LogForum

> Scientific Journal of Logistics <

http://www.logforum.net

e-ISSN 1734-459X

Scientific journal, issued quarterly
since 2005

The papers are published in English only, in four issues yearly. The journal is edited in the paper form and also presented on-line (www.logforum.net). Each publication is evaluated (double blind) by at least two independent Reviewers.

The ethical policy of LogForum journal follows the Committee on Publication Ethics (COPE) recommendations.

AIMS AND SCOPE

LogForum is a scientific journal created to be a global forum for an exchange of scientific achievements and implementations in the field of logistics.

The journal publishes reviewed papers, which paid special attention to the most important aspects of logistics, e.g.:

Logistics and Supply Chain Management

1. Sustainable, safe, secure supply chain and logistics processes organization,
2. Technologies, information systems and standards for interconnected logistics,
3. Corridors, hubs and logistics equipment in supply chain management,
4. Packaging, warehousing and transport problems.

Management science - theory and practice

1. Modeling, simulation and optimization of management processes,
2. Specific management solutions in various branches,
3. Logistics and management education.

The journal is tracked by: Web of Science Core Collection - Emerging Sources Citation Index, DOAJ, Business Source Premier (ebsco), Academic Search Complete/Business Source Complete (ebsco) Ulrichs WEB, Primo Central Index, HINARI, J-Gate, Electronic Journals Library (EZB), Scirus, BazEkon, EconBiz , Erih Plus, Socolar (China), ROAD Directory of Open Access scholarly Resources, University of California Libraries, Swiss University Library Network (RERO), Arianta, Baztech, CEJSH, Harvard Libraries, Index Copernicus, Bielefeld Academic Search Engine, Baidu, TRIS (Transportation Research Information Services), Cabell's International.

Contents
Volume 2 2006

Issue 1

Issue 2

Issue 3

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 1
No 1

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

SOLUTIONS FOR THE DISASSEMLEY OF UNDEPLOYED AIRBAGS

Heiko Vesper

Projektlogistik GmbH, Wildau, Germany

ABSTRACT. Since the resources of mankind are limited, the reusage of materials from obsolete products is necessary and gets more important day to day.
That is why the German government has decided to pass a specific law, called the "Kreislaufwirtschafts- und Abfallgesetz". This law forces the producers to take back and recycle theirs products, especially cars and their accessories. Today the cars are recycled through shredding. Beside many other problems at this, the airbags inside these cars are very problematic since they contain explosives. The manual disassembly of undeployed airbags is very dangerous. Therefore the only solution is the automatic disassembly.
This article will show a solution of disposal logistics, called "Airbagdemontagezelle ADZ 2007". It is a joint project with University of Applied Sciences Wildau, an engineering company for logistics located in Wildau, Projektlogistik GmbH and a mechanical engineering company RASOMA Werkzeugmaschinen GmbH.

Key words: airbag disassembly, airbag recycling, undeployed airbags, disposal logistics, logistics development.

INTRODUCTION AND CHARACTERIZATION OF THE NEED FOR LOGISTICS SOLUTIONS

In 1996, a law was created to define the circular flow of potentially recyclable resources in Germany (KrW-/AbfG). It contains the promotion of the circular flow of potentially recyclable resources to save natural resources as well as the maintenance of environmentally safe waste disposal.

Given this new law, the definition of the circular flow of potentially recyclable resources follows chart 1.

In the automotive industry the national law for used cars regulates this flow. Basis for this regulation was the guideline for used cars of the European parliament and the European Council (2000/53/EG). Starting from 1st of January 2006 it adjusts the utilization and recycling quota of material and energy recycling.

- minimum 80% of material (shred and fractionation),
- minimum 5% of energy (burn).

This quota will increase in 2015 up to 95% in total.

The utilization of material by shred and fractionation is a commonly used method. However it is not possible to use this method to recycle active airbags. Already used airbags can be shred but it is hard to find companies to do so. The reason for this lies in the assumption that a used airbag is contaminated und not suitable for recycling. Shredding active airbags results in an uncontrolled

Citation: Vesper H., 2006, Solutions for the disassemley of undeployed airbags. LogForum 2, 1, 1.
URL: http://www.logforum.net/vol2/issue1/no1
Accepted: 30.01.2006, on-line: 15.04.2006.

distribution of explosives in the shred facility. This may lead to a dangerous situation in which the explosives are capable of an explosion of unknown impact.

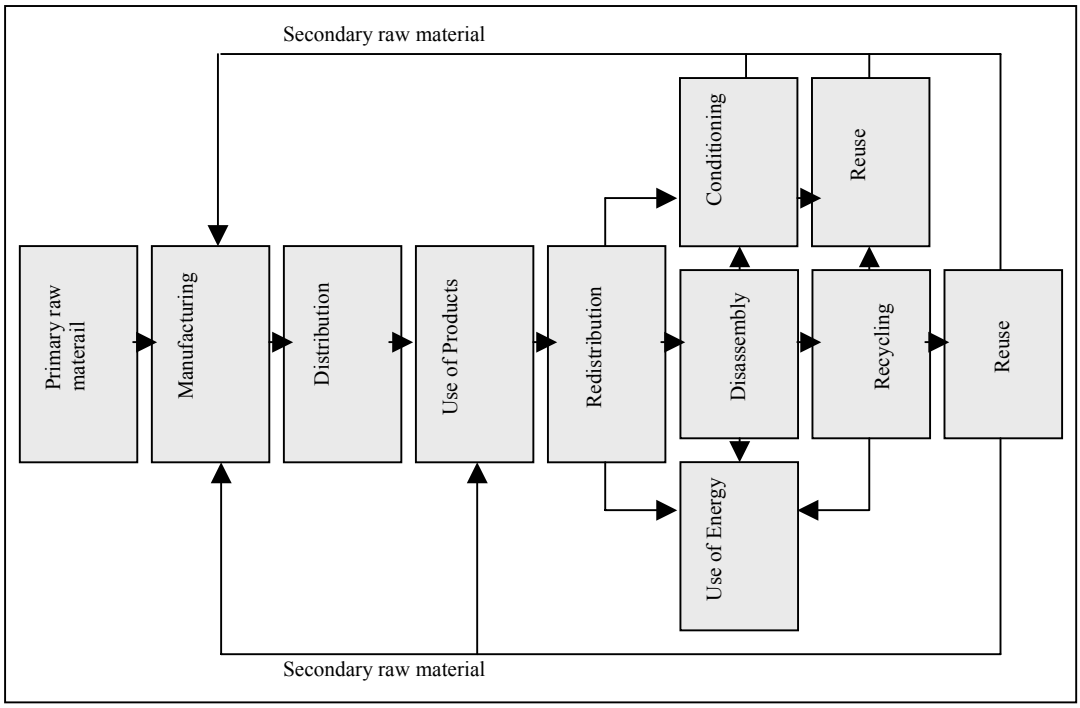


Fig. 1. New circular flow of potentially recyclable resources
Rys. 1. Nowy obieg zasobów recyklingowych

Nevertheless it is necessary to follow the regulations for recycling. To achieve this, it is essential to undergo the process of dismantlement of "armed" airbags. Additionally, the guidelines for handling of explosives are accomplished by the use of automatic disassembly processes.

CONSTRUCTION AND DISTRIBUTION OF AIRBAGS

An airbag is a basic equipment for almost each car, which has been manufactured for the last 10 years. Airbags for driver and co-driver as well as sidebags or windowbags are build-in to prevent the inmates from damages.

The picture 2 shows the construction of an airbag in principle.

To achieve a logistics solution the focus lies only on the airbag module and its components as relevant parts.

The generator and the fuse are the main parts of the airbag. They are responsible for the expansion of the airbag in case of crash. They have to be extracted and destroyed.

It is important to distinguish between the pyrotechnical generators with an exact amount of fuel and hybrid generators that produces the necessary quantity of gas in a very short time. Another element, the cover, is made of plastics, produced by injection moulding. The airbag is made of different polyamide fabrics.

Although, the components of an airbag are the same, they differ in shape and construction as presented in the picture.

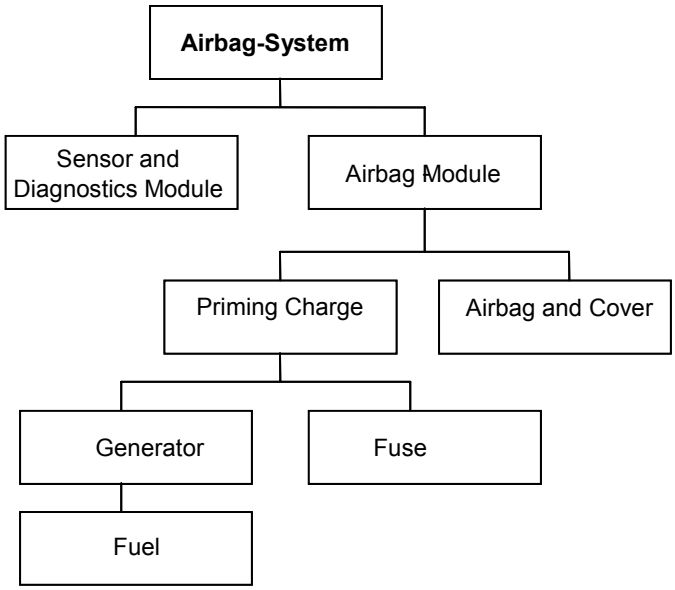


Fig. 2. Airbag terms according to the ISO-concept 1994
Rys. 2. Elementy poduszki powietrznej zgodnie z koncepcją ISO 1994

Fig. 3. (left to right) driver airbag, co-driver airbag, sidebag, windowbag
Rys. 3. (do lewej do prawej) poduszka powietrzna kierowcy, pasażera, boczna i okienna

This variety depends on the purposes of the airbags. These purposes are quite important to determine the dimensions of the solution. A problem is the connect determination of the actual lifetime of an airbag and the strains of these airbags. Consequently it is required to use estimations and forecasts that reflect a number of 6 million airbags in the year 2006. The cause for this high number is the increased need for security in cars. Rules for the installation of airbags in buses and trucks are already in use.

LOGISTICS REQUIREMENTS FOR THE DISASSEMBLY OF ACTIVE AIRBAGS

The process characteristics of the disassembly

General parts are:

- the single-variety segregation of materials,

- the recovery of parts, which should be made in good order.

The present industrial disassemblement is more or less characterized by manual labour especially in the field of airbag disassemblement.

The requirements for automatization have their roots in two reasons:

- a permanent danger of explosion and other harmful processes,
- a very complex sequence within the process.

Legal framework

The legal framework results from the fact, that active airbags are explosives and are subjects of the law for explosives (SprengG), the guideline for warehousing of explosives, the regulations for hazardous goods and the regulations for hazardous goods on streets (GGVS/ADR). These rules are valid not only for the transport of the airbags but also for the time of warehousing them.

DEFINITION OF THE DIFFERENT TECHNOLOGIES FOR THE DISASSEMBLEMENT

Due to the high numbers of manually dismantled airbags it was possible to obtain crucial results, which are important to determine the following processes. It was feasible to define for the mainly used airbags only two different technologies (A and B). The determination is characterized by the removal of the generator. While type A contains a generator, which is removable from the side facing the driver, type B contains a generator, which is turned away from the driver in the process of disassemblement.

As an extra step, the time for the manual labour was calculated. With these data it has become possible to specify an aimed-at time for the eventual automated process.

CHARACTERIZATION OF ELEMENTS FOR THE SOLUTION

ID-systems, which are associated with the process

The identification system, which is associated with the process, must use a technique, which is already in use. Currently every airbag has to be identified during the manufacturing process. To accomplish this, it is necessary to use a barcode system, which is applied by the manufacturer himself on the chassis of the airbag. It is important to have access via a manual barcode scanner. The advantage of this already used system lies in the reduction of input errors.

In case a barcode is not able to be read by a scanner, the employee will input the data manually.

Starting from the point of storage, the airbag is available for the whole system. This includes the automatic placing of the storage area and the allocation of specific programs for the disassemblement.

Development on a modular instep- and transport system

According to the demands of the processes of disassemblement, the innovative development must contain the following steps:

- exact order of process sequences of disassemblement,
- the same fixed point of mounting for all airbags,
- the resilience must be higher than any other force, which occurs during the process.

The transport system is based on an existing system made of conveyors and transport boxes.

Control of the system network

The control in the system network is using a main computer. This computer has access to all interconnected parts and contains the main control center. With its help, all relevant commands for the disassemblement, controlling, monitoring and guidance for the subsystems are maintained.

The main computer includes a central database and controls all data of the whole system including the flow of data. To assure a flawless process a secondary computer is used as "hot" redundancy. This way it makes it easy to maintain a continuous flow of data and an interruption-free process.

The main computer controls two different areas; first the control of the storage process and second the control of the actual process of disassemblement. The control of storage processes includes a subsystem for identification, storage in and out. The transport, the robotic systems and additional identification are part of the second subsystem.

A control system for emergencies is also implanted. This program stops all relevant processes of the disassemblement and the employee can interact without any danger if necessary.

OVERALL SOLUTION

Given the manual disassemblement and therefore the determination of the applied processes it was important to agree on the steps to implement all the process parts. To find a scientific and "optimal" solution, the morphologic scheme was applied. This scheme displays on one hand all possible characteristics of a potential solution and on the other hand all included processes.

By connecting these characteristics it was possible to create a variety of different results. All results were evaluated via a value benefit analysis. This kind of analysis consists of 4 evaluation groups and their specific criteria. The group of economical criteria includes for example costs of investment, costs for maintenance, costs for implementing the solution and costs of the development. In the field of general criteria, it was considered to evaluate the necessary qualifications of potential employees, the lifetime of the components and the dimensions of the facility. The area of process specifications was determined by retrofitting, efficiency per shift, industrial safety / the risk of injuries and the ease of operation of the instep system. The magnitude of realization, market chances and the implementation of the business model or the adjustment for other potential uses illustrate the fourth group (perspectives of the different versions).

Two versions emerged as favorable:

- version A: 2 robots with an automatic transport system,
- version B: 1 robot with an automatic transport system.

The main criterion that differs between these versions is the number of used robots. In version A, the transport system has the shape of the number eight and circulates around the robots. That leaves the possibility to work in different sections of the conveyor with the same tool. This version is the most efficient version but it is more expensive. Not only the investment of an additional robot and a more sophisticated conveyor is to be considered but also the higher costs of development and a more complex control system. All these considerations are the reasons to choose the version B.

As to be seen in the picture, two focuses were made in the whole system of the disassembly facility: for ones the transport system and the other is bulletproof cell.

Inside the cell the robot is operating according to the process steps. The different elements and the generator are put after the disassemblement in special boxes. The position for the connection elements is realized through deposited coordinates in the data pool or can be "trained" to the robot via the function "teach-in" which memorizes the coordinates and reproduces the data later on. The robot is located in a bulletproof and transparent cell. This cell makes it possible to monitor the whole process

and to detect any dangers as soon as possible. Due to safety reason, the airbags are channeled in visual range of the cell.

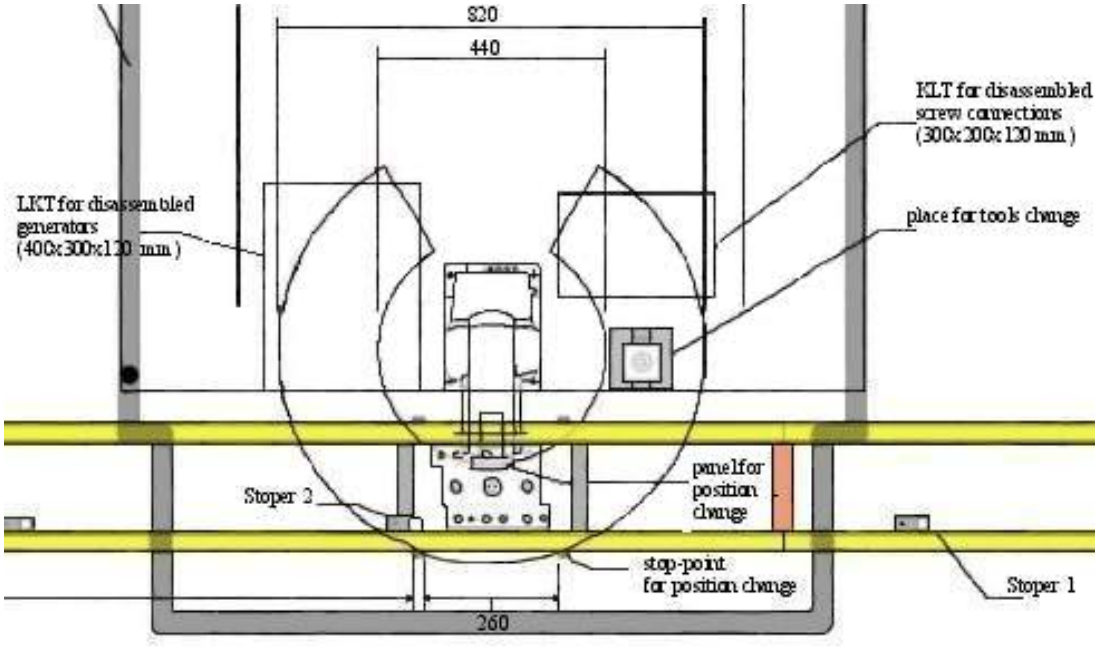


Fig. 4. Top view on the disassembly cell
Rys. 4. Rzut górny na komórkę demontażową

The transport system (bottom part of the picture, in front of the cell) is responsible for the supply in and out of the cell. The injection area in the initial part of the transport system identifies the airbag and the instep tool is installed on the robot. Thanks to that, a slipping of the airbag is prevented. Additionally the instep tool is fixed to avoid any danger for the robot or its components.

After the disassembly the transport system is moving to the start point. At the start point the instep system will be disengaged and the safe components will be extracted and deposited. Than it is possible to start the next cycle with the next airbag. The number of instep systems complies with the robots ability to disassemble.

CONCLUSIONS

The development of the airbag disassemblement cell has many advantages. The greatest benefits are the protection and safeness of the employees. The solution provides a high level of danger in the process of disassemblement. The introduced disassemblement cell stands for a maximum of flexibility. By using different technologies for the disassemblement process it was possible to gain a wide variety of possible uses. This disassembly cell is a real alternative in the light of the manual disassemblement. Only with this cell it is possible to achieve a safe process and to fulfill the needs of the circular flow of potentially recyclable resources.

REFERENCES

Airbag und Gurtstraffer, 2002, Vogel Buchverlag.

Verwertung & Entsorgung Airbag- und Gurtstraffer, VDA, 2001.

Gesetzestexte SprengG, SPrengV, SprengLR 240, GGVS.

ROZWIĄZANIA DEMONTAŻU NIEZUŻYTYCH PODUSZEK POWIETRZNYCH

STRESZCZENIE. Ponieważ surowce są dostępne ludzkości tylko w ograniczonych ilościach, odzyskiwanie surowców wtórnych z przestarzałych urządzeń jest metodą konieczną i nabierającą coraz większego znaczenia.
Dlatego też rząd Niemiec podjął decyzję o wprowadzenie w życie specjalnego prawa zwanego "Kreislaufwirtschafts-" oraz "Abfallgesetz". Prawo to zobowiązuje producentów do odbioru zużytych wyrobów ich produkcji, w szczególności ma ten przepis zastosowanie w przypadku samochodów i akcesoriów samochodowych. Obecnie samochody są poddawane recyklingowi poprzez cięcie na kawałki. Pominąwszy wiele innych problemów, jednym z podstawowych mankamentów tej metody jest problem poduszek powietrznych, zawierających materiały wybuchowe. Ręczny demontaż tych poduszek jest bardzo niebezpieczny. Dlatego też jedynym rozwiązaniem jest demontaż automatyczny.
Artykuł przedstawia rozwiązanie logistyczne tego zagadnienia znane pod nazwą Airbagdemontagezelle ADZ 2007. Jest to wspólny projekt Uniwersytetu Nauk Stosowanych w Wildau, firmy inżynieryjsko-logistycznej położonej w Wildau, Projektlogistik GmbH oraz firmy RASOMA Werkzeugmaschinen GmbH.

Słowa kluczowe: demontaż poduszki powietrznej, nieużyta poduszka powietrzna, rozmontowanie poduszki powietrznej, logistyka recyklingu, rozwój logistyczny.

ENTSORGUNGSLOGISTISCHE LÖSUNGEN FÜR DIE DEMONTAGE AKTIVER AIRBAGS

ZUSAMMENFASSUNG. Die Rohstoffe der Menschheit sind begrenzt. Daher wird der Einsatz von Sekundärrohstoffen immer wichtiger. Der deutsche Gesetzgeber hat dies erkannt und das Kreislaufwirtschaft und Abfallgesetz erlassen. Dies zwingt die Automobilhersteller zur Rücknahme und Verwertung von Altautos. Gängige Verwertungsmethode ist das Schreddern der Fahrzeuge. Besonders problematisch sind dabei die nicht ausgelösten Airbags, die ein beträchtliches Gefahrenpotential bergen. Die manuelle Demontage von Airbags ist sehr gefährlich, können diese doch beim Demontageprozess explodieren. Die einzige Lösung stellt die automatisierte Demontage dar.
Die "Airbagdemontagezelle ADZ 2007" soll in diesem Artikel als Lösung im Gebiet der Entsorgungslogistik vorgestellt werden. Hierbei handelt es sich um ein Gemeinschaftsprojekt der Technischen Fachhochschule Wildau, dem Logistikingenieurbüro Projektlogistik GmbH und der RASOMA Werkzeugmaschinen GmbH.

Codewörter: Airbagdemontage, Airbagrecycling, nicht ausgelöste Airbags, Entsorgungslogistik, Logistikentwicklungen.

Dipl.-Wirtsch.-Ing. (FH) Heiko Vesper
Projektlogistik GmbH
Bahnhofstr.1 / Halle VII
D-15745 Wildau, Germany
e-mail: Projektlogistik_GmbH@t-online.de

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 1
No 2

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

LOKALIZACJA ZAPASÓW W SIECI DYSTRYBUCJI

Stanisław Krzyżaniak

Instytut Logistyki i Magazynowania, Poznań, Polska

STRESZCZENIE. Celem tworzenia sieci dystrybucji jest lepsze udostępnienie klientowi dostępu do towarów oferowanych przez sieć. Przesunięcie zapasu bliżej odbiorcy poprzez ulokowanie go w magazynach regionalnych skraca czas realizacji zamówienia, wiąże się jednak z większymi kosztami wynikającymi z wyższych poziomów zapasów. Zazwyczaj jednak polityka lokalizacji zapasów nie jest jednorodna wobec wszystkich pozycji asortymentowych oferowanych przez firmę. W artykule rozpatrzono dwa sposoby rozdzielania zapasu zabezpieczającego pomiędzy oba rozpatrywane ogniwa sieci dystrybucji: Magazyn Centralny i Magazyny Regionalne. W praktyce taki rozdział jest przeprowadzany intuicyjnie. Na przykład pozycje wolno rotujące, zwłaszcza drogie, umieszcza się w zapasie centralnym, rozpraszając natomiast zapas towarów o dużej rotacji. W rzeczywistości można ustalić obiektywne kryteria wspomagające taką decyzję. W pracy przedstawiono modele pozwalające na wyznaczanie wartości kryterialnych i wszechstronną analizę wpływu poszczególnych zidentyfikowanych czynników (zmiennych niezależnych) na wynik i przyjętą decyzję.

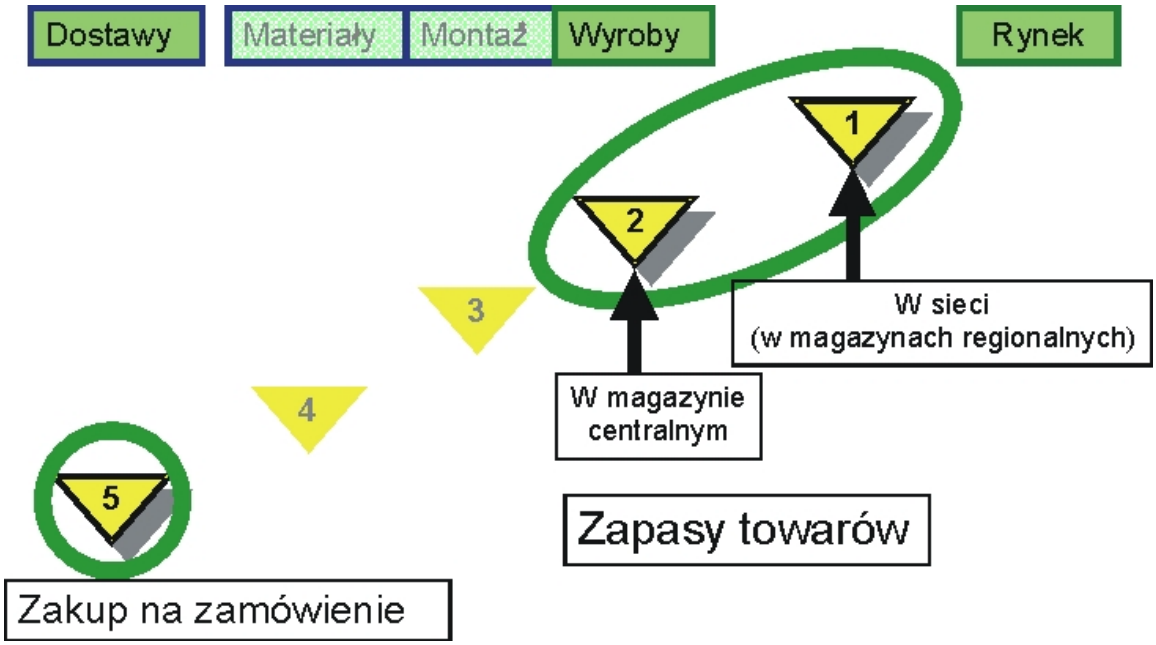
Słowa kluczowe: zapas zabezpieczający, sieć dystrybucji, lokalizacja zapasu.

WSTĘP

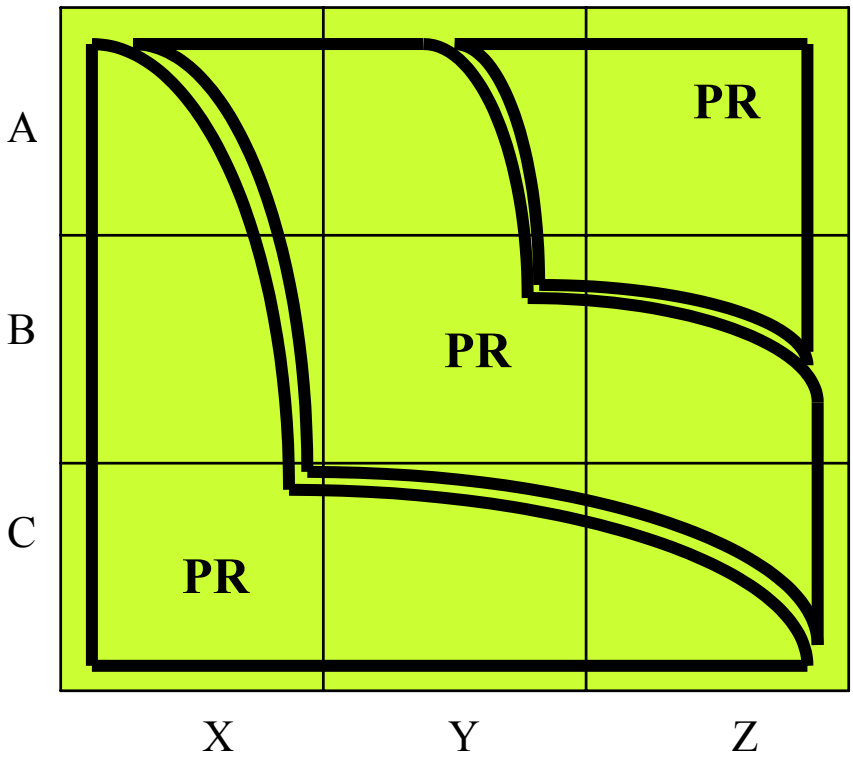
Celem pracy jest określenie ogólnego podejścia do właściwego lokalizowania zapasów (zwłaszcza zapasu zabezpieczającego) w sieciach dystrybucji. Koncepcja tzw. punktu rozdzielającego przewiduje skoncentrowanie zapasów zabezpieczających, koniecznych dla zapewnienia wymaganego poziomu obsługi w wybranym punkcie łańcucha dostaw [Pfohl 1998]. Klasyczne położenia tego punktu obejmują:

1. Zapasy wyrobów gotowych (towarów) zlokalizowane "blisko rynku" (np. w magazynach regionalnych firmy produkcyjnej lub dystrybucyjnej).
2. Zapasy wyrobów gotowych (towarów) zlokalizowane w magazynie centralnym producenta lub dystrybutora.
3. Zapasy elementów do montażu zlokalizowane w magazynie producenta umożliwiające tzw. "montaż na zamówienie".
4. Zapasy materiałów i surowców zlokalizowane w magazynie producenta umożliwiające tzw. "produkcje na zamówienie".
5. Zapasy materiałów, surowców i podzespołów zlokalizowane w magazynach dostawców producenta, lub zapasy towarów zlokalizowane w magazynach dostawców firmy dystrybucyjnej. To położenie wiąże się z rozwiązaniem: zakup (i produkcja) na zamówienie.

Cytowanie: Krzyżaniak S., 2006, Lokalizacja zapasów w sieci dystrybucji. LogForum 2,1, 2.
URL: http://www.logforum.net/vol2/issue1/no2
Zatwierdzono: 30.01.2006, on-line: 15.04.2006.



Rys. 1. Typowe położenia tzw. punktu rozdzielającego (z wyróżnieniem punktów charakterystycznych dla firm dystrybucyjnych)
Fig. 1. Typical decoupling point positions (together with characteristic points for distribution company)



Rys. 2. Przykładowe rekomendacje zależności pomiędzy lokalizacją punktu rozdzielającego, a położeniem danej pozycji asortymentowej w klasyfikacji ABC/XYZ
Fig. 2. Examples of correlations between localization of decoupling point and position of article in ABC/XYZ classification

Dystrybucja towarów obejmuje dwa pierwsze punkty rozdzielające, choć w strategii firm dystrybucyjnych znajdują się także działania objęte punktem nr 5, a więc zakup pod zamówienie

(zwłaszcza dla szczególnie drogich, a rzadko sprzedawanych pozycji). Warto też zauważyć, że coraz częściej firmy dystrybucyjne przejmują zadania ulokowane w punkcie nr 3, realizując część prac montażowych zgodnie z zamówieniem klienta.

Generalnie można przyjąć, że sposób postępowania z daną pozycją towarową zależy w pewnej mierze od jej położenia w klasyfikacji ABC/XYZ. Rysunek 2 pokazuje ogólne, raczej intuicyjne podejście do tej zależności. Na przykład towary drogie, wolno rotujące (a więc wykazujące niską dokładność prognoz, lokujące się w grupa AZ, będą raczej kupowane na zamówienie, a tanie, szybko rotujące, o wysokiej dokładności prognoz (grupa CX) będą zazwyczaj lokowane w sieci dystrybucji, w punkcie rozdzielającym nr 1.

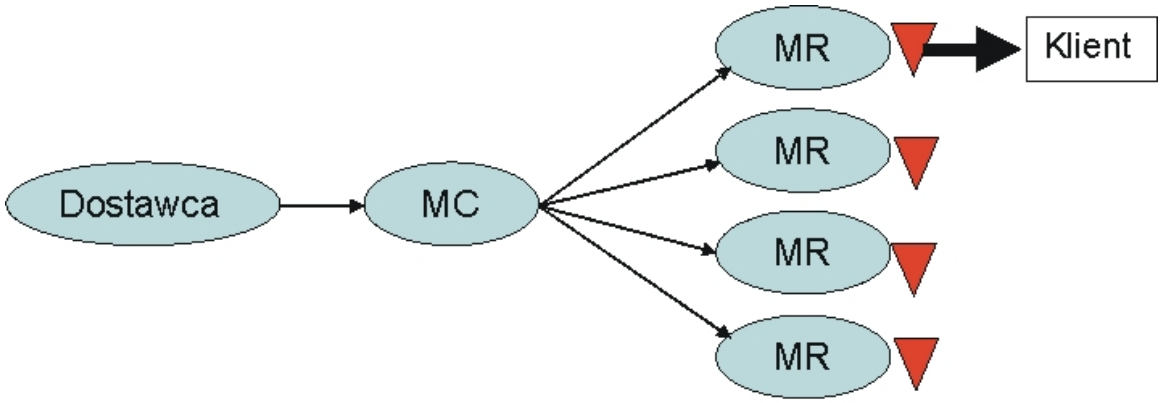
MODEL OGÓLNY

Jak zaznaczono, rysunek 2 raczej demonstruje pewne ogólne rekomendacje niż precyzuje zalecane rozwiązania. Granice pomiędzy poszczególnymi rozwiązaniami nie są bowiem "ostre", ale przede wszystkim na ostateczne rozwiązanie wpływa szereg dodatkowych czynników, takich jak: oferowany poziom obsługi (wymagany czas dostawy i dostępność), czas uzupełnienia, koszty dostaw, liczba magazynów regionalnych w sieci. Może się na przykład okazać, że w pewnych okolicznościach nawet bardzo wolno rotująca, a jednocześnie droga pozycja asortymentowa (lokującą się w grupie AZ), ze względu na swoje znaczenie "strategiczne" (odbiorcą jest ważny klient) będzie utrzymywana w zapasie, przynajmniej w magazynie centralnym. Podobnie skutkować będą bardzo długie terminy realizacji. Z kolei w rozległych sieciach, o dużej liczbie punktów lokalizacji zapasu (magazynów regionalnych), decyzje o pełnej decentralizacji zapasu będą podejmowane ostrożnie, z uwzględnieniem kosztu utrzymania zapasu.

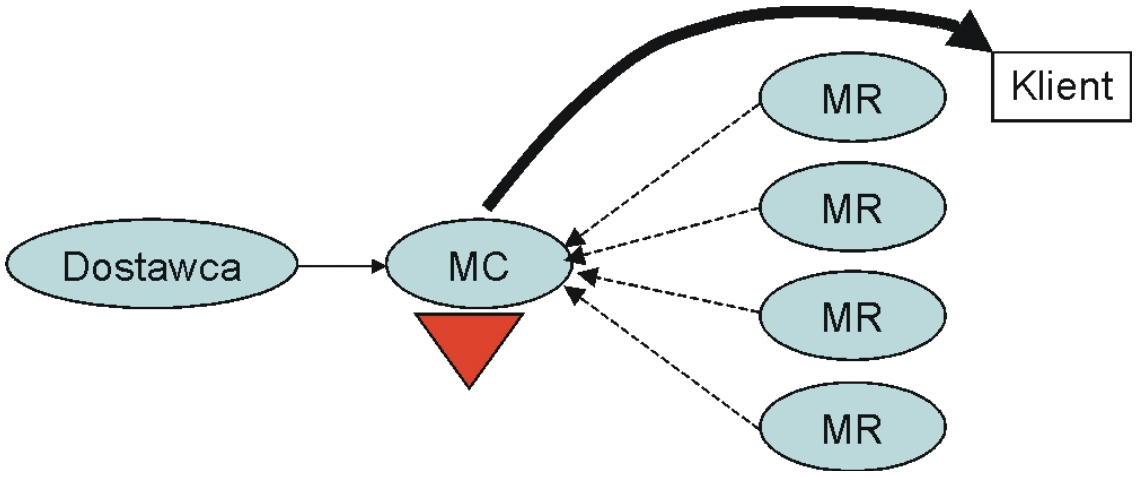
Poniżej rozpatrzone zostaną dwa sposoby lokalizacji zapasu:

a) Zapas rozproszony (rys. 3). Klienci obsługiwani są bezpośrednio z zapasu zlokalizowanego w Magazynach Regionalnych. Tam też utrzymywany jest zapas zabezpieczający.

b) Zapas scentralizowany (rys. 4). Klienci obsługiwani są z Magazynu Centralnego bezpośrednimi dostawami w postaci np. przesyłek kurierskich.



Rys. 3. Ilustracja przypadku zapasu rozproszonego
Fig. 3. Example of decentralized stock



Rys. 4. Ilustracja przypadku zapasu scentralizowanego
Fig. 4. Example of centralized stock

Powstaje pytanie: czy decyzje o właściwej lokalizacji zapasu można wspomóc jakąś formułą, uzależniającą rozwiązanie od wzajemnych relacji pomiędzy uwzględnianymi parametrami?

Poniżej przedstawiono propozycje prostych modeli mogących stanowić takie wsparcie.

Jak zwykle w takich przypadkach trzeba przyjąć pewne założenia. Dla potrzeb poniższych rozważań przyjęto, co następuje:

a) Jeśli zapas jest rozproszony, ulokowany w „n" Magazynach Regionalnych (punkt rozdzielający 1), to:
   - popyt rozkłada się równomiernie na „n" Magazynów Regionalnych,
   - tygodniowy popyt w każdym z tych magazynów daje się opisać rozkładem o średniej popytu P_{MR} i odchyleniu standardowym σ_{PMR},
   - cena zakupu u dostawcy jest równa C,
   - współczynnik tygodniowego kosztu utrzymania zapasu wynosi u_t i jest taki sam we wszystkich magazynach,
   - czas cyklu uzupełnienia zapasu w Magazynach Regionalnych jest dla każdego magazynu równy i wynosi T_1 (bez istotnych odchyleń).

Łączny tygodniowy koszt utrzymania zapasu zabezpieczającego w sieci jest równy:

$$K_1 = \sum_{1}^{n} KUtZB_{MR_i} \qquad [1]$$

Dla równomiernego rozłożenia popytu pomiędzy wszystkie magazyny otrzymujemy:

$$K_1 = n \cdot ZB_{MR} \cdot C \cdot u_t = n \cdot \omega \cdot \sigma_{P_{MR}} \cdot \sqrt{T_1} \cdot C \cdot u_t \qquad [2]$$

gdzie:

ω - współczynnik bezpieczeństwa, zależny od przyjętego poziomu obsługi i typu rozkładu opisującego dany rozkład częstości występowania popytu,

ZB_{MR} - zapas zabezpieczający w każdym z Magazynów Regionalnych.

Ponieważ zachodzi $\sigma_{P_{MR}} = \nu \cdot P_{MR}$ [3]

gdzie ν jest tzw. współczynnikiem zmienności $\nu = \frac{\sigma_P}{P}$, to wzór [2] przyjmuje postać:

$$K_1 = n \cdot \omega \cdot \nu \cdot P_{MR} \cdot \sqrt{T_1} \cdot C \cdot u_t \qquad [4]$$

b) Jeśli zapas jest ulokowany w Magazynie Centralnym (punkt rozdzielający 2), to:

- tygodniowy popyt w Magazynie Centralnym jest sumą popytów obserwowanych na rynkach związanych z poszczególnymi Magazynami Regionalnymi i można go opisać rozkładem o średniej $P_{MC} = n \cdot P_{MR}$ i odchyleniu standardowym $\sigma_{P_{MC}} = \sigma_{P_{MR}} \sqrt{n}$ (zgodnie z tzw. prawem pierwiastka kwadratowego [Sarjusz-Wolski, 2000]),
- współczynnik tygodniowego kosztu utrzymania zapasu wynosi u_t i jest taki sam jak w przypadku Magazynów Regionalnych,
- czas cyklu uzupełnienia zapasu w Magazynie Centralnym wynosi T_2 ($T_2=\alpha \cdot T_1$),
- w przypadku wystąpienia zapotrzebowania ze strony odbiorców produkt jest przesyłany bezpośrednio do klienta w formie przesyłki kurierskiej o jednostkowym koszcie k_{pk}. Pozwala to zachować zbliżony czas realizacji zamówienia klienta jak w przypadku obsługi z Magazynów Regionalnych.

Tygodniowy koszt utrzymania zapasu zabezpieczającego w Magazynie Centralnym jest równy:

$$K_{2(ZB)} = ZB_{MC} \cdot C \cdot u_t = \omega \cdot \sigma_{P_{MC}} \cdot \sqrt{T_2} \cdot C \cdot u_t \qquad [5]$$

Ponieważ, zgodnie z założeniami $T_2 = \alpha \cdot T_1$, to:

$$K_{2(ZB)} = \omega \cdot \sigma_{P_{MC}} \cdot \sqrt{\alpha \cdot T_1} \cdot C \cdot u_t = \omega \cdot \sigma_{P_{MR}} \sqrt{n \cdot \alpha \cdot T_1} \cdot C \cdot u_t \qquad [6]$$

Wstawiając zależność [3] otrzymamy:

$$K_{2(ZB)} = \omega \cdot \nu \cdot P_{MR} \cdot \sqrt{n \cdot \alpha \cdot T_1} \cdot C \cdot u_t \qquad [7]$$

Warto zauważyć, że założenie $T_2 = \alpha \cdot T_1$ uwzględnia różne rozwiązania organizacji dostaw dla obu przypadków. Na przykład w przypadku zapasów rozproszonych dostawy do magazynów regionalnych mogą być prowadzone według systemu przeglądu okresowego, a w systemie scentralizowanym w oparciu o tzw. punkt ponownego zamówienia (poziom informacyjny). Można przyjąć, że zazwyczaj będzie zachodziło $T_2<T_1$ (czyli $\alpha<1$).

Łączne tygodniowe koszty bezpośrednich kurierskich do klienta są równe:

$$K_{2(dostaw)} = n \cdot P_{MR} \cdot k_{pk} \qquad [8]$$

Stawiamy pytanie: kiedy „opłaca się" rozproszyć zapas, to znaczy kiedy taniej będzie utrzymywać zapas zabezpieczający w „n" Magazynach Regionalnych i z nich obsługiwać lokalnych odbiorców, niż skupić zapas w Magazynie Centralnym i realizować zamówienia klientów bezpośrednimi dostawami. Odpowiedź na to pytanie sprowadza się do rozwiązania nierówności:

$$K_1 < K_{2(ZB)} + K_{2(dostaw)} \qquad [9]$$

czyli

$$n \cdot \omega \cdot \nu \cdot P_{MR} \cdot \sqrt{T_1} \cdot C \cdot u_t < \omega \cdot \nu \cdot P_{MR} \cdot \sqrt{n \cdot \alpha \cdot T_1} \cdot C \cdot u_t + n \cdot P_{MR} \cdot k_{pk} \qquad [10]$$

Po kilku przekształceniach:

$$n \cdot \omega \cdot \nu \cdot \sqrt{T_1} \cdot C \cdot u_t - \omega \cdot \nu \cdot \sqrt{n \cdot \alpha \cdot T_1} \cdot C \cdot u_t < n \cdot k_{pk}$$

$$\omega \cdot \nu \cdot \sqrt{n \cdot T_1} \cdot C \cdot u_t \cdot \left(\sqrt{n} - \sqrt{\alpha}\right) < n \cdot k_{pk}$$

otrzymujemy

$$\nu < \frac{n \cdot k_{pk}}{\omega \cdot \sqrt{T_1} \cdot C \cdot u_t \cdot \left(n - \sqrt{n \cdot \alpha}\right)} \qquad [11]$$

Z tej postaci otrzymujemy zależności, których spełnienie gwarantuje spełnienie nierówności [9] i postawionego warunku:

$$\nu < \frac{\left[\frac{k_{pk}}{C \cdot u_t}\right]}{\omega \cdot \sqrt{T_1} \cdot \left[1 - \sqrt{\frac{\alpha}{n}}\right]} \qquad [12]$$

lub

$$\omega < \frac{\left[\frac{k_{pk}}{C \cdot u_t}\right]}{\nu \cdot \sqrt{T_1} \cdot \left[1 - \sqrt{\frac{\alpha}{n}}\right]} \qquad [13]$$

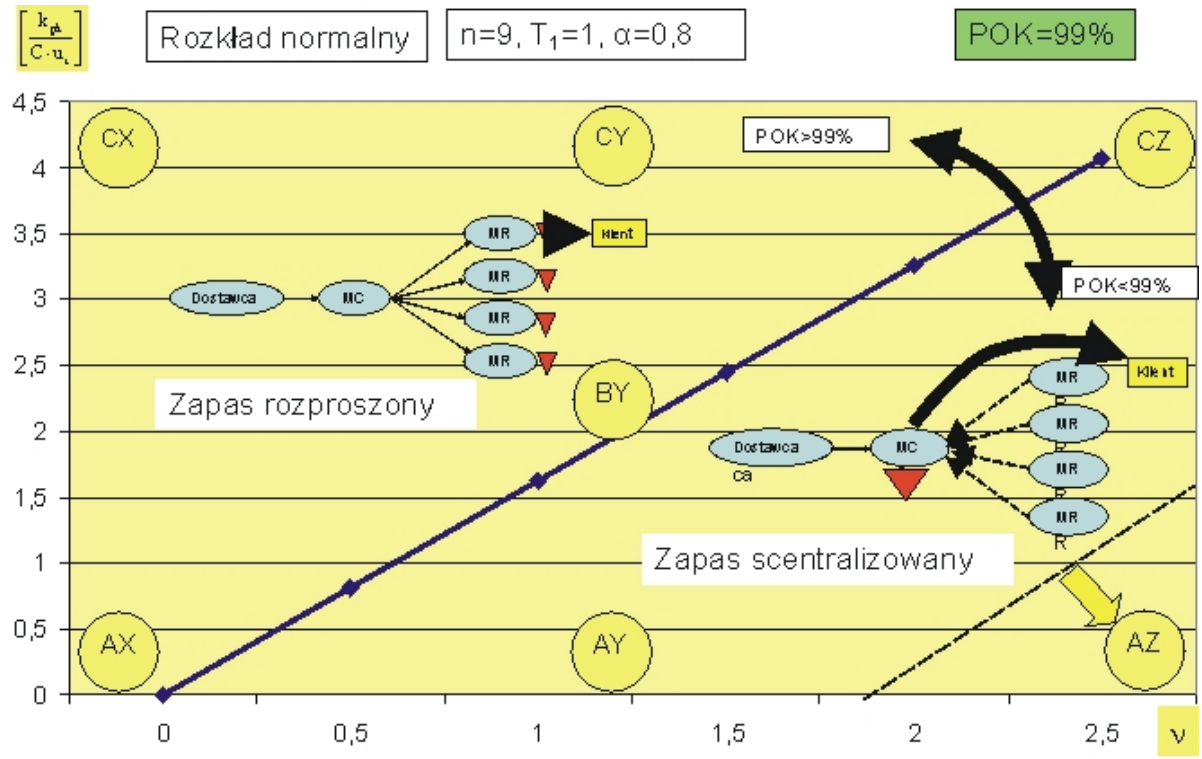
Wydaje się jednak, że zależność niosąca najwięcej informacji to:

$$\left[\frac{k_{pk}}{C \cdot u_t}\right] > \nu \cdot \omega \cdot \sqrt{T_1} \cdot \left[1 - \sqrt{\frac{\alpha}{n}}\right] \qquad [14]$$

łączy bowiem w wyrażeniu po lewej stronie nierówności wszystkie elementy kosztowe, a po prawej parametry związane z realizacja i wymaganym poziomem obsługi.

WYKORZYSTANIE MODELU DO ROZWIĄZANIA PROBLEMU DLA ROZKŁADU POPYTU ZGODNEGO Z ROZKŁADEM NORMALNYM

Rysunek 5 ilustruje tą zależność dla współczynnika zmienności n jako zmiennej niezależnej, dla rozkładu normalnego, przy poziomie obsługi POK=99% (w ujęciu probabilistycznym, jako prawdopodobieństwo nie wystąpienia braku w zapasie w danym cyklu jego uzupełnienia [Krzyżaniak 2005]). Założono alternatywne do scentralizowania zapasu rozproszenie pomiędzy 9 Magazynów Regionalnych.



Rys. 5. Ilustracja zależności [14] dla rozkładu normalnego i przykładowych wartości parametrów tej zależności (poziom obsługi POK=99%)
Fig. 5. Relationships in case of normal distribution and examples of parameters (for service level=99%)

Z zależności [14] i ilustrującej ją, dla wybranego zbioru parametrów, rysunku 5 wynika, że rozproszenie zapasu jest tym bardziej uzasadnione im:

- mniejsza jest wartość współczynnika zmienności ν (co oznacza wysoką jakość prognoz i zazwyczaj charakteryzuje towary szybko rotujące),
- większy jest koszt bezpośrednich dostaw do klienta, co zwiększa wartość wyrażenia $\left[\frac{k_{pk}}{C \cdot u_t}\right]$, oraz
- mniejszy jest koszt utrzymania jednostki towaru w zapasie, co również zwiększa wartość $\left[\frac{k_{pk}}{C \cdot u_t}\right]$.

Dotyczy to zatem towarów znajdujących się przede wszystkim w grupie CX. Podobnie większe wartości współczynnika zmienności (towary wolno rotujące), relatywnie niskie koszty dostaw bezpośrednich lub wysokie koszty utrzymania jednostki w zapasie (a więc na przykład grupy AY, BZ) wskazują na zasadność centralizacji zapasu. Wnioski te pozostają oczywiście w zgodzie z rysunkiem 2, ale w oparciu o zdefiniowane kryterium i określone wartości parametrów opisujących oba alternatywne rozwiązania.

ROZWIĄZANIE PROBLEMU DLA ROZKŁADU POPYTU ZGODNEGO Z ROZKŁADEM POISSONA

Nie ulega wątpliwości, że proponowane rozważania będą miały największe znaczenie dla towarów wolno rotujących. To właśnie w tej grupie obserwuje się najczęściej dylemat: utrzymywać zapas

towaru centralnie, czy przesunąć go do Magazynów Regionalnych. Przykładowe rozwiązanie przedstawione na rysunku 5 zostało oparte na założeniu o zgodności rozkładu tygodniowego popytu z rozkładem normalnym. Tymczasem towary wolno rotujące charakteryzują się raczej zgodnością z rozkładem Poissona [Sarjusz-Wolski 2000]. Rozkład ten charakteryzuje się jednocześnie pewną własnością, która pozwoli przekształcić zależność [11] w sposób nieco inny niż powyżej. Otóż dla rozkładu Poissona zachodzi: $P = \sigma_P^2$, a z tego wynika, że współczynnik zmienności jest tu równy:

$$\nu = \frac{\sigma_P}{P} = \frac{\sqrt{P}}{P} = \frac{1}{\sqrt{P}} \qquad [15]$$

Zatem zależność [11] przyjmie postać:

$$\frac{1}{\sqrt{P_{MR}}} < \frac{n \cdot k_{pk}}{\omega \cdot \sqrt{T_1} \cdot C \cdot u_t \cdot \left(n - \sqrt{n \cdot \alpha}\right)} \qquad [16]$$

co po przekształceniach daje:

$$P_{MR} > \frac{\omega^2 \cdot T_1}{\left[\frac{k_{kp}}{C \cdot u_t}\right]^2} \cdot \left(1 - \sqrt{\frac{\alpha}{n}}\right)^2 \qquad [17]$$

Przy próbie rozwiązania tej nierówności należy uwzględnić fakt, że dla rozkładu Poissona istnieje zależność pomiędzy wartością średnią P_{MR}, a wartością współczynnika bezpieczeństwa ω odpowiadającego przyjętemu poziomowi obsługi [Krzyżaniak, 2005]. Postać funkcji $\omega = f(P)$ jest różna dla różnych wartości poziomu obsługi. Przykładowo, dla POK=99,9% zależność ta ma postać $\omega \approx A \cdot P^b$, gdzie A = 3,7402; b = -0,05. Dla tej postaci funkcji otrzymamy:

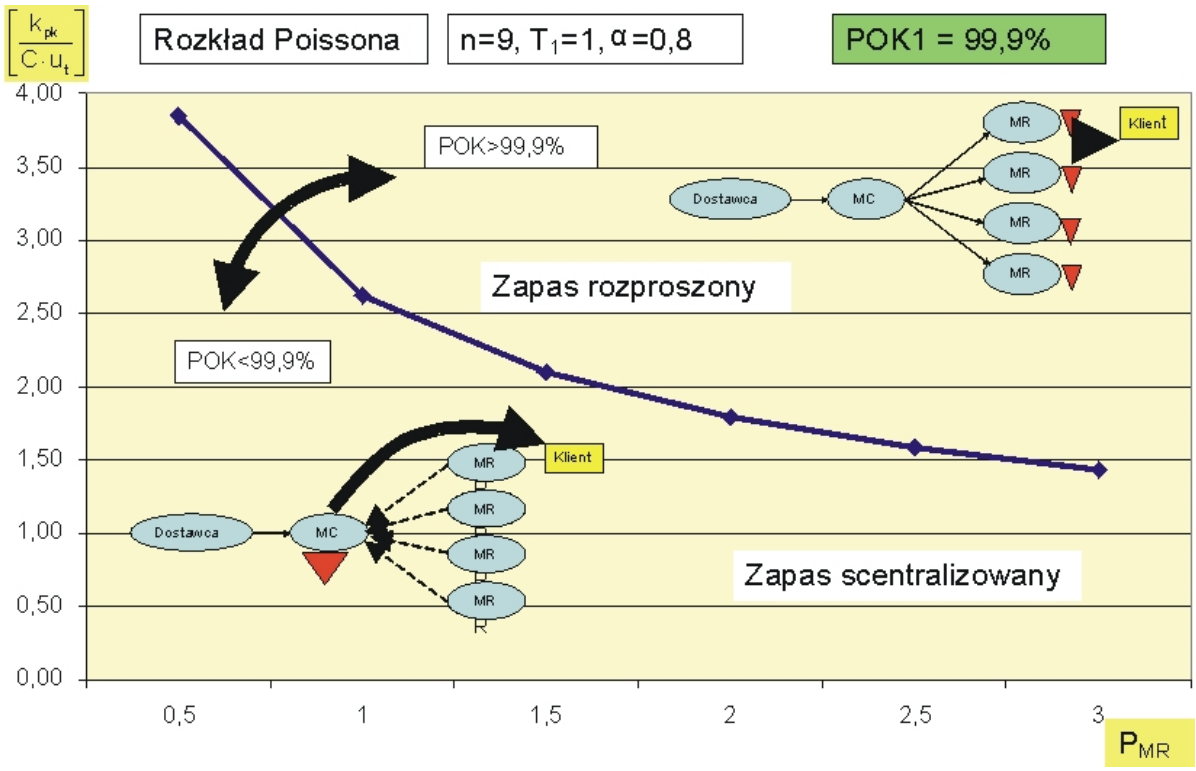
$$P_{MR}^{1-2 \cdot b} > \frac{A^2 \cdot T_1}{\left[\frac{k_{kp}}{C \cdot u_t}\right]^2} \cdot \left(1 - \sqrt{\frac{\alpha}{n}}\right)^2 \qquad [18]$$

a stąd

$$\left[\frac{k_{kp}}{C \cdot u_t}\right] > \frac{A \cdot \sqrt{T_1}}{\sqrt{P_{MR}^{1-2 \cdot b}}} \cdot \left(1 - \sqrt{\frac{\alpha}{n}}\right) \qquad [19]$$

Rysunek 6 ilustruje ta zależność.

Przedstawiona zależność jest zbieżna jeśli chodzi o ogólne tendencje z zależnością ilustrowaną na rysunku 6, bowiem wzrost tygodniowego popytu P_{MR} oznacza zmniejszanie współczynnika zmienności.



Rys. 6. Ilustracja zależności [19] dla przykładowych wartości parametrów tej zależności (poziom obsługi POK=99,9%)
Fig. 6. Relationships for typical parameters values (for service level=99,9%)

PODSUMOWANIE

1. W referacie przedstawiono przykład modelu wspierającego decyzję dotyczącą właściwej lokalizacji zapasu towarów w sieci dystrybucji. Rozważania dotyczyły wyboru pomiędzy centralizacją a rozproszeniem zapasu.
2. Wykazano, że w określonych przypadkach koszty utrzymywania zapasu zabezpieczającego w formie rozproszonej (to znaczy zlokalizowanych w sieci dystrybucji) mogą być większe niż w przypadku zapasu utrzymywanego w jednym miejscu, nawet jeśli wiąże się to z dodatkowymi kosztami szybkich dostaw.
3. Przedstawiono przykładowe zależności pomiędzy wielkościami określającymi te koszty, pozwalające na podejmowanie racjonalnych decyzji związanych z właściwą lokalizacją zapasu. Zależności te odzwierciedlają ogólne rekomendacje wynikające z położenia towarów do grup, wynikającego z klasyfikacji ABC/XYZ, ale pozwalają je uzależnić od określonych wartości kryterialnych.
4. W przypadku gdy rozkład częstości występowania popytu jest zgodny z rozkładem Poissona (znajdującego zastosowanie dla towarów wolno rotujących), dla poprawności wnioskowania należy uwzględnić zależności pomiędzy poziomem obsługi, współczynnikiem bezpieczeństwa oraz średnim (oczekiwanym) popytem.

LITERATURA

Krzyżaniak S., 2005. Podstawy zarządzania zapasami w przykładach, Biblioteka logistyka, ILiM, s. 100, 251-252.

Pfohl H.-Ch., 1998. Zarządzanie logistyką. Funkcje i instrumenty, ILiM. s. 143-146.

Sarjusz-Wolski Z., 2000. Sterowanie zapasami w przedsiębiorstwie, PWE, s. 40-44, 169-173.

LOCATION OF STOCKS IN DISTRIBUTION NET

ABSTRACT. The aim of developing a distribution network by a trade company, is to provide its customers with a better access to the offered goods. Moving stock of goods closer to the market, by deploying it in regional warehouses decreases lead times, but on the other hand leads to higher cost of carrying safety stock. Generally, the policy concerning stock deployment is not homogeneous for all items. The paper presents two different ways of deployment: in a central warehouse or in a network of regional warehouses. In practice the decision is taken intuitively. For example slow moving and expensive items are placed in central warehouse, while safety stock of fast movers is dispersed and located in Regional Warehouses. In the paper some cost models are developed. They also allow for in-depth analysis of how different identified factors influence the result and decision to be taken.

Key words: safety stock, distribution net, location of stock.

LOKALISIERUNG VON BESTÄNDEN IM DISTRIBUTIONSNETZ

ZUSAMMENFASSUNG. Der Zweck von Distributionsnetzwerken im Handel liegt im besseren Zugang der Kunden zu angebotenen Gütern. Die Verteilung der Güter eng am Markt, mittels regionaler Läger, verringert die Zeit zur Wiederbeschaffung, führt aber gleichzeitig zu höheren Ausgaben für den Sicherheitsbestand. Allgemein kann man sagen, dass die Aufstellung des Bestandes von Artikel zu Artikel unterschiedlich ist. Dieser Beitrag beschäftigt sich mit zwei verschiedenen Wegen der Aufstellung: innerhalb eines zentralen Lagers oder innerhalb eines Netzwerkes von regionalen Lagerhäusern. In der Praxis wird diese Entscheidung intuitiv getroffen. So werden zum Beispiel Langsamdreher und wertvolle Produkte zentral gelagert während der Sicherheitsbestand von Schnelldrehern dezentral bzw. regionalen gelagert wird. In diesem Bericht werden hierzu verschiedenen Kostenmodelle entwickelt. Diese Modelle erlauben eine Tiefen-Analyse von verschiedenen Faktoren, die diese Ergebnisse beeinflussen.

