GLN standard as a facilitator of physical location identification within hyperconnected logistics

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Abstract: *Distribution, from the business point of view, is a set of decisions and actions that will provide the right products at the right time and place, in line with customer expectations. It is a process that generates significant cost, but also effectively implemented, significantly affects the positive perception of the company. ILiM, based on the research results related to the optimization of the distribution network and consulting projects for companies, indicates the high importance of the correct description of the physical location within the supply chains in order to make transport processes more effective. Individual companies work on their own geocoding of warehouse locations and location of their business partners (suppliers, customers) but lack of standardization in this area causes delays related to delivery problems with reaching the right destination. Furthermore, cooperating companies do not have a precise indication of the operating conditions of each location, eg. Time windows, logistic units accepted, unloading supporting equipment etc. Lack of this information generates additional costs associated with re-operation and the costs of lost benefits for the lack of goods on time. The solution to this problem seems to be a wide-scale implementation of GS1 standard, which is the Global Location Number (GLN) that, thanks to a broad base of information, will improve the distribution processes within hyperconnected logistics.*

Keywords: *GS1 standards, GLN, distribution process, physical location identification, hyperconnected logistics*

1 Introduction

Physical Internet concept requires new standards in terms of distribution within hyperconnected logistics. One of them is an unified physical location identification that would support and ease word wide deliveries. Global Location Numbers that is a key concept in EDI seems to be the best solution for PI. It provides the globally unique identification needed to securely exchange business information on the Internet as well as unambiguously identifying all legal entities, physical/operational locations described in business documents. GLNs ensure lean and efficient communication and processing since names, addresses and other information about particular locations do not need to be communicated with every transaction. The necessary information is communicated only once, stored in the relevant system (e.g.Enterprise Resource Planning system) and subsequently retrieved by referring to a globally unique GLN. It allows computers to route information to the correct destination with no manual involvement. GLNs must be used when identifying locations and trading partners within Electronic Data Interchange (EDI) business messages and data pools, and they can also be used in barcodes to identify a physical location or to provide relevant information for delivery or invoicing purposes (http://www.gs1.org).

2 Physical Internet - hyperconnected logistics

Logistic networks intensely use means of transportation and storage facilities to deliver goods. However, these logistic networks are still poorly interconnected and this fragmentation is responsible for a lack of consolidation and thus efficiency. To cope with the seeming contradiction of just-in-time deliveries and challenging emissions targets, a major improvement in supply networks is needed. This new organisation is based on the universal interconnection of logistics services, namely a Physical Internet where goods travel in modular containers for the sake of interconnection in open networks (Sarraj et al., 2014).

The Physical Internet has the potential of revolutionizing the fields of material handling, logistics, transportation and facilities design. It exploits the enabling concept of standardized, modular and smart containers as well as the universal interconnectivity of logistics networks and services. Its underlying paradigm shift creates a tremendous breakthrough innovation opportunity for the material handling and facility logistics community in terms of equipment, systems and facility design and operation (Montreuil et. al., 2010).

The definition of Physical Internet, proposed by Montreuil et. al. (2014) is as follows: "The Physical Internet is a global logistics system based on the interconnection of logistics networks by a standardized set of collaboration protocols, modular containers and smart interfaces for increased efficiency and sustainability" (Ballot et al., 2014).

The concept of Physical Internet aims to create a logistics system in which there is unwavering flow of information and cooperation goes far beyond the standard schemas. Physical Internet is based on the full sharing of the supply network, resources and infrastructure, while leveraging standard, modular packaging. It is planned to replace the existing models. Its foundation is the cooperation of all entities involved in the distribution of goods and the full flow of information between them. Physical Internet aims at transforming handling, storage, distribution and implementation of the supply of goods, aimed at increasing the efficiency of global logistics and sustainable development (Zdziarska, 2015).

