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Improving the Food Supply Chain in Military Units

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Abstract:

Purpose: *The aim of the research was to analyse and evaluate logistic processes implemented in the food supply chain in the military system in peace conditions and to propose possibilities for improving these processes.*
Design/Approach: *The research was conducted using qualitative methods. As part of the research procedure, process analysis was carried out using the method of modelling logistics processes in the food supply chain implemented in a selected object of study (a military university from Poland). To analyse and evaluate the examined processes they have been presented in the form of graphical maps developed using the iGrafx software.*
Findings: *The results of the study indicate that innovative solutions (technological and organisational) have a significant impact on the efficiency of the food supply chain. It is necessary to support logistic processes with traceability and RFID technology as well as adaptation to EU requirements in the field of short supply chains and building partnerships under civil-military cooperation.*
Practical Implications: *The results can be used to improve the operation of the food supply chain for military units in peacetime by improving logistics processes using innovative methods of traceability to identify and track the flows of goods (food). Conducted analyses have significant practical implications for the design of new or modernising agility supply chains in military units in peacetime.*
Originality/Value: *Due to the importance of these issues for the effective implementation of logistics processes in the military system, it is necessary to understand and promote the aspect of improving the food supply chain in a scientific and practical dimension. The specificity of the system of military supply chains, high level of rigidity and multi-faceted risk analysis limits the possibility of using common solutions on the civil market.*

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The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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1. Introduction

The sphere of functioning of the military system is a specific type of activity of states and international military organisations. It is subject to regulations guaranteeing an appropriate level of sovereignty, security, and confidentiality (secrecy). Therefore, the solutions dedicated to this area require specific solutions, often different than for non-military sphere. Consequently, the application of business models is not always possible. The challenge for research in this area is to propose solutions which meet the developmental aspirations of the military under the terms appropriate level of security and defence, using the latest concepts developed in the civil sphere.

The implementation of logistics processes related to the food supply chain for the army in the conditions of a changing environment requires continuous improvement of operations. The challenges for the food supply chain management are changes occurring in the macro and microeconomic environment. The phenomena having a significant impact on the food supply chain management process include, among others the strengthening of customer orientation, the definition of revenue and cost solutions in the field of quality management systems and food safety, the changes in the consumption pattern (increased demand for organic, functional, convenient, exotic food, etc.), the increasing consumer awareness of the relationship between health and food, the climate change, the supply chain consolidation, the demand uncertainty and emphasis on sustainable supply chain management (Zimon, 2018).

In conditions of dynamic changes, the supply chain should be characterised by functions such as; the ability to react quickly and meet rapidly changing demand, flexibility and the ability to adapt to the optimal level of service costs as well as the ability to optimally use company sources and use all available information (Bujak, 2015). The need to improve logistics processes, their design in a sophisticated and efficient type depends on the meaning of quality (safety, reliability, stability) of the basic processes (including production) (Nowosielski, 2016).

Economic, socio-cultural, legal and, above all, environmental and technological conditions significantly force adaptation and improvement activities in the scope of logistic processes related to supplying the army with food. Ensuring the smooth functioning of food supply chains means the need to adapt to changes and improve the logistics processes of purchasing, delivery, and storage planning, also considering the political situation (peace, crisis or war).

The implementation of institutional food processes in the military system is subject to specific regulatory and control activities, thanks to which it is possible to maintain an appropriate level of quality and safety of the food supplied, reliability of logistic processes related to flows of goods, information and financial resources. The complexity of logistics processes implemented in the area of food supply for the army is affected by specific conditions resulting from the needs of the recipient

(soldiers performing tasks in different conditions), legal norms that specify the requirements for the production process, rules for collection, transport, storage, shelf life and volume of inventory etc.

2. Literature Review

2.1 Food Supply Chain

Presenting the essence of the concept of food supply chain requires consideration of the different approaches presented in the scientific literature. Due to the multi-faceted nature, the concept of supply chain is defined in various ways. As part of different approaches to defining the supply chain, there are several main aspects that are emphasised by the authors, such as: 1) in the system approach a set of participants, network, organisations and individuals involved in stream flows, 2) in the process approach sequence of processes and 3) in a functional approach a set of functions.

Mentzer *et al.* (2001) defines a supply chain as *"a set of three or more entities (organisations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer".* According to Chopra and Meindl (2007) "*a supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. Within each organisation, such as a manufacturer, the supply chain includes all functions involved in receiving and filling a customer request. These functions include, but are not limited to, new product development, marketing, operations, distribution, finance, and customer servic*e". Christopher (2005) emphasizes that supply chain is *"a network of connected and independent organisations mutually and cooperatively working together to control, manage and improve the flow of materials and information from suppliers to end users*".

