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Pallet Tracking and Cost Optimization of the Flow of Goods in Logistics Operations by Serial Shipping Container Code

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***Abstract*—**The case study method in this paper shows the implementation of Information Technology (IT) and the Serial Shipping Container Code (SSCC) in a Croatian company that deals with logistics operations and provides logistics services in the cold chain segment. This company is aware of the sensitivity of the goods entrusted to them by the user of the service, as well as of the importance of speed and accuracy in providing logistics services. To that end, it has implemented and used the latest IT to ensure the highest standard of high-quality logistics services to its customers. Looking for efficiency and optimization of supply chain management, while maintaining a high level of quality of the products that are sold, today's users of outsourced logistics services are open to the implementation of new IT products that ultimately deliver savings. By analysing the positive results and the difficulties that arise when using this technology, we aim to provide an insight into the potential of this approach of the logistics service provider.

***Keywords*—**Logistics operations, serial shipping container code, SSCC, information technology, cost optimization.

I. Introduction

IN today's competitive global marketplace, efficiency and timeliness are important qualities for business success and stay in the market. In addition to producing high quality products, an increasing focus in business is on market transactions, i.e. quality assurance flow of goods. The effectiveness and efficiency of logistics requires constant development and investments in the information system of integrated logistics (ILIS) [6].

In particular, the ability to monitor products through each segment of the supply chain becomes essential for firms operating in the logistics sector. The increasing use of Electronic Data Interchange (EDI), and Automatic Identification and Data Capture (AIDC) has increased productivity, while reducing costs, the cycle time of ordering, and the cycle time of delivery, as well as also allowing for greater focus on the customer.

By using EDI, time is optimized and the possibility of error in the exchange of administrative messages (such as ordering, dispatches, receipt, invoices, payment notifications, and inventory status) is reduced. Only the full compliance of physical markers at all hierarchical packaging levels (AIDCs) and EDI data can achieve the full efficiency of all information systems in the supply chain [1], [2], [8], [15], [20].

For timely and accurate provision of logistic services while reducing costs during freight transport, it has become necessary to accelerate the process of sending and receiving products, and not just providing the documentation required for safe commodities in logistic operations. That is why log shipping labels with an SSCC are used with all other components of IT support. The SSCC is an 18-digit digital numerical data structure whose uniqueness is ensured by using a unique GS1 System Marking System (a historical sequence established in 2003 by the European Article Numbering Association). GS1 standards connect all the logistics chain's stakeholders: manufacturers, distributors, retailers, hospitals, carriers, customs officers, developers, local and international bodies. The basic purpose of using log shipping labels with SSCC is that the various product information (located on pallets, containers or cartons) is automatically and quickly processed as soon as they are electronically scanned [10]-[12].

At the same time, logistic units have a unique number of pallets, boxes or cartons that are intended for a particular customer. The use of SSCC, as a source of data on a particular logistics unit (which often makes a set of different products), opens up the possibility for a wide range of applications such as cross-storage, forwarding, routing and automated acceptance, while the information labels, known as attribute data, can be added to the log sticker, e.g. lot number, usability date, weight and identification of merchant units contained in a logistic unit. In addition to the foregoing, SSCC is also used to track the movement and location of logistics units through the supply chain from the supplier, or the customer, which enables continual controlling the quality of service [13], [14].

A regional Croatian logistics company in the cold chain segment, RALU Logistics, in whose case, the work shows the implementation of the use of IT and SSCC, recognized the market need for more reliability, as an independent provider of logistics services to the refrigerated and deep frozen range of goods, and therefore, continually invests in cutting-edge solutions using IT infrastructure offered on the market. This approach has resulted in the provision of logistics services of high quality which attracts more clients, and their approach to work is particularly interesting for monitoring and research with the view of the fact that they are paid by users and entrusted with sensitive goods, i.e. food products and various

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pharmaceutical products [4], [9], [17], [20].

II. Innovative SSCC Usage

SSCC is a standard identification number that is used for the unique identification of logistic units formed for storage and transport for the purpose of their continuous control through the supply chain. Any such logistic unit must be identified with a unique serial number and bar coded SSCC, which permits scanning. Each logistic unit marked with an SSCC must have its own unique SSCC, different from the past, regardless of its content. The uniqueness of the data structure is provided using the GS1 system specification [12].