Codewörter: Absicherungsbestand, Distributionsnetz , Lokalisierung der Bestände.

dr inż. Stanisław Krzyżaniak
Instytut Logistyki i Magazynowania
ul.Estkowskiego 6
61-755 Poznań, Polska
tel. +48 61 850 49 02
e-mail: krzyzaniak@ilim.poznan.pl

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 1
No 3

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

SUPPLY CHAIN MANAGEMENT INSIDE COMPANY VALUE SYSTEM

Bogusław Śliwczyński

Higher School of Logistics, Poznan, Poland

ABSTRACT. The comprehension of business processes interactions along supply chain is an important factor to succeed in the fast changing and competitive business arena. From competitive point of view there are some critical issues for companies in every day activity: the pressure to reduce overall supply chain costs, exploiting company's assets more effectively, more effective cooperation with trading partners and improving service level of customer. Those issues are the main goal of supply chain's control at first step and managing value of product in supply chain at second step. The ability to create and increase product value in supply chain depends on the ability to control it.
The analytical data of a value chain analytical data provides companies with insights into their total product cost and profit behaviour. Logistics strategy controlling that bases on value measures of supply chain has its consequences in activity managment and assets allocation according to the guidelines of four BSC perspectives. Planning of cooperation in a supply chain is a business strategy issue that should base on value chain analysis.
The value chain analysis is used to identify the possible sources of improved performance. The management of mutually related business processes is supported by SCM (Supply Chain Management) integrated information system.
Applying a progressive approach to cost measurement of the value chain in company's integrated value system also brings a better understanding of their customers' cost, suppliers, products and processes as they move through procurement, production or distribution chain.
This paper focuses on the benefits of supply chain management inside company's integrated value.

Key words: supply chain, value chain, value analysis, controlling, Balanced ScoreCard, SCOR reference model, supply chain management, business process, process analysis, assets, mapping of strategy, SCM, productivity.

Today, each activity (or participant) in the supply chain is analyzed according to its value it adds to process. As a result, this analysis facilitates removing wasteful activities by applying trade-off analysis and what-if scenario modeling analysis of alternatives. Costing methods provide information about costs allocation and how profitable each customer is to a supplier, and the supplier to the customer. Applying this approach to cost measurement of the value chain also enables companies better to understand the cost of their customers, suppliers, products and processes as they move through the complex supply chain both internally and externally to the company.

Analysis of supply chain value starts from the activities of ordering, gathering and processing of raw materials, through material management at production phase, until distribution and delivery to the target customer. One crucial condition of the value analysis in supply chain is to obtain financial transparency in order to optimize decision-making concerning the level of engaged resources and their allocation or activity performance. Today suppliers need to meet the challenge how to measure the activity costs, processes and product movements - from sourcing and procurement and manufacturing to though storing, freight distribution and delivery.

Citation: Śliwczyński B., 2006, Supply chain management inside company value system. LogForum 2, 1, 3.
URL: http://www.logforum.net/vol2/issue1/no3
Accepted: 20.02.2006, on-line: 15.04.2006.

Value chain analysis (VCA) provides companies with insights into their own cost behaviour. The value chain analysis is used by a company to examine objectively costs attributed to products moving along its value chain (including insights to impact of external supply chain costs). Value Supply Chain Analysis (VSCA) is the method designed to monitor the costs of products in time as they move through the supply chain. In this meaning product is a result of an activity (or group of activities) that has a particular value for a receiver (customer). The term of value stream in supply chain is defined as all the steps - both value added and non-value added - required to bring a product from the raw material to the customer.

In every day activities of a company there is a number of key issues that became most significant regarding competitive position of company and its product on the market, such as:

- reducing overall supply chain costs,
- efficiency of using company assets,
- effective realization of activities,
- effective cooperation with trading partners,
- improving service level of customer.

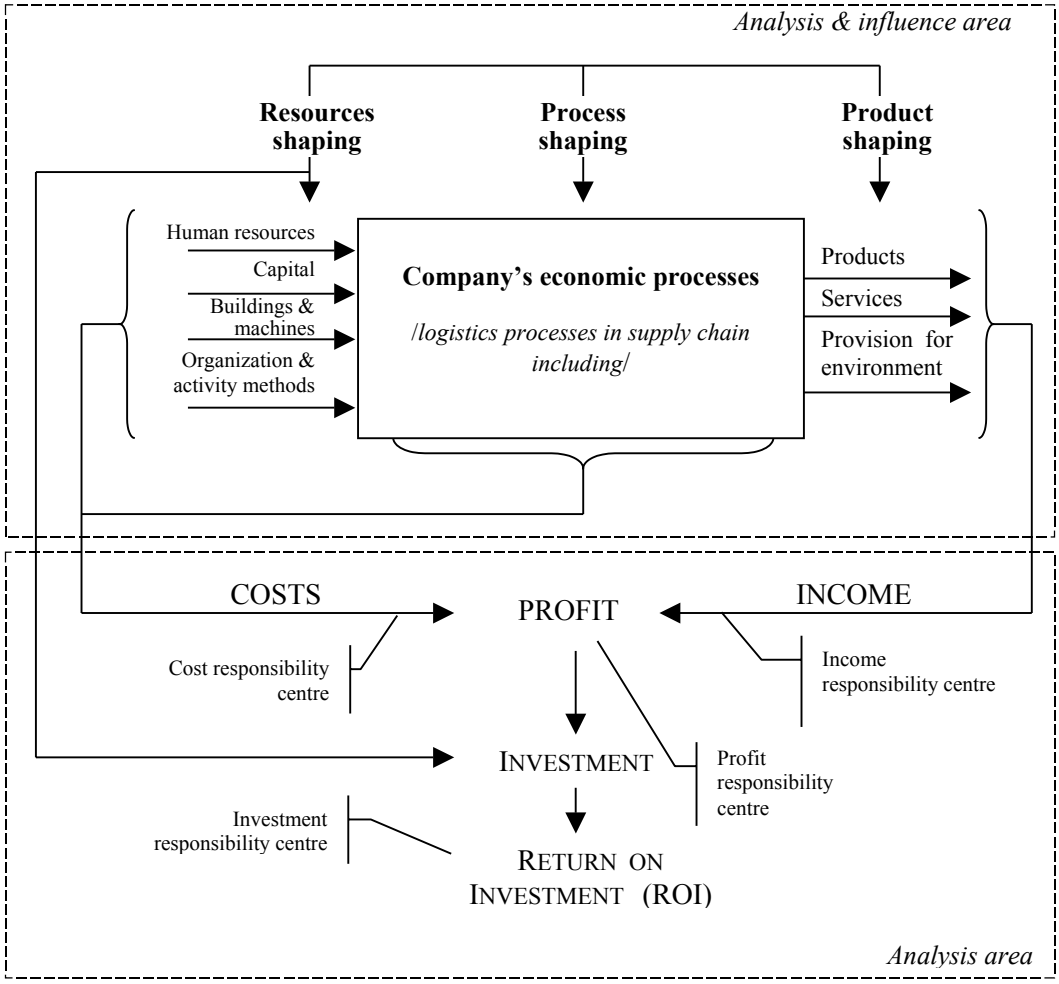


Fig. 1. Analysis and influence area of operational controlling
Rys. 1. Obszary wpływów i analizy w kontrollingu operacyjnym

Those issues are the biggest concern of at first supply chain's controlling and then while managing its value of product.

Area of analysis and influence of operational controlling on company's activity in a supply chain is presented in figure 1.

The ability to create and increase product value in supply chain depends on the ability to control it. One way is to better understand how each internal/external activity (e.g. in cooperation with a trading partner) or resources allocation affects the extended chain's cost structure. Reliable measures can foster better communication, analysis and understanding of how the various diverse processes and functions within company such as procurement, shipping and warehousing can collectively reduce costs. The idea of designing lean material flow in supply chain as a main point of mapping activity and resources allocation is represented by the future state map that aims at creating a vision of how the value stream should operate from raw material down to the finished product (in "door-to-door" process).

To manage supply chain inside company's integrated value chain Activity-Base Management (ABM) method as costing methodology is increasingly accepted. ABM is used to calculate costs of diverse outputs - including products and customers - and what is the cause of these costs. ABM method shows an organization that focuses on profit margins and unit-cost comparisons, in order better to understand what generates the costs in supply chain. Cost analysis in supply chain bases on measures, traces and expenses spent to calculate costs including product-making costs as well as the customer-related costs or costs-to-serve that are involved with front-office customer handling and service. The control and adjusting loop-back of supply chain logistics costs, make up an important part of real system of value chain management in a company. Such costs feedback focused on supply chain activities in logistics processes, supply chain resources and products is presented in figure 2.

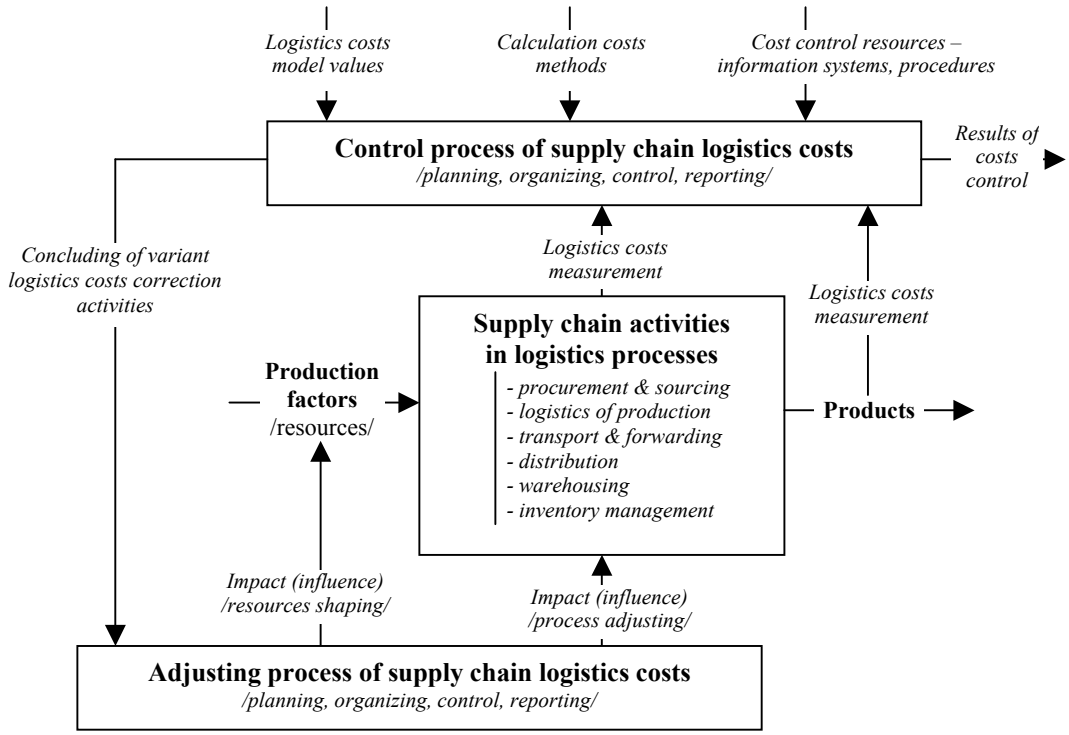


Fig. 2. Control and adjusting costs processes in integrated value chain
Rys. 2. Procesy kontroli i analizy kosztów w zintegrowanym łańcuchu wartości

The identification of differences in costs bearing and profitability of supplying various customers with various products using various logistics services is the fundamental task of value calculation.

Value management in supply chain needs to reflect various customer demands and different logistics activities in costs calculation.

Separating different distribution supply chains (with different products to different segments of market and groups of customers) lets to treat it as a profit center and makes it possible to match proper ways of management. Example of multidimensional costs analytical sheet according to variable costs algorithm for company's supply chains is presented in table 1.

Table 1. Example of multidimensional costs analytical sheet according to variable costs algorithm for company's supply chains

Tabela 1. Przykład wielowymiarowego arkusza analizy kosztów zgodny z algorytmem kosztów zmiennych łańcuchów zaopatrzenia przedsiębiorstwa

Calculation Item	Company													
	Region North						Region West				Region East			
	Supply chain 1			Supply chain 1			Supply chain 1		Supply chain 1		Supply chain 1		Supply chain 1	
	S1		S2	S3		S4	S5	S6	S7	S8	S9	S10	S11	S12
	A1	A2	A3	A1	A3	A4	A1	A3	A1	A5	A3	A4	A2	A5
1. Product assortment sale income														
2. Variable costs of product assortment														
3. Cost covering margin I (1 – 2)														
4. Fixed costs of product assortment														
5. Cost covering margin II (3 -4)														
6. Sum of product assortment covering margins for customer segment														
7. Sum of customer segments covering margins in supply chain														
8. Fixed costs of supply chain														
9. Cost covering margin of supply chain														
10. Sum of supply chains covering margins inside region														
11. Fixed costs of region														
12. Cost covering margin of region														
13. Sum of regions covering margins inside company														
14. Fixed costs of company														
15. Company profit														

S - customer Segment; A - product Assortment

On the basis of calculation results it is possible to determine sale profitability and to study relationships between production/sale changes and income/cost/profit changes. Related to above costs analytical sheet, ABM method gives a broad snapshot of costs that help to determine what to focus on and where. On the other hand, the VSCA method is already focused on testing the costs and benefits of changes. Commonly used applications that involve mentioned methods include:

- computing profit-and-loss statements for each customer (or customer segment) for profit margin analysis,
- comparing benchmarked activity costs and their relative value-added and cost-driver sources.

Effective management system of supply chain value should calculate and report the consequences and impacts of decisions and changes. These cost changes should range from "what-if" scenarios of alternative business actions to gap analysis between "as-is" and "to-be" business process reengineering. Activity-Base Management supports profit and value control that is essential for operations control in supply chain. Operations control methods applied in supply chain and related to Balanced ScoreCard support both: management of customer and product perspectives (that determine sale incomes) as well as process and resources perspectives (that determine supply chain costs). Relationships between those perspectives using ABM method context applied in a distribution chain are presented in figure 2. Identification and decision making process that is supported by ABM method is considered in the figure in the context of benefits and advantages across the supply chain. ABM method that is crucial for the value in supply chain analysis bases on Activity-Base Costing (ABC).

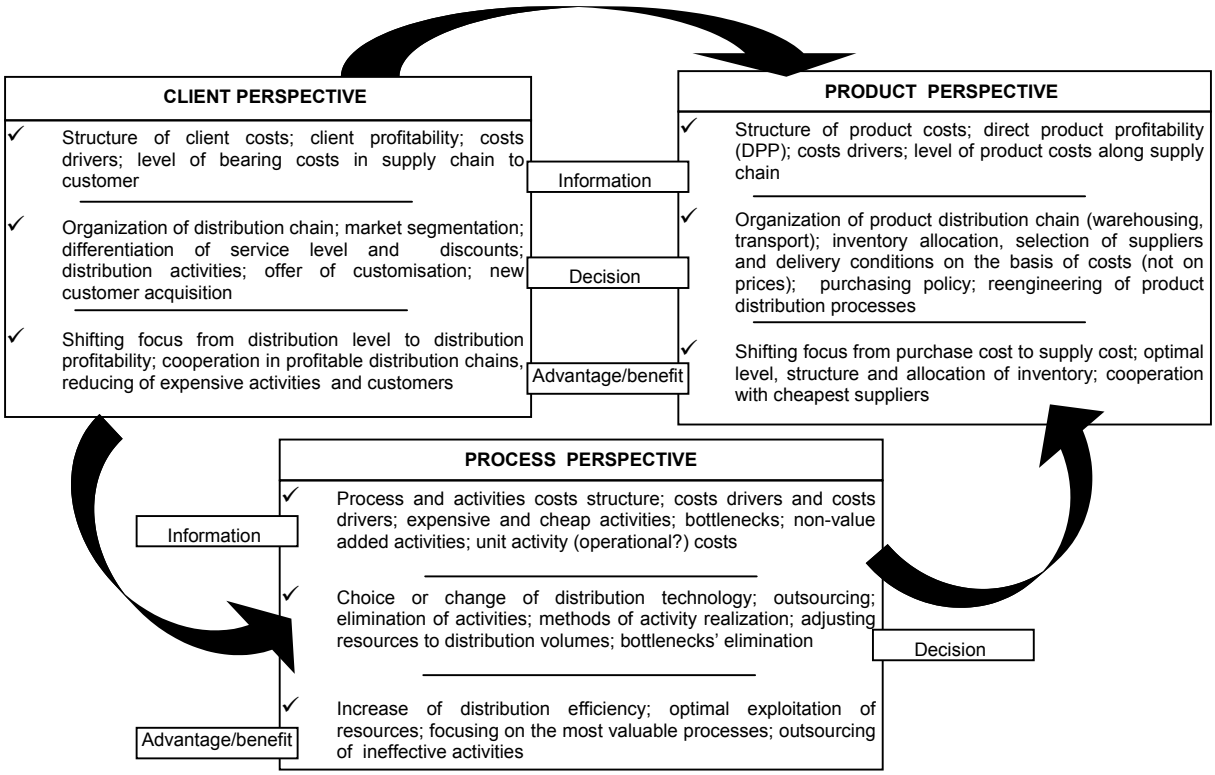


Fig. 3. Relationships between ABM perspectives in a distribution chain
Rys. 3. Powiązania pomiędzy różnymi perspektywami ABM w łańcuchu dystrybucji

Managing supply chain inside company value system requires reliable data from the company information system. Business partners cooperation in changing environment requires mass data flow acquisition and quasi-real time processing in many areas of supply chain, e.g. sourcing, warehousing, inventory control, production planning and materials handling, distribution and selling, finance management, etc. All mentioned methods and tools aim at processes rationalization together with suppliers (sellers) and receivers (buyers) that increase competitiveness in whole supply chain and complex supply network. Cost measures in the supply chain make mutually acceptable base, which allow for adjustments in supply chain. Without this agreed base, no change can occur.

The supply chain value analysis uses industry-standard language to foster communication across internal departments and external trading partners. It has a library of predefined activities (e.g. receive,

store, pick, move), product handling units (e.g. pallets, roll cages, cases), costs drivers (e.g. products, vehicles, routes to market, in-store fixtures, etc.) and other terms.

In the process of planning and verification of optimal activities in logistics processes, it is very useful to apply SCOR business process reference model. The model links process elements, measures, best practices and the features associated with the execution of a supply chain in a unique format. The model focuses on the activities involved, not the person or organizational element that performs the activity. One of the most important aspects in creating value across supply chain is to associate cycle time measures of reliability, responsiveness and flexibility (in external chain - customer oriented) with area of costs and assets (in internal facing chain). Apart from the five basic management processes (Plan, Source, Make, Deliver and Return) that provide the organizational structure of the SCOR-model, it is useful to mention the three classical management activities in the model: planning, execution, and enabling (formerly infrastructure). It is essential to use the SCOR model as a tool in operations control when aiming to create value in supply chain. Planning of activities (or processes) that base on SCOR model allows better resources alignment and in consequence, to meet expected requirements. Planning processes balance aggregated demand across a consistent planning horizon and generally occur at regular intervals and can contribute to supply chain response time.

It is important that, like the process elements themselves, the measures of those processes or their activities are hierarchical. It is very useful for the logistics strategy controlling based on value measures in supply chain to head for activity managing and resources (assets) allocation according to the guidelines of four perspectives of BSC.

Effective execution of strategic plan and competitive position achievement needs mapping aims into operational activities. The success on the market is attainable by communicating strategic and operational goals on each level of company's organizational structure. The Balanced Scorecard Methodology (BSC) should also consider system and process connection of company in procurement as well as co-operation or distribution supply chain. Analytical data of a value chain provides company with insights into their total product cost and profit behaviour.

Structural analysis focuses on desired achievements of value and productivity in supply chain based on the organization's broad aims and objectives. Managers are aware of inputs such as business strategy, management philosophy and organizational culture or all major determinants of organizational productivity (methods of cooperation, information exchange) which are not easy to quantify. It means that multi-dimensional value and productivity is difficult to analyze quantitatively. Hence that is the reason why so many management philosophies have been proposed: management by objectives (MBO), zero-based budgeting (ZBB), total quality management (TQM), business process reengineering (BPR), activity-based management (ABM), management by project (MBP), team-based management (TBM), etc. Unfortunately, there is no universally accepted model for internal and external supply chain productivity improvement, just guidelines, the success of which depends heavily on the nature of the organization and the approach of the individuals attempting to implement them.

These guidelines listed below are used for conducting a productivity improvement in supply chain to achieve its higher value:

- to identify needs to be met in supply chain and why (in four perspectives of BSC methodology),
- to establish appropriate productivity measures and corresponding measure system,
- to assess the current level of productivity and set stretch of productivity goals,
- to identify key factors that have impact on the productivity measures in all perspectives,
- to conduct a critical multi-dimensional analysis of each key factors focusing primarily on the SCOR referenced model of processes,
- to establish new policy and procedures with recommendations for improvement,
- to introduce recommendations to all stakeholders within their companies and conduct training sessions on the new procedures where required,
- to establish a system for the monitoring and reviewing of the new procedures.

CONCLUSIONS

Concluding these considerations about supply chain management inside company value system it is essential to point out VSCA method that delivers financial intelligence which a company can use to calculate the direct product cost (DPC). Value management in internal and external supply chain requires and includes:

- performance management analysis for decision support,
- accurate reflection of the consequences and decisions' impact,
- methodologies of costs calculations and decision optimization,
- visibility of the impacts throughout the value chain to every company or participant in external supply chain,
- tracing information that reflects influence of changing environment on supply chain,
- setting up performance modeling standards.

VSCA method allows a company to look both inside and outside its operation in order to achieve maximum benefits from improvement initiatives. The paper presents methods and tools used to manage the value of supply chain that include controlling as a support system for management and integration of products, processes and assets in supply chain.

REFERENCES

Gadiesh O., Gilbert J. L., 2001, Transforming Corner-Office Strategy into Frontline Action, Harvard Business Review, 73-79.

Kaplan R.S., Norton D. P., 2001, The Strategy Focused Organization. How Balanced Scorecard Companies Thrive in the New Business Environment. Boston-Massachusetts, Harvard Business School Press.

Rother M., Shook J., 1999, Learning to see - value stream mapping to create value and eliminate muda. The Lean Enterprise Institute, Brooklin Massachusetts.

Śliwczyński B., 2005, Controlling operacyjny łańcucha dostaw brakującym ogniwem Strategicznej Karty Wyników, LogForum 1, 2, 2, URL: http://www.logforum.net/vol2/issue2/no2.

ZARZĄDZANIE ŁAŃCUCHEM DOSTAW W SYSTEMIE WARTOŚCI PRZEDSIĘBIORSTWA

STRESZCZENIE. Zdolność do interakcji procesów biznesowych przedsiębiorstw w łańcuchach dostaw jest ważnym czynnikiem sukcesu w szybko zmieniającym się otoczeniu konkurencyjnym. Dążenie do redukcji kosztów łańcuchowych produktu, efektywne wykorzystanie zasobów przedsiębiorstwa czy efektywna współpraca z partnerami biznesowymi w łańcuchu dostaw, stanowią wybrane przykłady wielu zabiegów zmierzających do podwyższenia pozycji konkurencyjnej przedsiębiorstwa na rynku. Te działania są głównym celem kontroli i sterowania łańcuchem dostaw ukierunkowanych na zarządzanie wartością produktu wzdłuż całego łańcucha - od zaopatrzenia w materiały, po dostarczenie wyrobu gotowego klientowi na docelowym rynku. Zdolność do tworzenia i podwyższania wartości produktu w łańcuchu dostaw zależy od zdolności do kontroli i sterowania łańcuchem dostaw.
Dane analityczne łańcucha wartości umożliwiają spojrzenie przedsiębiorstwa na całkowity łańcuchowy koszt produktu i kształtowanie się zysku. Controlling strategii logistycznych bazujący na pomiarze wartości w łańcuchu dostaw, wspomaga zarządzanie działaniami i alokację zasobów w łańcuchu, zgodnie ze wskazaniami wynikającymi z analizy czterech perspektyw metodyki BSC. Planowanie współpracy w łańcuchu dostaw jest zagadnieniem strategii biznesowej, która powinna bazować na analizie łańcucha wartości.
Zastosowanie pomiaru kosztów łańcucha wartości w zintegrowanym systemie wartości przedsiębiorstwa, pozwala na lepsze zrozumienie kosztów tworzonych przez klientów, dostawców i produkty w trakcie przepływu w łańcuchu zaopatrzenia, produkcji i dystrybucji.

W artykule wskazano na istotne znaczenie i korzyści wynikające z zarządzania łańcuchem dostaw dla zintegrowanego systemu wartości przedsiębiorstwa.

Słowa kluczowe: łańcuch dostaw, łańcuch wartości, analiza wartości, Controlling, Balanced ScoreCard, model referencyjny SCOR, zarządzanie łańcuchem dostaw, analiza procesowa, zasoby, produktywność.

LIEFERKETTE-MANAGEMENT IM WERTESYSTEM DES UNTERNEHMENS

ZUSAMMENFASSUNG. Die Fähigkeit zur Interaktion der Geschäftsprozesse von Unternehmen in der Lieferkette ist ein wichtiger Erfolgsfaktor in dem sich schnell ändernden Konkurrenzumfeld. Die Ausrichtung auf die Senkung der Produktkosten, die entlang der Liefertkette entstehen, eine effektive Nutzung von Ressorurcen oder Zusammenarbeit mit Geschäftspartnern in der Lieferkette sind ausgewählte Beispiele mehrerer Aktivitäten, die auf die Erhöhung der Konkurrenzfähigkeit des Unternehmens eingestellt sind. Diese Aktivitäten sind Hauptziel der Kontrolle und Steuerung der Lieferkette, die auf das Management des Produktwertes entlang der ganzen Logistikkette - von der Materialversorgung bis zur Lieferung der Fertigware dem Kunden auf dem Zielmarkt eingestellt sind. Die Fähigkeit zur Bildung und Erhöung des Produktwertes in der Lieferkette ist von der Fähigkeit zur Kontrolle und Steuerung der Lieferkette abhängig.
Analitische Daten der Wertschöpfungskette ermöglichen dem Unternehmen die Produkt-Gesamt-Lieferkette-Kosten und die Gestalung des Gewinns zu erfassen. Das auf der Messung des Wertes basierende Controlling der Logistikstrategien in der Lieferkette unterstützt das Management von Aktivitäten und die Plazierung der Ressourcen in der Lieferkette gemäß der BSC Methodik. Die Planung der Zusammenarbeit in der Lieferkette gehört zur Geschäftsstrategie, die auf der Analyse des Wertschöpfungskette bauen sollte.
Die Anwendung der Messung der Wertschöpfungskette-Kosten in dem integrierten Wertschöpfungssystem des Unternehmens erlaubt ein besseres Verständnis der Kosten, die durch Kunden, Lieferanten und Produkte im Laufe des Flußes über die Versorgungs-, Produktions- und Distributionskette generiert werden.
In dem Beitrag wurde auf die wichtige Bedeutung und Nutzen hingewiesen, welche sich aus dem Lieferkette-Management für das integrierte Wertschöpfungssystem des Unternehmens ergeben.

Codewörter: Lieferkette, Wetrschöpfungskette, Analyse der Wertschöpfung, Controlling, Balanced ScoreCard, SCOR reference model, Lieferkettemenmanagement, Geschäftsprozess, Prozessanalyse, Ressourcen, Produktivität.

dr inż. Bogusław Śliwczyński
Institute of Logistics and Warehousing
Higher School of Logistics
ul.Estkowskiego 6
61-755 Poznań, Polska
e-mail: boguslaw.sliwczynski@ilim.poznan.pl

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 1
No 4

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

SIMULATION OF LOGISTICS PROCESSES (SIMPROCESS)

Bartłomiej Rodawski

Akademia Ekonomiczna we Wrocławiu, Jelenia Góra, Polska

ABSTRACT. The ability to identify and control business processes that cut across functions and organizations has become a new imperative, especially in logistics. Process approach in management forces implementation of appropriate tools. The most sophisticated of available tools is a computerized simulation. The main goal of this paper is to present the issue of building a model that reflects the real business process, as well as simulating the behavior of that model in order to draw conclusions about effectiveness and efficiency of a real business process.

Key words: business process, computerized simulation, logistics process model, simulation model, SIMPROCESS software.

INTRODUCTION

Many organizations nowadays are perceived as systems of business processes. This point of view has been replacing traditional perception of function-based companies. According to the process approach, each enterprise consists of horizontally grouped resources that have own suppliers, customers and add value while transforming inputs into outputs. Functional model assumes vertical structure of resources and sharp distinctions among various functional areas, which often leads to conflicts, inefficiencies and deterioration of competitive position.

From the logistics point of view horizontal management is a very innovative and effective approach, enabling smooth flow of materials and information, within and among companies forming supply chains. In other words process management facilitates eradicating most of the potential disruptions of material/ information flows that take place at functional or organizational boundaries.

Process approach has been popularized mainly thanks to the following management concepts:

- lean management - seeks for perfection by eliminating waste in organization; one of the main principles, on the course of achieving perfection, is identifying and optimizing the value stream - a set of processes that create value for final customer [Harrison, van Hoek 2002],
- business process reengineering - assumes essential redesign of business processes (the way business activities are done and coordinated) to achieve significant improvements in costs, quality, and lead time [Hammer, Quinn 1999],
- benchmarking - comparison of selected processes between partners (e.g. cooperating companies) in order to ascertain the best practices of carrying out tasks, activities and eventually improve process parameters.

Citation: Rodawski B., 2006, Simulation of logistics processes (SIMPROCESS). LogForum 2, 1, 4.
URL: http://www.logforum.net/vol2/issue1/no4
Accepted: 30.01.2006, on-line: 15.04.2006.

Implementing process model within company entails radical changes in management systems. Functional organization structures have to be replaced by process or matrix configurations, process managers and teams are appointed. Eventually they have to be equipped with new tools for designing, monitoring and measuring processes. One of the most powerful means of analyzing and (re)designing processes is a dynamic/computerized simulation. It allows to trace process behaviour by means of computer system in a very compressed time, without any risk of implementing inappropriate processes or disrupting existing ones.

PROCESS DEFINITION AND TYPOLOGY

Business process is a logical set of activities assembled to accomplish business goal(s). Process takes input from a supplier adds value to it and eventually transfers it to a customer [Harrington, Tumay, 2000].

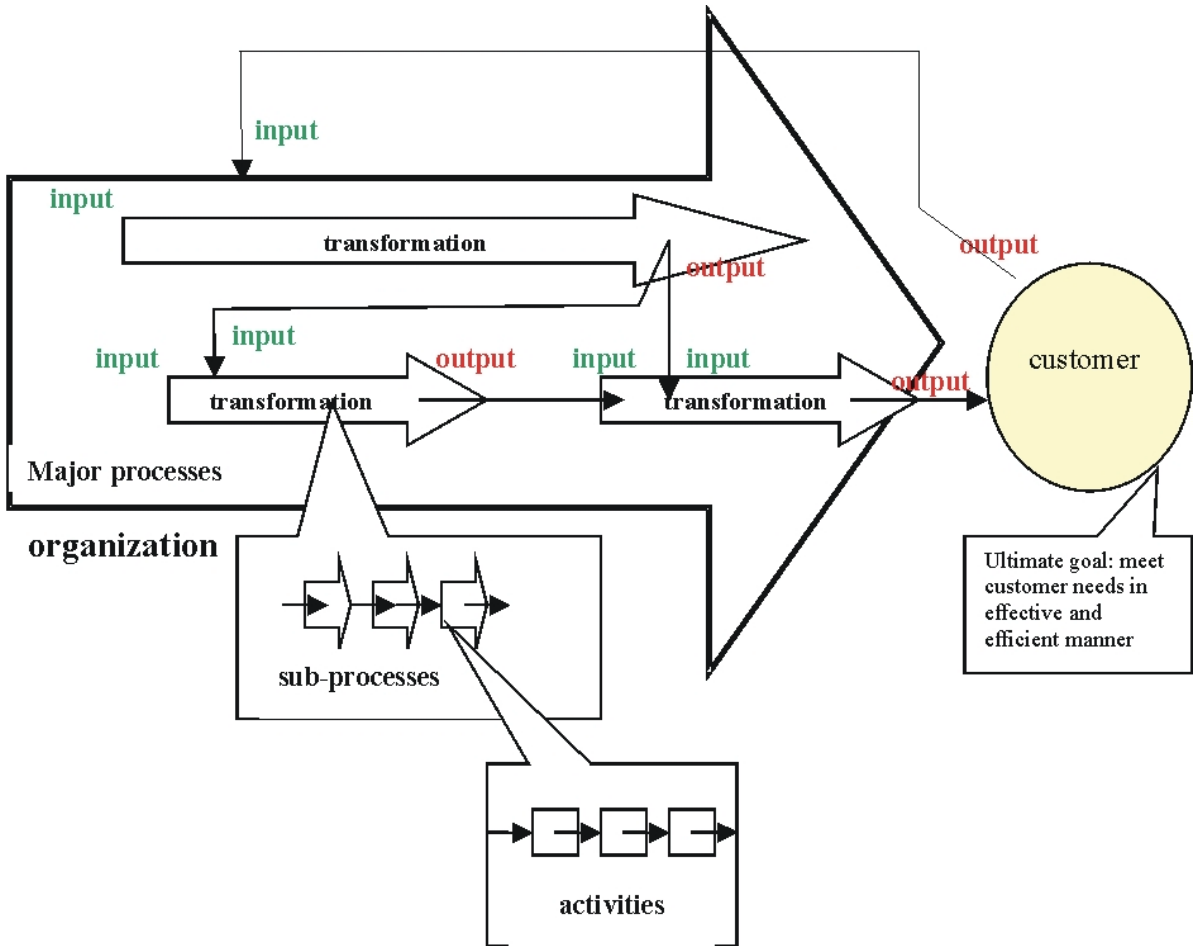


Fig. 1. Business processes in organization
Rys. 1. Procesy biznesowe w organizacji

According to figure 1 each business process has one or more inputs that may originate form other internal processes or external source (supplier or customer process). By analogy certain process serves one or more customers, internal or external. What is more, business processes are connected by entities that flow within and beyond organization, hence the processes act as customers and suppliers against each other. Eventually, business processes have a hierarchical structure. This means that company could be perceived as a single global process consisting of few major processes that could be further broken down into sub-processes, activities and eventually tasks. The number of levels in the hierarchy depends upon size and complexity of organization(s).

A comprehensive, sector-neutral model of process-oriented organization (process classification framework) has been developed by APQC International Benchmarking Clearinghouse, in close cooperation with Artur Andersen. As the authors state, the concept should be regarded as a benchmarking tool, enabling users to compare and accordingly improve business processes across industries. The model distinguishes seven operational as well as seven management and support processes that are broken down into two hierarchical levels table1 [APQS 2004].

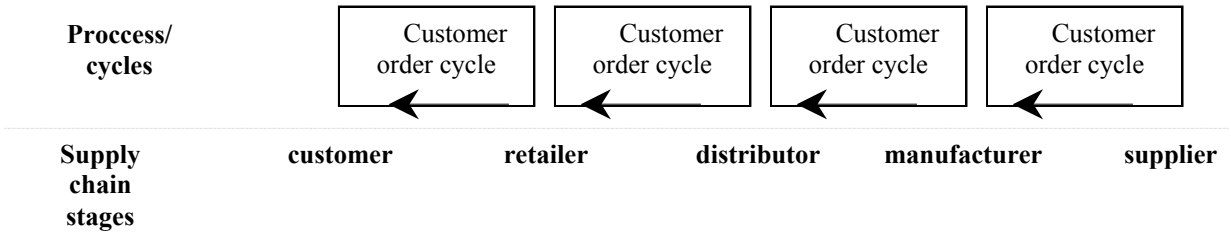
Table 1. Process classification framework
Tabela 1. Ramowa klasyfikacja procesów

Operating processes	Management and support processes
1. Understand markets and customers 2. Develop vision and strategy 3. Design products and services 4. Market and sell 5. Produce and deliver for manufacturing organizations 6. Produce and deliver for service organizations 7. Invoice and service customers	8. Develop and manage human resources 9. Manage information 10. Manage financial and physical resources 11. Execute environmental management program 12. Manage external relationships 13. Manage improvement and change 14. Acquire, construct and manage property

Source: APQS, Artur Andersen, Process Classification Framework, http://www.apqc.org/portal/apqc/ksn/PCF.pdf?paf_gear_id=contentgearhome&paf_dm=full&pageselect=contentitem&docid=108113
APQS, Process Classification Framework http://www.apqc.org/portal/apqc/ksn/PCF_Complete_May_5_2004.pdf?paf_gear_id=contentgearhome&paf_dm=full&pageselect=contentitem&docid=115313

The structure of the presented above process classification framework can be perceived, in a sense, as a derivative of the Porter's value chain, since both models divide processes/functions into two groups: value creating and supporting. The former contributes directly to producing and moving goods to final customers, while the latter enables efficient and effective realization of the value creating processes. From logistics angle, improvement and coordination of operating processes is essential, as they directly contribute to material flow. Albeit information as well as external relationships management seem to be also crucial elements of logistics and especially supply chain management.

Next to general approaches, there have been also developed supply chain dedicated models. Chopra and Meindl recognize supply chain as a sequence of processes that take place within and between different organizations (supply chain stages) to fill customer need for product. The processes are perceived as series of cycles, performed at the interface between two successive stages of supply chain (figure 2) [Chopra, Meindl 2001].



Source: Chopra, Meindl, 2001, Supply Chain Management. Strategy, Planning and Operation, Prentice-Hall, New Jersey.

Fig. 2. Supply chain process cycles
Rys. 2. Cykle/procesy w łańcuchu dostaw

Presumably the most recognized and popular model of logistics processes is Supply Chain Operations model (SCOR) developed by Supply Chain Council. SCOR is based on concepts of

business process reengineering, benchmarking and process measurement. It distinguishes five main supply chain processes [Swain 2005]:

1. Plan - collecting business data, balancing requirements with resources, issuing plans.
2. Source - sourcing stocked, make to order or engineered to order products.
3. Make - controlling production processes.
4. Deliver - all steps from processing orders to selecting carriers.
5. Return - controlling reverse flows of defective and excess products.

Above processes are broken down into sub-processes (process categories), elements, tasks and finally activities. The model also provides definitions, inputs, outputs, and metrics along with best practices for each process element.

Lambert defines eight key processes that make up the core of supply chain management. All the processes spread over cooperating organization and what is more, they cut across functional areas of each supply chain member. The supply chain processes are as follows [Lambert, Cooper, Pagh 1998]:

- customer relationship management,
- customer service management,
- demand management,
- order fulfillment,
- manufacturing flow management,
- supplier relationship management,
- product development and commercialization
- returns management.

Lambert brakes down the processes into strategic and operational sub-processes and further into activities that reside into functional areas. The model also describes interrelations between all elements [Croxton, Garcia-Dastugue, Lambert, Rogers 2001].

The important feature of the presented above approach is its comprehensiveness. The model goes beyond logistics and describes also marketing along with research and development processes. Nonetheless, interfaces between logistics, marketing and R&D elements are included.

PROCESS DESIGN AND ANALYSIS TOOLS

Implementation of process approach necessitates implementation of process design and analysis tools. There are various approaches and techniques for designing and improving processes. Some of them are utilized commonly across various management concepts, however they differ in level of complexity. Universal tools are described in turn.

The most common technique of analyzing process is flowcharting. In general **flowcharts** portray design and the logic of a certain process. They brake down the analyzed process into activities/events and indicate their interrelationships. These tools differ according to the level of sophistication. The simplest type of flowchart is **block diagram**. It provides quick and uncomplicated view of the process by the means of rectangles (blocks) and arrows. The former represents activities, while the latter indicates relations between activities or the workflow direction. **ANSI standard flowchart** presents each unique activity/ event by different symbol. **Functional** flowchart provides additional information on process flow between areas (functions, posts) in organization, while **graphical flowchart** portrays process flow among various locations (e.g. among nodes of supply chain) [Harrington, Tumay 2000].

Process performance analysis is another tool providing valuable data about the process performance. It boils down to collecting performance data at the activities or tasks level, including processing time, idle time costs, resources usage, quantity processed per time period, etc. Based on

these data, statistics of the whole process are derived. Advanced performance analysis should also include variations of the main statistics, which is necessary in making realistic predictions of the behavior of activities and processes, as well as in searching for existing opportunities of process improvement. [Petrovich]

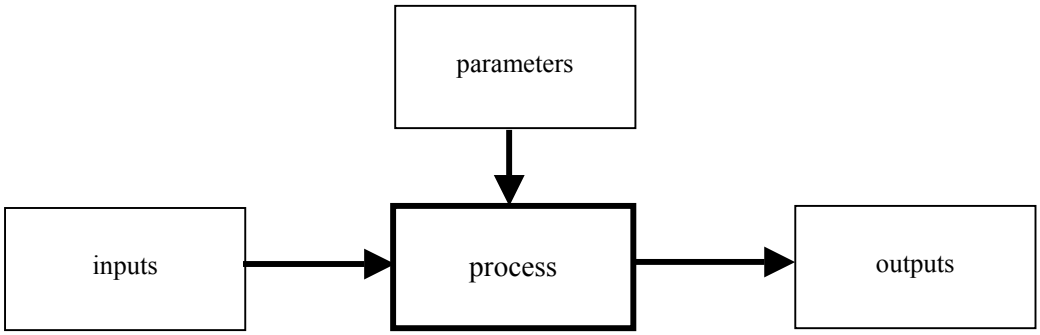
Process flow animation has became available mainly due to rapid development of information technology. Equipped with sophisticated software the analyst is able to track the flow of transactions (entities) throughout the process, accordingly he can indicate bottlenecks, queues, idle resources etc.

Computerized process simulation software packages integrate mentioned above techniques. First they picture the process by means of flowchart. Second, they are equipped with animation facilities that allow to observe the process behavior during simulation stage. Third, computer simulation models describe the process using a set of statistics. It is important to notice that instead of average/ static parameters, probability distribution are harnessed in order to mimic randomness of the model. Dynamic process simulations can be brought to bear during various stages of business management cycle: design phase (to choose the best alternative), operational phase (to enable existing process improvement), scaling down phase (to carry out ex-post evaluation). Therefore computerized process simulation should be regarded as a first comprehensive approach that helps to predict, compare and accordingly optimize the performance of the processes, without the costs and risks of disrupting existing operations [APQS 2004].

From logistics point of view dynamic simulation of processes could provide valuable information on number of orders realized, lead times, logistics resource utilization, inventories levels, etc. Hence on base of such a simulation analyst is able to draw conclusions on logistics customer service as well as logistics costs.

SIMULATION MODEL DEVELOPMENT

Building a model presents the most difficult part of simulating business process. The structure of the model consists of four main elements (figure 3). Inputs are entities that arrive through the process, usually goods, orders and other information. Parameters describe behavior of the process. Both inputs and parameters usually take the form of statistical distributions. Process is a logical representation of analyzed process, including sub-processes, activities along with their interrelations. Eventually, outputs represent main measures (statistical reports) of the process that are captured during simulation.



Source: Petrovich M. V., Performance analysis for process improvement, http://www.mvpprograms.com/docs/PPAtext.pdf

Fig. 3. Structure of a simulation model
Rys. 3. Struktura modelu symulacyjnego

Procedure of designing model includes the following steps [APQS 2004, Petrovich]:

1. **Identification of the simulation object -** there are two approaches in identifying process(es) to be simulated: top-down approach, in which major process is decomposed into elements, e.g. processes, sub-processes and activities; bottom-up approach that starts with defining all activities and grouping them into sub-processes, etc. While making the decision on the process that is to be simulated, the analyst has to choose between complexity and level of details. Simulating whole supply chain excludes high level of exactitude. On the other hand, simulating single purchasing process enables detailed presentation.
2. **Flowcharting the process** - chosen process is to be "represented" to the computer; the analyst using drag and drop technique deploys all the process elements on the screen (the number of hierarchy levels depends on model precision) and links them with connectors, i.e. marks out the way entities go through the process.
3. **Gathering process data and putting them into the model** - data describing entities arrivals and process behavior are to be collected and programmed into the model as inputs and parameters respectively; accordingly real process observation or collection of historical data is necessary at this stage.
4. **Validating the model** - comes down to comparison of the computerized model and the real system behavior; there are two main strategies to validate the model - run the simulation and compare its outputs with historical data of the real process, or ask an expert in the process if the simulated result are reasonable.

The next step after designing the model is simulation of the process, analysis of output data, and eventually decision regarding choice of process alternative, improvement, etc.

SIMULATION BY MEANS OF SIMPROCESS ® SOFTWARE

The range and variety of simulation software packages continues to grow. According to research conducted in 2005 there are at least 48 discrete-event systems simulation and related products [Swain 2005]. Although in many cases offered software are sector oriented, some vendors dedicate their systems to logistics processes (table 2).

Presented below SIMPROCESS® exemplifies universal simulation tool that could be utilized across different sectors, as well as various business processes. The software is also applicable in logistics systems and processes. It could be utilized in mapping and simulating whole supply chains or particular logistics processes.

SIMPROCESS® is a hierarchical process simulation tool that combines process mapping and discrete-events simulation along with activity based costing (ABC). The model is developed here in top-down manner, starting with main processes, through sub-processes and activities at the bottom of the structure. The main building blocks of the model are [Simprocess User's Manual]:

1. Process blocks - represent processes and sub-processes.
2. Activities - basic elements of the process - 19 standard activities are built in the software.
3. Entities - represent goods, information or people that flow thorough the model.
4. Connectors - link processes, sub-processes and activities; determine the way entities flow through the process.
5. Resources - agents required to perform activities (assets and people).
6. Attributes and expressions - tools for customizing model.

The important feature of SIMPROCESS® is model customization option. In order to be able to picture specific behaviour of the process it is possible to use so called logical or mathematical expressions that permits modification of standard model. The mentioned characteristic is really important in simulating logistics processes, especially inventory models.

Table 2. Logistics oriented simulation software
Tabela 2. Programy symulacyjne procesów logistycznych

Software	Vendor	Typical applications of the software	Primary markets for which the software is applied
Arena	Rockwell Automation	Facility design/configuration, scheduling, effective passenger and baggage-handling processes, patient management, routing/dispatching strategy	Airports, health care, logistics, supply chain, manufacturing, military, business process
AutoMod	BrooksSoftware	Decision support tool for the statistical and graphical analysis of material handling, manufacturing, and logistical applications using true to scale 3D graphics. Templates for Conveyor, Path based movers, Bridge Cranes, AS/RS, Power & Free and Kinematics	Warehousing and distribution, automotive, semiconductor, manufacturing, transportation, logistics, airports/baggage/cargo/ security, mail and parcel handling, steel and aluminum, controls testing and emulation
Extend Suite	Imagine That, Inc.	Model continuous, discrete event or discrete rate processes; 3D modeling and analytical distribution fitting	Large scale and rate-based systems, manufacturing, logistics, packaging lines, transportation and more
Flexsim	Flexsim Software Products, Inc.	Manufacturing, logistics, material handling, container shipping, warehousing, distribution, mining, supply chain	Manufacturing, logistics, material handling, container shipping, warehousing, distribution, mining, supply chain
Lean-Modeler	Visual8	Value stream mapping; inventory-level, lead-time, capacity, bottleneck and proof-of-concept analysis.	Manufacturing, supply chain, logistics, lean manufacturing consulting, Six Sigma training
ProModel Optimization Suite	ProModel Corporation	Lean, SixSigma, capacity planning, cost analysis, process modeling, cycle time reduction, throughput optimization and more	Manufacturing and logistics, pharmaceutical, defense
ShowFlow 2	Webb Systems Limited	Process improvement; investment feasibility; what-if; cycle time, work in process and waiting time reductions; layout improvement	Manufacturing, logistics, retail, distribution, financial services, teaching
SIMUL8 Professional	SIMUL8 Corporation	Work flow management, throughput analysis, de-bottlenecking, new product/process development, capacity analysis, continuous improvement	Business process, call centers, manufacturing, supply chain, logistics, healthcare, financial, pharmaceutical and others
SLIM	MJC" Limited	Strategic logistics network modeling and optimization	Logistics operations (retail, petroleum, freight, express, foods, construction, government, manufacturing and others)
Supply Chain Builder	Simulation Dynamics, Inc.	Address inventory problems and transportation or resource issues; library describes inventories, items, resources, operations, BOMs, and actions.	Manufacturing, service organizations, transport management and other corporations seeking ongoing, online process management tools

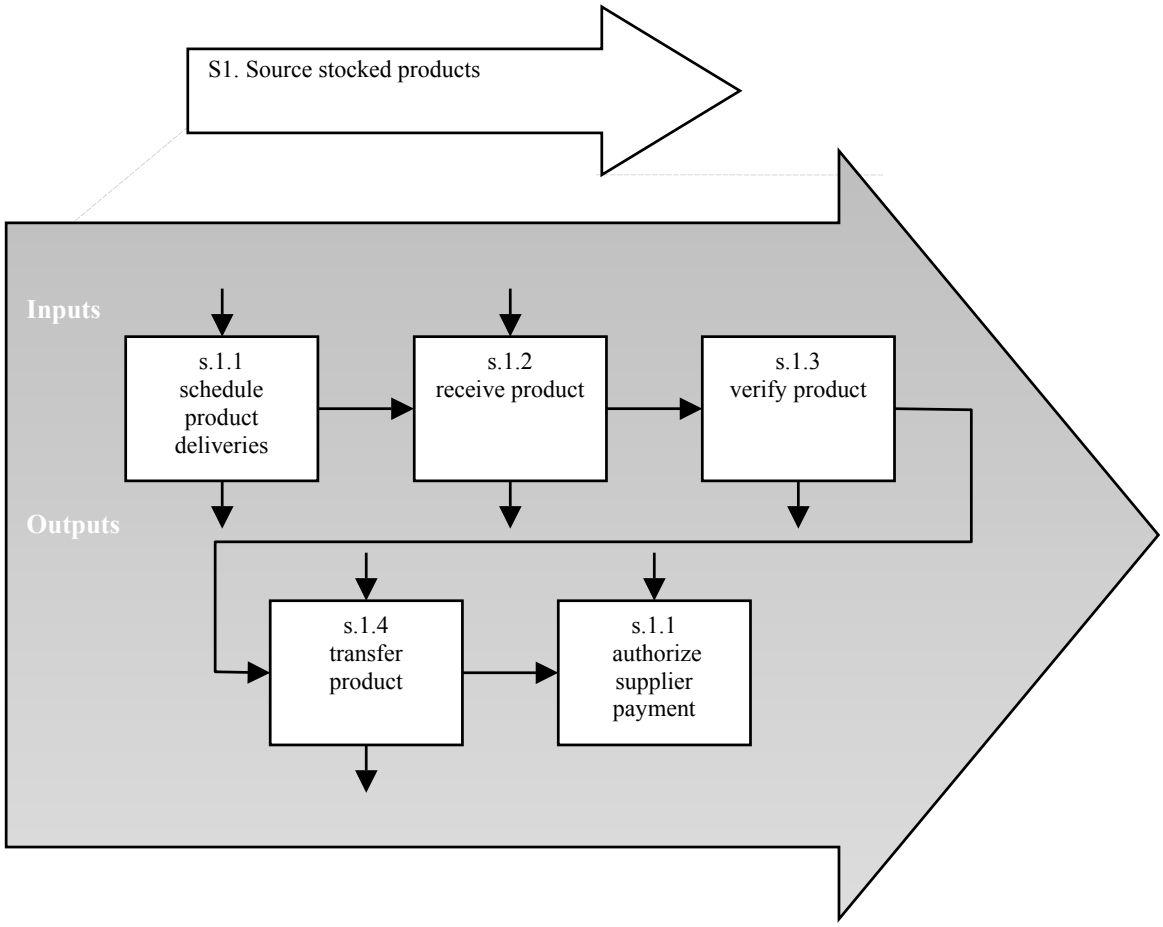
Source: J. Swain, 'Gaming' Reality, Biennial survey of discrete-event simulation software tools, http://www.lionhrtpub.com/orms/surveys/Simulation/Simulation.html

Process that is simulated here by means of SIMPROCESS® application is taken directly from SCOR model v7. It is one of 22 sub-processes (process categories) called source-stocked product. The sub-process consists of five consecutive elements. Its flowchart is pictured at figure 4.

The further assumption (inputs) of the simulated model are as follows:

- two groups of materials (two entities) that flow through the process have different usage pattern. Group A are fast rotating goods, with purchase orders arriving every 70 minutes on average. While group B consists of slow moving goods, with purchase orders put at 15 hours intervals,

- two possible scenarios of process realization are simulated. First, decentralized purchasing alternative, within which different purchasing clerks serve each material group. Second, centralized alternative, where purchasing specialists serve any material, depending on its availability,
- centralized process employs 10 clerks, 8 of them process fast rotating materials orders, while 2 are devoted to service slow moving goods orders. Decentralized process provide work for 9 specialists. In each case cost of single employee amounts 6 000 zł a month.



Source: Supply Chain Council, Supply-Chain Operation Reference-model, http://www.supply-chain.org/site/scor7booklet.jsp

Fig. 3. Structure of a simulation model
Rys. 3. Struktura modelu symulacyjnego

Thus the first step of model design is completed - possible process alternatives are identified.

Two other steps, i.e. flow-charting and putting statistical data to describe model behaviour are realized simultaneously. At the very beginning of programming entities as well as resources are defined (figure 5, 6). Next processes flowcharts and main inputs statistics (table 3) are programmed.

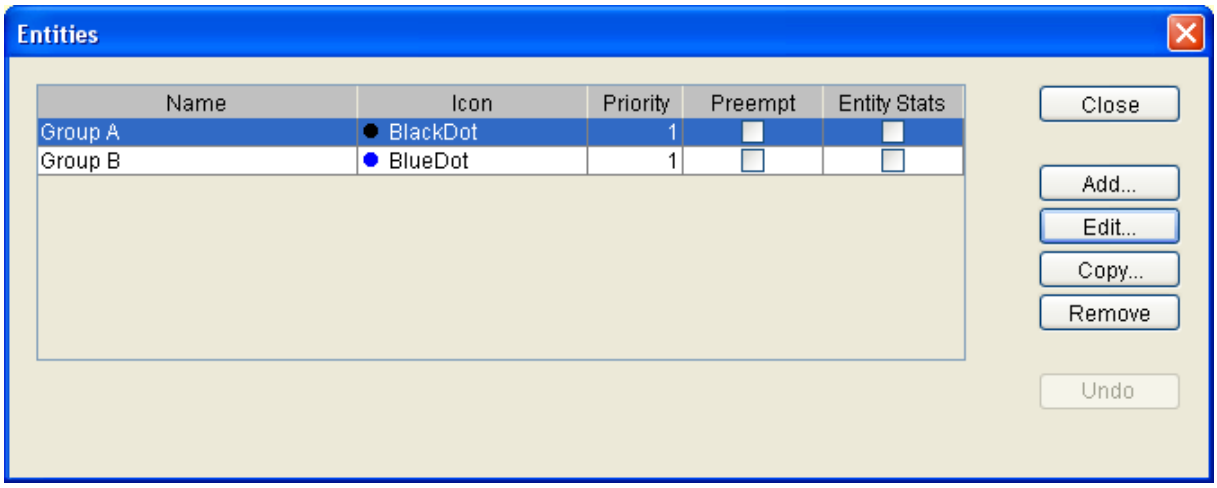


Fig. 5. Entities defined
Rys. 5. Definiowanie przepływów

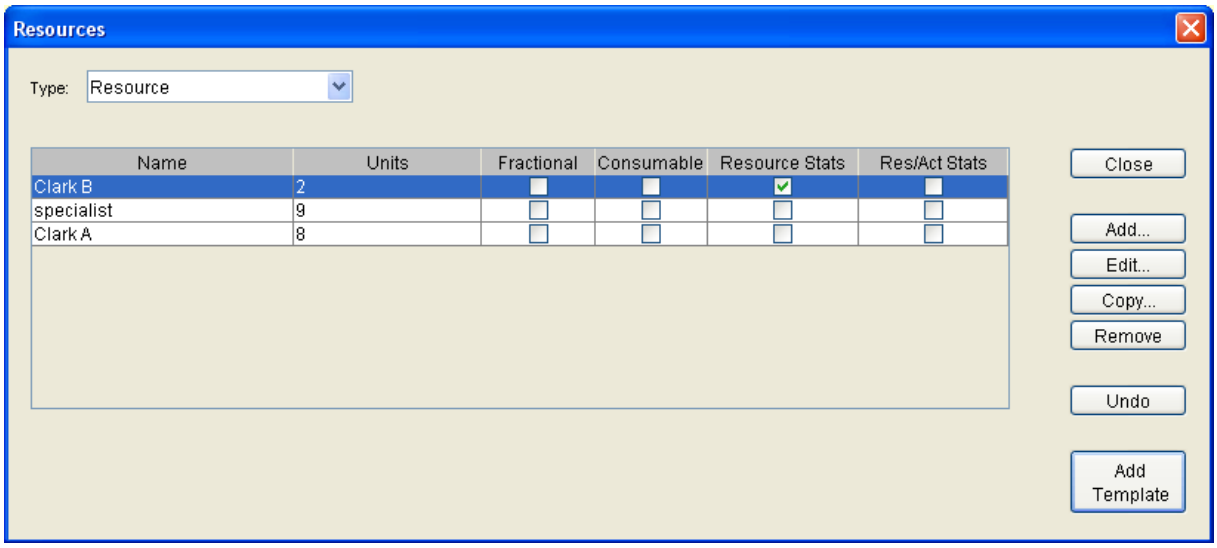


Fig. 6. Resources Defined
Rys. 6. Definiowanie zasobów

Figures below present model structure (flowchart), which consists of three levels. Top level is common for both alternatives. First icon (activity) stands for material order generation. Second icon symbolizes stock to order (purchasing) process that is simulated. The last icon denoting processed orders is necessary for collecting output statistics. Second and third levels of the process structure vary with alternatives.

In decentralized alternative order (entity) goes to A or B sub-process pending on its group assignment. Appropriate flow of the orders is facilitated by branch activity (level 2). Next, at the bottom level, individual clerk is assigned to the order and realizes five consecutive, time-consuming activities. After that clerk becomes idle, which means that he can process next order (level 3). Processed orders, that come out of sub-processes are merged and leave the decentralized process (level 2).

In the centralized alternative, incoming order, regardless of its type, is assigned to any idle specialist. Nonetheless, time needed for processing order still depends upon its type (level 2). Therefore, order with assigned specialist is branched and goes through A or B sub-processes that differ

in time durations (level 3). Having realized all activities specialist is set free, which follows entities merger (level 2).

