ADAPTING THE SCOR MODEL TO SUIT THE MILITARY: A SOUTH AFRICAN EXAMPLE

W.L. Bean, P.M.U. Schmitz, G.N. Engelbrecht
Logistics and Quantitative Methods, CSIR Built Environment, South Africa.

Introduction

The South African National Defence Force (SANDF) contracted the CSIR to investigate and propose methods to improve its logistics and inventory accounting capabilities. Based on suggestions by the U.S. Deputy Under Secretary of Defense (2000) and Parlier (2005) as well as on the CSIR's logistics and Supply Chain Operations Reference (SCOR) model experience, it was decided that supply chain management principles in conjunction with the SCOR model should be used to improve the SANDF's logistics effectiveness and the accounting of its inventory.

Three case studies were conducted to obtain a clear understanding of the SANDF and its supply chains. The first case study focused on the mapping and analysis of a single commodity in the SANDF. The chosen commodity for the first case study was 76mm high effect fused proximity ammunition, used by the South African Navy. The second, more complex, case study focused on the mapping and analysis of a multi-commodity supply chain. Three commodities, namely small arms ammunition, medicine and ration packs, were chosen for the study and these commodities were tracked from the SANDF's suppliers through to the SANDF's contingent in Burundi. The final, and most complex, case study focused on the mapping and analysis of supply chains as they appertain to weapon system supply in the SANDF. Three weapon systems, namely submarines, helicopters and armoured cars, were investigated. The SCOR v9.0 model (Supply-Chain Council, 2008a) was used to model the various supply chains of the SANDF.

During these case studies it was ascertained that the SCOR model did not cover the activities in the SANDF supply chain sufficiently and therefore, it had to be expanded to be applicable to the SANDF environment.

SCOR model applications

The SCOR model is a process reference model developed in 1996 by the Supply Chain Council as a tool that can be used for supply chain management in a wide range of industries. According to the Supply-Chain Council (2008a) it provides a unique supply chain management framework that links business processes, metrics, technology features and best practices into a unified structure that can be used to support communication between supply chain partners and to improve the overall effectiveness of supply chain management and other related supply chain improvement activities.

The SCOR model was developed to describe the business activities associated with the phases of satisfying customer demand (Supply-Chain Council, 2008a). The SCOR model is structured around five management processes, namely: PLAN, SOURCE, MAKE, DELIVER and RETURN. These management process building blocks can be used to describe very simple or very complex supply chains with one common set of definitions. The SCOR model covers all customer interactions, physical material transactions and market interactions but it does not attempt to cover sales and marketing, product development, research and development and some aspects of post-delivery customer support business processes.

The SCOR model is revised and adapted by Supply Chain Council members when it is deemed necessary and the SCOR v9.0 model is the eleventh revision of the original SCOR model. An overview of the SCOR v9.0 model is depicted in Figure 1.

