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The use of the CTU Code to increase freight transport safety and business competitiveness: An empirical analysis of a sample of Italian companies

Giovanna Bruno [a], Giordano Bruno Guerrini [b,c], Claudia Caballini [d,*]

[a] PSA Genova Pra' Container Terminal, Bacino Portuale di Prà, 16157 Genoa, Italy
[b] Chairman at Bureau International des Containers et du Transport Intermodal (BIC), 41, Rue Réaumur, 75003 Paris, France
[c] General Secretary of C.I.S.Co.- Centro Internazionale Studi Container, Via Garibaldi, 4, 16124 Genoa, Italy
[d] Politecnico di Torino, Dept. DENERG, Energy Department, Corso Duca degli Abruzzi 24, 10129 Torino, Italy

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ABSTRACT

The CTU Code (Code of practice for packing of cargo transport units) is the reference manual for all aspects of loading and securing cargo in intermodal transportation units. The purpose of the Code is to increase the safety of cargo loading throughout the transport chain and provide a benchmark for process standardization, with the final aim of increasing the safety and security of workers, goods, cargo units, means of transport and environment. The objective of this paper is to demonstrate, through an empirical survey of a sample of 26 Italian companies, how the application of the CTU Code to cargo loading and transportation processes can increase the safety level of transport activities, and also improve business processes and competitiveness. The results show that the use of the CTU Code provides an increase in safety with a drastic reduction of loading accidents and damage to goods, as well as important benefits in terms of costs, improved efficiency, corporate image and reduced environmental impact.

Introduction

The International Transport and Logistics insurer TT Club[1] states that two-thirds of cargo damage incidents are caused or aggravated by poor practices when packing goods into a container. This supply chain negligence causes multi-million-dollar losses, including tragic container ship fires with loss of life and significant delays. Extrapolating from known figures, all these incidents are estimated to cause economic losses in excess of $6 billion annually (TTClub, 2021). James Hookham, Secretary-General of the Global Shippers Forum (GSF), recognizes the crucial role cargo owners play in promoting high standards of safe and environmentally responsible container packing. In addition to the serious health and safety risks, poorly packed containers can also cause damage to adjacent cargoes in the event of an accident and have been the cause of severe losses for shippers.

Another relevant issue is combating the unintentional transfer of invasive plant and animal species: biological invasions result from international trade (Hulme, 2021). The importance of this contamination problem is confirmed by the Cargo Integrity Group[2] (CIG) which recognizes the importance of addressing the threat of invasive pests to natural resources worldwide and the urgency of developing risk reduction measures. This call to action follows the objective of pest control experts to adopt all-encompassing and internationally mandated measures to mitigate these risks, under the auspices of the International Plant Protection Convention[3]. The governing body of the IPPC, the Commission on Phytosanitary Measures[4], acknowledged that "*the packing of sea containers with cargo is the most likely stage in the sea container supply chain at which contamination can occur. Operators'*

* Corresponding author.
E-mail address: claudia.caballini@polito.it (C. Caballini).

[1] TTClub, International Transport and Logistics Insurance, https://www.ttclub.com/.

[2] Partner of Cargo integrity group: Container Owners Association (COA), Global Shippers Forum, ICHCA International, TT Club e World Shipping Council (WSC).

[3] The International Plant Protection Convention (IPPC) is an intergovernmental treaty signed by over 180 countries, aiming to protecting the world's plant resources from the spread and introduction of pests, and promoting safe trade, https://www.ippc.int/.

[4] The IPPC is governed by the Commission on Phytosanitary Measures (CPM), which was established under Article XII of the New Revised Text of the IPPC, approved in 1997, and serves as the Convention's governing body, while also being a FAO Statutory Body. https://www.ippc.int/en/core-activities/governance/cpm/.

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procedures for cleaning sea containers and handling containers and cargo, must therefore consider the risk of contamination at the packing stage". Improperly packed and secured cargo (Fig. 1-a,b,c,d), the use of unsuitable CTUs and the overloading of CTUs (Fig. 1-g,h) may endanger people during handling and transport operations. Improper declaration of the cargo may also cause dangerous situations. Misdeclaration of the CTU's gross mass may result in overloading a road vehicle or rail car or assigning an unsuitable stowage position on board a ship thus compromising the safety of the vessel (Fig. 1-f). Insufficient moisture control (Fig. 1-e) may cause severe damage to and collapse of the cargo and also cause the loss of the stability of the CTU.

In past years, cargo securing practices have received little attention despite the existence of the CTU Code and its benefits. The Code of Practice for Packing of Cargo Transport Units (CTU Code) (IMO/ILO/UNECE, 2014) was introduced in 2014 to make up for the shortcomings regarding cargo securing practices. The CTU Code is a reference manual covering all aspects of cargo transport and safety/security, with a focus on intermodal transportation. The Code has a broad perspective and addresses the key needs of all parties involved in cargo security globally. Nonetheless, the CTU Code has so far not been extensively implemented and its benefits have not been properly highlighted.