Table 3. Statistical model inputs
Tabela 3. Statystyki wejściowe modelu

Group A		Probability distribution	Average/ mode	Maximum value	Minimum value	Standard deviation	Time
Order generation frequency		Normal	70	n/a	n/a	5	Minutes
Activities duration	Scheduling	Triangular	2	3	1,5	n/a	Hours
	Receiving	Triangular	1	2	0,5	n/a	Hours
	Verifying	Triangular	5	6	3	n/a	Hours
	Transferring	Triangular	1	1,2	0,5	n/a	Hours
	Authorizing	Triangular	1	1,2	0,5	n/a	Hours
Group B		Probability distribution	Average/ mode	Maximum value	Minimum value	Standard deviation	Time
Order generation frequency		Exponential	15	n/a	n/a	n/a	Hours
Activities duration	Scheduling	Triangular	3	4	2	n/a	
	Receiving	Triangular	1	2	0,5	n/a	
	Verifying	Triangular	5	6	3	n/a	
	Transferring	Triangular	1,5	3	1	n/a	
	Authorizing	Triangular	1	2	0,5	n/a	

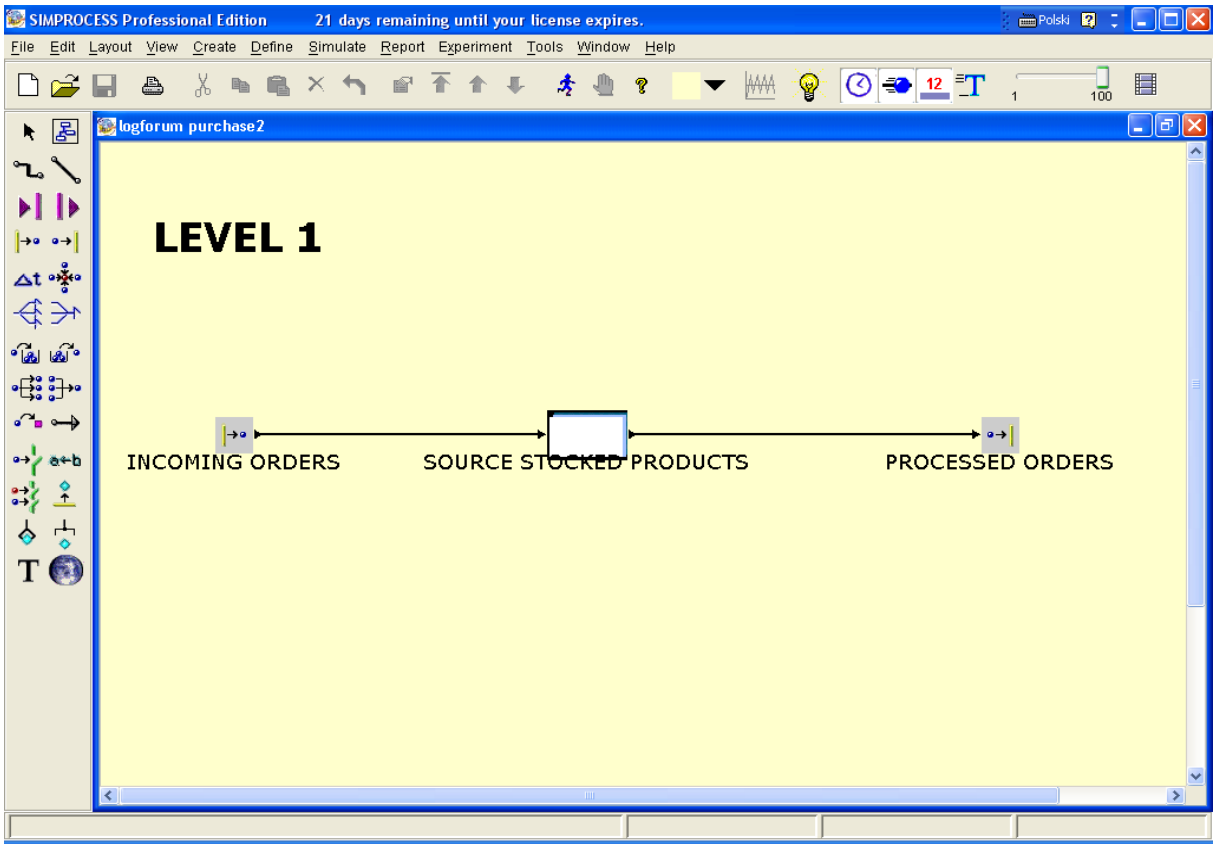


Fig. 7. Purchasing process - level 1
Rys. 7. Proces zaopatrzenia - poziom 1

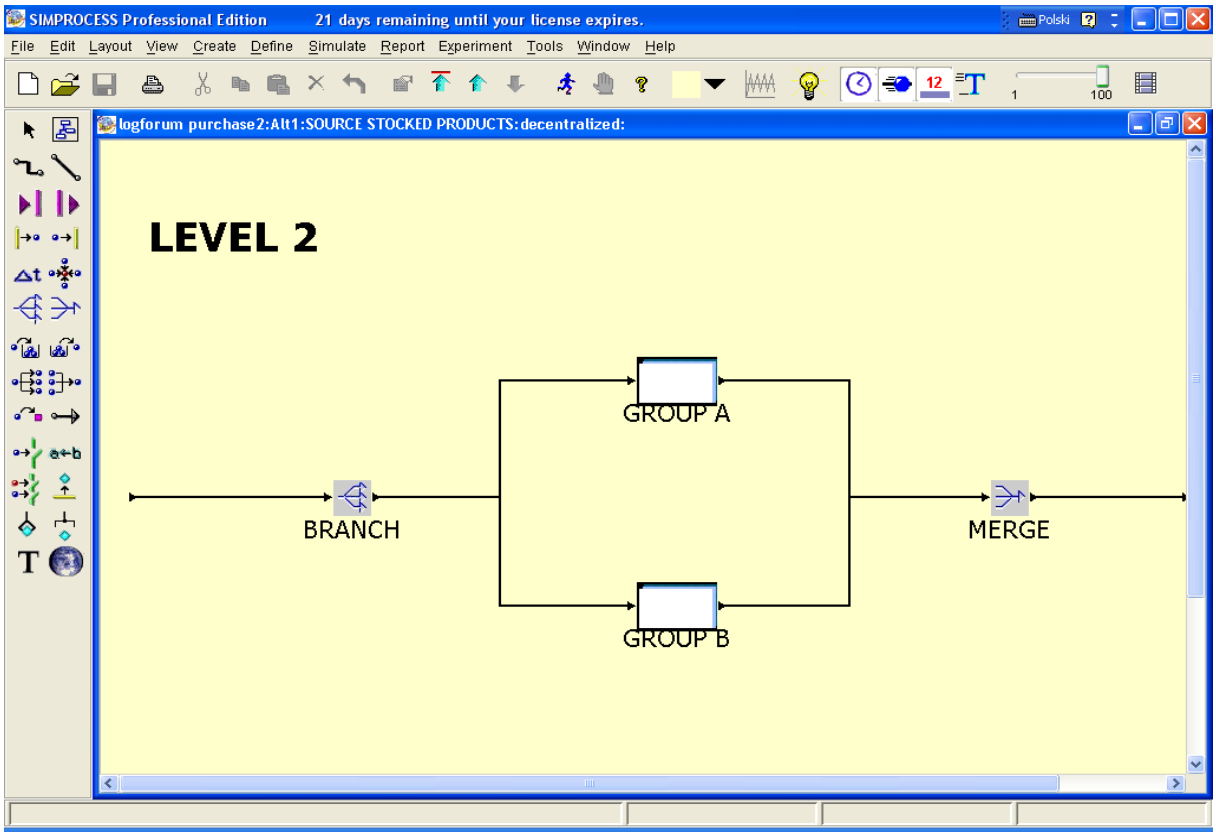


Fig. 8. Decentralized process alternative - level 2
Rys. 8. Proces zdecentralizowany - poziom 2

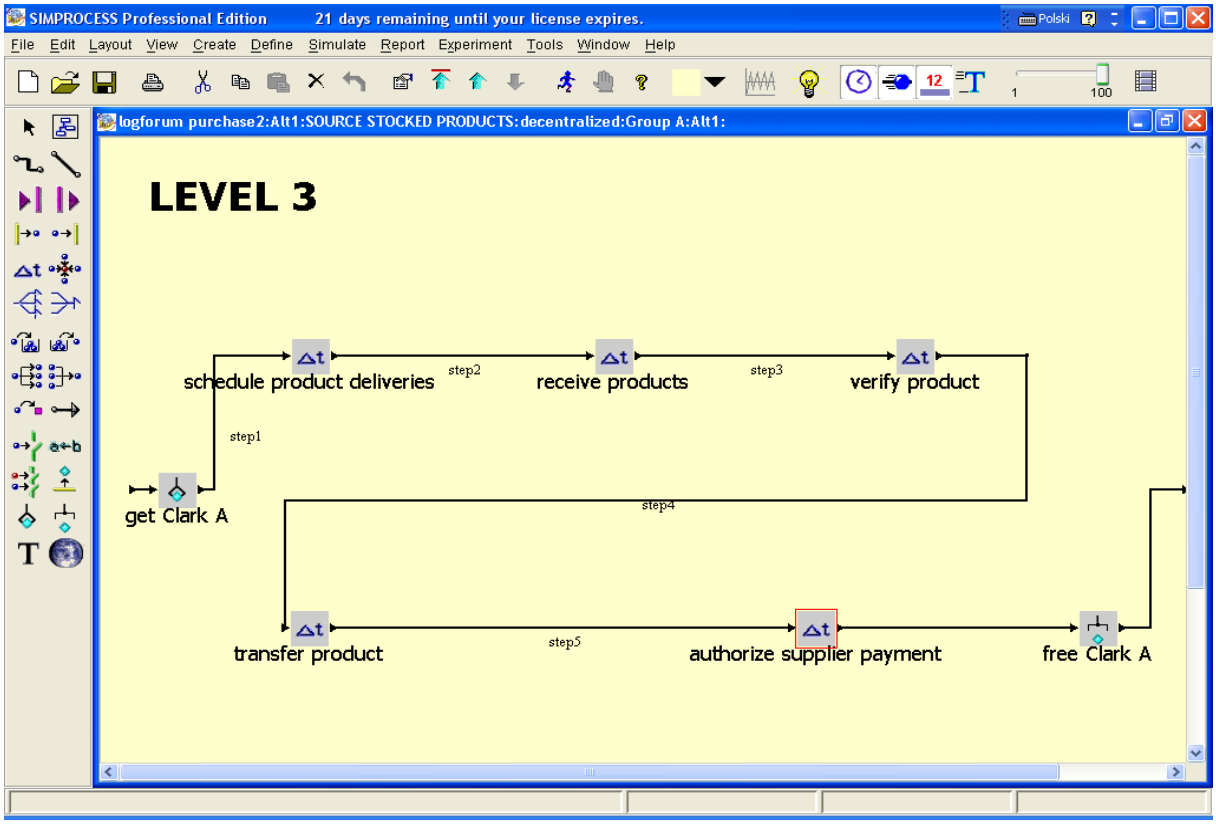


Fig. 9. Decentralized process alternative, group A sub-process - level 3
Rys. 9. Proces zdecentralizowany, sub-process grupa A - poziom 3

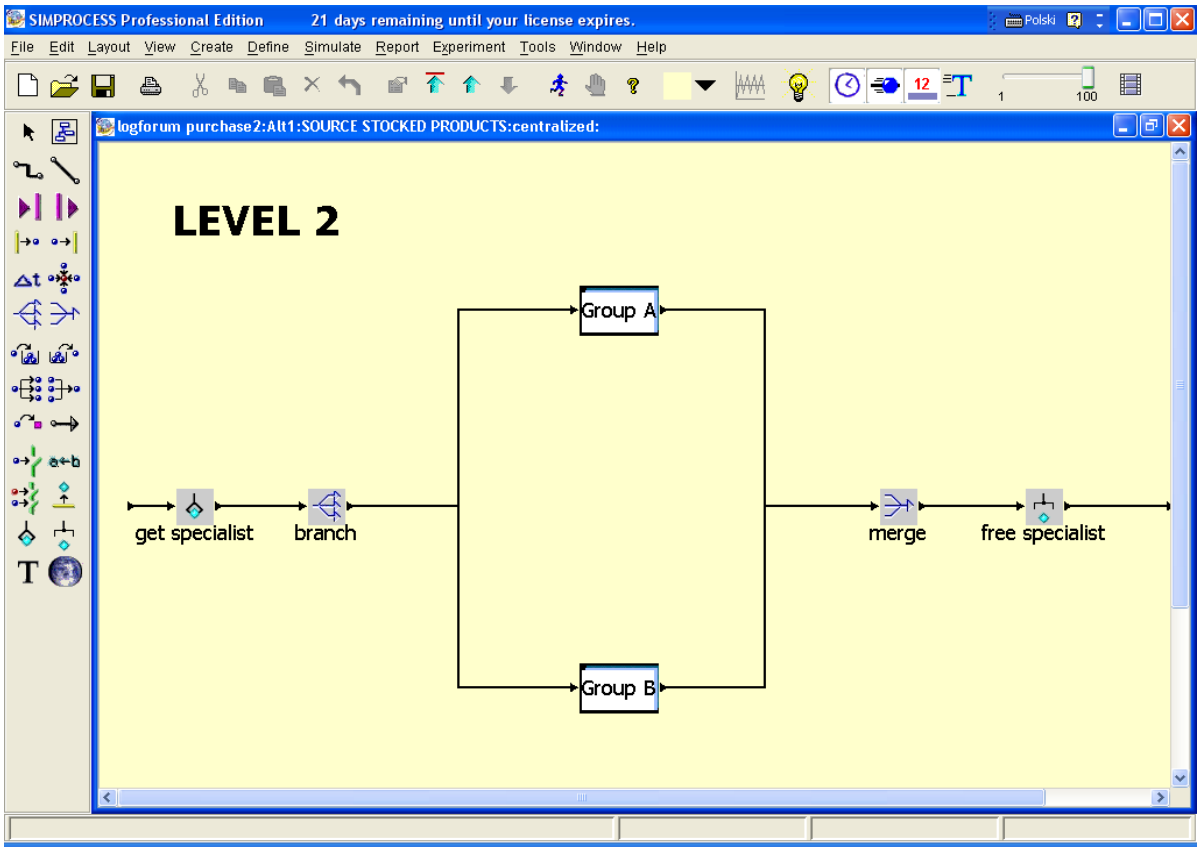


Fig. 10. Centralized process alternative - level 2
Rys. 10. Proces zcentralizowany - poziom 2

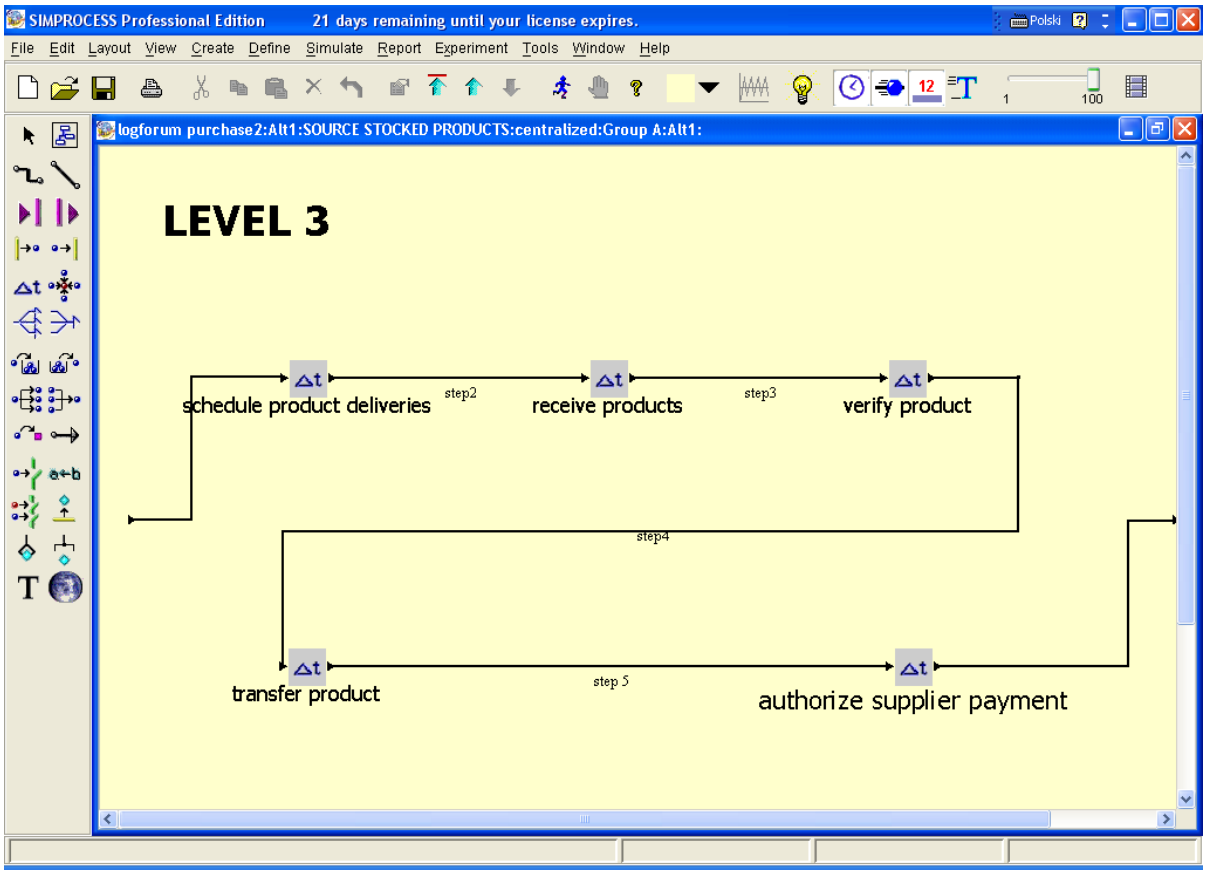


Fig. 11. Centralized process alternative, group A sub-process - level 3
Rys. 11. Proces zcentralizowany, grupa A - poziom 3

Validation of the model is skipped here. Therefore the next step is to set and run simulation. Two process alternatives are simulated during one year long period. Each alternative is run for three replications, which is important when the model contains randomness (parameters are set as statistical distributions). This averages the results and gives the more accurate view on model behavior. The main output statistics are presented in turn.

Table 4. Number of entities (orders) generated and processed
Tabela 4. Liczba przepływów (zamówień) wygenerowanych i zrealizowanych

Process alternative	Entity name	Number generated	Number processed	Customer service
decentralized	Group A	7515	7152	95,2%
	Group B	593	592	99,8%
centralized	Group A	7507	7484	99,7%
	Group B	544	542	99,5%

Assuming that customer service metric for purchasing process is defined as the relationship between number of orders generated and processed, the centralized alternative guarantees better results i.e. facilitates considerably higher performance in case of group A orders, at cost of slight deterioration of service for group B orders, compared to the decentralized alternative.

Table 5. Order cycle time (hours)
Tabela 5. Czas realizacji zamówienia (godziny)

Process alternative	Entity name	In system	Processed	Wait for resource
decentralized	Group A	218,9	9,7	209
	Group B	13,1	11,8	1,3
centralized	Group A	30,7	9,7	21
	Group B	33,7	11,8	22

Above table shows time necessary to process A and B orders within two alternatives. There is a clear distinction in case of group A. Due to insufficient number of clerks in the decentralized alternative, group A orders remain in system for 219 hours, 209 of which they queue up for resources. While in the centralized process alternative wait time is shorten to 21 hours. In case of group B orders, slightly better results are obtained in decentralized alternative.

Table 6. Resource utilization
Tabela 6. Stopień wykorzystania zasobów

Process alternative	Resource name	Busy	Idle
decentralized	Clerk A	99,95%	0,05%
	Clerk B	39,98%	60,0%
centralized	Specialist	99,53%	0,47%

It is clear that centralized alternative guarantees higher level of resource utilization accordingly superior productivity. In the decentralized process clerks B remain idle 60% of time, that is why cycle time of group B orders (presented in table 5) is lower compared to the centralized alternative.

Table 7. Resource cost
Tabela 7. Koszty zasobów

Process alternative	Capacity	Absorbed	%
decentralized	730 000	642 079,0328	88,0%
centralized	657 000	653 921,0923	99,5%

Resource cost are derivative of resource utilization. That is the higher utilization the smaller gap between cost of providing certain capacity level and cost really absorbed in the process. Although real costs of processing orders in both alternatives are almost the same, costs of providing capacity in the decentralized process are clearly higher that in case of centralized process.

To sum up, the centralized alternative seams to be more effective and efficient. It guarantees higher service level of the process, shorter cycle time for A group orders, and higher utilization rate of resources. Only in case of B group orders cycle time the decentralized process gives better performance, however at costs of really low resource utilization. Obviously, process designer could simulate other alternatives that would provide event better results, for instance develop mixed process with universal specialists and one additional clerk devoted for B group orders only.

Presented above example is rather simple. Simulated process is basic, and not all output statistics are presented in this paper. Software packages like SIMPROCESS ® facilitate programming and analyzing more complex, highly customized models with both material and information flows. Also available output statistics deliver more valuable data including costs of performing each activity. Nonetheless author intends to show, in the straight manner, that simulation is a valuable instrument for logistics process analysis. Managers who need to make decision upon credible information about processes that are realized in ever changing, accordingly random environment should utilize it. Simulation shows clearly relations between cost effectiveness and logistics service level, being valuable tool while designing, improving or just evaluating processes performance in both lean and agile logistics systems.

REFERENCES

APQS, Process Classification Framework, http://www.apqc.org/portal/apqc/ksn/PCF_Complete_May_5_2004.pdf?paf_gear_id=contentgearhome&paf_dm=full&pageselect=contentitem&docid=115313.

Chopra S., Meindl P., 2001, Supply Chain Management. Strategy, Planning and Operation, Prentice-Hall, New Jersey.

Croxton K.L., Garcia-Dastugue S.J., Lambert D.M., Rogers D.S., 2001, The Supply Chain Management Process, The International Journal of Logistics Management, Vol. 12, no 2.

Hammer M. and Quinn F. J. 1999, Reengineering the Supply Chain: An Interview With Michael Hammer, Supply Chain Management Review, http://www.manufacturing.net/scm/index.asp?layout=articleWebzine&articleid=CA155060.

Harrington H. J., Tumay K., 2000, Simulation Modeling Methods. To reduce risks and increase performance, McGraw-Hill, New York.

Harrison A., van Hoek R., 2002, Logistics Management and Strategy, Pearson Education Limited, Harlow.

Jefferis III R.P., Simulation of Business Processes, Widener University http://muse.widener.edu/~rpj0001/courses/Engr670/Book/Bookfiles.htm.

Lambert D. M., Cooper M.C., Pagh J.D., 1998, Supply Chain Management: Implementation Issues and Research Opportunities, The International Journal of Logistics Management, Vol. 9, no 2.

Petrovich M. V., Performance analysis for process improvement, http://www.mvpprograms.com/docs/PPAtext.pdf .

PQC's International Benchmarking Clearinghouse, Arthur Andersen & Co., Process classification framework, http://www.apqc.org/portal/apqc/ksn/PCF_Complete_May_5_2004.pdf?paf_gear_id=contentgearhome&paf_dm=full&pageselect=contentitem&docid=115313.

Simprocess User's Manual, http://www.caciasl.com/mscustcntr/dnlds/docs/simprocess/spuser.pdf.

Supply Chain Council, Supply-Chain Operation Reference-model, http://www.supply-chain.org/site/scor7booklet.jsp.

Swain J., 2005, 'Gaming' Reality, Biennial survey of discrete-event simulation software tools, http://www.lionhrtpub.com/orms/surveys/Simulation/Simulation.html.

SYMULACJA PROCESÓW LOGISTYCZNYCH

STRESZCZENIE. Identyfikacja i sterowanie procesami biznesowymi, które przecinają funkcje i organizacje staje się koniecznością, szczególnie w przekrojowej ze swojej natury logistyce. Podejście procesowe do zarządzania rodzi konieczność posługiwania się właściwymi narzędziami. Jednym z najbardziej zaawansowanych instrumentów jest symulacja komputerowa. Głównym celem artykułu jest prezentacja procedury budowy komputerowego modelu procesu biznesowego oraz jego symulacja, której wyniki stanowią informacje niezbędne do podejmowania decyzji dotyczących projektowania i usprawniania procesów.

Słowa kluczowe: proces biznesowy, symulacja komputerowa, model procesów logistycznych, model symulacyjny, oprogramowanie SIMPROCESS.

LOGISTIKPROZESSE-SIMULATION

ZUSAMMENFASSUNG. Identifizierung und Steuerung von Geschäftsprozessen, welche die Funktionen und Organisationen überschneiden wird insbesondere in der Logistik zur Notwendigkeit. Für das prozessorientiertes Denken an das Management sind richtige Toolls erforderlich.
Eines von den meist innovativen Tools ist die Computersimulation. Das Hauptziel des Beitrags ist die Präsentation der Vorgehenswese zum Aufbau eines EDV-gestützten Modells des Geschäftsprozesses und dessen Simulation, dessen Ergebnisse Informationen zum Entscheidungstreffen Projektierung und Verbesserung von Prozessen liefern.

Codewörter: Geschäftsprozess, Computersimulation, Logistikprozesse-Modell, Simulationsmodell, SIMPROCCESS Software.

dr Bartłomiej Rodawski
Akademia Ekonomiczna we Wrocławiu
Wydział Gospodarki Reginalnej i Turystyki w Jeleniej Górze
ul. Nowowiejska 3
58-500 Jelenia Góra, Polska
e-mail: rodawski@wp.pl

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 1
No 5

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

OPERA - OPTIMISATION OF OF THE TIMBER SUPPLY CHAIN

Mareike Schultze, M. Lange, Herbert Sonntag

University of Applied Sciences, Wildau, Germany

ABSTRACT. The cooperative project "Sustainable Management of Mixed Oak-Pine-Forest Stands in the Sub continental North-eastern German Lowlands (Oak Chain)" estimates technical, economical and ecological aspects of Mixes Oak-Chain-Forest Stands. The conversion of pine monocultures into mixed oak and pine stands entails an adaptation of the entire wood supply chain. The sub-project OPERA, which is managed by TFH Wildau, develops new methods for the transport logistics from forest to production site. Key aspects of activity are the navigation and positioning with RFID-technology and the optimization of the transport organization and the flow of information.

Key words: supply chain, RFID, navigation, transport, timber logistics, information system.

INTRODUCTION

The forest-based sector is an important economic factor in Germany and particularly in the economically underdeveloped regions of Brandenburg. The cooperative project of the Federal German Ministry of Education and Research "Oak-Chain - Sustainable Management of Mixed Oak-Pine-Forest Stands in the Sub-Continental North-Eastern German Lowlands" investigates new strategies for the conversion of pure pine stands into mixed oak-pine-forest stands. The focal points in this project are silvicultural, economic and environmental aspects of mixed oak-pine stands, the usage of small-dimensioned oak timber and the optimization of the timber value chain.

The conversion of pine monocultures into mixed oak and pine stands entails an adaptation of the entire timber supply chain. The challenge is twofold: on the one hand, the market conditions for small-dimensioned oak logs are very poor. Sophisticated logistics concepts are needed to allow for a higher added value. On the other hand, wood procurement costs are likely to rise due to assortment diversification. Timber allocation and transport costs have a share of up to 80% of the overall procurement costs. They are decisive for the profitability of the entire value chain. The logistical subproject OPERA "Optimization between pile and ramp" focuses therefore upon the transport chain for small-dimensioned pine and oak logs from wood road to production site. Optimized timber transport chains link sustainable forest management to economically sound timber utilization.

This paper shall deliver insight into the issue of timber transport logistics and provide an out-look on the research activities in the OPERA project. The center of interest is the transport chain for timber procurement from forest to production site. To begin with, some background information on the current status of the forest-sector is given and current challenges with respect to logistics are outlined. Then, an analysis of the timber transport chain is presented. Weak points and areas where there is

Citation: Schultze M., Lange M., Sonntag H., 2006, OPERA - optimization of supply chains for small dimensioned pine and oak logs. LogForum 2, 1, 5.
URL: http://www.logforum.net/vol2/issue1/no5
Accepted: 30.01.2006, on-line: 15.04.2006.

room for improvement in timber transport chains in Brandenburg are identified. Finally, solutions in terms of transport logistics suggested within the framework of the OPERA project are sketched out.

THE CURRENT SITUATION OF THE FOREST-BASED SECTOR IN BRANDENBURG

In the federal state of Brandenburg, the forest and timber industry is an important employer with over 6500 persons working in the public forest service, in forest enterprises, logging companies and in the wood processing industry. Its annual turnover of over 800 million euros shows the economic importance of this sector [MLUV, 2004].

The conditions for the German forest and timber industry have altered considerably over the last decades. There are novel requirements to forest operations coming from economic, ecological and structural changes [Becker et al, 2002, 2005; Strunk, 2003].

Key factors affecting the forest-sector in Brandenburg are:

- the tight revenue situation of forest enterprises resulting from high labour and transport costs compared to neighbouring countries,
- the increased competition in international markets,
- the concentration process in the timber industry from many small and medium-sized companies to a handful of powerful large-scale enterprises,
- nationwide timber procurement of the wood processing industry,
- the increasing demand for mass assortments.

To speed up operational processes in the timber supply chain, new systems and technologies are needed. Novel timber harvesting and supply technologies are, thus, an important field of research. In timber harvesting a high level of mechanization has already been achieved [Becker et al., 2002; Ehrhardt, 2005]. Further rooms for improvement come from the reorganization of timber transportation processes. Since logistics is an important cost factor, efficient transport chains are crucial for the profitability of the entire value chain. Research activities in the OPERA project focus therefore on the transport chain for timber procurement from the pile at the wood road to the industrial production site. Key factors for significantly reducing costs and time of timber transportation are the effective transport organization, the use of modern information and communication technology and novel solutions for navigation and position in the forests.

POTENTIALS FOR OPTIMISATION OF THE TIMBER SUPPLY CHAIN

The timber supply chain consists of the processes necessary to deliver timber from the pile in the forest to the ramp at the production site including organizational and operational processes as well as flows of information between the parties involved. Numerous partners characterize the traditional timber transport chain. Interfaces between the single processes are often undefined and information flows are incomplete, discontinuous and very slow. The responsibility for transport planning and organization can be assumed by different partners according to the specific situation. Either the costumer (delivery to wood road) or by the forest owner and the logging company (delivery to production site) respectively are responsible for transport planning and organization and for choosing and instructing the carrier.

The transport to the production site is performed by carriers, mostly small and medium enterprises (SME) who often are associated to the logging companies or act as their subcontractors. They dispose

of special equipment for the handling and transportation of round wood, for instance lorries with integrated cranes and adapted under-carriages.

Fig. 1. Handling of timber at the wood road (photo: TFH Wildau)
Rys. 1. Manipulowanie drewnem na drodze leśnej (zdjęcie: TFH Wildau)

The business processes of timber transport are still organized in a very traditional way and there is much room for improvement. The use of communication and information technologies is not very common. Information is usually forwarded by telephone or fax. Continuous end-to-end flows of information between the partners of a supply chain are scarce. An optimization of flow of information and transport planning procedures is therefore likely to raise significantly the efficiency of transportation processes.

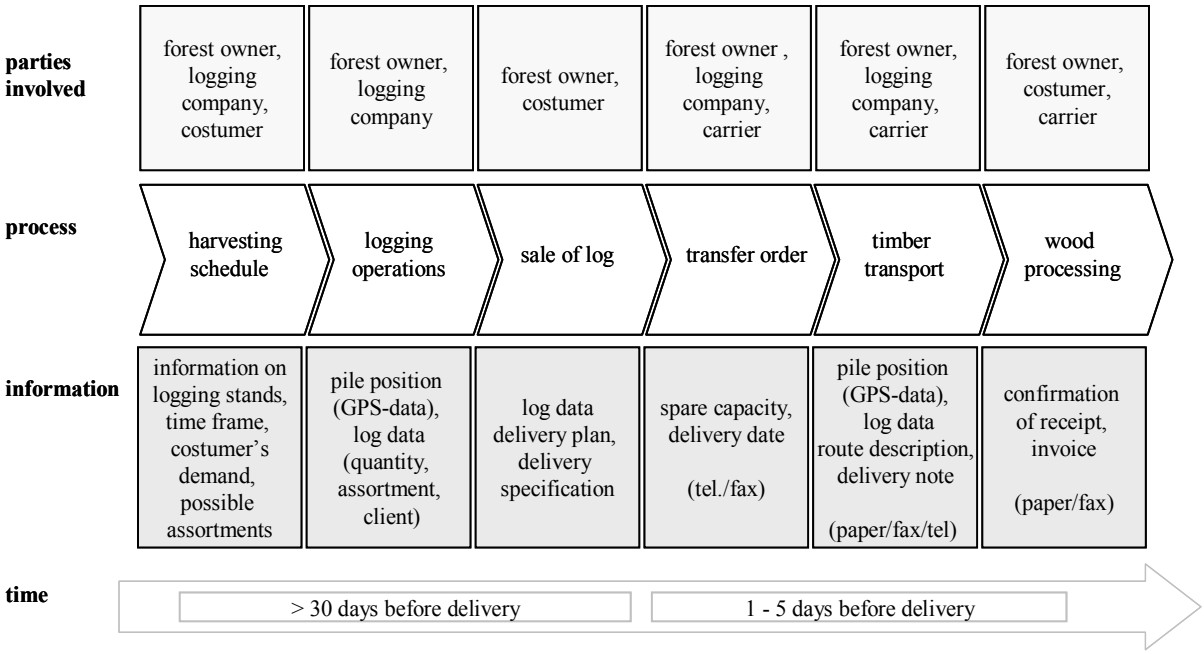


Fig. 2. The Timber Supply Chain - Processes, Partners and Information Flows
Rys. 2. Schemat łańcucha dostaw drewna – procesy, partnerzy i przepływ informacji

Transport Planning and Organisation

Cost and time efficient transportation depends on effective transport planning methods. Transport planners using fleet optimization techniques are able to combine transfer orders in an optimized way and, by this, to increase the performance of their fleet. As a result, the share of dead ends and unproductive periods can be reduced and overall costs can be trimmed down. However, the software tools currently available for transport planning are very expensive and they are not adapted to the special requirement of timber transport. There is a lack of reasonably priced software tools that can be used as a support for transport planning and fleet optimization in the field of wood procurement. Most small and medium sized timber carriers are therefore not able to plan efficiently their operations to optimize their resource exploitation.

Exchange of information and data transfer

Another reason for the low efficiency of timber transport operations are slow information flows and insufficient data exchange between partners. For high logistical performances in their transport operations, wood carriers need a data basis for transport planning in sufficient time before the delivery date. However, since forest enterprises and wood owners are usually not able to warrant timely information flows, carriers often act on very short notice.

A concerted effort by all partners in timber supply chains is necessary to improve this situation. Various projects have been launched to create continuous and timely information flows between partners in the forest sector. In a first step, the awareness for this subject has been raised. Considerable effort is currently dedicated to the application of modern technologies in the forest sector to support communication and data exchange between partners. In pilot projects, information platforms for the cross-company communication between partners of timber supply chains have been implemented and model processes have been designed. Special communication tools for the forest sector are for instance GeoMail® and LUKAS®. In Brandenburg, there is currently no system available to support the management of information flows between small and medium sized enterprises in the forest sector such as logging companies, wood carriers, sawmills and private forest owners.

Navigation and positioning in the woods

Another reason for high transportation costs is the large amount of time dedicated by the wood carriers in finding timber piles in the woods [Rösler, 1999]. This waste of time is mainly due to the following facts:

- wood carriers rely on imprecise, often only oral, route descriptions and usually do not know the exact position of a pile,
- widely available navigation systems usually do not include digital maps of wood roads,
- navigation systems adapted to the special requirements of timber transport are very expensive and are therefore not available for small and medium sized enterprises,
- digital maps for forest operations are expected to be introduced in most federal forest management departments in the forthcoming years but there is still further data logging needed in particular for private owned forests.

Particularly in the private owned forest, where wood roads are usually in a bad condition, tools for navigation and pile position should be combined with exact route descriptions to save time for localizing the pile. For this purpose, inexpensive and reliable systems for navigation and for pile positioning are needed.

RESEARCH ACTIVITIES IN THE OPERA PROJECT

The aim of the OPERA project is to provide logistical tools and techniques to partners in timber supply chains so that they can deal with the weak points identified in the paragraphs above. In order to improve the performance and efficiency of timber transport chains, the research program includes three different approaches:

- optimization of information flows between the partners of a supply chain,
- developing techniques and tools for transport planning and organization in timber supply chains,
- novel methods for navigation and pile positioning in the forests.

Within the framework of OPERA, software solutions will be developed, customized and implemented in select transport chains. In pilot projects they will be tested in small and medium sized enterprises of the forest-sector in Brandenburg. In detail, the following improvements shall be attained:

- the wood carriers should have sufficient and reliable information for their transport planning in sufficient time before the delivery date,
- they should have available better techniques and tools for transport planning. An extended data basis of potential transfer orders shall give them enhanced options for combining transfer orders in view of optimal resource exploitation,
- the locating of the woodpiles shall be supported by a navigation tool including positioning of the lorry, pile positioning and a detailed and reliable route description,
- the business processes for transport organization shall be rendered more straightforward.

Expected outcomes are a generally enhanced performance of the timber transport chain and a significant reduction of deadheads and unproductive periods. Resulting from this, the profitability of timber transportation particularly for small and medium sized enterprises will be increased.

The above-mentioned data, tools and techniques for transport planning and optimization will be made available to partners of timber supply chains on a web-based information platform. The platform consists of the following modules:

- virtual market place for freight transportation,
- GIS-based information on harvesting schedules and pile positions,
- databases and tools supporting the search for return or supplement freights,
- tools for the planning and description of optimal routes to the piles,
- web-based information and communication platform including database systems for data exchange.

Additionally an inexpensive and reliable system for navigation in the forest and for pile positioning adapted to the needs of SME timber supply chain in Brandenburg is under development. This system should help carriers to reduce considerably the time needed for localizing woodpiles. For this purpose, the RFID-technology is tested for its performance in low distance positioning and data transfer in outdoor conditions. RFID tags complement the route description and help carriers to localize the exact position of their lorries and of the woodpiles. Additionally, RFID can be used for pile identification and data exchange all along the timber transport chain. Research on similar approaches is going on at the Universities of Munich and Dortmund who are testing the applicability of RFID-technology for data transfer in the timber supply chain [Korten et. al., 2005].

In order to develop solutions adapted to real businesses in the forest-sector, the TFH Wildau cooperates closely with small and medium sized forest enterprises in Brandenburg. In pilot projects the tools will be implemented in select timber transport chains. The work packages are:

- analysis of the business process of timber transportation,

- design an implementation of more efficient business processes,
- test of the tools provided on the information and disposition platform,
- test of the RFID-technology for navigation and positioning in the forest.

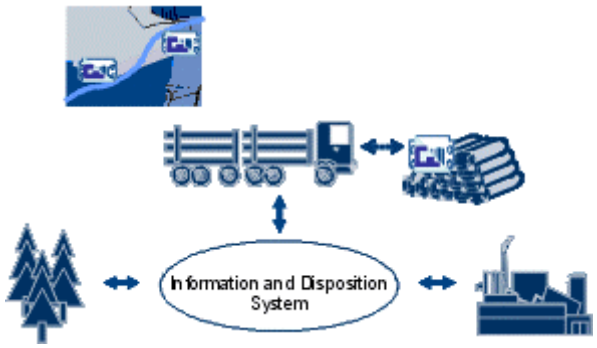


Fig. 3. Optimization of timber transport chains supported by an information and disposition system and an RFID-based tool for navigation and positioning
Rys. 3. Optymalizacja systemu transportu drewna przy zastosowaniu systemu informacyjnego z wykorzystaniem urządzeń RFID, służących do nawigacji i pozycjonowania

CONCLUSION

Before the background of major economic, ecological and structural changes in the forest-based sector, cost efficient timber transport changes are needed. Furthermore, the planned conversion of pure pine stands into mixed stands in Brandenburg entails an adaptation of the entire value chain. Innovative and reasonably priced tools are needed to support partners of the timber transport chain in their activities. The project OPERA provides solutions adapted to the needs of small and medium-sized companies of the forest-based sector in Brandenburg.

The information and disposition system shall support private forest owners, forest enterprises, wood carriers and their costumers so that they are able to create added value and to optimize their business processes. An up-to date virtual market place for freight shall help to reduce deadheads and unproductive periods. In addition, business processes will become more transparent and straightforward.

The RFID-based navigation and position system shall support wood carriers to cut back on unproductive times in the forest by localizing woodpiles in a more efficient way.

To assure the applicability and the practical relevance of the developed solutions the University of Applied Science cooperates closely with practitioners from the forest-sector in Brandenburg as well as with several research-labs.

REFERENCES

Bodelschwingh E. v., Bauer J., Longo M., 2003, Informationsflüsse in der modernen Holzerntekette. AFZ, Der Wald 17/2003, Stuttgart, 855- 857.

Ehrhardt I., 2005, Integrierte Holzlogistikkette vom Wald zum Werk - Holzdemonstrator Sachsen-Anhalt. information paper, IFF Fraunhofer, Magdeburg.

Forstware Informationssysteme GMBH, 2005, GeoMail - Von der Inventur bis ins Werk. Product information,. GeoMail, Meersburg.

Jönsson A., 2005, Der gläserne Wald. Forst und Technik, DLV Verlag München, 6-8.

Korten S. et al. 2005, RFID-Technologie in der Holzerntekette, AFZ, Der Wald 18/2005, Stuttgart, 969-970.

Landesbetrieb Wald und Holz Nordrhein-Westfalen, 2005, Logistikkette Holz NRW Informationsbroschüre LIGNA 2005, Münster.

Ministerium für Ländliche Entwicklung und Verbraucherschutz (MLUV) des Landes Bran-denburg, 2004, Cluster Forst und Holz in Brandenburg. Stand und Perspektiven, Referat Presse und Öffentlichkeitsarbeit des MLUV-Brandenburg, Potsdam.

Rösler S., 1999, Die optimale Logistikkette: Wie können Holztransport und Holzhandel besser in die Logistikkette integriert werden, Forsttechnische Informationen 10, Groß-Umstadt.

Strunk M, 2003, Zum Einsatz von Wechselbrücken beim Rohholztransport in der deutschen Forst- und Holzwirtschaft, Institut für Forstliche Arbeitswissenschaft und Verfahrenstechnologie der Universität Göttingen.

OPERA - OPTYMALIZACJA ŁAŃCUCHA DOSTAW DREWNA

STRESZCZENIE. Przedmiotem badań w projekcie „Zagospodarowanie leśnych siedlisk mieszanych dębowo-sosnowych na obszarze północno-wschodnich Niemiec" są techniczne, ekonomiczne i ekologiczne aspekty przekształcenia tych stanowisk. Konwersja monokultury sosnowej w mieszane zalesienia dębowo-sosnowe wymusza zmianę całego łańcucha dostaw drewna. Projekt OPERA, realizowany przez Wyższą Szkołe Techniczną w Wildau, ma na celu opracowanie nowych rozwiązań logistycznych transportu drewna ze stanowisk w lesie do przetwórni. Kluczowymi aspektami są: sposób nawigacji i pozycjonowania przy zastosowaniu technologii RFID, optymalizacja transportu i przepływu informacji.

Słowa kluczowe: łańcuch dostaw, RFID, nawigacja, transport, logistyka w branży drzewnej, system informatyczny.

OPERA - OPTIMIERUNG DER HOLZ-LIEFERKETTE

ZUSAMMENFASSUNG. Das Verbundprojekt "Nachhaltige Bewirtschaftung von Eichen-Kiefern-Mischbeständen im subkontinentalen Nordostdeutschen Tiefland" untersucht waldbauliche, technische, ökologische und betriebswirtschaftliche Aspekte von Eichen-Kiefern-Mischbeständen. Der Umbau von Kiefernmonokulturen in Mischwälder stellt besondere Anforderungen an die gesamte Wertschöpfungskette Holz. Das logistische Teilprojekt OPERA, das von der TFH Wildau geleitet wird, zielt auf eine Optimierung der Transportkette Schwachholz ab. Schwerpunkte sind die Ortung und Navigation im Wald mit Hilfe der RFID-Technologie, die Transportorganisation und die Optimierung der Informationsflüsse.

Codewörter: Wertschöpfungskette, RFID, Ortung und Navigation im Wald, IT-System.

Dipl.-Forstw. Mareike Schultze
Dipl.-Wirtsch.-Ing. M. Lange
Prof. Dr.-Ing. Herbert Sonntag
TFH Wildau Bereich Verkehrslogistik
Bahnhofstraße D-15745 Wildau, Germany
e-mail: schultze@igw.tfh-wildau.de

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 1
No 6

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

ORGANIZACJA DOSTAW DO SIECI HANDLOWYCH. WSPÓŁPRACA PRODUCENTÓW Z DUŻYMI DETALISTAMI

Agnieszka Tubis

Międzynarodowa Wyższa Szkoła Logistyki i Transportu, Wrocław, Polska

STRESZCZENIE. Obserwacje funkcjonowania handlu w Polsce wskazują wyraźnie, że coraz większą rolę odgrywają w nim sieci handlowe. Dynamiczny wzrost obrotów w sieciach nie pozostaje bez wpływu na relacje między sieciami i producentami. Dla producentów produktów szybkiego obrotu (FMCG) sieci stały się głównym kanałem dystrybucji. Ich udział w realizowanej sprzedaży detalicznej jest na tyle duży, iż producent FMCG niekorzystający z Nowoczesnych Kanałów Dystrybucji ryzykuje swoją dalszą egzystencją na obsługiwanym rynku. Znaczenie kontaktów z sieciami dostrzegają również inni producenci, czego dowodem jest wyodrębnianie w działach sprzedaży specjalnych komórek odpowiedzialnych jedynie za obsługę klientów kluczowych, wśród których podstawową grupę tworzą sieci handlowe. W prezentowanym artykule zostały przedstawione przykłady zasad obsługi klientów sieciowych stosowanych przez producentów różnych sektorów.

Słowa kluczowe: producent, kanały dystrybucji, sieć handlowa, organizacja dostawy, relacje, współpraca.

WSTĘP

Coraz silniejsza pozycja sieci handlowych względem producentów dóbr konsumpcyjnych powoduje istotne zmiany w oferowanych im standardach obsługi klienta. artykuł ma na celu prezentację ogólnych relacji występujących w kontaktach producentów z sieciami handlowymi, jak również przedstawienie przykładowych zasad obsługi klientów sieciowych stosowanych przez wybranych producentów sektora spożywczego, kosmetycznego oraz AGD.

ZNACZENIE I ROZWÓJ SIECI HANDLOWYCH

Ostatnie dziesięć lat to okres intensywnego rozwoju różnego rodzaju sieci handlowych w Polsce. Na terenie naszego kraju rozwijają się przede wszystkim trzy podstawowe formy detalicznego handlu sieciowego, a mianowicie hipermarkety, supermarkety i dyskonta. Obecnie pod względem liczby obiektów wielkopowierzchniowych (256 obiektów) jesteśmy na średnim poziomie europejskim. Wyprzedzają nas jedynie: Francja (1056 obiektów), Niemcy (1408 obiektów) i Anglia (872 obiektów). Już prawie dogoniliśmy Hiszpanię (264 obiektów) i Włochy (277 obiektów) - tyle tylko, że budowane u nas obiekty są dwu-, trzykrotnie większe od tych funkcjonujących w wymienionych krajach. W zdecydowanej większości hipermarkety budowane w Polsce należą do sieci z zachodnim kapitałem. W polskich rękach jest zaledwie 17 takich placówek. W przypadku supermarketów, do krajowych

Cytowanie: Tubis A., 2006, Organizacja dostaw do sieci handlowych. Współpraca producentów z dużymi detalistami. LogForum 2,1, 6.
URL: http://www.logforum.net/vol2/issue1/no6
Zatwierdzono: 30.01.2006, on-line: 15.04.2006.

sieci należy nieco ponad połowa. Na rynku funkcjonują również tzw. dyskonta, których liczbę w 2004 roku szacowało się na 1300 placówek [Szafraniec 2004].

Funkcjonowanie sieci handlowych w Polsce odgrywa bardzo istotną rolę dla rozwoju gospodarczego naszego kraju. Pojawienie się na polskim rynku zagranicznych sieci handlowych to nie tylko napływ kapitału zagranicznego w postaci różnorodnych inwestycji, ale również transfer nowych technologii, przede wszystkim informacyjnych oraz know-how, poparte wieloletnim doświadczeniem na różnego rodzaju rynkach. Procesy koncentracji i konsolidacji zachodzące na krajowym rynku umożliwiają niwelowanie dystansu dzielącego nasz kraj od rozwiązań rynku europejskiego.

Coraz silniejsza konkurencja ze strony zagranicznych sieci handlowych nie pozostaje bez wpływu również na rodzime przedsiębiorstwa handlowe. W ostatnich latach obserwować można licznie tworzące się sieci zrzeszające polskich handlowców. Ich konkurencyjność opiera się przede wszystkim na bliskim kontakcie z klientem oraz dobrej lokalizacji. Sklepy te, w odróżnieniu od zagranicznych hipermarketów, położone są bowiem na osiedlach mieszkalnych lub w centrum miasta, a więc możliwie blisko klienta. Obsługa ukierunkowana jest tu przede wszystkim na określoną grupę klientów (najczęściej mieszkańców danego obszaru), a pracownicy sklepu znają osobiście większość klientów oraz ich preferencje zakupowe. Polskie przedsiębiorstwa tworząc sieci handlowe wybierają głównie typ kontraktowy, opierający się przede wszystkim na umowach franchisingowych (np. Chata Polska, Lewiatan). Sporadycznie spotyka się również typ sfederowany, polegający na zgrupowaniu osób prawnych lub fizycznych, które uświadamiają sobie wspólnotę swoich potrzeb i chcą stworzyć we własnym zakresie sposoby ich zaspokajania [Łupicka-Szudrowicz 2004] (np. Polska Sieć Handlowa "UNIA" S.A.).

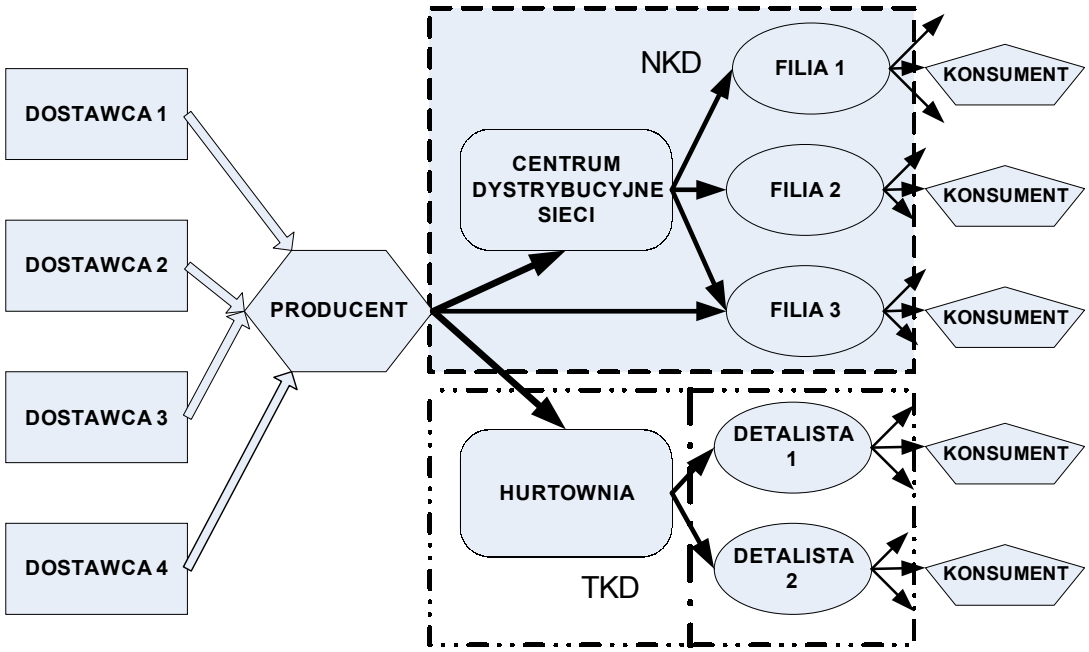
Ciągły rozwój różnego rodzaju sieci handlowych silnie oddziałuje również na polskiego konsumenta. Wraz z rozwojem gospodarczym kraju nastąpił wzrost liczby konsumentów lepiej wykształconych, o wyższym poziomie aspiracji konsumpcyjnych zróżnicowanych pod względem preferencji i oczekiwań stylów życia. Zmieniają się więc nie tylko preferencje konsumentów dotyczące standardu świadczonych usług handlowych, ale również miejsca dokonywanych zakupów. Według badań CEBOS-u [CEBOS 2004] z końca 2004 roku znacznie spada zainteresowanie zakupami żywności na bazarach i targowiskach, od 1997 roku zmalała (z 31% do 10%) liczba osób zaopatrujących się tam w artykuły żywnościowe. Zmalało również ich znaczenie przy zakupie środków czystości. Jednocześnie w ostatnich czterech latach wzrosła liczba Polaków robiących zakupy w dużych centrach handlowych (o 16 punktów do 66%). Wzrost ten dotyczy zarówno osób robiących zakupy często - przynajmniej raz w tygodniu, jak i odwiedzających hipermarkety rzadziej niż co tydzień.

WSPÓŁPRACA PRODUCENTÓW Z DUŻYMI SIECIAMI HANDLOWYMI I TRADYCYJNYMI KANAŁAMI DYSTRYBUCJI

Wzrost znaczenia sieci handlowych widać również w relacjach łączących je z producentami. Pierwszym elementem, na który należy zwrócić uwagę, jest fakt, że sieci handlowe zostały wyróżnione jako oddzielny kanał dystrybucji (Nowoczesny Kanał Dystrybucji - NKD), różniący się w sposób istotny od kanałów wykorzystywanych dotychczas (Tradycyjny Kanał Dystrybucji - TKD), (rys. 1).

Wykorzystanie przez producenta sieci handlowej jako ogniwa pośredniczącego między producentem a konsumentem skraca w istotny sposób drogę, jaką przebywa produkt od chwili wytworzenia do momentu konsumpcji. Dzięki temu skraca się ogólny czas dostawy produktu i zwiększa się elastyczność producenta w reakcjach na zmiany zachodzące na rynku. Nawet jeżeli produkt nie jest dostarczany bezpośrednio przez producenta do filii sieci, tylko występuje punkt rozdziału w postaci centrum dystrybucyjnego, to i tak funkcją tego centrum jest podział dostawy i przekierowanie jej do odpowiednich sklepów, a nie przechowywanie towaru na półkach magazynowych. W przypadku Tradycyjnego Kanału Dystrybucji, czas między wytworzeniem produktu a przejęciem go przez konsumenta znacznie się wydłuża, m.in. z powodu funkcji jakie pełnią

hurtownie. Zadaniem hurtowni jest bowiem nie tylko rozdział całościowej dostawy producenta i dalsza odsprzedaż do sklepów detalicznych, ale również czasowe przechowywanie towaru w swoich magazynach, pełniących rolę buforu między producentem a detalistami.



Źródło: opracowanie własne na podstawie wywiadów u producentów

Rys. 1. Kanały dystrybucji wykorzystywane przez producentów
Fig. 1. Distribution channels used by producers

Również realizacja dostaw do obu wyróżnionych powyżej kanałów dystrybucji jest zupełnie odmienna. Hurtownia, będąca ogniwem bezpośrednio zaopatrywanym przez producenta, z tytułu pełnionej funkcji, gromadzi zapas pozwalający jej zabezpieczyć ciągłość realizacji zamówień detalistów. Zapas ten jest zazwyczaj większy niż faktycznie występujące zapotrzebowanie, a wynika z wysokiego poziomu zapasu bezpieczeństwa. Poza tym hurtownia w celu uzyskania wysokich rabatów często decyduje się na zakup towaru w dużych partiach dostawczych, ale przy mniejszej ich częstotliwości. Taki charakter dostaw pozwala producentowi "przerzucać" obowiązek przechowywania części zapasu dystrybucyjnego na magazyn hurtownika. Takiej możliwości nie ma w przypadku NKD. Sieci handlowe nastawione są przede wszystkim na zachowanie wysokiego poziomu rotacji towaru na półkach sklepowych. Dlatego też ich działania ukierunkowane są na ograniczanie do minimum wielkości zapasu i czasu jego składowania. Dlatego też składane zamówienia dotyczą małych wielkości partii dostawczych, ale przy ich większej częstotliwości.

Istotnym elementem, którego w tym wypadku nie można pominąć, to możliwość bieżącego monitorowania popytu zgłaszanego przez konsumentów. Producent analizując zamówienia zgłaszane przez ogniwa bezpośrednio przez niego zaopatrywane, przekłada ich wielkość na informacje o popycie zgłaszanym przez klienta końcowego. W przypadku Tradycyjnego Kanału Dystrybucji informacja ta jest często zniekształcana, gdyż każde ogniwo pośredniczące niezależnie kalkuluje popyt, a w swoich zamówieniach zawiera oprócz faktycznego zapotrzebowania zapas towarowy zabezpieczający go przed nieprzewidzianymi zdarzeniami. W związku z tym zamówienie składane do producenta przez hurtowników zawiera faktyczny popyt zgłaszany przez konsumentów, oraz dodatkowo zapasy bezpieczeństwa wszystkich ogniw pośredniczących. Natomiast sieci handlowe składają do producenta zamówienie odpowiadające faktycznej wielkości realizowanej sprzedaży powiększone o minimalny zapas bezpieczeństwa. Dodatkowo kalkulacja popytu odnosi się do całej sieci i nie uwzględnia

kalkulacji żadnych ogniw pośredniczących (nawet jeżeli dostawy dostarczane są do centrum dystrybucyjnego). Dzięki temu wielkość zamówień składanych przez te przedsiębiorstwa handlowe odpowiada w sposób najbardziej zbliżony popytowi zgłaszanemu przez klientów końcowych.

Dodatkową cechą, która sprawia, że producenci są gotowi ponieść daleko idące ustępstwa, aby móc rozprowadzać towary za pośrednictwem sieci handlowych, jest fakt, że ten kanał dystrybucji daje możliwość dotarcia do znacznie większej rzeszy potencjalnych klientów niż TKD. Dlatego też zmniejsza się udział TKD w obrocie artykułami szybko rotującymi na rzecz NKD, średniorocznie w ostatnich latach o około 2-3%. Szacuje się przy tym, że obecny udział sieci handlowych w sprzedaży artykułów FMCG wynosi około 32% [Kłosiewicz-Górecka 2004]. Zwiększanie się udziału sieci handlowych w sprzedaży większości produktów konsumpcyjnych można prześledzić na podstawie tab. 1.