To prove efficiency of postulated concept many test, research and projects were conducted. Sarraj et. al. (2014) modelled the asynchronous shipment and creation of containers within an interconnected network of services in order to find the best path routing for each container and to minimise the use of transportations means. To carry out the demonstration and assess the associated stakes they used a set of actual flows from the fast-moving consumer goods sector in France. Various transportation protocols and scenarios were tested, revealing encouraging results for efficiency indicators such as CO2 emissions, cost, lead-time, delivery travel time, and so forth.

This innovative concept is based on three main pillars. The combined infrastructure means that companies start to take action aimed at optimizing the operation of such resources like storage space, vehicles capacities and production systems through sharing. The current situation shows that most companies are not in a position to fully exploit its potential, thereby freezing their capital. The market of logistics services will strive to create a common infrastructure. Logistics centres, hubs and transit points located all over the world will be widely available to all operators, thus creating one global network. The ability to use a large amount of docs will increase the efficiency of transport. P&G and Tupperware conducted the first tests of such activities. Thanks to the collaboration and joint programming of supplies, they were able to reduce logistics costs by 15%, reduce CO2 emissions by 2 million tonnes per year and increase the vehicle utilization from 55% to 85%. But these are not the only such

initiative in the market. Companies such as Walmart, HP, Volvo and Boeing are also heavily involved in the implementation of this concept among its business partners.

The second area is the introduction of modular cargo units. Trying to be achieved with analogy of the Digital Internet data distribution in physical processes in the real world. Digital Internet does not provide the information but only transmits packets with embedded data. These packages are designed in such a way as to be easily recognizable by internet networks. Information in the package is closed and is not directly decoded by the network. The packet header contains all the information necessary for the identification and designation of transit routes to the destination. Digital Internet is based on protocols that structure the data packets regardless of the mode of transmission. In this way, they can be processed in different systems and networks such as modems, fibre optic cables, routers, local area networks, Intranet, Extranet and virtual private networks. Similarly to the Physical Internet (open logistics network) will not handle the goods directly (whether they are raw materials, components or finished products), but only manipulated specially designed modular containers that allow an encapsulation of these goods. Target solution involves a complete change of pallet system into modular loading units. This involves, of course, the adaptation of vehicles, handling equipment and warehouse space that will allow handling this type of packaging. However, simulations conducted for research projects clearly demonstrate that the investments made in the long term will help to significantly reduce logistics costs and losses related to the movement of goods. Containers thanks to the folding panels can create boxes of various sizes tailored to the individual needs of the sender. M-Boxes are easy for handling, storage, transport, loading and composition. They have a standard phrases recognizable throughout the system and are equipped with sensors and transmitters to maintaining full control during the transportation process. As a result, shipping safety is maintained throughout the journey, and all actors involved in the distribution have full overview of the status of the order. Moreover, the package is reusable and easy to recycle.

The last pillar is the exchange of data. This is the most crucial element of the whole concept. Physical flow of information in the Physical Internet will operate through an integration of infrastructure. In the PI you would be able to report and organize the individual orders from your own ERP system in a standardized format, which will be processed into 'the cloud' and decrypted by the other participants in the process. An important aspect in this data exchange is the access level. The architecture concept, developed so far, has designated four areas. Information on the container (its designation, dimensions, special conditions of carriage) will be available to all, then the data associated with the transport process (detailed route and delivery address), reserved only for the carrier. Another area is an information covering the delivery data such as sender and recipient, description of goods, value of the contract and the terms and time of delivery. For this type of data only logistics operators and customs will get an access. Most sensitive information will be used only by the sender and recipient, and will be associated with contracts, number of orders, invoicing or discrepancies in the delivery.

Logistics service providers, carriers and owners of the storage infrastructure will also share their detailed information. They will provide information on the availability of their resources, capacity and the status of implementation of orders. By combining all these data, the system will optimize the process and suggest the best possible solution for minimizing the cost of each of the participants in the process. Physical Internet is called the concept of win-win-win, because it allows the balanced growth of all actors in the supply chain. (Zdziarska, 2015)

Although a lot of work has already been done, concept of the Physical Internet will not be able to emerge globally without international unified standards. One of the most significant problem in terms of deliveries in hyperconnected supply networks is lack of detailed

information about destination points (both physical location and their characteristics). Basic address and postal code is no longer sufficient. Physical Internet to work smoothly needs a wide range of logistic information that will be easy to send, transform and decode by any IT tool within the PI system in order to organize deliveries in dynamic environment. Physical Internet needs one unified number of the client (destination point) that will be understandable for everyone and identified with ease within the whole network.

