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ROZDZIAŁ 10
INTEROPERACYJNOŚĆ STANDARDÓW I ROZWIĄZAŃ W ZAKRESIE USPRAWNIANIA LOGISTYKI ŁAŃCUCHÓW DOSTAW GOSPODARKI CYWILNEJ I WOJSKOWEJ Z WYKORZYSTANIEM SYSTEMÓW AUTOMATYCZNEJ IDENTYFIKACJI
ANNA KOSMACZ-CHODOROWSKA, INSTYTUT LOGISTYKI I MAGAZYNOWANIA

ROZDZIAŁ 10.
INTEROPERABILITY OF STANDARDS AND SOLUTIONS IN THE SCOPE OF IMPROVING SUPPLY CHAINS LOGISTICS IN CIVIL AND MILITARY ECONOMY USING AUTOMATIC DATA CAPTURE SYSTEMS

Anna Kosmacz-Chodorowska[1]

[1] Instytut Logistyki i Magazynowania, Estkowskiego 6, 61-755 Poznań
anna.chodorowska@ilim.poznan.pl

1. Introduction

One of the fundamental tools to improve supply chain logistics is the automatic identification and exchange of business data (ADC - Automatic Data Capture). Among many ADC techniques the bar code technique is the most popular, with a few hundred symbologies. Companies and institutions are still often implementing ADC systems using internal solutions, which are the least useful in improving supply chains or according to domestic, or potentially international, but trade-only standards, thus causing specific difficulties in the use by other members of the supply chain. The application of automatic identification based on the global and inter-sectoral standards and ADC solutions, in line with the global GS1 System as a communication tool in supply chain, is an example of civil technology, the implementation of which helps improve logistics management and cooperation with partners in supply chain. The uniform application of these technologies based on shared standards by all trade partners in the supply chain helps improve the

cooperation and coordination and therefore brings may well-documented benefits, e.g. reduction of lead time, lower out-of-stock rate, lower distribution costs [Halas, Kosmacz-Chodorowska, 2014]. NATO implemented ADC from the beginning in line with international standards and solutions, though only trade ones. Due to the multi-sectoral nature of military supplies, NATO also, in 1998, decided that it was worth to use the civil experience and leverage synergies in military supplies. Between 2000 and 2006 the Polish Armed Forces were ineffectively implementing ADC in line with internal solutions. Therefore the Logistics and Warehousing Institute - GS1 Polska started researching the purpose and applicability of ADC in military economy in line with global standards (implemented globally and in all economic sectors and trades), i.e. in line with GS1 System (formerly known as: EAN.UCC). In consequence, the Polish Armed Forces decided it was worth to use the civil experience and leverage synergy in military supplies.

The objective of the research was to determine shared standards and ADC solutions which, to the largest possible extent, may be applied in practice and in parallel, in both economies. This paper presents the examples of shared standards and solutions applied in practice in terms of improving supply chain logistics, using the automatic identification systems. They have been used in the Polish civil economy for 27 years and in the military economy since 2014 and are promoted in 54 NATO associated countries. The presented interoperability standards and solutions cover:

- ADC techniques and standards applied in civil and military logistics,
- types of objects coded in both economies,
- product, company and logistics unit IDs,
- methods of product data exchange,
- applied bar code symbology,
- types of data according to application IDs, used in both economies.

The application of basic ADC standards and solutions in civil and military economies was researched and the implementation recommendations were drawn up, taking into consideration the specificity of trade and covering the whole of supplies. The identified problems with coding the supplies for each product range, taking into account the needs of civil and military economies, are a topic for another paper. The proposed and implemented solutions regarding codes of retail and non-retail trade items and logistics units, in line with the product range specificity and new ADC solutions proposed by the author for the nearest future, aimed at the reconciliation of requirements and conditions for the logistics of both economies are a continuation of the presented topic.