Tabela 1. Procentowe wielkości sprzedaży w latach 2003 - 2004 wybranych produktów rozprowadzanych za pośrednictwem NKD
Table 1. Sales volumes in 2003-2004 for some products distributed by MDC

Produkt	Rok 2003	Rok 2004	Zmiana
Papier toaletowy	54%	63%	9%
Płyny do płukania tkanin	52%	60%	8%
Detergenty	53%	60%	7%
Płyny do naczyń	41%	48%	7%
Pasty do zębów	50%	56%	6%
Wino	39%	44%	5%
Herbata	45%	49%	4%
Batony czekoladowe i chłodzone	32%	36%	4%
Czekolady	36%	39%	3%
Słone przekąski	28%	31%	3%

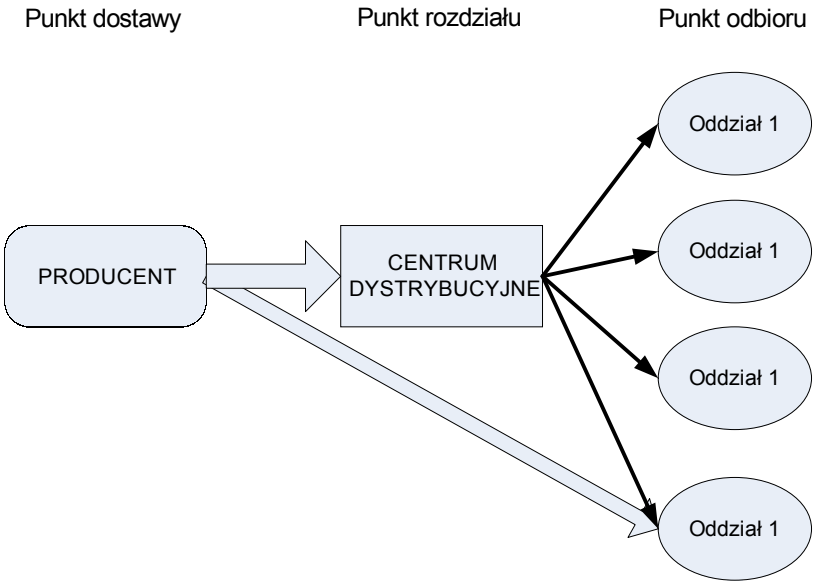
Źródło: opracowanie własne na podstawie Klajda [2004]

ZAOPATRZENIE SIECI HANDLOWYCH PRZEZ PRODUCENTA

Jak widać sieci handlowe stanowią specyficzny kanał dystrybucji, rządzący się własnymi prawami, w tym również wymaganiami dotyczącymi organizacji dostaw przez dostawców. Z wagi tych wymagań coraz częściej zdają sobie sprawę producenci, którzy dla obsługi sieci handlowych powołują specjalne komórki w ramach działów sprzedaży, które odpowiadają tylko za kontakty z klientami sieciowymi. Obserwację tę potwierdziły badania przeprowadzone przez autorkę w pierwszym kwartale 2005 roku. Z powodu małej ilości otrzymanych odpowiedzi, badania te nie miały charakteru badań statystycznych, a ich celem było jedynie wstępne rozpoznanie relacji łączących wybranych producentów z sieciami handlowymi. W ramach badań przeprowadzono wywiad z 15 producentami z sektora spożywczego, kosmetycznego/chemicznego oraz AGD, których wyroby znalazły się w rankingu 100 najbardziej cenionych marek polskich i zagranicznych, opublikowanym przez tygodnik Wprost [Wprost 2004], a przygotowanym przez Pentor. U każdego z ankietowanych producentów stwierdzono wyróżnianie sieci handlowych jako odrębnej grupy klientów (na uwagę zasługuje tu fakt, iż często producenci tak definiują klienta sieciowego, aby automatycznie wyeliminować małe polskie sieci handlowe, o charakterze grup zakupowych, które łączą swoją

działalność tylko w celu uzyskania korzystniejszych warunków handlowych). Dodatkowo część producentów w ramach swoich struktur organizacyjnych wyróżnia osobny dział, zwany Działem Obsługi Klientów Kluczowych (lub Sieciowych), odpowiedzialny jedynie za zarządzanie relacjami z tą wybraną grupą klientów. Do grona tych producentów należą przede wszystkich producenci z sektora spożywczego i kosmetycznego. Z badań wynika również, że negocjacje z klientami sieciowymi prowadzone są przez producentów na poziomie kierownictwa (kierownik działu sprzedaży lub kierownik ds. kluczowych klientów), natomiast umowy są zatwierdzane przez członków zarządu lub podpisywane przez prezesa zarządu. Świadczy to o randze przypisywanej tej grupie klientów.

Sieci handlowe w swojej polityce zaopatrzeniowej starają się wykorzystać wszystkie atuty wynikające z równoczesnej centralizacji i decentralizacji wybranych funkcji zaopatrzeniowych. Realizacja pierwszej fazy procesu zaopatrzenia (ustalenie polityki zakupów, wybór dostawców, prowadzenie negocjacji) na szczeblu centralnym, umożliwia sieci handlowej osiągnięcie efektu skali i uzyskanie wyjątkowo korzystnych warunków współpracy. Równocześnie z centralizacją strategicznych decyzji zaopatrzeniowych, większość sieci decentralizuje funkcje zakupowe na poziomie poszczególnych oddziałów. Dzięki temu każdy oddział może szybko reagować na faktyczne zapotrzebowanie występujące w jego regionie i elastycznie dopasowywać wielkość zamówienia do rzeczywistych swoich potrzeb. Oczywiście taka sytuacja ma miejsce w przypadku dostaw realizowanych bezpośrednio do oddziałów sieci. Pamiętać bowiem należy, iż dostawy realizowane przez producenta do sieci handlowych mogą mieć charakter dualny. Są one bowiem realizowane za pośrednictwem centrum dystrybucyjnego sieci lub bezpośrednio do jej oddziałów. Takie zróżnicowanie miejsca dostawy nabiera istotnego znaczenia, gdyż wiąże się to z różnorodnością partii dostawczych. O ile bowiem do centrum dystrybucyjnego dostarczane są zazwyczaj przesyłki całopojazdowe, o tyle do oddziałów kierowane są najczęściej mniejsze ilości towaru, mające na celu uzupełnienie bieżącego zapasu. To wiąże się z koniecznością stosowania odpowiednio zróżnicowanego taboru, wykorzystywanego do przewozu towarów. Dlatego też coraz częściej obserwuje się, iż producenci decydują się na outsourcing usług transportowych, jako bardziej efektywnego rozwiązania, w przypadku dostaw do klientów z tej grupy. Za outsourcingiem usług transportowych przemawia tutaj również fakt, iż oddziały sieci, wymagające dużej elastyczności w stosunku do dostawców, zamawiają często małe ilości produktów, np. jedna paleta wyrobów, które muszą być dostarczone w określonym czasie. Wykorzystywanie do tych dostaw transportu własnego oznaczałoby często dla producenta realizację pustych przejazdów.



Źródło: opracowanie własne w oparciu o Pfohl [2004]

Rys. 2. Dostawy towarów do sieci handlowej
Fig. 2. Deliveries to trading networks

Powyżej przedstawiona realizacja dostaw do sieci jest typowym przykładem logistycznego systemu kombinowanego, a mianowicie towar może być przekazany zarówno bezpośrednio do oddziały, jak i za pośrednictwem punktu rozdziału jakim jest centrum dystrybucyjne sieci.

W obu przypadkach zamówienie sieci handlowej generowane jest na podstawie sprzedaży (oddział) lub wydań (centrum dystrybucyjne) z ostatnich dwóch tygodni. Zamówienie generowane jest zazwyczaj automatycznie przez system informatyczny. Wyjątek stanowi sytuacja, kiedy w danym okresie planowana jest promocja wyrobów producenta, wówczas zamówienie może być ręcznie skorygowane o planowany wzrost sprzedaży. Zamówienie przesyłane jest do producenta, który zgodnie z umową zobowiązany jest do dostarczenia kompletnej przesyłki w wymaganym czasie (zazwyczaj krótszym od standardowo przyjętego przez producenta). Zauważyć przy tym należy, że sieci coraz liczniej do wymiany dokumentów handlowych wykorzystują elektroniczną wymianę danych (EDI) i ten standard niejako wymuszają również na producentach. Przed dostawą konieczne jest precyzyjne określenie terminu dostawy (co do godziny), gdyż większość sieci handlowych stosuje awizację dostaw. Niedotrzymanie terminu dostawy przez producenta oznacza albo odrzucenie (nieprzyjęcie) dostawy albo długie oczekiwanie kierowcy na pojawienie się wolnego "okienka", w którym dostawa może być ewentualnie rozładowana. Przy przyjmowaniu dostaw zarówno towar, jak i dokumentacja poddawane są wnikliwej kontroli ze strony pracowników sieci. Jakiekolwiek uchybienie dotyczące dostarczonej dokumentacji, towaru, opakowania, rozmieszczenia wyrobów, przekłada się na odrzucenie lub reklamowanie dostarczonej partii towaru. Ponieważ sieci nastawione są głównie na zakup towarów o wysokim poziomie rotacji, zazwyczaj płatność do producenta za dostarczone produkty następuje już po ich zbyciu przez sieć handlową. Niektóre sieci starają się w ramach współpracy z producentami wdrażać strategię VMI (Vendor - Managed Inventory), polegającą na przekazaniu obowiązku zarządzania zapasami w sieci handlowej dostawcy. Jednak w ślad za zwiększeniem odpowiedzialności producentów nie idą żadne zobowiązania ze strony sieci, jak na przykład zapewnienie trwalszej, długookresowej współpracy. Dlatego też producenci bronią się przed tą formą innowacji, gdyż brak jest w niej podstawowego założenia obowiązującego w koncepcji VMI, a mianowicie długotrwałych relacji partnerskich.

Jak wynika z badań prowadzonych przez autorkę, większość sieci handlowych we współpracy z producentami stosuje strategię "wygrany-przegrany". Jest to charakterystyczne dla relacji transakcyjnych, które obecnie dominują w prezentowanym obszarze. Relacje te charakteryzują się zachowaniem oportunistycznym obu stron, działaniem w warunkach wysokiego ryzyka, a przede wszystkim minimalną wymianą informacji między partnerami handlowymi. Jedynie w przypadku producentów dostarczających produkty sprzedawane pod marką handlową sieci można mówić o wyższym poziomie współpracy. Dla tych dostawców sieć handlowa ustala wymagania kosztowe i jakościowe dostarczanych wyrobów oraz często przejmuje częściową kontrolę nad wytwarzanymi wyrobami. Wymaga to zwiększenia zakresu wymienianych danych oraz silniejszych więzi handlowych między partnerami. Jednak nawet w stosunku do tej grupy wybranych dostawców można nadal obserwować stosowanie przez sieci strategii "wygrany-przegrany".

WNIOSKI

Sieci handlowe odgrywają coraz bardziej istotną rolę w strategiach dystrybucji realizowanych przez producentów. Uwaga im przypisywana wynika zarówno z ich wymagań w zakresie obsługi logistycznej dostaw, jak i potencjalnych możliwości, jakie dają one producentowi w dotarciu do klienta końcowego. Jednak nastawienie transakcyjne w relacjach łączących partnerów sprawia, iż potencjał sieci handlowych nie jest wykorzystywany w całości w celu osiągnięcia obustronnych korzyści. Wysokie wymagania dotyczące obsługi, jak również dodatkowe opłaty stosowane przez sieci handlowe sprawiają, że producenci nie postrzegają tego ogniwa pośredniczącego jako "partnera" we wspólnych interesach, a raczej jako "przeciwnika" w rozgrywanych potyczkach. A przecież duzi detaliści stanowią wyjątkowe przedsiębiorstwo handlu detalicznego. Charakter ich działalności

i organizacja pracy sprawia, że stanowią one ogniwo pośredniczące o równie silnej pozycji rynkowej co producent, a jednocześnie gromadząc informacje mogą wspierać jego działania. Dzięki temu sieci handlowe mają możliwość wpływać m.in. na ograniczenie całościowych zapasów dystrybucyjnych i związanych z nimi kosztów, jak również zwiększyć efektywność procesu dystrybucji realizowanego przez producenta. Osiągnięcie takich efektów jest jednak realne tylko w przypadku współpracy charakteryzującej się szerszą wymianą informacji dotyczących planowanych i realizowanych działań obu partnerów niż ma to miejsce w chwili obecnej. Aby to jednak było możliwe konieczne jest nawiązanie między producentem i siecią handlową relacji o charakterze partnerskim, budowanych na wzajemnym zaufaniu i opartych o długotrwałą współpracę.

LITERATURA

Klajda M., 2004, Motywy wyboru miejsca zakupów. Co dzisiaj działa na klienta? Materiały z Międzynarodowej Konferencji Forum Handlu Detalicznego BestShop 2004, Warszawa.

Kłosiewicz-Górecka U., 2004, Współpraca producentów i przedsiębiorstw handlowych, Logistyka 3, 12 –16.

Łupicka-Szudrowicz A., 2004, Zintegrowany łańcuch dostaw w teorii i praktyce gospodarczej, Wyd. AE w Poznaniu, Poznań.

Maleszy P., Chodura P., Wielgosz A., Kopański M., 2004, Możliwość aliansu producentów FMCG na rynku polskim, Praca magisterska na studiach MBA UW, Warszawa.

Pfohl H. C., Systemy logistyczne. Podstawy organizacji i zarządzania, Biblioteka Logistyka, ILiM, Poznań 2001.

Pokorska B., Maleszy E., 2002, Koncentracja i integracja w handlu wewnętrznym, PWE, Warszawa.

Szafraniec G., 2004, Co dalej z polskim handlem. Podgląd 01.11.2004, www.wiadomoscihandlowe.com.pl/handel/id,1241.html.

Komunikat z badań Centrum Badania Opinii Społecznej BS/172/2004, 2004, Warszawa,, www.cebos.pl.

Rankingu 100 najbardziej cenionych marek polskich i zagranicznych, 2004, Wprost nr 1118.

DELIVERY ORGANIZATION TO TRADING NETWORKS. COOPERATION BETWEEN MANUFACTURERS AND BIG RETAILERS

ABSTRACT. Recently observing trading networks in Poland we can see that the role of this kind of companies has magnified. Dynamic increase of trade turnover has also influenced the relationship between trading networks and manufacturers. For the producers of fast moving consumer goods (FMCG) trading companies organized as networks has become their main distribution channel. Their share in the segment of retailer sales is so large that a FMCG manufacturer who doesn't cooperate with the trading network takes a great risk of his further existence in the market. Other manufacturers have also noticed great significance of good relationships with trading networks. Many of them create special sections only responsible for core customers' service that are mainly trading companies. The article presents examples of network customers' service in manufacturers operating in various lines of business.

Key words: producer, distribution channel, network, order processing, relationship, cooperation.

DIE LIEFERUNGORGANISATION ZU DEN HANDELSNETZ-WERKEN. DIE ZUSAMMENARBEIT VON DEN HERSTELLERN UND DEN GROSSEN EINZELHÄNDLERN

ZUSAMMENFASSUNG. Die Beobachtung des polnischen Marktes zeigt deutlich, dass Handelsnetzwerke eine wichtige Rolle spielen. Die Steigerung des Anteils der Handelsnetzwerke im Markt zum normalem Einzelhandels hat einen Einfluss in Relation zwischen Herstellern und Netzwerken. Für die Hersteller von Fast Moving Consumer Goods (FMCG) werden die Handelsnetzwerke ein Hauptvertriebsweg. Ihre Beteiligung im Einzelhandel ist so groß, dass der FMCG-Produzent der nicht Handelsnetzwerke nutzt, seine Existenz auf dem Markt gefährdet. Auch andere Geschäftszweige sehen die Wichtigkeit der Handelsnetzwerke und schaffen spezielle Abteilungen die nur die Handelsnetzwerke betreuen. In diesem Referat werden Beispiele von Netzkundendiensten vorgestellt die durch Hersteller aus verschieden Wirtschaftszweigen angewandt werden.

Codewörter: Hersteller, Vertriebsweg, Handelsnetzwerk, Lieferbedingungen, Relation, Mitarbeit.

mgr Agnieszka Tubis
Międzynarodowa Wyższa Szkoła Logistyki i Transportu we Wrocławiu
ul. Sołtysowicka 19 B
51 - 168 Wrocław, Polska
e-mail: a.tubis@post.pl

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 2
No 1

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

GS1 GLOBAL STANDARDS AND EPC GLOBAL AS A SOLUTION ENABLING TRACEABILITY OF GOODS IN SUPPLY NETWORK

Grzegorz Sokołowski

Institute of Logistics and Warehousing, Poznań, Poland

ABSTRACT. The process of ensuring the safety of goods delivered to the market is connected with monitoring and administrating of needed dates at every stage of supply chain and at the level of every supplier included in this chain. The problem started to be discussed more closely when the new legal food traceability requirements were introduced. Food sector companies were forced by these requirements to introduce the system of monitoring of origin and every movement of every item offered to clients (so called traceability system). This system is composed of special procedures and rules to monitor and gather all needed information about goods. The idea of traceability system is to be able to track every item of goods offered at every stage of supply chain, included every raw material used for production of this item as well as to transfer these information to next step of supply chain. Global standards used by GS1 system of monitoring, registration and flow of information are sufficient to meet above-mentioned requirements. The paper presents the GS1 and EPC global standards and possibilities to introduced them into FMCG companies. The case of implementing GS1 standards to trace food goods in whole supply chain is presented.

Key words: traceability, GS1 system, EPC global, supply chain.

"TRACEABILITY" - FULFILLMENT OF LEGAL REQUIREMENTS

Every supplier of food products (producer and retailer) is obliged to register every movement of goods, that means - where, when and from whom he bought these goods, etc. The best way to automate this process is to implement the global standards, readable for all participants of supply chain.

The obligation of monitoring of movement and origin of foods and fodders results directly from Regulations 178/2002 from 28 January 2002 of European Parliament and Council of Europe. The regulations came into force in countries of European Community since 1 January 2005. The English word "traceability" is used very often instead of polish one, because the English version is used and recognized more widely.

All participants of supply chain are responsible for monitoring of goods distributed in this chain, not only producers and wholesalers of goods but retail shops as well, which are the last stage of supply chain. In fact, retail shops are the first ones where the "searching" of problems reasons is being held, if any alarm occurs on the market. In case the client reclaims the product not suitable for use, the retail shop is obliged to identify the product (name, producer, who delivered the product, batch number of product, etc.) and to transfer these information to supplier of this good.

Citation: Sokołowski G., 2006, GS1 global standards and EPC global as a solution enabling traceability of goods in supply network. LogForum 2, 2, 1
URL: http://www.logforum.net/vol2/issue2/no1
Accepted: 10.07.2006, on-line: 15.08.2006.

According to present legal regulations the one who offers the product on the market is responsible for its quality and safety. To offer on the market means to store and present goods to be sold to clients, to deliver them as well as any other way to introduce these goods to the market, with only exception of direct sale. These rules are covered in details by Regulations from 29 January 2004 (of Veterinary Inspection), from 11 May 2001 (of foods and conditions in which they are kept) and from 28 July 2005 (its amendment). Following this interpretation the producer or brand owner will be the one who introduces products into the market. But in fact the differently constructed commercial agreements are signed and according to them usually the delivers of products are responsible for withdrawing of goods from the market.

There are a few basic rules of monitoring goods origin and movements, which should be considered by every handler of food products [ECR Europe 2004]:

- systems and procedures of traceability processes should fulfill the main aim, to cover legal requirements of access to information about traced products and to ensure the possibility of quick withdrawing of these goods from the market,
- monitoring system should be based on standards approved and accepted by all participants of supply chain to ensure the quick and precise flow of information and optimatisition of data processing,
- every participant of the chain has a free will to choose his own traceability system, the only condition is, his system must enable to exchange all information needed with other participants of the chain.

According to above-mentioned rules every participant of supply chain of food products has to gather information about goods bought and delivered by him. From the point of view of safety of goods introduced on the market, the most important case is to possess the information and to have quick access to it. The way the information is gathered is also very important. These data should be collected in a way acceptable for all participant of supply chain. Of course, records may be performed manually. However, from the point of view of logistic process management, it is more efficient for a company to develop a database in a computer system.

The suppliers of raw materials are also responsible for health quality of food products. They are the part of supply chain as well. This results directly from Regulation (EC) No 1935/2004 (together with Regulations 80/590/EWG and 89/109/EWG overruling the first one). This legal document, article 17, specifies requirements regarding traceability:

1. The traceability of materials and articles shall be ensured at all stages in order to facilitate control, the recall of defective products, consumer information and the attribution of responsibility.
2. With due regard to technological feasibility, business operators shall have in place systems and procedures to allow identification of the businesses from which and to which materials or articles and, where appropriate, substances or products covered by this Regulation and its implementing measures used in their manufacture are supplied. That information shall be made available to the competent authorities on demand.
3. The materials and articles, which are placed on the market in the Community, shall be identifiable by an appropriate system, which allows their traceability by means of labeling or relevant documentation or information.

This Regulation will come into force in October 2006, thus upstream sector connected with a food industry will be obliged to observe traceability rules.

The GS1 System, which uses global standards to identify individual units and flow of information, offers tools and solutions to fulfill the traceability requirements.

SYSTEM GS1 – SOLUTION FOR "TRACEABILITY"

The GS1 System is administered by GS1 (previously EAN International) being a global organization that currently consists of over 1.000.000 user companies, 104 member organizations from 105 countries. The GS1 standards are used in over 20 industries such as FMCG, healthcare, automotive and transportation.

It is generally assumed by representatives of food sector companies that they meet food traceability requirements by means of the following norm and standards: ISO 9001:2000, HACCP, IFC or BRC. Indeed, those standards ensure safety of food products produced, stored or distributed, thanks to internal systems of product and trade partner monitoring. However, this does not guarantee the continuity of traceability processes in the whole supply chain. Companies obliged to track and trace their products may encounter the following problems:

- lack of relation registration between:
  - batch/lot numbers (e.g. records of connections between particular batch numbers of products or semi-manufactured articles),
  - batch or lot numbers or number of logistic units (e.g. the records of information about number of logistics units in relation to lot number of units contained),
  - numbers of logistics units and numbers of trade partners (e.g. records of information from whom a particular logistic unit was received and to whom it was sent),
- lack of a uniform identification method and data record about tracked and traced products and the trade partners, and thus lack of possibility of effective information exchange.

The GS1 System allows for elimination of the above-mentioned problems. In order to broaden possibilities of the system and in order to support its users, the implementation grid [EAN International 2004] presented in Table 1 was defined. It combines basic traceability rules with accessible technologies and the GS1 System tools.

Table 1. Implementation grid of the GS1 standards
Tabela 1. Siatka wdrażania standardów GS1

Traceability principles	Enabling technologies	GS1 system tools
unique identification	automated identification	GTIN, SSCC, GLN, application identifiers
data capture and recording	automated data capture	EAN/UPC GS1-128
links management	electronic data processing	software applications
data communication	electronic data interchange	EANCOM / XML

The unique identification of products, lot production, logistics units in range of traceability can be assured using GS1 global identifiers:

- GTIN (Global Trade Item Number) - which can identify the individual number of a consumer packaging (retail unit) or trade packaging (non retail),
- SSCC (the Serial Shipping Container Code) - which usually identifies the individual number of a pallet or trade unit,
- GLN (Global Location Number) - it enables unique and unambiguous identification of physical, functional or legal units, such: the warehouse, individual loading docks, the branches of firm etc.,
- AI (Application Identifier) - are identifiers which identify data that appears after them; each attribute of logistics units or trade unit included in a logistic label are definite by means of AI's.

Batch/Lot number presented by means of AI (10) is essential information, which needs to be linked with collective packaging number.

Data capture and recording is realized based on an assumption that every participant of supply chain uses uniform GS1 standards which are reflected in appropriate bar code symbols. To realize requirements of traceability all units should be equipped with labels with bar code. Several basic symbologies are used in the GS1 system depending on the type of packaging and function in the supply chain:

- bar-coding trade units (retail): EAN-13, EAN-8,
- bar-coding trade units (non retail): EAN-13, ITF-14 or GS1-128,
- bar-coding logistic units: GS1-128.

The management of data related to tracked and traced units requires correct data connection in databases. It means that information about numbers of units on each packaging level are associated with information about trading partners, and/or the places of delivery and receipt of these units.

Data communication is the key element ensuring the realization of traceability rules, because when any hazardous product appears on the market, the suitable flow of information among trade partners makes quick and effective actions possible, e.g. product recall. In order to exchange information more efficiently, EDI is the best solution.

EDI - (Electronic Data Interchange) is defined data structure transfer, by means of standard messages, from one computer application to another, without or with minimum human intervention. In order to exchange information more effectively and to meet traceability requirements it is enough for trading partners to exchange the following EDI message - DESADV (Dispatch Advice).

This message contains a lot of information characterizing in detail a given dispatch. However, from the traceability point of view the most important information is as follows:

- information about trade partners – GLN,
- information about delivered product - GTIN + AI (10),
- information about logistic unit - SSCC.

Generally, the above mentioned principles are related to correct identification of packaging within a logistic process taking into account batch/lot number and/or other data which must be recorded to meet traceability rules.

Taking into account the above mentioned rules for traceability system which would function in a company, guarantees the fulfillment of traceability requirements and simultaneously generates some additional benefits:

- reduction of labour work,
- elimination of errors,
- reduction of costs,
- effective management,
- and improve the competitiveness of company.

There is one basic conclusion arising from the above mentioned rules defining the usage of the GS1 standards for traceability reasons: every partner engaged in a food supply chain should gather information related to delivered and shipped goods. This information concerns both the goods themselves but also recipients and suppliers of these goods. From the point of view of product safety, information and a quick access are the most important issues. Data capture method is another important issue. It is important to present the data in a way comprehensible for all participants of a supply chain: standard, universal and common. Records may be performed manually. However, from the point of view of logistic process management, it is more efficient for a company to develop a database in a computer system.

Technology based on RFID and EPC global standards offers larger visibility of supply chain and more effective methods of monitoring goods through this supply chain.

TECHNOLOGY RFID/EPC

The technology of recording and reading bar codes was developed and popularized worldwide and that it is why it is cheap and globally used. However, the main reason why this technology is globally used, are the global GS1 numbers, which unambiguously identify product, pallet or location. Bar codes, which are data carriers, will slowly be pushed out by RFID tags, which consist of a microchip with and antenna activated via radio waves. Information in a tag is recorded in a binary manner and processed by means of special transferred into numerical data. The superiority of RFID technology (Radio Frequency Identification) over a traditional one (e.g. bar codes) lies in considerably broadened quantitative possibilities of data record about a specific object.

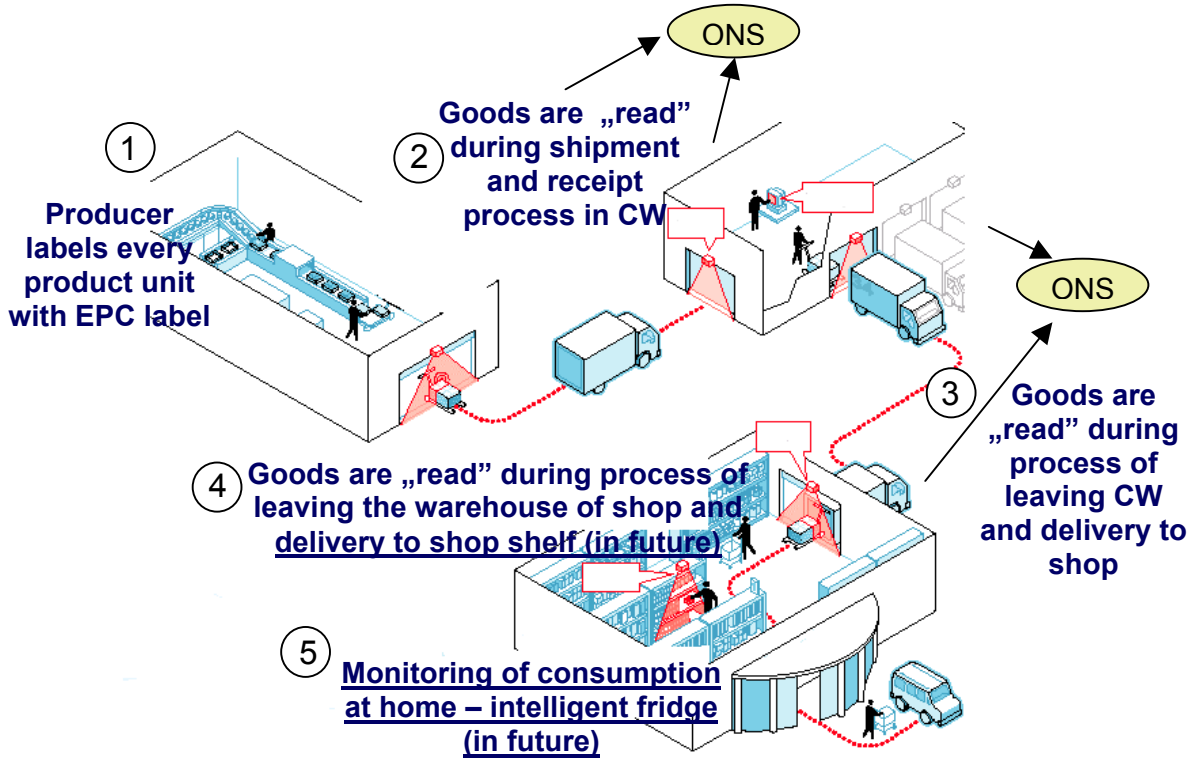


Fig. 1. The whole supply chain by use of EPC global system [GCI/IBM 2003]
Rys. 1. Schemat pełnego łańcucha dostaw w aspekcie wykorzystania sieci EPC global [GCI/IBM 2003]

Open EPC standards are not only standard ways of recording definite information in an EPC tag, but first of all the EPC global network, permitting to identify automatically an individual unit in a supply chain in every company, in every branch of industry, worldwide. EPC global network consists of the following basic elements:

- EPC - product code written on an electronic carrier; individual, global object identifier,
- tags and readers - the device to collect data, connecting flow of goods with flow of information,
- middleware - the software for filtering output data from readers and for reducing overloading of network; this is also the interface to internal computer systems and to the EPC global network,

- ONS (Object Naming Service) - resource, which "knows" where information about EPC is kept (ONS is similar to DNS),
- EPC IS (the EPC Information Service) - the server, enabling the users to exchange data between trading partners based on EPC codes. This server uses the PML language (Physical Markup Language) - designed by Auto - ID laboratory as a method of product description. PML is a standardized XML dictionary for description of physical object, systems, processes and environments connected with the object.

The possibility of tracking the flow of goods in real time is one of basic advantages of the above-described technology and at the same visibility of the whole supply chain. Each product identified with an individual number EPC is tracked and traced in a supply chain. Whenever a product leaves a warehouse, this action is recorded and visible for participants of the whole EPC global network. A retailer orders a particular product for example from a manufacturer. Thanks to the EPC global network such a company can observe when the ordered goods leave factory, when they appear in a distribution centre and when they are delivered to the shop. But what is the benefit of monitoring flow of an individual product in a supply chain?

Looking for answer to the above-mentioned question about reasons for such a detailed identification, we come to the following conclusions:

- by means of an individual EPC number in case of a product recall, we can reduce size of the assortment to be withdrawn - not always will it be necessary to withdraw the whole lot after having defined the source of the problem,
- it is possible to react more quickly to critical situations caused by the introduction of dangerous products into the market - the possibility of tracing product history, without necessity of insight to internal databases; such functionality is in place thanks to the EPC global interfaces and internet tools.

SOLUTION "TRACEABILITY" USING GS1 STANDARDS IN PRACTICE

Many companies use GS1 standards as a solution for monitoring and tracing products in supply chain now. The example of implementation of EDI communication in connection with GS1 standards in food product supply chain is presented below.

This case present three companies - participants of supply chain on Dutch market:

- REMIA - producer of margarines, oils and dressings,
- Van Uden Food Express - logistics operator for Remia, who is responsible for warehousing and transport of REMA goods,
- Makro - network of shops of Metro group - retail shop.

The flow of goods and information among these three companies can be described shortly as follows. REMIA prepares the order based on EDI ORDER send by MAKRO. REMIA sends the INSDES message (dispatch instructions) to Food Express, which describes the details about client's order. After picking process is finished, Food Express sends a DESADV message (shipment note) to MAKRO and REMIA (including the details about goods prepared). REMIA prepares the invoice for MAKRO, sending special INVOIC message (Invoice).

Describing the flow of goods, four steps of process can be marked out:

1. REMIA marks the pallet with a logistics label, including such data as: number of logistics units, quantity, shelf-time, production batch number, etc. Warehouse stock in REMIA is automatically actualized and a DESADV message is sent to Food Express. Before shipment, the data read from logistics label are confronted with data from computer system by using ADC system.

2. Food Express sends periodically the warehouse stocks report via INVRPT message to producer. Thanks to this process the producer knows exactly when and in what quantities the stocks have to be replenished. When Food Express receives the goods, the logistics label is read and data from it are introduced and automatically confronted with the system (the information about delivery was sent earlier via EDI message DESADV).

3. REMIA sent the INSDES message connected to MAKRO order. Food Express labels the pallets with logistics label having the SSCC code. Then the message DESADV (shipment note) is sent to METRO and REMIA, including details about shipment. Warehouse stocks are actualized automatically in Food Express system.

4. MAKRO prepares receipt note based on DESADV message. The goods are accepted in receipt zone, SSCC codes are read and confronted with a receipt note in the system.

In the present example, the basic traceability rules are processed through the system based on GS1 standards, where the whole supply chain uses global standards for gathering and administrating of data. If a crisis situation occurs in above-presented example, the withdraw of any batch will be possible quickly and efficiently thanks to implemented system.

SUMMARY

Solutions based on the GS1 standards in the context of traceability requirements fulfillment come down to correct packaging identification taking into account batch/lot number and/or other data, which must be recorded to meet traceability rules. Therefore correct usage of the GS1 standards, also in critical situations, makes it possible to withdraw products from the market, using global GS1 identifiers, recorded and stored in databases: GTIN, SSCC, GLN and suitable AIs. EPC numbers are based on the same numbers as GS1 identifiers, e.g. GTIN, SSCC, and GLN. They are however enriched with a serial element, which makes it possible to identify individual units, objects by means of EPC tags.

REFERENCES

EAN International 2004, Traceability management tools for agriculture, food and beverage products" published by EAN International, Brussels.

ECR Europe 2004, ECR - Using Traceability in the Supply Chain to meet Consumer Safety Expectations, published by ECR Europe.

GCI/IBM 2003, Global Commerce Initiative EPC Roadmap, published by GCI/IBM.

STANDARDY GLOBALNE GS1 I EPC GLOBAL JAKO ROZWIĄZANIE WSPOMAGAJĄCE ŚLEDZENIE TOWARÓW W ŁAŃCUCHU DOSTAW

STRESZCZENIE. Zapewnienie bezpieczeństwa dostarczanych na rynek produktów wiąże się z rejestrowaniem i gromadzeniem danych na ich temat na każdym etapie łańcucha dostaw żywności, a więc na poziomie każdego z przedsiębiorstw biorących udział w tym łańcuchu. Na problem zwrócono szczególną uwagę podczas ustanawiania nowych przepisów prawa żywnościowego. Wymogi te w naturalny sposób wymusiły na przedsiębiorstwach branży żywnościowej i żywieniowej konieczność śledzenia ruchu i pochodzenia produktów - z ang. "traceability", czyli stosowania określonych zasad i procedur pozwalających zapisywać konieczne informacje o produktach. Istotą "traceability" jest możliwość monitorowania ruchu i pochodzenia danego produktu (partii produkcyjnej) na każdym etapie łańcuch dostaw, czyli możliwość uzyskania danych z poprzedniego etapu łańcucha (od kogo i co otrzymano?) i jednocześnie przechowywania informacji dotyczących następnego etapu (do kogo i co wysłano?). System GS1 posługujący się globalnymi standardami

w zakresie oznaczania jednostek i przepływu informacji, posiada niezbędne narzędzia pozwalające spełnić to założenie. W artykule zaprezentowane zostaną standardy GS1 i EPC global i możliwości ich zastosowania w branży FMCG. Poza tym przedstawiono case, opisujący zastosowanie standardów GS1 w celu śledzenia żywności w pełnym łańcuchu dostaw produktów spożywczych, czyli na linii: producent - centrum dystrybucji - detalista.

Słowa kluczowe: śledzenie towarów, system GS1, EPC global, łańcuch dostaw.

Grzegorz Sokołowski
Institute of Logistics and Warehousing
Instytut Logistyki i Magazynowania GS1 Polska
ul.Estkowskiego 6
61-755 Poznań, Polska
ph. + 48 61 850 49 78
e-mail: grzegorz.sokolowski@ilim.poznan.pl

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 2
No 2

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

EFFICIENT CONSUMER RESPONSE CONCEPT AS A SUPPORT FOR SUPPLY CHAIN DEVELOPMENT

Justyna Lewandowska

Institute of Logistics and Warehousing, Poznań, Poland

ABSTRACT. The article provides a set of information about Efficient Consumer Response (ECR). ECR is defined as a concept focused on increasing the effectiveness of supply chains. It aims at better responding to consumers' needs at reduced costs along the whole supply chain by close co-operation of all members of the supply chain. Pre-condition for successful ECR is a high-level (in terms of transfer rates and correctness) information flow from the selling point (the consumer) throughout the entire supply chain by using common information standards. With this, the ECR concept provides methods for overcoming existing practical and content-related lacks in sphere of up-to-date solutions for truly integrated co-operation in supply chains and satisfying the huge demand for such knowledge in the companies.

Key words: supply chain management, efficient consumer response, category management, product replenishment, enabling technologies, cross docking, electronic data interchange (EDI), electronic funds transfer (EFT), item coding/database management, ABC Costing.

EFFICIENT CONSUMER RESPONSE AT SUPPLY CHAINS

Traditional logistic chain management is characterized by independent links, which fulfill their own specific task. This type of management is identified by optimization of each link independently. However this can result in inconsistency when one link adopts a strategy, which conflicts with the strategy adopted by the previous or next link. The results are high logistic costs and low consumer service levels, which eventually can result in less competitive power for every link and thus for the whole chain.

Despite the fact that most companies are optimizing their links in the chain, practice proves that this is not sufficient. The market is becoming more dynamical and that also counts for relationships with suppliers and consumers. Therefore modern companies must also have an eye for logistic developments outside the walls of their own company. This is where Efficient Consumer Response (ECR) plays an important part.

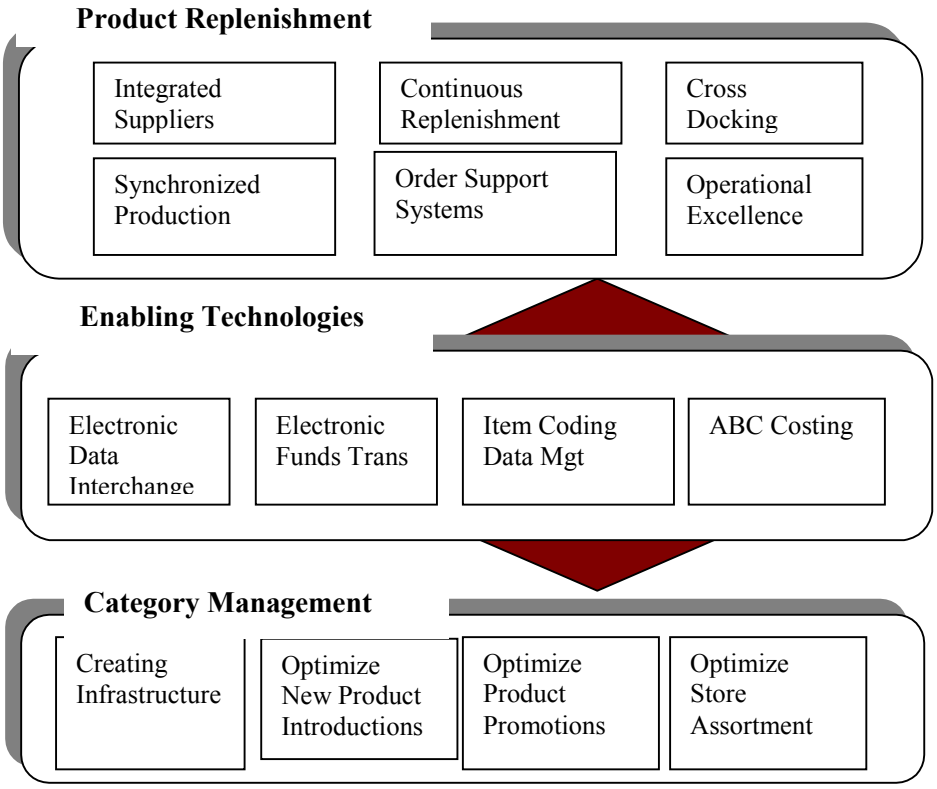
Efficient Consumer Response is a global movement in the consumer goods industry. The ECR Europe Executive Board expresses the ECR vision as: "working together to fulfill consumer wishes better, faster and at less cost".

ECR has a few starting points. Firstly the definition shows that consumer demand plays an important part. The chain has to ensure continual improvement of consumer satisfaction, products, and quality. Secondly, the definition also shows that maximum efficiency of the total logistic chain is required. The realization of the two starting points cannot be done without accurate information, which

Citation: Lewandowska J., 2006, Efficient Consumer Response concept as a support for supply chain development. LogForum 2, 2, 2.
URL: http://www.logforum.net/vol2/issue2/no2
Accepted: 24.07.2006, on-line: 15.08.2006.

must be available when needed. To keep the costs low, it is preferred that this information and communication is paperless. To accomplish these aspects of ECR, three focus areas can be distinguished, (see Fig. 1):

1. Category management.
2. Product replenishment.
3. Enabling technologies.



Source: Coopers & Lybrand, 1996.

Fig. 1. ECR focus areas
Rys. 1. Obszary ECR

CATEGORY MANAGEMENT

Here the objective is to maximize the effectiveness of the demand creation process. This comprises:

1. Optimize new product introductions.
2. Optimize product promotions.
3. Optimize store assortment.

ECR looks at both how effective trading partners are in their internal activities and how well they work together and use their joint capabilities to maximize consumer value. Of great importance is category management infrastructure, which sets goals in organization, strategic intent and systems on how trading partners communicate with each other and take decisions.

PRODUCT REPLENISHMENT

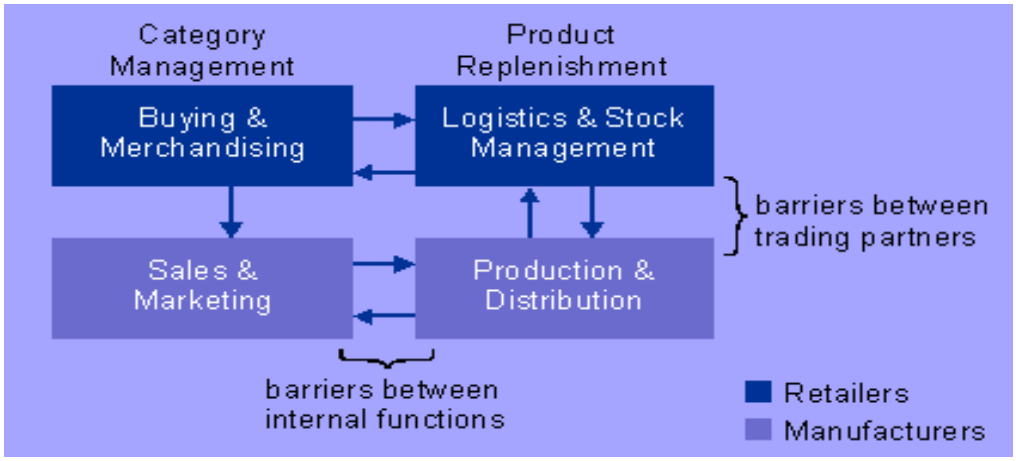
The focus here is on ensuring the slickest possible flow of products to the retailers' shelves. This supports joint category management with a physical supply chain that is flexible and responsive enough to react quickly to changes in demand. Rapid and efficient product replenishment contributes to cost savings through minimizing the amount of inventory in the system while meeting required service levels.

Again, a critically important issue is how trading partners work together to achieve these objectives.

ECR seeks to make a quantum leap in costs and responsiveness through well integrated planning, which avoids activities that magnify variations in demand, which stress the supply chain. Standardization of information and communication can also save a lot of time and money.

ENABLING TECHNOLOGIES

Category management and product replenishment, and especially the joint aspects between retailers and manufacturers are confronted with a few barriers. To overcome these barriers enabling technologies are needed to make category management and product replenishment work.



Source: Coopers & Lybrand, 1996.

Fig. 2. ECR Focus Areas and trade partners barriers.
Rys. 2. Obszary ECR i bariery między partnerami handlowymi.

A lot of data about demand and supply at Stock Keeping Units (SKU) level will need to be moved around and manipulated to determine optimum solutions. Electronic data interchange (EDI) and electronic funds transfer is two ways to do this on the scale required. Item coding and database management are necessary to track products accurately at SKU level. Finally, Activity Based Costing (ABC) ensures that decisions are taken based on the actual cost of doing business and not on what accountants or others assume.

FOCUS AREAS OF ECR

FOCUS AREAS - PRODUCT REPLENISHMENT

Most improvements in operational activities can be found in the way a store is replenished. Product replenishment deals with efficient delivery of the correct product on the correct time at the correct place in the correct quantities. This process is primarily a logistic oriented strategy, which is activated by consumer demand, which is called a 'pull' situation. As we saw in the previous chapter, three trajectories can be identified:

- trajectory from manufacturer to warehouse,
- trajectory from warehouse to retailer,
- trajectory from retailer to consumer.

The aim of replenishment is to integrate these three independent trajectories into the logistic chain in order to create one efficient and effective trajectory throughout the whole chain. This can be accomplished by working together and by using several logistic methods.

In general there are two methods: methods, which work downwards the chain and methods, which work upwards the chain. Downward methods focus on the trajectories from manufacturer to consumer. Much attention is paid to these methods, because it affects the main part of the stream of goods. This chapter deals with the following methods:

- continuous replenishment (CRP),
- integrated suppliers,
- synchronized production,
- Cross docking,
- operational excellence,
- order support systems.

The upward methods deal with the stream of goods, which are sent in the direction from consumer to manufacturer. One can think of empty containers, pallets, empty packing, defective products and material, which have to be recycled. For many years this topic received little attention, but the upward stream of goods is becoming more and more a hot item, due to environment policies.

Still many companies do not react on this, because most methods result in an increment in costs and are therefore not considered efficient. But other companies realize that profits can be gained by using these methods as a marketing instrument. That is why methods concerning the upward stream will not be discussed in this chapter, because they are still in preliminary stage. [Gaither, N., 1994]

CONTINUOUS REPLENISHMENT

One of the major subjects in product replenishment is called continuous replenishment (CRP). Continuous replenishment coordinates the information trajectories and the stream of goods in the logistic chain in order to create a continuous stream of products. This enables retailers to keep fewer products in inventory.

The advantage of inventory reduction is lower inventory costs and shorter product lead times. Also the operational costs often decrease due to decrement in handling. The effect is higher and improved service levels, because less out-of-stock sales will occur and the retailer will become more flexible.

Continuous replenishment consists of three stages. First one has to determine the order to be placed for each product based on the sales, which are registered at the cash register. Then the order has to be

processed correctly at the warehouse. Finally the goods have to be delivered. These stages have to be well coordinated in order to reduce errors and to create a continuous process.

Enabling technologies can be of great help; scanning and electronic data interchange can speed up the process of ordering and reduce errors in processing the order, due to standardization of information. Furthermore good relations and cooperation between trading partners is very important in order to make continuous replenishment work. Only when all involving partners are willing to share information, such as information on sales, CRP can work.

CROSS DOCKING

Cross docking considers moving goods in a warehouse with minimal handling. Goods, which are brought in from manufacturers, are not stored in the warehouse, like in the traditional way. Instead they are shifted into trucks, which are meant to drive away to the store. This method decreases the inventory costs and handling costs. Cross docking also reduces lead times of products. This can result in lower prices, which serves the consumer's needs.

Cross docking in its optimal form consists of shifting a whole pallet, arrived from the manufacturer, to the truck of the store without any handling. This is only possible when a store needs a whole pallet from a specific manufacturer. When this is not the case, one speaks of partial cross docking. In that case parts of a pallet have to be shifted to another pallet first. In both cases no inventory is used for storage, thus eliminating the warehouse's storage function.

Cross docking requires close cooperation with manufacturers, warehouses and stores. Coordination of the information trajectories is a necessary condition in order to coordinate the stream of goods. It is necessary that a warehouse has information about the goods to arrive before shifting these over to trucks. Therefore enabling technologies, such as electronic data interchange and usage of sales information, can improve the process. Without standardization the warehouse cannot make a schedule related to usage of docks and personnel.

Cross docking is only applicable to products with short lead times and which are ordered in great quantities. This technique is frequently applied in warehouses, which form the most important part in this process.

ORDER SUPPORT SYSTEMS

Ordering by computer is an important medium, which is relevant when considering efficient delivery in the logistic chain. Order support systems are systems that implement the order process by means of information technology (IT). The goal of order support systems is faster and better order processes and processing of the orders. This does not only affect ordering for consumers, but also for retailers and warehouses.

Users are able to quickly send an order with the advantage that errors are reduced in processing that order. This means that lower lead times are established, which result in less out-of-stock sales and eventually lower prices. A necessary condition is the usage of standardized electronic communication. [A. Mitchell, 1997].

FOCUS AREA - ENABLING TECHNOLOGIES

Information Technology is focused on acquiring, processing and transmitting of data. After World War II this technology developed explosively. Prospective people pointed out the implications of this technology, when computers were introduced. While the industrial revolution brought mechanization,

this technology would bring automation. Until that time, people were needed to process data in order to control processes. Information technology would change that in future.

We speak of computer networks, when different computers or computer-based systems are connected to each other. Although there are quite a lot networks today, most of the possibilities and implications are not realized yet. In most cases one is still busy with the technology itself, others just use several simple applications. Apart from that, still a lot of possibilities have to be discovered. Networks have created a lot of new techniques to provide information.

These enabling technologies can be used to overcome the barriers between retailers and manufacturers, as pointed out in the part about Focus Areas of ECR. Efficient category management and efficient product replenishment are very dependent on accurate information. It is clear that enabling technologies are very important; therefore this chapter will discuss this topic more extensively than other topics.

In this chapter the following technologies will be discussed:

- Electronic data interchange,
- Electronic funds transfer (EFT),
- item coding/database management,
- ABC costing.

ELECTRONIC DATA INTERCHANGE

Electronic Data Interchange in literal sense is nothing special. Someone who types a text on a computer, saves it on a floppy and reads the same text on a different computer, would in this sense also be doing electronic data interchange. Therefore, in practice a different meaning has been given to EDI. We define:

EDI is the interchange of standardized messages between computers about trade transactions between the involved parties.

Taking a closer look at this definition reveals three interesting key points. Firstly, the messages are standardized, which means that the messages are specified according to fixed rules, such that the meaning is clear and unambiguous. Communication between two parties is roughly done as follows: the sending party fills in a form, which is then standardized by a message processor. This translated message will be sent to the other party and is translated back by their message processor.

Secondly, the definition speaks about interchange between computers. It is better to speak about interchange between computer applications instead of interchange between computers. Interchange between computer applications does not only cover pure communication, but also automatically sent messages, which are generated by an application. This feature makes EDI a value adding technology for most companies. If EDI were considered as pure communication only, then it would be just an expensive alternative for a fax machine. Moreover if companies do not integrate EDI into their internal applications, they lose 70% of the potential benefits.

Finally, EDI involves data interchange of trade transactions of the involved parties. This means that standardized interchange of information between establishments of the same company is not considered as EDI. Note that this type of interchange is already implemented and used on large scale. The parties, implied by the definition, have to be juridical independent companies, such as manufacturers, consumers, banks and transporters.

ELECTRONIC FUNDS TRANSFER (EFT)

Electronic funds transfer (EFT) is a quite young technology, which has been successfully introduced in 1996. This technique enables one to pay with and withdraw electronic money, which is thus not physically available.

DATABASE MANAGEMENT

After World War II, information technology developed explosively. People began to store a lot of information into computers. But after several months or several years the space occupied by information was nearly exceeding storage capacity. Research showed that a lot of information was not needed in daily business processes and furthermore there were a lot of errors and redundancy in the data. This development led to a new scientific approach of information storage and usage, called Database management.

Database management focuses on the creation, maintenance and usage of databases. This concept is very important, because most of the methods discussed in this paper are dependent on accurate information. For example a database with product information, such as prices, inventory levels etc., is very important for efficient product replenishment and order support systems. A database with customer information is crucial for efficient product promotion. Just-in-time management can lead to great losses when wrong or erroneous information is used.

The goal of database management is to:

- reduce redundancy in data, such as storage of duplicate records. This leads to less input and storage costs and less probability on erroneous data,
- create logical data independence, which means that programs can use and alter data, without conflicting with other programs, which use the same data,
- create physical data independence, which means that programs do not have to be altered, when a different storage technology will be implemented. This enables one to change to a better, cheaper or bigger storage medium,
- better security against data loss, damages, electrical disturbances and data abuse.

These goals lead to faster response times and search capabilities, correctness and consistency of data, faster development times for new applications. There are three levels of database management in order to achieve this. These are:

- database administration,
- data administration,
- information resource management.

[Epiq Technologies, 2006]

FOCUS AREAS - CATEGORY MANAGEMENT

The purpose of category management is improving the operating results of the company by focusing on the consumer. Consumers are getting more demanding and want to choose from a large assortment of products. Furthermore consumer satisfaction is a great advantage in a competitive business environment. In this view products are more than goods, which are just being sold; products also play a strategic role.

In practice one treats a group of specific products as a business unit, which is called a category. A category is defined as a distinct, manageable group of products that consumers perceive to be interrelated or substitutable in meeting consumer needs. In this setting category management is defined as follows by the ECR category management subcommittee:

Category management is the process between parts in the logistic chain, where categories are being managed as strategic business units, producing enhanced business results by focusing on delivering consumer value.

Looking carefully at this definition reveals a few key points of category management:

- category management is a process and involves series of interrelated activities,
- category management is comprised of many distinctly different distributor and supplier components. Therefore, either should not do this process alone,
- the aim of category management is improved business results, but also (considering the previous key points) an improved relationship between trading partners,
- the underlying foundation for these improved results is ultimately based upon understanding and meeting consumer needs more effectively in the products offered.

Thus a basis for good category management is formed by good cooperation, where the retailer takes the initiative. In order to analyze and adopt a good strategy for category management, several focus areas can be identified. Category management has the following three-focus area:

Optimize New Product Introduction

Optimize new product introduction deals with efficient and effective developing and introductions of new products or services based on consumer needs. The primary goal is to reduce the number of failures of product introductions and the costs associated with them. The secondary goal is to react more dynamically by means of better information structure throughout the logistic chain. The profit due to this will be that the consumer will have a clear product overview. Moreover only value adding products will be on the shelves in the stores.

Product introductions can be classified in many ways. One aspect is the measure of innovation. The simplest introduction is the introduction of a product, which is an improvement of an existing product. One also has expansion of the assortment, for example introducing soap for dry skin, while normal soap already exists. Introducing a product, which is completely new, is called a product innovation.

A second aspect of product introductions is time. Some products are added to the assortment in a specific period of the year, which is crucial for the sale of that product. One can think of charcoal for barbecues in a supermarket or orange custard during the Dutch Champions League football.

Optimize Product Promotion

Optimize product promotion deals with efficient and effective promotion strategies, which affects all parts in the logistic chain. Three techniques of product promotion can be identified, these are:

- consumer advertising,
- consumer promotion,
- trade promotion.

The goal of product promotion is using these three techniques throughout the logistic chain efficiently and effectively in order to improve the application of the promotion-budget and to form a clear overview of products for the consumer. The next figure displays the three techniques in relation with the logistic chain.

The first technique of promotion is consumer advertising, which concerns promotion between retailer, manufacturer and consumer. Traditional means of consumer promotion are advertisements on

radio, television and advertisements in newspapers and magazines. But with new technologies such as CD-ROM, CD-I and the Internet, one can place consumer specific advertisements.

A special application of this technology is electronic consumer-cards, which make it possible to track and analyze consumer behavior. This analysis can be used to send advertisements by E-mail to consumers. This technology also makes it possible to show a specific advertisement on a LCD screen, when a consumer walks in the store, based on his consumer behavior. In this way the retailer can stimulate a consumer to buy specific products. This approach has great advantages, however certain privacy issues must be dealt with first.

The second technique of promotion is consumer promotion. This technique forms an important part of promotion strategy. It concerns promotion between the manufacturer, retailer and the consumer. One must think of special offers or premiums (little gifts, which come with the product). Traditional means are coupons and savings-stamps. The differences between these two are that coupons create product-loyalty, whereas savings-stamps create store-loyalty.

The special offers and saving methods can now be implemented more efficiently by using electronic cards, which replace the savings-stamps and can be used to acquire a discount. Again it is technology that makes this possible.

The last technique is called trade promotion, which only affects the first three parts in the logistic chain. This type of promotion only concerns transactions between companies and does not affect consumers. The promotion often concerns special offers and discounts. Traditional means are letters and folders, which are being sent between the parties involved.

This type of promotion can also be done more efficiently by using electronic data interchange. This technology makes it possible to send and receive information very fast and allows better coordination of promotion, which can serve consumer needs better.

Optimize Store Assortment

Optimize store assortment deals with composing an assortment of products and services, which is complete and profitable, and also satisfies consumer needs. The aim is to use the space in the store efficiently and the advantages are higher profits, better clientele and less frequent out-of-stock sales. Optimize store assortment, from the point of view of the consumer, means a better and flexible assortment and also less frequent out-of-stock sales.

When optimizing the existing space and assortment in the store, the value of the product, which accounts for the profit gained, must be taken in consideration. The preferences of consumers can be studied with the help of information on the actual sales, which are gathered by the cash registers and by information revealed by market research. This enables one to adjust the assortment to the consumer's needs.

Determining the profit of a product per cubic meter can also be helpful to assortment planning. However one must not forget to take into account the needs of the consumer. There is a strain between the value a consumer assigns to a product and the value, which the product generates when it is sold.

Two methods, which can help in the above analysis, are direct product profitability (DPP) and direct product costing (DPC). Both methods are variants of activity based costing (ABC). Activity based costing is a method, which relates costs and profits with activities. This results in better understanding and insight in costs and profits, which enables one to make decisions about those products.

There are several important issues, which have to be taken into account when planning optimize store assortment. Firstly, the cooperation between parts in the chain is of crucial importance. When several trading partners combine information about products and sales, a good overview of the market can be formed. This makes optimize store assortment possible with great success.

Secondly the space must be allocated on basis of correct data. Allocation space is an important key point in Optimize Store Assortment and this space is directly related to the profit per cubic meter. Therefore this allocation must be based on information retrieved from:

- correct scanning at the cash registers,
- historical data of sales,
- database with products in the store,
- demographically oriented data.

Optimize store assortment is a difficult process. That is why it is important to monitor the results of the current assortment and the results due to changes in the assortment. This enables one to response quickly to product introductions or special offers.

Prior to discussing category management, it is helpful to position category management in the context of several opportunities facing the industry.

Category management represents a method for managing increasingly complex consumer demographics. Consumer lifestyles have changed dramatically over the past decades. Consumers are getting more demanding and want to choose from a great assortment of products. Furthermore consumer satisfaction is a great advantage in a competitive business environment.

Given these challenges, many distributors and suppliers are intensifying their efforts to understand and meet the changing consumer needs. For example, many have a growing interest in understanding the composition of their "loyal consumer base" and in defining the purchase behavior associated with these consumers.