To date, the literature has investigated a number of aspects related to loading methods and steps to reduce cargo damage in order to ensure a greater safety level. Oktaviani et al. (2017) researched methods to reduce the amount of cargo damage, using fishbone diagrams and interviews. Singh et al. (2014) outlined the risk associated with improperly loaded trailers and recommended appropriate loading methods. Durai Murugan and Kannan (2021) applied the Six Sigma statistical tool to a shipping company in order to identify solutions to reduce cargo damage.

Regulations and guidelines to assess and prevent cargo damage have also been studied. Kamarumtham (2022) proposed guidelines and improvements that may be useful for reducing cargo losses, but did not specifically address cargo securing procedures. Papanikolaou and Eliopoulou (2008) outlined the main regulations currently in place for the assessment of stability in the event of dry cargo and passenger ship failure. Shigunov et al. (2010) provided an operational guide for container ships explaining the key navigational factors that can cause cargo loss and damage.

Maritime safety, ship accidents and their causes, and the management of maritime transport safety risks have also been addressed. Kulkarni et al. (2020) provided a literature review on maritime accident risks to outline the trends and gaps related to this topic. Wan et al. (2019) investigated safety and security risks in the shipping industry, while Hetherington et al. (2006) and Lorenzi et al. (2018) specifically analysed how the human element can affect safety in shipping. Hasanspahić et al. (2020) assessed the quality and effectiveness of near-miss management systems in the shipping industry. Based on the analysis of ship accident investigation reports, Zhang et al. (2019) assessed the factors that cause ship accidents and their consequences. Mitroussi (2004) discussed the International Maritime Organisation's (IMO's) maritime transport quality and safety standards and outlined the challenges associated with their implementation. Speier et al. (2011) identified useful initiatives to increase the level of security along the entire supply chain, but not specifically related to cargo securing procedures. Palšaitis and Petraška (2012) dealt with the risks associated with the transport of heavy and oversized cargo. It should be noted that none of the aforementioned works included or mentioned the CTU Code.

In general, in the literature very little attention has been paid to date to load securing procedures and the CTU code, the benefits of which have not yet been adequately researched. Jagelčák et al. (2013) illustrated the differences that occur in the calculation of restraint forces using measured dunnage values and the CTU Code guidelines. Gnap et al. (2021) used the CTU code to define the acceleration and forces acting on goods transported by road when stressed by dynamic events. Nieoczym et al. (2019) studied an efficient procedure for securing free loads using straps, considering the DIN - EN12195/2 standard and the 'IMO model course 3.18'. Tkaczyk et al. (2021) researched the use of stretch film to identify an optimal wrapping method that would ensure load safety and reduce costs; the tests were performed considering the acceleration values for stability provided by the CTU Code. In most cases, the CTU Code is only mentioned but never discussed in depth (Chmieliński, 2019; Hur et al., 2019; Lacey et al., 2018).

The contribution of this paper is to outline the advantages for companies in applying the CTU Code, along with the reasons why some companies do not apply it. A survey investigating the use of the CTU Code was administered to 26 Italian companies handling different commodity categories with the aim of providing evidence of the practical implications of the CTU Code. The benefits for the companies using the CTU Code were quantified in terms of time, cost, safety, environmental impact and corporate image. To the best of our knowledge, no other work in the literature has addressed this issue to date. This work is the first to attempt to assess and quantify the benefits of the CTU code for companies that have implemented it. This paper claims that experimental evidence of the application of the CTU Code can be very effective in communicating its importance and benefits. This work also contributes to raise awareness of the technical/training aspects and benefits of applying the CTU Code among all stakeholders involved in the supply chain.

The paper is structured as follows: Section 2 provides an overview of the CTU Code and a SWOT analysis of the application of this Code. Section 3 illustrates the methodology adopted for this research, while Section 4 describes the experimental investigation in detail. Section 5 discusses the results obtained and their potential implications. Finally, in Section 6 some conclusions are outlined.

The CTU Code

The term CTU (Cargo Transport Unit) refers to a vehicle, a wagon, a container, a tank-container vehicle, a portable tank or a means multiple-element gas container[5] (ADR 2021[6], RID[7], IMDG Code[8]). This definition is broader than that of Intermodal Transport Unit (ITU), and is critical to understanding the scope of the CTU code. This section clarifies what the CTU Code is and provides a qualitative analysis of the possible impacts deriving from a careful application of its guidelines.

CTU Code description

The Code of Practice for Packing of Cargo Transport Units (CTU Code) is a publication jointly endorsed in 2014 by international Maritime Organization (IMO), the International Labour Organization (ILO) and the United Nations Commission for Europe (UNECE). It is a non-binding global code of practice and provides a set of global practical standards for the proper loading, handling, and securing of cargo in cargo intermodal transport units. It provides advice to those who are responsible for packing and securing goods, and also to those who receive and unpack such units.

The CTU Code is an update of the 1997 IMO/ILO/UNECE[9] Guidelines for Packing of Cargo Transport Units. The Code is structured in 13 chapters, with one or more annexes per chapter. Additional practical

[5] https://www.imo.org/en/OurWork/Safety/Pages/DangerousGoods-default.aspx.