Considering the essence of the supply chain in the functional and process context, the following definitions can be cited:

(1) "*life cycle processes comprising physical, information, financial, and knowledge flows whose purpose is to satisfy end-user requirements with products and services from multiple linked suppliers*" (Ayers, 2001),
(2) "*a general description of the process integration involving organisations to transform raw materials into finished goods and to transport them to the end-user*" (Pienaar, 2009),
(3) "*any combination of processes, functions, activities, relationships and pathways along which products, services, information and financial transactions move in and between enterprises*" (Gattorna, 2006).

The complexity of the concept of supply chain is also manifested in the area of food supply. In general, it can be assumed that the food products supply chain "*relates to*

all the processes (production, manufacturing, distribution, sales and consumption), which describe the flow of foods from the farm (field) to the consumers' tables" (Bendeković *et al.,* 2015). The differences of FSCM (Food Supply Chain Management) from other supply chains such as furniture logistics and supply chain management are the importance reflected by factors like food quality, safety, and freshness within limited time, which make the underlying supply chain more complex and difficult to manage (La Scalia *et al.,* 2016). This is not a single sequence of specific entities, but rather a complex network of connected elements cooperating to make products available to consumers (Gani, 2016). Food supply means agricultural producers, intermediary (trade) companies, processing, production and service enterprises and their clients, cooperating in various functional areas, between which flows of agri-food products, information, and financial resources (Jarzębowski and Klepacki, 2013). Organisations belonging to the food chain form an ordered collection including producers of feed and primary products, food producers, transport and storage operators and their subcontractors, as well as the sphere of retail sales of food products and services, including organisations of manufacturers of machinery, equipment, packaging, cleaning products, ingredients and additives, etc. (Dobrowolski *et al.,* 2016).

In the food supply chain considerations, the specific characteristics and conditions of food products are of particular importance. Specific features of agri-food products include the universality of the consumption of food products and their huge variety, short durability, high sensitivity to external factors, susceptibility to spoilage, diversification of the volume of deliveries conditioned by the seasonality of production and variability of crops, most agricultural raw materials are not fit for direct consumption, which forces the creation of many stages of their processing, as a consequence food is produced by a large number of small farms and by many processing plants (Michalczyk, 2017).

As emphasised by Nowakowska-Grunt and Kiełbasa (2017), the implementation of logistics processes in the food chain is determined by external factors that result from the activities and cooperation of various processing and distribution enterprises and agribusiness sector institutions, as well as significant changes resulting from growing competition on local, regional and global markets. Considering the concept of sustainable development in food supply chains, it is important to ensure customer satisfaction in the most efficient and effective way, while taking into account the impact of operations on the environment and society (Kumar and Kushwaha, 2014).

The variety and diversity of participants in the food supply chain, specific requirements in the field of food quality and safety, and changing socio-economic, technological as well as environmental conditions have implications for its management. In addition to external factors, extremely important for the design and operation of the food supply chain have both the needs of final recipients and the ability to shape value by entities involved in the flow of goods and services. To ensure the quality and safety of food in the management of the food supply chain,

issues such as trust, strategic alliance, commitment, and quality of information are key issues (Ding *et al.*, 2014). Turia *et al.* (2013) point out that the overall performance attributes associated with logistics processes relate to quality (product quality, the quality performance of logistics processes along the supply chain), timeliness (the capacity to react and respond to customer's requirements in a certain timespan), logistics cost (related to all logistics activities at all stages of preparation, distribution, transport and storage), productivity and capacity (related to the efficiency in using available resources).

Supply chain management means the integrated action of its participants to meet the nutritional needs of consumers. It should be emphasised, that customer requirements are changing, they are individualised, and the importance of quality and differentiation of products and services increases, and shopping habits change. Therefore, in the face of such challenges in the management of modern food supply chains, aspects such as social responsibility, good agricultural practice (GAP), total quality management and hazard analysis at critical control points (HACCP) are important (Naik and Suresh, 2018).

