APPLICATION OF MODERN TECHNOLOGIES IN THE SUPPLY CHAIN

Daria Vidović [1] [ORCID 0000-0001-9960-0783], *Nikola Stakić* [1][0009-0002-8060-2433], *Gordana Ostojić* [1] [ORCID 0000-0002-5558-677X], *Milovan Lazarević* [1] [ORCID 0000-0003-3889-8509]

[1]*University of Novi Sad, Faculty of Technical Sciences, Department of Industrial Systems and Engineering Management, Novi Sad, Serbia*

Abstract: *Modern technologies have resulted in improvements in many parts of the production process. Supply chains are complex networks involving a large number of people. In real processes, supply chains and logistics intertwine and complement each other. Classic logistics and lean logistics, lean production as well as information technologies in the production process were analyzed. By researching the production system for the production of wines and their location in Serbia, the problems that occur in the process of supplying catering facilities with quality wines produced in Serbia were observed. The application of new technologies provided solutions that gave results to the examined production process. A sketch of the improved process and a solution to eliminate the observed problems were presented.*

Keywords: Supply chain, logistics, QR code, wine.

1. INTRODUCTION

Among the vast types of fraud, the counterfeiting and relabeling of cheaper wines as expensive, rare, and collectible wines are the most prevalent (Biswas *et al.*, 2017). The actors involved in the wine supply chain are thus paying more attention to preventing every kind of counterfeiting. By adopting new technologies that enable traceability, anyone can check and verify each phase of the whole wine supply chain, from vineyard cultivation to wine consumption and packaging disposal, including reverse logistics processes (Danese *et al.*, 2021). In the supply chain from wineries to hospitality establishments in Serbia, there is a problem that affects both sides. Wineries produce a certain amount of wine each year, and the information they have is only initial information on how many bottles they managed to produce that year. In the wine cellars, wines are stored in appropriate conditions, but the state of the stocks in the wine cellar is not kept. When they want to know the actual state of stocks in the warehouse of each variety and from each year, physicists must count the bottles of wine and that information would be recorded on paper. On the other hand, hospitality establishments do not have quick information about how many bottles of wine they have in their warehouse and from which supplier.

When a guest orders a certain wine, the employees have to put it in the warehouse and check if they have that wine in their warehouse or if they have run out of stock. Commercialists are in charge of the field that they have to visit to check the state of stock in each hospitality establishment and in this way, the order of new quantities is made. Another way to order products is by phone, in which communication errors occur. More than 450 wineries are registered in Serbia and this problem occurs in a large number of wineries. With the advent of the Internet of Things (IoT) technologies, several traceability tools have been developed to track supply chain activities: barcodes, Quick Response (QR) codes, and Radio-Frequency IDentification (RFID) tags(Haroon *et al.*, 2016).

Barcodes are a one-dimensional pattern of parallel spaces and bars arranged to represent 10 digits. The encoded information can be read by an optical scanner that sends the data to a system where they are stored and processed. The QR code is a typical two-dimensional barcode and is commonly used in traceable labels because it can store more information than one-dimensional barcodes (Liang *et al.*, 2013). Quick Response (QR) code is a two-dimensional barcode using the ISO/IEC 18004:2006 (it is revised in 18004:2015) standard (Tarjan *et al.*, 2014). A QR code is generated by following certain protocols, the same of which are utilized for its decoding. While the generation of a QR code is a straightforward process, the main challenge lies in recognizing it with greater accuracy and speed. Getting information from a QR code in real-world environments comprises three vital steps: localization, image preprocessing, and decoding. Localization refers to the detection of a QR code and its exact coordinates or location in an image. Image pre-processing is an intermediate step where the detected QR code's image is improved to reduce blur, noise, distortion, angular perspective, etc to enable accurate decoding. Decoding is the final step where the information/data is retrieved and relies on the main standard architecture of the QR code. RFID is similar to barcoding because data from a tag or label are captured by a device and stored in a database,

but it is more advantageous than systems that use barcode asset tracking software (Fan *et al.*, 2019). The most notable advantage is that RFID tag data can be read outside the line of sight, whereas barcodes must be aligned with an optical scanner. Moreover, it has a larger storage capacity (around 32-128 Bit) and can be continuously updated, ensuring the highest level of security compared to previous solutions (Bosona and Gebresenbet, 2013). Within this context, traceability is becoming an essential management tool also for improving production efficiency. Traceability enables effective process control and allows for the elaboration of reliable risk assessment models to identify factors that cause quality and safety problems(Wang and Li, 2007). Each product is given a unique digital identity via the use of a unique tag (a barcode, RFID, or QR Code). This tag is a one-of-a-kind digital cryptographic identification that links the physical product to its network-based virtual identity, allowing any actor to access all or any related information (González-Reséndiz *et al.*, 2018).

