LOGISTICS AND SUPPLY CHAIN EFFECTIVENESS MEASURE AREAS IN LNG COMPANIES

Alicja NERĆ-PEŁKA

Summary

The article describes the issues of logistics and supply chain measures in companies. It considers different management systems in the area of production, which evolved from isolated production activities to business connected systems. There are performed three case studies - three examples of systems proposed and implemented in the LNG industry: I-MAC, ICIMS and PMS. Data gained from these systems are the basis to create effectiveness measures for LNG companies and LNG supply chains.

Key words: logistics and supply chain measures, LNG supply chains, production management systems

Introduction

To be successful - competitive in the marketplace, company should manage their processes, relationships with clients and focus on effectiveness not only on profit (M. Christopher, H. Peck, 2005). The practical and theoretical effectiveness evaluation methods propose a variety of measures, which are appropriate to different types of companies or supply chains. For that reason there is a problem choosing correct logistics and supply chain measures. Moreover, in literature various definitions exist for these two terms. Most companies' and supply chains' effectiveness evaluation methods are based on process analysis. The LNG supply chain can be evaluated accordingly to a process approach though earlier research includes only the Balanced Scorecard. The LNG supply chain is an unconventional chain. Its alterity is determined by dangerous material – LNG, which demands a suitable infrastructure. The LNG supply chain consists of other companies, gas exploration and production companies, production plants, receiving terminals, which have to manage complex, automated extraction, liquefaction and regasification installations. To gain high effectiveness of the LNG supply chain, there technical and management integration of the various links is fundamental.

The purpose of this research paper is to consider management systems, which are implemented and propose to implement in LNG companies, assessment grade of integration in LNG supply chain and possibility of effectiveness evaluation this supply chain.

Literature review

The relationship between logistics and the supply chain has been described frequently in literature. Research on 104 professionals in supply chain management (P. D. Larson, R. F. Poist, A. Halldórson, 2007) shows that in practice are in ebistence four models of logistics and supply chain management relations:

1. traditionalist – supply chain management is a part of logistics (J. R. Stock, D. M. Lambert, 2001) – 19% of respondents,
2. re-labeling – logistics is the same concept as supply chain logistics (D. Simchi-Levi, Ph. Kaminksy, E. Simchi-Levi, 2000, 2003) – 6% of respondents,
3. unionist – logistics is a part of supply chain management (D. M. Lambert, 2004, J. T. Mentzer, 2004) – 47% of respondents,
4. intersectionist – logistics and supply chain management have partly common elements (N. Rich, P. Hines, 1997) – 28% of respondents.

Logistics can be defined as “a process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and related information flows) through the organization and its marketing channels in such a way that current and future profitability are maximized through the cost-effective fulfillment of orders” and supply chain is “the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole” (M. Christopher, 2005). Accordingly to the unionist approach “supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies” (Council of Supply Chain Management Professionals).

Correctly defined relations between logistics and supply chain allows managers to choose the most suitable performance indexes for company and companies’ net. In science there are several methods and models which are equipped in the system of performance indexes such as Sink and Tuttle Model (D.S. Sink, T.C. Tuttle, 1989), Performance Pyramid (R. L. Lynch, K. F. Cross, 1992), Performance Prism (C. Adams, A. Neely, 2000), The Balanced Scorecard (R.S. Kaplan, D. P. Norton, 1992), Supply Chain Operations Reference Model (Supply Chain Council, 1996), Supply Chain Management Model (Global Supply Chain Forum GSCF, 1996) or Benchmarking (R.C. Camp, 1989).

Using the same measures in internal logistics operations and in supply chains cause many problems and there is need to create new types of measures for supply chain. Problems include (D. M. Lambert, T. L. Pohlen, 2001): the lack of measures that capture performance across the entire supply chain; the requirement to go beyond internal metrics and take a supply chain perspective; the need to determine the interrelationship between corporate and supply chain performance; the complexity of supply chain management; the requirement to align activities and share joint performance measurement information to implement strategy that achieves supply chain objectives; the desire to expand the “line of sight” within the supply chain; the requirement to allocate benefits and burdens resulting from functional shifts within the supply chain; the need to differentiate the supply chain to obtain a competitive advantage; the goal of encouraging cooperative behavior across corporate functions and across firms in supply chain. The lack of a balanced approach to financial and non-financial measures and the lack of clear distinction between metric and strategic, tactical and operational levels, these are additional problems in supply chain measurement (A. Gunasekaran, C. Patel, E. Tirtiroglu, 2001). Many companies are still relying primarily on traditional financial performance measures (S. Tangen, 2003). Performance measurement is a complex issue that normally incorporates at least three different disciplines: Economics, Management and Accounting (S. Tangen, 2004).