2.2 Specificity of the Food Supply Chain to Military Units

To ensure the operational readiness of soldiers, maintain their physical ability and mental fitness at an optimal level, it is necessary to provide adequate food, both in terms of quality and quantity, and adequate hydration (Hill *et al.*, 2011). The organisation of the feeding system of military units is one of the components of military logistics. It is identified as a field covering the planning, preparation and use of means of supply, as well as the realisation of benefits and specialised services in order to maintain troops in appropriate combat readiness in the territory of the state and to secure the functioning of troops performing tasks outside its borders (D-4 (B)). Its purpose is to comprehensively secure the needs of troops specified in the National Strategies for National Security. The created defence policy of individual countries, although it is their autonomous sphere, in the case of membership in international organisations such as the North Atlantic Treaty Organization (NATO), must be included in the established framework for the processes of support and logistic security of the alliance forces (MC 0319/3). From the point of view of multinational activities, logistics is used to implement tasks in the field of material security for troops participating in allied joint operations.

Tasks related to the supply of food, water and fuels are an important element of resource planning as part of the NATO Defence Planning Process (NDPP). Taking this into account, it is possible to indicate the main reference documents setting out the framework for planning the resources of the armed forces of the National Armed Forces, which include alliance and national documents; NATO's Operations Planning MC 0133/4, Bi-SC Joint Operational Guidelines for Logistics, Allied Joint Doctrine for Logistics AJP-4, Allied Joint Doctrine for Operational – Level Planning AJP-5, Functional Planning Guides, Allied Command Operations Comprehensive

Operations Planning Directive COPD and Combined Action Doctrine, Armed Forces Logistics Doctrine, Operational Level Planning Doctrine.

In peacetime, the main effort of the material subsystem is focused on securing the needs of the troops with means of supply resulting from ongoing operations and maintaining stocks of means of supply. It is intended for planning, organising, and meeting the material needs of troops, taking into account the potential and resources of the Armed Forces.

The efficiency and effectiveness of this subsystem is critical to achieving the intended purpose of the operation. The essence of material security is the intentional, planned and systematic implementation of tasks related to satisfying the needs in terms of range and quality of required quantities of supplies and specialist materials services at the place and time enabling the proper functioning of the Armed Forces. One of the main material security groups are "*items of subsistence, especially food which is consumed by personnel*" (NATO Logistics Handbook) and specialised material services including a set of projects implemented by the military with the support of civilian potential, which is part of the non-military subsystem. This subsystem consists of non-armed executive entities of public administration, other state institutions, as well as entrepreneurs and associations on which tasks are imposed or commissioned to perform defence tasks.

Cooperation and coordination across the full spectrum of logistics, including between the civilian and military sector within and between Allies, contributes to the best use of limited resources (AJP-4). Support by external contractors (civilian suppliers) supplements the military logistics potential in military operations and non-military activities. This creates opportunities for effective security of logistics activities while optimising costs. Factors determining the use of support from external contractors include (D-4 (B)); the need to supplement the potential and logistics resources of the armed forces, the possibility for external contractors to provide supplies and services in an appropriate quantity and quality, positive result of the risk assessment, operational situation, economic considerations and legal conditions. In the context of the above conditions, it should be emphasised that the functioning of the military supply chain is largely determined by external civil participants, which under civil-military cooperation must be ready to fulfil orders with special requirements.

3. Research Approach

3.1 Methodology

The starting point for the research process was the assumption that the efficient functioning of institutional food in military units requires continuous improvement of logistics processes implemented in the area of food supply. The security, quality, and reliability of the supply chain in which flows of food, information and financial

resources play a key role in ensuring the ability of military systems to carry out tasks in both peace and crisis or war conditions. Due to the importance of these issues for the effective implementation of logistics processes in the military system, it is necessary to understand and promote the aspect of improving the food supply chain in a scientific and practical dimension. The article is conceptual authors attempt to answer the following questions:

(1) what is the essence of the food supply chain for wax units in peacetime, what is its specificity,
(2) what processes are carried out in the food supply chain for the army, what factors determine these processes,
(3) what methods and tools can be used to improve logistics processes implemented in the food supply chain.

The aim of the research is to present the essence and conditions of the food supply chain to military units in peacetime, analysis, and assessment of logistic processes in the food supply chain, and to develop proposals for improving these processes. The research process included the following stages:

(1) description of the nature and character of the food supply chain,
(1) identification of logistics processes implemented as part of the food supply chain in the examined facility, process modelling and analysis of their course and conditions,
(1) formulation of conclusions and recommendations regarding the improvement of the analysed process in order to ensure its efficiency in the operation of the food supply chain in the conditions of a changing environment.

The article focuses on the analysis of the fresh food supply chain, with relatively short shelf-life, whose deliveries are made on an ongoing basis, excluding the elements of "dry" food rations and products subject to long-term storage (holding). To achieve the adopted objectives, the following research methods were used:

- literature research (review and in-depth analysis of scientific literature),
- document analysis (review and analysis of documents, reports, legal acts, and doctrines),
- participant observation,
- case study (a military university operating in Poland) and process analysis.