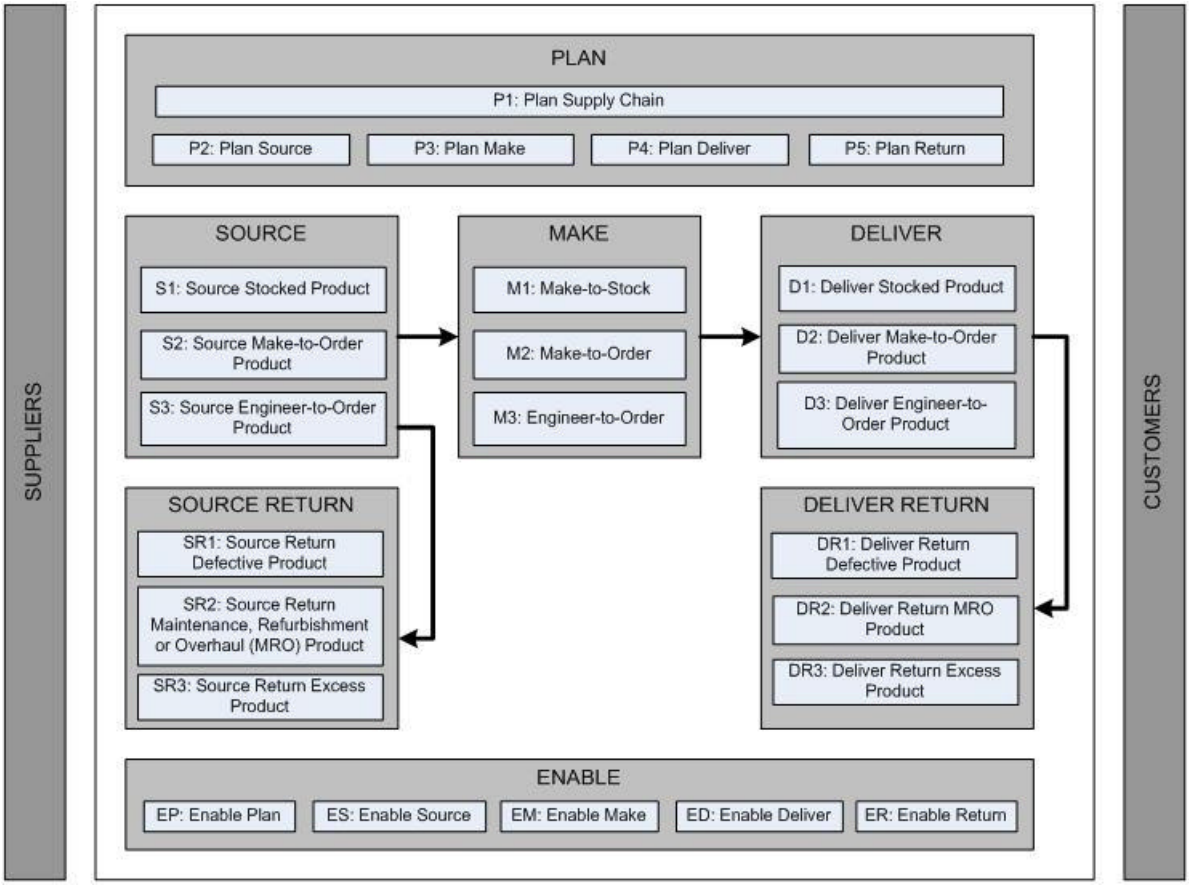

Figure 1: Original SCOR V9.0 Model (adapted from Supply-Chain Council, 2008b)

A summary of various case studies in which the SCOR model had been applied worldwide in the past are provided in Table 1. For each case study, the applicable industry or area, the way in which the SCOR model was applied as well as the adjustments or extensions made to the model are identified and summarised.

Application area	SCOR model application	SCOR model extensions and adjustments	Reference
Military environment of the United States of America.	The SCOR model is used to provide a structured approach that can be used to implement modern day supply chain management processes in Department of Defense (DoD) logistics organisations.	A *Maintain* management process is used instead of *Make*, due to the need for materiel repair in the DoD supply chain. The *Return* management process is excluded from the study.	Deputy Under Secretary of Defense (2000)
Geographical Information System (GIS) industry in South Africa.	The SCOR model is used to introduce supply chain management into a GIS unit in order to improve the effectiveness and efficiency of the unit when creating a GIS product. This SCOR application focuses on the management of the data used by a GIS unit.	In the extended version of the SCOR model, GISDataSCOR, the original five management processes are used and the *Make* management process is extended to include an extra process category for maintenance (*M4: Maintain-to-Stock).*	Schmitz (2007)