A factory prefix is combined with the serial number of a company that is a member of the organization, and acts as an identifier license and allows the free passage of information stored in the computer memory, transferred to electronic business transactions [21]. Companies that are users of the GS1 system must have certain leased capacity of Global Location Numbers (GLNs), which provides them with a sufficient number of SSCCs needed for their operation, where the GLN "key" is used to search for information from the database. The names, titles, addresses and information about specific locations to which the company performs logistics services do not have to be transmitted during each transaction, but they are delivered only once, entered into the IT system and later obtained from the database reference for a unique GLN. The use of the GLN provides unambiguous and efficient identification of all locations relevant to the EDI transaction [23]. A prerequisite for meaningful and quality use of the GS1 system and SSCCs with logistic service providers is implemented Warehouse Management System (WMS) that allows monitoring and control of all warehouse processes. The function of this system is the IT support for the receipt of goods, for the setting up the space provided in the warehouse, for the order of selection of goods for onward transportation (depending on shelf life), for the movement of goods in the warehouse, and for shipping. In using modern IT technology, this system provides in all aspects of warehouse operations, optimizing the time and minimizing the possibilities of mistakes of employees, improving their job performance [16]. Algorithms of WMS systems provide FIFO/FEFO output of goods by determining the position of the stock; thus, speeding up the collection of goods (ordered by the employees), which ultimately put in order on pallets or placed in transport containers to goods delivered to the outlets on the orders of users of logistics services.

By using Radio Frequency Identification (RFID) systems, which are a segment of the WMS system, allows pairing of physical movement logistic units and electronic business messages that apply to them for the purpose of individual monitoring and to open the possibility of applying a wide range of applications such as cross-storage, shipment reference, automated acceptance, but also facilitates the planning phase of the business process, control and process control, inventory, and total business improvement. These applications rely on a standard coding structure by which to identify all relevant items and their data relating to the logistic unit. RFID technology uses the interaction properties of the highlighted object in the electromagnetic or electrostatic field at certain frequencies. The detector emits radio frequency (RF) waves at a frequency or frequencies, and the logistic unit is set to "respond" to send the information stored in it. It can be said that RFID technology performs the evolution of the bar code in an electronic product-by-Electronic Product Code (EPC) which enables the components of RFID such as: transponder radio signal (tag), reader and software [19].

Here, we promote the innovative usage of the formation of SSCCs and their electronic transactions, according to Fig. 1 that gives the general structure of SSCC (always the length of 18 digits).

AI= Application Identifier	Indicator of packaging	Prefix of national organizations	Code of companies	The serial number of the logistic unit - assigned by company	Control Number
00	N_1	$N_2N_3N_4$	$N_5N_6N_7N_8$	$N_9N_{10}N_{11}N_{12}N_{13}N_{14}N_{15}N_{16}N_{17}$	N_{18}

Fig. 1 SSCC general structure [21]

SSCCs can identify all logistic units, whether they are homogeneous or mixed in content. Companies also have the option of differentiating their operation or business unit numbers in the SSCC, which can be achieved by allocating blocks of SSCCs for each individual drive. Once the unit is assembled, the accuracy of the data being carried by the SSCC ensures the creation of a code that is unique to each logistic unit. The storage of the desired data on a logistics sticker, i.e. the SSCC assigned from the IT system as a logistic service provider, allows the use of RFID technology so that the stored information about the contents of the logistic unit electronically switches to a logistic sticker. SSCCs become the keys to access databases and serve for unambiguous identification of articles (which are handled during logistic operations). In this way, the logistic service provider communicates the data (for description of some logistic units) to the logistic service user [19].

The innovative formation of SSCCs and the process of using them can be explained through several steps, as follows:

1st step: The user sends an order to the provider of logistics services in the form of orders via EDI.

2nd step: Once the order is received, the logistics service provider prepares the ordered goods in boxes or pallets. In doing so, the logistic service provider establishes a logistic unit (using RFID technology) identifying products, their quantity, lot numbers and refers them to a database.