2. Material and methods

Based on over twenty five years of experience, in line with results of the research conducted at that time and taking into account expert assessment, a review was made of ADC systems implemented thus far, which improved the supply chain logistics in Poland and globally. The works were carried out on products of various sectors of civil economy and military supplies of some NATO associated states. The results and conclusions stem from the original works carried out over the last 6 years for a few hundred civil companies as well as for the military and military suppliers.

3. Improvement of supply chain using ADC

ADC (Automatic Data Capture), e.g. based on bar codes, is an example of increasingly widespread technology, in civil economy, the implementation of which helps improve the management of logistics and cooperation with partners in supply chain. A uniform application of this technology, based on shared standards for all trading partners in the supply chain, helps improve the cooperation and coordination and therefore brings may well-documented benefits. Due to the multi-sectoral nature of military supplies, first NATO, and then the Polish Armed Forces, decided that it was worth to use the civil experience and apply synergy in military supplies [Halas, Kosmacz-Chodorowska, 2014].

A positive example of a synergy effect may be the mutual alignment of the supply and warehouse service process combined with stockholding or mutual adjustment of manufacturing, distribution and procurement processes - thus reaching a higher level of customer service, higher and even level of use of enterprise's resources, lower stock level and shorter working capital cycle [Kisperska-Moroń, Krzyżaniak, 2009]. Access to a growing pool of data, capacity to process and share the data with partners in supply chain are becoming the key issue for the integration of supply chain. Thus the supply chain is slowly transforming into a value chain, wherein the relations with the partners are made stronger and fixed in the processes of mutual improvement of communication channels and assuring the interoperability of IT systems [Feller et al., 2006]. In practical civil economy, the basic tools for integration include: ADC through e.g. bar codes and Electronic Data Interchange (EDI), replacing business documents with standard electronic documents. In ADC and EDI systems, GS1 (Global System 1) standards are most used for identification of trade items, logistics units and locations. In many industries, the civil sector requires tracking products "farm to fork". In the military sector in many countries, there is also the

awareness that it is necessary to introduce improvements in supply chain management in order to track the movement and origin of products "from factory to foxhole" [Harps, 2005]. The principles of civil and military cooperation, and most of all the NATO requirements, as well as the market principle of outsourcing, make the Polish Armed Forces actively participate in the development of logistics, also in the area of automatic product, resource, service and location identification. The GS1 system is in line with the NATO programme of standardisation and interoperability as it boosts the operational capabilities of multinational armed forces through widespread standardisation and unification of basic procedures and components of military logistic supply chains [Ficoń, 2010].

ADC is an automatic, direct upload of data to a computer system or other microchip-controlled device, using dedicated equipment, without the use of a keyboard [Collective work, 2012]. Such an upload of data in required detail, using special electronic equipment called readers or scanners, is a quick and error-free method, contrary to the manual mode which is time-consuming and a source of errors. Due to these benefits, ADC-based IT systems are used to improve the effectiveness of repetitive operations: registration, transaction, supervision and control [Hałas, Kosmacz-Chodorowska, 2014].

ADC techniques are applied in various processes, in particular in warehouse management, procurement, distribution: retail and wholesale, transaction recording etc

4. ADC techniques and standards applied in civil and military logistics

Out of six various ADC techniques in civil and military logistics, two dominate - optical, based on bar codes, and electromagnetic, based on the identification using radio waves - RFID. Bar codes, as the most accessible and cheapest method, are successfully used in warehouse management and in supply chains of both economies. A few of the few hundred selected bard codes (linear and two-dimensional), are commonly used, especially, in logistics, and function as trade or universal, international standards. In special cases, when e.g. bar codes, for technical reasons, may not be used, it is recommended to use radio tags, e.g. to track bulk size resources. This method is widely used by departments of defence, e.g. in the USA and Brazil.

