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Multi-criteria comparative analysis of software for load planning and unit load formation

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ABSTRACT

Unit load formation and load planning constitute key elements of contemporary logistics processes, influencing operational efficiency, transport safety, and the utilisation of cargo space. With the increasing complexity of logistics systems, the importance of software tools supporting these processes continues to grow. The aim of this study was to conduct a multi-criteria evaluation of selected software solutions for load planning and unit load formation. The study considered five software systems: Best Load, Cargo Optimizer Enterprise, CubeMaster, EasyCargo oraz Goodloading. The evaluation was conducted using a weighted scoring method, encompassing eleven criteria grouped into three categories: functional, usability, and economic, with weights of 0.50, 0.30, and 0.20, respectively. Each system was assessed on a scale from 0 to 3, and the final score was determined as a weighted sum of individual scores. The highest final score was obtained by Goodloading (2.80 points), which performed best in both the functional (1.45 points) and usability (0.85 points) categories. EasyCargo ranked second (2.35 points), followed by CubeMaster (2.00 points) and Cargo Optimizer Enterprise (1.80 points), while the lowest score was recorded for Best Load (0.90 points). Within the functional criteria, the most influential factors were the ability to calculate axle loads and support for irregularly shaped cargo. In terms of usability, mobility and web-based accessibility were decisive, whereas in the economic category, the key aspects were cost levels and the flexibility of the licensing model. The results demonstrate that, within the scope of the analysed sample, cloud-based solutions tend to outperform desktop systems in terms of functionality, usability, and economic flexibility. This advantage results from higher accessibility and the integration of advanced features, including the consideration of vehicle structural constraints and axle load calculations. The findings indicate that accurate representation of real-world loading conditions, combined with flexible system architecture, is a key factor influencing software effectiveness. The proposed approach provides a structured basis for the comparative evaluation and selection of logistics software solutions.

Keywords: load planning, unit load formation, load optimisation, multi-criteria decision-making, logistics software, decision support systems, axle load distribution.

INTRODUCTION

The importance of unit load formation in transport and logistics

Unit load formation is a key element in the organisation of transport, warehousing, and distribution operations. It involves combining individual packages or products into larger, structured units, enabling the efficient execution of operations such as loading, transport, transshipment, storage, and goods distribution. This approach contributes to improved operational efficiency, reduced handling activities, and enhanced safety throughout the supply chain [1–3].

In logistics, proper unit load formation directly influences the utilisation of cargo and storage space. The appropriate arrangement of goods on pallets, in containers, or on other load carriers minimises unused space, improves space utilisation, and reduces transport and storage costs [1, 4, 5]. Another key aspect is the stability of the unit load, as it affects transport safety, reduces the risk of product damage, and ensures compliance with transport and organisational requirements [3, 6].

The importance of unit load formation increases with the growing complexity of logistics systems. The increasing diversity of products, shorter production series, rising customer expectations, and the need to shorten order fulfilment times mean that it is no longer merely a supporting activity, but rather a fundamental element of logistics management. It directly influences customer service levels, operational costs, and the efficiency of goods flows within the logistics and transport system [1, 2, 5]. The resilience of these flows is increasingly tested by global disruptions, such as the Russia-Ukraine war, which has redefined the role of logistics in maintaining regional food security [7].

The role of software in load planning and palletisation

Software used for load planning and unit load formation, including palletisation, plays a crucial role in optimising logistics processes. It enables the analysis of cargo parameters such as dimensions, weight, and packaging type, as well as the selection of optimal load arrangements on pallets or within the cargo space of transport vehicles. As a result, it enhances space utilisation and reduces transport and storage costs [8–10]. Their practical effectiveness is increasingly measured by their ability to solve complex, real-life loading problems encountered by modern distributors [11]. These tools are increasingly integrated into Logistics 4.0 environments, where real-time data processing, automation, and system interoperability play a key role.

Moreover, load planning support systems allow for the consideration of technical and organisational constraints, including permissible loads, unit load stability, and unloading sequence requirements [8, 12]. In this context, ensuring strict compliance with axle weight limits remains a critical research focus for maintaining transport safety [13]. The automation of these processes significantly reduces the risk of errors associated with manual planning and improves operational efficiency [10, 14].

In addition, the ability to simulate different load arrangement scenarios and evaluate them according to predefined criteria, such as cost, processing time, and space utilisation, is essential. This facilitates more informed logistics decision-making and enhances the flexibility of transport process management [14, 15]. However, the reliability of these simulations is strictly determined by the quality of input parameters. Discrepancies between different data sources and the resulting difficulty in verifying source information constitute a universal challenge in all measurement-dependent fields, where unverified data can lead to significant errors in final models [16]. Consequently, such software not only supports planning activities but also constitutes a core element of logistics management within an enterprise. The importance of these solutions continues to grow with the increasing complexity of modern logistics systems [14].

Decision-making problems in software selection

The selection of software supporting load planning and palletisation is a complex decision-making problem in logistics and transport enterprises. This decision requires consideration of multiple factors, such as system functionality, acquisition and implementation costs, ease of use, the potential for integration with other IT tools, and adaptability to the specific processes carried out within the organisation [17, 18]. The complexity of this choice arises from the need to simultaneously evaluate technical, organisational, and economic criteria [19, 20]. From a methodological perspective, this problem can be formally classified as a MCDM problem involving both quantitative and qualitative attributes.

