SCI's supply chain

We similarly adopted several KPIs at Level 3 to measure related Level 3 processes. Since the focus of the study is HRO's logistics performance at country level, we only adopt nine important Level 3 KPIs. Seven of them are measuring some high impact aspects with potential to deliver tangible benefits to HROs such as on hand inventories. The other two KPIs, "store documentation accuracy" and "delivery documentation accuracy", are more detailed measure of Level 2 KPI "documentation accuracy" and can help the analysis of the Level 2 KPI. The list of KPIs we adopted at Level 3 is presented in Table 4.

SCOR Metrics	SCOR #	Performance Attribute & process	Description	Formula
Store documentation accuracy	RL 3.43	Reliability & store process	the percentage of orders with accurate documentation supporting the order in storage	[Total number of orders delivered with accurate store documentation] / [Total number of orders] x 100%
Delivery documentation accuracy	RL 3.50	Reliability & final delivery process	the percentage of orders with accurate documentation supporting the order in delivery	[Total number of orders delivered with accurate delivery documentation] / [Total number of orders] x 100%
Risk mitigation plan	RL 3.48	Reliability & all processes	It addresses two aspects, sources with documented contingency plans and sourced items with alternate or redundant sources. A simpler approach is to measure sourced items with alternate sources.	[Total number of items with alternative sources] / [Total number of items] x 100%
In stock %	RS 3.47	Responsiveness & store process	It measures the percentage of relief items that are in-stock when needed.	[Total number of essential items where the stock level falls below its minimum stock level during emergency event] / [Total number of essential items] x 100%
External event response (average days)	RS 3.31	Responsiveness & all processes	The average response time in days to an external risk event from the onset of the event, including detection lags.	For all items delivered for an emergency events, the average value of ([Date when a specific resource is delivered to victim] – [Onset date of a particular humanitarian event]).
Current on hand inventories	AG 3.39	Agility & store process	All current on hand inventories, including safety stock required to sustain current order fulfilment. An HRO has to know its actual on-hand inventories as well as the planned on-hand inventories to make this KPI useful.	The amount of all items currently in warehouses.
Current purchase order cycle time	AG 3.40	Agility & source process	The sum of time to place a purchase order and supplier lead times. It gives an overall cycle time from purchase request, to procurement, and finally to goods receipt.	For all supply items ordered, the maximum value of ([The goods receipt date] – [Date of purchase request])
Cost to manage product Inventory	CO.3.82	Supply chain costs & store process	All cost to manage inventory, covering all costs at the stage of store such as warehousing operating cost, rental cost, and manpower cost.	The sum of all costs on activities for store, including warehousing operating cost, rental cost, and manpower cost.
Cost to manage performance of supply chain	CO.3.78	Supply chain costs & all processes	The total cost associated with assessing supply chain performance, including cost associated to the monitoring of both internal and external players such as suppliers and shippers.	The sum of all costs on activities for supply chain performance management, including both manpower and documentation costs.

Table 4: Proposed SCOR metrics at Level 3 for humanitarian organizations

5. KPI VALIDATION AND RECOMMENDATIONS

Among the total 26 KPIs proposed in the above section, we remove two Level 1 KPIs to avoid duplication and put the rest 24 into validation. The two removed KPIs, "perfect order fulfillment" and "supply chain management cost", are well represented by their respective Level 2 components.

We have surveyed several international HROs, and got responses from seven of them between May and June 2013. Among the seven respondents, two are from SCI's branches (one Indonesia and one regional office), three are from large HROs, while the other two are from smaller international HROs. The respondents are asked to evaluate the importance and implementation difficulties of each KPI with five-point Likert scales ((1, 1) = (not important at all, not difficult at all) and (5, 5) = (very important, very difficult to implement)).