The answer to these needs seems to be the GLN (Global Location Number) standard developed by GS1.

3 Characteristics of GLN standard

All organizations exchange information in business processes, both internally and externally. Global Location Number (GLN) uniquely identifies these entities and their positions (Nakatani, Chuang, Zhou, 2006). GLN is a globally unique number that can be used to gain access to basic data about the physical location of the objects (example on Fig. 2).

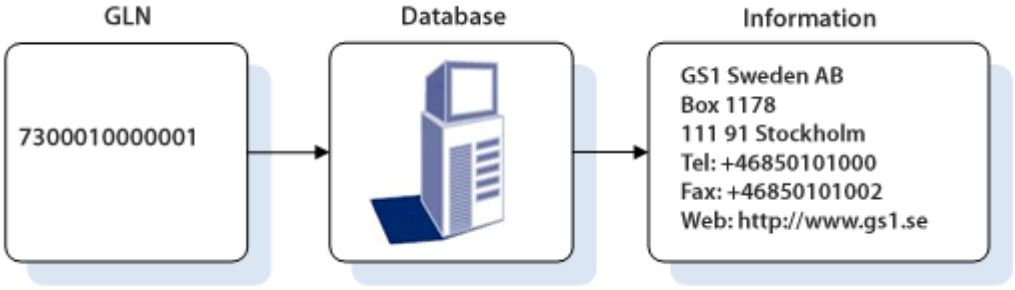

Figure 1: Example of information that can now be retrieved from the database using the GLN identifier
Source: http://www.gs1.se/en/our-standards/Identify/gln/

GLN is a key identification tool (according to GS1 standards) used to identify any location (physical, digital, functional or legal), which must be defined for the needs of processes in the supply chain.

3.1 GLN standard and its value for the customer

The primary use of GLN is to identify the company in business transactions, such as sending orders and invoices. If the company has buildings in different locations, it may need to assign the GLN to each object. This is especially important in the loading and delivery process to factories, warehouses, distribution centers and stores.
GLN enables companies to efficiently perform various operations and implementation processes without the need to repeatedly transmit the address or other location data (Śliwczyński, Hajdul, Golińska, 2012). Supply chain can efficiently perform transactions, knowing that the information associated with each of the sites is accurate, so you will direct the flow of goods and services in the right place. GLN identifies not only particular area, but also information about the locations and its additional attributes that may be used in the process of distribution. Usage of GLN positively affects the precision and accuracy in communicating and sharing information about the location of the transaction. In addition, all the data is stored in a central database, which reduces the effort needed to maintain and transfer of information between the stakeholders both nationally and globally.

Global Location Number can be used to identify the various organizational units. Under the principle of allocation GLN is distinguished by its 4 main types:

- physical location: the place (area, object or group of objects)
- legal entity, every company, government body, department, charitable organization, person or institution having the ability to enter into agreements or contracts,
- function: the organizational department of the company in separate structures on the basis of specific tasks / functions
- digital location: the location represents the digital electronic address (not physical) used for communication between computer systems of individuals

GLN assigned to the company tells us "who?". GLN assigned to the physical location tells us "where?" The ability to determine "who" and "where" in business processes makes the GLN an essential key to tracking the flow of products and information in the supply chain, and to increase the visibility and location authentication.

Structure of GLN

GLN is a 13-digit code consisting of the Company Prefix by GS1, a reference to a specific location and a check digit (structure is shown on Fig. 3).

Figure 2: GLN Structure
Source: http://www.gs1.se/en/our-standards/Identify/gln/

- GS1 Company Prefix - awarded by the state organization GS1 user / subscriber
- Localization Number - assigned by the company to a specific object
- Check digit - calculated according to a standard algorithm helps ensure the integrity of the system.