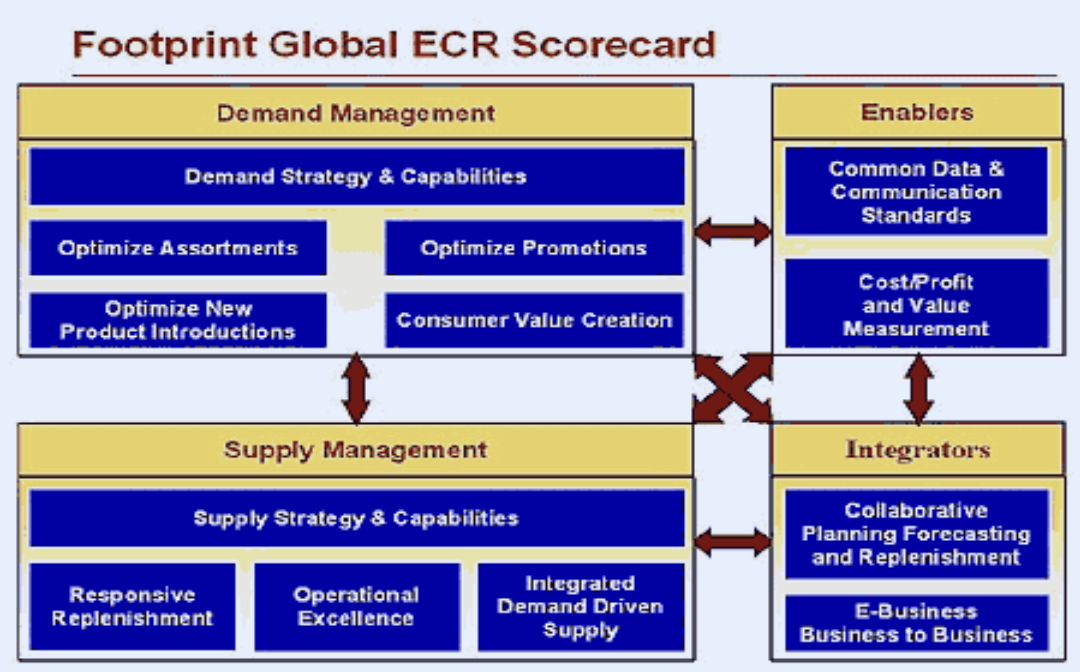
Awareness is growing that failure to recognize and appreciate consumer loyalty can be costly. For retailers, research consistently shows that the loyal consumer represents a fraction (20 to 30 percent) of consumer traffic yet results in the majority of sales and profits (70 to 80 percent). [Partnering Group, 1995].

By providing better consumer value through category management, both distributors and suppliers can become more productive, especially in the key areas of new product introductions. But suppliers are faced with significant competitive pressures as well. In addition to the intense competition among manufacturers in increasingly mature categories, the emergence of high quality distributor brands has further pressured the market share of national or regional brands. Concurrently, many suppliers are experiencing unprecedented new product failures.

All these and other changes have triggered many within the industry to do more with current resources and to refocus on the basics of meeting consumer needs for value, variety and service. This is where category management can be a powerful tool for meeting these consumer needs in a marketplace sharply and more competitive.

SUMMARY

The previous discussion on Efficient Consumer Response shows that most methods and techniques used in ECR were already known. But ECR shows how these methods and techniques can be used with each other and with new technologies. So the way in which they are used is new. In this setting the focus moves to a total supply chain optimization instead of independent optimization of parts in the chain. The goal is obviously to decrease the costs throughout the chain and a more dynamical reaction to consumer needs. ECR focus areas have a dynamic structure, so they have been changing through the years. The focus areas of ECR look as following, see figure 3.



Source: http://www.ecrnet.org, January, 2006.

Fig. 3. New structure of ECR Focus areas.
Rys. 3. Nowe struktury obszarów ECR.

There are some aspects, which are named in the other way, and some which are quite new such as CPFR or RFID belonging to communication standards.

There is no doubt that ECR can make a real difference to the business prospects of those companies, which successfully implement it. Judging by the interest shown in the activities of the ECR board, there is no doubt that many leading companies regard ECR as a powerful initiative for a change. But surprisingly it is the traditional benefits that these companies are looking for from ECR: profit, revenue, market-share and fundamental competitive strength.

These companies understand that the creation of outstanding consumer value is the only secure route to achieving sustainable financial success. The industry faces a number of threats over the next few years, with developments such as on-line shopping, which would open up new retailing possibilities, giving consumers the ability to replenish their larders without ever visiting grocery stores. New entrants, with different capabilities could bring even greater pressures to bear on those players who have not maximized their efficiency and effectiveness.

Few people disagree that the industry is in need of reform. Compared with other high profile industries, which have undergone radical changes in recent years, for example the automotive, electronics and financial services industries, other industries must realize that they too will have to undergo its own version of "Big Bang".

Trading partners need to have informed discussions about which activities lead to benefits and which do not. Only then can they take rational decisions on which practices to keep and which to change. The "survival of the fittest" rule is still destined to apply in the ECR world. Companies' willingness and ability to achieve excellence in ECR implementation will largely determine how much they will win or lose.

REFERENCES

Coopers & Lybrand, 1996, Efficient Consumer Response - Europe: Value Chain Analysis Project Overview.

http://www.ecrnet.org, 2006.

ECR Poland Office materials, 2005, Poznań.

Epiq Technologies, 2006, Inc. materials.

ECR Board, 1995, ECR Europe Executive Board Vision Statement.

Gaither, N., 1994, Production and Operations Management. The Dryden Press, London.

Mitchell A., 1997, Efficient Consumer Response, Financial Times Report, London.

Lewandowska J., 2005, a doctor thesis "Determinants and instruments of supply chain effectiveness creation in the FMCG sector", University of Economics, Poznań.

Partnering Group, 1995, Category Management Report. Joint Industry Project on Efficient Consumer Response.

ECR JAKO KONCEPCJA WSPOMAGAJĄCA ROZWÓJ ŁAŃCUCHA LOGISTYCZNEGO

STRESZCZENIE. Praca przedstawia koncepcję Efficient Consumer Response (ECR), ukierunkowaną na ciągłe zwiększanie efektywności łańcuchów logistycznych. Głównym celem takiej metody postępowania jest osiągnięcie większej możliwości reakcji na potrzeby klientów przy jednoczesnej redukcji kosztów całego łańcucha dostaw poprzez ścisłą współpracę wszystkich członków tego łańcucha. Warunkiem koniecznym, aby ten model sprawnie funkcjonował, jest zapewnienie przepływu informacji o wysokim poziomie jakości (w sensie: częstości transferu oraz poprawności i trafności przekazywanej informacji) z punktu sprzedaży (konsumenta) poprzez cały łańcuch logistyczny, przy wykorzystaniu standaryzowanych form tego transferu. W ramach powyższego zagadnienia, koncepcja ECR dostarcza metody postępowania usuwające istniejące słabe punktu obecnie stosowanych rozwiązań, które umożliwiają pełną zintegrowaną kooperację w obrębie całego łańcucha dostaw i spełniającą wymagania stawiane przez przedsiębiorstwa w stosunku do przepływu informacji.

Słowa kluczowe: zarządzenie łańcuchem dostaw, ECR, category management, uzupełnianie zapasów, stosowane technologie, cross docking, elektroniczna wymiana danych (EDI), elektroniczna wymiana funduszy (EFT), oznaczanie jednostek, zarządzanie bazą danych, metoda kosztów ABC.

Dr Justyna Lewandowska
Institute of Logistics and Warehousing, Poznań, Poland
ul. Estkowskiego 6
61-755 Poznań
phone: +48 61 850 49 51
e-mail: justyna.lewandowska@ilim.poznan.pl

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 2
No 3

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

ECO4LOG - DEVELOPMENT OF AN EAST BORDER CORRIDOR 4TH PARTY LOGISTICS SERVICE APPROACH ALONG THE AXIS BRANDENBURG-SAXONIA-AUSTRIA WITH NEIGHBOURING ACCESSION COUNTRIES

Piotr Nowak[1], Bertram Meimbresse[2]

1) Institute of Logistics and Warehousing, Poznań, Poland
2) Technische Fachhochschule Wildau, Germany

ABSTRACT. The idea of the project was created by the close co-operation of ECO4LOG partners in former Interreg and EU projects. The partners recognized, that a discrepancy exists in the border regions of the EU member and accession countries in Central Europe regarding the expected increase in goods flows and the partly missing transport infrastructure. A way out is the improvement of intermodal structures, the better use of intermodal facilities and the implementation of supplying IT-solutions. Such changes in the intermodal strategy can only partly initiated by the regions. An intermediary to reach the aims is a 4th Party Logistics Provider. 4PL are the new type of independent IT-driven business units, which are successful in the outsourced operation of supply-chain-management.

Key words: intermodality, international co-operation, interreg III C, logistics, 4 Party Logistics.

In the border regions between the member and the accession countries of the European Union in Central Europe and along this still existing boundary substantial increases are expected in good flows and in a demand for partly missing transport infrastructure. This applies in particular to the north south corridor along this line in the Interreg Area East which leads from Germany (Brandenburg/Saxonia)/Poland in the north via Czech/Slovakia/Austria/Hungary in the center up to the Adria with Slovenia/Italy (Friuli).

The existing infrastructure, consisting of transportation networks and logistics knots, in view of realized infrastructure investments in the accession countries (e.g. ISPA program), will not be sufficient for the coverage of the goods flows at present, if not efficient organization and computer science solutions are also provided. Such solutions should aim at an innovative, intelligent and above all intermodal networking of the infrastructural basis.

In principle, the project ECO4LOG wants to improve the region and country-spanning co-operation within the field of goods transport between the public administrations in the European Union border region East. By the creation of co-operation and information structures, respectively their initiation, public administration can take influence on the goods transport and promote the use of intermodal

Citation: Nowak P., 2006, ECO4LOG - Development of an East border COrridor 4th party LOGistics service approach along the axis Brandenburg-Saxonia-Austria with neighbouring accession countries. LogForum 2, 2, 3
URL: http://www.logforum.net/vol2/issue2/no3
Accepted: 3.07.2006, on-line: 15.08.2006.

systems. The intermodal logistics knots form the physical basis for it. In this regard, the public administrations can take over steering functions like 4th party Logistic service Providers (4PL).

The partners in the ECO4LOG project support the intensified use of intermodal and sustainable logistics and transport systems by such a 4 PL concept. The benefit is acceleration and efficiency increase of the intermodal transport flows by the elimination of organizational, administrative, tariff and informative weak points, especially at logistic knots.

Beside transport, respectively operational effects (lowering of transport costs, avoidance of traffic jams, lowering of capital commitment etc.) macro-economic effects can be expected like jobs creation, the increase of the competitiveness of the border regions and sustainable use of resources by a more efficient utilization of the existing systems.

ECO4LOG aims at integration and networking of successful new logistic service providers. These 4th Party Logistics Providers become generally accepted more and more with the control of enterprise-spreading Supply Chain Management Systems. They have got the ability to provide from one hand planning, the job control as well as the operations of the logistics chains for the forwarders. ECO4LOG plans a region crossing integration and networking of such new logistic service providers with the intensified use of IT solutions to promote intermodal goods transport.

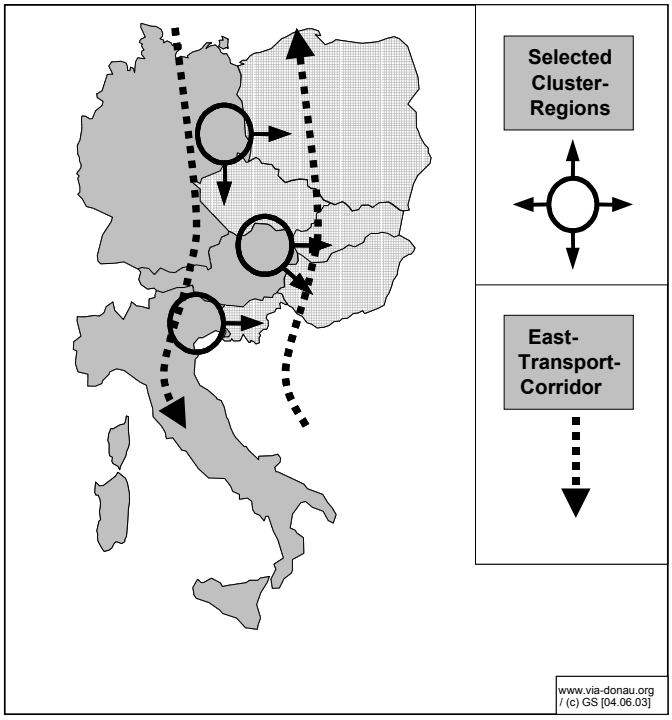


Fig. 1. ECO4LOG corridor
Rys. 1. Korytarz ECO4LOG

The project ECO4LOG will examine the application of such an enterprise-spreading concept in four main components as an economical nucleus for the development of the border regions:

- analysis of the stages of development of the infrastructure (logistics networks and logistics knots / freight villages) and the logistic chains and means of transport,
- analysis of the impact of 4th Party Logistic Providers and propagation in the border region including sustainable business models with consideration of the characteristics of the individual cluster,
- usage of available and design of additional IT Tools for intermodal transportation planning and transport control,

- the effects on the economics (creation of jobs) as well as the effects on the environment.

As regards the promoting of the transnational co-operation it is intended to join 2 cluster regions under the "project umbrella" ECO4LOG.

Cluster north	Germany (Brandenburg)-West Poland
	Germany (Saxonia)-Czech
Cluster central-south	Austria-Hungary
	Austria, Slovakia, Slovenia

Localization of partners participating in the project is shown on the picture 2.

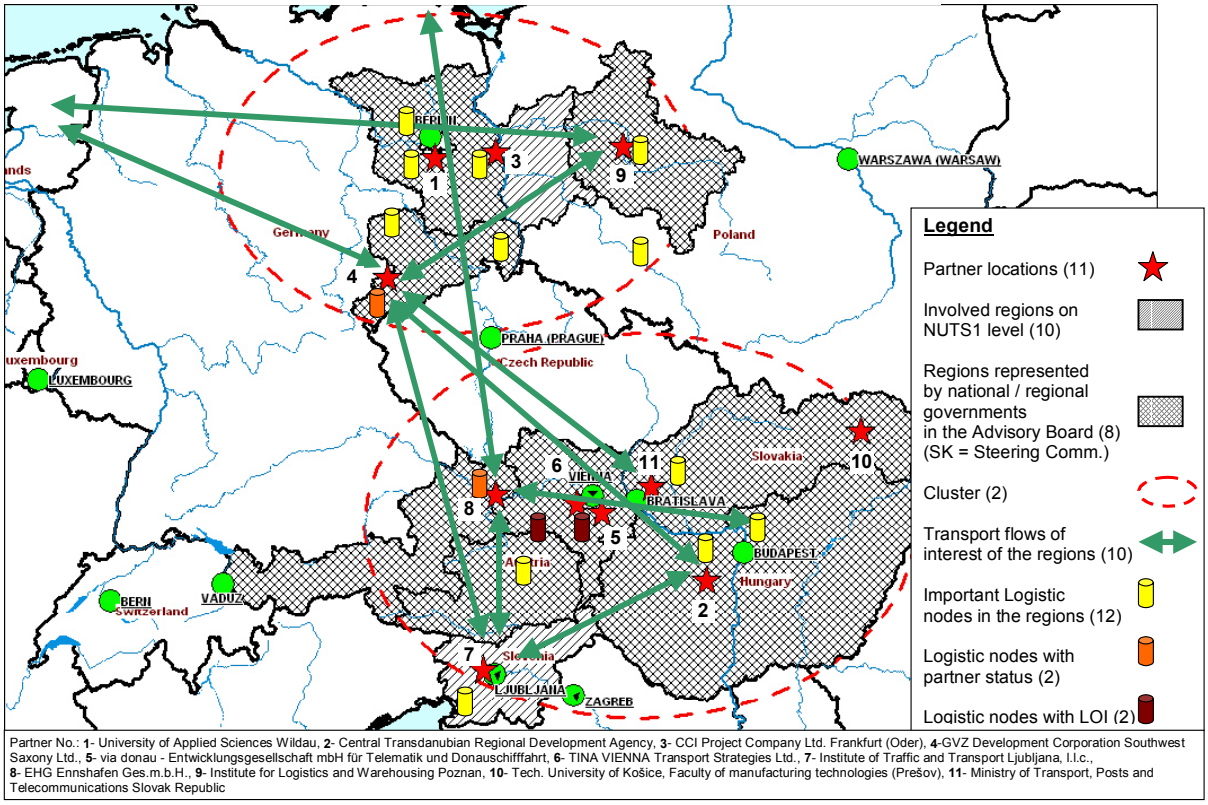


Fig. 2. Localization of ECO4LOG project partners
Rys. 2. Lokalizacja partnerów projektu ECO4LOG

Transport and economic challenges/problems in the spatial region Interreg III East are to be identified in the respective clusters. Due to the intentions of the Interreg III C program no spatial proximity between the individual partners must exist, particularly the project has a transnational focus. The illustration shows the three selected cluster regions, which are in close relationship to the new accession countries.

The question on possible differences between the cluster regions (north, center and south) regarding the coming European Union extension is also relevant to the project. If necessary, significant differences can be identified here concerning infrastructure measures already made, effects for current or planned international, respectively regional location and logistic concepts. The possible exchange of experience and the know-how transfer is also important here, which arises from the

composition of the interregional consortium in order to discuss existing procedures, problems and to generate innovative solutions.

A survey of the existing services in the individual logistics knot / transshipment terminals (e.g.: sea and/or inland port, railway terminal, freight village etc.) and with the carriers should show the state of the art concerning services and should supply reference points for the development of new services. Beside the design of new innovative services for the network of logistics knots into the ECO4LOG clusters, it is the task to compare these with each another (e.g.: benchmarking, best practice method etc.) in order to be able to draw conclusions for possible improvement potentials.

The authorities and public bodies involved in the ECO4LOG approach play therefore an important role, because they can include interested transport companies (logistic service provider, transshipment centers, carrier as well as other public and/or private enterprises) into the implementation plan in the individual clusters.

The project management promotes the coordination between the partners and the working on mechanisms as well as the adherence to the approved work and time schedules by all involved parties. The exchange with further projects shall increase the effectiveness of the project. Intermediate results will be presented among experts.

One of the final results of the ECO4LOG project is recommendation for future actions. A few of them are listed below.

1. Continuous modernization programs of state railways.
2. Attractive financing options (e.g. leasing or residual value approach).
3. Creation of a used rolling stock market.
4. Supporting purchase of intermodal wagons.
5. Modernization of rolling stock fleet.
6. Intensive regional marketing and promotion to local shipping and transport industry.
7. Conceptional integration of the terminal in national and international networks.
8. Reduction of last mile costs into terminals and reduction of operation costs in terminals e.g. by optimized shunting.
9. Planning and implantation of new logistics centers near terminal facilities.
10. Marketing network (e.g. European Bulls) of private rail operators and of State Railways.
11. One Stop Shop by different State Railways for international transport offers.
12. Synchronization of processes for international rail services.
13. Equal treatment in prioritizing procedures by rail infrastructure owners regarding international trains.
14. Same level of liberalization in all countries to allow constant growth of private engagement.
15. Reasonable processes for receiving operating licenses in each country.
16. Avoidance of any discrimination against private TOCs by operators.
17. Liberalization of the terminal market for private investors in Central and Eastern Europe.

ECO4LOG – ROZWÓJ KONCEPCJI KORYTARZA USŁUG LOGISTYCZNYCH W KRAJACH UNII EUROPEJSKIEJ ORAZ KRAJACH KANDYDUJĄCYCH POŁOŻONYCH WZDŁUŻ OSI BRANDEBURGIA-SAXONIA-AUSTRIA

STRESZCZENIE. Opisywany w artykule projekt ECO4LOG zajmuje się rozwojem koncepcji "4th party Logistics" w krajach Unii Europejskiej i krajach kandydujących położonych wzdłuż osi Brandenburgia - Saxonia - Austria. Oczekiwanym rezultatem projektu realizowanego przez 11 partnerów jest poprawa i wzmocnienie współpracy międzyregionalnej jednostek administracji publicznej zajmujących się problematyką transportu towarowego (intermodalnego), jak również przyspieszenie wzrostu efektywności intermodalnych przepływów transportowych. Celem projektu jest również eliminacja organizacyjnych, i informacyjnych słabości węzłów logistycznych oraz stymulowanie sieciowania dostawców usług logistycznych. Cel ten jest realizowany m.in. poprzez wymianę wiedzy o procesach logistycznych oraz stworzenie oprogramowania wspierającego współpracę.

Słowa kluczowe: intermodalność, współpraca międzynarodowa, Interreg III C, logistyka.

Piotr Nowak MBA
Institute of Logistics and Warehousing
Instytut Logistyki i Magazynowania
ul.Estkowskiego 6
61-755 Poznań, Polska
e-mail: piotr.nowak@ilim.poznan.pl
Dipl. Ing. Bertram Meimbresse
Technische Fachhochschule Wildau
e-mail: bmeimbre@igw.tfh-wildau.de

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 2
No 4

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

FORMS OF MARKET COORDINATION VERSUS SUPPLY CHAIN MANAGEMENT AS COMPANIES CORE COMPETENCIES

Anna Łupicka

University of Economics, Poznań, Poland

ABSTRACT. Basic issues of logistics and SCM must be analyzed against the network among companies. Definitely most important are relationships, in which some companies are suppliers and others receivers. In the context of supplier-receiver relationship the problem of coordination and its impact on companies activities is involved. The supply chain is a specific example of companies' ties, where different ways of coordination interchange starting from competition throw control finishing on cooperation. It is worth emphasizing that the concept of integration, which may create a huge competitive advantage stemming from improving responsibility and cost reduction, leading to modern activities and greater profitability of companies in the supply chain does not have to refer only and exclusively to cooperation.

Key words: supply chain management, core competencies, supply chain integration, buyer-supplier relationship, market coordination.

Basic issues of logistics and supply chain management must be analyzed against the network among companies. Definitely most important are relationships in which some companies are suppliers and others buyers. In the context of buyer-supplier relationships the problem of coordination and its impact on companies activities is involved. The supply chain is a specific example of companies' ties, where different ways of coordination interchange starting from competition throw control finishing on cooperation.

It is worth emphasizing that the concept of integration, which may create a huge competitive advantage stemming from improving responsibility and cost reduction, leading to modern activities and greater profitability of companies in the supply chain does not have to refer only and exclusively to cooperation relations. All the possible situations in the relation buyer-supplier in the supply chain are described by "KKK" paradigm.

Apart from competition and cooperation it also indicates control understood as striving to reach economic power or as striving to obtain and use more bargaining power. The "KKK" mechanisms are equally strong ways of interorganizational coordination of decisions. Strengthening the company's position on the market is connected with competing if an organization considers that this method will help in reaching the valorization goals of the possessed resources or when it is unable to apply control strategy and/or cooperation strategy. Strategic analysis reveals their advantages and disadvantages in the defined market configuration and companies' resources [Sulejewicz 1997]. Thus the supply chain integration is a mixture of competition, cooperation and control.

Considering "KKK" paradigm against the supply chain integration it is worth noticing, that the form of coordination tied with competition may also appear as the first level of creating supply chain

Citation: Łupicka A., 2006, Forms of market coordination versus supply chain management as a companies core competencies. LogForum 2, 2, 4.
URL: http://www.logforum.net/vol2/issue2/no4
Accepted: 5.08.2006, on-line: 15.08.2006.

integration. Then the remaining forms of coordination can be recognized as further levels of supply chain integration.

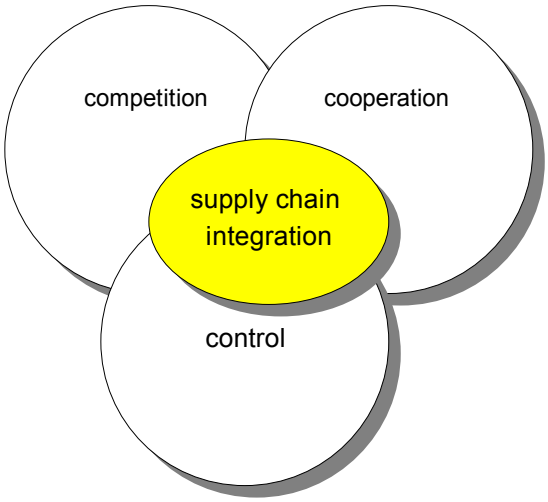


Fig. 1. Paradigm KKK
Rys. 1. Paradygmat KKK

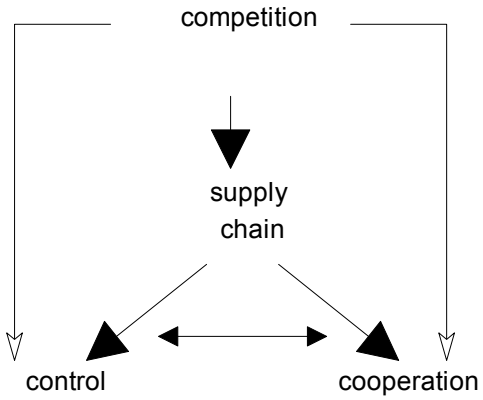


Fig. 2. Forms of coordination as levels of supply chain integration
Rys. 2. Formy koordynacji jako poziomy integracji łańcucha dostaw

In the literature of the subject research results concerning the first relations are most frequently present. It is likely that an attempt of examining the relations producer-distributor or producer-logistics operator. The third type of relations may result from a growing role of logistics operators in the coordination of supply chain functioning. Deciding on examining the above relations it is necessary to answer a few basic questions:

1. How economic power influences the supply chain integration?
2. Is supply chain management able to exist in the presence of power asymmetry?
3. What role does power play in supply chain strategy?
4. How economic power influences the core competencies of the firm in the supply chain?

Undoubtedly, achieving competitive advantage is possible on the way of using and improving core competencies. Prahalad and Hamel define a core competence as follows:

A core competence is a bundle of skills and technologies that enables a company to provide a particular benefit to customer. One of the core competencies as mentioned earlier is supply chain management. Core competencies are skills or capabilities that make an organization unique. The economic power of the firm in supply chain depends on skills and technologies which they posses. Understanding the nature of power in the relationships is very important.

Researches in the automotive industry improve that attempts to verify partnering benefits generally finds that the rewards tend not to be realized until several years after alliances formation, hinting at the necessary long-term nature of the relationship [Maloni, Benton 2000]. Though no quantifiable boundary exists between a transactional and integrated relationship, several key elements make the integrated relationship unique including trust, cooperation and commitment.

Table 1. Definitions of relationship elements
Tabela 1. Definicje elementów struktury zależności

Relationship elements	Description	Integrated relationship characteristic
Commitment	Feeling of being emotionally impelled to maintain a long – term relationship	High level of commitment
Conflict	Disunity caused by competitive or opposing action	Low level of conflict
Conflict resolution	Ability to mitigate disunity through mutual solution	Strong ability to resolve conflict
Cooperation	Association of mutual benefit through join effort	High level cooperation
Trust	Confidence in honesty and integrity of partner	High level of trust

Source: Maloni, Benton 2000

Power may be defined as the ability of one firm (the source) to influence the intention and action of another firm (the target). A lot of scientists tried to explore inter firm power research in the development of the bases of power. Table 2 shows these bases, which examine the perceived reasons why one party may hold authority over another. Reward and coercive remain the most transparent and recognized power bases, indicating the ability of the source to mediate dividends or punishment to the target. Other power bases may also retain a prominent role in the supply chain. For one, expert power refers to the perception that one firm holds information or expertise that is valued by another firm. Another consequential base, referent power, implies that one firm desires identification with another for recognition by association. Finally, legitimate power, which includes both its inherent and legal forms, infers that target believes in the right of the source to wield influence [Maloni, Benton 2000].

Logistics researchers have applied the power literature to the analysis of marketing channel relationships and have found that the different bases of power affect inter-firm relationships in significant, yet contrasting ways. The significant and expansive effects of power on inter-firm relationships hold direct implications for the supply chain. Power affects the elements (trust, cooperation, commitment, conflict and conflict resolution) critical to effective supply chain integration, so power may play a consequential role in the formation and maintenance of supply chain relationships. There is one conclusion which improve that firms which have more power in supply chain, consequently have more skills and better technologies as theirs core competencies.

There are a lot of examples of commitment between core competencies and supply chain integration.

Table 2. Bases of inter firm power
Tabela 2. Główne składniki wewnętrznej siły przedsiębiorstw

Power base	**Descriptions**	**Automotive industry example**
Reward	Source retains ability to mediate rewards to target	Manufacturer awards additional business to supplier
Coercion	Source holds ability to mediate punishment to target	Manufacturer cancels business with supplier
Expert	Source has access to knowledge and skills desired by target	Supplier desires participation with Honda's BP program
Referent	Target values identification with source	Supplier desires association with Chrysler's Extended Enterprise
Legitimate	Target believes source retains natural right to influence	Supplier views itself as direct subsidiary of manufacturer
Legal legitimate	Source retains judiciary right to influence target	Supplier and manufacturer maintain a formal sales contract

Source: Maloni 2000

A model proposed by Cox placing the supplier relationship in relation to core competence. The model proposes five supplier relationship structures:

1. Adversarial leverage - the most commonly found form of external contractual relationship is when the contractor is always in a position to choose alternative suppliers and the supplier has no ownership over goods or services produced.
2. Preferred supplier - is judged to be the best at providing complementary goods or services of medium asset sensitivity, but low strategic importance to the firm.
3. Single sourcing - relationships occur when goods or services are of increasing sensitivity to the core competencies of the firm.
4. Network sourcing - is multi-tiered partnership arrangement, but without moving to vertical integration.
5. Strategic supplier alliances - is classically referred to as joint venture.

Cox uses the term " assets specificity" to describe how close to a company's core competencies a supplier's product may lay. However, whilst the model was accepted on a theoretical basis, it was not viewed as a useful tool.

Whilst it was recognize that the model proposed by Cox reflected the nature of customer supplier relationships, in practice a simpler four-box model proposed by Kraljic was found to be actively used to manage the relationship. It was though to better describe the process and to drive the business to achieve the desired nature of relationships. There are four boxes:

1. Routine - refers to items, such as stationary, which are not produced by the company, and are not in their area of competence.
2. Leverage - refers to items such as printed circuit boards, where there may be a number of potential suppliers with different skills or competencies.
3. Strategic - relationships may involve simple products that add great value to the company.
4. Bottleneck - area requires investigation.

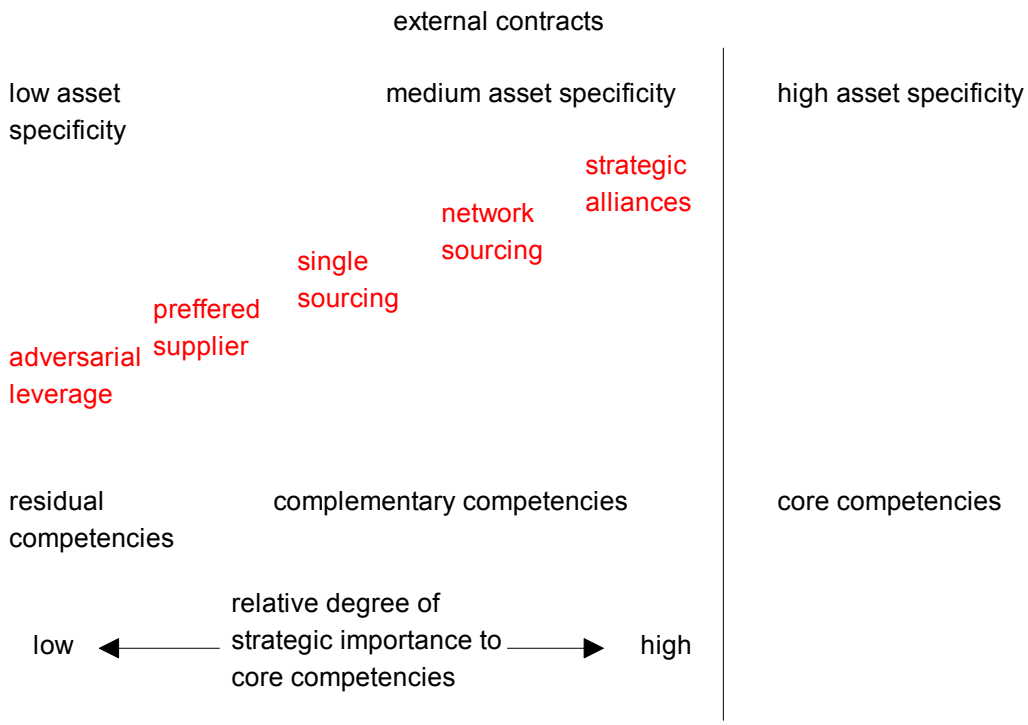


Fig. 3. Cox supplier relationship model
Rys.3. Model zależności dostawcy Cox'a

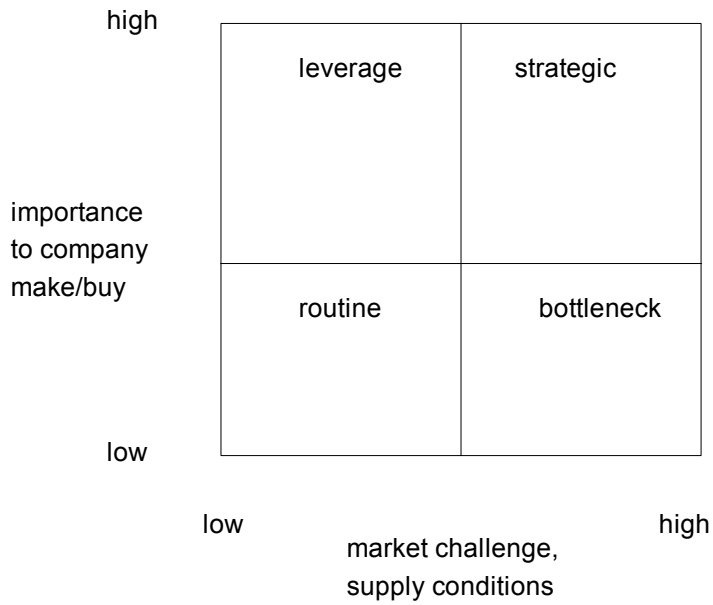


Fig. 4. Four box model proposed by Kraljic
Rys. 4. Czteroczęściowy model proponowany przez Kraljica

SUMMARY

There are issues around core competence protection, which need consideration in all supplier relationships. Relationships are dependent on the relative market power relationship between buyer and supplier. In many economic sectors those companies that have direct contact with final customers often hold the balance of power. Knowledge of the organization's position within the industry is required in order to identify particular strengths and weaknesses. Core competencies are specific strengths, which mean for the company a set of skills, and technologies that enable a firm to provide a particular benefit to customer.

REFERENCES

Hines T., 2004, Supply Chain Strategies, customer-driven and customer-focused, Elsevier Butterworth-Heinemann, Oxford.

Logistics Research Network, 2005, Conference Proceedings United Kingdom.

Maloni M., 2001. Power in supply chain, Journal of Business Logistics, vol. 21, No. 1.

Sulejewicz A., 1997, Partnerstwo strategiczne: modelowanie współpracy przedsiębiorstw, SGH Warszawa.

FORMY KOORDYNACJI RYNKOWEJ A ZARZĄDZANIE ŁAŃCUCHEM DOSTAW JAKO KLUCZOWEJ KOMPETENCJI FIRM

STRESZCZENIE. Podstawowe zagadnienia logistyki i zarządzania łańcuchami dostaw muszą być analizowane na tle siatki powiązań miedzy przedsiębiorstwami. Najważniejszymi relacjami w łańcuchu dostaw są relacje zachodzące pomiędzy dostawcą i odbiorcą. Łańcuch dostaw jest swoistym przykładem powiązań firm, w którym przeplatają się różne sposoby koordynacji począwszy od konkurencji przez kontrolę a skończywszy na kooperacji. Warto zauważyć, że pojęcie integracji, która koncepcyjnie może tworzyć ogromną przewagę konkurencyjną wywodzącą się z poprawiania odpowiedzialności i redukcji kosztów, prowadzącą do nowoczesnych działań i większej opłacalności firm w łańcuchu dostaw nie musi oznaczać stosunków kooperacyjnych.

Słowa kluczowe: zarządzanie łańcuchem dostaw, kluczowe kompetencje, integracja łańcucha dostaw, relacje dostawca-odbiorca, koordynacja rynkowa.

dr Anna Łupicka
Department of Transport and Logistics
University of Economics
al. Niepodległości 10
60-967 Poznań, Poland
e-mail: anna.lupicka@ae.poznan

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 2
No 2

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

ELECTRONIC TRACKING AND TRACING IN FOOD AND FEED TRACEABILITY

Gashaw Ayalew, Ultan McCarthy, Kevin McDonnell, Francis Butler, Paul B. McNulty, Shane M. Ward

Biosystems Engineering, University College Dublin, EarlsfortTerrace, Dublin2, Ireland

ABSTRACT. Automatic identification and Electronic Data Interchange (EDI) are two most applicable electronic tools for food and feed traceability. This work has presented the main features of printed graphic identifiers, radio frequency identifiers, and electronic data interchange protocols that have potential for the traceability of food and feed.
Two-dimensional printed graphic identifiers offer cheaper electronic identification alternative to radio-frequency identifiers (RFID), and may be the best alternatives until such time that existing difficulties with RFID application to food substances, originating from attenuation, are addressed fully and properly.
Preliminary results from an experiment aimed at the evaluation of UHF RFID application to the identification of modified atmosphere packaged meat show that to attain a probability of detection of approximately 0.67 (two-third) with a system that employs three antennae requires an effective radiated power of not less than 700 mW and distances of at most 0.2m. Linearly polarized antennae performed better than circularly polarized, especially at longer distances. Presence of bone in the meat samples is observed to have positively affected readability, although further experimentation is necessary to verify this phenomenon.
The lack of a single road-map to electronic data interchange (EDI) leaves the choice open to a few alternatives that may fall into two broad classes, namely internet based EDI enabled and traditional EDI based. Cost considerations make the former is an attractive choice and there are still developments in the area, perhaps with the new protocol, ebXML, leading the way.

Key words: food, feed, traceability, barcodes, RFID, EDI.

INTRODUCTION

Traceability, in relation to food, may be defined as the ability to follow a product batch and the ingredients of the product batch forward through the production process via the distribution chain to the immediate customer and backwards to the supplier of the ingredients, services and packaging, and processes (see Figure 1). In terms of input to the food chain, these products refer to food, feed for consumption by food-producing animal, food producing animals or substances through all stages of production and distribution [Cheftel, 2005, Schwägele, 2005, The European Commission, 2002, FSA-UK, 2002]. While authentication of products and processes are best carried out using biometric and bio-analytical methods [Schwägele, 2005, Prache et al., 2005], operational efficiency and accuracy of information handling is best served using automatic identification and data capture (EIDC). This is implemented using electronic identification tools and related data interchange infrastructure [Schwägele, 2005].

A functional traceability system must identify units or batches of all ingredients and products gather and properly organize temporal and spatial information on moved and transformed products,

Citation: Ayalew G. et al., 2006, Electronic tracking and tracing in food and feed traceability. LogForum 2, 2, 2
URL: http://www.logforum.net/vol2/issue2/no2
Accepted: 20.07.2006, on-line: 15.08.2006.

and consists of a system linking these data [FSA-UK, 2002]. As voluntary and mandatory labeling information expands mainly as a result of widening traceability requirements by legislation and consumer preference [Cheftel, 2005], so does the information to be recorded, transmitted, and stored for further use. The implication is that the data carriers need to match the requirement through larger sizes and/ or greater complexity [Zebra Technologies, 2004] with the accompanying higher costs.

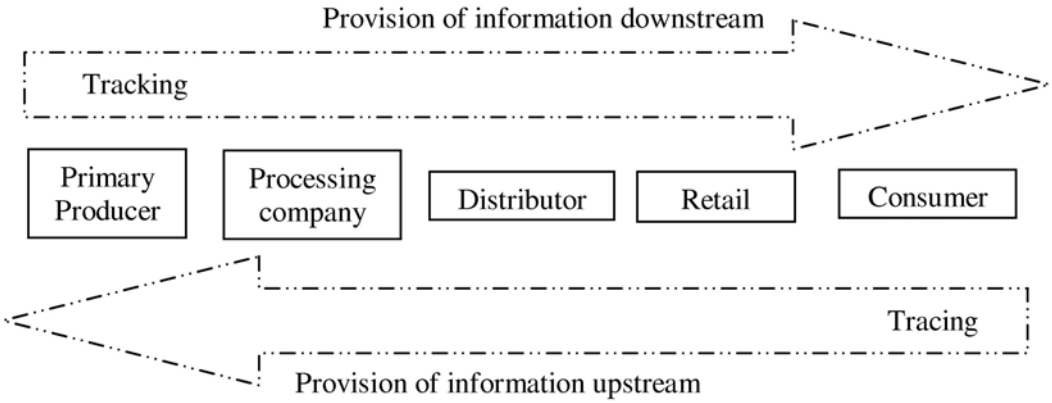


Fig. 1. A simplified view of information flow in traceability [Schwägele 2005].
Rys. 1. Uproszczony schemat przepływu informacji w trakcie procesu śledzenia towaru [Schwägele 2005].

Desirable features of electronic traceability systems are conformance to existing global identification and communications standards in order to improve accuracy and speed of traceability information [FSA-UK, 2002] and smooth operation in the system, unique identification internationally [EANI, 2002], overall cost-effectiveness and data security.

Technologies enabling traceability may be categorized into automatic identification and data management in the tracking and tracing of animals, food and feed, water, and the tracing of food/ and feed (where appropriate) ingredients to their sources. Previous reviews [FSA-UK, 2002] and studies (such as IDEA Project Team [2001]) show that electronic identification (EID) and electronic data interchange (EDI) are the best tools in delivering individual animal and product traceability.

Although technologies are developing quickly and new ones may still be in development like the ZigBee [ZigBee Standards Organization, 2005], Finkenzeller [2003] and Swartz [1999] identify one- and two-dimensional barcodes (referred hereafter as printed graphic identifiers, PGIs), optical character recognition, magnetic stripes, RFID (smart cards included) and automatic biometrics (such as voice recognition, finger printing, and retinal scanning [Marchant, 2002]) as the most outstanding automatic identification technologies. Of these, PGIs, retinal scans, and RFID have direct relevance to food traceability [Schwägele, 2005]. Although retinal scans are proven to be an effective automatic identification tool [Marchant, 2002], they can only be practically used for identity verification purposes, as their operation requires checking against an existing database of retinal vascular images. This leaves PGIs and RFIDs for use in the tracking of food and feed products.

This study reviews the features of major electronic identification and electronic data interchange tools used or which have potential of being used in traceability of food and feed, and a brief description of an ongoing study on the application of a UHF RFID system to meat traceability.

AUTOMATIC IDENTIFICATION DATA CARRIERS

Printed graphic identifiers

This section deals with PGIs that are known with the generic name barcode. PGIs are constrained by the conflicting requirements of high-density information, reliable code reading, minimal cost of printing and minimal cost of reading equipment [Pavlidis et al., 1990], and accordingly various codes exist to satisfy one or more of these requirements.

PGIs are attributed with merits such as low-cost (less than a cent); being accurately readable by machine with different symbologies offering differing levels of error detection/ protection; encoding possibilities for numeric, alphanumeric ASCII, and other characters; being well established; existence of different code forming materials and techniques such as metals, in addition to printed media; fast, line-of-sight readability with a wide range of equipment available catering for reading distances from direct contact to several metres; availability of wide range of symbol formation and printing software and hardware. Disadvantages of PGIs are low-capacity, typically less than 100 characters (linear codes) and at most 2335 alphanumeric characters (Data Matrix codes), dependence on symbology; requirement of line-of-sight; warping of label, and damage of symbol by hostile environmental factors such as moisture and friction; and being read-only [Acuity CiMatrix/Siemens, 2006; AIM, 2005; Jalaly and Robertson, 2005a, 2005b; Finkenzeller, 2003].

Linear barcode symbologies

In use for over a quarter of a century [AIM, 2005], and more than a hundred encoding schemes, linear barcodes are still the most widely used PGIs. Linear barcodes encode information along one dimension with varying widths of parallel light and dark patterns. A linear barcode would typically contain guard bar patterns at its ends to enable the reader identify the beginning and end of a code, and to enable bi-directional reading. For the EAN-13 symbology, for instance, it is bar-space-bar (101) [Pavlidis, 2000] on both sides. The reader illuminates the code symbol and measures the reflected light, from which it determines the pattern in width and brightness variations and decodes based on the encoding table for that particular symbology [Zebra Technologies, 2006].

The most common linear barcodes are Code 39, pioneered by the defense and automotive industries; the Universal Product Code (UPC), first employed by the supermarket industry in 1973 and adopted by the EAN-13 (European Article Numbering) in 1976 for applications in the grocery industry; Codabar, used in high safety requirement applications such as blood banks and other medical/clinical fields; Interleaved 2-of-5 (ITF), used in automotive industry, goods storage, pallets, shipping containers and heavy industry; and Code 128 (which is the parent set of the EAN-128 code structure [Anonymous, 2004d]). Bar codes may encode only numeric data (e.g. UPC/EAN-13 and ITF), or all or part of the ASCII character set (e.g. Codes 39 and 128) [AIM, 2005, Finkenzeller, 2003]. The advantages of linear barcodes are simplicity and cheaper readers, whereas their major disadvantage is that they have limited data storage capacity, and hence their function only to carry indices to databases - in a number plate fashion. Also too small and/or low-resolution printing can challenge readability [Pavlidis, 2000]. Detailed structures and encoding techniques employed for selected linear barcodes are given in Pavlidis et al. [1990].

Two-dimensional (2D) symbologies

There are two types of 2D symbologies - stacked and matrix type. The stacked symbols (e.g. Code 49 and PDF417 (see Figure 2) are structured in the form of a rectangular block consisting of numbers of rows, each of which is like a linear barcode. The matrix-type symbols (e.g. DataMatrix see Figure 2), Maxicode, and QR code) are made of an array of binary (black or white) cells placed in a grid. Individual matrix symbologies differ in the way input data is converted to a binary pattern, the way the pattern is placed on the grid, the grid size, and additional features needed to help locate the particular symbol in the field of view [Hahn & Joung, 2002]. 2D symbologies help overcome the analogue

nature of encoding information in linear barcodes, by localizing the points where information is to be stored and only have to decide whether a location is black or white. They also offer greater data density compared to linear symbols. Furthermore, with some additional overhead, varying levels of immunity to error can be achieved [Acuity CiMatrix/Siemens, 2006, Anonymous, 2006]. 2D symbologies make the data density of PGIs more competitive to those of RFIDs (dealt with below), with a significantly lower cost [Pavlidis, 2000]. In this regard, 2D symbologies may be considered as the figurative mid-way house between linear barcodes and RFIDs, as they offer the sought data density at competitive price. Although other 2D symbologies also exist [Kato & Tan, 2005, Pavlidis, 2000], the PDF417 code (owing to its wide-spread use Pavlidis [2000]) and the Data Matrix code (as a representative matrix code) will be briefly discussed below.

Fig. 2. The word "traceability" encoded in PDF417 (left) and Data Matrix (right) Codes.
Rys. 2. Słowo „śledzenie" zakodowane kodem PDF417 (z lewej) oraz Data Matrix (z prawej).

The PDF417 Code

PDF417 (where PDF stands for portable data file, a name attributed to 2D symbologies) is the most widely used 2D symbology. This symbology is a stacked code designed to provide significantly higher density than linear barcodes while keeping most of their advantages [Pavlidis, 2000; Kato & Tan, 2005]. It consists of redundant information in its many code words. This allows stitching of partial scans (using laser scanners), which enables not only error detection but also error correction. As this level of error correction capability (and hence level of redundancy) is set by the user, one can say that this symbology has an embedded facility for security versus density trade-off [Pavlidis et al., 1992]. Up to 50 % of the label of PDF417 may be damaged or torn while maintaining readability [Anonymous, 2006]. The maximum data capacity of a PDF417 symbol is 1108 bytes, which is equivalent to 1850 ASCII characters (approximately 500 English words), or 2710 digits, and actual capacity is limited by the resolution of the scanner. As this symbology can also encode binary data it can be used to encode data like biometrics [Pavlidis, 2000], which is of a great significance in traceability.

The Data Matrix (DM) Code

The DM symbol has been used in many sectors of industry not so much for replacing other kind of graphic symbols, but extending barcode applicability to new areas [Acuity CiMatrix/Siemens, 2006]. DM codes can store up to 3116 numeric characters, 2335 alphanumeric characters, or 1555 bytes of binary data. Advantages of the DM symbology is encoding of data in real digital format and hence better tolerance to errors due to low-contrast printing, very high-information density, no need of predetermined orientation of code in relation to camera, and built-in error-correction capability. Information in DM codes can be retrieved from codes, parts of which have been damaged by as much as 20 %. In one study [Hecker, 2006] the DM code provided 99.74 % readability, including missed reads resulting from dirty tags, on over 1.5 million reads on reusable plastic containers. Added benefit of the DM code is that it is physically extensible within a wide range of sizes [Acuity CiMatrix/Siemens, 2006]. There is also a potential for further increase in data density if a multi-color DM code is adopted as proposed by Tarassenko et al. [2003].

Application of PGIs in traceability

The FoodTrace system [Anonymous, 2005], that is proven to be an effective traceability system in the industry, at least in Ireland, is based on the EAN-128 code and Application Identifiers "AI"s (an application identifier may be considered as a description of the content of what follows it in an EAN-128 barcode structure) defined by GS1. EAN-UCC standards on traceability of beef specify protocols, using part of their internationally accepted numbering and bar coding system, in the traceability of beef. In the EAN-UCC standard document [EANI, 2002] the AIs have been defined for reference source identity (ear-tag number, for instance), country of origin, country of initial process, country of processing, and approval number of processor. In addition, AIs for country of birth, country(ies) of fattening, country of slaughter and approval number of slaughterhouse, approval number of first cutting hall, approval number of second cutting hall, approval number of third to ninth cutting hall, either ear tag number for individual cutting or batch number of cuttings have been defined and recommended by GSI [Anonymous, 2005] for inclusion on carcass labels.

Radio Frequency Identification

Radio Frequency Identification (RFID) systems are characterized by the contactless transfer of power and data between the reader (a.k.a. interrogator) and the tag (a.k.a transponder) [Finkenzeller, 2003]. For that reason, while a line-of-sight is necessary for barcode scanning, RFID scanners can read even when the tag is embedded for either aesthetic or security reasons [Want, 2004]. Another disadvantage associated with barcodes is that they are not re-programmable and are of limited storage capacity [Finkenzeller, 2003], although there is an improvement in this regard in 2D PGIs [Hecker, 2006]. It is believed that RFIDs overcome these disadvantages and would bring about automatic tracking of assets. The operation of an RFID system is as follows. An RFID reader transmits a radio-frequency electromagnetic field, the tag receives the field, and uses part of the absorbed energy (Such RFID tags are called passive tags, as opposed to active tags where they have on-board power sources) to identify itself by changing the load on the reader (for low (LF), and high frequency (HF) systems), or the field pattern around it (UHF systems) in such a way as to send a pre-programmed code, which in turn is decoded by the reader (LF, HF, and UHF refer to RFID standards in the wave bands of 9 - 135 kHz; 6.78, 13.56, and 27.125 MHz; and 433.920, 869.0 and 915.0 MHz, respectively. Microwave (> 3 GHz) tags also exist (Finkenzeller, 2003)). A software compiles and collates the ID with other collected information on a database [Kampers et al., 1999; Scharfeld, 2001].

RFID tags are also classified according to their specification. Class-0 RFID tags have, by definition, the following required functions [Auto-ID Center, 2003]:

- being factory programmed with an electronic product code (EPC) (The EPC is the core identification segment of an RFID data; has internal sub-segments called the EPC version number, domain manager number, object class number, and serial number; and has sizes of 64, 96, 256, and up to 496 bits (in Class 1 Generation 2 tags), 24-bit kill code (a code to disable the RFID tag to stop tracking), and CRC (cyclic redundancy check, an error checking component),
- being read by the reader,
- being selected as part of a related group of tags,
- being individually destroyed,
- not containing re-writable memory.

EPCglobal also defines other four RFID tag classes based on the base class called Class-1. Class-1 identity tags are passive-backscatter tags with the minimum features of [Anonymous, 2004b]:

- an electronic product code (EPC) identifier,
- a tag identifier (TID),
- a kill function,
- optional password protected access control,

- optional user memory.

Class-2, Class-3, Class-4 or higher class tags do not, by specification, conflict with the operation of, nor degrade the performance of Class-1 tags located in the same RF environment [Anonymous, 2004b]. Class-2 tags possess higher functionality, and are passive tags with the following features above and beyond those of Class-1 tags:

- an extended TID,
- extended user memory,
- authenticated access control,
- additional features to be defined in Class-2 specification.

Class-3 tags are semi-passive tags with the following anticipated features above and beyond those of Class-2 tags:

- an internal power source,
- integrated sensing circuitry.

Class-4 tags are active tags with the following anticipated features above and beyond those Class-3 tags:

- tag-to-tag communication,
- active communications,
- ad-hoc networking capabilities.

Table 1. Comparison of linear barcodes with RFID systems [Finkenzeller 2003]
Tabela 1. Porównanie liniowych kodów kreskowych z systemem RFID [Finkenzeller 2003]

System parameter	Barcode	RFID systems
Typical data quantity (bytes)	1-100	16-64k
Data Density	low	very high
Machine readability	good	good
Readability by people	limited	impossible
Influence of dirt/dampness	very high	no influence
Influence of optical covering	total failure	no influence
Influence of direction and position	low	no influence
Degradation /wear	limited	no influence
Purchase cost	very low	medium
Operating costs (e.g. printer)	low	none
Unauthorized copying/modification	slight	impossible
Reading speed (including handling of data carrier)	low, ≈ 4 s	very fast, ≈ 0.5 s
Maximum distance between data carrier and reader	0-0.50 m	0-5 m
Additional features provided	none	temperature

Źródło: Kumar & Budin, 2006.

Table 1 contrasts linear barcodes with RFIDs. Although the technology is highly promising and there are desirable features for a traceability system such as security and high data capacity suitable for

traceability information, they are still to be verified in situations where the effect of lossy and reflective materials must be reliably circumvented. The case in point is the fact that most, if not all food materials consist of lossy, moist contents, and/or conducting packages such as tins. Improvements attained with 2D symbologies have, at lease partially, overcome some of the setbacks listed in Table 1, especially regarding data quantity and data density.

Application of RFIDs in traceability

RFID has been considered the most important identification tool for the establishment of an effective traceability system [Wang et al., 2006]. RFID tags allow a manufacturer of food items to have an audit trail of moments of the retail unit's life, monitoring correct handling, storage, transportation and delivery. Some tags also have the capability to monitor temperature-controlled product on a per unit basis, hence allowing manufacturers to find out exactly where a temperature abuse occurred [Kumar & Budin, 2006].

The comparison of applications of Hazard Analysis and Critical Control Points (HACCP) on one hand, and RFID tracking on the other, for the purpose of reduction of recalls and the subsequent impact in the processed-food industry shows [Kumar & Budin, 2006] that:

- long history, long-time understanding among experts, prevention of food contamination by identifying potential hazard in the food processing chain are strengths of the HACCP; while being most advanced technology, ability to track units of sale to the cash register and product traceability being those of RFID,
- the perception of being bureaucratic, and frequent misunderstanding are the weaknesses of HACCP; while the facts that micro-organisms take time to manifest themselves, and that in-plant control capabilities not as clear apply in case of RFID,
- potential for further improvement, and re-training of workers are opportunities existing in HACCP; while the potential to change the retail practice, and direct consumer tracking in the event of an emergency in the case of RFID,
- eventual obsolescence in the wake of improved technology is a threat to HACCP; while system crashes, risk of hacking and loss of data are threats to RFID.

Hecker [2006], on the other hand, argues that RFID promises to solve problems associated with linear barcodes by enabling item-level automatic tracking throughout the supply chain, but this promise has been tempered by accuracy problems, high costs, and environmental limitations when used around metals and liquids. Therefore, he argues it might be prudent to slow down a bit, until such time that these issues are fully addressed. This issue is even more important to the food and feed industries as such features are dominant in food and feed items.

Another application of RFID technology in traceability is its use in animal identification. The radio frequency animal identification standard (ISO 11784/85) is a well tested [IDEA Project Team, 2001] application where animals are tagged and identified automatically, as required. The frequency of operation this standard specifies is 134.2 kHz [Kampers et al., 1999], owing to the low absorption rate, high penetration depth in non-metallic materials and water at this frequency [Finkenzeller, 2003]. The tag may be attached to the animal in one of three modes, namely ear tags, subcutaneous injection, or ruminal bolus (only applicable to ruminants). The bolus has been identified as the best tamper proof (99 % retention rate, and 100 % recovery rate) animal identification tag provided it is implanted at the right age and weight of animals [IDEA Project Team, 2001; Fallon et al., 2002].

THE EFFECTS OF DISTANCE, ANTENNA POWER, AND TYPE OF MEAT ON THE READING EFFICIENCY OF AN UHF RFID SYSTEM

Glidden et al. [2004] gives the theoretical range (m) of detection for tags as:

$$R \leq \frac{\lambda}{4\pi}\sqrt{\frac{1.64 \cdot ERP_{reader} G_{tag}}{P_{tag}}} \quad (1)$$

where P_{tag} is power required at the tag antenna output, G_{tag} is the tag antenna gain, ERP is the effective radiated power, and λ is the wavelength of the RF carrier (all in the MKS system of units). Want [2004] puts the dependence of signal strength as a function of the inverse cubic of distance. Either way, distance is a crucial factor for RFID operation. As actual P_{tag} cannot be directly measured the only means available is the monitoring of tag operation by placing it at different distances from the reader.

RFIDs depend on the interaction of EM waves with their surroundings (tags included) for their operation. As a result, material properties inside and around the actual medium of interest (such as a pack of meat) affect readability. An experiment is currently being conducted to verify the readability of class 1 Generation 1 UHF RFID (also applicable to Generation 2, as the operating frequencies are similar [Anonymous, 2004b]) system as applied to beef and pork samples. A brief account of the experiment, and the preliminary results is provided below.