Based on these quantitative feedbacks, we first classify the 24 KPIs into four regions in a 2x2 dimension of importance versus difficulty. It is easy to see that the proper strategy for KPIs in Region I is to implement them, and the reasonable strategy for KPIs in Region IV would be not to implement these KPIs. The strategies for KPIs in Region II and Region III would be trickier. For KPIs that are important but difficult to measure, HROs may need to explore possible means to measure them, and the strategy would be future implementation. For KPIs in Region III, the strategy is unsure. HROs may need to examine these KPIs individually to decide whether to measure them or not. The strategies we discussed are summarized in Table 5.

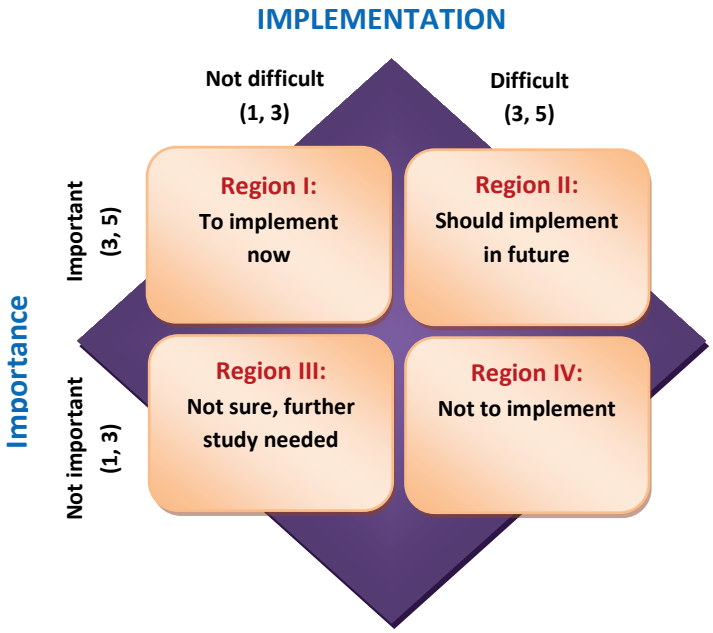

Table 5: General strategy for KPI implementation

Based on general strategies presented in Table 5, we are now exploring strategies for the draft 24 KPIs. According to initial results, all the KPIs are in either Region I (total 5 KPIs) or Region II (total 19 KPIs), thus the choice is only between implementation now or later. We then examine them in details.

As all KPIs are valued as important, we further differentiate KPIs by importance to two groups, highly important (average importance score at 4 and above), and less important ones (average importance score between 3 and 4). We can then divide the 24 KPIs into four sub-groups by importance and difficulty as shown in Table 6.

	Not difficult (1,3)	Some difficulty (3,4)	Very difficult (4,5)
Highly Important (4,5)	% goods are delivered in full and on time (L2); Current on hand inventories (L3); Source cycle time (L2); Current purchase order cycle time (L3)	Three KPIs on Documentation accuracy (3 to 5, L2 or L3); Perfect condition (L2); Order fulfillment cycle time (L1); In stock % (L3); External event response (L3); Cost to manage product inventory (L3)	Cost to plan (L2); Cost to source (L2); Cost to delivery (L2); Supply chain risk mitigation cost (L2)
Relatively Less Important (1,3)		Risk mitigation plan (L3); Assembly cycle time (L2); Delivery cycle time (L2)	Upside supply chain flexibility (L1); Upside source flexibility (L2); Upside delivery flexibility (L2); Cost to manage performance of supply chain (L3)

Table 6: Current KPI matrix by importance and difficulty

The first sub-group (in yellow) consists of KPIs that are highly important (score 4 and above) and easy (score below 3), which are expected to be implemented quite quickly. Five KPIs are in this sub-group, including two KPIs on reliability ("% orders delivered in full" and "delivery performance to customer commit date"), one KPI on responsiveness ("source cycle time"), and two KPIs on agility ("current on hand inventories" and "current purchase order cycle times"). The first two KPIs can be combined as one index to measure the delivery reliability, GOTIF (goods are delivered in full and on time), and we thus have four KPIs as the start. From the detailed feedback, some HROs feel GOTIF could be difficult to measure for the last mile delivery. Thus we have to add a constraint that this KPI is limited to the deliverance of suppliers. Similarly, "source cycle time" and "current purchase order cycle time" refer to the procurement processes. The two KPIs are a bit similar, but the former includes the time for internal order processing while the latter refers to the suppliers' lead time only.