3rd step: After packing logistic units, the logistics service provider denotes each with the SSCC (with a special code of the logistic service provider and with a special label for the packed cargo).

The SSCC consists of several component parts that have a certain symbolism, which is mandated by the product coding

organization. Although this code always consists of 18 digits (the meaning is shown in Fig. 1), its creation depends on the type of packaging of goods (to which a logistic sticker is attached with the accompanying code). In the past, there was a need to use standardized and systematic labelling of goods only at POS (Point of Sale) retail. At that time, it was enough to mark the basic product with the Global Trade Item Number (GTIN), which was most often represented by the symbolism of a barcode. There was no automation when receiving goods. The increasing demands of the market have resulted in the introduction of the code which is usable for AIDC, not only for basic products, but also for all higher hierarchical levels such as transport boxes, pallets and containers [13].

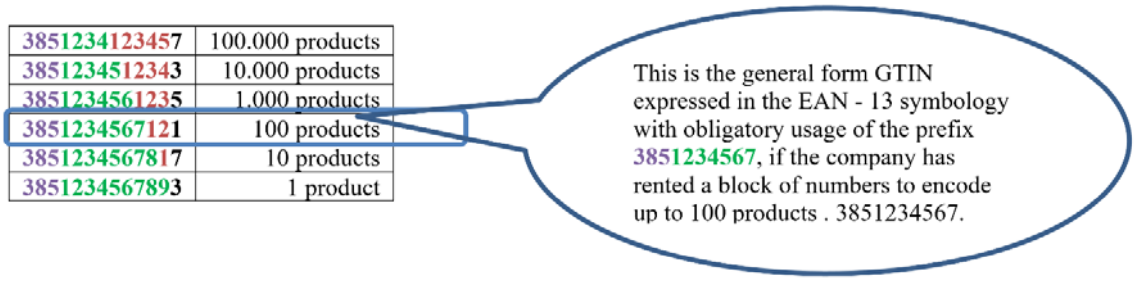

Fig. 2 Creating SSCC company code with GTINs (EAN - 13 numbers)

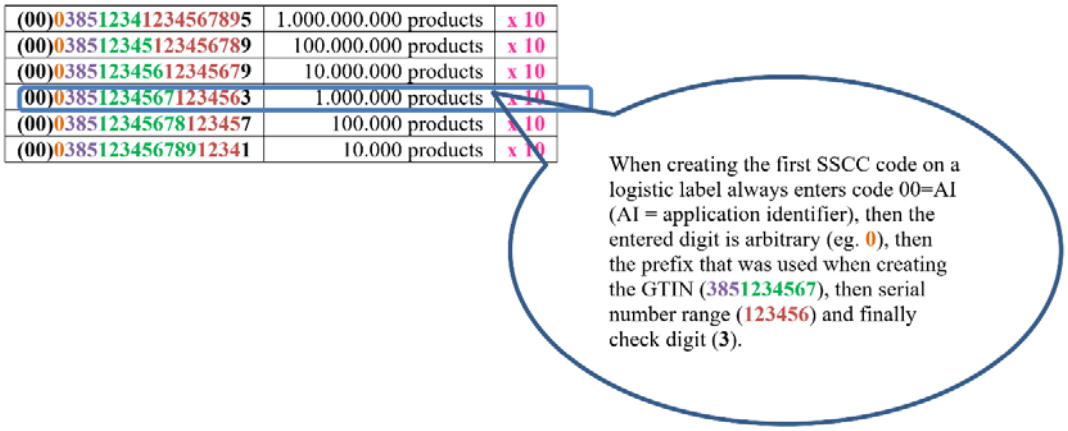

Fig. 3 Creating the first SSCC on a logistic label with: AI = application identifier, arbitrary digit, GTIN prefix, serial number range, and check digit [14]

Example 1. Creating the SSCC of the company (Fig. 2) that has leased a certain number of numbers to create GTINs (EAN - 13 numbers). In order to ensure consistent and global applications, we have to set some basic rules for the formation of SSCCs depending on the content of the logistic unit to which the logistic label, with the code, implies. GTIN represents a unique global (non-speaking) identification code of a particular merchandise article, which does not contain any item information, but merely serves as a key for retrieving the data previously written to the database containing all attributes associated with that item (name - full, short, post-name, weight of packaging, tariff group for VAT, etc.).