The decision-making problem in software selection is inherently multi-criteria, as individual solutions may differ in terms of functionality, level of automation, operational flexibility, and the quality of generated load plans [18, 19]. In practice, this requires the comparison of multiple alternatives and the identification of a solution that best meets user requirements. The process is further complicated by the fact that not all criteria are measurable, and their importance may be interpreted differently by decision-makers [19, 20].

Proper software selection has a direct impact on the efficiency of logistics planning processes, resource utilisation, and the operational performance of an enterprise [21]. Therefore, this decision should not be based solely on the price or popularity of a given solution, but rather on a comprehensive and structured analysis that takes into account key requirements and the specific characteristics of the organisation [22]. Consequently, the application of decision support methods is justified, as they enable a systematic evaluation and comparison of available software solutions [17, 20].

Review of software evaluation methods

The evaluation and selection of software supporting logistics processes require the use of appropriate analytical methods. Due to the multi-criteria nature of this problem, the decision-making process should take into account both quantitative and qualitative criteria, which are often difficult to compare directly.

The literature identifies a wide range of decision support methods that enable a comprehensive evaluation and comparison of available software solutions [23, 24]. The most commonly used approaches include multi-criteria methods such as AHP, SAW, and TOPSIS [25–27]. These methods allow for the ranking of decision alternatives according to predefined criteria and the identification of the solution that best meets user requirements [25, 27].

The application of multi-criteria methods enables the varying importance of individual criteria to be taken into account and reduces subjectivity in the evaluation process. As a result, the software selection process becomes more structured, transparent, and well-justified, which is essential for logistics management.

Research gap

Despite the availability of numerous software solutions supporting unit load formation, including load planning and palletisation, the literature lacks systematic and structured comparative analyses of these solutions. Existing studies most often focus on describing the functionalities of selected systems, while less frequently providing a comprehensive comparative evaluation [28, 29].

In particular, there is a noticeable shortage of studies that incorporate clearly defined evaluation criteria covering user-related, functional, and economic aspects. Few approaches enable a consistent evaluation and ranking of available software solutions in terms of their practical applicability [15, 21].

Additionally, there is a lack of studies employing approaches based on assigning weights to criteria and aggregating partial evaluations to determine a final ranking of the analysed solutions [30, 31].

Therefore, this study aims to conduct a multi-criteria comparative analysis of selected solutions, considering criteria reflecting user needs and enabling an objective and transparent ranking of the analysed alternatives in terms of their practical applicability. Furthermore, existing studies rarely provide reproducible evaluation procedures and transparent weighting structures, which significantly limits the comparability of results and their applicability in real-world decision-making processes.

Research objectives

Main objective

The main objective of this study is to perform a multi-criteria comparative analysis of selected software solutions and to identify the solution that best meets user requirements in load planning and transport operations.

Specific objectives

- To identify and characterise selected software solutions used for unit load formation.
- To develop a set of evaluation criteria covering the functional, usability, and economic aspects of the analysed solutions.
- To perform a comparative evaluation of software solutions using a multi-criteria approach.
- To develop a ranking of the analysed alternatives based on the adopted criteria and their weights.
- To identify the strengths and weaknesses of individual solutions and assess their applicability in practice.

Unlike previous studies, this research provides a fully reproducible evaluation framework based on explicitly defined criteria, weighting structure, and scoring procedure, enabling transparent comparison of logistics software solutions.

MATERIALS AND METHODS

Selection of software

The selection of software solutions included in the analysis was guided by the objective of identifying a representative group of tools supporting load planning. A key criterion was the diversity of delivery models, encompassing both locally installed desktop applications and modern cloud-based (SaaS) platforms. The chosen programs represent a cross-section of the professional market, selected based on their visibility and direct accessibility for logistics operations.

Five software solutions were selected for the analysis, namely Best Load [32], Cargo Optimizer Enterprise [33], CubeMaster [34], EasyCargo [35], and Goodloading [36]. These solutions reflect the functional diversity of systems available on the market, including both solutions focused on the analysis of structural and stability-related parameters of unit loads and systems designed for the optimisation of large datasets. The selection was also conditioned by the availability of fully functional trial versions or demo accounts. Access to these tools enabled a uniform assessment of each system's performance under identical conditions, rather than relying on manufacturer-provided documentation. This selection enables a comprehensive evaluation of their applicability in the context of diverse logistics requirements, while also addressing the research gap identified in Section 1.

Characteristics of the analysed software

This subsection provides an overview of the selected software solutions supporting load planning, including their main functionalities, operating principles, and areas of application in logistics processes.

Best Load

Best Load is a locally installed software application running on the user's workstation. This solution ensures high operational stability and operates in network-isolated environments.

The functionality of the system is primarily focused on the structural analysis of unit loads, including the assessment of packaging resistance to compression and the simulation of deformation in lower layers under static loads. It also enables the design of pallet structures through the selection of component parameters and the analysis of their load-bearing capacity. The system offers limited visualisation capabilities, with a primary focus on structural parameters.

The system is mainly applied in the transport of loads characterised by low mechanical strength, where unit load stability and the minimisation of damage risk during storage and transport are critical.

Cargo Optimizer Enterprise

Cargo Optimizer Enterprise is a locally installed software solution, enabling operation within the enterprise environment. This approach facilitates integration with internal databases and ensures full control over processed data.