Logistics performance may be defined as the goals which are achieved in the area of cost-efficiency, sales growth, profitability, job security and working conditions, customer satisfaction, product availability, on-time delivery, social responsibility, keeping promises, low loss and damage, “fair” prices for inputs and flexibility (G. Chow, T. D. Heaver, L. E. Henriksson, 1994). Performance metrics for the supply chain (POA method) include cost, time, capacity, capability, productivity, utilization and outcome (F. T. S. Chan, H. J. Qi, 2003). Cost, activity time, customer responsiveness and flexibility used in supply chain either singly or jointly have many limitations as supply chain performance measures (B. M. Beamon, 1999). Dimensions of supply chain performance contain total supply chain cost, service level, asset management, customer accommodation, cash-to-cash cycle time and benchmarking (J. Thakkar, A. Kanda, S.G. Deshmukh, 2009). According to SCOR model supply chain measures should include indexes in the fields of: reliability, responsiveness, costs and asset management.

Methodology

Case study method is used in this article as the main method to find answers to the "what", "why" and "how" questions:

- question "what" – case study describes three informatics solutions which improve internal and external integration in LNG companies. Examples of management systems point out similarities, differences, possibilities and barriers in chosen concepts,
- question "why" – current situation in LNG companies and different approaches to activities in LNG plants, both allows to estimate level of integration in LNG supply chains and point out areas where effectiveness can be measured,
- question "how" - the objective of this stage is to examine the effects that the causes found in question "why" have on the current theories of logistics and supply chain integration and provide concrete solutions for companies.

The research provides current theories and practical solutions in the range of production methods and systems development in LNG industry. Two examples of management systems implemented in LNG companies have been analysed: I-MAC (Integrated Main Automation Contractor) and ICIMS (Integrated Control and Information Management System) together with the recommended system: PMS (Plant Management System). Comparison of data which is collected by these companies points out creating measurements possibility, lack of supply chain measures and level of integration between companies.

Data have been collected from secondary sources. The materials and information for the case studies and comparison were collected from Honeywell and TGE Gas Engineering GmbH conference publications and articles from Scientific Journals.

Results

Manufacturing has evolved and changed throughout the years. In literature and practice there can be seen a significant development of production methods and systems. Production-oriented systems such as computer aided design (CAD), computer aided manufacturing (CAM), computer integrated manufacturing (CIM) - 1970s, popular in 1980s, flexible manufacturing system (FMS) (1980s) and manufacturing resource planning (MRP-II) (1988 APICS) do not fulfill all companies expectations. High-tech production plants implementing new solutions include enterprise and supply chain management concepts. There are many gaps between production and information systems. Due to the lack of coordination and cooperation between computer integrated manufacturing (CIM) and management information systems (MIS) (1960s and 1970s) (J. A. Gowan Jr, R. G. Mathieu, 1994), D.A. Grant, O.K. Ngwenyama, and H.K. Klein propose the nomenclature, computer integrated manufacturing information systems (CIMIS), to describe all information systems of the manufacturing-based organization, both man-machine and machine-machine systems. Since the 1990s, when Gartner Group created ERP, this system has gained popularity among manufacturing enterprises (D. A. Hicks, K. E. Steche, 1995). ERP system by nature is not suitable for controlling day-to-day shop floor operations, and for this purpose, a new type of industrial software called MES (manufacturing execution system) emerged during the 1990s. MES aims to provide an interface between an ERP system and shop floor controllers by supporting various "execution" activities (MESA 1997). "Execution" means: making products; turning machines on and off; making and measuring parts; moving inventory to and from work stations; changing order priorities; setting and reading measuring controls; assigning and reassigning personnel; changing order priorities; assigning and reassigning inventory; scheduling and rescheduling equipment (M. McClellan, 2001). MES architecture is suitable for managing FMS lines under an ERP environment (B. K. Choi, B. H. Kim, 2002). The MES system bridges the gap between the planning system and the controlling system using on-line information to manage the current application of manufacturing resources: people, equipment and inventory. For many years modern control systems that manage or control a machine's functions such as PLCs used to run machine tools. Components of Manufacturing Execution Systems can also include: Statistical Process Control, Maintenance Management, Time and Attendance, Product Data Management, Process Data/Performance Analysis, Supplier Management, Genealogy/Product Traceability, Laboratory Information Management, Quality Assurance (M. McClellan, 2001). MES can work with software systems such as Six Sigma, Lean Quality, Demand Flow Scheduling (Industry Directions, 2004).