The GS1 organization allows GTINs to be assigned to an interested manufacturing company by assigning an interval or a block of numbers to mark their articles. The block size depends on the product mix of items that Member States wish to encode. The retail items are most often referred to as the 13-digit GTIN and the EAN-13 barcode symbolism, and the more complex formulation of the code is used only for larger transport packages.

Identification of transport units that are not subject to trade, have already been created in order to facilitate transport to the SSCC (GS1-128), which is placed on the pallet so that it is visible and easily accessible for reading through the distribution chain.

4th step: The RFID detector stores the data from the database on the logistic sticker, which contains all the data related to the formed logistic unit and is placed in the positions indicated above (Fig. 4).

5th step: The Logistics Provider sends an electronic notification of the delivery of ASN (Advanced Shipping Notice) to a logistic service user, or performs deliveries according to a predefined delivery tachograph. Information on the content of the information cargo stored on the SSCCs is sent by EDI. The notice contains all information related to the logistic unit, and which logistic service user should know. The logistic service provider is responsible for receiving the appropriate notification from the logistic service user.

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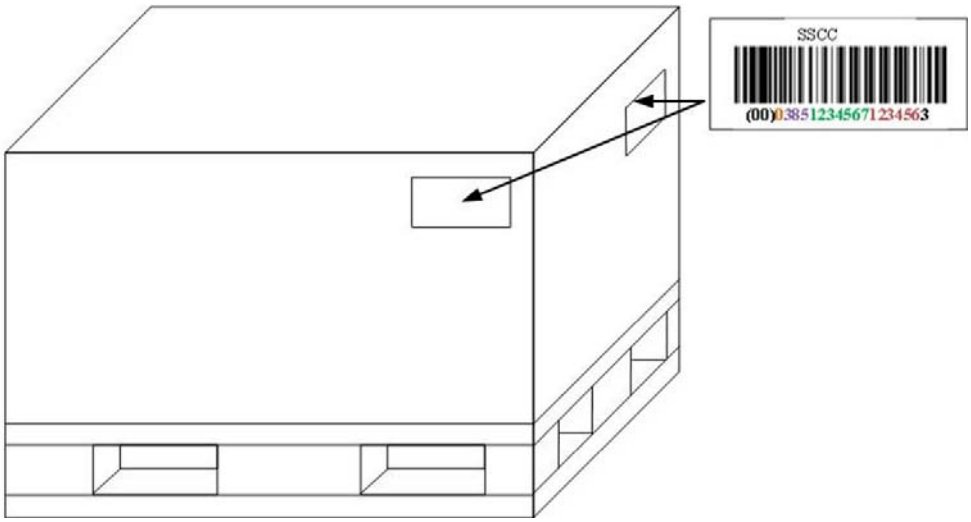

Fig. 4 Possible positions for placing a logistic sticker on a pallet-shaped logistic unit

6th step: The logistics service receives notification of delivery, which is saved to the system.

7th step: Cargo is delivered to an agreed location.

8th step: Using RFID technology, the user of the logistic service reads the SSCC (indicated on logistic units: pallets or boxes).

9th step: A logistic service user receives information that is associated with the currently read SSCC through a special application.

10th step: The logistic service user base system contains all the information stored via SSCCs and can find all the necessary information about the inbound logistic units.

11th step: The user of the logistic service is able to pass the cargo in transit without opening or checking the validity of the cargo, or the cargo can be immediately placed in their storage spaces.

A logistic service user may use an ASN message (with a serial number) if the user intends to forward a logistic service to third parties with whom logistic service user has a delivery contract provided that the further logistical service is performed by the same service provider and only through a customer service order that has already specified the terms and conditions third-party delivery sites (via already contracted business relationship with the supply of products). Reliability of the logistic service provider is controlled randomly. Periodic inventories are conducted to check the quantitative status of delivery of the logistic units. Errors are possible because no system is ideal. Practice has shown that this kind of error risk works to a minimum and that there is no need for additional information sharing in logistical operations if all distribution chain members are doing their job well: reading the data stored in SSCCs, all notices (giving full description logistics units) are exchanged through EDI, and have established relevant databases with online access.