The system enables the creation and management of product and customer databases, facilitating the reuse of predefined cargo parameters during the planning process. It also supports the design of packaging tailored to product dimensions, reducing unused space. Additionally, the system enables automatic allocation of cargo across transport units and provides three-dimensional visualisation, allowing for manual modification of load arrangements.

The system is particularly applicable in processes characterised by high repeatability, where the reduction of planning time and the flexible adaptation of load arrangements to customer requirements, such as unloading sequences or spatial constraints, is essential.

CubeMaster

CubeMaster is available in both locally installed and cloud-based versions, which enables flexible adaptation to different working environments and ensures seamless integration with enterprise IT systems.

The system provides comprehensive support for unit load formation processes, including product packing, palletisation, and the loading of transport units, such as containers and air cargo units (ULD). It supports integration with ERP and WMS systems and enables the automation of data flows. The system also provides three-dimensional visualisation of loading plans, along with the ability to modify them and to analyse physical parameters, such as the position of the centre of gravity.

In logistics operations, the system is primarily used in enterprises handling complex transport processes, where process integration and the control of safety-related parameters are essential.

EasyCargo

EasyCargo is a cloud-based application accessible via a web browser, eliminating the need for local installation. This solution enhances mobility and enables easy access across different working environments.

The system supports load arrangement planning using three-dimensional visualisation, with the possibility of manual modification and the use of virtual spatial constraints, such as partitions. It also provides a simplified analysis of weight distribution within the cargo space, allowing for an initial assessment of the impact on axle loads.

The system is primarily used in multi-drop transport planning and in situations requiring the rapid preparation of loading plans. Its visual nature supports operational communication and reduces the risk of errors resulting from incorrect cargo placement, although the analysis of physical parameters remains approximate.

Goodloading

Goodloading is a cloud-based platform accessible via a web browser, enabling rapid deployment and use without the need for local installation or configuration of IT infrastructure.

The system enables the representation of cargo space, taking into account its actual structural constraints, such as wheel arches, slopes, and equipment elements. It supports planning at both the pallet level and the direct placement of cargo within transport units. The system provides three-dimensional visualisation of loading plans, along with the possibility of their modification, and offers functions for the calculation of loading metres (LDM) and the generation of loading instructions.

The system is primarily used in operations requiring fast and transparent load planning, while also supporting communication between operational units and reducing the risk of errors resulting from incorrect cargo placement.

The analysis demonstrates that the examined systems differ in terms of functional scope, the level of optimisation algorithm advancement, and software delivery models. The analysed solutions include both systems focused on the analysis of physical and structural parameters of unit loads and those supporting rapid operational planning using three-dimensional visualisation. This diversity supports the application of a multi-criteria evaluation method for their comparison.

Evaluation criteria

To conduct a comparative analysis of the selected software solutions, a set of evaluation criteria was developed as the basis for a multi-criteria decision support model. The selection of criteria was based on the analysis of the decision-making problem and the need to consider key aspects of software performance in logistics processes.

The adopted criteria were divided into three categories: functional, usability, and economic. This division enables a multi-dimensional evaluation of the analysed solutions and ensures that technical, organisational, and economic parameters are taken into account.

Functional criteria

Functional criteria refer to the system's capabilities in supporting load planning and unit load formation. They include both the level of advancement of optimisation algorithms and the availability of tools supporting the decision-making process. The following criteria were considered:

- Advancement of palletisation and load planning – the system's ability to efficiently arrange loads within a constrained space;
- Calculation of axle loads and load distribution – functionality supporting transport safety and compliance with applicable regulations;
- Support for various load shapes and multiple cargo spaces – the system's versatility in handling different types of loads and transport units;
- Manual plan editing – the ability to modify automatically generated loading plans;
- Data import/export and integration with external systems – the scope of integration with data formats and systems such as ERP and WMS.

Usability criteria

Usability criteria refer to the quality of user interaction with the system and the accessibility of the software in different working environments. They reflect how easily the system can be used in practice and how effectively it supports operational tasks. The following criteria were considered:

- Ease of use and interface clarity – the degree of intuitiveness of navigation and the readability of the graphical user interface;
- Mobility and web accessibility – the ability to access and use the system across different devices without the need for local installation;
- Language support – the range of available language versions of the system.

Economic criteria

Economic criteria refer to the costs associated with the implementation and operation

of the software, as well as the conditions of its availability for users. The following criteria were considered:
- Software cost – the total financial expenditure required to use the software, including its pricing structure and overall affordability;
- Licensing model and terms of access – the licensing type (e.g., subscription or perpetual) and the associated usage rights, access conditions, and any applicable restrictions;
- Availability of a trial version – the possibility of verifying the system's functionality before implementation.

MCDM method

To systematise the comparative process and provide a measurable framework for the analysis, a weighted scoring method was applied. This approach ensures transparency and facilitates interpretation. It enables the transformation of qualitative and quantitative software characteristics into numerical values, allowing for an unambiguous comparison of the analysed solutions and their ranking. The SAW method is one of the most widely used techniques in multi-criteria decision-making due to its simplicity, transparency, and ease of interpretation [20].

The comparative analysis consists of the following stages:

1. Weights were assigned to each group of criteria (usability, functional, and economic criteria), reflecting their relative importance in the overall assessment. This allows for the differentiation of the impact of individual software features on the final score, in accordance with the assumed priorities of the analysis. Weights were assigned to eleven evaluation subcategories, and the sum of all assigned weights equals 1.0 (Table 1).