Table 1: An overview of SCOR model applications

Application area	SCOR model application	SCOR model extensions and adjustments	Reference
Thin film transistor-liquid crystal display (TFT-LCD) industry in Taiwan.	Critical metrics for the sourcing processes in the TFT-LCD industry supply chain are established by using the SCOR v7 model.	Although the study focuses on the *Source* management process, the other four management processes are also considered. No extensions are made to the model.	Hwang *et al.* (2008)
Information Technology (IT) and technology consulting industry.	The SCOR model is used as a basis for developing a complete methodology and framework for supply chain management problem solving.	The SCOR model is not adjusted, but simulation and optimisation techniques are used with the SCOR model to develop SmartSCOR, which is an integrated platform that supports end-to-end supply chain transformation using various techniques.	Dong *et al.* (2006)
Ethanol and Petroleum industry in the United States.	Documentary data obtained in a study of the U.S. Petroleum and Ethanol industry are coded in accordance with the five SCOR model management processes. The SCOR model is then used to synthesise data of operational activities and identify links, challenges and strategic priorities in the petroleum and ethanol supply chain.	The five SCOR management processes, i.e. *Plan*, *Source*, *Make*, *Deliver* and *Return*, are used as a basis for supply chain analysis. No extensions are made to the original SCOR model.	Russel *et al.* (2009)
Professional services industry.	The SCOR model is applied to the professional services industry in order to investigate the relevance of the model in the services sector. It is concluded that the SCOR model does not fit the services industry as a whole.	Although the SCOR model is not adjusted explicitly, a number of potential modifications are identified in the article. The *Make* and *Deliver* processes should be one process and the *Return* process is not required in the services industry. Provision should be made for additional work if a service is not acceptable to a customer.	Ellram *et al.* (2004)
Lamp production industry.	The SCOR model is used as a basis to develop a complete Supply Chain Performance Management System (SCPMS) for a company in the lamp production industry.	No adjustments or extensions are made to the existing five management processes in SCOR. Selected SCOR metrics as well as other additional metrics are used to develop the integrated SCPMS.	Vanany *et al.* (2005)

Table 1 (continued): An overview of SCOR model applications

Even though the SCOR model has been applied extensively in a wide variety of industries and supply chains, applications of the SCOR model to military supply chains are limited.

Problem description

While conducting the three case studies of SANDF supply chains, as discussed in the introduction, it was ascertained that the existing SCOR model did not cover all the activities in the SANDF supply

chain sufficiently. Therefore, the existing SCOR model had to be expanded to be more applicable to the military environment, in particular to the SANDF. The areas where expansion was required were identified and through collaboration with SANDF personnel adjusted according to military requirements.

SCOR model in the military

The adapted version of the SCOR v9.0 model to suit the military environment is depicted in Figure 2 and comprises six management processes, namely PLAN, SOURCE, MAKE, DELIVER, USE and RETURN.