In civil economy the tag/radio tag technology, so highly announced since 2005 as gradually replacing bar codes, is still facing so many obstacles that its domination is unlikely in the foreseeable future. Currently, and to a small extent,

the GS1 logistic labels with GS1-128 code are complemented with radio tag GS1 and global number of logistic unit. The application thereof is justified mainly when the trading partners use EDI, including the standard advice note.

Trade standards must be applied under bilateral contracts and therefore cannot be used in the entire logistic chain. An example of these standards, in civil economy in Poland, is the ODETTE system in the automotive industry and IATA in passenger aviation, and in the military - NATO system in the original version. Some NATO states started with such ADC solutions. At the moment, ADC and EDI trade standards migrate to global standards, but this process is difficult and long-lasting. NATO adopted GS1 global standards (formerly known as EAN.UCC) as late as in 1998, and the Polish Armed Forces had worked on the implementation since 2010, but only the publication of the Decision no. 3 of the Minister of National Defence dated 3 January 2014 (Journal of Laws Dz. Urz. of 2014 item 11), defining the requirements regarding the bar coding of products supplied to the sector of national defence (hereinafter referred to as decision no. 3 MON), based on the results of conducted research and recommendations drawn up based thereon, accelerated the implementation of ADC in the military in line with GS1.

5. Objects coded in both economies

Items to be bar-coded in both economies include most of all: resources, including mostly trade items, logistics units and locations, where:

- trade items include all products (and services) which are traded in civil economy and products which are army equipment, some of which are tangible fixed assets and the other are products issued for consumption and all military supplies. Most products are purchased on an ongoing basis as trade items, in various packaging versions (unit packing or collective packaging, e.g. cartridge box of specific parameters, a bag of sugar, a box of socks) or without packaging (bulk size, e.g. tank, plane);
- logistics units (also known as: transport units, shipment units or unit loads) which comprise any combination of trade items, created for storage or transport, for the purpose to identify and track these units in supply chains. These are then units of any composition, created for the purpose of transport and/or storage, which require the management in supply chain or in warehouse. The most typical logistics units include: palletised goods/products, and also packages with any contents, single items ordered in varying quantities (e.g. a few screws in a polyethylene bag) or singular products which, due to considerable size, comprise a separate trading and logistics unit, e.g. washing machine, car etc.;

- locations, including those of formal and legal nature (identification of companies and institutions and their branches: manufacturers, distributors, logistic operators, retail chains, including suppliers to the military and customers of the military), as well as physical locations, e.g. storage areas in a warehouse and shipment tracking points.

6. IDs used in both economies

For the purpose of ADC implementation, to code items in civil and military economy, basically the same global GS1 IDs are used for globally unambiguous identification of trading, logistics units and location. In the military, in addition, trade NATO IDs are used for international, though trade-only, identification of trade items and for formal and legal location. Additionally, in the Polish Armed Forces, a complementary domestic and trade ID is used for trade items, which serves as a classifier.

Global Trade Item Numbers, GTIN used in civil economy are the following numbers: GTIN-8 (small products), GTIN-12 (product from, or until 2005 - to be sold to the markets of the United States and Canada), GTIN-13 (most widely used) or GTIN-14 (only for non-retail trade units: collective packaging or homogeneous contents or of variable quantity). In Poland, trade item marks assigned only by the recipient are used, partly, in the automotive industry, as the trade international system - ODETTE is being used. This means that each product in the system may have as many various IDs as it has recipients.

In military economy, in some NATO associated states which have not transitioned to the global system, NATO Stock Numbers (NSN) are used as trade item IDs. NSN is an international supply classifier (trade items) denoting the material item of supply as recognised by NATO, according to its purpose. In the Polish Armed Forces mainly GS1 are used as trade item IDs, including most of all GTIN-13, GTIN-14 and, to some extent, GTIN-12. At the same time, if a trade unit has been assigned the NSN number, next to the GTIN global ID an additional, parallel NSN is used. This means that any item of supply identified with an NSN number must be unambiguously identified with a GTIN number. Moreover, the Polish Armed Forces use domestic identifiers of trade items: JIM (Polish: Jednolity Indeks Materiałowy) Standardised Material Index. It is an alphanumeric code, often classifying products according to industry, used only for visual check on supplies. This label is not presented in the bar code, therefore is of no use for automatic identification.