The adopted weight distribution (Table 1) reflects priorities related to the optimisation of transport processes, in which safety and operational efficiency are of key importance. The highest weight ($W_i = 0.50$) was assigned to functional criteria, as parameters such as load distribution and cargo space utilisation directly affect both transport safety and compliance with applicable operational constraints.

Within the group of usability criteria ($W_i = 0.30$), particular importance was attributed to mobility, ease of use, and online accessibility. This reflects the increasing need for rapid decision-making in a dynamic logistics environment, where access to planning tools and the intuitiveness of the interface contribute to reducing the risk of operational errors.

Economic criteria ($W_i = 0.20$) were assigned a lower weight, which reflects the assumption that software implementation costs are less significant than the potential benefits resulting from the optimisation of transport processes. In particular, the system's ability to increase cargo space utilisation and reduce empty runs may lead to cost savings that outweigh the initial investment.

2. Each of the analysed systems was assigned partial scores for individual criteria. A discrete scoring scale ranging from 0 to 3 was applied, where:

- 0 – no fulfilment of the criterion;
- 1 – low level of fulfilment;
- 2 – good level of fulfilment;
- 3 – very good level of fulfilment.

The qualitative and quantitative requirements for each score across all eleven criteria are detailed in Table 2.

3. The final evaluation score for each system was calculated according to the simple additive weighting (SAW) method [37], as expressed by Equation 1:

$$S = \sum_{i=1}^{n} W_i \cdot S_i \tag{1}$$

where: S – final score of the analysed system, W_i – weight of the i-th criterion, S_i – score assigned to the i-th criterion, n – total number of evaluation subcategories.

The obtained final score constitutes the basis for comparing the analysed tools and establishing the final ranking.

The adopted multi-criteria method enables a clear identification of the influence of individual criteria on the final result and ensures transparency of the decision-making process, which is of particular importance in logistics practice. It should be noted that the applied method assumes linear aggregation of criteria and independence between them, which may not fully reflect complex interactions in real-world decision-making problems.

Table 1. Weight distribution of criteria subcategories for evaluating software supporting load planning and unit load formation

Criteria group	Subcategory	Weight (W_i)
Functional (W_i = 0.50)	Advancement of palletisation and load planning	0.15
	Calculation of axle loads and load distribution	0.15
	Support for various load shapes and multiple cargo spaces	0.10
	Manual plan editing	0.05
	Data import/export and integration with external systems	0.05
Usability (W_i = 0.30)	Ease of use and interface clarity	0.15
	Mobility and web accessibility	0.10
	Language support	0.05
Economic (W_i = 0.20)	Software cost	0.10
	Licensing model and terms of access	0.05
	Availability of a trial version	0.05

Table 2. Scoring table and qualitative requirements for the evaluation criteria

Criteria group	Subcategory	Score 1 (Low)	Score 2 (Good)	Score 3 (Very good)
Functional	Palletisation and load planning	Basic stacking and optimization	Advanced in one domain (unit/space); simplified in the other	Advanced optimisation (unit & space integrated)
	Axle loads and load distribution	Total weight only	Simplified distribution (centre of gravity)	Full dynamic axle load calculation
	Load shapes and multiple cargo spaces	Basic shapes and limited load spaces	Limited shapes or load spaces	Various shapes and load spaces
	Manual plan editing	Limited adjustments; basic positioning with low ergonomics	Functional editor; requires increased manual effort	Intuitive 3D drag-and-drop; real-time visual feedback
	Data import/export and integration	Manual data entry; basic export of static reports	Standard file-based import/export for cargo lists	Full automated handling via native API/ERP/WMS
Usability	Ease of use and interface clarity	Non-intuitive; high operational complexity	Functional; moderate ergonomics or legacy design	Modern, ergonomic; intuitive 3D visualisation
	Mobility and web accessibility	Basic web access; significant limitations	SaaS/Web access; limited mobile/touch ergonomics	Native cloud/SaaS; full cross-device optimisation
	Language support	English version only	Several major languages supported	Wide range of native versions
Economic	Software cost	High initial cost; no flexible billing	Competitive pricing; standard market flexibility	Optimal price-to-performance; high accessibility
	Licensing model and terms of access	Workstation-bound	Account-based; restricted by additional fees	Flexible account-based SaaS
	Availability of a trial version	Restricted access (limited features or operations).	Full feature access with standard duration (10–14 days)	Full feature access with extended duration

Note: A score of 0 represents the total absence of the evaluated feature.

Stages of MCDM

The analysis was conducted by dividing it into stages that enable a systematic and comparable evaluation of the analysed software tools. The adopted approach ensures a uniform evaluation procedure and allows the analysed solutions to be ranked accordingly (Figure 1).

