# A Review of the Modern Software Systems and Tools in Logistics for Digital and Smart Manufacturing

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***Abstract:*** *Logistics represents an industrial and multidisciplinary scientific field that deals with the analysis, planning, management, and control of all logistics operations (distribution, warehouse, shipping, transportation etc.). Modern trends in logistics involve the use of advanced software systems, tools and digital technologies (DT) to address all operations and activities within a single logistics task. Digital technologies (DT) in logistics encompass the application of intelligent and smart digital technologies, smart technologies (ST), smart manufacturing (SM), smart logistics (SL), artificial intelligence (AI), cloud computing (CC), data mining (DM), and more. The application of all these technologies in logistics has created a new concept called Logistics 4.0, which is based on the concept of Industry 4.0. While SMEs (small and medium-sized enterprises) and corporations in middle-developed and underdeveloped countries of the world are beginning to think about introducing the concept of Logistics 4.9, a new concept of Logistics 5.0 has already been created and defined. Within the Logistics 4.0 concept, which is part of Industry 4.0, advanced and modern versions of software systems and tools in the field of logistics are used for planning, transportation, warehousing, distribution and other logistics operations. Modern software systems and tools for logistics are classified into several groups: logistics database (LDB) for quick search and access of logistics data, logistics information systems (LIS) for storing, processing and management of logistics data and information, logistics management systems (LMS) for managing logical operations, logistics decision support systems (LDSS) for decision-making in specific logistics operations, logistics expert systems (LES) and other software systems and tools for logistics operations. This paper provides an overview of different software systems and tools for logistics operations.*

***KEY WORDS:*** *LOGISTICS, LOGISTICS 4.0, SOFTWARE SYSTEMS AND TOOLS, LOGISTICS DATABASE (LDB), LOGISTICS INFORMATION SYSTEMS (LIS), LOGISTICS MANAGEMENT SYSTEMS (LMS), LOGISTICS DECISION SUPPORT SYSTEMS (LDSS), LOGISTICS EXPERT SYSTEMS (LES).*

## *1. Introduction*

Logistics is an industrial and multidisciplinary field that focuses on the management of goods, services, and related products from the point of origin to the point of consumption, with the aim of meeting customer requirements. It includes operations such as analysis, planning, purchasing, management information, distribution, shipping, transportation, quality control, warehousing, and more, ensuring the efficient and effective movement and storage of goods and services [9,10,14,17,25-27,37,53,69]. The foundational definition of logistics was established by the Council of Logistics Management (CLM) in 1991.

The logistics of physical items typically involves the integration of information flow, material handling, manufacturing, packaging, shipping, inventory, transportation, distribution, warehousing, often and security, and more.

Logistics is closely linked to the supply chain (SC), and in modern business practices, these two areas are often integrated. Furthermore, logistics management (LM) is increasingly aligned with supply chain management (SCM). This integration has led to the development of a new concept known as supply chain logistics (SCL) [17,18,31,49].

In large companies, all logistics activities are centralized within a dedicated logistics department. In contrast, small and medium-sized enterprises (SMEs) and similar organizations often distribute logistics functions across various departments. Additionally, some companies outsource specific logistics services to specialized providers, either partially or fully. These companies, which manage and execute such outsourced logistics operations, are known as logistics service providers (LSPs).

The ultimate domain of logistics is the development and application of Logistics 4.0, which is used in the new concepts of digital manufacturing (DM), smart manufacturing (SM), Industry 4.0, etc.

Within the concept of Logistics 4.0, modern logistics models are used, such as: digital logistics (DL), distribution logistics (DL), green logistics (GL), reverse logistics (RL), smart city logistics (SCL), supply chain logistics (SCL), smart logistics (SL), sustainable logistics (SL), smart urban logistics (SUL), sustainable urban logistics (SUL), urban logistics (UL) etc. The main trend in the development of new types of logistics is the inclusion of smart technologies in logistics [17,23,35,42,59].