LNG manufacturing processes are becoming more complicated for general operators to understand completely due to the complexities of the processes and their automation. Due to the information integrated manufacturing environment, recent manufacturing plants have been operated with many advanced technologies such as on-line fault diagnosis, on-line optimization, scheduler, APC (S. Lee, Y. Yang, 2003). Advanced Process Control (APC) has evolved from the process control of the early 1950s, process control computers on chemical and petroleum plants in the 1960s, at the beginning of the 1990s as a distributed control systems DCS to economic performance evaluation of MPC (M. Bauer, I. K. Craig, 2008). To support their business processes and operating procedures, LNG terminals require both Terminal Information Management System (TIMS) and Process Control Systems (PCS). The main role of TIMS is to ensure operational safety and efficiency, and provide integration between corporate management systems and terminal Process Control Systems (M. M. Barash Ph.D., D. Rangnow). The latest systems implemented in LNG companies are complex, integrated tools which are based on automation, control and business solutions. Examples of the newest systems implemented in LNG production plants and LNG receiving terminals are I-MAC, PMS and ICIMS. Figure 1 shows practical solutions examples selection model.

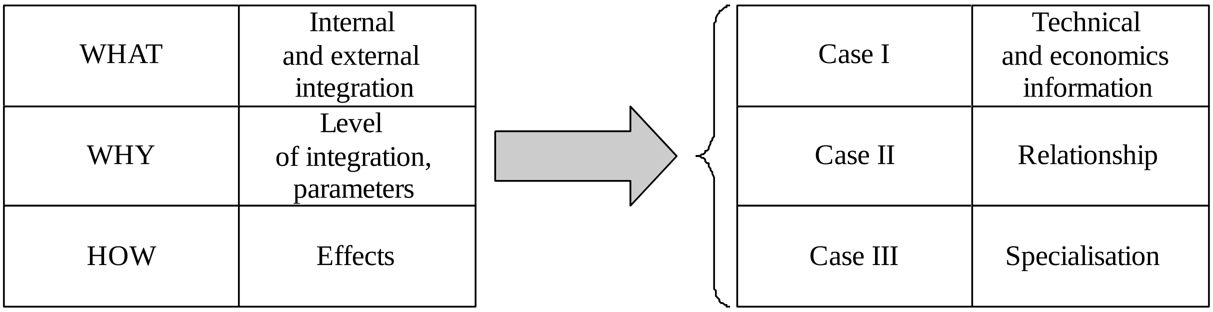

Fig. 1. Practical solutions examples selection model

I-MAC - Integrated Main Automation Contractor

I-MAC is a solution proposed by Honeywell for oil and gas production plants (Honeywell), for infrastructure, comprised of the Experion® Process Knowledge System (PKS) (based on DCS architecture), Enterprise Buildings Integrator™ (EBI) building automation system, fail-safe controllers, field instrumentation for fire and gas, physical security system, plant network design services, UniSim® simulation technology, PHD historian, Production Control Center MES applications for LNG, and Business Hiway XML services to integrate to various ERP systems (Honeywell, 2009). Honeywell Process Solutions (a division of Honeywell Automation and Control Solutions (ACS) a pioneer in automation control for more than 30 years delivers leading-edge automation and control solutions, equipment and services designed to improve customers' business performance. Traditional MAC includes field devices (control valves, pressure, temperature, level, analyzer, local indicators, tank gauging) and control (DCS, SIS, PLCs, compressors controls, RMPCT). The I-MAC concept is expanded for advanced control optimization (operator training, asset management), production management and enterprise resource planning and takes a three dimensional approach to build upon the benefits of (Honeywell, 2009):

- project objectives of cost, schedule and risk,
- operational and business readiness, ensuring that the asset is ready for flawless startup and reliable first year operations

- lifecycle sustainability through integrated lifecycle services.

This holistic approach addresses plant-wide integration and optimization at all levels of the enterprise and prepares the company for operational and business excellence (Honeywell, 2008).