The next sub-groups (in light blue) are highly important (score 4 and above) but having some difficulties to measure (score between 3 and 4). 8 KPIs, including four KPIs on reliability (three KPIs on documentation and KPI "perfect condition"), three KPIs on responsiveness ("order fulfillment cycle time", "In stock %", and "external event response"), and one KPI on cost ("cost to manage product inventory"). KPIs in this sub-group would be the focus of our study as these KPIs have the possibility to be implemented based on existing reporting systems in HROs after some improvement. For the four KPIs on reliability, the difficulty in measuring the three KPIs on documentation is the lack of record as well as the difficulty in recording checking. KPI "perfect condition" faces similar problem in implementation. For the first two KPIs on responsiveness, the measuring difficulty also lies on the ordering data checking and tracing. The other one is more related to the demand data estimation.

The third sub-group (in light red) is important KPIs but very difficult to measure. There are total 4 KPIs in the group, and are all related to the cost. It shows current financial system in HROs does not fit with costing for supply chain operations. It would be important for HROs to develop more relevant measures on these KPIs though it may take some times and efforts due to the measuring difficulties.

The last sub-group (in green) is less important KPIs but also difficult to measure. These KPIs are not in priority in this project unless improvements on the system make them easier to measure.

More specifically, we would suggest HROs to install some automated systems to improve the documentation accuracy while reducing the human effort of logistics workers. This system should record the sending out of order request as well as the delivery of suppliers, warehouse check-in and out. With the support from vendors and partners, the automation may help us to measure the three KPIs on documentation. Similarly, other KPIs in the second sub-group such as "perfect conditions", "order fulfillment cycle times", and "In stock %" can also be easily measured by the automated system. Moreover, some KPIs belong to the fourth sub-group such as assembly cycle time and delivery cycle time can then be easily measures as well. Such a system would increase the visibility of the supply chain as well and support the efficiency and effectiveness improvement of HROs. After the automation, we expect the distribution of the 24 KPIs would be shown in Table 7. Now we have 13 KPIs implementable compared to the original 5 KPIs.

	Not difficult (1,3)	Some difficulty (3,4)	Very difficult (4,5)
Highly Important (4,5)	% goods are delivered in full and on time; Current on hand inventories; Source cycle time; Current purchase order cycle time; Three KPIs on Documentation accuracy (3 to 5); Perfect condition; Order fulfillment cycle time; In stock %	External event response; Cost to manage product inventory	Cost to plan; Cost to source; Cost to delivery; Supply chain risk mitigation cost
Relatively Less Important (1,3)	Assembly cycle time; Delivery cycle time	Risk mitigation plan	Upside supply chain flexibility; Upside source flexibility; Upside delivery flexibility; Cost to manage performance of supply chain

Table 7: Revised KPI matrix by importance and difficulty after automation

6. CONCLUSIONS

The concept of performance measurement framework is well established in commercial organizations but generally lags in humanitarian organizations. Most humanitarian organizations recognize the importance of establishing a suitable performance measurement and the positive results it brings to their organization. Transferring the know-how and experience in performance measurement from commercial to humanitarian organizations makes good sense. SCOR model, being a framework that links business process, metrics, best practices and technology to improve the effectiveness of supply chain management, is a logical next step in the evolution of performance measurement in humanitarian organizations.