MATERIALS AND METHODS

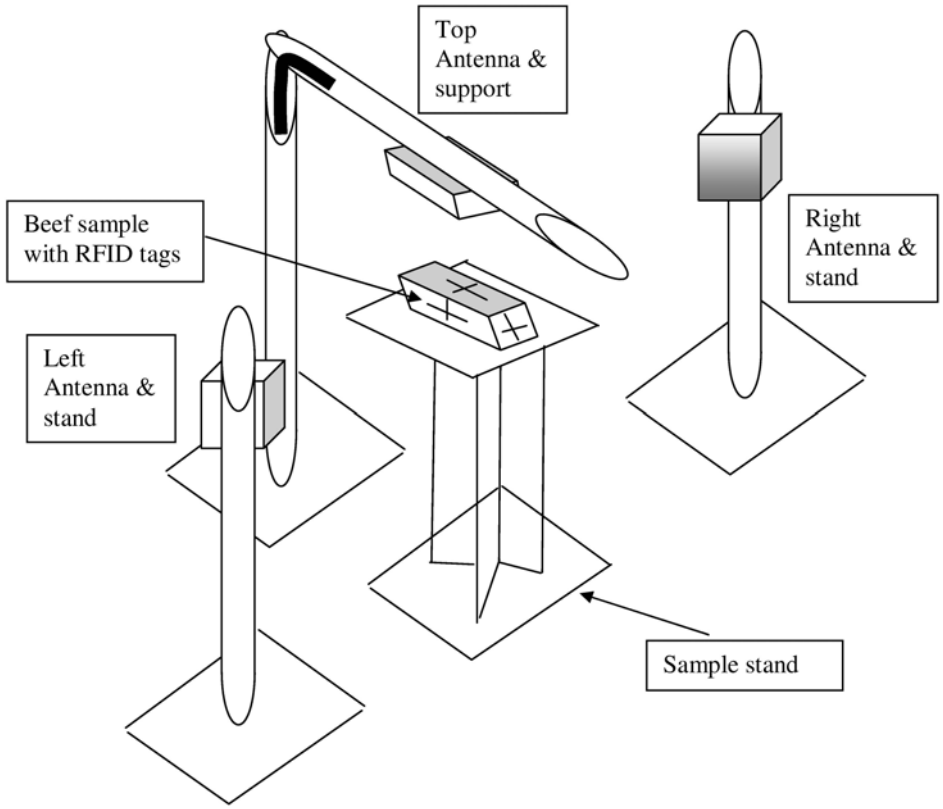


Fig. 3. Schematic representation of the physical arrangement of RFID readability test apparatus (this study).
Rys. 3. Schemat testowego urządzenia RFID.

Figure 3 is a schematic representation of the physical arrangement of RFID readability test apparatus developed in this study. The RFID system consists of a CAEN (Construzioni

Apparecchiature Electroniche Nucleari (C. A. E. N.) S.p.A., Sede Sociale, Uffici e laboratori: Via Vetraia, 11 - 55049 VIAREGGIO, Italy) UHF Class 1 Generation 1 RFID Development Kit, with sets of 3 antennae (linearly polarized, or circularly polarized), a perspex-made sample seat 1 m high and 0.2 m x 0.2 m top platform. PVC are pipes used as support for antennae, each of which was connected to the UHF RFID reader. A PC running a CAEN reader software was used to control the RFID system and acquire tag IDs.

Two modified atmosphere packaged beef and pork samples of roughly equal weight (ca. 1.1 kg), one from each meat type with bone and another without bone were used for the experiment. Two Class 1 Generation 1 UHF RFID tags of the Philips U-code type were bonded on each surface of each sample (12 in total), one tag always parallel to the ground and the other bonded perpendicular to it (shown in Figure 3).

Three antennae were used in each trial, and their distances from the sample were adjusted from a minimum of 0.2 m to a maximum of 1.2 m. The Effective Radiated Power (ERP) was adjusted between 101 to 2200 mW using the software provided.

A tally of total tags detected out of 12 was made after each reading procedure (with the omission of replicate detection), and this plotted against ERP and antenna distance.

RESULTS AND DISCUSSION

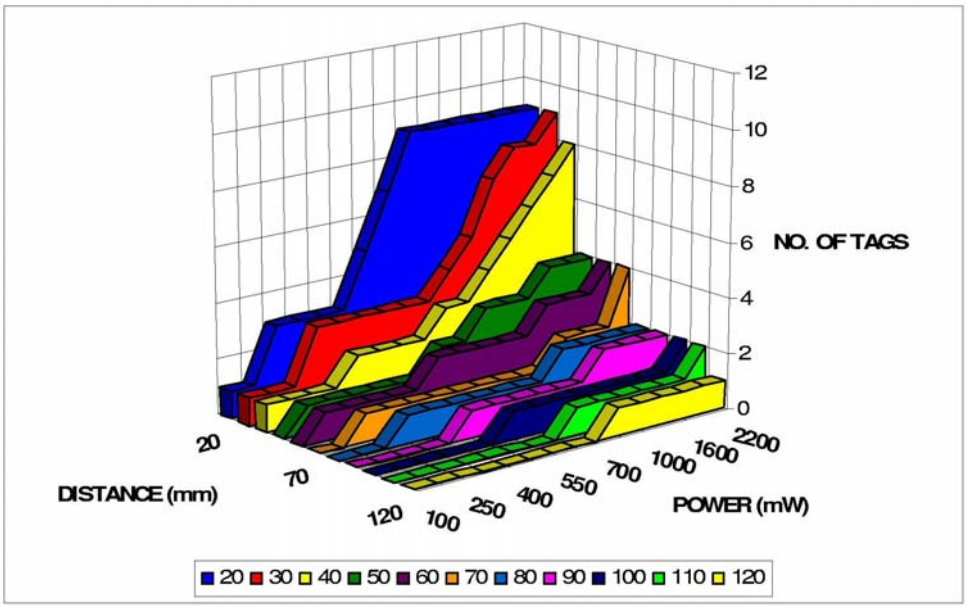
Figures 4 and 5 show the number of tags detected as a function of antenna power and distance. Comparison of circularly polarized and linearly polarized antenna operation shows that use of linearly polarized type antennae yielded higher reading rates over larger distances (up to 1.2 m), whereas the performance of the circularly polarized type antennae declined dramatically at distances over 0.8 m.

Also, as the ERP was increased the number of tags detected, at a given distance, increased - a trend common in both antenna types. The distance was also shown to be an important factor in that the number of tags detected decreased as the distance between tag and reader increased for a constant ERP. Preliminary results also suggest that the presence of bone in meat samples improved readability over longer distances regardless of antenna type used. This may be attributed to the lower loss caused by bone than meat [Pethig, 1987] (dielectric constants and conductivities for bone and muscle tissue are, respectively, 4.9 & 55, and 0.15 & 1.45, at 915 MHz), and perhaps due to a reflection at the interfaces between them.

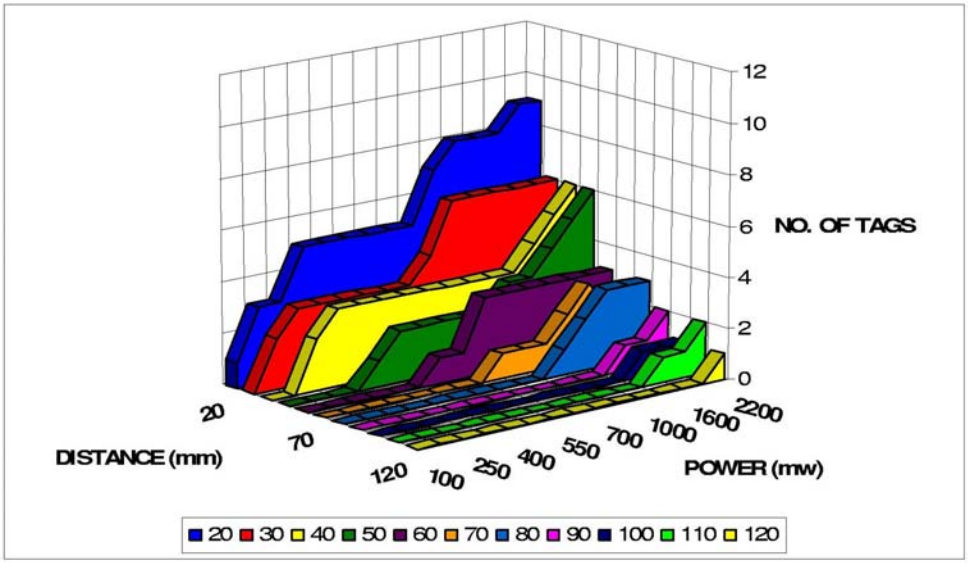
These results also suggest that no significant difference exists between linearly polarized and circularly polarized antennae up to a distance of 0.5 m. However, read efficiency of circularly polarized antennae decreased after this point, while the linearly polarized antennae continued to detect tags up to a maximum of 1.2 m.

Again from these preliminary results, it can be said that linearly polarized antennae performed generally better than circularly polarized antennae, which may be attributable to the fact that for a perfectly aligned tag and reader antennae, a linearly polarized antenna delivers more RF power than its circularly polarized counterpart [Finkenzeller, 2003]. It is too being seen in Figure 3 that for each of the three linearly polarized antennae in the vertical direction (along the supports shown), there exist 4 tags in the plane of polarization. Also it can be seen that 2/3 (66.7 %) of tags were read with power levels of at least 700 mW and distances of at most 0.2 m.

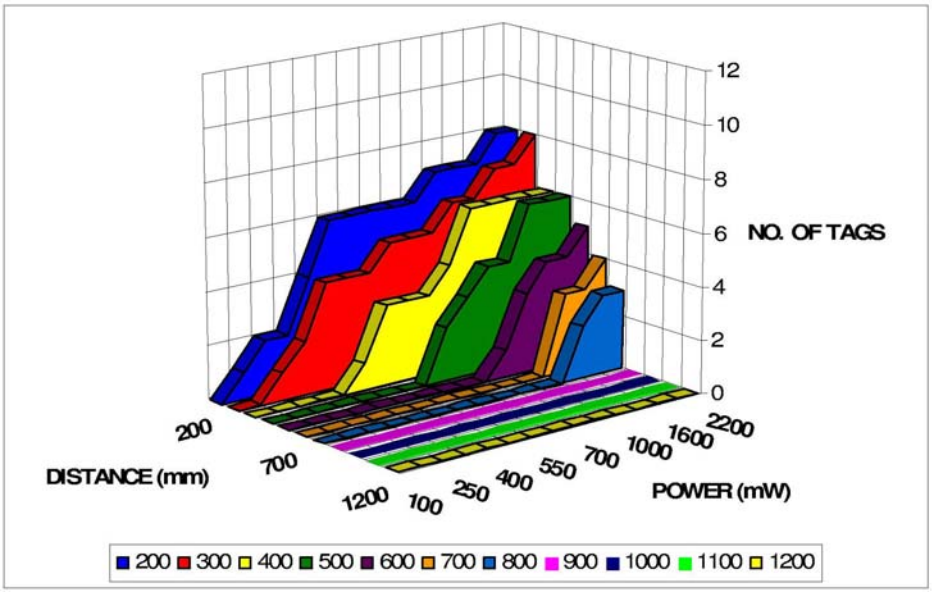
(a)


12
10
8
6
NO. OF TAGS
4
2
0
20
70
120
100
250
400
550
700
1000
1600
2200
DISTANCE (mm)
POWER (mW)
20 30 40 50 60 70 80 90 100 110 120

(b)


12
10
8
6
NO. OF TAGS
4
2
0
20
70
120
100
250
400
550
700
1000
1600
2200
DISTANCE (mm)
POWER (mw)
20 30 40 50 60 70 80 90 100 110 120

(c)


12
10
8
6
NO. OF TAGS
4
2
0
200
700
1200
100
250
400
550
700
1000
1600
2200
DISTANCE (mm)
POWER (mW)
200 300 400 500 600 700 800 900 1000 1100 1200

(d)

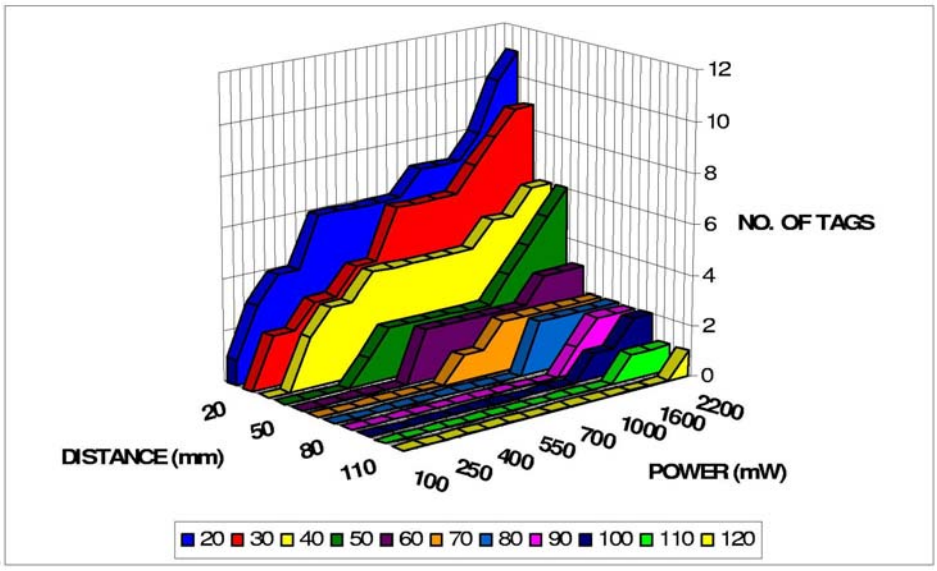
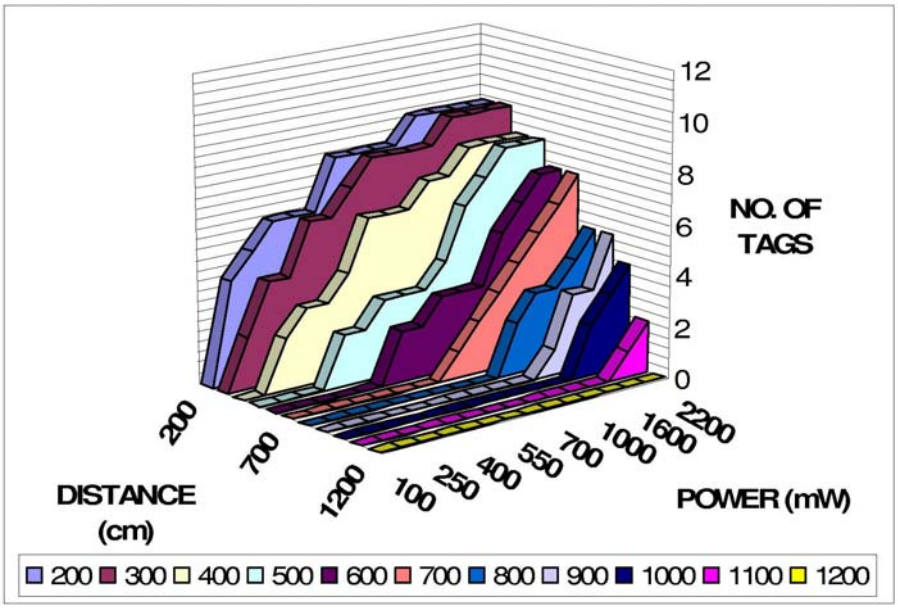


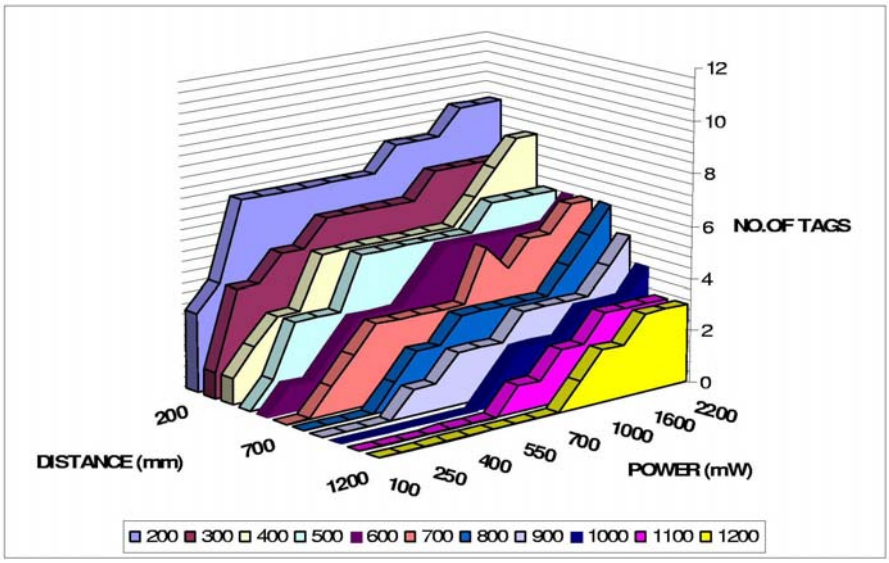
Fig. 4. Preliminary results from RFID readability test: (a) beef with bone, circularly polarized antenna, (b) beef with bone, linearly polarized antenna, (c) beef without bone, circularly polarized antenna, and (d) beef without bone, linearly polarized antenna (this study).

Rys. 4. Wstępne wyniki testu czytalności RFID: (a) wołowina z kością, antena spolaryzowana kołowo, (b) wołowina z kością, antena spolaryzowana liniowo, (c) wołowina bez kości, antena spolaryzowana kołowo, (d) wołowina bez kości, antena spolaryzowana liniowo.

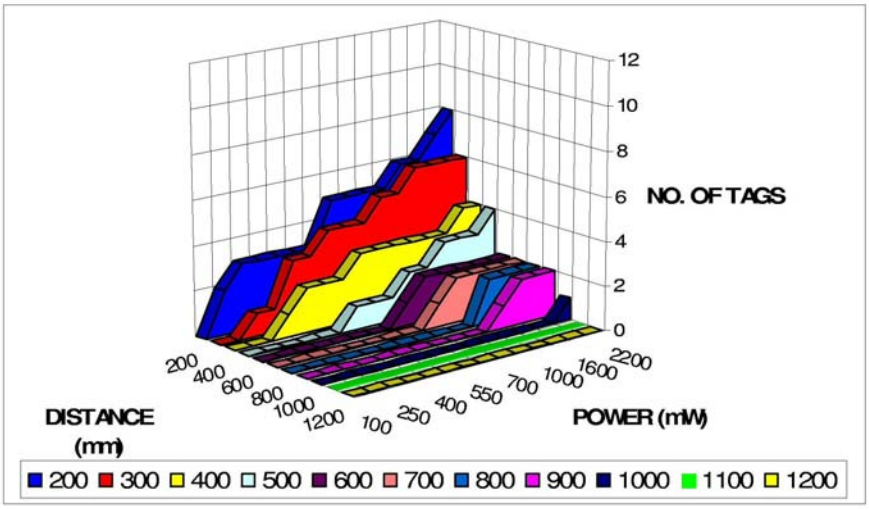
(a)



(b)



(c)



(d)

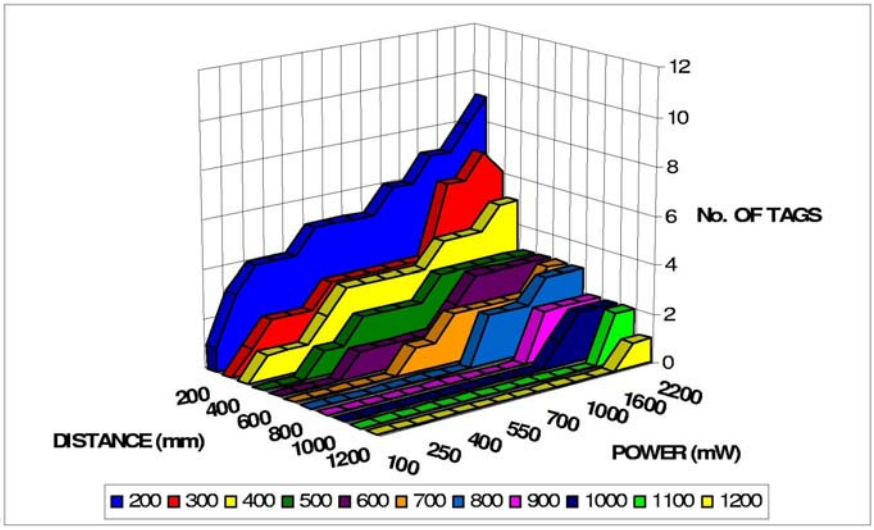


Fig. 5. Preliminary results from RFID readability test. (a) pork with bone, circularly polarized antenna, (b) pork with bone, linearly polarized antenna, (c) pork without bone, circularly polarized antenna, and (d) pork without bone, linearly polarized antenna (this study).

Rys. 5. Wstępne wyniki testu czytalności RFID: (a) wieprzowina z kością, antena spolaryzowana kołowo, (b) wieprzowina z kością, antena spolaryzowana liniowo, (c) wieprzowina bez kości, antena spolaryzowana kołowo, (d) wieprzowina bez kości, antena spolaryzowana liniowo.

ELECTRONIC DATA INTERCHANGE

Traceability data management methods range from paper based records to information technology enabled systems, for which there are different systems in the food industry [FSA-UK, 2002]. Technically, Electronic Data Interchange (EDI) is a reliable means for the exchange of traceability data. It comprises of computer-to-computer exchange of structured information, by agreed message standards, from one computer application to another with a minimum of human intervention. One typical application of EDI is the automated purchase of goods and services. EDI makes data transfer independent of transmission technologies like the Internet or private networks. Two major standards exist, namely the UN/EDIFACT (The United Nations rules for Electronic Data Interchange For Administration, Commerce and Transport) and the ANSI ASC X12, the latter being more popular in North America while the former is more so in the rest of the world [The Free Encyclopedia (http://en.wikipedia.org)]. UN/EDIFACT comprises a set of internationally agreed standards, directories and guidelines for the electronic interchange of structured data, and in particular that related to trade in goods and services between independent, computerized information systems [UNECE, 2006].

Formal document and transmission standards inherent in EDI combined with adequate bandwidth permit large transaction volumes [Gunasekaran et al., 2002]. However, high cost and non-flexible nature of dedicated EDI systems, is turning SMEs and large business alike to implement Internet based technologies compatible with EDI messaging protocols [Gunasekaran et al., 2002], or irrespective of compatibility [Themistocleous et al., 2004] for their electronic commerce activities. The XML/EDI (visit www.xmledi.org) integrates XML (The Extensible Markup Language -visit www.w3c.org, www.xml.org for details) with EDI to provide business, irrespective of size, and is a cheaper system to carry out electronic transactions with any trading partner worldwide. This model provides lower costs, compatibility with ANSI ASC X.12 and UN/EDIFACT, suitability for short-term trade relation, improved global accessibility, and easy integration with existing systems. The major cost is that EDI messages were four to eight times larger [Lu et al., 2001). Another XML-based messaging protocol is being developed by the ebXML Initiative, which aimed to develop a single global electronic market based on an open public infrastructure enabling the global use of electronic business information in an inter-operable, secure and consistent manner by all parties (www.xml.org).

E-mail-attached UN/EDIFACT messages have been implemented during the research phase of the IDEA Project [IDEA Project Team, 2001], with success. Therefore, one can say still the use of EDI messaging, in whatever the means of communication be, is an attractive option for the exchange of traceability information. Another development that may be effective in the transfer of data from a scattered farming community to central databases is through the use of mobile phones. In one application, farmers can register calf-births using their mobile phones (Mr. Alan King, Personal Communication, Department of Agriculture, Food and Rural Development, Ireland). The EANCOM, owned by GS1global is an EDI that is a subset of the UN/EDIFACT and incorporates the GS1 (EAN-UCC) numbering system. It allows to integrate the physical flow of goods with related information sent by electronic means [EAN International, 2005].

The EPCglobal Network (formerly the EPC Network) is intended to improve asset visibility and help ensure product safety and integrity across the supply chain, through the delivery of seamless, efficient, and secure business transactions. The EPC Network enables trading partners to track and trace items identified by the electronic product code (EPC) throughout the supply chain [Anonymous, 2004c]. In addition to operational efficiency, the EPC Network provides with applications that address counterfeiting, tampering, terrorism, and regulatory compliance - which are all requirements of a food traceability system [Anonymous, 2004a].

According to the above discussion regarding EDIs, there is not a single roadmap to EDI and this leaves the choice open to the alternatives that may fall into two broad classes, namely internet based EDI enabled, and traditional EDI based. The former may be led by the ebXML as heavyweight players such as the UN/CEFACT and ANSI are behind it (visit www.ebxml.org). This poses an opportunity as well as a challenge, and perhaps it is time that the Governmental bodies and the food/feed/agricultural industry look into standardization of EDI for the purpose of traceability.

Also, as stressed in FSA-UK [2002], there is a great element of trust being expected from partners, as there is no inseparable physical link between the information being recorded and the food item being traced. From this point of view, the accuracy of traceability information is limited by that of what is entered into the tracking and tracing technologies [EANI, 2002].

CONCLUSIONS

Although many applications outside the food industry have been reported and the future of RFID as a dominant tool for traceability seems assured, there still remain issues like operation in high-attenuation environments and cost, and an immediate adoption seems doubtful. The additional cost of RFID in traceability can add to the reluctance of the industry to adopt them. An incentive to the food-related sectors to share costs associated with traceability among all concerned sectors may help the food industry to adopt RFID systems.

2D PGIs have developed to the extent that they can be used to store traceability information such as biometrics of an animal, for instance, on board the product to be sold, and perhaps will serve in the medium term before the cost of RFID tags fall to an attractive cost level, and technical difficulties related to attenuation are decisively overcome. Linear barcodes on the other hand, being widely adopted by all major sectors including the food industry are likely to remain serving the function of holding the index to the database.

Given the multiple choices existing regarding EDI technologies, perhaps it is time Government bodies and food/feed/agricultural industry looked into the standardization of EDI as applied to food and feed traceability.

Preliminary results from a study on readability of a UHF RFID system show that a reliable automatic identification of beef and pork items in the supply chain requires further study with the hope to improve performance in detection.

ACKNOWLEDGEMENTS

This project is supported by the European Commission under the 6th Framework Programme through the Key Action: Strengthening the European Research Area, Food Quality and Safety, Contract No: FP6-518451.

REFERENCES

Acuity CiMatrix/Siemens, 2006, The data matrix code. Note: Acuity CiMatrix, now acquired by Siemens, claim to have created the Data Matrix Symbology. http://www.acuitycimatrix.com/ DM20Basics.html, accessed on 30 May 2006.

AIM, 2005, Linear (one-dimensional) bar code symbologies. Association for Automatic Identification and Mobility. http://www.aimglobal.org/technologies/barcode/linear_ symbologies.htm, accessed on 12 July 2005.

Anonymous, EPC Network Architecture, 2004a, White paper, Verisign, Inc., VeriSign Worldwide Headquarters, 487 East Middlefield Road, Mountain View, CA 94043, U.S.A. www.verisign.com.au/guide/epc/epc_architecture.pdf.

Anonymous, 2004b, EPC Radio-frequency identity protocols Class-1 Generation-2 UHF RFID protocol for communications at 860 MHz-960 MHz, Version 1.0.9. Specification for RFID air interface, EPCglobal Inc.

Anonymous, 2004c, The Sun EPC Network architecture. White paper, Sun Microsystems, Inc., 4150 Network Circle, Santa Clara, California 95054, U.S.A.

Anonymous, 2004d, UCC/EAN-128 Guidelines, Version 2. A guide to the implementation of the EAN 128 bar code on pallet and outer case labels in the grocery trade in Ireland, GS1 Ireland, GS1 Ireland, Confederation House, 84/86 Lower Baggot Street, Dublin 2, Ireland.

Anonymous, 2005, Beef traceability case study. Technical Report, GS1 Ireland, Confederation House, 84/86 Lower Baggot Street, Dublin 2, Ireland.

Anonymous, 2006, Fundamentals of the PDF417 symbology. Technical note, OPAL Associates AG, Motorenstrasse 116, CH-8620, Wetzikon, Switzerland, http://www.barcode-fonts.de/microscan/PDF417.pdf, accessed on 31 May 2006.

Auto-ID Center, 2003, 860 MHz-930 MHz Class 0 radio frequency identification tag protocol specification candidate recommendation, Version 1.0.0. Technical Report MIT-AUTOID-WH-012, Massachusetts Institute of Technology, 400 Technology Sq., BLDG NE 46, 6th floor, Cambridge, MA 02139-4307, USA.

Cheftel, J. C., 2005, Food and nutrition labeling in the European Union. Food Chemistry 93, 531-550. EAN International, 2005. Numbering system. http://www.gs1.org/ index.php?http:// www.ean-int.org/prefix.html&2, accessed on 28 June 2005.

EANI, 2002, Traceability of beef: application of EAN-UCC standards in implementing Regulation (EC) 1760/2000. Standard 3rd revised edition, EAN International, EAN International, 145 rue Royale, 1000 Brussels, Belgium.

Fallon, R., Rogers, P., Earley, B., 2002, Electronic animal identification. End of Project Report ARMIS No. 4623, Teagasc, The Irish Agriculture and Food Development Authority, Grange Research Centre, Dunsany, Co. Meath, Ireland.

Finkenzeller, K., 2003, RFID Handbook, 2nd Edition. John Wiley & Sons Ltd., The Atrium, Southern Gate, Chichester.

FSA-UK, 2002, Traceability in the food chain: a preliminary study. Tech. rep., Food Standards Agency, Government of UK, Aviation House, 125 Kingsway, London WC2B 6NH, UK.

Glidden, R., Bockorick, C., Cooper, S., Diorio, C., Dressler, D., Gutnik, V., Hagen, C., Hara, D., Hass, T., Humes, T., Hyde, J., Oliver, R., Onen, O., Pesavento, A., Sundstrom, K., Thomas, M., 2004, Design of ultra-low-cost UHF RFID tags for supply chain applications. IEEE Comm. Mag., 42(8), 140 - 151.

Gunasekaran, A., Marri, H. B., McGaughey, R. E., Nebhwani, M. D., 2002, E-commerce and its impact on operations management. Int. J. Prod. Econ., 75, 185-197.

Hahn, H. I., Joung, J. K., 2002, Implementation of algorithm to decode two-dimensional barcode pdf-417. In: Proceedings of the IEEE 6th Int. Conf. Sig. Proc., 26-30 August 2002. Vol. 2. IEEE, pp. 1791 - 1794.

Hecker, R., 2006, An alternative to RFID: finding the silver bullet for traceability. Comp. & Cont. Eng. J., 16(6), 36 - 38.

IDEA Project Team, 2001, IDEA Project: IDentification Electronique des Animaux, 1998-2001. Final report, European General Directorate on Agriculture (DG Agri) and The Joint Research Council (JRC).

Jalaly, I., Robertson, I., 2005a, Capacitively-tuned split microstrip resonators for rfid barcodes. In: Proc. IEEE 2005 Eur. Microwave Conf., 4-6 October 2005. Vol. 2. IEEE, pp. 1161 - 1164.

_____, RF barcodes using multiple frequency bands. In: IEEE MTT-S Int. Microwave Symp. Digest, 12-17 June 2005. IEEE, pp. 1-4.

Kampers, R., Rossing, W., Eradus, W., 1999, The ISO standard for radiofrequency identification of animals. Comp. Elect. Agric., 24, 27-43.

Kato, H., Tan, K., 2005, 2D barcodes for mobile phones. In: Proc. IEEE 2nd Int. Conf. Mobile Tech., App. & Sys. 15-17 November 2005, pp. 1 - 8.

Kumar, S., Budin, E., 2006, Prevention and management of product recalls in the processed food industry: a case study based on an exporter's perspective. Technovation, 26, 739 - 750.

Lu, E. J.-L., Tsai, R.-H., Chou, S., 2001, An empirical study of XML/EDI. J. Sys. & Software, 58(3), 271-279.

Marchant, J., 2002, Secure animal identification and source verification. Whitepaper, OptiBrand Ltd., LLC, Optibrand Ltd., LLC, 123 N. College Avenue, Ste 240, Ft. Collins, CO 80524, USA.

Pavlidis, T., 2000, A new paper/computer interface: two-dimensional symbologies. In: Proc. IEEE 15th Int. Conf. Pat. Rec., 3-7 September 2000, pp.145 - 151.

Pavlidis, T., Swartz, J., Wang, Y., 1990, Fundamentals of bar code information theory. Computer, 23(4), 74- 86.

_____, Information encoding with two-dimensional bar codes. Ibid, 1992, 25(6), 18 - 28.

Pethig, R., 1987, Dielectric properties of body tissues. Clin. Phys. and Physiol. Meas., 8, (Suppl. A), 5-12.

Prache, S., Cornu, A., Berdagué, J., Priolo, A., 2005, Traceability of animal feeding diet in the meat and milk of small ruminants. Small Rum. Res., 59, 157-168.

Scharfeld, T. A., 2001, An analysis of the fundamental constraints on low cost passive radio-frequency identification system design. Master's thesis, Department of Mechanical Engineering, Massachusetts Institute of Technology, Room 3-173, 77 Massachusetts Ave., Cambridge MA 02139.

Schwägele, F., 2005, Traceability from a European perspective. Meat Sci., 71, 164-173.

Swartz, J., 1999, The growing magic of automatic identification. IEEE Rob. & Autom. Mag., 6(1), 20 - 23,56.

Tarassenko, V., Dychka, I., Sulema, Y., 2003. Means of transforming, storing and inputting data represented as multicolor matrix barcodes. In: Proc. 7th Int. Conf. Experience of Designing and Application of CAD Systems in Microelectronics, CADSM 2003. Vol. 2:486 - 489.

The European Commission, 2002. Regulation (EC) No. 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. Official Journal of the European Communities L 31/1, 1-24.

Themistocleous, M., Irani, Z., Love, P. E. D., 2004, Evaluating the integration of supply chain information systems: a case study. Eur. J. Op. Res., 159(2), 393-405.

UNECE, 2006, UN/EDIFACT draft directory. Intoduction and Rules, website of the UN Economic Comission for Europe, http://www.unece.org/trade/untdid/texts/d100_d.htm, accessed on 14 June 2006.

Wang, N., Zhang, N., Wang, M., 2006, Wireless sensors in agriculture and food industry-recent development and future perspective. Comp. Elect. Agr., 50, 1-14.

Want, R., 2004, Enabling ubiquitous sensing with RFID. IEEE Comp. Mag., 37(4), 84 - 86.

Zebra Techlologies, 2004, Bar coding and RFID: the key to traceability and safety in the foodservice supply chain. Tech. rep., Zebra Technologies Corporation, 333 Corporate Woods Parkway, Vernon Hills, Illinois 60061-3109 USA.

Zebra Techlologies, Barcode FAQs. Application White paper, http://www.zebra.com/id/zebra/na/en/index/resource_library/faqs/bar_code_printing.html#FAQ_0001, accessed on 27 May 2006.

ZigBee Standards Organization, 2005, Zigbee specification. Standard, ZigBee Aliance, Inc., 2400 Camino Ramon, Suite 375, San Ramon, CA 94583.

ELEKTRONICZNE ŚLEDZENIE PRZEBIEGU PRODUKCJI WYROBÓW MIĘSNYCH

STRESZCZENIE. Narzędzia elektroniczne, najczęściej stosowane w celu śledzenia partii żywności lub paszy to automatyczna identyfikacja oraz elektroniczna wymiana danych (EDI). Praca przedstawia podstawowe cechy drukowanych graficznych identyfikatorów, identyfikatorów wykorzystujących fale radiowe oraz protokołów elektronicznej wymiany danych, które mogą być stosowane przy śledzeniu partii żywności i pasz.
Zastosowanie dwuwymiarowego drukowanego graficznego identyfikatora jest tańszym sposobem elektronicznej identyfikacji w stosunku do identyfikatorów opartych na falach radiowych i wydają się być najlepszych rozwiązaniem do momentu rozwiązania problemów, jakie obecnie występują przy zastosowaniu identyfikatorów radiowych do śledzenia partii żywności.
Wstępne wyniki badań nad opracowaniem aplikacji wykorzystującej fale radiowe UHF do identyfikacji mięsa pakowanego w zmodyfikowanej atmosferze wykazują, że uzyskanie prawdopodobieństwa wykrycia równego 0,67 (dwie trzecie) przy zastosowaniu sytemu z trzema antenami wymaga efektywnej mocy nadawczej nie mniejszej niż 700 mW oraz odległości najwyżej 0,2 m. Zastosowanie anteny spolaryzowanej liniowo daje lepsze efekty niż spolaryzowanej kołowo, szczególnie na większych odległościach. Obecność kości w mięsie poprawia zdolność odczytu, jednak potwierdzenie tej obserwacji wymaga kolejnych badań.
Brak jednego rozwiązania umożliwiającego elektroniczną wymianę danych (EDI) prowadzi do wyboru jednego z kilku dostępnych rozwiązań, które można zaklasyfikować do jednej z dwóch grup: EDI oparte na usługach internetowych oraz EDI oparte na rozwiązaniach tradycyjnych. Ze względów kosztowych pierwsze rozwiązanie wydaje się atrakcyjniejsze. Obecnie trwają nadal badania nad rozwojem w tym kierunku, między innymi nad nowym protokołem ebXML.

Słowa kluczowe: żywność, pasza, śledzenie partii, kody kreskowe, RFID, EDI.

ELEKTRONISCHE VERFOLGUNG DES PRODUKTIONSPROZESSES VON FLEISCHWAREN

ZUSAMMENFASSUNG. Automatische Identifizierung und elektronischer Datenaustausch (EDI) sind zwei der am häufigsten anwendeten elektronischen Werkzeuge für die Verfolgung von Lebens- und Futtermitteln. Diese Arbeit zeigt die Eigenschaften der gedruckten Kennzeichnungen, RFID und elektronische Datensaustauschprotokollen, die Potential für die Verfolgung von Lebens- und Futtermitteln haben. Zweidimensionale, gedruckte Kennzeichnungen bieten eine billige Alternative zu RFID. Sie sind solange eine Alternativen bis zu dem Zeitpunkt, an dem die existierenden Schwierigkeiten mit der Anwendung von RFID auf Lebensmitteln entstehend gelöst worden sind. Erste Ergebnisse eines Experiments, das die Bewertung der Anwendung von UHF RFID zum Ziel hatte, gezielten, dass für eine Wahrscheinlichkeit der Erkennung von 0,67 drei Antennen gebraucht werden sowie eine effektiv ausgestrahlte Energie von mindestens 700 mW bei einer Entfernungen von höchstens 0.2 m. Linear polarisierte Antennen sind dabei besser als kreisförmig polarisierte, besonders bei größeren Entfernungen. Das Vorkommen von Knochen in den Fleischproben wirkt sich positiv auf die Lesbarkeit aus, dennoch sind weitere Experimente notwendig, um dieses Phänomen zu überprüfen. Der Mangel an einem einheitlichen Standard im elektronischen Datenaustausch (EDI) lässt die Wahl zwischen zwei Klassen von Alternativen; entweder internetbasiertes oder traditionelles EDI. Kosten-Überlegungen machen das erstgenannte ist eine attraktive Wahl und es gibt weitere Entwicklungen in diesem Gebiet, vielleicht sogar mit dem neuen Protokoll, ebXML.

Codewörter: Lebensmittel, Futter, Verfolgbarkeit, Barcodes, RFID, EDI.

Gashaw Ayalew
Biosystems Engineering
University College Dublin
Earlsfort Terrace, Dublin 2, Ireland
Phone: +353 1 7165597
Fax: + 353 1 4752119
e-mail: gashaw.ayalew@ucd.ie

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 3
No 1

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

SERVICE LEVEL MODELING IN THE SUPPLY CHAIN WITH THE USAGE OF SOLUTIONS BASED ON DECOUPLING POINT CONCEPT

Ireneusz Fechner

Higher School of Logistics, Poznan, Poland

ABSTRACT. The customers' demand often requires to be satisfied within time, which is shorter than the real time necessary for manufacturing and delivering a product to a consignee. In a traditional supply chain the uncertainty of a forecast based on inflowing orders is repeatedly a reason for its delayed response to the market needs, and gathering excessive stock in comparison with real requirements is a counteracting method. However, there is a possibility of implementing a faster and more efficient supply chain reaction to consumers' behaviours. It is especially important when dealing with frequently purchased consumer products. Due to the popularization of automatic identification and EDI systems, it is possible for the final supply chain links to make the data on sales and stock available to manufacturers and suppliers co-operating with them as a result of which the supply chain may undertake activities steered with demand. The effect of such activities is a better accuracy of forecasts and the possibility to eliminate stocks excessive in comparison with real demand.

Key words: supply chain, supply chain management, logistic reaction time, order processing cycle, decoupling point.

The superior aim of the supply chain is a permanent competitive advantage, which is confirmed by customers who favour a product or a service. The competitiveness of the supply chain can be observed in a wide array of its functioning aspects and there is no one decisive factor. Even the constant product availability is not such a factor as it may be unsatisfactory for a customer due to the price. The competitive advantage of the supply chain is composed of a set of jointly occurring factors. Among the most important one may enumerate:

- shorter response time,
- lower costs,
- higher value,
- efficient quality protection,
- increased elasticity and flexibility to changes.

The above-mentioned factors are often defined as partial supply chain management aims. When fulfilling those aims it is vital to perfect internal processes within specific chain links, to improve operations at their meeting point, to shorten the supply chain size and to speed up the product flow via all its chain links.

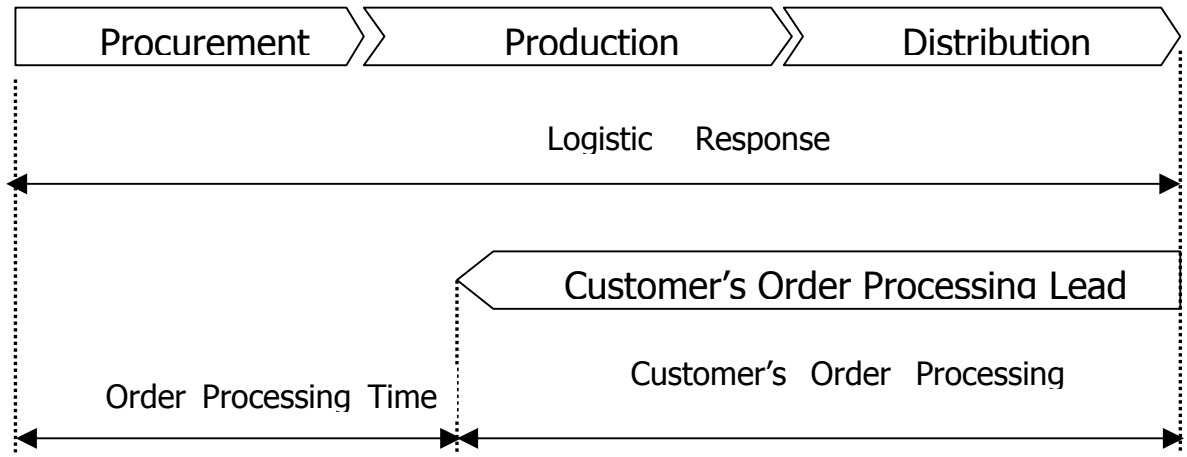
Citation: Fechner I., 2006, Service level modeling in the supply chain with the usage of solutions based on decoupling point concept. LogForum 2, 3, 1
URL: http://www.logforum.net/vol2/issue3/no1
Accepted: 20.11.2006, on-line: 15.12.2006.

One of the key problems in supply chain management is liquidating the discrepancy between the supplier's lead time length and the time the customer is willing to wait for order processing.

The supplier's lead time length is called **logistic reaction time** and is understood as the time within the supply chain between its radical sizes necessary to manufacture the product starting with ordering raw materials and delivering a finished product to the final consignee.

Customer's order processing lead-time is a time the customer is willing to wait from the moment of order placement till the reception of ordered goods.

Those two concepts are a reason for tensions within the supply chain as in the case of many products the customer does not accept the order processing lead time which equals to the time necessary for the full manufacturing lead time and demands instant availability or the availability within the time which is shorter than the logistic reaction time. In such a case the time lag appears (fig. 1) which must be liquidated one way or another or which requires undertaking such actions as a result of which the customer accepts the terms and conditions offered by the supplier.



Source: Christopher M., PCDL 2000.

Fig. 1. Order processing time lag
Rys. 1. Schemat okresu realizacji zamówienia

Time lag liquidation (closure) is a supply chain challenge. The nature of the product is a decisive factor affecting time lag's size. The next factor affecting the time lag is the possibility of satisfying the demand with the available stock. The time lag does not occur when products are manufactured to order. Those are usually single products of high value e.g. buildings and structures, ships, planes, cars with the most luxurious standard of furnishings which are decided upon by the customer, etc. However, the time lag does not equal with the dependent demand. In strong competition environment also the manufacturer of unique complex goods is often made to maintain stock of some materials, structural components and subassemblies to make the customer's order processing lead time shorter.

Aiming at gaining competitive advantage in supply chain one should liquidate or shorten the time lag. It may be done in several ways:

- by maintaining factory and finished product stocks,
- by shortening the time of sub-processes constituting the order processing lead time,
- by prolonging order processing lead time in a conventional way by better demand recognition.

Maintenance of factory and finished product stocks is a traditional and not very efficient but at the same time the most popular way of time lag liquidation. Stock administering increases the probability of satisfying demand. But in the case of independent demand the risk connected with the forecast error is significant and if demand is not satisfied the customer may be lost or high stock

maintenance costs may affect the enterprise's financial condition leading to its elimination from the supply chain or, what is even worse, to the elimination of the whole supply chain from the market. Adopting such a strategy in order to liquidate the time lag indicates a low level of supply chain integration or high unpredictability of demand with the accompanying desire to satisfy it maximally.

Shortening the time of sub-processes constituting the order processing course is a more effective approach, which is based on two types of actions:

- improving their internal processes which affect in a vital way the speed of manufacturing and delivering e.g. by modernization of production lines, implementing new manufacturing technologies, applying more efficient technical and organizational solutions, etc. by enterprises creating a supply chain,
- rationalizing the co-operation chain links' meeting point by implementing the solutions concerning automatic identification and EDI with the usage of global standards (GS1 System), applying returnable transport packages, simplifying ordering procedures, delivery acceptance, complaint examination, etc.

The extreme way of enhancing the efficiency of sub-processes is the elimination of enterprises which do not meet the criteria and replacing them with their partners who have at their disposal a better co-operation potential indispensable for the fulfillment of aims necessary for the supply chain functioning.

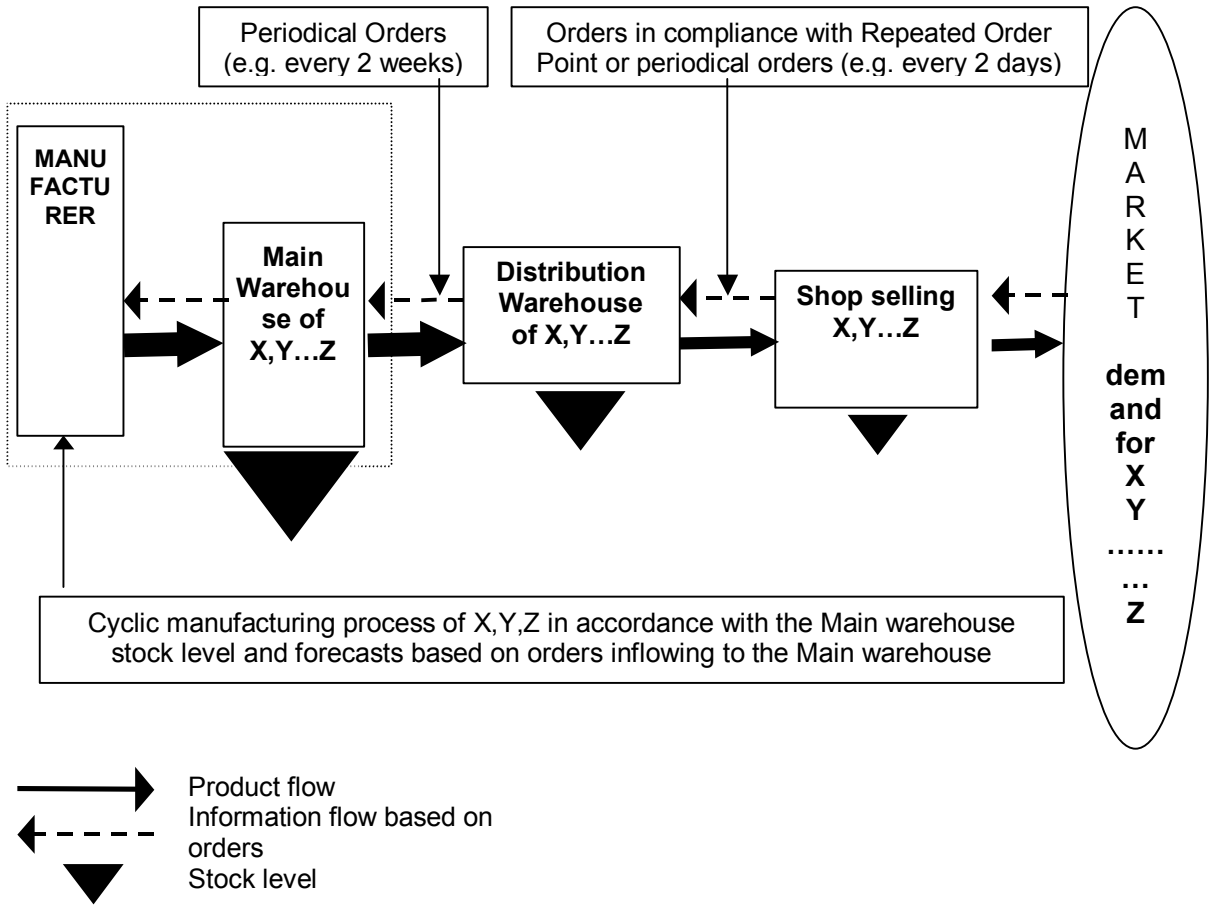
Prolonging the order processing lead time seems to be contradictive to the above-quoted statement that the majority of customers do not seem to be inclined to wait long for order processing. Thus, this activity seems unreal. In fact, many enterprises effectively use that possibility by forcing both their trade partners and final individual recipients to make concessions. Those concessions are achieved by offering other benefits in exchange for the order processing time prolongation. Among the benefits offered to enterprises there are: lower price, longer payment deadline, complying with additional requirements e.g. deliveries in quantities, at time, at hour, in packaging specified by the customer as well as after-sale service and returns' procedures expected by him, etc. Individual customers are convinced in a similar way, but in that case the negotiations and marketing activities are limited to goods of high unit value for example selected car models, and the sets of incentives are more limited and usually encompass the price or additional equipment and furnishing for instance the longer order processing time in exchange for a set of winter tyres, a better radio receiver, etc. The above mentioned activities take place at the meeting point of co-operating chain links and do not take into account the requirements of the whole supply chain and they do not lead to the increase of its integration degree.

The second much more important method of order processing lead time prolongation is the integration of the information flow within the supply chain and steering its reaction for the benefit of customers in accordance with a well-recognized current demand. The source of information necessary for that purpose is data on sales acquired directly from the cash-point systems. In a traditional supply chain the only credible information source on the market needs and behaviours are the orders periodically gathered in specific chain links which means that they are gathered with some delay in comparison with demand which caused sending the information to the supplier (fig. 2). In subsequent chain links orders are additionally distorted as a result of the security increase of stock calculated on the basis of forecasts based on the orders incoming in a similar way from the preceding chain links.

In a supply chain of a higher integration degree, orders are still a basis for trade co-operation but they are not the only source of data out of which the market-distant chain links gather information concerning demand and the phenomena connected with them. A very important information source is the information on customers' behaviours, which for example in the form of a daily sales reports is sent to the remaining chain links (fig. 3). Thanks to them they may verify the sales forecasts prepared by them on the basis of received orders and adjust both the forecasts and production plans, sales plans and orders to suppliers. Having at one's disposal a more detailed permanently updated forecast enables making decisions concerning production process starting or stock movement before the real order is placed. Therefore, by remaining ahead of the order, which in all likelihood would soon be placed, one

may effectively (but also only conventionally) prolong the customer's order processing lead time at the same time by closing the time lag.

The supply chain integration degree is a pertinent factor determining whether the higher co-operation level is limited only to making the information on sales results available or whether the co-operating enterprises inform one another on the volume of maintained stock and stock localization which enables them concentrate on the activities aiming at a faster product flow to customers and at the same time the faster stock rotation. Information integration within the supply chain is thus a source of stock level reduction and at the same time a method of satisfying demand in a more efficient way. It must be stressed, however, that the information integration must be accompanied by the sufficient efficiency of the supply chain in the sphere of manufacturing and delivering.

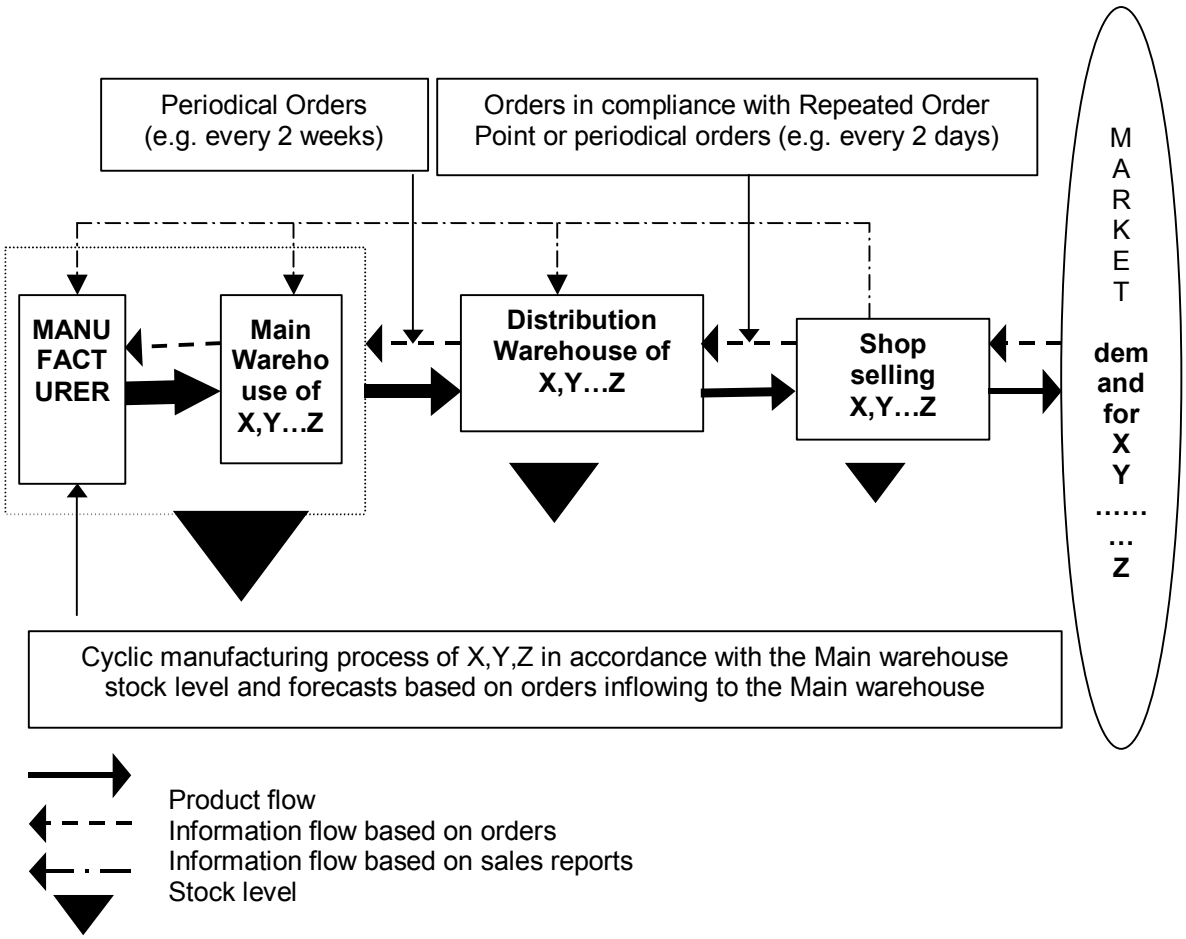


Source: Fechner I., Krzyżaniak S., 2006.

Fig. 2. Supply Chain with Traditional Information Orientation
Rys. 2. Łańcuch zaopatrzenia przy tradycyjnym przepływie informacji

The diagram presented in figure 3 does not reveal the full information integration opportunities of the supply chain. There are more advanced solutions in existence, which are going to be discussed in the next part of the paper. The basic problem which must be faced when integrating the supply chain is not the lack of technical means (which are sufficient to make it possible for the supply chain not to use orders as the only source of information on the market needs) but the complex co-operation nature which makes it difficult for enterprises to open themselves to the requirements of their trade partners without the fear of endangering their vital interests.

The final effect of activities aiming at closing the time lag is shortening the logistic reaction time and/or prolongation of customers' order processing lead time. But its complete liquidation in the majority of cases is impossible (fig. 4). Having exhausted all action opportunities the decision must be made whether the remaining time discrepancy should be covered by stock which leads to the cost increase not necessarily generating the sales increase at the same time, or whether it should be included in the risk of not satisfying the demand as a result of accepting a specified service level lower than 100 per cent.



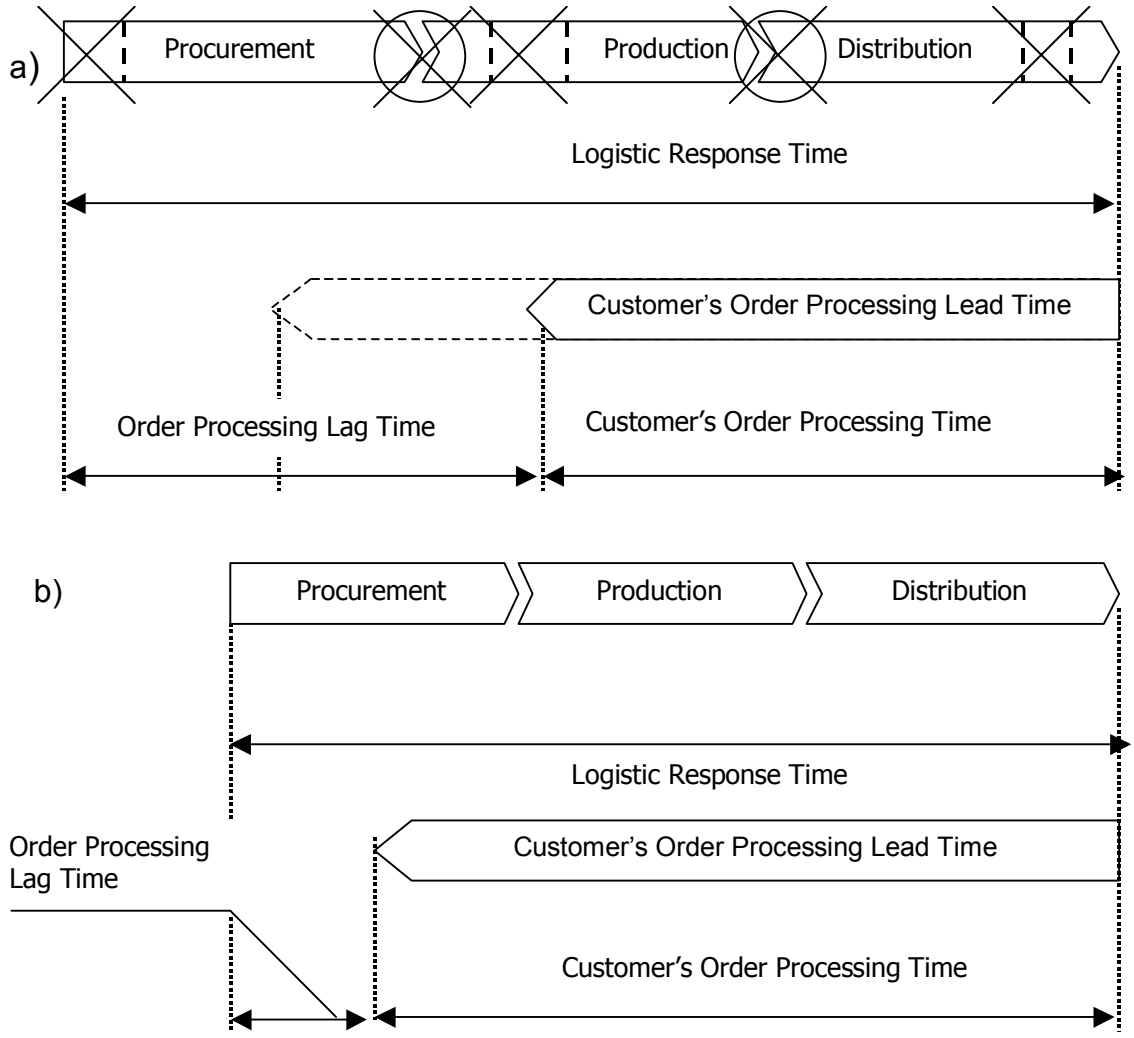
Source: Fechner I., Krzyżaniak S., 2006.