Automated Identification: Concepts and Systems – The core of the approach is decoupling the physical item from the information representing it (as is the case with bar codes). In particular, digital identity is the only piece of product data that must be directly located on the product itself. All the other information can be stored elsewhere, with the identity providing a unique code to access it (Research, n.d.). Automated identification (Auto ID) involves the automated extraction of the identity of an object The Auto ID system described in this paper draws heavily on past and current developments in the area of Radio Frequency Identification (RFID).

2. METHODS

To succeed in proposing a method for solving problems in the supply chain of catering establishments with wines from wineries in Serbia, it was necessary to examine the market. The survey was sent to a total of one hundred addresses of both wineries and hospitality establishments. We received feedback and data from only ten respondents. Logistics can cause several problems for which winery owners have no solutions. The lack of expertise of employees in high positions in hospitality establishments results in the fact that they are not even aware of the problems they have. Communication with the wineries is done only through the salesperson. Neither the wineries nor the hospitality establishments are aware of how much stock each customer currently has in their inventory of each type of wine. When we talk about wineries, a large percentage of their wine is sold to hospitality establishments, which is up to 10,000 bottles per year. Wineries have an employee who performs commercial tasks and communicates with customers. Most of the wineries answered that the wines are transported by small van or car. Delivery of products is mostly delivered on a weekly or monthly basis. Not a single winery has information on how many of their wines are in each hospitality establishment and whether there is a sufficient amount of stock. Also, none of the surveyed wineries noticed problems in the supply chain. On the other hand, more than 60% of surveyed hospitality establishments said that they purchase wines directly from wineries. Most hospitality establishments purchase over a hundred bottles per month. they deliver wines by order, most often by phone or text. The wine lists are usually changed twice a year, guided by the wishes of the guests and current events in the market. A large percentage of hospitality establishments buy wines in wine shops, and often in liquor stores because quality wines cannot be found there. They sometimes order the products they need a day before and most often communicate with commercialists. There are also problems in that sometimes the winery cannot fulfill the customer's order and deliver it to a certain facility in one day. Also, hospitality establishments do not find any significant problems or improvements in this kind of supply chain. Modern technologies can greatly improve the supply chain and each party benefits from the use of new technologies. There are many benefits to implementing product traceability, and some of the most important are:

- Supply signals,
- The quality of the wine is monitored,
- Monitoring of wine stocks in the warehouse for each year and each type of wine,
- Stock status feedback,
- Transport is easy to follow,
- Wine guarantee,
- Food and wine combination recommendation,
- Guests in the hospitality facility can be informed about the wine they are drinking, the method and year of production, grape variety, percentage of alcohol, taste, style, and price,

- Quick and easy product ordering,
- Avoiding communication errors.

Salespeople communicate with customers (hospitality establishments) by phone or text. Orders are packed in a box and customers are supplied with products by a small van or car. The current situation in the supply chain is shown in *Figure 1.*

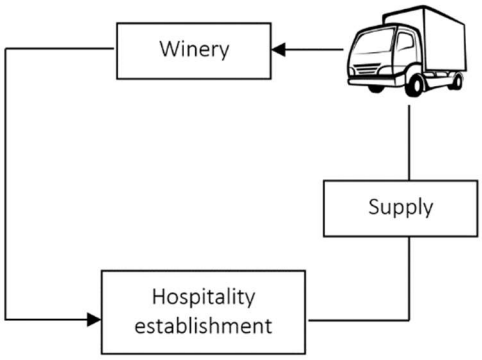

Figure 1: Current situation in the supply chain

Due to the problems observed in the supply chain, improvements need to be made to make the entire supply chain system work better. By using new technologies and QR codes, all steps in the supply chain can be tracked and every part of the chain benefits from the implementation of this improvement. *Figure 2* shows a block diagram showing the winery, catering facility, projected value stream, information system, and connection. Scanning the QR code opens an app that everyone can access, but they have different options, depending on their needs. The winery has the largest amount of data that it can enter, check and control. Hospitality establishments can easily check stock levels and order products. If there is any problem with the product they can report it through the application. Guests can read all the information about the product itself. The supply chain improvement model is shown in *Figure 3..*