This paper demonstrates how the SCOR framework and its associated performance attributes can be adapted to the humanitarian supply chain. With the support of SCI and the other HROs, we are able to map the generic supply chain processes of humanitarian organizations and develop a set of twenty-four draft KPIs for HROs to measure and monitor their supply chain performances effectively. These metrics cover the key elements of quality, time, and cost in humanitarian supply chains, and assist humanitarian organizations to measure their performances in terms of agility, responsiveness, reliability and cost effectiveness along the whole supply chain processes. More importantly, from these metrics, organizations are able to benchmark internally against previous periods, externally with other humanitarian organizations and set objectives with quantifiable goals, all of which support

continuous improvement. It will enable humanitarian organizations to provide timely aid and efficient use of donor funds.

The validation of the draft KPIs with HROs shows the importance of these KPIs as well as the difficulty in their implementation. Only five KPIs out of the original twenty-four KPIs can be easily implemented in most HROs based on their existing procedures and practices. Based on the existing procedures of HROs, we suggest the automation of goods ordering, receiving and delivery in their logistics operations, which could improve documentation accuracy and reduce the workload of the logistics staff. We expect that automation would facilitate the implementation of eight more KPIs on supply chain reliability and responsiveness. Nevertheless, automation cannot help the implementation of the rest eleven KPIs, including those on supply chain costs. The weakness in cost measuring exists in most HROs. They need to improve by integrating their internal procedures across other operations functions such as Finance, Awards Management and distribution activities, for more effective measurement of their supply chain performances, especially in the supply chain cost estimation. Using organizational Monitoring, Evaluation, Accountability & Learning (MEAL) systems could support this process. Note that the platform and application requirements of an automated solution need to be carefully considered as the operational environment is very different from the commercial sector and new emergencies in particular would require an IT infrastructure before an automation system could be established.

Further work can be done to implement a logistics management system to automate the supply chain processes with real-time dashboards for better supply chain visibility. It is possible to find some KPI variations between logistics heavy and light countries. Here logistics heavy countries are countries with large logistics investment and spending for an HRO. Most Southeast Asian countries are deemed logistics light. For example, pre-qualification, contracting, and framework agreement would be more applicable in logistics heavy countries with high logistics demand. The automation of the delivery process would also be more applicable to logistics heavy countries. This will result in a comprehensive set of performance measurement metrics that is able to facilitate continuous improvement in the end-to-end supply chain processes of humanitarian organizations.

REFERENCES

IFRC, "World Disasters Report 2011," International Federation of Red Cross and Red Crescent Societies, Geneva, Switzerland12/01/12, 2011.

L. N. V. Wassenhove, "Humanitarian aid logistics: Supply chain management in high gear," The Journal of the Operational Research Society, vol. 57, no. 5, pp. 475-489, 2006.

B. M. Beamon and B. Balcik, "Performance measurement in humanitarian relief chains," International Journal of Public Sector Management, vol. 21, no. 1, pp. 4-25, 2008.

M. O'Neill and D. R. Young, "Educating managers of nonprofit organizations," in Educating Managers of Nonprofit Organizations, M. O'Neill and D. R. Young, Eds., ed New York, NY: Praeger Publishers, 1988, pp. 1-21.

A. Thomas and M. Mizushima, "Logistics training: necessity or luxury?," Forced Migration Review, vol. 22, pp. 60-61, 2005.

M. A. Ertem, N. Buyurgan, and M. D. Rossetti, "Multiple-buyer procurement auctions framework for humanitarian supply chain management," International Journal of Physical Distribution & Logistics Management, vol. 40, no. 3, pp. 202-227, 2010.

L. Clemens, L. Fortuin, and M. Wouters, "Designing a performance measurement system: A case study," European Journal of Operational Research, vol. 156, pp. 267-286, 2004.

A. Gunasekaran, C. Patel, and R. E. McGaughey, "A framework for supply chain performance measurement," International Journal of Production Economics, vol. 87, pp. 333-347, 2004.

A. Neely, M. Gregory, and K. Platts, "Performance measurement system design; A literature review and research agenda," International Journal of Operations & Production Management, vol. 15, no. 4, pp. 80-116, 1995.