In the case of inventories not yet labelled by the suppliers, before the trade units leave the company/organisation (are used for in-house needs such as: supply

materials) these products may be given (according to GS1) an internal number of GS1 – RCN (Restricted Circulation Number). In 2017 the Polish Armed Forces will still be working on the implementation thereof.

To identify logistics units, both in civil and military economy, most of all the global identifier is used - the SSCC (Serial Shipping Container Code). It is a globally unambiguous code of a logistics unit using an 18-digit standard GS1 number structure (so-called licence plate).

The ODETTE system does not offer a unambiguous identifier of logistics units. To identify location, both in civil and military economy, the global GS1 standard is used, i.e. 13-digit GLN number (Global Location Number), i.e. a globally unambiguous code of an entity, a part or location thereof. In trade solutions, its counterpart is the NCAGE identifier, a NATO supplier code used by those those NATO countries, which have not transitioned fully to global standards, i.e. GLN. In the Polish Armed Forced the GS1 global standards are used to identify all suppliers and ordering parties/customers, i.e. GLN. Also this type of identifiers, based on the results of research and recommendations drawn up on the grounds thereof, is to be used for automatic identification of physical location in warehouses. These codes are currently being worked on.

7. Product data exchange in both economies

The basis for effective ADC and EDI are high quality basic data on products, exchanged between the members of the supply chain using relevant documents. In practice, usually product (trade item) description with GTIN number is entered between the manufacturer and sales outlet, e.g. retail chain, based on the so-called product sheets. The results of research on improvement of the effectiveness of such solutions, widely applied in civil economy at the moment, indicated the purpose of standardising the contents and formats of the sheet so that the manufacturer does not need to describe the same product as many times as they have customers.

Based on the results of research and recommendations based thereon, including the standardised product sheet, a single sheet for all army suppliers has been drawn up, the so-called goods sheet. A template thereof is the element of the Decision no. 3 MON [Decision 3/MON 2014]. At the same time, based on over 3-years worth of experience gained during implementations related to the use of the drawn up goods sheet template in a few hundred companies, it will require a slight modification. The modifications will pertain to the presentation of data regarding shelf life (which cannot be specified in months for all products, e.g. perishable food products, cosmetics, products under warranty, some military equipment for which

e.g. the number of shots fired is essential and not the period of use etc.), dimensions (accuracy of up to 1 cm proved to be too large for some products, e.g. DVD disc). The largest challenge, however, was to prepare the description of all products which, due to e.g. their size, do not fit in one packaging. Relevant modifications are being worked on and after the recommendations have been agreed, the goods sheet template will be modified, as will the Decision no. 3 MON.

While presenting the issue of product data exchanged in both economies, the currently recommended solutions of data exchange were omitted:

- – GDSN networks
- – or relevant EDI documents.

The GDSN (Global Data Synchronisation Network) is an international network of cooperating electronic catalogues, which helps exchange, in a standard manner, information on products and partners / companies / locations to eliminate costs of uploading data from the supply chain to the data owners, mainly manufacturers and recipients - retail chains, wholesalers, online stores.

The second recommended data exchange solutions include the EDI electronic documents which present partner data: PATRIN message and product catalogues: PRICAT message. The messages are elements of the global EDI standard: GS1 EANCOM® (version: EANCOM 7/EDIFACT D.96A), which contains a full set of messages (e.g. order, invoice, advice note etc.) to be used in trading, while based on standard UN/EDIFACT messages and GS1 XML, built based on the UN/CEFACT guidelines (formerly known as UN/EDIFACT). Together, these standards are a collection of compatible eCOM standards to be chosen by a company depending on the preferred technical solution.