The size of the global logistics market is valued at 10.2 trillion $ in 2023. Consulting firm AMR (Allied Market Research) predicts that it will reach 20.1 trillion $ by 2033, with a CAGR (compound annual growth rate) growth of 7.3% from 2034 to 2034.

For the field of logistics, the Scopus of citation database has indexed 843.942 publications in the ”Article title, Abstract, Keywords” option and 54.535 publications in the ”Article title” option (as of 31-12-2024).

The aim of this paper is to describe the different variants of software systems and tools for logistics, as well as the possibilities of their application in all areas of human activity.

### *2. From Logistics 1.0 to Logistics 4.0*

Analogous to the historical development of industry from Industry 1.0 to Industry 4.0, many authors have begun to present a similar evolution of logistics from Logistics 1.0 to Logistics 4.0 (Fig. 1) [17,19].

Logistics 4.0 is a new generation of logistics and logistics management (LM), which is based on a combination of modern software systems, tools and digital technologies (DT). It ensures integral and intelligent cooperation for the

implementation of logistics operations, which the physical, digital and virtual worlds are connected.

Some of the most significant digital technologies (DT) applied in Logistics 4.0 include [17,19,21,32,33,44,64]: Internet of Things (IoT), Internet of Everything (IoE), Internet of People (IoP), Internet of Services (IoS), robotics, sensors, artificial intelligence (AI), cloud computing (CC), logistics-as-a-service (LaaS), cyber-physical systems (CPS), smart manufacturing (SM), augmented reality (AR), blockchain, data mining (DM), networks (4G, 5G, 6G, WAN, WBAN, WSN, WiFi etc.) etc.

Along with the development of Logistics 4.0, the development and application of new concepts of digital production (DM), smart production (SM) and Industry 4.0, have predicted the development of accompanying areas with a similar admixture of ”4.0”, such as: Marine 4.0, Maritime 4.0, Port 4.0, Quality 4.0, SC4.0 (supply chain 4.0), Transport 4.0, etc.