GLNs are recognized by the Center for the United Nations as a tool for the implementation of improvements in trade and electronic commerce (UN / CEFACT). The extension component is optional - it is the attribute data of 20 characters used to identify physical internal locations in the object specified in the GLN (for example: shops, factories, buildings). Companies can assign unique GLNs to accurately identify the internal locations of a specific area, eg. rooms in buildings or slots in warehouses.

Using the GLN bar codes and RFID applications

Like all GS1 identifiers, GLNs can be presented in the form of a barcode or EPC / RFID for efficient data collection (Ramos, Lazaro, Girbau, Villarino, 2016; Nam, Yeom, 2011). The three most popular use:

- Marking a physical location - GLN encoded in the carrier data, such as a bar code to identify the physical location, a ramp or shelf storage,
- Logistic label by GS1 standard - GLN specifying the place of delivery of encoded carrier data on the label,
- Label with a trade - GLN encoded in the carrier data in order to determine the trading party on the label.

Regardless on its presentation form, GLN could be used in different situation of data exchange process – some are shown on Figure 3.

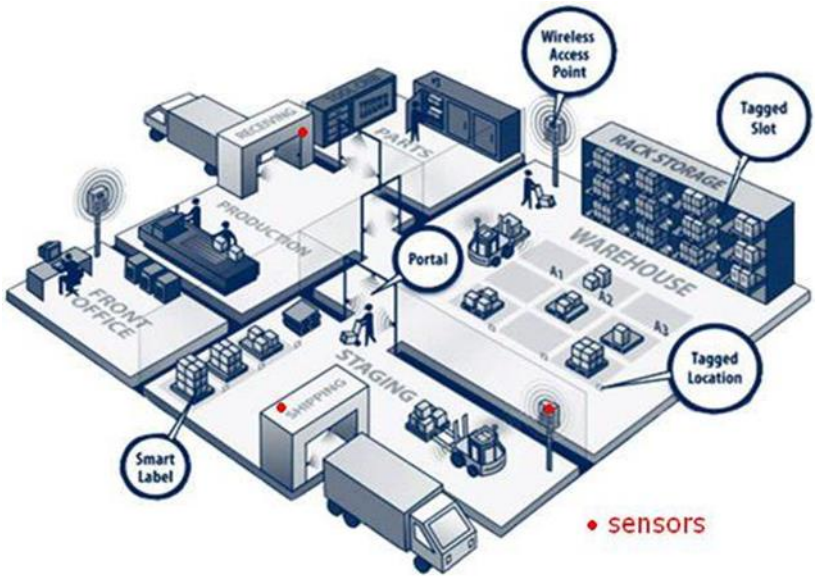

Figure 3: Use of GLN in the process of data exchange
Source: Own elaboration by ILiM

Electronic Data Interchange (EDI) ideally uses Global Location Numbers (GLN) to identify trading partners and their physical locations. EDI mailbox and network addresses can also be identified with GLN. EDI standards promoted by the GS1 System (EANCOM GS1 XML) use GLN to simplify the message in the course of trade.

GLNs are a key concept in EDI. They represent a unique global identification standard needed to secure exchange of business information in the Internet, as well as uniquely identify all legal, physical and functional entities described in the working documents.
GLNs provide efficient communication and processing of data as names, addresses and other information about the individual locations / entities that do not have to be transferred in each transaction. The necessary data is transmitted only once, stored in the system (eg. ERP) and then recovered by reference to the globally unique GLN (Fig. 4).