To analyse and evaluate the processes examined they have been presented in the form of graphical maps of processes developed using the iGrafx software.

3.2 Case Study

The Polish Army currently consists of 100,000 professional soldiers and, including the formation of the Territorial Defence Forces, 120,000, with development plans

providing for an increase of up to 200,000 (PCh24.pl). In 2017, the Polish army was ranked on the 22nd place among 136 classified countries (Jagiellonia, 2020). From this follows the importance of properly creating food supply chains for the military sphere.

The conducted research concerns the logistic supply of food products to military units, implemented as part of the military logistics system of the General Tadeusz Kosciuszko Military University of Land Forces (MULF). Military University of Land Forces, despite being a high educational institution, is also a structural element of the Polish Armed Forces. MULF is a military university financed by a grant from the Minister of National Defence. As part of its statutory tasks, the University implements didactic processes as part of bachelor's and master's studies, post-graduate studies and courses. This means that on average around 2,100 people a month participate in mass nutrition on a 24-hour system organised by MULF (Paterak and Wincewicz-Bosy, 2019). The main principles and conditions of the feeding process of soldiers at MULF are presented in Table 1.

Providing food in times of peace includes deliveries of fresh foods, concentrated foods, foods with long maturities food (especially military supplies), food testing and food for training. Focusing on providing food not only with long shelf life, but also ensuring rules resulting from modern standards of public nutrition (fresh vegetables, fruits, and dairy products) is a major challenge for the military system.

The basic assumption of composing food plans for individual military units refers to the concept of a soldier as a completely healthy person, with established psycho-physical characteristics and predispositions that allow the adoption of assumptions for the standardisation of nutritional needs. Their differentiation is the result of differences in the implementation of tasks, not a derivative of social, cultural, ideological or health differences. The base is composing meals that ensure the delivery of appropriate caloric values and the right quality of food that allows keeping a soldier in the right condition, enabling the implementation of tasks, and enabling development.

4. Results and Discussion

4.1 Food Supply Chain - Process Mapping and Analysis

The development of the process model consists in making design decisions regarding the identification of key elements such as actors involved in operations, operational activities, performers of individual activities, inputs and outputs of activities, determination of the sequence of activities (dependence of activities, the possibility of parallel implementation) (Pietroń, 2011). Lambert and Cooper (2000) suggest that analysing the structure of the supply chain management to consider three closely related elements such as:

Table 1. *The main principles and conditions of the feeding process of soldiers at MULF*

Stages	**Principles and conditions**
Planning stage - detailed research and identification of market segments, estimation of the volume of demand.	The basic document for planning the feeding of soldiers in units is the menu of the decade. Feeding of soldiers is planned on the basis of recipes of dishes contained in food files and information systems. The daily meal schedule depends on many factors, with the assumption that breaks between meals should not be longer than 6 hours.
Selection of food assortment in the MULF food department	It requires the development of a key document in the form of a statement of food needs for the next year. This list includes 27 product groups including 426 products. On this basis, a "Food Purchase Plan for a given year" is created for individual types of products.
Supplier analysis and assessment stage	Among the requirements for suppliers, in addition to providing evidence of compliance with phytosanitary and standardisation conditions, are important: readiness for mobilisation, size of the entity - its production capabilities, guarantee of adequate quality and price. Readiness to mobilize means the possibility of increasing deliveries by 50%, up to a maximum of 7 days and 100% up to a maximum of 14 days. Confirmation of appropriate production or delivery capabilities is done by presenting reference letters from the last 3 years: for three deliveries with a total value of PLN 900,000.00 or one delivery for PLN 900,000.00 - for food supplies and for two deliveries together for 450,000, PLN 00 or one delivery for PLN 450,000.00 - for confectionery. Contracts are concluded with suppliers for a period of one year, subject to the tendering procedure for their selection.
Supplies and storage	Food deliveries to military warehouses are organised and planned at every supply level. Deliveries carried out twice a week are the standard in force at MULF. The food sellers/ warehousemen check the quantity and quality of food delivered in accordance with the received income document and the requirements contained in the contract.
Preparation of meals	In accordance with applicable regulations, meals should be prepared within the prescribed period, being careful about the earlier preparation of dishes; especially meat and fish. Meals should be issued no later than 15-20 minutes after cooking and completed within a maximum of 2 hours. If necessary, ready meals should be stored for no more than 4 hours, at a temperature not higher than 8ºC and issued after heating. Canned food should be opened immediately before heat treatment, which should not take less than 15 minutes.
Serving of meals	The following meal delivery schedule applies: breakfast served between 7-8 am, second breakfast - around 11.00, lunch - between 14-16 and dinner between 18-20. A self-service meal delivery system is used in the military canteen. It consists in organising the canteen forces only the points of serving dishes and collecting dirty dishes. The rest of the activities related to the collection of dishes and, according to dirty dishes, consumers are obliged to do themselves.