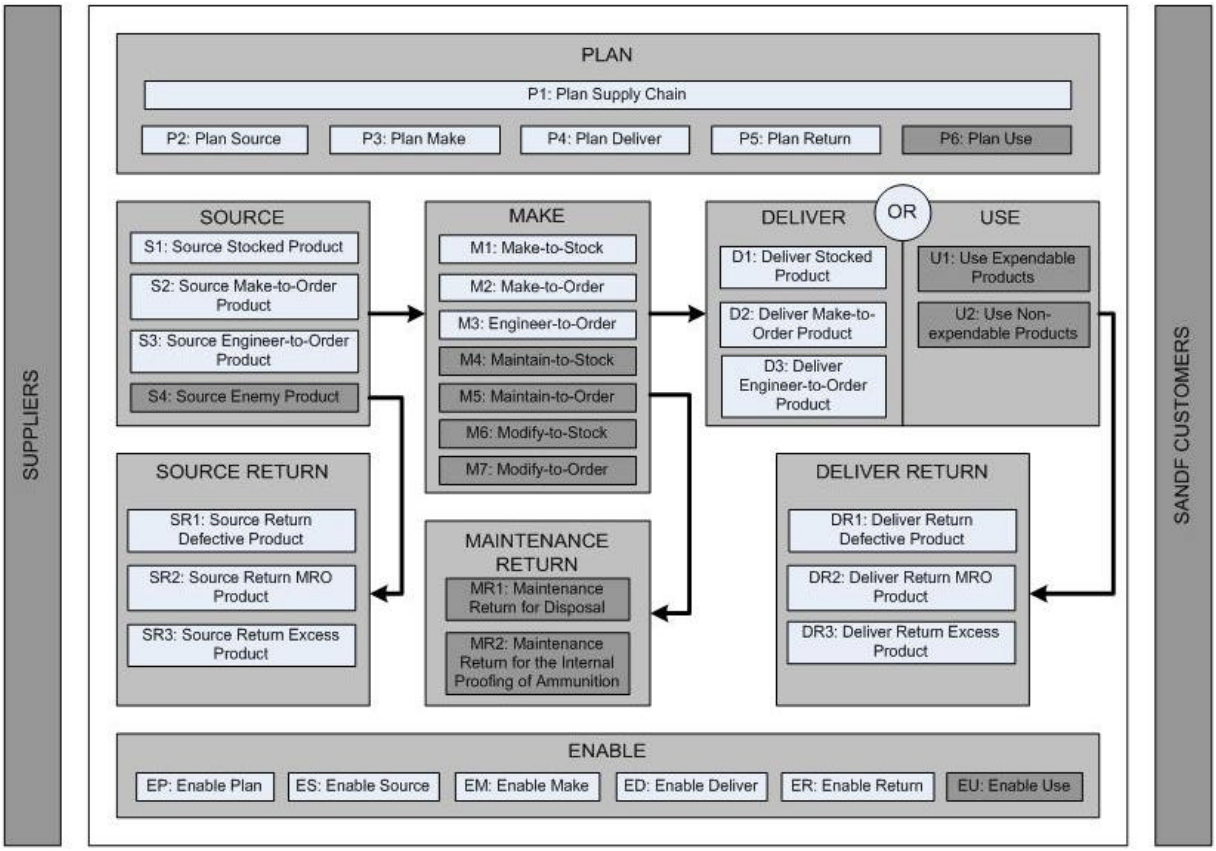

Figure 2: Adapted SCOR model for the military

Plan

The PLAN management process deals with the planning of the supply chain as a whole as well as the planning activities regarding the sourcing of products, the production, maintenance or modification of products, the delivery of required products, the use of products and the return of products for storage, maintenance or disposal.

Plan Supply Chain is the process category that includes all activities associated with the planning of the SANDF supply chain as a whole while the planning of all sourcing activities is described in the *Plan Source* process category. The planning of product manufacturing, maintenance and modification activities is described in the *Plan Make* process category. *Plan Deliver* and *Plan Use* are the process categories that describe all the activities associated with the delivery of products and the use of the delivered products respectively. The final plan process category, *Plan Return*, comprises all the planning activities included in the returning of excess products for storage as well as in the returning of defective products for maintenance or disposal.

Source

The SOURCE management process considers all the activities and processes involved in the sourcing of products from suppliers either outside or within the SANDF. The SOURCE management process comprises four process categories, namely: *Source Stocked Product*, *Source Make-to-Order Product*, *Source Engineer-to-Order Product* and *Source Enemy Product*.

Source Stocked Product is the process category that describes the activities involved in obtaining products that are stored for future use by the SANDF and includes the procurement, delivery, receipt and transfer of raw material items, sub-assemblies, products and services. There are five process elements within this process category which include the scheduling of product deliveries, the receipt of products, the verification of products, the transfer of products to their designated storage or use locations and the authorisation of supplier payments.

The *Source Make-to-Order Product* process category describes the activities performed when an order is placed for a product at a supplier and then produced by the supplier once the order is confirmed. Process elements included in the *Source Make-to-Order Product* process category are the scheduling of product deliveries, the receipt and verification of products, the transfer of products to their designated locations and the authorisation of supplier payments. The ordering of Ration Packs from a supplier is an example of a *Source Make-to-Order Product* process.