R. Vahrenkamp and C. Siepermann, Logistik: Management and Strategien. Munchen: Oldenbourg Verlag, 2005.

H. Stadtler and C. Kilger, Supply chain management and advanced planning. Concepts, Models Software and Case Studies, 4th ed. Berlin, Germany: Springer-Verlag, 2008.

F. A. Garcia, M. G. Marchetta, M. Camargo, L. Morel, and R. Q. Forradellas, "A framework for measuring logistics performance in the wine industry," International Journal of Production Economics, vol. 135, no. 1, pp. 284–298, 2012.

R. Kaplan and D. Norton, "The Balanced Scorecard – measures that drive performance," Harvard Business Review, vol. 70, no. 1, pp. 71-79, 1992.

R. Bhagwat and M. K. Sharma, "Performance measurement of supply chain management: A balanced score card approach," Computers and Industrial Engineering, vol. 53, no. 1, pp. 43–62, 2007.

C. N. Verdouw, A. J. M. Beulens, J. H. Trienekens, and J. Wolfert, "Process modelling in demand-driven supply chains: A reference model for the fruit industry," Computers and Electronics in Agriculture, vol. 73, no. 2, pp. 174-187, 2010.

T. H. Davenport, Process Innovation: Reengineering Work through Information Technology. Boston, MA: Harvard Business School Press, 1993.

J. Cheng, K. Law, H. Bjornsson, A. Jones, and R. D. Sriram, "Modeling and monitoring of construction supply chains," Advanced Engineering Informatics, vol. 24, no. 4, pp. 435–455, 2010.

G. Stewart, "Supply Chain Operations Reference Model (SCOR): the first cross industry framework for integrated supply chain management," Logistics Information Management, vol. 10, no. 2, pp. 62-67, 1997.

S. Huan, S. K. Sheoran, and G. Wang, "A research and analysis of Supply Chain Operations Reference (SCOR) model," Supply Chain Management: An International Journal, vol. 9, no. 1, pp. 23-29, 2004.

SCC. Supply Chain Operations Reference Model 10.0 [Online].

R. S. Kaplan, "Strategic performance measurement and management in nonprofit organizations," Nonprofit Management and Leadership, vol. 11, no. 3, pp. 353-370, 2001.

N. Buckmaster, "Associations between outcome measurement, accountability and learning for non-profit organisations," International Journal of Public Sector Management, vol. 12, pp. 186-197, 1999.

D. A. Henderson, B. W. Chase, and B. M. Woodson, "Performance measures for NPOs," Journal of Accountancy, vol. 193, no. 1, pp. 63-67, 2002.

A. L. Davidson, "Key Performance Indicators in Humanitarian Logistics," Engineering Systems Division, Fritz Institute, 2006.

P. Tatham and K. Hughes, "Humanitarian logistic metrics: where we are, and how we might improve," in Humanitarian Logistics: Meeting the challenge of preparing for and responding to disasters, M. Christopher and P. Tatham, Eds., ed London: Kogan Page, 2011.

J. C. Sawhill and D. Williamson, "Mission impossible? Measuring success in nonprofit organizations," Nonprofit Management and Leadership, vol. 11, no. 3, pp. 371-386, 2001.

The Logistics Institute – Asia Pacific

Established in 1998, the vision of The Logistics Institute – Asia Pacific is to be the Asia Pacific's premier institute nurturing logistics excellence through research and education. Since its formation, it has served as the training ground for aspiring logisticians, equipping them with analytical tools to meet supply chain challenges. Since 2003, the institute has been voted Asia's Best Education Course Provider at the annual Asian Freight & Supply Chain Awards for eleven consecutive years. The Institute was also awarded the Best Training Provider at the Supply Chain Awards from 2009 to 2011.

A Collaboration Between

The Logistics Institute – Asia Pacific
National University of Singapore
21 Heng Mui Keng Terrace, #04-01, Singapore 119613

Tel: (65) 6516 4842 · Fax: (65) 6775 3391
Email: tlihead@nus.edu.sg · URL: www.tliap.nus.edu.sg