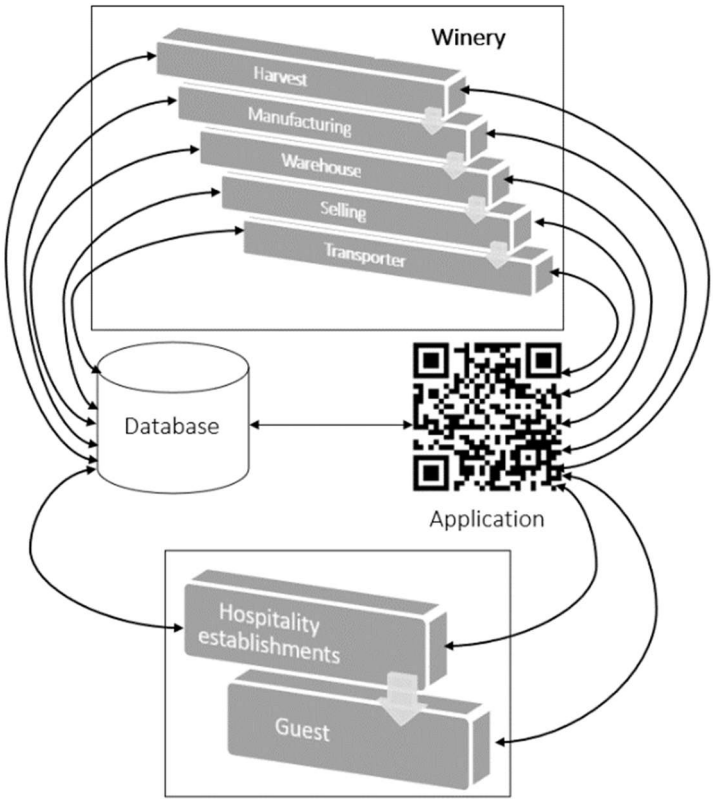

Figure 2: Block diagram of connection

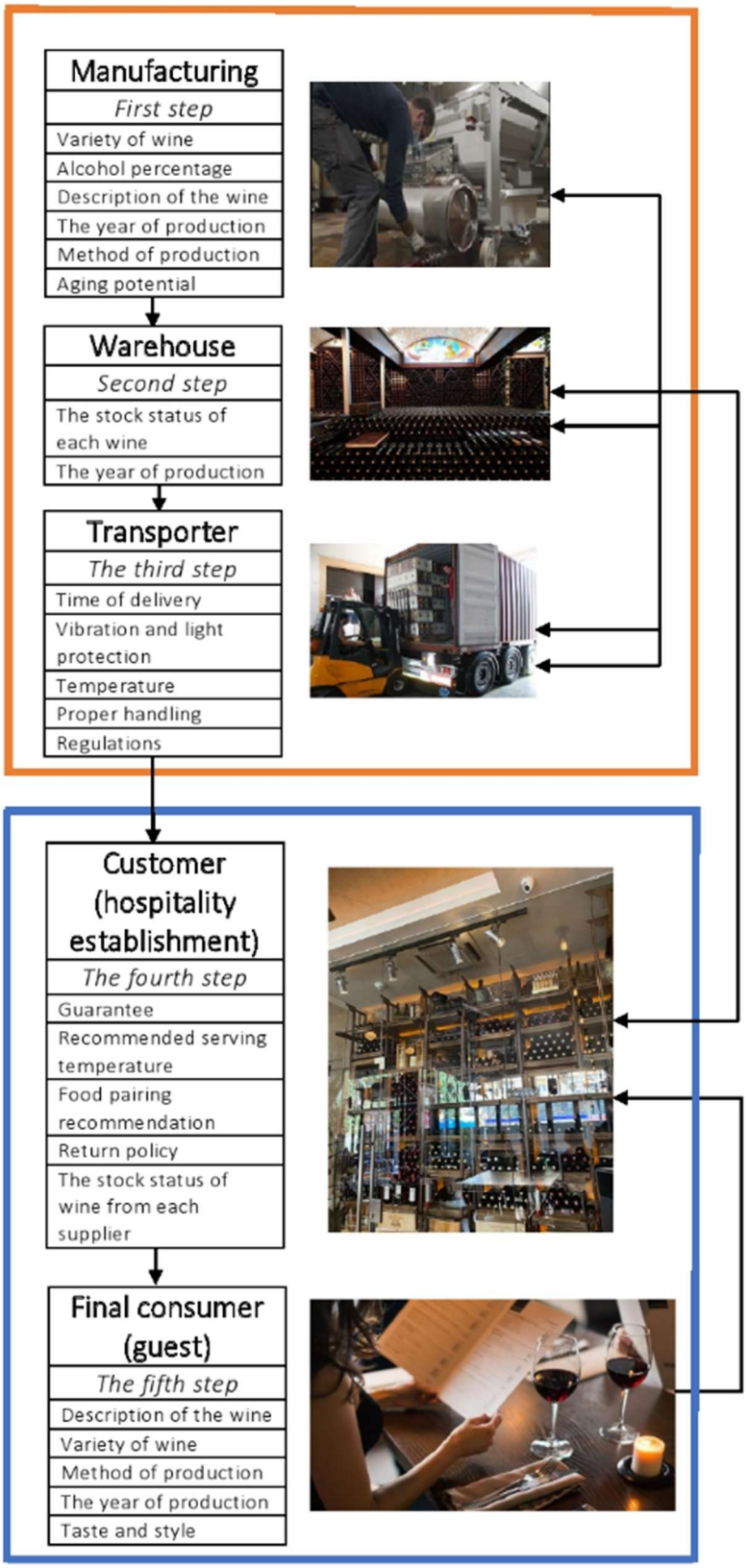

Figure 3: The supply chain improvement model

3. RESULTS

The first time you scan the QR code, you enter the application. There is a possibility of choosing an employee of a winery, or a restaurant. After the selection, you can register (if you don't have an account yet) or login to an existing account. Winery employees have various options, such as monitoring the status of restaurants, some kind of statistics, whether there are orders, complaints, or wines that are in transit and the possibility of monitoring the status of stocks... Hospitality establishments can monitor their stock status in the warehouse through the application, receiving notifications about signals for ordering new stocks, fulfilling requirements, tracking their shipment, and the possibility of complaining or leaving comments. Guests would have a special QR code that would be on the wine list and by scanning the code they would receive all the information about the wines.

4. DISCUSSION

As shown, the results of this research showed that the wineries did not perceive the problems occurring in the supply chain. The incompetence of employees causes problems to occur, but the root of the problem is not sought and not solved. The supply chain has brought benefits for all users when using the application. For the winery, the time to deliver and collect orders from customers has been drastically reduced. Many data and information that the winery has started to be used. They have reduced the possibility of making mistakes that occur with traditional work methods, they get information faster, communicate better with customers, and have the ability to plan production and sales forecasts. Also, they have information about changes in quantities in the warehouse, how much is in stock from all years, and from each type of wine. Logistics work is much easier. Hospitality establishments receive their orders much easier, faster, and more efficiently. All problems that occur during communication are avoided and they can track their product inventory. Guests who are wine lovers can get all the information about the wines they are drinking in just one step.

5. CONCLUSIONS

By using QR codes, employees in wineries and catering establishments will be able to access the application in a very simple way, which will bring new opportunities for every member of the supply chain. This represents only one step in the improvement of the supply chain of catering facilities with wines. In this paper, the basis of the information system, which can be upgraded, changed, and improved, is designed and presented. The winery application is very practical, useful, and new on our market. The application is very easy to use for any user. The steps are very simple and in just a few clicks, your action is complete.

The possibility of adapting the application to any winery located in Serbia. Further directions of research are aimed at introducing RFID tags so that each bottle of wine can be tracked individually. Also, with the progress of each winery, the problems of wine counterfeiting arise. To solve such problems, the application will be connected to the blockchain so that the data can be stored without the possibility of abuse.

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