Source Engineer-to-Order Product is the process category where a product is designed, developed and manufactured based on the requirements or specifications of a particular customer order. This process category comprises five process elements, namely: *Schedule Product Deliveries*, *Receive Product*, *Verify Product*, *Transfer Product* and *Authorise Supplier Payments*. The sourcing of submarines, frigates, aircraft and armour are examples of engineer-to-order products in the SANDF.

The final SOURCE process category, *Source Enemy Products*, is an addition to the original SOURCE management process in the SCOR v9.0 model and deals with products that have been captured by the SANDF from an opposing force and recorded in the asset register for utilisation by the SANDF in current and future operations. This category consists of only three process elements, namely the receiving of the captured products, the verification of the captured products, specifically with respect to safety, and the transfer of these products to demanding units, warehouses or mobilisation depots.

Make

MAKE is the management process that considers all the processes and activities associated with the production, maintenance and modification of SANDF products. The MAKE management process has been expanded from the original three process categories in the SCOR v9.0 model to seven process categories. The three original process categories cover the activities associated with the manufacture or assembly of products for storage, the manufacture or assembly of products based on a particular order and the design and manufacture of products based on a particular order. The additional four process categories describe the maintenance of products within the SANDF as well as the modification of products by the SANDF to extend the lifetime of these products.

The *Make-to-Stock* process category includes all the activities related to the manufacture of a product with the intent to store the product in a finished goods state before delivering it to a particular customer. Products that are made to stock are manufactured before an actual customer order is received. When a product is manufactured based on the actual receipt of a customer order, the *Make-to-Order* process category is used. The *Engineer-to-Order* process category is used to describe all activities related to the design, development and manufacture of a product based on a particular customer order.

Two process categories that are used to address the maintenance of products within the SANDF were added to the original SCOR v9.0 model (Supply-Chain Council, 2008a), these include the *Maintain-to-Stock* and *Maintain-to-Order* process categories. The *Maintain-to-Stock* process category includes the maintenance activities that are performed without a particular maintenance order and with the intent to store the maintained product in a finished goods state before distributing it to demanding entities in the SANDF. The maintenance of ammunition at an ammunition depot is an example of a *Maintain-to-Stock* process. When a product is maintained as a result of a particular maintenance order, the *Maintain-to-Order* process category is used.

Final adjustments to the MAKE management process include the addition of *Modify-to-Stock* and *Modify-to-Order* process categories. Products are modified when certain product components are replaced with improved components or if a particular component is no longer available. The main reason to modify stock in the SANDF environment is to extend its useful life. The *Modify-to-Stock* process category describes all activities associated with the modification of a product, which is placed in stock at a warehouse or a mobilisation depot for later use. The *Modify-to-Order* process category is

used to describe the process of modifying a product that is based on the specific requirements of a customer. Products modified to order are delivered directly to the customer for immediate deployment upon completion of modification activities.

Deliver
Once the products have been sourced, produced, maintained or modified they need to be delivered to the various demanding entities within the SANDF, such as the delivery of various product systems to a user system manager to integrate them into a user system. The DELIVER management process consists of three process categories, namely *Deliver Stocked Product*, *Deliver Make-to-Order Product* and *Deliver Engineer-to-Order Product*.

The *Deliver Stocked Product* process category includes all the activities involved in the delivery process of a finished product from storage while the *Deliver Make-to-Order Product* encompasses all activities associated with the delivery of a product that is made based on a particular customer order. Finally, the *Deliver Engineer-to-Order Product* process category includes the processes involved in the delivery of a product that is designed, developed and manufactured in order to meet a specific customer order. No extensions have been made to the DELIVER management process of the original SCOR v9.0 model.