Both these solutions are being gradually implemented in Poland, but their scope is still too small, therefore military economy is currently based on a data interchange solution, dominating at the moment in civil economy, i.e. goods sheets.

8. Bar codes symbologies used in both economies

Out of over 400 symbologies (types) of bar codes developed thus far, only a few have been regarded as global standards to be applied in supply chains. These codes include GS1 bar codes, including EAN/UPC group, ITF-14, GS1-128 codes (former names: UCC/EAN-128 or EAN-128), GS1 DataBar, GS1 DataMatrix, Ad on 2 and Ad on 5, GS1 QR.

The GS1 system is using the codes specified above and each of them has a specific application. Linear codes: EAN-13 and EAN-8 as well as UPC-A and UPC-E – are put mainly on individual products and scanned during retail sale. The

ITF-14 code helps identify trade items in some bulk packs and GS-128 symbology is used mostly to code specific data, e.g. on a logistics label. GS1 logistics label, e.g. with a palletised unit loads/transport unit/logistics unit, is moved from the supplier of raw material, semi-finished product, packaging or consumer products and other goods to their destination. On the other hand, linear codes of type: GS1 DataBar or two-dimensional GS1 DataMatrix and GS1 QR codes may include at least the same information as the GS1-128 code, but owing to their structure, they take up much less space than a linear code and thanks to that they are mainly placed on small packagings [Kosmacz-Chodorowska, 2016].

In trade solutions, linear bar codes are used most often: code 39 and 128 as well as two-dimensional PDF 417 and DataMatrix, used also in in-house solutions, and recently also the QR code has been used in data interchange. These codes are also applied in military economy by these NATO states which have not fully transitioned to global GS1 standards.

The Polish Armed Forces, in line with the research results, adopted for use all GS1 code symbologies, including in particular EAN-13 and GS1-128. Thanks to that full inter-operability has been achieved in the discussed scope.

Probably, in the next implementation stage, the Polish Armed Forces will adopt the GS1 DataMatrix code, as did Bundeswhera, the German federal armed forces, or they will choose a fuller application of RFID tags in line with GS1. The answer to question which of these solution proves more effective requires further research.

9. Types application ID used in both economies

Standard data identifiers include:

- GS1 Application Identifiers, GS1 Application Identifiers (GS1 AI)), formerly known as IZ EAN.UCC, are global data identifiers: two, three or four digits at the beginning of a string of elements which clearly identify the type and format of business data in the global GS1 system. These data are most often encoded in GS1-128 symbology.
- ANSI/FACT ID ANSI/FACT, FACT Data Identifiers - ID FACT) international data identifiers: two or more digits, always with a letter, at the beginning of elements encoded in the bar code symbol, most often Code 128 or Code 39 which define its format and meaning, for applications agreed on bilaterally.

In civil economy mainly the GS1 Application Identifiers are used, and the trade ANSI/FACT only to a small extent, e.g. the are still used in Poland, in the automotive industry. Our of several dozen GS1 AI, the Polish Armed Forces adopted those which are also the most popular in civil economy [Kosmacz-

Chodorowska, 2014 (b)]. The list of business data used in ADC according to the GS1 AI and in both economies is presented in table 10.1.

Tab. 10.1 List of GS1 Application Identifiers adopted in the Ministry of Defence.

No.	IZ GS1	Purpose
1.	IZ 00	to mark all logistics units with SSCC number
2.	IZ 01	GTIN to mark each non-retail trade item
3.	IZ 02	to mark the contents of a non-trade logistics unit of homogeneous product contents according to GTIN
4.	IZ 37	to mark the number of products in a logistics unit
5.	IZ 11	to mark the production date of technical products
6.	IZ 13	to mark the date of packing mix-type logistics units
7.	IZ 15	to mark quality data: Best Before for food products
8.	IZ 17	to mark the shelf life for medicines and, non-compulsory, for other medicinal products
9.	IZ 21	to mark the serial number of products which have this number
10.	IZ 10	to mark the production series/batch for all other products
11.	IZ 310n	to mark variable product quantity: in kg
12.	IZ 311n	to mark variable product quantity: in m
13.	IZ 315n	to mark variable product quantity: in l
14.	IZ 400	to mark the order number on mix-type logistics unit
15.	IZ 410	to mark the supplier's GLN of each logistics unit
16.	IZ 412	to mark the GLN of the recipient on mix-type logistics unit
17.	IZ 7001	to mark NSN of products that have the NATO Stock Number