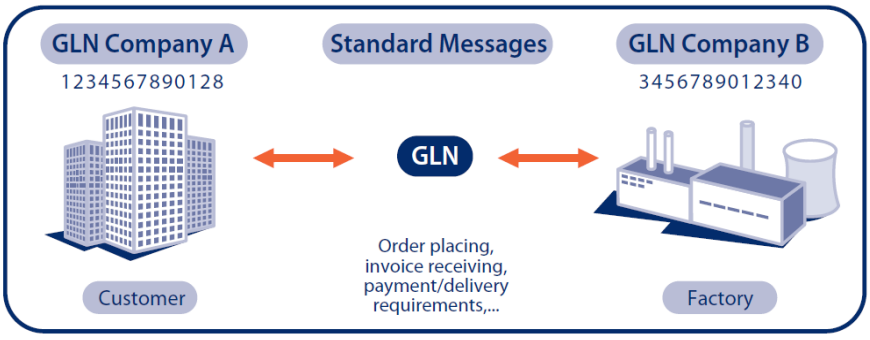

Figure 4: Use of GLN standard
Source: Own elaboration by ILiM

4 Research methodologies exploring the GLN standard implementation

Research into the use of the GLN standard is based on the methodology outlined in Figure 5.

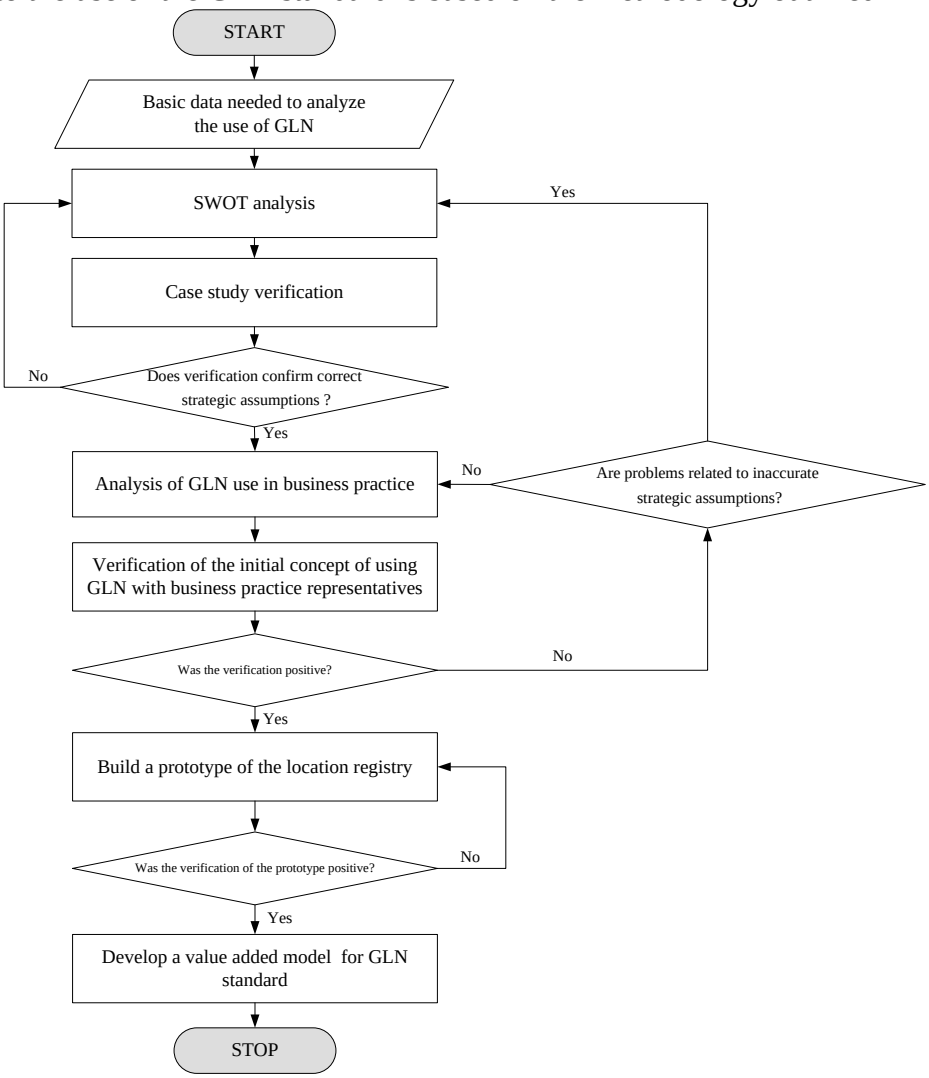

Figure 5: Methodology of GLN application analysis in information flow efficiency
Source: own elaboration