Return
The RETURN management process deals with the return of products by the demanding entity to the supplying entity for replacement, for Maintenance, Refurbishment or Overhaul (MRO) and for storage. Process categories included in this management process are *Source Return Defective Product*, *Source Return MRO Product*, *Source Return Excess Product*, *Deliver Return Defective Product*, *Deliver Return MRO Product*, *Deliver Return Excess Product*, *Maintenance Return for Disposal* and *Maintenance Return for the Internal Proofing of Ammunition*.

When a product received from a supplier is deemed defective, it is returned to the supplier for replacement. The activities associated with the return of this defective product to the supplier, as well as the disposition of expired material by a supplying entity, are discussed in the *Source Return Defective Product* process category. This process category comprises six process elements namely: *Identify Defective Product Condition*, *Disposition Defective Product*, *Request Defective Product Return Authorisation*, *Schedule Defective Product Shipment*, *Return Defective Product* and *Supplier Test or Proof Results*. The latter process element is exclusively applicable to ammunition and is the process where the supplier tests or proofs the received ammunition and releases the results to the SANDF for further action. The supplier disposes any excess ammunition. The results may lead either to disposal of ammunition, as given in the *Maintenance Return for Disposal* process category, or the remaining ammunition is kept in storage for use until the next maintenance cycle.

The *Source Return MRO Product* and *Source Return Excess Product* process categories are used when a product is returned to the supplier for MRO or when a product that is in excess is returned to the supplier for storage or reallocation, respectively. The process elements in these two process categories are similar to the process elements of the *Source Return Defective Product* category.

All activities associated with the return of a defective product from the customer, after the delivery of the product has taken place, are described by the *Deliver Return Defective Product* process category. This process category consists of four process elements, i.e. *Authorise Defective Product Return*, *Schedule Defective Return Receipt*, *Receive and Verify Defective Product* and *Transfer Defective Product*. When an item is returned from the customer for MRO or when an item, that is in excess at the customer, is returned for storage or reallocation to another customer, the *Deliver Return MRO Product* and *Deliver Return Excess Product* process categories are used respectively. The process elements in these two categories are similar to those of the *Deliver Return Defective Product* process category.

The RETURN management process has been extended to include the *Maintenance Return for Disposal* process category in order to cater for the physical return of defective products for disposal to designated disposal sites, identified during the maintenance or modification processes that cannot be dealt with under the *Return Defective Product* process category. There are four process elements included in this process category, namely*: Request for Disposal*, *Schedule Shipment for Disposal*, *Return for Disposal* and *Disposal of the Product*. The final extension to the RETURN management

process is the *Maintenance Return for the Internal Proofing of Ammunition* process category that deals with the internal proofing of ammunition by an ammunition depot and is exclusively used for ammunition in the military. Process elements included in this category are the proof request, the scheduling of the proof, the return of the product for proofing and the actual proofing, reporting and returning of the ammunition.

Use

The sixth management process, USE, describes all the activities and processes involved in the use of the various products by the SANDF and consist of the *Use Expendable Product* and *Use Non-expendable Product* process categories. The process elements of the two process categories in the USE management process were adopted from the DELIVER management process of the original SCOR v9.0 model.

The *Use Expendable Product* process category includes all the activities associated with the use of products that are exhausted upon the use thereof. An example of an expendable product in the SANDF is ammunition. The process elements included in the *Use Expendable Product* process category includes the processing of the customer demand, the reservation of inventory and the determination of the delivery date, the consolidation of orders, the receipt of the product from the warehouse, the issuing of the product, the expenditure of the product, the handling of arisings and the disposal of waste. Arisings can be described as anything that is recovered from the expenditure process, for example when expending ammunition the empty shells can be returned to the issuing entity as scrap metal.

Activities included in the use of re-usable products, such as vehicles, are contained in the *Use Non-expendable Product* process category. There are seven process elements in this process category, namely: *Process demand*, *Reserve resources and determine delivery date*, *Consolidate orders*, *Receive product from warehouse*, *Issue product*, *Use product* and *Return product*.