Fig. 3. Supply Chain with Information Integration Elements
Rys. 3. Łańcuch zaopatrzenia przy zintegrowanym systemie przepływu informacji

When analyzing the time lag it is important to identify the place in which the customer's order processing lead time starts. This place is the location of the decoupling point.

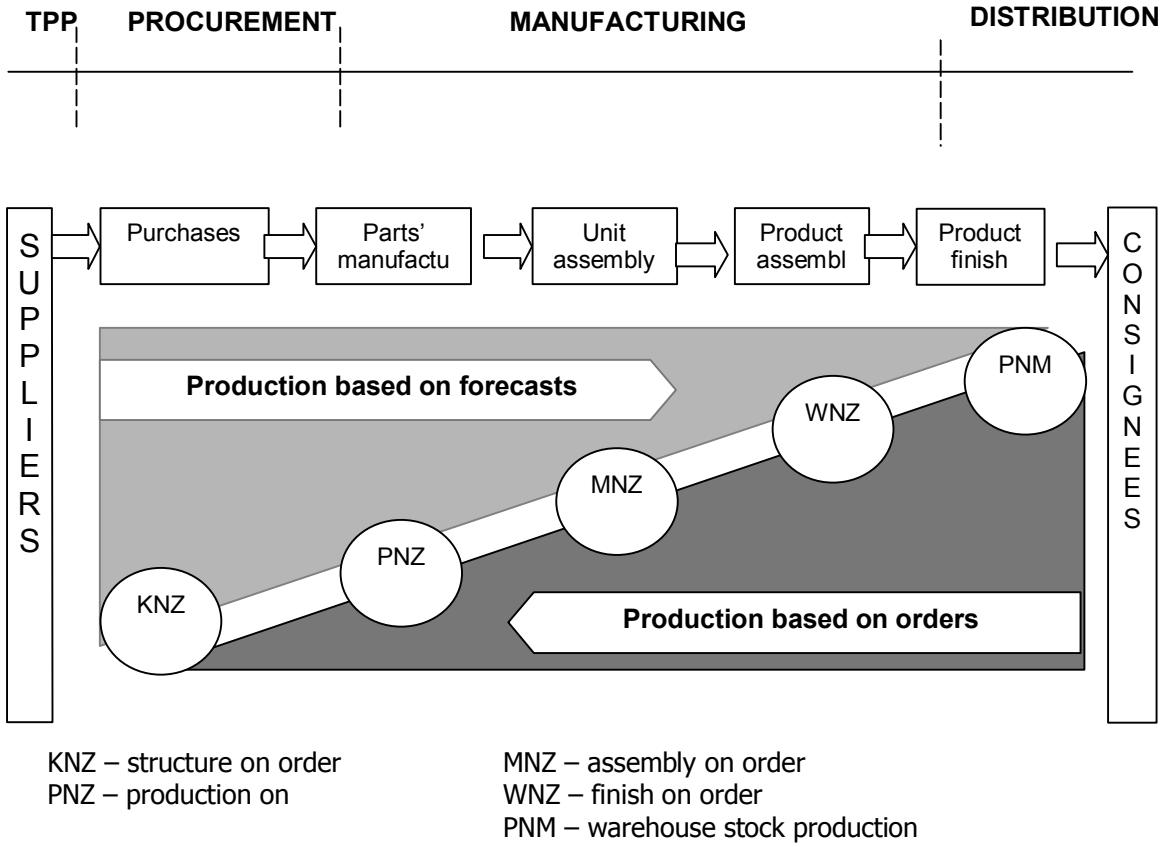
According to the definition [Dictionary of Logistic Terminology, 2006] a decoupling point is a place in a product manufacturing process in which there is a borderline between the activities organized in accordance with the customer's order and activities undertaken on the basis of the forecast requirements. The decoupling point localization is the same as the place in the stream of goods within which the stock is created in order to process the order. It may be assumed as a definition extension that the decoupling point is a place in which independent demand is converted into dependent demand, which means that the customer's order finds coverage in the production plan or available stock. Five typical positions of the decoupling point are differentiated in logistics (fig. 5).

The decoupling point position is pertinent to the time lag problem and possibilities of decreasing its impact on the costs of supply chain functioning and ensuring the required service level. The higher the decoupling point is in the supply chain, the easier it is to satisfy the demand quantitatively (the customer does not immediately require the finished product, and thus, he accepts the need to wait for the order processing) and according to the value (the uncertainty of proper demand satisfaction is lower, thus the gathered stock of finished goods and highly-processed parts/units may also be lower). The higher the decoupling point in the supply chain, the shorter the time lag between the order processing lead time and the logistic reaction time (fig.6). The location of the decoupling point affects the size of the time lag but it cannot be perceived as a simple and therefore fully efficient tool enabling its liquidation as the location of that point in the supply chain may be negotiated by the supplier and consignee within a very limited scope. It happens so due to the fact that it depends above all on the product nature, competitive environment and the supplier's competitive position. It means that the manufacturer of technologically complex and expensive goods will not maintain them in stock without having orders and the manufacturer of consumer goods for daily usage will not be able to negotiate long order processing lead time amounting to the full manufacturing lead time due to the existence of a wide array of alternative products on market on offer from competitors. Negotiations are possible but the uncertainty of their success makes the enterprise gather stock or risk the loss of a customer.



Source: Author's analysis.

Fig. 4. Time Lag Closure in the Supply Chain a) before adopting activities, b) after the end of activities
Rys. 4. Skrócenie luki czasowej realizacji zamówień w łańcuchu zaopatrzenia a) przed wprowadzeniem zmian, b) po wprowadzeniu zmian

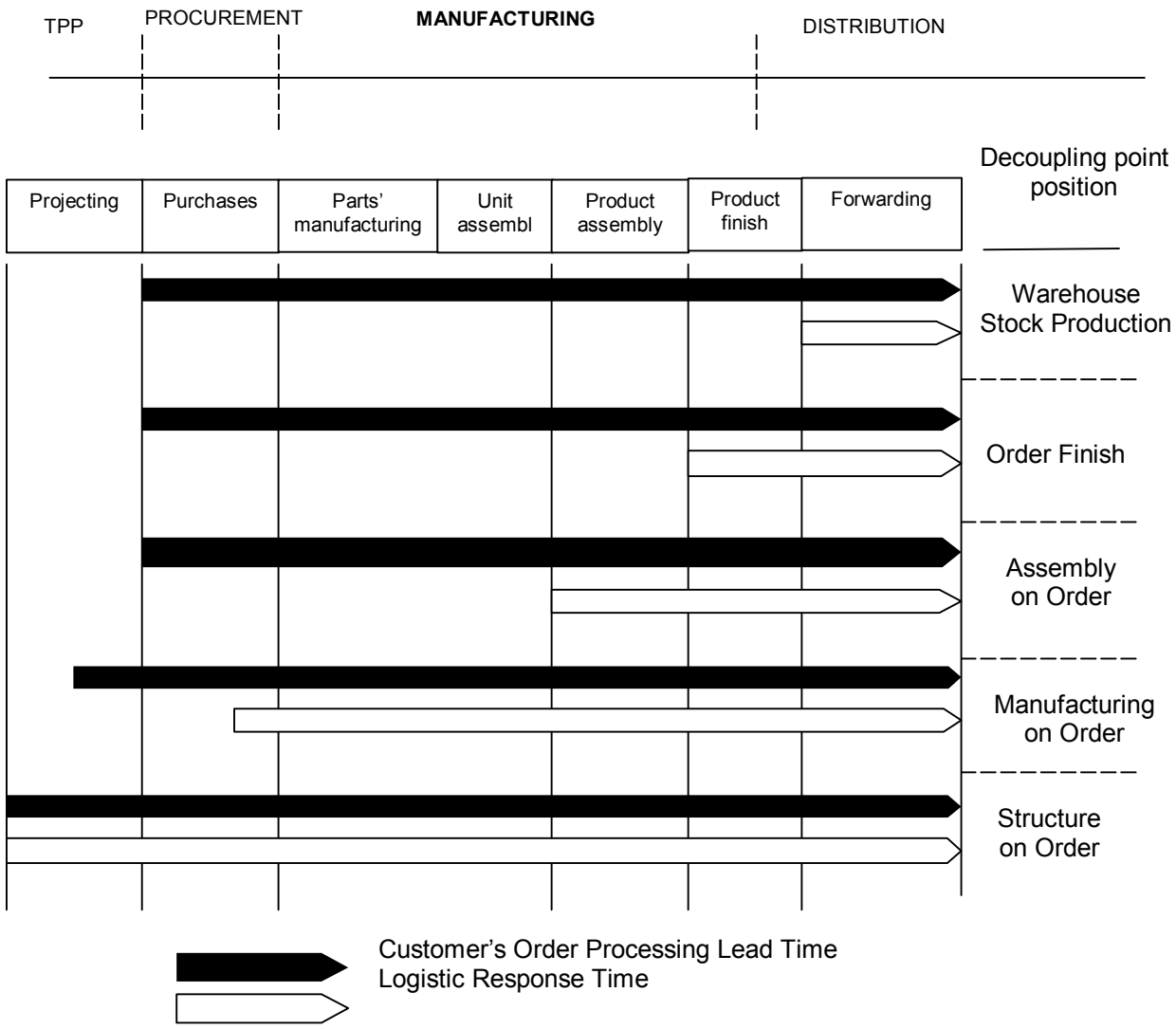


Source: Zbroja T., 1998.

Fig. 5. Five Typical Positions of the Decoupling Point in the Supply Chain
Rys. 5. Pięć typowych punktów rozdziału w łańcuchu zaopatrzenia

There is, however, the possibility of a conventional shift of a decoupling point up the supply chain by better demand recognition and undertaking activities preceding the placement of an order by a customer as mentioned before. The manufacturer may recognize the demand more successfully than in the past. Coding products and recording sales by automatic identification techniques give an opportunity to trace the current demand and to observe the stock consumption; and electronic communication enables passing that information to trade partners (with the reservation that it depends not only on technical possibilities but also on the scope of co-operation and degree of supply chain integration). Thus, the manufacturer has at his disposal better planning data than before, and orders are not the only credible source of information concerning the demand. Moreover, the higher the orders are created in the supply chain, the more they distort the demand whereas the EPOS (Electronic Point of Sale which is understood as a check-out equipped with a scanner and data archiving possibilities) data made available to trade partners are up-to-date at the moment they are delivered, and the possibility of updating forecasts prepared on their basis depends only on the frequency of their delivering from the demand recording chain links.

The increasing availability of information has influenced the development of information systems in enterprises and supply chains. The information flow more and more often separates itself from the flow of materials and goods and it often precedes it. A traditional delivery model may serve as an example here because during such a delivery documents accompany the packed products and they are delivered usually by a driver. Right now, the information included in delivery documents and sent to the consignee electronically precedes the physical delivery giving the consignee time to prepare for its acceptance. The increase of information availability creates also new opportunities for its usage. It is possible to artificially (conventionally) divide the decoupling point into two elements (fig. 7): a material decoupling point (connected with the material aspect of order processing) and an information decoupling point (concerning the information on the order, forecast and demand).



Source: Author's analysis on the basis of Zbroja T., 1998.

Fig. 6. The Discrepancy between the Length of the Order Processing Lead Time and the Product Manufacturing Lead Time

Rys. 6. Rozrzut pomiędzy długość procesu realizacji zamówienia a długością cyklu produkcyjnego

A Material Decoupling Point is defined as:

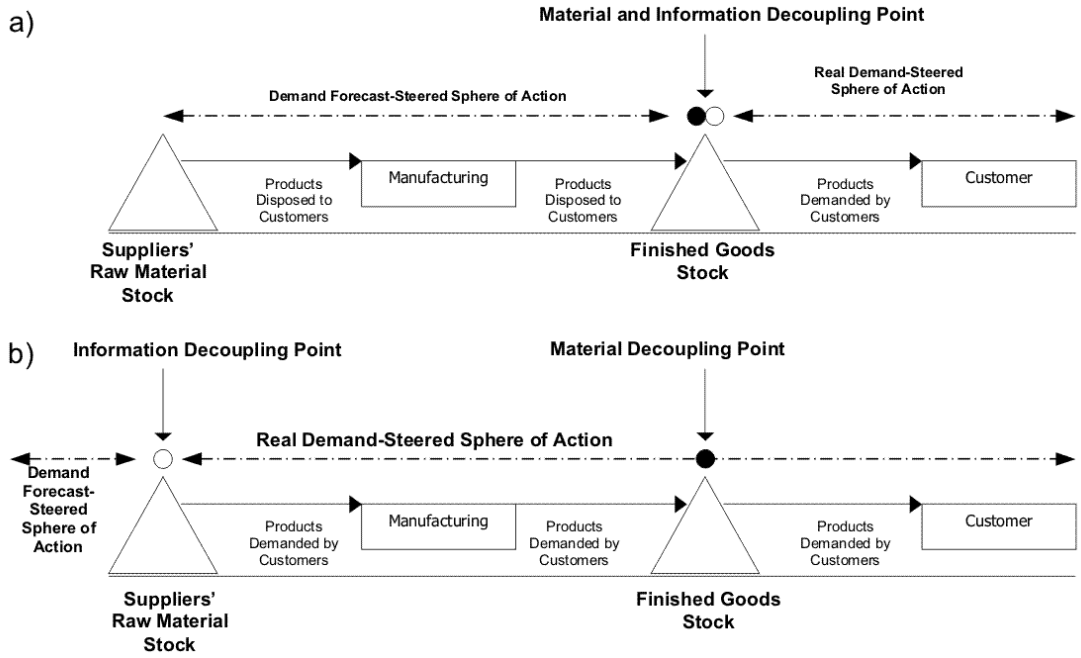
- order penetration point,
- the meeting point of the order and plan,
- the point where the steering rule of product stream changes into the supply chain.

An Information Decoupling Point is defined as:

- the point reached by the real market data,
- the point from which the real market data are distorted.

Distinguishing two elements of the decoupling point allows to understand the idea of a conventional customer's order processing lead time prolongation. The material decoupling point is still a place in which the customer's order is confronted with the product availability. The material

decoupling point, however, goes up the supply chain as far as the real data concerning sales, orders and available stock are, and as far as it is possible to prepare forecasts compliant with the accepted probability of their fulfillment which enables to start the activities connected with satisfying the future demand before it finds confirmation in orders.



Source: Arntzen B.C., Shumway H.M., 2002.

Fig. 7. Graphical Interpretation of Decoupling Point Dual Nature.
Rys. 7. Graficzna interpretacja dualistycznej natury punktu rozdzielenia

CONCLUSIONS

1. The expectations of customers as far as the shortening of the order processing lead time is concerned in confrontation with the real time necessary for manufacturing and delivering ordered goods make the supply chain gather stock or undertake risk of sales loss.
2. The quality of forecasts created within the supply chain links distant from the market and pertinent as far as the availability of products and stock volume is concerned may be improved by making updated information on the demand gathered in the check-out systems of retailers available to trade partners.
3. Increasing technical opportunities within the scope of sales data recordation and EDI make the supply chain information integration possible. There are technical possibilities and conditions for gathering and making market data available and making it possible to exchange information in a sufficient way to make the supply chain respond efficiently to market requirements by undertaking activities steered by the demand. Thus, there is a possibility to provide a declared level of customer service in the conditions of acceptable costs, and the burden of responsibility is shifted to the physical delivery process dependent on the efficiency and effectiveness of the supply chain.

REFERENCES

Arntzen B.C., Shumway H.M., 2002. "Driven by Demand". A Case Study. Supply Chain Management Review, No.1.

Christopher M., 2000. Logistics and Supply Chain Management. PCDL.

Fechner I., Krzyżaniak S., 2006. Efekty integracji łańcucha dostaw - materiały szkoleniowe niepublikowane [Supply Chain Integration Effects] (non-published training materials)

Słownik terminologii logistycznej [Dictionary of Logistic Terminology], 2006. Biblioteka Logistyka, Poznań.

Zbroja T., 1998. Rola środowiska produkcyjnego przedsiębiorstwa w zarządzaniu łańcuchem dostaw [The Role of Enterprise Production Environment in Supply Chain Management], LOGiSTICS' 98.

KSZTAŁTOWANIE POZIOMU OBSŁUGI KLIENTA W OPARCIU O KONCEPCJĘ PUNKTU ROZDZIELAJĄCEGO

STRESZCZENIE. Popyt zgłaszany przez klientów wymaga niejednokrotnie jego obsłużenia w czasie krótszym od czasu, jaki rzeczywiście jest niezbędny do wyprodukowania wyrobu i jego dostarczenia do odbiorcy. W tradycyjnym łańcuchu dostaw niepewność prognozy opartej na napływających zamówieniach jest często przyczyną jego spóźnionej reakcji na potrzeby rynku, a sposobem przeciwdziałania jest gromadzenie zapasów nadmiernych w stosunku do rzeczywistych potrzeb. Istnieje możliwość szybszej i bardziej skutecznej reakcji łańcucha dostaw na zachowania konsumentów, co jest szczególnie ważne w przypadku produktów konsumenckich częstego zakupu. Dzięki upowszechnieniu systemów automatycznej identyfikacji i elektronicznej wymiany danych możliwe jest udostępnianie przez końcowe ogniwa łańcucha dostaw danych o sprzedaży i zapasach współpracujących z nimi producentom i ich dostawcom, w wyniku, czego łańcuch dostaw może podejmować działania sterowane popytem. Efektem tych działań jest większa dokładność prognozy i możliwość eliminacji zapasów nadmiernych w stosunku do rzeczywistego popytu.

Słowa kluczowe: łańcuch dostaw, zarządzanie łańcuchem dostaw, logistyczny czas reakcji, cykl realizacji zamówienia, punkt rozdzielający.

GESTALTUNG DES SERVICENIVEAU IN DER LIEFERKETTE MIT HILFE DER AUF DEM KONZEPT DES ENTKOPPLUNGSPUNKTS BASIERTEN LÖSUNGEN

ZUSAMMENFASSUNG. Die Nachfrage muß nicht selten in einer kürzeren Zeit abgedeckt werden als dies tatsächlich für die Herstellung eines Produktes und dessen Anlieferung bei dem Kunden erforderlich ist. In der herkömmlichen Lieferkette die Ursache der Unsicherheit der auf den Bestellungen basierten Prognose ist eine verspätete Reaktion auf die Marktbedürfnisse. Es besteht die Möglichkeit einer schnelleren und effektiveren Reaktion der Lieferkette auf das Kundenverhalten, was bei den FMCG Produkten besonders wichtig ist. Infolge der Verbreitung des Auto ID und des Elektronischen Datenaustauschs können Endglieder der Lieferkette den mit ihnen kooperierenden Herstellern und Lieferanten die Verkaufs- und Bestandsdaten zur Verfügung stellen. Dadurch kann die Lieferkette nachfragegesteuerte Aktivitäten vornehmen. Das Ergebnis dieser Aktivitäten ist eine bessere Genauigkeit der Prognose und die Möglichkeit des Eliminierens der Überbestände gegenüber der tatsächlichen Nachfrage.

Codewörter: Lieferkette, logistisches Reaktionszeit, Bestellungsabwicklungs-Zyklus, Entkopplungspunkt.

Dr inż. Ireneusz Fechner
Higher School of Logistics
ul. Estkowskiego 6
61-755 Poznań, Poland
e-mail: Ireneusz.Fechner@ilim.poznan.pl

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 3
No 2

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

RULES FOR MODELLING AND REDESIGNING SUPPLY CHAINS

Wacław Szymanowski

Warsaw Agricultural University, Warsaw, Poland

ABSTRACT. This paper's goal is description of modeling and designing terms for supply chains. The most efficient method is the application of the supply chain permanent improvement rule. This rule was defined 1993 by T. Davenport and based on the evolutionary approach to the redesigning/reengineering of economic processes. The application of this rule for planning purposes is facilitated by the W. Deming's PDCA (Plan-Do-Check-Act) rule adapted later by J.B. Ayers for supply chains design. The supply chain reengineering rules are executed in three stages: design concept stage, detailed design stage, execution stage. The paper's last part regards the selection of evaluation criteria for the supply chain variant chosen to be redesigned.

Key words: Supply Chain Modeling, Supply Chain Redesign.

INTRODUCTION

Logistics has added greatly to the European economy growth already. Despite being a relatively young knowledge area, logistics gains in significance together with efficient methods for supply chain modeling and redesign.

The supply chain management is understood as processes carried out for designing and maintaining the reliability and operating activity undertaken in order to satisfy the end user [Ayers, 2001].

The basic supply chain management (SCM) rules are as follows [Christopher, 2000]:

- the supply chain should be treated as an organization, entirety, and not as a group of separate subjects bearing responsibility for separate activity areas they operate within,
- the SCM requires the strategic approach to the decision making,
- the SCM requires an approach based on the integration of separate links thereof, and not only on the co-ordination thereof,
- in the SCM area, product/material stocks only play an auxiliary instrument role in the chain link integration activities, and not the basic role.

Citation: Szymanowski W., 2006, Rules for modelling and redesigning supply chains. LogForum 2, 3, 2
URL: http://www.logforum.net/vol2/issue3/no2
Accepted: 20.11.2006, on-line: 15.12.2006.

THE PERMANENT SUPPLY CHAIN IMPROVEMENT RULE AS THE BASIS FOR MODELLING SUPPLY CHAINS - APPLICATION OF THE DEMING CYCLE

The supply chains modeling is applied for designing new supply chains and redesigning old ones. The supply chain redesign can be executed as a radical restructurisation, which was proposed 1993 by M. Hammer and J. Champy in the shape of the Business Process Reengineering (BPR) method, or as an evolutionary process reconstruction based on the incremental rules as proposed 1993 by T. Davenport.

The supply chain restructurisation process is based on the permanent improvement rule resulting from the **Deming cycle: Plan - Do - Check - Act (PDCA).** The Deming cycle consists of stages as follows (Deming 1993):

Stage 1 - "Plan" - set a goal for each process. Meeting the goals will provide with compliance of processes with customer requirements and with the general enterprise policy. In the context of making the supply chain more able, this means the determination of strategy for the entire chain, such strategy including: the vision, goals, mergers and fusions, product development plans, organization improvement plans.

Stage 2 - "Do" - processes should be implemented as planned. With regard to the supply chain improvement, this stage should include the development of an operating plan consisting of strategy components, i.e. initiatives, and activity proposals. As well, separate teams should be organized for: the strategy execution - Steering Committee (SC); processes - Supply Chain Design Teams (DT); activities - Front Line Teams (FLT). The teams carry out the tasks assigned to them in the three-stage implementation process. The implementation process includes:

1. Project concept;
2. Detailed project and pilot tests;
3. Full implementation.

Work division: the Steering Committee (SC) is responsible for the 1st stage work (project concept); the Design Teams (DT) supervises the 2nd stage work, whereas the Front Line Teams (FLT) are representatives of supply chain users. The teams support the redesign of supply chains.

Stage 3 - "Check" - this stage consists of metering and monitoring significant parameters of processes and products. Then, the actual parameters are compared against the set parameters obtained from product-related strategies and goals as well as from product requirements. When the supply chain is reengineered, this means that changes are proposed, and the change implementation experiment is monitored.

Stage 4 - "Act"- is the undertaking of activities related to the permanent improvement of processes and their results. The change proposals should be evaluated in the context of supply chain redesign, and executed.

The project concept execution procedure for the supply chain improvement includes 5 stages: description of the supply chain current status, i.e. description of the chain supply major processes (As - Is); determination of strong items and weak items of the current supply chain status (As - Is); development of a new final vision of the supply chain; definition of required process statuses (To - Be); determination of gaps between the starting status and the required final status of the supply chain component processes, such determination being the basis for the formulation of the design concept and activity plan.

Within **the Stage 1**, a process map is made to be the basis for the identification of process structures. The process list includes: new product research and development; supplies, internal logistics; production planning and control; manufacture and product picking; sales; customer orders; external logistics; customer service and after-sales services support [Handfield, Nichols, 2002]. The mapping process executes numerous tasks:

- facilitates a better understanding of processes: activities, results, and structure of responsibility for individual stages,
- determines the process areas and limits,
- provides with methods for improving processes for future.

The following activities should be carried out in order to find out the current status of As-Is processes:

1. Processes defined and described in quality terms, using the relation mapping. Such work will facilitate obtaining answers to the questions: who is the process user; what is the process outcome; who are the suppliers; what is put into the process; what are the requirements for the input data and output data; what flows through the process.
2. Flow map produced to show all activities as a detailed map.

The process mapping provides with information with regard to: [Ayers, 2001,]:

- register of process activities and stages, and of people responsible for the execution thereof,
- definitions of characteristic parameters describing the processes, relating to the work time, leisure time, and costs,
- determination of process customers. Customer groups are divided in segments, with a division in external customers and internal customers,
- process results, depending on information collected from interviews and by different methods.

Stage 2 facilitates assessing weak points and strong points of the starting situation, and then making the SWOT analysis. The assessment of weak/strong points of the current chain processes facilitates a better assessment of the process usefulness. This assessment is made based on: quality meters, benchmarks, comparison of design rules, e.g. for supplies (As-Is), and facilitates determining how good the processes are and whether processes can be improved by application of: the best practice, the customer value-added evaluation, interviews-assessments obtained from customers or users, identification of narrow throats, application of quality house analysis, or SWOT assessment. The assessments allow specifying new processes and are collected by Design Teams (DT). The process specifications have attachments with assessments that allow determining the competitive edge of these processes as the starting pointy for the definition of a new vision in Stage 3.

Stage 3 consists in the development of a new vision target for the supply chain; this new vision should be dramatically different than the starting point. The Design Teams should use expert opinion while creating the new vision. The following changes should be carried out in order to create this vision:

- flow processes revised,
- organisation adapted to support these processes,
- changes made within the supply chain,
- infrastructure (equipment, assets) adjusted,
- meters developed for redesigned processes,
- costs decreased - receipts increased,
- to-do-tasks specified,
- steps proposed for Stage 5 - detailed design, pilot program implementation.

Stage 4 consists in the definition of required process statuses (To -Be). This stage is executed by numerous meetings, in three sequences: presentation of numerous required process statuses that create the new vision for the supply chain; a number of sessions for preparing variants for the new vision; and, in the end, by the final decision on the final process (To-Be) as set in the required vision.

Stage 5 - consists in the preparation of detailed design with the target vision of the improved supply chain and of the pilot implementation, in three form of a detailed documentation. The proposed

solutions undergo tests; the to-be-implemented solutions are accompanied by change proposals regarding the organization of new supply chains. Figure 1 shows the location of five groups of tasks selected to be carried out.

TASKS REGARDING THE SUPPLY CHANGE REENGINEERING

Within **Stage 1,** the Design Concept, or the task no 1, is carried out: *Designing Supply Chains for Strategic Advantage,* where segments are redefined - this is the area (domain) for the chain activity, new products development coordination and management.

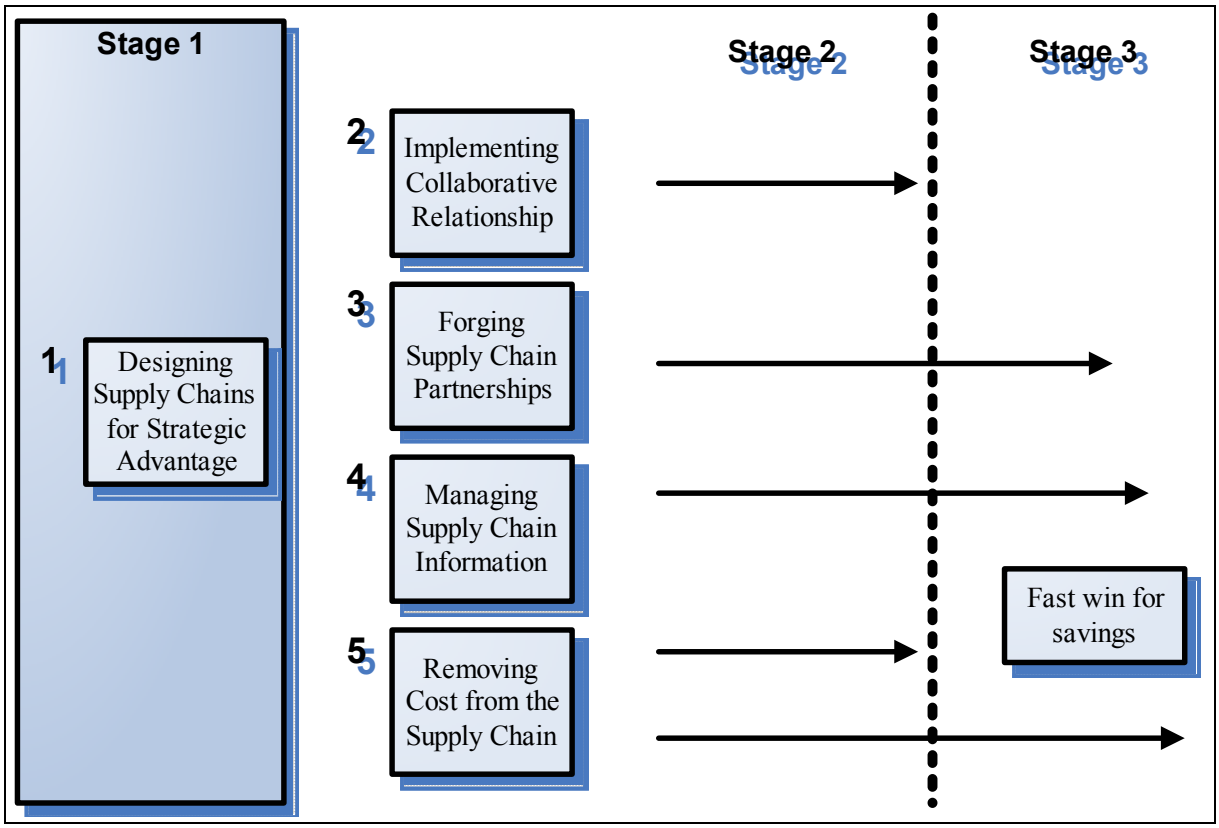
Stage 2 - *Detailed design and pilot solution tests* - ***Task number 2*** is carried out. - *Implementing Collaborative Relationship.* This task includes: organization structure changes for specified functions within the supply chain reorganization procedures; determination of activity evaluation meters, new positions for management functions in the supply chain organization.

Stage 3 consists in the execution of ***tasks 3, 4, and 5***.

Task 3 - *Forging Supply Chain Partnerships* includes: determination of competencies for chain links; forging partnership structures in the supply chain; forging motivation systems.

Task 4 - *Managing Supply Chain Information* includes: determination of system components; selection of technological innovations and software solutions; determination of barriers.

Task 5 - *Removing Cost from the Supply Chain* includes: cost removal sources; factors supporting cost removal; weak points of product design procedures; incorrect information in decision making; weaknesses of partnership rules within the supply chain (see fig. 1).



Source: J.B. Ayers: Handbook of Supply Chain Management, St. Lucie Press, 2001, p. 289.

Fig. 1. Supply chain design method
Rys. 1. Metoda projektowania łańcucha dostaw

SELECTION EVALUATION CRITERIA FOR VARIANTS OF THE REDESIGNED SUPPLY CHAIN

When working according to the permanent supply chain improvement method and while doing Task 5, the cost reduction is executed in three dimensions at the same time: cost, execution time, and quality achieved for the analyzed supply chain processes. A multi-dimensional problem is created, which only can be solved using the M. Porter value-added analysis.

Unlike the efficiency analysis executed by T. Kasprzak in "*Modele referencyjne w zarządzaniu procesami biznesu"* ("Reference models in business process management"), the metering rule and evaluation analysis for logistic processes was based on three criteria: quality of the product, logistic services, and customer service; order execution time; logistics costs [J. Twaróg, 2003].

While creating the added value for customers, the achievement of an optimum between the level of services executed for the customer and the costs thereof is the major issue. The selection of logistics system variant should facilitate minimizing the total logistics costs for the execution of logistics services' level as assumed.

The VCA (*Value Chain Analysis*) method (approved by the ECR Europe Council) is commonly used for distribution processes. This method is defined as the integrated set of tools and processes for the determination of running costs and for the evaluation of proposed improvements' impact on the entire supply chain. This method facilitates the chain actors to evaluate financial effects of their own and of their partners. The VCA method applies various solutions, including standard solutions such as: the ABC (*Activity Based Costing*) method facilitating the supply chain actors to examine the cost structure over the entire value chain for individual product groups; logistic efficiency indicators KPI (*Key Performance Indicators*) used for the benchmark-based determination of current potential in comparison to leaders; determination of non-financial targets. The non-financial targets include: promotion efficiency; supply reliability; stock rotation; order coverage; product program complexity. For the execution of strategic goals and for the supply chain efficiency evaluation, a set of logistic criteria was proposed as follows: improved production and sales planning; flow time minimization for materials and products in the network; stock reduction and optimization for all supply chain links; cost reduction to a customer-accepted level; improvement and assurance of high customer service level [J. Twaróg, 2003,].

SUMMARY

The main goal of the paper is presentation of circumstances for supply chain modeling and redesign. The most efficient approach for modeling business processes is the Business Process Orientation developed 1993 by T. Davenport. This approach was adapted for planning processes using the W. Deming PDCA method. Then, the supply chains redesign principles as defined by J.B. Ayers are presented. The redesign process is divided in three stages: design concept, detailed design, and implementation. The goal of the last part of the paper is: forging the supply chain partnerships and mapping the supply chain information, as well as removing cost from the supply chain as part of the detailed design.

REFERENCES

Ayers J.B., 2001, Handbook of Supply Chain Management, St. Lucie Press, London, New York, Washington D.C.

Christopher M., 2001, Logistyka i zarządzanie łańcuchami dostaw ("Logistics and supply chain management"), Polskie Centrum Doradztwa Logistycznego, wyd. II.

Deming W.E., 1993, The New Economics for Industry, Government Education, MIT Center for Advanced Engineering Studies, Cambridge MA.

Handfield R., B., 2002, Nichols Jr. E., L., Supply Chain Redesign, Transforming Supply Chains into Integrated Value Systems, Prentice Hall.

Kasprzak T. (editor), 2005, Modele referencyjne w zarządzaniu procesami informacyjnymi ("Reference models in the information process management"), Difin, Warszawa.

Szymanowski W., 2006, Modelowanie projektowania łańcuchów dostaw ("Modelling the supply chain design), Ekonomika i Organizacja Przedsiębiorstwa, nr.1.

Twaróg J., 2003, Mierniki i wskaźniki logistyczne ("Logistics meters and indicators"), Biblioteka Logistyka, Poznań.

ZASADY MODELOWANIA I PRZEBUDOWY ŁAŃCUCHA DOSTAW

STRESZCZENIE. Podstawowym celem powyższego artykułu jest prezentacja uwarunkowań modelowania i przebudowy łańcucha dostaw. Najbardziej efektywnym podejściem do modelowania procesów biznesowych jest podejście BPO (Business Process Orientation) sformułowane w 1993 roku przez T. Davenporta. To podejście zostało adoptowane dla procesów planowania z wykorzystaniem metody PDCA stworzonej przez W. Deminga. Następnie zaprezentowane zostały zasady przebudowy łańcucha dostaw sformułowane przez J.B. Ayersa. Proces przebudowy podzielony został na trzy fazy: projektowanie koncepcji, projektu szczegółowego oraz wdrożenia. Celem ostatniej części artykułu było określenie zasad partnerstwa oraz diagnozowania systemu informacyjnego, a także redukcji kosztów związanej ze szczegółowym projektem określonego łańcucha dostaw.

Słowa kluczowe: modelowanie łańcucha dostaw, przebudowa łańcucha dostaw.

GRUNDÄTZE DER MODELLIERUNG UND DES REDESIGN DER LIEFERKETTE

ZUSAMMENFASSUNG. Das Hauptziel dieses Beitrags ist die Darstellung der Prämissen für die Modellierung und das Redesign der Lieferkette. Der effektivste Ansatz für die Modellierung der Geschäftsprozesse ist das 1993 von T. Davenport formuillierte BPO (Business Process Orientation). Dieser Ansatz wurde adoptiert für die Planungsprozesse unter Anwendung der von W. Deming entwickelten PDCA Methode. Im weiteren wurden Grundregeln für das Redesign der Lieferkette, die J.B. Ayers entwickelt hat. Das Redesign-Prozess wurde in drei Phasen aufgegliedert: Entwicklung des Konzepts, Erarbeitung des detaillierten Projektes und Implementierung. Das Ziel des letzten Teils des Beitrags ist die Aufstellung der Grundregeln für eine Partnerschaft und die Ermittlung des Informationssystems und der Kostensenkung, die mit dem detaillierten Projekt der jeweilgen Lieferkette verbunden sind.

Codewörter: Modellierung der Lieferktette, Umgestaltung der Lieferkette.

Dr hab. Wacław Szymanowski, prof. nadzw. SGGW
Warsaw Agricultural University
Faculty of Wood Technology
Nowoursynowska 166
02-787 Warsaw, Poland
e-mail: wszymanowski@acn.waw.pl

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 3
No 3

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

KNOWLEDGE MANAGEMENT AND LOGISTICS: WHERE WE ARE AND WHERE WE MIGHT GO TO

Gaby Neumann[1], Eduardo Tomé[2]

1) Otto-von-Guericke-University of Magdeburg, Germany, 2) Instituto Piaget, Viseu, Portugal

ABSTRACT. By the commonly accepted theory, today's logistics processes and systems are characterized by an increasing complexity and by the need for global networking to cope with the growing diversity of logistics problems; because of this, knowledge is becoming more and more a strategic resource in logistics.
But some questions remain unanswered: How far has implementation of knowledge management methods gone in the logistics practice? To what degree does the supposed (theoretical) relevance of investments into knowledge and knowledge management match the actual priority of several knowledge management activities as shown by the respective investment volume? How do knowledge-related investments change a company's logistics performance?
In order to answer those questions, a survey was run with German and Portuguese logistics companies on the relevance of knowledge and knowledge management for executing logistics processes, on the need of investment into knowledge and knowledge management activities in logistics, and on the eventually existent relationship between knowledge and logistics performance. To analyze the impact of knowledge management on a company's logistics performance a model has been developed which contributes to an economic assessment of knowledge management and the analysis of its potentials.
As a result, a qualitative determination of the state-of-the-art in implementing and applying knowledge management in the logistics practice was produced. Specifically, severe differences between the German and Portuguese reality turned out, although it has been quite challenging to derive statistical benchmarks for an optimal use of knowledge in logistics from the small amount of responses received.
The paper will present conclusions drawn from the use of the methodology and a list of recommended actions derived from this respectively.

Key words: knowledge management, investments into knowledge, knowledge management activities.

KNOWLEDGE MANAGEMENT: AN INTRODUCTION

In the last decade, as a logical consequence of the changing organizational structures and of the changing relations within and between companies, the new roles for managers and employees, and the new international division of labour, knowledge has been seen as a new strategic resource. This development finds its expression in the numerous projects and research activities on how to deal with the knowledge resource and how to gain, retain and distribute it, as well as on requirements, potentials and concepts for running a company in a knowledge-oriented way - all of this summarized by use of the term knowledge management. Therefore, knowledge management describes the conscious, systematic and strategically anchored handling of knowledge considering people, organization and technology in order to encourage individual, social and organizational learning processes in the end leading to a learning and knowledge-based organization (Reinmann-Rothmeier et al. 2001).

Citation: Neumann G., Tomé E., 2006,. Knowledge management and logistics: where we are and where we might go to. LogForum 2, 3, 3
URL: http://www.logforum.net/vol2/issue3/no3
Accepted: 20.11.2006, on-line: 15.12.2006.

Initially, companies had high expectations on all activities aiming to manage knowledge:

- Efforts to be spent on finding certain knowledge should decrease.
- The re-use of existent knowledge was expected to increase.
- More time should be available for creating ideas and innovation.
- Internal and external communication should improve.

New employees should more easily and in shorter times be integrated into the company environment and tasks.

This led to significant investments, mainly targeted towards the introduction of technical solutions like e.g. knowledge banks. But in practice, the intended economic success was not achieved within short terms and many of those projects or initiatives for knowledge management implementation into a specific company setting have significantly been reduced or even completely cancelled. Here, the fact that knowledge management requires a holistic approach including all three of its dimensions (i.e. people, technology and organization) and eventually initiates change processes usually showing effects in medium to long terms has erroneously been ignored. Therefore (and as it is typical for practically implementing technical innovations and concepts), a phase of excessive expectations from knowledge management was followed by a phase of strong disillusionment on its power. Further introduction of knowledge management methods and approaches into company practice as well as further identification of new application areas were slowed down or even prevented.

LOGISTICS: APPLICATION AREA FOR KNOWLEDGE MANAGEMENT CONCEPTS

The same hesitant implementation of knowledge management in a company's practice as described above can also be found in the logistics business area. Here, knowledge has been widely recognized and accepted as strategic resource, too:

- Whether or not a supply chain operates successfully does not only depend on the intensity and quality of material and information flows in a supplier-customer relation. As generally recognized, the success of a supply chain is also heavily affected by the kind and quality of the collaboration between human resources involved on both sides of the partnership. This collaboration is based on knowledge, understanding and trust.
- The number and variety of methods and software tools available to support logistics planning is permanently increasing. Unfortunately, those tools quite often dominate the planning person and prevent him/her from creative problem solving instead of purposefully giving personalized support (Neumann 2003).
- Team building to master complex problems in logistics planning and operation can only be successful if the team consists of the right mix of knowledge, experience and competence stakeholders, that is adequate to the problem to be solved. Within those well-balanced teams, a range of individual strengths is combined to overcome a range of individual weaknesses in order to better perform jointly at a higher level (Neumann 2001).
- Logistics is a quite young and very dynamic field of knowledge and science. Resulting from this, contents, methods, tools as well as way and time frame of modern logistics education and training oriented towards future needs and requirements are significantly being changed (Neumann et al. 2001).

Consequently, knowledge management is expected to provide a tremendous contribution to the improvement of logistics planning and performance. To learn from previous experience, to know about valuable experts, their location and expertise for getting them involved in running projects or new tasks, to better understand pre-conditions, settings and decisions from the past and with relevance to today's activities, to easily identify and get access to the right knowledge exactly when it is needed -

these are some important sources for increasing a person's, a team's or an organization's logistics competence and performance and to let them become more knowledgeable consumers, well acquainted supervisors or enthusiastic developers of logistics services, systems and processes.

The biggest challenge for properly handling logistics knowledge by applying knowledge management methods and tools to the planning of logistics systems and processes and to the operation of logistics services consists in providing the right knowledge of the right quality and with the right costs at the right place and time. In other words, it is essential not to focus on the introduction of knowledge management technology and integration of software tools for storing and retrieving knowledge and information into a company's setting only (Gudehus 2003), but to put the human resources driving the company's performance back into the center of gravity and to try to give them that kind and amount of support which is needed in a particular situation.

In fact, the quality of the logistics services and the success of the logistics activities strongly depend on the knowledge, skills and abilities (i.e. the competence) of the people that design or operate the logistics systems and processes. Therefore, knowledge management can be expected to be an essential method, tool, and principle for improving the people's performance in logistics, and consequently, for improving the outcome, i.e. the quality of logistics systems, processes and services. Preconditions of the knowledge management success are sophisticated knowledge management systems tailor-made to the specific needs of a particular company, supply chain collaboration or even network of companies, and also a knowledge-friendly environment in this frame.

Despite of this common understanding, knowledge management has not yet been implemented in logistics companies or logistics departments of big companies in large scale. Although (Baumgarten and Thoms 2002) were able to identify logistics knowledge management champions (with special focus on those companies involved in supply chain networks), they also had to recognize severe challenges in implementing knowledge management and running it in the daily logistics business. Major problems were seen in financial limitations, time restrictions, insufficient structuring and presentation of knowledge, as well as methodical misconceptions. Other problems are related to indicators and impact measurement: indicators characterize the suitability and appropriateness of knowledge management tools and systems like the amount of knowledge units stored or access rates and response times. The latter aspect is represented by categories such as trust or intelligibility and so, it is very difficult to be measured. Probably, this missing economic measurement is another reason for acceptance problems and the slack implementation of knowledge management into logistics services planning, operation and management.

KNOWLEDGE MANAGEMENT AND LOGISTICS: SETUP OF AN EMPIRICAL IMPACT STUDY

Aims and setting

Taking into consideration the current situation of the introduction of knowledge management into the logistics field of business, a study was run to compare the high expectations on what knowledge management could do with today's reality. In particular it aimed:

- To gain a clear picture on what is knowledge management practice in a certain business sector,
- To develop a domain-specific approach for measuring the impact of knowledge management on a company's performance,
- To understand the impact of knowledge management on the logistics performance taking cultural specifics and organizational diversity into consideration and
- To identify existing potential for improving a company's performance by means of knowledge management.

Specifically, we expected to obtain descriptions of knowledge investments, needs for investments in knowledge and impacts related to knowledge in the logistics sector. For this, we designed a sectorial impact study rather than a case study (Neumann and Tomé 2005). With this, we differ from other studies that already have been run in the field. Those studies did not focus on understanding the impact of knowledge management on a company's performance as well as related needs and investments, but aimed, for example, to identify the relevance of certain knowledge management methods in today's supply chains (Strubelt and Neumann 2006), the state-of-the-art in knowledge management implementation and in using knowledge management tools in companies and organizations (Fraunhofer 2005), or the success factors of computer-mediated knowledge systems in an international technical consulting firm (Reihlen and Ringberg 2006).

The study has purposefully been designed as a three-stage process. After having gained first results and general feedback from a limited sample of logistics companies in Germany by use of a prototype questionnaire (stage 1 - Neumann and Tomé 2005), an improved questionnaire was sent by mail or e-mail to 389 companies in Germany and 62 companies in Portugal attaching themselves to the logistics sector (stage 2). Those companies were either logistics service providers of various kinds or, for example, big companies such as car manufacturers with a specific logistics department. In order to ensure a useful number of responses, they have been approached in different ways and even pre-contacted by phone before sending off the questionnaire (Figure 1). In order to eventually detect cultural influences, the study was less focused on global players, and more centered on German and Portuguese companies with a strong orientation towards regional and national markets; in addition, the questionnaire was provided in the respective local languages. In future, stage 3 of the project will aim to extend the investigation to further countries across Europe.

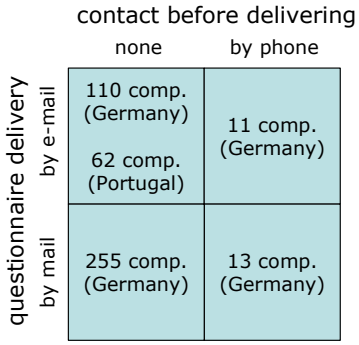


Fig. 1. Methods of approaching companies
Rys. 1. Metody pozyskiwania danych z przedsiębiorstw

Questionnaire

To originate the intended insights, the questionnaire comprised five groups of questions addressed to different responsible managers in a company:

- The first group aimed at specifying the main company characteristics. Furthermore, in order to account for the dynamic of the firm, we asked if the company had recently incurred in some substantial change. These questions were to be answered by the top manager of the unit to which the data were related.

- The second group should give a clue on the logistics manager's opinion about the role of knowledge in the company. Questions specifically dealt with the importance and dynamics of knowledge, the role of knowledge management with regard to the logistics processes or services, and whether or not Intellectual Capital (IC) Reports are produced.

- The third group asked the human resources (HR) manager to qualitatively assess specific investments into knowledge made in 2004 fully relying on the good faith of the respondents. We

used a detailed grid of 16 items describing different ways of investing into knowledge, but deliberately not considering investments into knowledge management systems and Information Technology (IT) infrastructure, because - as already pointed out - successful knowledge management can never be based on technology only.

- The fourth group used the same grid and scaling as before to ask for the HR manager's opinion about the importance of providing employees with access to the 16 types of investments into knowledge in 2005.

- The fifth group was based on a grid of 32 company performance indicators related to economic factors, human relations within the company, customer relationship, operations within the company, personnel, production process, and strategy. To define the evolution of the company from before the investment into knowledge (2003) to after the investment (2005), we asked the unit's top manager for classifying the respective company situations.

Through its special design, this questionnaire was expected not only to provide a snapshot of the company's current way of handling knowledge, but also, and more importantly, to allow concluding on cultural changes and developments related to knowledge management. For this, all responses, no matter if they were positive or negative ones, have been treated carefully in both ways question-by-question and as subject of an interrelated analysis.

KNOWLEDGE MANAGEMENT AND LOGISTICS: CURRENT SITUATION AS APPEARING IN THE STUDY

Response rate

As previously explained 389 German and 62 Portuguese companies received the questionnaire in electronic or printed versions. The overall response rates (in terms of completed questionnaires) of 4.6% in Germany (equally distributed between small, medium-sized and large companies) and 4.8% in Portugal were slightly disappointing and do not allow drawing any statistically significant conclusions. Nevertheless, some qualitative results and general findings can be derived from this:

- There were several reasons why companies did not answer the questionnaire. They ranged from objection to contribute to studies on principle and too much effort or time required via the respective contact person is currently not available and no relationship to knowledge management to too sensitive data requested. One company refused because they had just completed a very similar questionnaire - which in fact did not show too many similarities. Furthermore, a number of companies did not exist anymore or had changed their addresses. Among the Portuguese companies not answering to the questionnaire, usually transportation companies were found, in which the driving capability (and no specific knowledge-intensive competence) seemed to be the most wanted skill to qualify the average employee.
- Sending electronic questionnaires by e-mail is an inappropriate questioning method, because nearly no response was gained from those. Reasons for this might be seen in the missing anonymity of responses, an eventual e-mail overload, and a traditional posture of logistics companies.
- Pre-contacting companies before sending off the questionnaire seems to increase the response rate. In Germany, 12.5% of the previously informed companies did return a completed questionnaire.

On the other hand, companies, which responded to the questionnaire, showed a strong interest in learning about results and outcomes of the study and welcomed some benchmarking of their own knowledge management activities and eventually existing further potential. In Germany, this is

particularly true for small to medium-sized consulting companies with a high percentage of well-educated employees (university degree).

The role of knowledge in the company

Nearly all respondents declared knowledge was a key resource for the company's performance: more than 75% of the responding companies (at least in the logistics managers' opinions) characterize knowledge management as supportive to all activities and helpful to better perform at the market; furthermore knowledge changes and improves all the time (in more than 60% of the cases) and/or develops with particular activities such as projects (in 50% of the cases). This one is a quite surprising and very positive view on knowledge, which also explains why those companies finally responded to the questionnaire.

On the other hand, nearly none of the companies confirmed the production of an intellectual capital report to monitor developments of the company's knowledge base. Those disagreeing with that statement describe to have only rudimental experience with this management instrument so far, that it often fails in the daily business, or even that the term "intellectual capital report" or "knowledge audit" is not yet established. This represents the other much less enthusiastic and much more hesitant attitude towards knowledge management detected in this study, and a probable explanation for the low participation rate.

Investments into knowledge management activities

On the scale from 0 (no investments) to 5 (very big investments) the average level of investment of companies per item was rated 2.69 in Germany and 2.06 in Portugal. From this finding we may conclude that in 2004, German logistics companies invested into knowledge management at a medium level, whereas Portuguese ones just reached a low level. However, two other findings help to clarify this average description of the situation (see Figure 2):

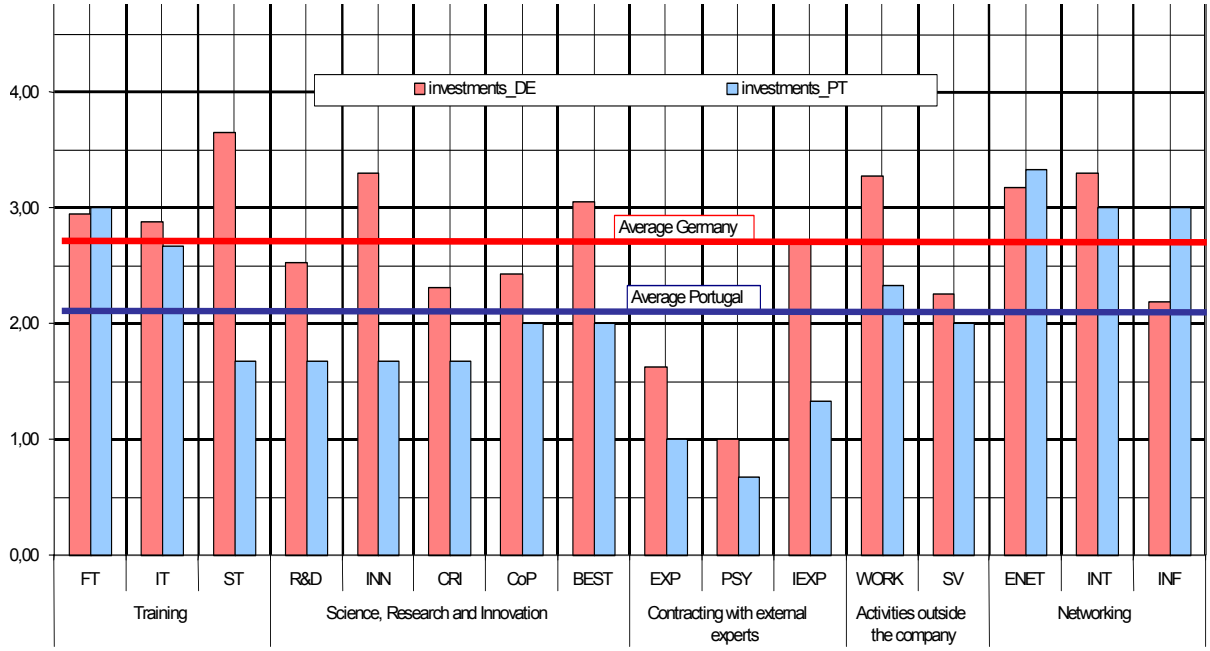


Fig. 2. Assessment of investments into knowledge management activities
Rys. 2. Zaangażowanie w działania służące podwyższeniu wiedzy o zarządzaniu

- Significant differences were detected between each one of the 16 items used. Knowledge management activities like self-training, innovation practices, participation in conferences/workshops, participation in external knowledge-sharing networks or establishment of internal knowledge-sharing networks reached values between 3 and 3.5 (i.e. more than medium level of investment). On the contrary some other variables showed very small levels of investment: hiring of consultants in Human Resources Development (HRD), Intellectual Capital (IC), or knowledge management (with a value of 1.53 - i.e. low to very low investment level), and meetings with labour psychologists (0.94 - i.e. very low investment level).
- Important differences could also be detected amongst the companies: one company showed an average value of 3.69 per item, whereas the lowest had an average value of 0.625 only. All in all, the majority of the companies showed an average value between 2 and 3 (i.e. a low to medium level of investment into knowledge management activities).

Therefore, we may conclude that the investment in knowledge management activities is considerable even if not very substantial, and that the level of investment is not uniform in companies. Also, some knowledge management items receive far more attention from managers than others.

Priorities of accessing knowledge management activities

In contrast to the investment level and using the same scale, the Portuguese companies felt a higher priority for investing into knowledge management than German companies did (average of 3.67 and 2.87 respectively; see Figure 3). The difference may be explained because German logistics companies already made the investments the Portuguese still lack.

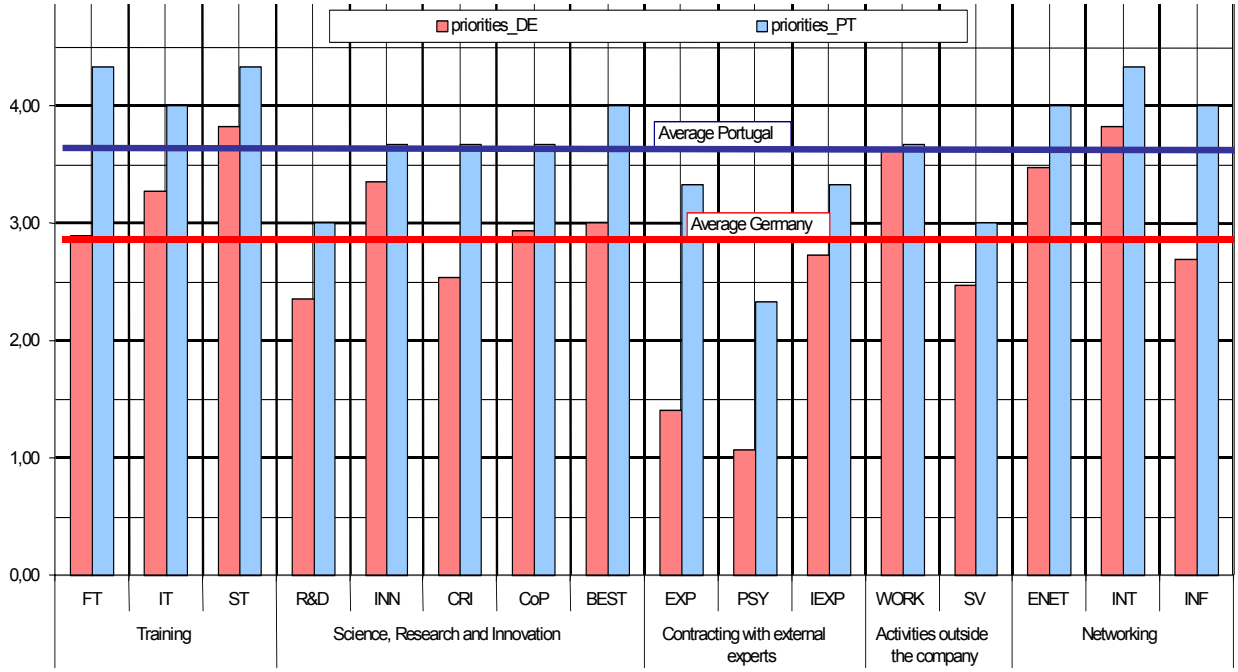


Fig. 3. Investments into knowledge management activities and priorities for accessing them
Rys. 3. Inwestycje w działania służące podwyższeniu wiedzy o zarządzaniu i priorytety ich uzyskania

Per item, the average priority was 2.98 with heavily varying results for the different knowledge management activities: nine items showed an average priority above 3, with the highest values (between 3.5 and 4 - meaning nearly high priority) being registered for self-training, participation in conferences/workshops, participation in external knowledge-sharing networks or establishment of

internal knowledge-sharing networks. In contrast, hiring of consultants in HRD, IC, or knowledge management, and meetings with labour psychologists had very low values of less than 2 (i.e. low to very low importance).