The analysis comprised the following stages:

1. Software selection: Based on a review of available market solutions, five software systems supporting load planning and unit load formation were selected. The selection considered the diversity of software delivery models (desktop, cloud-based, and hybrid), as well as the functional scope of the tools, enabling the

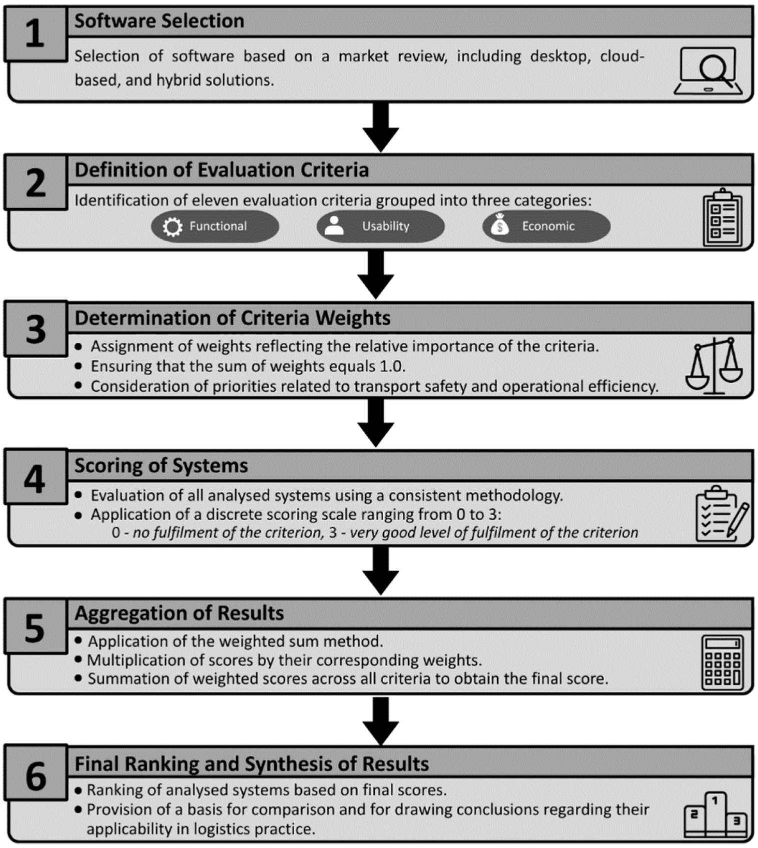


Figure 1. Procedure of the MCDM method applied to software for load planning and unit load formation

comparison of solutions representing different technological approaches.

2. Definition of evaluation criteria: Based on the analysis of the decision-making problem and a literature review, eleven evaluation subcategories were identified and grouped into three main areas: functional, usability, and economic. The adopted set of criteria constituted a common basis for the evaluation of all analysed systems.
3. Determination of criteria weights: Individual criteria were assigned weights reflecting their importance in the decision-making process. The weights were defined such that their sum equals 1.0, enabling their direct use in the weighted sum formula. The adopted weight distribution accounted for priorities related to transport safety and operational efficiency.
4. Scoring of systems: Each of the analysed systems was evaluated using a consistent approach. Each subcategory was assigned a score ranging from 0 to 3. The evaluation process included an assessment of system functionality, usability, and accessibility.
5. Aggregation of results: The partial scores were multiplied by their corresponding weights and then summed in accordance with the adopted mathematical model. This made it possible to determine the final evaluation score for each system.
6. Final ranking and synthesis of results: Based on the obtained final scores, the analysed systems were ranked. These results serve as the basis for further comparative analysis and for drawing conclusions regarding the suitability of individual solutions in logistics practice.

To ensure comparability of results, all systems were evaluated using a uniform procedure consisting of five test scenarios based on identical input data. The scenarios involved forming unit loads and planning the placement of mixed cargo with diverse dimensions and weights. This included standard EUR-pallets (1200 × 800 × 1400 mm), as well as various non-standard shapes such as long items (3000 × 200 × 200 mm), flat objects, and large oversized crates (2000 × 1200 × 1500 mm), with unit weights ranging from 15 to 1200 kg. These loads were planned within different cargo spaces, such as a standard 13.6 m semi-trailer and a 40 ft HC container. Additionally, the scenarios included attempts to distribute the cargo across multiple spaces to verify system

Table 3. Comparative evaluation of the functional criteria of the analysed load planning software

Subcategory	Software				
	Best Load	Cargo optimizer enterprise	CubeMaster	EasyCargo	Goodloading
Advancement of palletisation and load planning (W_i = 0.15)	2	3	3	2	3
Calculation of axle loads and load distribution (W_i = 0.15)	0	1	1	3	3
Support for various load shapes and multiple cargo spaces (W_i = 0.10)	1	2	2	1	3
Manual plan editing (W_i = 0.05)	1	2	0	3	3
Data import/export and integration with external systems (W_i = 0.05)	1	2	3	2	2
Weighted score	0.50	1.00	0.95	1.10	1.45

capabilities in multi-vehicle planning. The evaluation covered varying cargo volumes, from small partial loads to full shipments equivalent to 66 EUR-pallets, to assess performance under diverse stacking constraints (e.g., "place on top" permissions and weight limits for stacked layers) and load-bearing requirements. Consideration was given to optimal space utilisation, axle load distribution, and the ability to manually modify plans. This standardised approach, utilising the same load lists and dimensions for each tool, ensures a consistent and reproducible comparative analysis under real-world logistics conditions.

RESULTS

Results of the evaluation in the functional criteria group

This subsection analyses the software features determining its applicability in practical load planning. The assessment covered the level of advancement of palletisation and load planning, the capability to calculate axle loads and load distribution, flexibility in handling various types of cargo and cargo spaces, as well as the availability of manual plan editing functions and integration with external systems. Detailed results are presented in Table 3.