Source: *Based on Paterak and Wincewicz-Bosy, 2019.*

(1) the supply chain network structure, considered in the context of three elements: the members of the supply chain, the structural dimensions of the network, and the different types of process links across the supply chain;

(2) the supply chain business processes: the activities that produce a specific output of value to the customer;
(3) the supply chain management components: the managerial variables by which the business processes are integrated and managed across the supply chain.

Between participants in the food supply chain occur a variety of relationships associated with the performance of specific functions and the implementation of appropriate processes. The following processes can be implemented in the food chain (Nowakowska-Grunt and Kiełbasa, 2017):

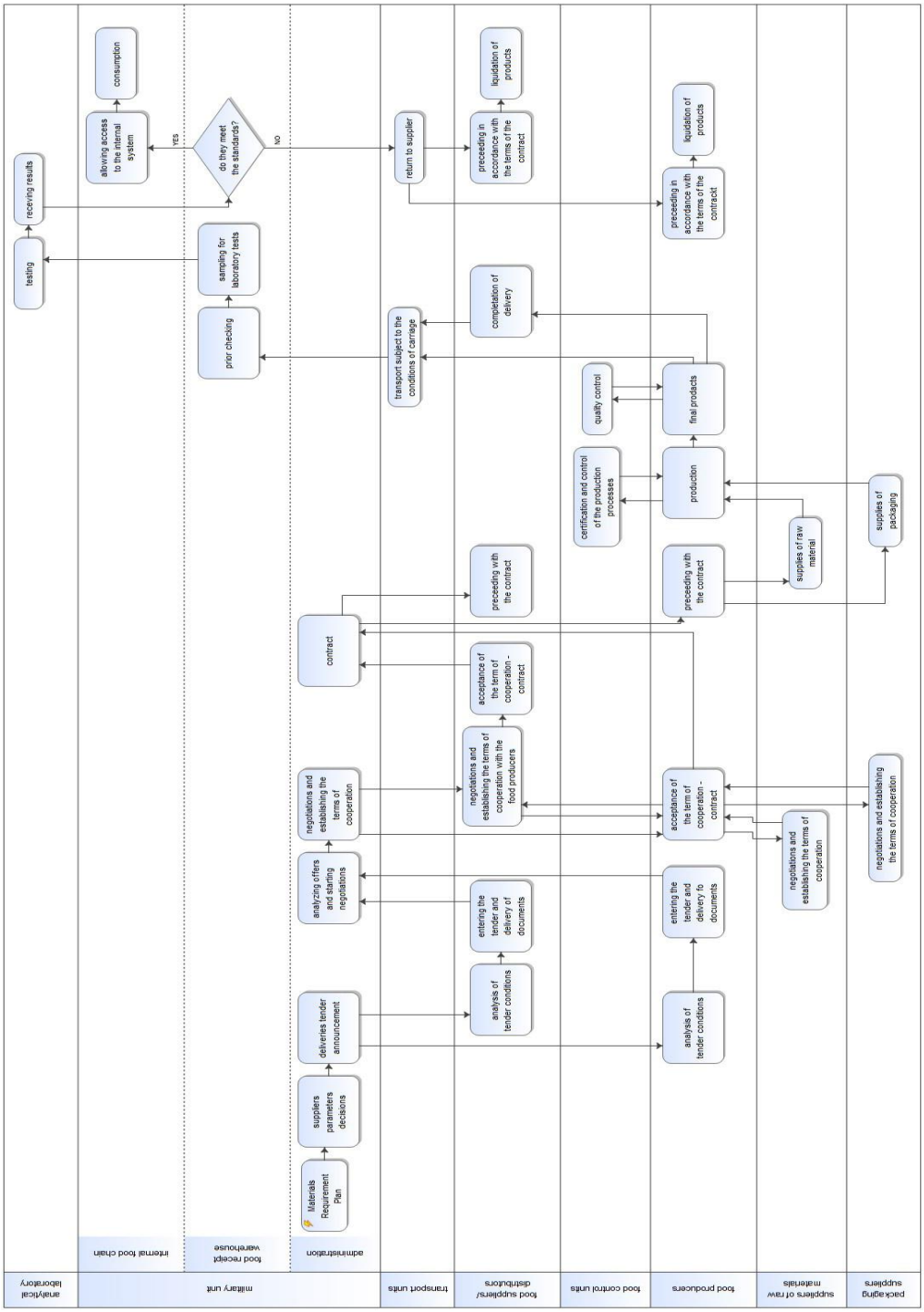
(1) basic; related to the production and processing of basic products,
(2) auxiliary; supporting production and processing processes,
(3) management; connected with defining goals and strategies,
(4) purchase; sale of appropriate quantities of raw materials, semi-finished and food and non-food products for production,
(5) connected with consumers and other clients; building relations with recipients,
(6) control; controlling the quality of all processes in the chain,
(7) logistics; related to product and material flows throughout the entire chain,
(8) knowledge and information management; necessary to implement all processes in the food chain.