III. Croatian Case: Implementation of SSCCs & IT

RALU Logistics is the leading Croatian logistics company in the cold chain segment, with regional coverage throughout the Republic of Croatia, Serbia and Slovenia. RALU Logistics is a reliable logistical partner of many Croatian and international companies that promote highly standardized logistics services and comply with European standards. In addition to standard logistics operations, transport, and storage, the company offers distribution services such as product repackaging, product labelling, reverse logistics, logistics services in certain regions, customs and excise storage and implementation of the highest standards of quality in the entire business (IFS, ISO 9001: 2008, HACCP) [4]. The activity of this company is based on the provision of logistics services related to food and pharmaceutical products subject to temperature regime. Due to the specific conditions that must be met related to both types of products, the company has continuously invested funds in the implementation and application of IT technologies. This allows them traceability of entrusted products, and compliance with legal regulations, which in its business, results in the confidence existing users of logistics services, and facilitates access to new challenging markets. Logistic service users who use outsourcing are awaiting the fulfilment of many of their own requirements in the supply chain on a daily basis, such as reliability, delivery speed, and price competitiveness.

RALU Logistics uses the services of GS1 Croatia [10]. GS1 Croatia is part of an international system with over 100 national organizations responsible for automatic identification and electronic data exchange. GS1 Croatia (as well as other members of the GS1 system of national organizations) has the basic task of assigning unique numbers, performing professional training and providing technical support for the assignment and use of bar codes, and providing information on standards and continuous system development for which it receives a specific financial reimbursement (by service user companies).

By using their services, RALU Logistics provides a platform for successful cooperation with manufacturers and retail chains at the local, regional and global levels; enabling them automatic identification of products, services and locations, and thus simplifying the management of business

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processes. The use of such a business model and of the latest technological solutions of the WMS system and RFID technology makes their business more effective and efficient [19]. Using the WMS systems allows for the tracking manipulation of each item through the warehouse from input to output, and the ability to move any item from one position to another. By commissioning the goods, it is easier to work because of the ability to record every change related to the amount of items that are removed at a certain point from a certain position in the warehouse. With the help of this system, processes in warehouse space are significantly accelerated and their usability is increased. Implemented pick by voice technology [3], as part of the WMS system, makes it easier for employees to shorten the time spent in the warehouse. The usefulness of this technology is particularly apparent in RALU Logistics due to the specific conditions of its operation in deep freeze and at extremely low temperatures. At least the inefficient use of labour force is reduced because human resources in all processes are very important. Delivery errors are minimized, as well as delivery time, and to facilitate the tracing of goods ordered by storage space and prevent congestion at loading and unloading ramps. RALU Logistics, with this way of working, continuously provides information on quantities, time and manipulation of goods in the warehouse (always at the right time and in the right place). Inventory and inventory tracking procedures are simplified, and planning is indirectly facilitated. It has been made easier, faster, more accurate and more efficient dispatch and shipment of goods. The system ensures transparency in the procedures at every stage, which allows for easy controlling. The result of this operation is to minimize the risk of errors, ensuring transparency of warehouse operations and distribution operations, and ultimately reducing costs for all stakeholders of the logistics chain.