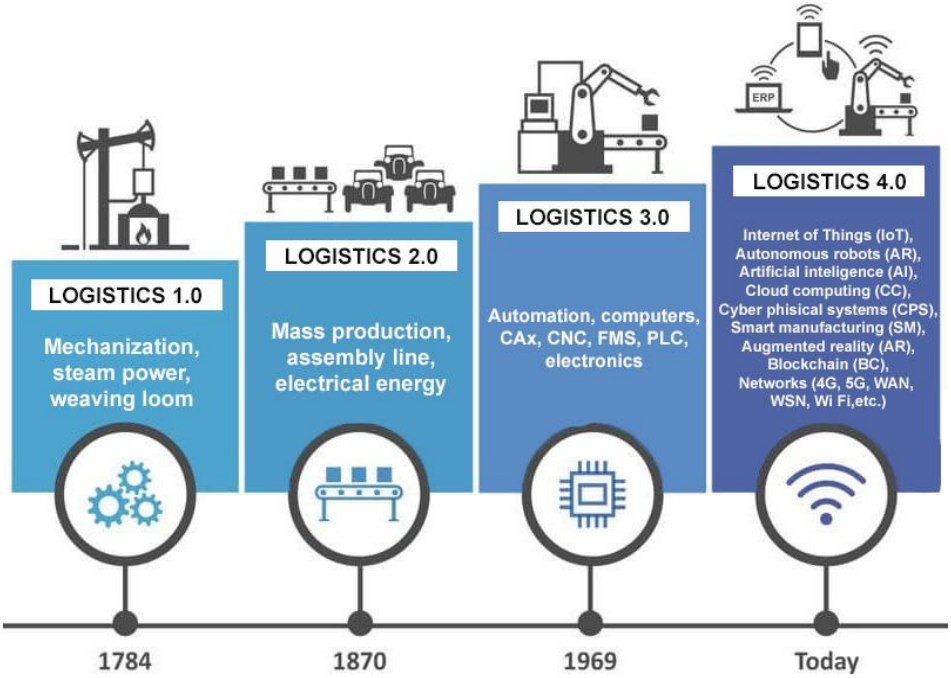


***Fig. 1.*** *The stages of logistics evolution from Logistics 1.0 to Logistics 4.0 [17,19]*

While many countries are still exploring the development and implementation of the Logistics 4.0 concept, advanced countries have already taken pioneering steps towards Logistics 5.0 [39,60]. This emerging paradigm emphasizes intelligent logistics (IL), smart logistics (SL), smart logistics systems (SLS) and advanced digital technologies (DT). Logistics 5.0 is designed to enhance customized planning, supply chain management (SCM), transportation, distribution, inventory management (IM), warehousing, and more. It prioritizes interconnectivity, integration, digitization, and optimization to create seamless and efficient logistics operations and supply chain (SC).

## *3. Software Systems and Tools for Logistics*

For the efficient realization of logistics and Logistics 4.0, a large number of modern software systems and tools have been developed and are used, which can be classified into the following groups:

- Logistics Databases (LDBs) are used for updating, searching and accessing logistics data;
- Logistics Information Systems (LISs) are used for storing, processing and managing logistics data and information;
- Logistics Management Systems (LMSs) are used for managing logical operations;
- Logistics Decision Support Systems (LDSSs) are used for decision-making in specific logistics operations;
- Logistics Expert Systems (LESs) are used to assess, analyze, provide recommendations and execute changes for numerous logistical and business situations and
- Other software systems and tools for logistics operations.

### *3.1. Logistics Databases (LDB)*

A database for the field of logistics, i.e. logistics database (LDB), enables the updating, quick searching and access to logistics data.

Several examples of developed logistics databases (LDBs) and logistics database systems (LDBSs) are:

- HILDA (Highly Integrated Logistics Database Application), which represents a software system designed to improve the updating and maintenance of the logistics data associated with the jet engine testing facilities [65];
- MLDB (Marine Logistics Database), which represents a database (DB) for maritime logistics designed to integrate data on BD (Big Data) and IoT (Internet of Things) in maritime, such as: port, ship, route, AIS

(Automatic Identification System), trade data, etc. [1,2];

- SHIELDS (Sanctuaries Hazardous Incident Emergency Logistics Database System), which represents a logistics database system and Internet-based information system designed to improve access to critical data, plans, and tools for contingency planning and response situations, developed by National Oceanic and Atmospheric Administration (NOAA) [7], etc.

For the phrase ”logistics database”, the Scopus citation database has indexed 42 publications in the ”Article title, Abstract, Keywords” option and 6 publications in the ”Article title” option (as of 31-12-2024).

### *3.2. Logistics Information Systems (LIS)*

Information system for the field of logistics, i.e. logistics information system (LIS), enables the storage, processing and management of logistics data and information. LIS is a software system that unifies logistics and information system (IS). LIS systems also enable the evaluation of actual data and the data creation for planning and forecasting all logistics operations.

The universal structure of the logistics information system (LIS) with four levels is shown in Fig. 2 [17,20].