The supply chain improvement process can take place in two target areas that can be streamlined simultaneously or sequentially, including the internal supply chain in which internal integration activities are carried out and the external supply chain, which relates to relationships between enterprises in the supply chain and includes external integration, consisting in the implementation of joint projects with process partners improving processes in the supply chain (Baraniecka, 2011).

In this context, the analysis of the military food supply chain may relate to the external and internal chain. In the research undertaken in the article, it was assumed that processes implemented in the external supply chain will be analysed. In the first stage, the participants of the external chain were identified, among which were distinguished: military unit (administration, food receipt warehouse, internal food chain), food suppliers/distributors, including suppliers of food products being their producers, and resellers (e.g. wholesale companies, agricultural cooperatives or associations of food producers: farmers, gardeners, fruit growers), suppliers of raw materials, food control units, analytical laboratory, transport units and packaging suppliers.

Next, the activities, tasks and operations identified by the participants of the supply chain were identified, considering specific features, determinants, and requirements. This allowed the development of a supply chain map (Figure 1) that presents the sequence of the main tasks and activities of processes implemented in the area of food providing. Input data was defined as the need to implement the process of providing food to a military unit, considering specific requirements and rules.

Figure 1. *The map of the external food supply chain to the military unit*



Source: *Own study.*

Key principles determining the military food supply chain include:

(1) the principle of using local resources for the needs of fighting forces - consists in the rational and organized use of stationary supply infrastructure and local resources of the national economy, useful in carrying out activities;
(2) the principle of district supply - district supply and provision of services is the implementation of material tasks for all forces and means carrying out tasks in a territorially designated region, regardless of their organisational allocation, where the supply region is the area where the supply infrastructure is located ensuring the maintenance of prescribed norms of supply for the benefit of individuals and institutions residing in this area;
(3) the principle of local supply – media, utilities, and other services (repairs, maintenance).

The expected result (output) is to ensure food supplies that meet the quantitative and qualitative requirements, in accordance with the needs of recipients. To present the course of activities, a process map was developed, using the iGrafx program. The following stages have been distinguished in the model) the first preparatory phase, covering activities such as:

(1) planning needs, determining the conditions and requirements necessary to undertake cooperation with external, civil food and service suppliers, negotiations and determining the terms of the contract;
(2) the second phase - contract implementation, order picking, packaging, transport and delivery of food;
(3) the third phase - testing of food samples in the analytical laboratory and transfer to the internal supply chain in the military unit for delivery to consumption.

The external military food supply chain begins the Material Requirements Plan (MRP) developed by a military unit, which is an independent economic unit. Based on this, a tender for food delivery is announced, in accordance with applicable national regulations. Food supplies are diversified in line with the premise of guaranteeing diversity of supply sources and security of supply, so that in the event of problems you can reconfigure the delivery system. Some orders are carried out by the central system, especially when it concerns the supply of rotation from strategic stock warehouses or product purchases where significant price reductions are realised as part of economies of scale. The analysed case omits these delivery options due to the different regulations and procedures.

In the case of specific products (e.g. exotic fruit, fresh fish), it is not possible to make direct deliveries from producers, therefore it is necessary to involve intermediaries - non-producer food suppliers. Regardless of whether food suppliers are its producers or intermediaries, they are obliged to guarantee an appropriate level of its quality and safety, confirmed by appropriate certificates and certificates. Food producers are responsible not only for the final product delivered to the market, but

also for all components and raw materials used for production. An important element is packaging that performs not only marketing and security functions, but also transports, handling and storage. Food suppliers are also responsible for carrying out manipulation processes in safe conditions that do not change the products supplied. That is why it is so important that transport processes are carried out by relevant entities. A common practice in local markets is the realisation of transport of food within their own means of transport manufacturer (whether owned). Especially when it guarantees proper adaptation of the means of transport to the specificity of transported products and requirements related to safety and quality of transport.