I-MAC has been successfully implemented in the LNG receiving terminal – Freeport LNG, where performance can be created in the fields of (Honeywell, 2009):

- enterprise needs: business planning, accounting, warehousing, procurement, maintenance planning, human resource management, asset management, personnel training,
- fleet needs: fleet management, fleet scheduling, fleet performance,
- regulatory requirements: change management, compliance planning, compliance monitoring, incident management, contract administration, environmental monitoring,
- berthing requirements: berth scheduling, harbor management, vessel reporting,
- operations execution system needs: ship load/unloading, LNG capacity planning, Intranet services, laboratory info management system, long-term and short-term production planning, web-based user interface, batch control and APC, user logs and authorization, operations reporting, Key Performance Indication management, tank management, energy balancing, production balancing,
- automation infrastructure: control system DCS, safety instrumented system, fire & gas system, enterprise data historian, simulation (Ops Training), instruments, metering, process/ business LAN, HVAC, Telecommunication System,
- security requirements: access control system, personnel tracking system, surveillance system, port security, cyber security solution.

Honeywell has implemented its solutions also in Sines LNG (2006), Atlantic LNG (APC, 2008) and many other companies.

ICIMS Integrated Control and Information Management System

The concept of ICIMS has grown out of the need to provide for the integration of information across the enterprise. It has evolved out of a gradual extension of process information flowing from real time control systems into plantwide databases for historization and management reporting. The system has evolved from ERP and MIS systems, through Process Management Information System to integration with automation systems (N. Bhatti, 2007). The ICIMS system electronically collects and integrates business information, technical information, and plant control information for both onshore and offshore operations of the facilities. The

ICIMS consists of the following three major systems, with listed sub-systems, which are connected together by ICIMS network infrastructure and are accessible from PC/Workstations on the network (H. M. Al-Muhannadi, T. Okuyama, Ch. Durr; N. Bhatti, 2007):

1. ***Plant/Platform Control and Information Management System (PCIMS):***

- Real Time Information System (RTIS) – the RTIS system is based on the historical database and it has a calculation engine and client application packages. There is a possibility of data exchange between RTIS and DCS (Distributed Control System), so RTIS applications include schematic diagrams with data on pressures, temperatures, flow rates, status of motors, status summary and detailed reports about various units or production information & shipping data to assist in the management, production allocation and planning of company facilities. RTIS application files are shared and accessed by the client workstations to execute applications, view graphics and trend displays, and analyze and manipulate data using a set of end users tools (N. Bhatti, 2007). RTIS is a primary data source for the following key technical & business systems: PMS – Pipeline Management System, DRS – Data Reconciliation System, HAS – Hydrocarbon Accounting System, SCMS – Supply Chain Management System, SAP - Financial System (S. Al-Aqaily, 2008),
- Laboratory Information Management System (LIMS),
- Electrical Integrated Control System (ELICS),

2. ***Technical Information Management System (TIMS):***

- Engineering Work Environment – Computer Aided Engineering (CAE),
- Computer Aided Design and Drafting (CADD),
- Electronic Document Management System (EDMS),
- Computerized Maintenance Management System (CMMS),

3. ***Business Information Management System (BIMS):***

- Accounting and Finance,
- Production Management,
- Material Management,
- Human Resources Management,
- Procurement and Contract Administration,
- Management Information and Decision Support Tools.

ICIMS' SCMS Supply Chain Management System objectives are to maximize the synergy between the various projects and to optimize overall land utilization, facility sharing arrangements, shared storage and loading facilities (economic optimization of production, cargo rescheduling due to unplanned events external to the port, accommodating multiple annual programs in a single port environment, port management of short term unscheduled events, economic optimization – over entire supply chain, fleet optimization and terminal inventory control). There are some constraints on SCMS specifically related to: individual company sales contracts, different shareholders, different product spectrums, complex individual fiscal agreements and single harbor (N. Bhatti, 2007).

ICIMS was introduced in 1999 with the startup of a grass root LNG facility in Ras Laffan by the joint venture of Qatar Petroleum and ExxonMobil. The RasGas Real Time Information System (RTIS) is based on OSISoft PI system (S. Al-Aqaily , 2008).