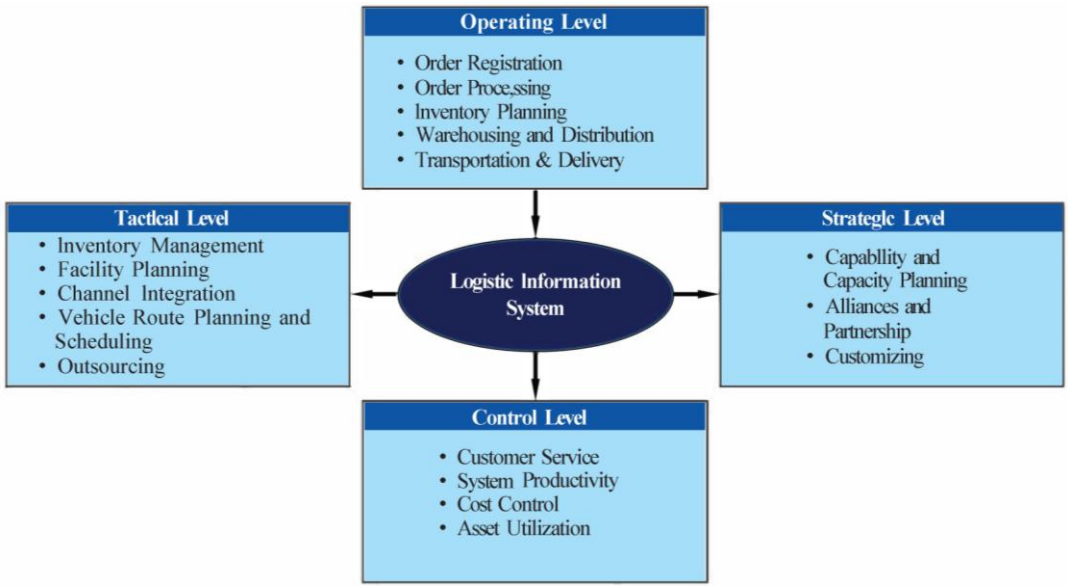


***Fig. 2.*** *The universal structure of the logistics information system (LIS) with four levels [17,20]*

The structure of each LIS system is developed on a modular principle and consists of the following information systems [17,20]:

- Sales Information System (SIS);
- Purchasing Information System (PIS);
- Inventory Controlling (IC);
- Shop Floor Information System (SFIS);
- Plant Maintenance Information System (PMIS);
- Quality Management Information System (QMIS);
- Retail Information System (RIS) and
- Transport Information System (TIS).

Within the LIS system, in the form of system modules, the following components can be used: Sales and Operations Planning (SOP), Logistics Data Transport (LDT), Logistics Data Warehouse (LDW), Logistics Data Quality (LDQ) etc.

Logistics information systems (LIS) are used in practice in two ways [17]:

1. As a module within a comprehensive and complex firm’s total information system (TIS) and/or a complex software system for management and planning of production, such as the software system SAP (System Analysis Program Development). In this case, the LIS represents a subset of the firm's TIS and it is directed to the particular problems of logistics decision making. The LIS system is located within SAP as part of the ERP (Enterprise Resource Planning) module and is called SAP-LIS (SAP (System Analysis Program Development) LIS (Logistics Information System)) or
2. As a separate system that functions as an independent software and information system.

Several examples of developed logistics information systems (LIS) are [17]:

- CLIS (City Logistics Information System) [34];
- ILIS (Integrated Logistics Information System) [13,56];
- MLIS (Manufacturing and Logistics Information System) [17];
- RLIS (Reverse Logistics Information System) [28,38];
- SLIS (Smart Logistics Information System) [17];
- WLIS (Warehouse Logistics Information System) [62] etc.

All developed variants of Logistics Information Systems (LIS) have wide application in the military industry and warfare, manufacturing, shipbuilding, maritime, aviation industry, automotive industry, agriculture, healthcare, etc. [3,5,15,29,30,43,56,66].

For the phrase ”logistics information system”, the Scopus citation database has indexed 412 publications in the ”Article title, Abstract, Keywords” option and 158 publications in the ”Article title” option (as of 31-12-2024).

In addition to logistics information systems (LIS) in the field of logistics, several other similar information systems have also been developed:

- LEIS (Logistics Enterprise Information Systems) [50];
- LIMS (Logistics Information Management Systems) [45];
- LITS (Logistics Information Technology Systems) [22];
- LMIS (Logistics Management Information Systems) [6], etc.

### *3.3. Logistics Management Systems (LMS)*

Logistics Management System (LMS) is a software system and/or tools that goods automate and optimise logistics operations (inventory, freight, distribution, warehouse, transport, etc.).

Developed modern LMS systems realize all logistics operations using a large number of new digital and smart technologies based on artificial intelligence [11].