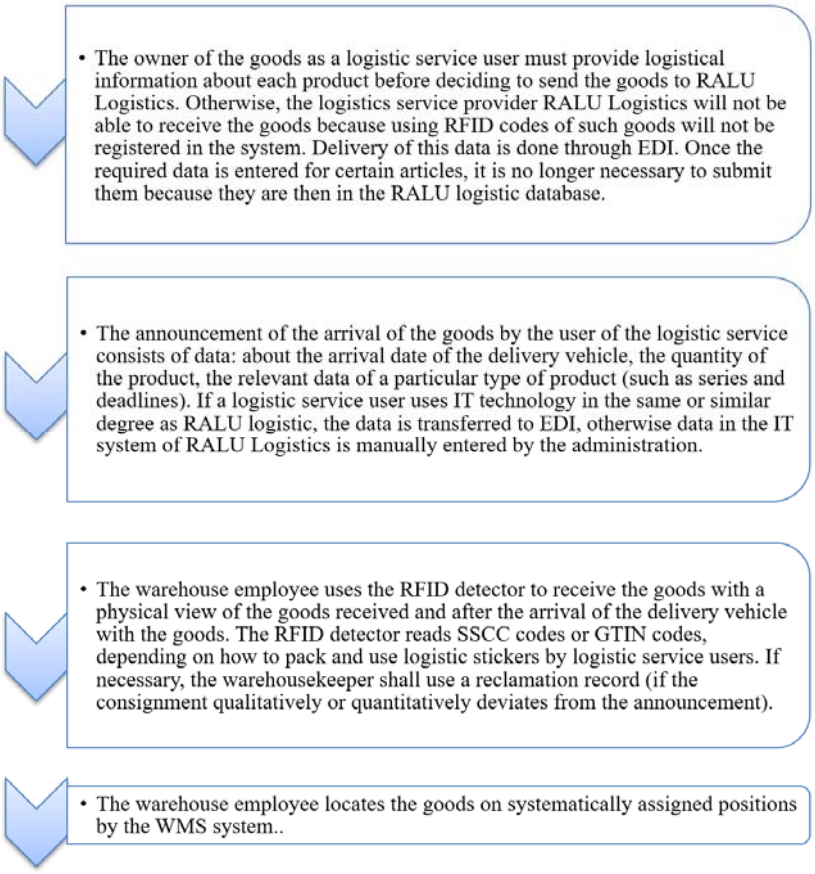

Fig. 5 Receiving and placing goods in storage area using ICT technologies [22]

RALU Logistics also deals with logistics operations related to pharmaceutical products, so the importance of the special conditions placed on them by such service providers should be emphasized. Pharmaceutical products must be stored separately from food products and their delivery must take place by means of special vehicles in the prescribed mode. The entrances and exits of warehouses containing pharmaceutical and food products must be separated. Traceability is extremely important in handling these types of goods, as prescribed by the relevant laws of Croatia [18] in accordance with the decisions of the European Commission. Providing traceability allows for ease of product recalls or the withdrawal of products from the market. Central to this, is that all members along the chain have the same standards of quality and the same infrastructure information [7].

At any point, RALU Logistics provides access to

information that has been delivered to a specific stock of goods (in the context of WMS). If necessary, it facilitates the process of withdrawing the goods from the market by the manufacturer. The recent opening of a new warehouse and the expansion of the manipulation space have increased the opportunities for additional services offered to the users of logistics services. Such as, for example, the promotion of packaging products (packaging two or more items with thermo-collecting foil) in cardboard or canned packaging, i.e. creating a new product with a new code and a new GTIN (EAN) code.

Example 2. Receiving and placing goods in the warehouse using IT technology.

Example 3. Preparing goods for transport using ICT technologies.