All products delivered to the military unit are subjected to detailed inspection before they are transferred to the warehouse. This control also covers the documentation and condition of the means of transport supplying products. After the products are transferred to the entrance warehouse, they are technically inspected, including sampling and sending them to the laboratory. Most often, units provide samples to independent external laboratories, as their operation requires specialised infrastructure (including equipment) and qualified personnel. After receiving positive test results confirming the proper quality and safety of food, the next stages follow, such as storage, processing, and transfer for consumption.

4.2 Methods and Tools to Improve the Process

The presented map is a simplified supply chain model and requires detailed modelling of the sub processes associated with the identified main processes, but it can, however, be a starting point for the analysis and development of the food delivery system. Improvement of logistics processes may have the nature of small changes in the scope of current operations or larger, more fundamental changes involving the construction of new processes, their modelling or reconstruction (Nowosielski, 2016). Considering the specificity of the food system in the improvement of modern food supply chains, six key factors can be distinguished quality, technology, logistics, information technology, legal framework, and the buyer (Bendeković *et al.*, 2015).

In the analysed case the following critical factors can be identified: quality verified in many stages, specific needs of consumers - soldiers, specific requirements of contracting, timeliness of deliveries. A particularly important issue is the quality control of delivered products covering two basic aspects. The first is the quality of the products themselves; the second is the control of the delivery process - meeting the delivery conditions (intermediate element - storage and handling conditions). On the suppliers' side, the necessary condition is quality and security certificates confirming their proper preparation and proper securing of procedures. The process of execution - the implementation of deliveries is also checked because the certificates do not guarantee obtaining the actual, final quality at the implementation

stage, but they are a condition for the proper preparation of processes and procedures.

On the unit side, it is necessary to test the products delivered in appropriate laboratories. Cooperation with external and state laboratories is common. However, for large entities, it is beneficial to have your own food control laboratory. Increasing the number of suppliers also argues for owning a laboratory, in cooperation with local suppliers. This results from both the concept of short supply chains (in accordance with EU policy) (European Parliament, 2013) and the principles of functioning of military food supply chains, including the use of local resources, district supply and service provision, and local supply (D-4(B)). The flexibility of rules concerning safety trade conditions in the presence of the short food chain make it possible to reduce the costs for farms selling their products directly or operating in a local market (Canfora, 2016), but it forces increasing the level of control in other links in the supply chain.

Own suppliers also offer greater flexibility for the menu (greater variety and better adaptation to changing conditions) and shorter response times with more direct contact. Because of the cost of the food inspection process, entities must pay particular attention to the control of deliveries from smaller suppliers. Cooperation with local suppliers gives the possibility of greater diversification of supply sources, which results in less dependence on central sources and reduces the risk of undesirable phenomena that are a derivative of the centralised distribution system.

The main principle of the organisation of food flows is that raw materials and semi-finished products should be transferred by the shortest and convenient route from warehouses through individual stages of processing to the point of dispensing meals and then to consumers. In the situation of a road crossing, a timetable should be developed so that transport takes place at different times to ensure a collision-free delivery (Paterak and Wincewicz-Bosy, 2019).

Therefore, dependence on central suppliers and the consequences of their mistakes decrease. As a result, the vulnerability to central system disturbances and external disturbances is reduced, which may result in reduced damage in the event of hostile activities. In this situation, the need to have own laboratory increases. It gives more control and more rational and flexible inventory management. However, having own laboratory results in the need to incur higher costs and expenses for this sphere of activity. It also means greater responsibility as well as the need to have the right infrastructure and suitably qualified staff.

Another important issue is controlling data transfer both within the unit and between the unit and suppliers, and between the unit and the central system. This generates the need to track the loads of food delivered. As a consequence, it may be useful to apply traceability technology in the field of transport technology suppliers (cargo security and tracking, transport and handling conditions) and RFID technology for

quality control (especially timeliness - shelf life) and resources. Cooperation with suppliers of necessary equipment (refrigerators, cold stores) and warehouse equipment is also a challenge. Karlsen *et al.* (2013) observed that traceability is more goal-oriented and efficient. Thus, Regattieri *et al.* (2007) presented a general framework and used experimental evidence to analyse legal and regulatory aspects on food traceability. They designed effective traceability system architecture to analyse assessment criteria from alphanumerical codes, bar codes, and radio frequency identification (RFID).