Each LMS system consists of a large number of modules that serve to implement specific logistics operations (Fig. 3) [48,51].


***Fig. 3.*** *The main modules of logistics management system (LMS) [51]*

Standardized management systems, such as: ISO 9000 Quality Standards, ISO 14000 Environmental Standards or OHSAS 18001 Health and Safety Standards, can be integrated within the LMS system.

Several examples of developed groups of logistics management systems (LMS) are:

- ALMS (Autonomous Logistics Management Systems) [24];
- DLMS (Decentralized Logistics Management Systems) [41];
- GLMS (Green Logistics Management Systems) [67];
- ILMS (Intelligence Logistics Management Systems) [68];
- KLMS (Knowledge-Based Logistics Management Systems) [12];
- RLMS (Reverse Logistics Management Systems) [8];
- SLMS (Smart Logistics Management Systems) [11];
- SLMS (Sustainable Logistics Management Systems) [52], etc.

A large number of software systems and tools for the LMS system have been developed in the world so far, such as: SAP Supply Chain Logistics (URL: https://www.sap.com/products/scm/supply-chain-logistics.html), FarEye (URL: https://www.fareye.com/), NetSuite Logistic Solutions (URL: https://www.netsuite.com/portal/industries/transportation-logistics.shtml), BluJay Logistics Software (URL: https://www.blujaysolutions.com/), Quixy's Custom Logistics Software (URL: https://quixy.com/solutions/industries/supply-chain-and-logistics/), Optym Logistics Software (URL: https://www.optym.com/), Acumatica Logistics Software (URL: https://www.acumatica.com/), etc.

On Fig. 4 shows the conceptual illustration of smart logistics management system (SLMS) [11].

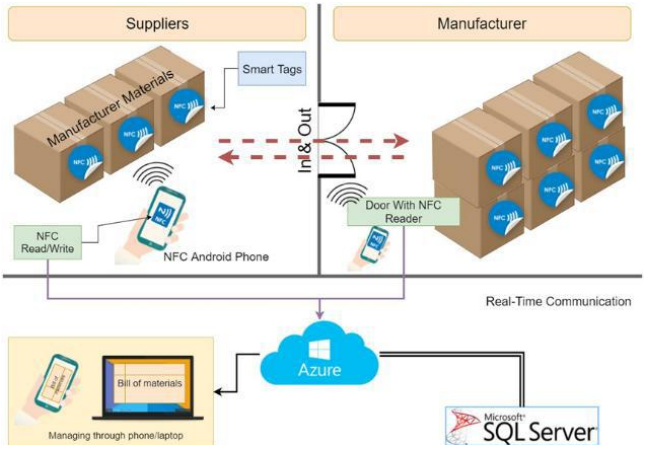


***Fig. 4.*** *Conceptual illustration of smart logistics management system (SLMS) [11]*

For the phrase "logistics management system", the Scopus citation database has indexed 332 publications in the "Article title, Abstract, Keywords" option and 121 publications in the "Article title" option (as of 31-12-2024).

### *3.4. Logistics Decision Support Systems (LDSS)*

Logistics Decision Support System (LDSS) is a software system that enables effective management by integrating various information about logistics operations within an organization and predicting the potential impact of possible decisions. It is based on a set of procedures used for data processing, information management in the field of logistics, and decision-making, supporting complex and

challenging decisions. LDSS systems for management used different information about logistics operations in organization and predicts the effect of possible decisions, based on methods of complex and hard decision making.

Logistics decision support system (LDSS) is a variant of the decision support system (DSS) applied in the field of logistics. A large number of developed decision support systems (DSS) are also classified based on their application, as shown in the papers [16,47,52,58,63].

Several examples of developed logistics decision support systems (LDSS) are:

- ILDSS (Intelligent Logistics Decision Support System) is a software system for managing and predicting logistics operations, which uses modern intelligent technologies;
- LDNPDSS (Logistics Distribution Network Planning Decision Support System or Decision Support System for Logistics Distribution Network Planning) is a software system for managing and predicting logistics operations, which uses reasoning center (RC) and multi-agent systems (MAS) [61];
- OLDSS (Outsourcing Logistics Decision Support System) is a software system for integrated design and manufacturing of products, developed on the activity analysis of a Lithuanian industry and theoretical assumptions by knowledge economy [4], etc.