The decision to include the USE management process is based on the fact that the use of products by the SANDF triggers events within the supply chain for example, expended ammunition needs to be replaced (*Use Expendable Product)* or vehicles used by the SANDF need to be maintained after a specified period (*Use Non-expendable Product*).

Conclusions

The CSIR has been contracted by the SANDF to investigate and propose methods to improve its logistics and inventory accounting capabilities. It was decided that supply chain management in conjunction with the SCOR model should be used to improve the SANDF's logistics effectiveness and the accounting of its inventory, therefore the SCOR v9.0 model was chosen as a basis for modelling the SANDF's supply chains. Three case studies with increasing complexity were conducted and during these case studies it was ascertained that the SCOR model did not cover the activities, with regard to materiel, in the SANDF supply chain sufficiently. Consequently the SCOR model had to be extended to be more suitable for the military environment.

The extensions to the SCOR model include the introduction of a sixth management process, USE, which describes the use of ammunition and user systems, such as an armour regiment, during training and operational exercises. The MAKE management process is extended to include maintenance as well as the modification of materiel. A fourth process category is included in SOURCE to deal with captured materiel from the enemy that can be used by SANDF against the enemy in future. It was necessary to add two RETURN process categories, namely *Maintenance Return for Disposal*, where unusable material is destroyed by the SANDF and *Maintenance Return for the Proofing of Ammunition* where ammunition is proofed by the SANDF. Proofing of ammunition by suppliers is modelled through the normal RETURN process categories.

The research outputs achieved from this study are the basic building blocks that can be used to describe the various supply chains within the SANDF as well as the laying of a foundation for future SANDF logistics and supply chain policy.

References

- Deputy Under Secretary of Defense (2000). *DoD Supply Chain Management Implementation Guide.* Deputy Under Secretary of Defense (Logistics and Materiel Readiness), Office of Supply Chain Integration. Logistics Management Institute, 2000 Corporate Ridge, McLean, Virginia 22102-7805, USA.
- Dong, J., Ding, H., Ren, C. and Wang, W. (2006). IBM SmartSCOR – A SCOR Based Supply Chain Transformation Platform through Simulation and Optimization Techniques. Research Report, IBM Research Division, China.
- Ellram, L.M., Tate, W. L. and Billinton, C. (2004). Understanding and Managing the Services Supply Chain. *The Journal of Supply Chain Management*, 40(4):17 – 32.
- Hwang, Y.D., Lin, Y.C. and Jung, L. Jr. (2008). The performance evaluation of SCOR sourcing process – The case study of Taiwan's TFT-LCD industry. *International Journal of Production Economics*, 115: 411 – 423.
- Parlier, G.H. (2005). Transforming U.S. Army Logistics: A Strategic "Supply Chain" Approach for Inventory Management. *The Land Warfare Papers, No. 54.* The Institute of Land Warfare, Association of the United States Army, United States of America.
- Russel, D.M., Ruamsook, K. and Thomchick, E.A. (2009). Ethanol and the Petroleum Supply Chain of the Future: Five Strategic Priorities of Integration. *Transportation Journal*, 48(1): 5 – 22.
- Schmitz, P.M.U. (2007). The use of supply chains and supply chain management to improve the efficiency and effectiveness of GIS units. PhD thesis, University of Johannesburg, South Africa.
- Supply-Chain Council (2008a). *Supply Chain Operations Reference Model Version 9.0.* Supply-Chain Council, Pittsburgh, USA. www.supply-chain.org.
- Supply-Chain Council (2008b). *Supply Chain Operations Reference Model Version 9.0 Overview Booklet*. http://www.supply-chain.org/cs/root/scor_tools_resources/scor_model/
- scor_model.
- Vanany, I., Suwignjo, P. and Yulianto, D. (2005). Design of Supply Chain Performance Measurement System for Lamp Industry, *1st International Conference on Operations and Supply Chain Management*, Bali, Indonesia.