The results indicate that Goodloading achieved the highest score in the functional criteria group (1.45 points), significantly outperforming the other analysed systems. The high evaluation is primarily due to its advanced load planning capabilities, support for diverse cargo shapes, and the ability to calculate axle loads. An additional advantage is its capability to account for physical constraints of the cargo space, such as wheel arches. This enables the generation of loading plans that more accurately reflect the real operating conditions of the vehicle.

Second place was taken by EasyCargo (1.10 points). The system stands out due to its intuitive manual plan editing function and the ability to calculate axle loads. However, its limitations include reduced flexibility in handling non-standard cargo shapes and a limited capability to operate with multiple cargo spaces. This indicates that EasyCargo is particularly suitable for standard loading operations involving regular-shaped cargo and a single cargo space, but may be less effective in more complex load planning scenarios.

Similar results were obtained by Cargo Optimizer Enterprise (1.00 points) and CubeMaster (0.95 points). Both systems offer advanced automatic load planning algorithms. CubeMaster is particularly distinguished by its data import and export capabilities and integration with external systems, making it more suitable for large organisations and enterprises utilising ERP systems. However, the lack of a manual plan editing function reduces user flexibility during further modification of the generated plan.

The lowest score was obtained by Best Load (0.50 points). The low evaluation is primarily due to the lack of axle load calculation functionality and limited support for various types of cargo spaces. However, the software has a significant advantage in the form of advanced palletisation functions, making it useful in cases where the design of a stable unit load is more important than that of comprehensive load planning.

In summary, within the functional criteria group, the leading positions were primarily determined by the ability to reflect real structural constraints of the vehicle. The most important factors included axle load calculation, support for irregular cargo shapes, consideration of the vehicle's cargo space structure, and the possibility of manual plan adjustment. For this reason, Goodloading received the highest evaluation, as it combines automated planning with practical functions for technical control of the loading process.

Results of the evaluation in the usability criteria group

Within this group of criteria, the operating conditions of the systems were assessed, taking into account interface intuitiveness, the availability of tools in a web-based environment, and language support. Detailed results are presented in Table 4.

EasyCargo and Goodloading exhibit the highest level of interface ergonomics, which directly translates into user efficiency. Their structure is based on a clear arrangement of functions, making the planning process intuitive and requiring no extensive training. CubeMaster, despite its wide range of features, has an interface with a high density of information, which may increase the time needed to access individual modules. Cargo Optimizer Enterprise employs legacy visual solutions which, although still readable, lag behind the leading systems in terms of navigation speed. The lowest score was assigned to Best Load, whose interface is characterised by limited clarity.

In the category of mobility and online accessibility, CubeMaster and Goodloading achieved the highest scores. As cloud-based SaaS solutions, they enable stable operation in a web browser across various devices. Verification conducted on mobile devices confirmed their full functionality beyond a stationary workstation. EasyCargo also supports cloud-based operation; however, when used on touch-screen devices (e.g. tablets), certain limitations in manual editing of the loading plan were identified. Best Load and Cargo Optimizer Enterprise did not receive any points in this subcategory, as they are exclusively desktop-based solutions and do not provide access via a web browser or mobile devices.

In terms of language support, EasyCargo received the highest rating, offering an interface available in 14 language versions. CubeMaster and Goodloading provide support in eight languages. The ranking is completed by Best Load and Cargo Optimizer Enterprise, which offer an interface exclusively in English, thus meeting only the basic requirement of this criterion.

In summary, the differentiation of results within the usability criteria group was primarily determined by software architecture and the ergonomics of the working environment. The findings indicate a clear advantage of cloud-based solutions (CubeMaster, EasyCargo, Goodloading), which enable flexible process management from any device with internet access. The most significant factors influencing the results were ease of use and the level of mobility provided. Desktop-based systems, namely Best Load and Cargo Optimizer Enterprise, allow operation only on the computer on which they are installed. The lack of access via web browsers or mobile devices makes them significantly less flexible in working environments that require access from multiple devices.

Results of the evaluation in the economic criteria group

This subsection analyses the economic aspects determining the total cost of ownership and financial flexibility of the analysed solutions. The assessment covered the level of financial expenditure and the payment model, licensing terms and conditions of access, as well as the scope and availability of trial versions. Prices and licensing terms were verified as of April 13, 2026, based on official provider price lists [32–36]. All prices are net (excluding VAT) and refer to a single-user license (one workstation/account). Where a price range is provided (e.g., for Goodloading or EasyCargo), the lower value represents the monthly equivalent when billed annually, while the higher value applies to a single-month subscription. Detailed results are presented in Table 5.

The conducted cost analysis demonstrated that the highest evaluations were achieved by Cargo Optimizer Enterprise and Goodloading. The former is characterised by the lowest total annual cost (approximately EUR 43 per licence), while the latter offers the most affordable subscription model (approximately USD 19–23 per month). EasyCargo was evaluated at a medium level (2 points), which results from its relatively high monthly cost (USD 67–79), while simultaneously providing flexibility through the option

Table 4. Comparative evaluation of the usability criteria of the analysed load planning software

Subcategory	Software				
	Best Load	Cargo optimizer enterprise	CubeMaster	EasyCargo	Goodloading
Ease of use and interface clarity (W_i = 0.15)	1	2	2	3	3
Mobility and web accessibility (W_i = 0.10)	0	0	3	2	3
Language support (W_i = 0.05)	1	1	2	3	2
Weighted score	0.20	0.35	0.70	0.80	0.85

of purchasing a daily licence (approximately USD 10 for 24 hours).