Developed methodology enables the case study method to be repeatedly applied as an effective research method, allowing multi-criterion analysis of the problem. The case study is designed to show the relationship between phenomena occurring in the described processes. Quantitative methods based on a statistically representative sample do not allow such analyzes. Taking into account the specifics of the GLN standard usage, the author have studied a multiple cases in order to compare variant features in a larger case. Case-by-case review is considered to be more reliable than a single case study (Eisenhardt, Grabner, 2007, p. 27), as it enables a description of the differences and similarities between the analyzed variants to identify general trends. In the literature on the subject of the ability to verify models through case studies, you can find different views on the number of variants to be analyzed so that the conclusions of the study are scientific in nature. The dominant view suggests to conduct four to ten case studies (Eisenhardt, Grabner, 2007; Yin, 2009). The verification of the use of GLN in practice was based on 8 case studies that allow author to create the general trends.

Presented methodology also uses observations and consultations on the degree and conditions of using GLN in the leading logistics companies, which increases the reliability of conducted research in this field. The next part of the paper presents the steps of the research carried out in accordance with the presented methodology.

4.1 GLN standard SWOT analysis

In order to explore scientifically the possibility of GLN standard author conducted SWOT analysis based on secondary research: literature, materials available on the enterprises and existing case studies described in research and optimization projects.

Table 1: SWOT analysis

S – Strengths	**W – Weaknesses**
- All the benefits of GS1 standards: global, international, simple structure, coding in various forms (EAN, RFID / EPC) - Data protection - you cannot directly identify the location of the object - Ability to use different angles: legal, physical, functional - Allows reduction of returns due to incorrect address information delivery - The ability to extend the range of information related to the GLN (ie. Geolocation, driving directions, characteristic of delivery places) - Precise uniform nomenclature (the problem of many towns of the same name) – errors exclusion / duplication of company names, cities, - Numbers can be given by the independent body (eg. Public administration) - The ability to extend the GLN (GLN extension component) to address internal location - The ability to easily "connect" local routes planning of the register (API) - Benefits of the registry: - unified way to collect and store information - single point of access to data	- To be given GLN you must be a member of GS1, - Currently GLN in Poland applies only to businesses - no application for the couriers industry services for private customers - No description of good practices to use GLN in Poland - A large flexibility in assigning numbers within prefix, lack of mechanisms to control (except for providing unique number) of the information contained under no clear structure (everyone can construct any name, description) - Locations with no classification (flat floor, loading gate) - Descriptions are created based on the knowledge not on the needs - Lack of a public database / registry in Poland - Lack of knowledge - necessary education among current and potential users
O – Opportunities	**T – Threats**
- Ability to use in public administration - Existing use cases - the ability to take advantage of the experience - Ability to top-down / administrative updates (eg. Change zip codes, street names, etc.). - Low margin (every penny spared counts) - environmental savings through better route planning and avoiding mistakes - Trend for the digitization and standardization - digital exchange of information - The trend to globalization - a very useful especially in international transport, - Physical Internet - distribution planning, accounting, data protection - The notion of large entities (companies - eg. Retail chains (case codes requirements GTIN), offices - case number NIP, REGON) will result in avalanche expansion of the system.	- GLN topic did not came out from the potential users but from the supplier (GS1) - Lack of GS1 Global coordination (Global Location Register) on local activities - The high cost of reaching the stage when the GLN and the register will be widespread and benefits will be tangible / incentives of joining / using the system - Expected "resistance of the stakeholders" if it is not tangible

Source: Own study by ILiM

4.2 Research on use of the GLN standard in enterprises

Despite several satisfactory implementations of GLN standard in Europe, this topic is not very popular in Poland, and the content of the national database still leaves much to be desired. The results of surveys among the leading Polish enterprises in the TSL conducted in the second half of 2016 indicate an unsatisfactory degree of implementation of the transport processes, resulting from incorrect or inaccurate description of the location, and thus, a significant number of errors in deliveries.