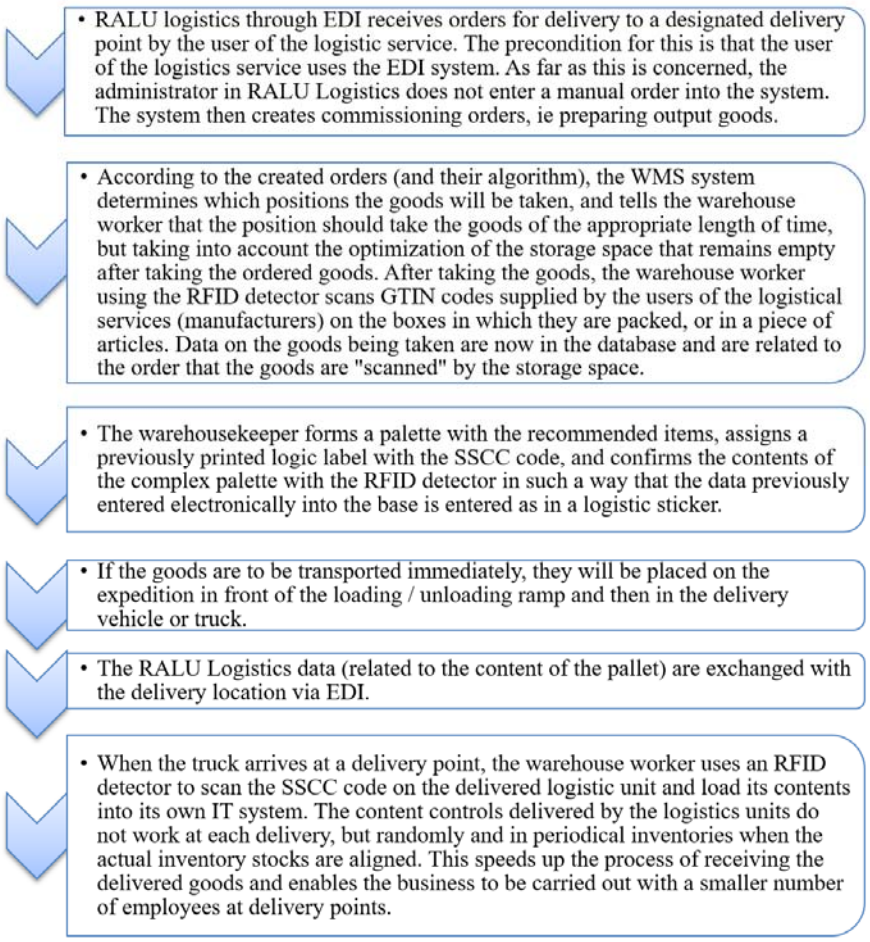

Fig. 6 Preparing goods for transport using ICT technologies [22]

Weighing products with variable masses (unregulated) with price and weight for certain customers, providing customs and excise warehouse services, and other services depends on the needs of RALU Logistics customers i.e. logistics service users. Significant investment in IT technology (such as, the implementation of route planning software [5] with the already used EDI), RALU Logistics is able to offer for their clients complete service and indirect sales planning, forecasting and the necessary supplies on the basis of historical data recorded from the previously services provided to specific customers (on orders of users of logistics services). RALU Logistics has leased 100 GLNs from GS1 Croatia, providing 10,000,000 SSCCs for use.

IV. Conclusion

Scientific analysis of the case of the innovative use of IT technology and SSCCs in logistics operations, focusing on the Croatian company RALU Logistics, which recognized the market need for a reliable logistical service provider in the refrigerated and deep frozen assortment, concludes that it ultimately achieves significantly better results (although more investment in IT infrastructure equipment and continuous human resource training is required for this type of work). This only enables real-time operation and process management, while capacity, efficiency and accuracy are increased. Considerable reductions are associated with inventory-related shortage, as well as with the number of people are required to manage the processes, which are also markedly accelerated. Significant elimination of paper records

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and the avoidance of multiple manual inputs resulted in a huge reduction in errors, minimizing the need for frequent controls. Access to data, enabled primarily by wireless technology, with continuous and easy creation of databases (with very important logistic data), provides significantly easier and accurate predictions that are required for quality planning.

Using SSCCs as a result of cooperation between RALU Logistics and GS1 Croatia, the processes of manipulation of goods, delivery of goods, and receipt of goods at delivery locations have been improved. To the satisfaction of all participants in the chain of logistic operations, the possibility of errors in filling orders set by the users of logistics services was reduced. RALU Logistics Company was meaningful for participation in this kind of scientific research - case studies, especially, since it has recognized the usefulness of virtually all the most modern technologies currently implemented in the logistic operations process in Europe and the world, while ensuring the quality of the logistics service of a specific and demanding assortment. The analysis confirmed that the success of RALU Logistics is based on: a modern logistics fleet, the highest quality of service, high operating standards (in line with European and world practice), and professional and motivated employees who, regardless of automation, still remain a very important part of such a lean organization. The next step in analytical science research is the comparative scientific study of RALU Logistics with the best European and global logistics companies.

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