The lowest evaluations were obtained by Best Load and CubeMaster. In the case of Best Load, the decisive factor is the high base price (approximately USD 103 per month per licence) combined with the lack of short-term options, requiring annual payment in advance. In CubeMaster, a significant barrier is the additional fee model, as despite a moderate subscription price (approximately USD 89 per month), high API access fees (ranging from USD 250 to USD 490 per month depending on the selected plan and billing cycle) substantially increase the total cost of use.

In terms of the licensing model and conditions of access, the highest evaluations were achieved by EasyCargo and Goodloading, due to the implementation of the SaaS model, in which the licence is assigned to a user account. This approach enables access to the software from multiple devices and increases resilience to hardware failures. CubeMaster received a lower evaluation due to the high cost of API access, which limits integration with external systems. The lowest evaluations were assigned to Best Load and Cargo Optimizer Enterprise, which utilise device-based licensing, thereby limiting mobility and increasing the risk of access loss in the event of hardware failure or replacement.

In the criterion of trial version availability, the highest evaluation was achieved by CubeMaster, which offers full 30-day access to all functionalities. EasyCargo and Cargo Optimizer Enterprise provide 10- and 14-day trial periods, respectively. The lowest evaluations were assigned to Best Load and Goodloading. In the case of Goodloading, the free version without time limitation restricts access to key functionalities (e.g. axle load calculation), preventing a full assessment of the system's capabilities. Best Load, in turn, allows only five loading operations in the trial version, which is insufficient for a comprehensive evaluation of the software.

In summary, within the analysed sample, the variation in evaluations is primarily determined by the relationship between the cost level and the flexibility of use. The highest evaluations are achieved by cloud-based solutions, which, due to licence mobility and the availability of short-term access options, reduce financial risk. Locally installed systems, despite sometimes competitive base costs, are characterised by lower attractiveness due to limited licensing flexibility and restricted opportunities for comprehensive testing of system functionalities.

Table 5. Comparative evaluation of the economic criteria of the analysed load planning software

Subcategory	Software				
	Best Load	Cargo optimizer enterprise	CubeMaster	EasyCargo	Goodloading
Software cost (W_i = 0.10)	1	3	1	2	3
Licensing model and terms of access (W_i = 0.05)	1	1	2	3	3
Availability of a trial version (W_i = 0.05)	1	2	3	2	1
Weighted score	0.20	0.45	0.35	0.45	0.50

Final results and software ranking

In the final stage of the analysis, the partial results from the three criteria groups, namely functional, usability and economic, were aggregated. The adopted weighting structure enabled the verification of the level of fulfilment of technical and operational requirements imposed on tools supporting the optimisation of unit load formation. A detailed summary of the weighted results and the final ranking is presented in Table 6.

The aggregated analysis indicates that Goodloading represents the leading solution, with the highest final score (2.80 points). Its first-place position results from high evaluations in the key functional category, as well as a high level of interface usability. This system most effectively integrates advanced engineering calculations, such as axle load computation, with a modern cloud-based architecture and an economically efficient subscription model.

Second place was achieved by EasyCargo (2.35 points). This system constitutes a significant alternative to the leading solution, offering the most extensive language support and unique financial flexibility through the option of purchasing a daily licence. Its slightly lower score results from limited algorithmic flexibility in handling irregular cargo shapes and interface constraints when operating on mobile devices. CubeMaster ranked third (2.00 points), representing an advanced tool with strong integration potential; however, it loses points primarily due to high additional API access fees and a relatively dense user interface.

The remaining positions were occupied by locally installed systems. Cargo Optimizer Enterprise (1.80 points) remains a cost-effective solution; however, its limited mobility and outdated visual architecture reduce its usability in dynamic working environments. The ranking is closed by Best Load (0.90 points), which received the lowest evaluations across all analysed criteria groups. The lack of axle load calculation functionality, device-bound licensing, and the most restrictive financial model make this solution the least effective among the analysed tools.

In summary, within the scope of the analysed sample of tools, the final software ranking indicates a clear advantage of cloud-based systems. Their performance is determined not only by mobility and economic flexibility but, above all, by their ability to reflect real structural constraints of transport vehicles. Under the adopted evaluation framework, the results indicate that Goodloading represents the most comprehensive solution among the analysed tools supporting load planning and unit load formation processes.

DISCUSSION

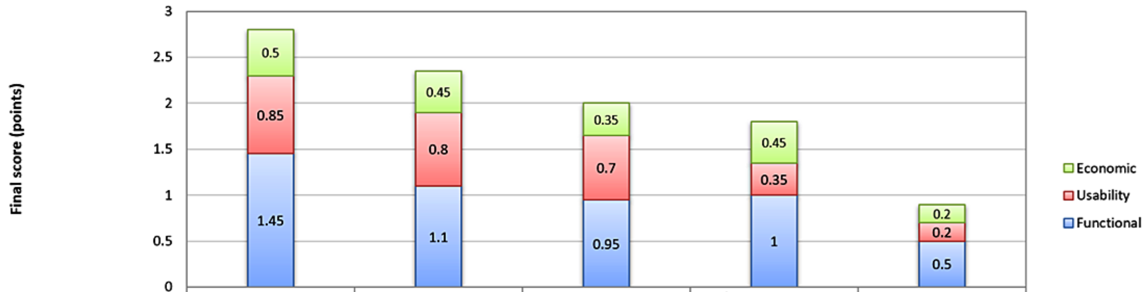
The conducted multi-criteria comparative analysis enabled an assessment of the technological advancement of contemporary logistics support systems. To illustrate the differences between the analysed tools, the final results were normalised relative to the maximum possible score (3.00 points), which enabled the determination of a percentage indicator reflecting the degree of fulfilment of the adopted criteria (Figure 2).