Lack of details about location generates enormous costs on both the supplier and the customer site. Therefore, the efficient retrieval of information regarding the location and including elements such as time windows, time of unloading, conditions for unloading etc. would allow the optimization of the distribution process and delivery within the prescribed period (no need to re-supply, eliminating the cost to the operator). One of the solutions to avoid supply problems is to implement register of locations using GLN numbers. Such a register in addition to the address data identifying specific company would have information about the characteristics of the location such as unloading conditions, opening hours, time windows, ramps, etc.

Accordingly, the literature and examined case studies indicate the possibility of using GLN standard to identify the physical location and to show the perspective of its implementation in the TSL industry. In the next section, author present materials that were collected during the meeting on the current problems of enterprises in the location identification. The meetings were characterized by the Delphi study using the method of network thinking.

Conclusions from the research studies:

- Companies create their own address database with relevant logistics information and individualized information regarding the location - this is due to the lack of unified market standards of such data collection and lack of access to an open database,
- Customers of contract logistics, even though many of them are members of the GS1 organization, do not fully benefit from the opportunities offered by the GLN, that makes it difficult to work with logistics operators,
- Problem of who will be responsible for updating the database. The essence of the registry is preserved only when it is valid and reliable,
- An important player for a greater popularization of the use of GLN are **retail** chain stores – they may force their suppliers and logistic operators to participate in the GS1 System,
- The problem is the low level of awareness and knowledge among entrepreneurs about the benefits that entails the use of a GLN standard.

4.3 Verification of the location register prototype

In each meeting, the participants verified or added the data fields to the location register prototype. The most common needs for additional location information:

- Categories of materials stored (eg. Food, chemicals...),
- Accepted logistic units (eg. Pallets, containers, roles...),
- Ability to accept the goods with temperature control - frozen or fresh goods,
- Storage Temperature,
- The possibility of storing ADR materials (eg. Gas, explosive substances and articles, flammable liquids...),
- Supported transport (eg. TIR, tanker, tilt, cold ...),

- The landing surface,
- Types of ramps (eg. A simple, gear, stepped ...),
- Equipment of the ramps (eg. Crane, lift, loading bridges ...),
- Technical conditions of the ramps (eg. Turning radius, maximum load, height ...),
- Technical delivery conditions (eg. Pallets arranged by narrow side, the wide side, stackable acceptable...).

Because of the strictly defined information structure for GLN standard and its large number and requirement for a relatively quick access to the on-line data, it is proposed to use a relational database in conjunction with a Web site allowing interactive access to the base in order to view, add, edit and delete records.

4.4 Developing the proposal value model for use the gln standard

In the second half of 2016 at the headquarters of ILiM author organized a meeting, which the main aim was to develop a business model and determine the unique value proposition, which entails the use of a GLN standard in the TSL.

One of the most popular concepts in defining business models is the Business Model Canvas by Alexander Osterwalder. This model accurately describes how organizations create and deliver value to its customers. The model is presented by 9 elements that represent different aspects of the enterprise.

Description of individual parts should start from the most important of them, that is, customer segmentation (1). It is the basic model. It defines different groups of recipients, which receive the added value produced by the company. Customer segments identified for GLN are mainly companies from the TSL industry, retailers and producers with an extensive distribution network.

Another key aspect is the value proposition (2), which is to satisfy the specific needs or solving customer problems. In other words, the value proposition is a set of perks that the company offers to its customers. Author defined the following advantages within GLN standard:

- reduction of costs associated with re-handling the point and the cost of lost benefits due to the lack of goods on time,
- discount on transport companies for use GLN (win-win situation),
- easy update of data visible to everyone in the database,
- access to full location information in one place,
- reduction of delays and increase of on-time deliveries,
- reduction of errors in the delivery,
- a positive impact on Customer Service rates,
- guidance on the selection of the vehicle by the carrier,
- the appointment of load (eg. Stacking pallets in AMAZON),
- guidance for on time delivery and advising,
- directions, coordinates.