For the phrase ”logistics decision support system”, the Scopus citation database has indexed 21 publications in the ”Article title, Abstract, Keywords” option and 8 publications in the ”Article title” option (as of 31-12-2024).

### *3.5. Logistics Expert Systems (LES)*

Logistics expert system (LES) is asoftware system designed to use expert approaches in decision-making to analyze, assess, provide recommendations and execute change for numerous logistical and business situations. Logistics expert system (LES) combines transportation management system (TMS), warehousing management system (WMS), business intelligence (BI), mobile intelligence (MI), consulting intelligence (CI), artificial intelligence (AI), machine learning (ML) and big data (BD) in one software system [36].

For the phrase ”logistics expert system”, the Scopus citation database has indexed 7 publications in the ”Article title, Abstract, Keywords” option and 1 publication in the ”Article title” option (as of 31-12-2024).

Based on the very small number of publications on Scopus and the fact that most of these publications are from the period 1986-1990, it can be concluded that the development of these systems is stagnant and that their obvious advantages are being utilized in other newer systems.

### *3.6. Other Software Systems and Tools for Logistics Operations*

A large number of modern software systems and tools for logistics operations also exist, which cannot be classified into any of the previously mentioned groups. A several examples of other groups of software systems and tools developed for logistics operations are:

- LES (Logistics Execution System) or SAP-LES (SAP (System Analysis Program Development) LES (Logistics Execution System)) is a software system and information system specialized in managing an organization's internal logistics, covering all processes from the receipt of raw materials, through storage and internal movement, until the delivery of the final product to shipping areas or consumption points within the organization itself [46];
- LPS (Logistics Planning Systems) is a group of software systems that enable solving tasks from planning in logistics, with several examples of developed LPS systems such as: ELPS (Emergency Logistics Planning System), AELPS (Artificial Emergency Logistics Planning System) [40], etc.;
- LPS (Logistics Production Systems) is a group of software systems designed to support and manage production-related tasks within logistics [55];
- LQMS (Logistics Quality Management Systems) is a group of software systems that enable quality management in logistics [57];
- LTS (Logistics Transportation Systems) is a group of software systems that enable solving tasks from transportation in logistics [54];
- LTS (Logistics Warehousing Systems) is agroup of software systems that enable solving tasks from warehousing in logistics [70], etc.

## *5. Conclusion*

In modern industry and society, logistics is a cornerstone of all areas of human activity.

Building on the principles of Industry 4.0, the concept of Logistics 4.0 has emerged. This innovative approach integrates advanced software systems, tools, and intelligent digital technologies (DT) to optimize planning, transportation, warehousing, distribution, and other logistics operations.

Modern business requires greater speed and accuracy during the flow of information within the logistics domain, which can be effectively addressed through the use of software systems and tools (LDB, LIS, LMS, LDSS, LES, etc.) for all logistics operations.

To support the diverse range of logistics activities, numerous logistics databases (LDB) and logistics information systems (LIS) have been developed. These systems provide comprehensive solutions for data storage, processing and management, ensuring efficiency and accuracy in the logistics field.

Modern logistics management systems (LMS) ensure efficient and reliable automation and optimization of all logistics operations including transport, distribution, warehousing, etc.

Developed logistics decision support systems (LDSS) enable the management of logistics operations in an organization, based on various decision-making methods.

Most logistics expert systems (LES) were developed in the period 1980-1990, and its positive advantages are used within the framework of newer systems.

All of the above modern software systems and tools for logistics, compared to traditional ones, use new technologies such as: artificial intelligence (AI), Internet of

Things (IoT), big data (BD), cloud computing (CC), etc. for their intelligent upgrading.

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