The results indicate that Goodloading achieved a score of 2.80 points, corresponding to 93.3% fulfilment of the adopted criteria. At the opposite end of the ranking was Best Load, with a score of 0.90 points, representing only 30.0% fulfilment. The remaining systems were positioned within the medium-to-high range: EasyCargo (78.3%), CubeMaster (66.7%), and Cargo Optimizer Enterprise (60.0%). Such a wide range of results clearly highlights significant functional and technological differences among the analysed solutions under the adopted weighting system.

The obtained results are consistent with previous studies [25, 27], which demonstrate

Table 6. Summary of weighted results and final ranking of the analysed load planning software

Criteria Group	Software				
	Best Load	Cargo optimizer enterprise	CubeMaster	EasyCargo	Goodloading
Functional (W_i = 0.50)	0.50	1.00	0.95	1.10	1.45
Usability (W_i = 0.30)	0.20	0.35	0.70	0.80	0.85
Economic (W_i = 0.20)	0.20	0.45	0.35	0.45	0.50
Final score	0.90	1.80	2.00	2.35	2.80



	1st Goodloading	2nd EasyCargo	3rd CubeMaster	4th Cargo Optimizer Enterprise	5th Best Load
Final score (points)	2.8	2.35	2	1.8	0.9
Criteria fulfilment (%)	93.3%	78.3%	66.7%	60.0%	30.0%

Figure 2. Comparison of analysed software systems based on final scores and criteria fulfilment

that multi-criteria approaches enable effective differentiation between software alternatives. However, in contrast to these studies, the present work focuses specifically on logistics load planning systems and incorporates operational constraints such as axle load distribution and cargo space structure.

The high level of criteria fulfilment observed for EasyCargo and Goodloading (above 75%) can be attributed to their extensive functionality in load planning. In addition to the implementation of key algorithms, such as axle load calculation and control, their performance is also supported by the high quality of the user interface layer. These systems are characterised by intuitive operation, clear interfaces, and the ability to manually modify loading plans in real time, which significantly enhances their practical usability in logistics operations.

In the analysed sample, the higher scores achieved by cloud-based systems can be explained by their scalability, accessibility, and integration capabilities, which are characteristics of Logistics 4.0 environments. These features enable flexible process management and facilitate real-time decision-making, which is particularly important in dynamic transport and logistics systems.

However, several limitations of the study should be acknowledged. The applied scoring method, despite striving for objectivity, involves a degree of subjectivity in the assignment of weights to individual criteria. The adopted weighting system reflects priorities typical of road transport planning and may differ depending on specific operational contexts. Additionally, the use of a discrete scoring scale (0–3) may reduce the sensitivity of the model and limit the differentiation between closely ranked alternatives.

Furthermore, the analysis focused on the standalone operation of the software, without a detailed assessment of its performance or long-term integration capabilities with ERP- and WMS-class systems in real-world logistics environments. The study also covered a limited number of tools, which restricts the generalisability of the results. Future research should therefore include a sensitivity analysis of the decision model with respect to the adopted criteria weights, enabling an assessment of the robustness and stability of the obtained ranking.

An evolution in software evaluation methods is evident in the existing literature. While traditional approaches were often limited to descriptive analyses, this study applies a structured multi-criteria approach consistent with MCDM methods, enabling a more precise representation of the complexity of the decision-making problem. The findings suggest that modern load planning systems increasingly function as decision-support tools rather than merely visualisation tools.

CONCLUSIONS

The multi-criteria comparative analysis enabled the ranking of the analysed software systems supporting load planning and unit load formation. This study provides a transparent and reproducible evaluation framework for logistics software assessment. Based on the adopted weighting system, Goodloading achieved the highest final score, demonstrating the best overall performance among the analysed software systems. EasyCargo also ranked highly, while the remaining systems demonstrated a moderate or low level of fulfilment of the evaluated criteria within this specific framework.

The results indicate that system functionality and user interface quality play a critical role in determining the efficiency of logistics processes. Within the analysed sample, systems that offer advanced optimisation algorithms and reflect real-world transport constraints, while ensuring intuitive operation and enabling user interaction, demonstrate higher effectiveness compared to solutions with limited functionality.

From a managerial perspective, the results provide practical guidance for decision-makers in the transport and logistics sector, supporting the selection of software solutions aligned with operational requirements and organisational needs. The findings highlight the importance of considering not only technical parameters, but also usability and economic flexibility when selecting software tools. The results are particularly relevant for small and medium-sized enterprises, where the selection of appropriate software tools has a direct impact on operational efficiency.

The analysis confirms the validity of applying a multi-criteria approach, which enables a comprehensive and relatively objective assessment of available solutions and supports informed decision-making. The proposed method provides a structured framework that is adaptable to different logistics contexts.

In the context of future research, it is recommended to extend the adopted methodology by incorporating other multi-criteria methods, including AHP and TOPSIS, which would allow for a comparative evaluation and further enhance the reliability of the obtained results. Future studies should also consider a larger number of systems and examine their performance under real-world operational conditions.

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