Source: own study

Trouble, however, could not be not be avoided. During the implementation of the provisions of Decision no. 3 MON it was found that it did not include marks for goods not fitting in one packaging, for which the GS1 provides for an individual Application - IZ 8006. Moreover, Application Index - IZ 90 (used for bilateral reconciliation) was included needlessly to mark the so-called batch of assembled

combat assets, and this turned out to be a counterpart of production batch, identified by IZ 10. For the above reasons, GS1 Polska, in cooperation with the military, will develop a draft annex to the Decision no. 3 MON, in cooperation with the military.

According to the research results, the army put to use the GS1 Application identifiers, including the most popular ones also in the civil economy. The Polish Armed Forces outdistanced, in this respect, the typically civil companies by introducing comprehensive marks for ADC purposes on all non-retail trade items and on all logistic units and on some retail trade items, but this is a topic to be discussed.

10. Results

Based on the standards and solutions used in civil economy, the following was prepared for the military economy:

- principles of coding military supplies in individual packagings according to their function in the supply chain, i.e. specifying: retail and non-retail logistic and non-logistic trade item, of fixed and diverse contents of single products and of varied quantity; in specified units of measure, for individual product ranges, covering total supplies [Kosmacz-Chodorowska, 2014 (a)],
- principles of coding stocks held by: companies - customers and the military, not labelled with GS1 bar codes of the suppliers,
- assumptions for the ADC system implemented currently in the Polish Armed Forces,
- principles of comprehensive verification of codes, made for the military since 2014.

The Polish Armed Forces, by starting the reorganisation of logistics and launching large warehouses, are currently implementing the ADC based on GS1 bar codes, in line with the results of completed studies.

The selection of standards and solutions regarding: types of business data, data formats and bar code symbologies, taking into account product ranges, which are in the military referred to as material groups, covering in total all types of goods traded in civil and military economy, comprises original research achievements in the area of interoperability [Kosmacz-Chodorowska, 2015].

Moreover, further needs were identified regarding the development of GS1 standards in order to comprehensively code the goods which do not fit in one

packaging (e.g. due to size, weight of logistic conditions), i.e. furniture in a number of packages.

11. Conclusions

The works conducted to date for the military and related suppliers indicate a considerable extent of alignment between the standards and solutions proposed, in the discussed scope, as a result of the research and being currently implemented, thus achieving significant interoperability.

The research confirmed the usefulness of GS1 standards and solutions, used to date mostly in trade operations of consumer goods manufacturers (in particular FMCG) and retail chains , also for other sectors of the economy, including heavy and machine industry and precision engineering etc.

Concurrently, discrepancies were identified and their significance for interoperability determined; and solutions were proposed to increase interoperability. The results of these works, after confronting them with members of the supply chain to the military in 2017, will become a business practice in Poland, which other countries may follow.

It is recommended to distribute the results of the works performed to date at home and abroad, taking in particular into consideration the absence of publications regarding the discussed topics. The identified current market needs require the following measures:

- development of a proposal of a new, extra standard and solution under GS1, in order to achieve comprehensive coding of goods that do not fit in one packaging,
- testing and comparing the effectiveness of the automatic identification of individual packagings / goods using bar codes and radio tags.

Therefore there is a need for further research, including in particular to develop good practices, to make it easier to implement, at home and abroad, the recommended standards and solutions to improve the supply chain logistics in civil and military economy, using ADC.

Acknowledgments

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