Channels (3) is an element that describes how the company communicates and gets to customers segment to provide added value and knowledge about the product. In its activities, the organization GS1 may use the database of GS1 members to promote GLN content (eg. trainings, webinars, brochures, newsletters) to disseminate knowledge about the GLN through partners (eg. The Ministry, ILiM), contact with the associations of producers / clusters / Chamber of Commerce, share information in magazines and at industry conferences (eg. ECR Forum) and publication of good practices on web sides of GS1 and partners.

The element named customer relationships (4) describes the type of interaction that the company establishes with separate customer segments. As part of the implementation of the GLN, GS1 will build a personal relationship with the customer (consultants for individual support to replenish and register GLN - the co-value) and the open access to the database - automatic assignment to the self-service platform.

Structure of revenues (5) describes the way the company generates profits of individual customer segments. In the case of GLN standard income will come from fees for granting the pool of numbers and the fee for participation in the GS1 System.
Key resources (6) are necessary to generate benefit and reaching out to segments of customers through distribution channels. The main resources identified for GLN:

- GLN hotline supports clients in completing the data,
- database of registered numbers GLN - ICT infrastructure,
- Internet platform with access for the user,
- technical consultants (human resources),
- financial resources to carry out the educational and promotional activities,
- intellectual resources related to the brand and the rights to the GS1 GLN standard,
- database errors, problems, additional costs created by the industry TSL, which allows to calculate the potential savings from the use of GLN and thus, the basis for the promotion of the standard.

Key actions (7), the most important tasks that the company needs to do to provide benefit, establish a relationship with customers and generate revenues. The creation of a fully functioning registry GLN is associated with:

- the introduction of customer support services for the creation and configuration of the base,
- filling and update the database and quality check of the information entered by the customer,
- increasing awareness of members of the GS1 and their need to use GLN - trainings, webinars,
- creation of case studies with examples and implementation of pilot actions,
- analysis of data from the database of interference - to calculate the costs of errors by logistics operators,
- joint projects with operators, retailers and manufacturers in order to complete GLN registry in cooperation with retail chains,
- consultations with the public administration (eg. Ministry of Development, Ministry of Digitization).

The concept of key partners (8) describes a network of suppliers and contractors who make the service implementable. In case of GS1 we are talking about state administration (eg. Ministry of Development, Ministry of Digitization), large logistic operators (eg. Dachser, Raben, Schenker, etc.), Institute of Logistics and Warehousing, large retail chains (eg. Jeronimo Martins) and producers who are members of the GS1 system (eg. Kompania Piwowarska, Colian, Zywiec Group, etc.).

The last element is the cost structure (9) - all the expenses, which are generated by the business model i.e. creating and delivering value, maintaining customer relationships and generating revenue. As part of the implementation of GS1 standards, we have to deal with the cost of creating the GLN register (the conception and information technology), the cost of

data collection and individual customer support in rectifying the base and the cost of promotional activities and education.

5 Conclusions

In this article, author presented the case of the efficiency of the flow of information in enterprises and supply chains, using the Global Location Number (GLN). Both theoretical considerations, supported by expertise in creating SWOT analysis of the discussed issues, as well as research conducted by the Institute of Logistics and Warehousing, on the use of standard GLN to improve the identification of physical and unification descriptions of locations, indicate the potential for new opportunities for the use of GS1 standards in the integration of information flow in economic practice within supply chains.
Based on the results of work carried out in the framework of the study author can draw the following conclusions:

- there is a market need for both research and design work associated with the construction of GLN location register in the practice of economic enterprises,
- effective implementation and popularization of location register requires not only the support of major players in the market, or industry leaders, but also scientific support for the conceptual work,
- strong interest in economic practice in the construction of GLN location register is proof of the need to propose business solutions, allowing their practical application, but also the existence of the possibility of continuing further research in this area.

Presented, in this article, case studies, regarding the specifics of distribution processes, were based on research and observations carried out in the leading logistics companies in Poland. The test results are only a basis for further studies in the use of GLN in the flow of information throughout the supply chain.

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