PMS - Plant Management System

Another management system proposed by TGE Gas Engineering company for LNG companies is PMS - Plant Management System, based on enterprise resource planning (ERP), terminal and gas pipeline management and process control system (PCS) (C.-O. Pross, 2009):

1.Enterprise Resource Planning (ERP)

- Purchasing & Warehouse Management –Materials Management (MM)
- Economic and Financial –Financial Accounting (FI) /Controlling (CO)
- Maintenance Management –Plant Maintenance (PM)

2. Terminal & Gas Pipeline Management (TGPM)

- Integration of Plant Information and Measurement (PIM)
- Process Information Management (RTIS)
- Interface Management with the Technical System Manager (IM-TSM)

3. Process Control System (PCS)

- DCS Design and Structure
- DCS Application
- PCS Communication Bus Network
- Safety Control System (SCS)
- Fire, Spill & Gas Detection System (F&G)
- Pipeline PCS
- Electrical Management System (EMS)

PMS is a system that is proposed not only in LNG industry but also in the chemical process industry for example for an ammonia plant (ThyssenKrupp).

Figure 2 shows evolution of production management systems implemented in LNG industry.

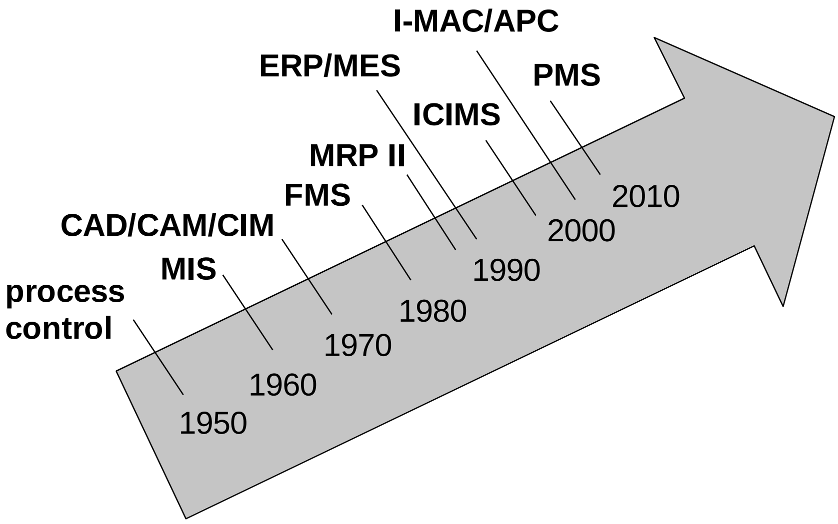

Fig. 2. Evolution of production management systems implemented in LNG industry

The latest management systems are complex solutions, which considers not only technical but also business aspects with connection to ERP system.

Discussion

On the basis of data, gained from the systems implemented in LNG companies, it can be concluded that most receiving terminals and production plants are integrated inside company. New solutions include not only data connected with material flow and installation maintenance but also data connected with information and financial flows. The ICIMS system is an example of relations development between supply chain links, that is external integration, where connected companies can take up decisions in real time. Effectiveness evaluation of LNG supply chain demands choosing appropriate indexes which are taking into consideration risk, added value, time, quality and costs in material, information and financial flows. It suggests the need from the creation of a method of effectiveness evaluation suitable for LNG companies. This method can help in the estimation of mutual cooperation between companies, highlight the areas in these companies and the processes in all supply chains which need improvement.

Conclusions

Performance of the specific manufacturing system can be created along the following dimensions (T. Guimaraes, N. Martensson, J. Stahre, M. Igbaria, 1999): manufacturing costs, output flexibility and cycle time, product quality, operator's motivation, stress, productivity and turnover. MESA International has conducted studies of companies using MES and offers the following benefits as reported by system users: reduction in manufacturing cycle time, reduction or elimination in data entry time, reduction in work-in-process inventory, reduction in lead times, reduction in paperwork between shifts, improvement in product quality, elimination of lost paperwork/blueprints, empowerment plant operations people, improvement of customer service, respond to unanticipated events (Michael McClellan, 2001). Application solutions such as MES allow to enhance performance in production plants and better material and information flows on company, however, if the company wants to be competitive in the market, it has to develop its relationships with suppliers and customers.

Nowadays computerized enterprise integration (CEI) is concerned with not only what happens within a given enterprise (intra-enterprise integration), but also what happens among a group of enterprises (inter-enterprise integration) (R. Davidrajuh, Z. Deng, 2000). The evidence of this situation are new complex management systems solutions, which point to integration development in LNG supply chains in the management area.

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The Szczecin University

The Faculty of Management and Economics of Services,

The Department of Logistics

ul. Cukrowa 8

71-004 Szczecin

e-mail: alicja.nerc-pelka@wzieu.pl