Needs for knowledge management

This part of the study intends to help companies in identifying knowledge management areas in which they shall invest in the near future and may thus have a short run and important consequence. Based upon (Reinhardt 2003) we consider that the need for investment in knowledge is defined as difference between, on one hand, the priority for accessing knowledge in a certain way and, on the other hand, an indicator of access frequency. As an indicator of frequency we use the investments made. Crucially, we think it is much more interesting and correct to define "needs" - as we did - indirectly by asking for "frequencies" and "priorities" than naively asking a manager this question directly: needs are potentially infinite if we look at them directly.

A first impression on the companies' needs is given by Figure 4, which visualizes the shift in ratings for each category of knowledge management activities between 2004 and 2005. Here, any positive value indicates a higher priority than investment (meaning that urgent need for investment exists is these sub-areas), while any negative value shows that priorities do not justify investments made (and thus a reduction of investment might be recommended in these cases).

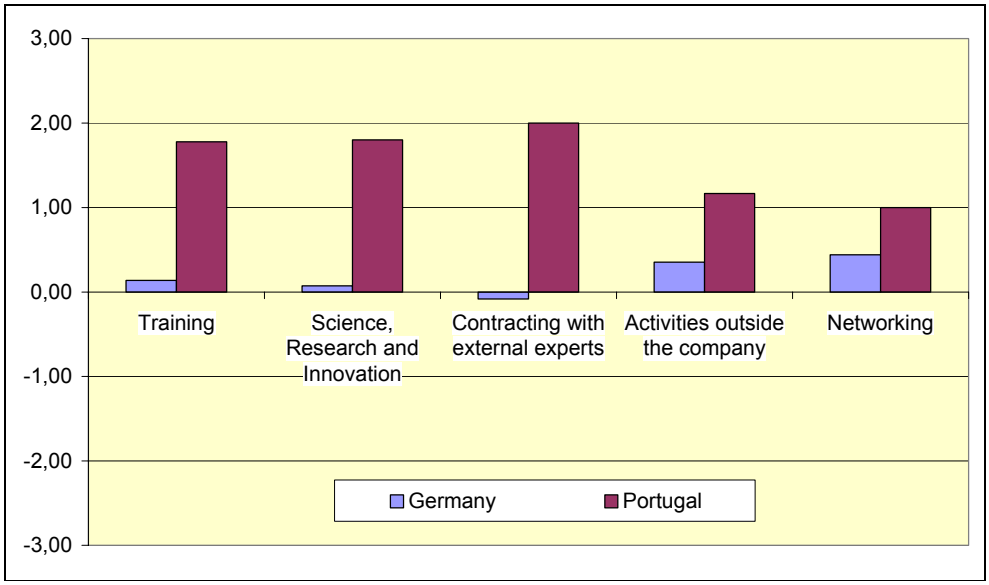


Fig. 4. Needs for knowledge management activities according to categories
Rys. 4. Zapotrzebowanie na działania służące podwyższeniu wiedzy według kategorii

More precisely, on a scale from -5 (over-investment, i.e. strong need for reducing investment) to +5 (urgent need for investing further) we found that the indirectly perceived average need for becoming active per knowledge management item is small even if it exists (+0.4), but that in Portugal (+1.6) this need is much higher than in Germany (+0.16). The difference between the two countries is probably explained by the different levels of economic development and by the different levels of implementation of knowledge management in their logistics sectors. Other details give more realism to that generic finding:

- On average all types of knowledge management activities had positive values pointing at needs for further investment rather than needs for reducing it. Here, the relatively strongest need for investing (although it still is pretty low) could be found for the development of internal knowledge sharing networks (+0.65), Communities of Practice (+0.59), development of informal networks (+0.55), and self training (+0.55). In contrast, there seems to be nearly no need for any change in the investment for hiring of HRD experts (+0.15), formal training (+0.14), and research and development (+0.05).
- Significantly high values of need for becoming active in either of the directions were demonstrated by companies as shown in Table 1: a very small number of companies seemed to have over-invested significantly (11 occurrences for 21 companies and 16 items, that is 3% of the cases), whereas a bigger number of other companies seemed to have strong investment needs to satisfy (12% of the cases). Quite interestingly, there was no specific knowledge management activity for which needs were perceived as much higher than those of the other items.
- When the over-investment and needs data of each company were put together, 14 companies presented positive values (pointing to a global unsatisfied need for investment into knowledge management) and four presented negative values (pointing to an over-investment into knowledge management). Three had 0 values (i.e. investments and priorities seemed to be well balanced). Very interestingly, the three Portuguese companies were among the four companies with higher needs, and the German company with more needs had a total value of needs equal to the Portuguese company with the smallest need.

Table 1. Number of companies with significant differences between investment and priority
Tabela 1. Ilość przedsiębiorstw w których wystąpiły istotne rozbieżności między inwestycjami a priorytetami

		-4	**-2**	**2**	**3**	**4**	**5**	**Total**
FT	Formal training			2				2
IT	Informal training		1	3				4
ST	Self training			2		1		3
R&D	Research and Development		1			1		2
INN	Innovation practices		1		1	1		3
CRI	Creativity linked activities		2	1	1	1		5
CoP	Communities of Practices			1		1	1	3
BEST	Study of Best Practices	1	1	2		1		5
EXP	Hiring of HRD experts	1	1		1	1		4
PSY	Contact with labour psychologists			1	1			2
IEXP	Meeting with invited experts		1	2	1			4
WORK	Participation in workshops and conferences			2				2
SV	Study visits to companies or cultural sights		1	3	1			5
ENET	Participation in external nets of knowledge sharing			1	1			2
INT	Establishment of internal formal network			3	1			4
INF	Development of internal informal network			3				3
	TOTAL	2	9	26	8	7	1	

Note n= 21. Scale from -5 to 5. Negative: Over-investment. Positive: Need for investment.

- But, the global situation hided some unbalances. Thus, the values shown in Table 1 did not distribute themselves evenly by all the companies, not at all. It is very curious to note the following occurrences:
  - The big negative values (sign of probable over-investment) were all detected in Germany,
  - In Portugal big absolute values were only positive (pointing to needs for further investment),
  - Seven German companies had only values ranging from -1 (small over-investment) to +1 (small investment need) simultaneously,
  - Three German companies only had big problems concerning over-investment,
  - One and the same Portuguese company showed all seven judgments of +4 (nearly urgent need for further investment) and 8 of the judgments of +2; another Portuguese company showed 3 values of +3 and 6 of +2,
  - Similar to the Portuguese ones, just two German companies were presenting investment needs problems only.

Therefore it is possible to conclude that even if on average the needs for investing into knowledge management are small, several situations of under-investment and of unsatisfied needs exist - the first being essentially located in Germany and the latter in Portugal.

KNOWLEDGE MANAGEMENT AND LOGISTICS: THE IMPACT

In recent years some very well known models have been developed to deal with the question of economically evaluating knowledge management and Intellectual Capital, the more important ones being the Skandia Navigator (Edvinsson and Malone 1997), the Intangible Assets Monitor (Sveiby 1997), and the Balanced Scorecard (Kaplan and Norton 1994). The main ideas behind those models are two: first to define the "intangible" assets and second to measure their implications - just because knowledge is intangible, this does not mean that its impact is (APQC 2004a). Those models assume the diversity and complexity of the notion of knowledge. Furthermore, they also assume the diversity and complexity of the consequences from using knowledge. It is assumed that those results may be positive in a number of perspectives like business processes, employee satisfaction, costumer satisfaction, financial results, learning and growth (North and Hornung 2003). Applications of those models have been done for companies and organizations (Mertins et al. 2001; Kagelmann 2003; Kukko et al. 2003; North, Reinhardt and Schmidt 2004) but also for countries and regions (Bonfour and Edvinsson 2004). Also, and very interesting, some authors have tried to audit knowledge (Reinhardt 2003; Sabater et al. 2003). All those ideas are well known, and studied. What has to be done now is to apply them to relevant sectors, which in the present case is the logistics sector.

A very simple equation could be used to describe the presented study (Neumann and Tomé 2005):

$$Y = aX + bKM + e \qquad (1)$$

Here, Y represents the outcomes, KM the investment variables (the tool), and X the controls. The controls would be related to sectors, quality of human capital and other relevant characteristics of the company. The impact of knowledge management would be defined by b. Finally, variable a represents a set of coefficients associated with controls and variable e corresponds to the statistical error and also to the non-observable variables. Very complex developments of this formula may be made (Heckman et al. 1999). Of course, one question could arise: is it the tool (KM) that fails, or is it people who do not know how to use it properly? But this is a secondary problem. The first one is to access somehow the impact of knowledge management on a company's logistics performance. For this, we applied the

equation by estimating regressions using the 32 company performance indicators as dependent variables and the 16 knowledge management activities as independent variables.

On this basis we were able to extract the following main conclusions:

- Self training (ST) had usually associated negative coefficients, whereas formal (FT) and informal training (IT) had positive ones.
- In the science and innovation block (INN, R&D, CRI, CoP, BEST), expenses in R&D, study of best practices, and creativity related activities seemed to have some positive influence, on the market value of employees, the informative content of services (R&D), consumer satisfaction, and the retention of costumers (BEST), the making of new products and risk analysis (CRI).
- Knowledge management activities linked with external experts (EXP, PSY, IEXP) showed few important results, the exception being a positive and significant relation between meetings with external experts and the number of costumers.
- The block on activities outside the company (WORK, SV) only provided a positive and significant relation between workshops and the market value of the personnel.
- Amongst those activities related to networking (ENET, INT, INF) internal networks (INT) were the most important one showing a positive and significant influence on attitudes towards change and the competence level of personnel. Informal networks (INF) had some positive and significant influences, too (on the time doing routine work and on redundancies).

Due to small sample of companies that responded to the questionnaire we understand these results as very preliminary ones. Nevertheless, from what we obtained we only can conclude that knowledge management has a small importance in defining a companies' economic evolution. But this finding is in quite some contradiction to theory on one hand and all enthusiastic expectations from practice on the other. So, what is the truth? Of course, we hope that a bigger sample, in a more advanced step of the study, will allow detecting some more meaningful relations between knowledge management and company performance. On the other hand we also have to take into consideration that the effects caused by introducing a knowledge-friendly culture and knowledge management methods into a particular company or even throughout the entire supply chain will mainly be brought out in longer terms. Consequently, this requires a corresponding setup of the study using our results achieved so far as first benchmark to be subject to further investigations repeated at regular intervals and continually analyzed according to impacts and sensitiveness between knowledge management items and logistics performance indicators.

KNOWLEDGE MANAGEMENT AND LOGISTICS: SOME PROSPECTS

In theory, knowledge management is expected to provide a tremendous contribution to the improvement of logistics planning and performance. The presented study aimed at comparing these high expectations with today's reality in business. The focus was set not just at analyzing and measuring what is happening, but also at developing a set of best practices and suggestions for effectively and efficiently integrating knowledge management into different types of logistics activities.

Due to the small number of respondents, and regretfully, the findings of this study cannot be considered very significant by now, but anyway, the paper contributes to the discussion about the use and importance of knowledge management in companies. Summarizing our findings, the main conclusion of the study is that knowledge management still seems to be just of little importance in the logistics sector in Germany and Portugal. We base this conclusion on the following observations:

- The response rate was extremely low - we obtained only 5% of answers and were able to validate only 3% of them.

- On a scale from 0 to 5 the detected investments into knowledge management activities showed an average of 2.6, which is even below a medium investment level.
- On a scale from -5 to +5 the average of the detected needs for investments into knowledge was +0.4, which not really indicates a need for further investments.
- Just a handful of significant and positive relations could be detected between 16 variables representing the companies' investments and 32 variables representing the companies' performance.

This conclusion is disappointing. But in contrast to this and quite interestingly, all of the responding companies considered knowledge extremely important. They also showed a strong interest in learning about and from the outcomes of the study. This indicates that despite of all the disillusionment that global empirical findings provoke, the role of knowledge and the fact that application of knowledge management can bring some good effects are indisputable. The problem simply seems to be a lack of knowledge and understanding with the companies on how to implement knowledge management methods in a customized way. The fact that, for example, intellectual capital reports are seldom produced or even unknown at all, serves as indicator of this statement. The way to overcome this problem is to provide companies with respective information and eventually lend them a hand in managing their human resources, selecting technology or changing the organization.

Furthermore, a number of cultural or much more economically influenced differences between the levels of knowledge management maturity in German and Portuguese logistics companies turned out: In Portugal the investment in knowledge still seems to be much smaller than in Germany, whereas providing employees with access to knowledge in one or the other way is felt much more important. Consequently, with the Portuguese companies a much stronger need for investments into knowledge and knowledge management activities could be detected than with the German ones. And even more, these needs are not just significantly higher in Portugal, but they also cover more or less all kinds of knowledge management activities we were asking for. In contrast to this, German companies showed the strongest needs (at much lower level than the Portuguese companies) with those activities related to individual initiatives of the human resources outside formal structures, like e. g. self-training or sharing of best practices in informal networks.

Looking a bit more in detail at the individual knowledge management activities, again some clear difference have been identified according to investment levels, priorities and needs for investments:

- Self-training, innovation practices, participation in conferences and workshops or external knowledge sharing networks, and establishment of internal knowledge sharing networks had the highest average investment per company.
- Self-training, participation in conferences and workshops or external knowledge-sharing networks, and establishment of internal knowledge-sharing networks showed the highest average level of priority with the companies.
- Establishment of internal knowledge sharing networks or informal networks, communities of practice, and self-training finally were the items with the strongest average needs.

Although the companies' individual levels of investment and needs per item were widely varying, these average results allow to derive suggestions for fields of activities the main focus should be put on or for knowledge management projects the companies should start with. To generalize, the companies require and favour their employees' own initiatives for gaining, deepening, updating knowledge (which eventually would cost the company the least), but they also should be aware of their responsibility to provide their human resources with some freedom and time for the networking, best-practice sharing or learning activities they expect from them to the benefit of the company.

From the scientific point of view, the main message of the paper is that even if scholars consider that knowledge management and knowledge are of paramount importance in the world of today, this idea is far away from being put into common practice. That realization should bring out further studies on the use of knowledge management in society and on its implications. The biggest weakness of the study presented in this paper is the scarce number of responses. Therefore, further efforts will be spent

on extending the study to other European countries (stage 3 of the project) to achieve a bigger sample of companies insight the logistics sector. Finally, even the current results are still subject to an ongoing analysis to more clearly demonstrate similarities and differences between the German and Portuguese companies, but also to better understand the impact knowledge management has on a company's logistics performance. This might also open up the possibility to run a similar project within another business sector and to compare the results with those from the logistics sector.

REFERENCES

APQC - American Productivity and Quality Center, APQC, 2004. Knowledge Management; [on-line] http://www.apqc.org/portal/apqc/site/generic?path=/site/km/overview.jhtml

Baumgarten H., Thoms J., 2002. Trends und Strategien in der Logistik - Supply Chains im Wandel. Berlin 2002. Trends and strategies in logistics - supply chains in change. In German.

Edvinsson L., Malone, M., 1997. Intellectual Capital. Harper Business.

Fraunhofer-Wissensmanagement Community, eds., 2005. Wissen und Information 2005. Fraunhofer IRB; Stuttgart. In German.

Gudehus T., 2003. Der Einfluß des Menschen auf die Leistungsfähigkeit von Logistiksystemen; Proc. 12. Deutscher Materialfluss-Kongress, VDI-Berichte 1744, VDI Verlag, Düsseldorf, 281-289.

Heckman J., Smith J., Lalonde R., 1999. The economics and econometrics of Active Labour Market Programs; O. Ashenfelter and R. Lalonde (eds), Handbook of Labour Economics, vol 3A, chapter 31; North Holland, 1865 - 2097.

Kaplan R.; Norton D., 1994. The Balanced Scorecard. Harvard Business School, Boston.

Neumann G., 2001. Learning by Planning: How to Improve Logistics Planning Competencies. D. Ziems (ed.), Logistikplanung im e-Zeitalter (logistics planning in the e-age), proc. 7. Magdeburger Logistiktagung; Magdeburg, Germany, November 15-16, 217-232.

Neumann G., Krzyzaniak, S., Lassen, C. C., 2001. The Logistics Knowledge Portal: Gateway to More Individualized Learning in Logistics. Proc. ED-MEDIA 2001 - World Conference on Educational Multimedia and Hypermedia; Tampere, Finland, June 25-30.

Neumann G., 2003. Framework for Integrating Knowledge Management into Personalized Problem Solving; Proc. I-KNOW '03 - 3rd International Conference on Knowledge Management; Graz, Austria, July 2-4, 500-506.

Neumann G., Tomé E., 2005. Knowledge Management and Logistics: An Empirical Evaluation; Proc. I-KNOW '05 - 5th International Conference on Knowledge Management; Graz, Austria, June 29-July 1, 96-103.

North K, Hornung T., 2003. The Benefits of Knowledge Management - Results of the German Award "Knowledge Manager 2002"; Proc. I-KNOW '03 - 3rd International Conference on Knowledge Management; Graz, Austria, July 2-4, 302-310.

North K., Reinhardt R,. Schmidt A., 2004. The Benefits of Knowledge Management: Some Empirical Evidence. OKLC 2004, Innsbruck Austria, [on-line] http://www.ofenhandwerk.com/oklc/Prog12.html#a8

Reihlen M., Ringberg T., 2006. Computer-Mediated Knowledge Systems in Consultancy Firms: Do They Work? R. Greenwood, M. McDougald, R. Suddaby; Professional Service Firms (Research in the Sociology of Organizations, Volume 24). JAI Press: Greenwich, Connecticut, London. 307-336.

Reinhardt R., 2003. Theoretical Basis of a Knowledge Audit: An Integrative Measurement Approach; Proc. I-KNOW '03 - 3rd International Conference on Knowledge Management; Graz (Austria), July 2-4, 389-397.

Reinmann-Rothmeier G., Mandl H., Erlach C., Neubauer A., 2001. Wissensmanagement lernen. Beltz: Weinheim und Basel. In German.

Sabater R., Moreno A., Sanz R., Jimenez D.j Lopez C.j Cegarra J., 2003. Knowledge Management and Intellectual Capital Audits: The Strategy Model; Proc. I-KNOW '03 - 3rd International Conference on Knowledge Management; Graz (Austria), July 2-4, 406-14.

Strubelt H., Neumann G., 2006. Requirements for Knowledge Management Support to Implement ECR in Practice; MSL - Magdeburger Schriften zur Logistik; 23, 47-57.

Sveiby K. E., 1997. The new organizational wealth. San Francisco: Berret-Koehler.

WIEDZA O ZARZĄDZANIU I LOGISTYCE: GDZIE JESTEŚMY I CO MOŻEMY OSIĄGNĄĆ

STRESZCZENIE. Zgodnie z ogólnie przyjętą teorią, występujące dzisiaj procesy i systemy logistyczne charakteryzują się wzrastającą kompleksowością oraz biorąc pod uwagę efekt globalizacji, z rosnącą różnorodnością procesów logistycznych. Z tych też powodów, wiedza jest coraz bardziej stategicznym zasobem w logistyce.
Jednak niektórre pytania nadal pozostają bez odpowiedzi. Jakie jest zaawansowanie wdrożenia metod zarządzania w praktyce, w jakim stopniu poziom faktyczny inwestycji w specjalistyczną wiedzę odpowiada aktualnym priorytetów w tym zakresie, czy poczynione inwestycje w poszerzenie wiedzy o zarządzaniu wpływa na postępowanie firmy?
Aby odpowiedzieć na te pytania, przeprowadzono badania obejmujące niemieckie i portugalskie przedsiębiorstwa. Zakres tych badań obejmować zakres inwestycji w poszerzenie specjalistycznej wiedzy dotyczącej zarządzania logistycznej, potrzeby poszerzania tej wiedzy oraz wpływ zdobytej wiedzy na sposób postępowania przedsiębiorstwa. Stworzono model uwzględniający zarządzanie poszerzaniem wiedzy oraz potencjał czynników podlegających analizie.
W rezultacie otrzymano ilościowe określenie stanu wdrożenia wiedzy o zarządzaniu w praktyce logistycznej. Wyszczególnione parę różnic pomiędzy realiami występującymi w Niemczech i Portugalii, choć stworzenie schematu uwzględniającego zastosowanie wiedzy w logistyce było trudne ze względu na małą liczbę danych.
Praca przedstawia wnioski z zastosowanej metodologii oraz listę rekomendowanych zasad, jakie zostały wypracone w trakcie analizy.

Słowa kluczowe: zarządzenie wiedzą, inwestowanie w wiedzę, metody zarządzania wiedzą.

WISSENSMANAGEMENT UND LOGISTIK: WO WIR STEHEN UND WOHIN DIE ENTWICKLUNG GEHEN KÖNNTE

ZUSAMMENFASSUNG. Es ist eine allgemein akzeptierte Theorie, dass Logistikprozesse und -systeme heutzutage durch zunehmende Komplexität und die Notwendigkeit einer globalen Vernetzung charakterisiert sind, um die wachsende Vielfalt an logistischen Aufgaben bewältigen zu können. Aus diesem Grund wird auch in der Logistik das Wissen immer mehr zu einer wettbewerbsrelevanten strategischen Ressource. Allerdings sind in diesem Zusammenhang verschiedene Fragen noch unbeantwortet: Wie steht es um die Implementierung von Wissensmanagement-Methoden in die logistische Praxis? Inwieweit stimmt die vermeintliche (theoretische) Relevanz von Investitionen in Wissen und Wissensmanagement mit der tatsächlichen, in entsprechenden Investitionsvolumina gezeigten Priorität verschiedener Wissensmanagement-Aktivitäten überein? Wie verändert sich die (logistische) Unternehmensperformanz infolge wissensbezogener Investitionen?
Zur Beantwortung dieser Fragen ist in deutschen und portugiesischen Logistikunternehmen Befragung zur Bedeutung von Wissen und Wissensmanagement für die Realisierung der logistischen Leistungsprozesse, zum Investitionsbedarf in Wissen bzw. Wissensmanagementaktivitäten in der Logistik sowie zu der eventuell bestehenden Verbindung zwischen Wissen und Logistikleistung durchgeführt worden. Für die Analyse des Einflusses von Wissensmanagement auf die logistische Leistungsfähigkeit der Unternehmen ist ein Modell entwickelt worden, das zu einer betriebswirtschaftlichen Beurteilung und Potentialanalyse für das Wissensmanagement beiträgt.
Im Ergebnis ist eine qualitative Standortbestimmung zur Einführung und Nutzung von Wissensmanagement in der Logistikpraxis möglich geworden. Hierbei sind gravierende Unterschiede zwischen der deutschen und der portugiesischen

Realität zutage getreten, auch wenn es schwierig war, aus der Auswertung der relativ wenigen Rückantworten statistisch gesicherte Benchmarks für den optimalen Einsatz von Wissen in der Logistik abzuleiten. Der Beitrag präsentiert die gewonnenen Schlussfolgerungen und leitet eine Reihe von Handlungsempfehlungen ab.

Codewörter: Wissensmanagement, wissensbezogene Investitionen, Wissensmanagement-Methoden.

Gaby Neumann
Otto-von-Guericke-University of Magdeburg
Logistics Knowledge Management Group
Magdeburg, Germany
e-mail: gaby.neumann@mb.uni-magdeburg.de
Eduardo Tomé
Department of Economics
Instituto Piaget
Viseu, Portugal
e-mail: eduardo.tome@clix.pt

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 3
No 4

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

ANTROUTE - LARGE SCALE DYNAMIC OPTIMISATION OF VEHICLE ROUTES AND FLEETS

Dario Coltorti

AntOptima SA, Lugano, Switzerland

ABSTRACT. The software product AntRoute is developed by AntOptima, a spin off company of the Swiss Research Institute for Artificial Intelligence IDSIA, Istituto Dalle Molle di Studi sull'Intelligenza Artificiale. IDSIA is one of the leading Institutes in Ant Colony Optimisation (ACO), a powerful method to solve different types of combinatorial optimisation problems, especially vehicle routing.
The developed algorithms are among the best currently worldwide available and they have found new best-known solutions for many benchmark instances.
With AntRoute AntOptima implements this technology for Logistics provider to speed up their business in terms of time and efficiency. The integrated high performance Tour Optimizer of AntRoute based on ACO and is automatically able to optimize thousands of daily orders in a few minutes considering the company related constraints like truck fleet, client time windows, unit load, access limitation, etc. The Tour Optimizer can be adapted to the needs of the most transportation industries, how different AntRoute implementations demonstrate.

Key words: Ant Colony Optimisation, Transport Planning, Vehicle Routing, AntOptima, Logistics provider.

INTRODUCTION

Most problem faced by logistics providers have been known for centuries, think of the Chinese postman problem, first formulated by Euler in 1736. These problems have the ugly characteristic of being combinatorial, that is, all the possible combinations of the decisions and variables must be explored to find a solution of the problem. The downside of this is that as the number of decisions and variables increase (and in real world problems is quite easy to find problems with hundreds of variables) the time required to find a solution becomes rapidly unaffordable.

Heuristics methods have been devised to explore only parts of the search space, concentrating in those parts that appear to promise a probable improvement of the solutions, thus reducing the time required to obtain a solution, which is often sub-optimal, but already a good improvement from the starting situation. A heuristic makes use of peculiar characteristics of a problem and exploits them to find a solution. Other empirical methods do not exploit only the problem characteristics but especially the analogy with other optimisation methods found in Nature.

Such heuristic methods, independent of the problem, are called Metaheuristics.

Ant Colony Optimisation (ACO) is such a heuristic. Based on the observation that ants find the optimal path between a food source and their nest, a computer analogy has been implemented and

Citation: Coltorti D., 2006, ANTROUTE - Large Scale Dynamic Optimisation of Vehicle Routes and Fleets. LogForum 2, 3, 4
URL: http://www.logforum.net/vol2/issue3/no4
Accepted: 20.11.2006, on-line: 15.12.2006.

applied to various problems, ranging form the traveling salesman problem, to the sequential ordering problem and the vehicle routing problem.

FROM THEORY TO PRACTICE

Metaheuristics are a powerful tool to solve combinatorial optimisation problems, which are so frequent in logistics and transports, but they cannot be applied blindly.

In transportation one of the most important tasks is: Given a fleet of vehicles and a set of customers asking for pick-up and delivery operations the goal is to minimize a given cost function. In theory this challenge is known as vehicle routing problem, where metaheuristics, especially ACO, are finding best solutions in terms of efficiency and calculation time. Due to the excellent theory results from Swiss Research Institute Dalle Molle for Artificial Intelligence (IDSIA) and the support of Swiss National Science Foundation ACO reached the international scientific break through.

To apply these methods in practice further steps had been necessary. The algorithms had to be adapted to many different practical constraints of transportation sector:

- Accessibility based on vehicle type,
- Distribution areas,
- Deliveries with multiple time windows,
- Urgent requests,
- Stochastic travel time,
- Multiple days planning,
- Stochastic customer demand,
- Unexpected events.

Inspired from the scientific success IDSIA was and is involved in projects where the Institute in collaboration with industrial partners and the support of European Commission and Swiss Commission of Technology and Innovation develops vehicle routing algorithms, which are customized to the transportation sector to reduce the economical and environmental impact.

After several successful practice implementations the market requested concrete applications. AntOptima as a spin off of IDSIA was founded with the mission to parameterize the powerful algorithms for transportation companies and to satisfy the transportation industries needs. One of the present main application product is AntRoute.

ANTROUTE

AntRoute optimizes distribution logistics thanks to an integrated approach to the various features of the problem, thus rapidly enabling the user to:

- optimize the use of the vehicle fleet (type and quantity of the used vehicles, workload scheduling, capacity optimisation),
- improve the efficiency (less kilometers, less time, more delivered goods, all of this within the time constraints),
- increase customer satisfaction, thanks to the focus on service level and punctuality.

The automatic generated and practical tours of AntRoute consider:

- multiple goal functions,
- flexible areas,

- tour building attributes,
- different loads units,
- heterogeneous fleet (trailers, semi-trailers,…),
- single and multi-depot optimisation problems,
- third-party vehicles.

AntRoute can be used to strategically plan the management of the fleet of vehicles and of the resources under alternative scenarios. It also allows to gather and analyze statistical data on the distribution process and to deduce trends and make forecast. It can be easily integrated in existing company systems and it can dialogues with most supply-chain management software tools.

The product uses standard road network data and it can perform the daily optimisation of fleets in primary and secondary distribution processes ranging from a few tens to thousands of vehicles, how the two following case studies show.

REAL CASE STUDY PINA PETROLI (SME)

With many years of experience, Pina Petroli SA is now a constant presence in Ticino economy. The development that the company knew from 1949, year of its foundation, is quite visible in the dimension of the depot of Grancia, with fifteen great tanks, twelve vehicles and thirty employees. These technical and human resources make Pina Petroli a leader in the area, profit in heating oil distribution in the whole Ticino and Grigioni southern valley. Everyday Pina Petroli carries out hundred of deliveries, satisfying the customers needs and their details. Pina Petroli chose AntOptima to implement new technologies in order to optimize transportations and to serve the customer with always greater efficiency and precision.

AntRoute (resulting from Dyvoil project) was parameterized as a software application for the management and optimisation of heating oil distribution, which allows to:

- optimize the use of the fleet of vehicles,
- forecast the customers' consumption and reduce the costs of distribution,
- improve the efficiency (less miles, less time, more deliveries),
- increase customer satisfaction, thanks to real time management of urgent deliveries.

REAL CASE STUDY NUMBER 1 LOGISTICS GROUP

Number 1 Logistics Group is the Italian logistic operator leader in grocery with 400.000.000 of necks managed, 2.500.000 delivers for about 2.100.000 tons, 250.000.000 of km traveled in a year, 2.600 vehicles and 110.000 customers served. At the beginning its activity was born to distribute Barilla's products in different depots and supermarkets and to transport the grain from the production areas to the productive sites. Once activated this logistic process, it has thought to develop it by offering the same service to other companies that should transport goods in the same depots and supermarkets.

A primary phase allows the goods to come from the origin zone to the final distribution zone using big trucks. When it is possible and suitable, the final customer is served directly by these trucks, otherwise the goods are collected in local logistic centers. In these centers the goods are consolidated and distributed locally by smaller trucks (secondary phase).

Number 1 chose AntRoute for the automatisation of the route creation phase and for the optimisation of the goods distribution. The goal is to maximize the transportations efficiency respecting the constraints on the opening time of the different depots and the limits established from

the law on the travel times of each vehicle. The routes considered cover the whole Italy with services in one, two and sometimes also three days. Based on initial information, AntRoute optimizes in a few minutes pick-up & delivery orders to satisfy the requirements and the specific needs of Number1.

CONCLUSIONS

AntRoute is a powerful instrument for Transportation companies, which would like to improve their planning and distribution processes in terms of efficiency and calculation time. The intelligent software uses state-of-the art optimisation algorithms, invented at the IDSIA, during various project, co-financed by the Swiss National Research Fund and by the Swiss Commission for Technology and Innovation. These algorithms, inspired by ant colonies, learn from past experience, adapt to unforeseen circumstances, and they are able to solve with extreme speed complex combinatorial optimisation problems, intractable with traditional algorithms.

Given the great effort in the recent years of logistics and transportation companies in the integration with the existing data exchange infrastructure it brings new great opportunities to make an intelligent use of the data and AntRoute is ready to take this chance.

Other powerful products of AntOptima are AntNgage (Tariffoptimisation of transport services considering external and internal fleet) and Tourplanner (software tool for the dynamic optimisation of vehicle routes and logistic flows, especially designed for the needs of SMEs).

REFERENCES

Bonabeau E., Dorigo M., Theraulaz G., 2000. Nature, Inspiration for optimisation from social insect behavior, Volume 406 Number 6791, London, 39-42.

Bonabeau E., Meyer Ch., 2001. Harvard Business Review, A Whole New Way to Think about Business, 5/2001, Boston, 106-114.

Casagrande, N., Gambardella L.M., Rizzoli A.E., 2001. ECCO XIV, Conference of the European Chapter Solving the vehicle routing problem for heating oil distribution using Ant-Colony Optimisation on Combinatorial Optimisation, May 31-June 2 2001, Bonn, Germany.

Coltorti D., 2005. Ameisensysteme, Verfahrensüberblick und betriebswirtschaftliche Anwendungs-potenziale.

Dorigo M., Di Caro G. and Gambardella L. M., 1999. Artificial Life, Ant Algorithms for Discrete Optimisation, 5 (2), Cambridge MA, 137-172.

Gambardella L.M., Taillard E., Agazzi G., 1999. MACS-VRPTW: A Multiple Ant Colony System for Vehicle Routing Problems with Time Windows, In D. Corne, M. Dorigo and F. Glover, editors, New Ideas in Optimisation, McGraw-Hill, London, 63-76.

Gambardella L.M., Dorigo M., 2000. INFORMS Journal on Computing, An Ant Colony System Hybridized with a New Local Search for the Sequential Ordering Problem, vol.12(3), Cincinnati, 237-255.

Gambardella L.M., Taillard E., Dorigo M., 1999. Journal of the Operational Research Society, Ant colonies for the Quadratic Assignment Problem, 50, Hampshire, 167-176.

Heinzelmann E., 2006. Logistik & Fördertechnik, Intelligenz von Ameisen im Dienst der Logistik, 10/2006, Basel, 38-39.

Heinzelmann E., 2003. Swiss Engineering, Machen wir's den Ameisen nach, 06/2003, Zürich, 2-6.

Kloss K., 2006. DVZ, Auf die Ameisen gekommen, Nr.38, Hamburg, 6.

Schmundt H., 2000. Der Spiegel, Der Duft der Daten, n.46, November 13th, Hamburg.

http://www.derspiegel.de/spiegel/0,1518,102399,00.html.

ANTROUTE - WIELKOSKALOWA OPTYMALIZACJA ZARZĄDZANIA FLOTĄ POJAZDÓW

STRESZCZENIE. Oprogramowanie AntRoute zostało opracowane przez AntOptima, firmę stworzoną przez Swiss Research Institute for Artificial Intelligence IDSIA oraz Istituto Dalle Molle di Studi sull'Intelligenza Artificiale. IDSIA to jeden z wiodących instytutów w dziedzinie Ant Colony Optimisation (ACO), metody rozwiązywania różnego typu złożonych zagadnień optymalizacyjnych, szczególnie w zakresie optymalizacji tras.
Zastosowane w tym rozwiązaniu algorytmy są obecnie najlepszymi z dostępnych na rynkach światowych są używane w wielu wiodących implementacjach.
AntRoute umożliwia Logistyce poprawić zarówno wydajność jak i efektywność działalności. Zintegrowany Tour Optimiser (moduł optymalizacji tras), oparty na ACO umożliwia optymalizację tysięcy dziennych zamówień w przeciągu paru minut, przy uwzględnieniu takich ograniczeń jak: posiadana flota samochodowa, żądany czas dostawy, jednostki załadunkowe, ograniczenia ruchu, itp. Tour Optimiser może być dostosowany do potrzeb większości przedsiębiorstw spedycyjnych, czego dowodzą już przeprowadzone wdrożenia.

Słowa kluczowe: Ant Colony Optimisation, planowanie transportu, trasa pojazdu, AntOptima, dostawca logistyczny.

ANTROUTE - DYNAMISCHE OPTIMIERUNG DER ROUTEN UND DES LOGISTISCHEN GÜTERFLUSSES

ZUSAMMENFASSUNG. Das Softwareprodukt AntRoute wurde von der Firma AntOptima entwickelt, eine Spin-off des Schweizerischen Forschungsinstituts für Künstliche Intelligenz (IDSIA), Istituto Dalle Molle di Studi sull'Intelligenza Artificiale. IDSIA ist eines der führenden Institute in Ant Colony Optimisation (ACO), eine leistungsstarke Methode um verschiedene Arten von kombinatorischen Optimierungsproblemen zu lösen, besonders was Vehicle Routing Problems betrifft. Die entwickelten Algorithmen gehören aktuell zu den international Stärksten und Sie haben neue Bestmarken für viele Benchmark Instanzen erzielt.
Mit AntRoute implementiert AntOptima diese Technologie für Logistikdienstleister um Ihre Prozesse zu beschleunigen bezüglich Zeit und Effizienz. Der integrierte Tourenoptimierer von AntRoute basiert auf ACO und ist automatisch in der Lage tausende Bestellungen für einen Tag innerhalb von wenigen Minuten zu optimieren. Dabei werden die unternehmensspezifischen Bedingungen wie Flotte, Kundenzeitfenster, diverse Masseinheiten, Zutrittsbedingungen, etc. mitberücksichtigt. Der Tourenoptimierer kann auf die Bedürfnisse der meisten Transportsektoren angepasst werden, wie verschiedene AntRoute Implementationen zeigen.

Codewörter: Ant Colony Optimisation, Transportplanung, Vehicle Routing, AntOptima, Logistikdienstleister.

Dario Coltorti, lic.rer.pol.
Business Developer
AntOptima SA
Via Fusoni 4 CH- 6900 Lugano
Tel.direct: +41 41 781 39 35
e-mail: dario.coltorti@antoptima.com
www.antoptima.com

LogForum

ISSN 1734-459X
2006
Vol. 2
Issue 3
No 5

> Elektroniczne czasopismo naukowe z dziedziny logistyki <

http://www.logforum.net

LOCALIZATION OF SOFTWARE IN LOGISTICS

Marek Matulewski

Higher School of Logistics, Poznan, Poland

ABSTRACT. The author presents the problems connected with localization of logistic software. The following factors affecting the process of localization are discussed: information and it role, globalization, internationality and the command of foreign languages. Three types of localization depending on the type of interaction are taken into consideration. The main emphasis is put on the efficiency decrease, which is observed in the case of logistic software as a result of communication distortions. SAP R/3 logistic software was used as an example illustrating the localization problems. Three situations have been presented namely: lack of localization, partial localization and deficient complete localization, which is hard to understand for the users. The author concludes that even high-quality software in the case of the lack of or partial localization becomes less efficient and effective than in the case of complete localization. But the lack of localization finds its justification in the age of globalization.

Key words: information, information system, IT system, software localization.

INTRODUCTION

The increased role of information may be observed not only in Poland but also all over the world. Information affects all manifestations of human activities. Information here is understood as strictly specified data having some meaning. In an economic activity it encompasses all data streams within and between enterprises and between enterprises and external centers such as customers, suppliers and governmental agencies. [Jabłoński 2003]

Information is a factor, which enriches people with knowledge about the surrounding world. Information is commonly observed both in daily and professional lives. It can be noticed in procurement processes (supplying materials and components), production, distribution, sales and services. Information is equally valuable as specific products or physical stocks. Such a treatment of information has led to vital changes in practice. For instance, such strategies as Just-in-Time or Quick Response use logistic information for the purpose of cutting delivery costs. All those strategies assume that information is a physical resource. It should be reliable, accurate and true. It must reflect the current market situation and allow for making forecasts. As a consequence, the information source should be localized as close to the final recipient as possible. Moreover, the form of information transmission must be fast (thus, the information transmission methods such as EDI - Electronic Data Interchange are used), high quality and secure. Such information fulfills the rule of 6Rs (right quantity, right condition, right time, right place, right cost, right customer), may be subject to trade and, as a consequence, may generate some specific economic benefits. It is one of the most important (apart from people and capital) assets for enterprises.

Citation: Matulewski M., 2006, Software localization in logistics. LogForum 2, 3, 5
URL: http://www.logforum.net/vol2/issue3/no5
Accepted: 10.12.2006, on-line: 15.12.2006.

The second factor clearly affecting the problems connected with software localization in logistics is a trend of constant broadening of the territory of enterprises' economic activities. A typical symptom of that trend is the creation of multinational or even global companies. A multinational company is an organizational entirety composed of autonomous units. They conduct business activities in different countries and are usually well adjusted to the conditions of a specific territory. A global company, on the other hand interferes strongly into its business activities putting emphasis on the interrelations between specific countries. The company adopts the strategy of co-ordination. There are no national-market oriented strategies present. The existence of such organization forms affects the management style. Thus, one may distinguish here cross-cultural management. In that case it is necessary, however, to take into account cultural differences between specific countries on the territory of which the business is conducted. Cultural differences affect intercultural communication. One must take it into consideration, as it is a vital factor ensuring the success of negotiations, business talks and business contacts. Each ethnic group, each nationality reacts differently to some specific environment. Americans put emphasis on an individual. Everyone must be able to take care of himself. Japanese, on the other hand, concentrate on the long-lasting clan culture. They identify themselves with society. What is more, aliens are discriminated against. Therefore, one must know cultural factors affecting business activities in order to avoid unnecessary disturbances and distortions. [Koźmiński 1995]

The third factor visibly affecting logistic software localization is the problem of the command of foreign languages in Poland. According to the recent survey carried out by CBOS (Polish public opinion poll agency) 55 per cent of Poles do not speak any language. People aged 18-24 are most willing to learn languages. 77 per cent in that group stated that they know foreign languages. When taking into consideration the education the situation is the following: 83 per cent of people who graduated from higher education institutions can communicate in a foreign language. 56 per cent of people with secondary education can communicate in a foreign language. 34 per cent of people who have graduated from vocational schools and 28 per cent of people who graduated from primary school can communicate in a foreign language. The survey was carried out from 2 to 5 November 2006, and a random group of 979 adult Poles was asked about their command of foreign languages.

The fourth factor is related with the software. Right now, it is impossible to live in information society and conduct business without a proper hardware and software. Moreover, in order to be efficient the software must be localized properly that is adjusted to the market. Localization is a long and complex process. It encompasses the following issues: terminology specific for a given language, translation strategy, and content-related verification. The text, which appears on a computer screen, must be translated including help, guidelines and manuals. Localization consists in adjusting the software to Polish regulations and standards. Additionally, it should be a process of software adjustment to the needs of users conducted as a result of a co-operation of a translator and a computer scientist.

INTERACTION-CONDITIONED TYPES OF LOCALIZATION

When analyzing the software localization in logistics one may enumerate three basic interaction models:

- dominance model,
- co-existence model, and
- co-operation model.

As far the implementation is concerned the model of dominance is the best one. The implementation process is short (in comparison with other models). In the course of the implementation process the management style of the mother company is imposed on all daughter companies, and sometimes even business partners and co-operators. Other management styles characteristic of specific cultures are ignored or even discriminated against. In that case one may usually observe complete lack of software localization.

The co-existence model requires more time, money and engagement of specialist who must be at the company's disposal. It is based on the search for compromise. The compromise is connected with looking for solutions acceptable for all parties. It is more expensive than the first model as it requires conducting research. However in the long run it may turn out to be more profitable (as it generates fewer problems and does not pose so many threats and risks in the system operation). It is based on taking advantage of the existing similarities. In that case one has to face partial software localization.

The co-operation model is based on the so-called cultural co-operation. It is a process during which strategies, operations and behaviour models are created on the basis of cultural patterns characteristics of process co-participants. Moreover, the final product strives at taking advantage of the best patterns and minimizing the influence of negative phenomena. This model has been created as a result of long-lasting observations the direct result of which is taking advantage of both similarities and differences between existing solutions. The effectiveness of its operation depends on the cultural diversity. It is the cultural diversity, which is treated as a resource, which must be used in order to provide satisfactory development of the company and to hold the advantage over competitors. The co-operation model processes are time-consuming, expensive and laborious but the final product generates additional benefits in comparison with two above discussed models. It allows for eliminating risky situations and reduces dangerous situations to a minimum. In that case the software localization should be complete. In fact, one may unfortunately often encounter deficient software localization.

SELECTED PROBLEMS CONNECTED WITH LOCALIZATION

The author has analyzed SAP R/3 software supporting management in MRP II organizations. SAP provides a comprehensive range of enterprise software applications and business solutions, which encompass all managerial functions (planning, organizing, motivating, monitoring and supervising). They also encompass all managerial levels: manufacturing, controlling, finance, accounting, raw materials' procurement, quality management, projects, sales and distribution, personnel, remunerations, redecorations, tangible and intangible assets, investments, etc. Those software enable manage the company in all spheres of its operation. They help to satisfy the needs and expectations of customers.

SAP R/3 software enables data transmission not only via data export/import but also by the on-line data exchange. They have efficient input-output interface, well-developed data-bases (the core of the system), advanced information retrieval structures and management informing and monitoring tools. The choice of the software was conditioned by its popularity on the Polish market. SAP has about 800 customers in Poland. According to the IDC, SAP had 32.65 per cent share on the Polish market.

Lack of software localization

The lack of logistic software localization is quite a popular situation in Poland despite the Act on the Polish Language. It is a typical example of a dominance model. It occurs when one global enterprise composed of one mother and many daughter companies located in many parts of the world is made to use software (e.g. SAP R/3) in English-language version. The culture of a mother company is imposed on daughter companies. Other culture-models are discriminated against. The problem of the lack of localization was observed in a Polish daughter company where the SAP R/3 software was implemented and used. In that case it was subject to standardization procedures and algorithms designed to enable efficient management previously implemented in other cultural environments of different daughter companies.

The threats usually appear in many fields: planning, production, sales, scheduling production plans, demand management, material requirements' planning, or production capacity planning. They refer among others to transaction systems, information retrieval systems and management informing, monitoring, databases' management. I have divided all those threats into two categories:

- dominance imposing one language within one multinational company, and
- dominance imposing one settlement period within one multinational company.

The first type of distortion results from a different intuitive and habitual usage of commas and full stops (e.g. 238.428 in English equals 238,428 in Polish; 238,428 in English equals 238 428 in Polish). Many problems were spotted due to not adjusting the software to Polish norms concerning the usage of commas and full stops. It made it impossible for users to assess the real situation. They decreased the efficiency by prolonging the reaction time to the asked questions and in some cases even led to the system operation suspension. Such a situation took place as a result of implementing IT procedures automatically verifying the correctness of data. They additionally created distortions within the sphere of interactions with past activities. The existing statistics was distorted and it contributed to regrouping of physical data structures. Moreover, a different intuitive usage of commas and full stops generated serious errors in settlements and discrepancies of existing warehouse stock levels. As a result, the company had to incur extra costs e.g. due to the need to carry out additional stock inventories.

The next observed problem referred to the information retrieval system and management informing system. The disturbances in system operation were generated by errors caused by misunderstanding abbreviations and names used in English language version of SAP R/3 (e.g. Dd - Delivery date, Ed - Execution date). As a consequence there were problems connected with deliveries to specific consignees for over 6 weeks. It resulted from incorrect marking of the date of delivery on delivery documents. Instead of the delivery date there was the date of document issuing. A direct consequence of such a state of facts was a distorted picture of a real situation on the market and the creation of excessive stock levels of one product and lack of other products. Moreover, due to the lack of reaction of the management (improper management informing procedures e.g. by generating reports inconsistent with the truth) the previously worked-out system of customer service broke down and additional costs had to be incurred to maintain the order portfolio.

The next issue concerns the operation of monitoring systems the main aim of which was to inform the management as fast as possible about the threats and make them intervene before the losses would occur. It is a basic component of SAP R/3. One of such components is HACCP (defined by the Codex Alimentarius as the Hazard Analysis and Critical Control Point). Its main function is to analyze and prevent the creation of microbiological, technological, chemical and/or physical hazard; to reduce and prevent possible intensification by not allowing product contamination. What is more, HACCP is to minimize risk. In that case the source of distortion was of language character. Due to misunderstanding the manual (the help was written in English) and abbreviations (Ed Expiry date, Bi Batch index) workers incorrectly fed the production data and batch number into the system. Additionally, there were not sufficient relations in the SAP R/3 system between the batch number and expiry date. As a result the management did not have proper data at their disposal and could not make proper decision.

Dominance consisting in imposing on the whole multinational organization one method of accounting period settlement was a source of incorrect time-period settlements. Insufficient understanding of information concerning the beginning of the accounting year resulted in the creation of unnecessary disturbances in the company's functioning. Those problems were directly connected with the monitoring and transaction systems. In the past the accounting year was the calendar year and thus it started on 1 January and ended on 31 December. When SAP R/3 software was implemented the accounting year started on 1 July and ended on the last day of June next year. Moreover, a new system of short-term settlements was introduced. The new settlement period is composed of four up to five weeks depending on the month. Additionally, the beginning of the period does not start at the beginning of the month (e.g. July 2006 is composed of five weeks which started on 2 July and end on 5 August, August is composed of four weeks which start on 6 August and end on 2 September, etc.). Consequently, many discrepancies appeared as a result of the system stock levels and physical warehouse stock levels. The need to clarify the discrepancies occurred - it was necessary to carry out inventories (within 6 months three extra inventories had to be taken).

Partial software localization

The co-existence model is connected with partial software localization. It is a way of finding a compromise between business partners' cultures. The emphasis is put on looking for solutions acceptable to all interested parties. In order to achieve it one must carry out research on the basis of which the acceptable model, which may be implemented and effectively used, is worked out. SAP R/3 software was in that case implemented in a Polish language version. However, some undesirable distortions occurred. For instance the language of SAP R/3 software was contaminated with direct borrowings from English including English abbreviations. Among such direct borrowings users had to face the following: *Service level, Out of stocks, Glossary, Easy Access user menu, Feedback, ZSD_OOS - SD, BMBC - Batch Information Cockpit*. As a consequence, the users had problems when using transaction systems, information retrieval systems and databases. The time necessary for conducting rudimentary operations was prolonged. The physical operations such as delivery acceptance, order submission, order acceptance, transport dispatch etc, were also prolonged. The errors were made more frequently e.g. in the case of inaccurate assessment of stocks of spices, condiments and aromas at the company's disposal. As a result the monitoring system operated inefficiently. Due to those unnecessary disturbances appeared and additional costs were incurred but it must be stressed that in the majority of cases especially in the first period (the process of staff training and learning) they referred mostly to the personnel of lower job qualifications. Moreover, they were connected with the input-output interface and language barrier, which generated additional tension and stress. As a consequence, workers stopped reading communiqués and messages. The routine of work appeared fast. Employees started working as automats deprived of human intelligence, binary machines which generate a question every time a problem appears. Unfortunately, in the majority of cases the questions were not addressed to proper addressees. Such a situation, on the one hand, leads to the communication channels' jamming, and, on the other hand, to unnecessary burdening of high-quality specialist (among others consultants responsible for system implementation or computer science department staff), management, or even top executives.

Deficient software localization

As I have just mentioned before, the co-operation model occurs in the case of complete localization without errors. However, when investigating software localization problems I have encountered deficient software localization examples. The first problem is connected with a so-called professional pidgin. It is a sort of professional jargon, which is shaped and created in a specific environment within a specific community. It may also be encountered within IT systems. The term mandant is one of professional pidgin examples. It is defined as a legally and organizationally independent unit of the highest level within the system. It is an organizational unit of the highest level, which constitutes a logical entirety for specific economic units. Using such terms and expressions hampers IT system usage (especially in the first period of system's operation), introduces unnecessary disturbances and generates errors. Not knowing available *mandants* (such as test performance copies, training copies, or others) leads to making errors and as a consequence makes the work within the company ineffective and inefficient and furthermore leads to unnecessary burdening of personnel with extra work. It prolongs the time necessary for conducting rudimentary operations (such as delivery acceptance, creation of a new material position) and indirectly contributes to the creation of unfavourable work routines.

The second problem is connected with a help desk system, which is available in Polish language version in SAP R/3 software. This basic element of information retrieval may operate in an interactive way. The user is not always satisfied with the first answer he gets, and thus, the system asks more detailed questions and/or generates some additional hints. The scope of the operation of such systems is very wide and it is restricted only by the contents of the database and the scope of the user's powers as far as the system usage is concerned. Such a situation takes place in the case of a complete properly conducted software localization. Unfortunately, when investigating the software I have found out that

although the software is supposed to be in Polish language version, the help desk is in English (e.g. 'The user menu contains only those items - such as transactions, reports, and Web addresses - you need to perform your daily tasks. If a user has been defined by your system administrator, it appears when you log on to the system.'). One may use it effectively only when he/she knows English sufficiently (a good command of English is necessary). This fact generates additional complications. On the one hand, the software user must know a foreign language at the level enabling understanding the guidelines incorporated into the system, and on the other hand there is a need to prepare guidelines in Polish (in analogue or electronic form). Furthermore, SAP R/3 software in Polish language version differs to some extent from the English language version, which poses some difficulties as far as effective usage is concerned.

The third example is connected with dates. In the analyzed SAP R/3 version the dates were used incorrectly because in two different transactions there were fields with different names with the same meaning. Two synonyms appeared namely: '*Data dostępności*' and '*Data przydatności*' (Expiry Date or Best Before Date). As a result unnecessary errors were made, additional questions were generated and the need to create additional guidelines occurred. The company had to incur extra costs again.

CONCLUSIONS

The complete lack of software localization has many negative features such as work cycle disturbances' creation within the whole company and within specific departments or smaller organizational units. But it must be stressed that it also brings some additional positive benefits. The implementation of the software without its localization eliminates the problem of data conversion within a global enterprise. It enables a far-fetched standardization of used documents and reports. Moreover, it simplifies the internal communication within the entire global enterprise.

The most desirable situation in all respects out of the three presented in this article is the co-operation model. It is the co-operation model in logistics, which enables most efficient usage of software in specific, determined circumstances. It gives a chance to achieve success understood as taking advantage of all opportunities and capabilities, which are related with the personnel at the enterprise's disposal. According to the commonly known laws and rules of management the best capital is not money, time or unlimited access to state-of-the-art technologies but people. People create a unique atmosphere necessary for learning, development, and achieving set goals. But they must be equipped with proper tools, which will be intuitively understandable for them. The problem of localization is connected with it. Localization should take into consideration both linguistic and cultural factors. It is a prerequisite for localization to be compliant with the language and intuitively understandable for users who operate within that culture.

When choosing a translator to do translation part of the software localization project, one should follow a specific algorithm. The following criteria should be met:

- high professional qualifications (including the knowledge of IT systems),
- specialized linguistic knowledge,
- software knowledge enabling using it,
- teamwork skills.

One should realize that such large projects as software localization must be carried out by teams of people who co-operate and who are high-class specialists.

The existence of synonyms within the software is unacceptable and thus should be eliminated at any cost because it may lead to:

- information processes' distortions,
- unnecessary multiplication of information,
- prolongation of rudimentary information operations,

- jamming the existing information channels.

As a result, the information system may become completely ineffective and jammed. Furthermore, the premises will be created that the system must have better information flow capacity and consequently the costs will be incurred on newer and more efficient hardware and finding solutions for their implementation, including new organizational methods.

Starting the process of software implementation (localized or not) one must always adjust them to the existing information system. It is hard to imagine a situation in which SAP R/3 software does not co-operate with the existing information system. It must efficiently support the system and create conditions for the most effective operation of the company. It should create new development opportunities and indicate where it is possible to generate new financial benefits connected with operation time and speed.

REFERENCES

Chmielewska-Gorczyca E., Sosińska-Kalata B., 1991, Informacja naukowa z elementami naukoznawstwa, Wydawnictwa Szkolne i Pedagogiczne, Warszawa.

Haverkamp D.S., Gauch S., 1998, Intelligent Information Agents: Review and Challenges for Distributed Information Sources, In: Journal of the American Society for Information Science. 49(4), pp. 304-311.

Jabłonski Wł., 2003, Zarządzanie informatyką w przedsiębiorstwie, Wydawnictwo Wyższej Szkoły Zarządzania i Marketingu w Sosnowcu, Sosnowiec, 12-18.

Kempny D., 2001, Logistyczna obsługa klienta, PWE, Warszawa, 15-20.

Kisielnicki J., Sroka H., 2005, Systemy informacyjne biznesu. Informatyka dla zarządzania, Placet, Warszawa, 20.

Kondratowicz L., 1999, EDI w logistyce transportu, Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk.

Koźmiński A.K., Piotrowski W.,1995, Zarządzanie. Teoria i praktyka, , PWN, Warszawa, 410-440.

Kraemer K.L., Managing Information Systems, In: Handbook of Public Administration. p. 527-544.

Oleński J.,1997, Standardy informacyjne w gospodarce, Wydawnictwo Uniwersytetu Warszawskiego, Warszawa, 22-23.

Shim J.K., Siegel J.G., Chi R., 1999, Technologia Informacyjna, Biblioteka Praktyków Zarządzania, Dom wydawniczy ABC, Warszawa.

http://www.cbos.com.pl

http://www.euroinfo.org.pl/index.php?option=com_content&task=view&id=740&Itemid=39

http://www.idc.com/

http://www.sap.com/

http://www.sap.com/poland/

http://www.keisp.po.opole.pl/dydaktyka/arch_sap.

LOKALIZACJA SOFTWARE'U W LOGISTYCE

STRESZCZENIE. Autor przedstawił problemy związane z lokalizacją logistycznego oprogramowania komputerowego. Przedyskutowano następujące czynniki wpływające na ten proces: informacja i jej rola, globalizacja, internacjonalizm, znajomość języków obcych. Przedstawiono trzy typy lokalizacji w zależności od typu zależności. Główny nacisk położono

na zjawisko obniżenia efektywności w wyniku zakłóceń w komunikacji. Problemy te pokazano na przykładzie oprogramowania SAP R/3. Przedstawiono trzy sytuacje: brak lokalizacji, częściowa lokalizacja oraz nieprawidłowa lokalizacja, niezrozumiała dla użytkowników. Autor udowodnił, że nawet wysokiej jakości oprogramowanie może być mniej efektywne w przypadku niepełnej lokalizacji aniżeli w przypadku kompletnej lokalizacji. Niemniej jednak brak lokalizacji jest uzasadnione w epoce globalizacji.

Słowa kluczowe: informacja, system informacyjny, system informatyczny, lokalizacja oprogramowania.

SOFTWARE-LOKALISIERUNG IN DER LOGISTIK

ZUSAMMENFASSUNG. Der Autor stellt in diesem Beitrag Probleme der Lokalisierung der Logistiksoftware dar. Es werden Implikationsfragen, wie die Bedeutung der Information, Internationalisierung und Globalisierung der Unternehmen oder Fremdsprachen-Kenntinsse erörtert. Es wurden auch Typen der Lokalisierung hinsichtlich der aufgetretenen Interaktionen beschrieben. Der Schwerpunkt liegt auf der Verminderung der Effizienz, die im Falle von IT Systemen infolge der Kommunikationsstörungen am Beispiel des SAP R 3 sichtbar ist. Es wurden drei Situationen dargestellt: völliges Fehlen der Software-Lokalisierung, deren partielle Lokalisierung und Probleme, die im bei einer Lokalierung auftreten, die für den Anwender nicht verständlich ist. Der Autor beweist, dass die Effizienz einer hochqualitativen Software beim Fehlen oder partiellem Fehlen der Lokalisierung abschwächt. Zugleich wird die Effizienz die Leistung der Anwender kleiner als bei den richtig lokalisierten Systemen. Der Autor weist auch auf bestimmte positive Folgen des Fehlens der Lokalisierung im Zeitalter der Globalisierung hin.

Codewörter: Information, Informationssystem, IT Systeme, Software-Lokalisierung.

Dr inż. Marek Matulewski
Higher School of Logistics
Estkowskiego 6
61-755 Poznań/Poland
e-mail: marek.matulewski@edu.wsl.com.pl