Despite widespread use in civilian research and practices of data collection approaches used in the food supply chain, there are still a number of challenges that limit data-based decision making and use of this technology:

(1) The concept of Short supply chain (EU) increases the involvement of small/medium and local entities for which investments in traceability technologies are not a priority - especially in the context of medium-term cooperation (1 year).
(2) Manual and paper-based operations are common in food supply chain, especially in agri-food logistics. Data from these approaches are usually prone to be inaccurate and incomplete. As a result, decisions based on such data are unreasonable (Zhong *et al.,* 2016).
(3) Moreover, various data collection devices such as sensors, smart phones, and GPS have different data formats that are usually unstructured and heterogeneous. Integration and sharing of these data among the food supply chain are extremely difficult (Pang *et al.,* 2015).
(4) Current data collection system cannot deal with huge number of data capturing in a simultaneous fashion. Due to the limited central calculation capacity and signal transmission methods, data collisions and jams could be happened occasionally (Zhong *et al.,* 2017).
(5) In military systems, there is a need to guarantee limited access to data, information confidentiality, which affects the need to create an appropriate security system so that data does not get into the entities undesirable (intelligence from other countries). This introduces the need for restrictions on access, processing, and transmission.

The functioning of the supply chain is determined by specific conditions of cooperation. In accordance with formal requirements, contracts are concluded for one year, which for small and medium-sized entities creates an extremely high risk of incurring costs related to investments and innovations. It seems that the form of long-term contracts with an annual system of renegotiation of conditions, with an appropriate deadline (e.g. 6 months before the closing of the year for the following year) would be more advantageous, so as to ensure the possibility of adapting to new conditions or acquiring a new supplier. For the processors and deliverers, long-term dealing, information sharing and direct communications with the suppliers may reduce the costs of repetitive contracts and provide the benefit of a consistent supply and quality produce (Uddin, 2017). Mutual understanding and shared priorities

between buying and selling entities have a substantial impact on the supply chain as it increases the level of confidence and reduce lead time, enhanced quality, and quantity of delivered products.

5. Conclusion

The presented analyses are of particular importance for the development and improvement of planning processes, especially the logistics subsystem. Logistic planning in the armed forces of individual countries provides effective support and security for their functioning. Rational replenishment of military resources is achieved by preparing a "Material Security Plan", which estimates the consumption of means of supply, subject to the conditions of continuity, efficiency, and suitability (optimisation).

This plan is developed on the basis of the demand placed by individual units and their organisational components, as well as forecasts, considering material interoperability resulting from the implementation of tasks in a multinational environment (DD/4.21). The organisation of deliveries should be characterised by diversifying the method of delivery considering the place, time and security of delivery, and shortening the supply of supply, taking into account the requirements arising from the supply of potential manoeuvres.

Food suppliers and producers must comply with norms and rules resulting from good practices, industry standards (including HACCP) as well as national and international standards. It is necessary to subject the system to both national standards (for example: PN-EN ISO 9000:2015-10, PKN-ISO/TS 22003:2015-06) and international standards, in particular ISO 22000:2018. Compliance with the requirements contained therein by all organisations involved in food chains is part of the food safety management system.

The supply system has a high degree of hierarchy and must also consider the need for a quick "switch" to the crisis or war economy system. In times of peace, its flexibility increases, so there are greater opportunities for improvement. However, the introduction of new solutions is strongly limited by the need for multi-faceted analyses, especially in the context of outbreaks of war or crisis. This is important in the context of differences in the priorities of the military and non-military system. This is particularly evident in the light of the pandemic events caused by the new SARS-Cov-2 coronavirus. In Poland, none of the states of emergency envisaged by the Polish constitution has been announced, allowing the economy to transition into a system of crisis solutions that would also change the operating conditions of food supply chains. This would, inter alia, allow for the implementation of mobilisation systems enabling the subordination of supplies to the changing requirements of military units. When the crisis is not resolved, military units continue to function as they did in peacetime. This forces the introduction of a negotiation system and compliance with market rules, which means submission to the consequences of the

business. In this situation, the previously created partnerships in the supply chain are the basis for making the system more flexible and meeting the needs of military units.

In conclusion it should be emphasized that in order to ensure the smooth functioning of the food supply chain for military units, it is crucial to constantly improve and search for optimal solutions and opportunities to operate in changing environmental conditions, both in times of peace, as well as in times of war or crisis. The considerations made in the article allowed to answer the research questions formulated and to achieve the research objectives. However, the presented analyses relate to a complex and multi-faceted issue, and therefore it was necessary to focus on selected aspects. Nevertheless, the presented conclusions and proposed solutions can be helpful in practical and scientific dimensions and constitute a starting point for wider, in-depth research.

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