[6] https://unece.org/transport/documents/2021/01/standards/adr-2021-vol-1.

[7] https://otif.org/en/?page_id=1105.

[8] https://www.imo.org/en/publications/Pages/IMDG%20Code.aspx.

[9] https://unece.org/DAM/trans/doc/2011/wp24/IMO_ILO_UNECE_Guidelines_packing_cargo_1997_01.pdf.

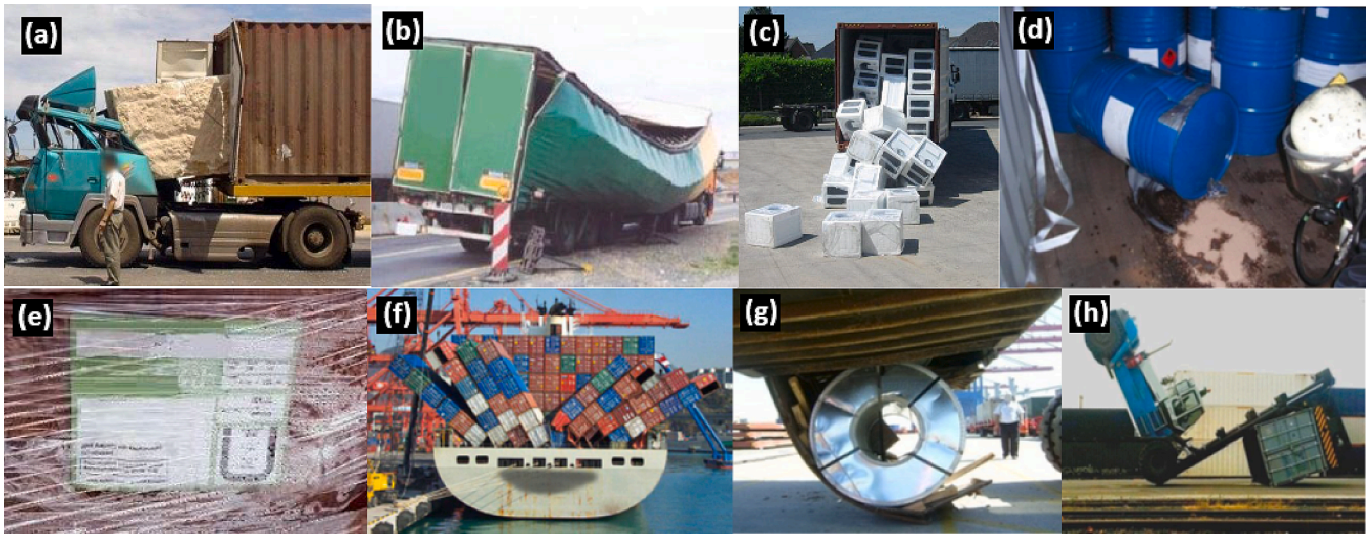

Fig. 1. Consequences of badly packed and secured cargo: lack of longitudinal securing (a); inadequate side wall strength (b); unsecured packages (c); spilled liquid dangerous goods(d); consequences of insufficient control of humidity, condensation damage (e), consequences of improper documentation and misdeclaration, stack failure (f), consequences of the use of unsuitable CTUs, overstressed floor (g); consequences of overloading of CTUs, tipped container handler (h). Source: CTU Code, informative material 1.

guidance and background information[10] is available in relation to the IMO/ILO/UNECE code of practice for packing of cargo transport units, which does not constitute part of this Code. Appendix 1 illustrates the topics covered by the CTU code. The CTU Code is also accompanied by a "CTU Code Quick Guide"[11], which is a route-map for the industry to foster a broader understanding of good packaging practices. The Quick Guide includes a checklist for safe packing and avoiding pest contamination of freight containers, based on the CTU Code. This checklist outlines the main checkpoints from the perspective of the container packer, supporting proper decision making. Its successful completion facilitates the safe and secure shipment of a container.

The main objectives of the CTU Code are to protect the safety of the people involved in the handling the goods, to preserve the transported goods by avoiding damage to the cargo, and to protect the environment from the risks related to pest contamination.

The Code reinforces and clarifies the responsibilities and obligations of the various participants in the transport chain and also provides specific guidelines on the handling of dangerous goods. As the transport unit is managed by different operators within the global shipping chain, the identification of responsibility makes everyone aware of their role. The CTU Code is not conceived to conflict with or replace any existing national or international regulations that relates to packing and securing cargo in CTUs.

CTU Code SWOT analysis

Prior to conducting the experimental investigation, a SWOT analysis (Fig. 2) was performed consulting experts in the field (i.e., C.I.S.Co. and Cordstrap) to assess the positive implications and intrinsic weaknesses in the guidelines and implementation of the Code, as well as future opportunities and threats considering the socio-economic environment. The SWOT analysis was also found to be effective for assessing the effectiveness of cargo securing procedures, as well as identifying key issues to be investigated in order to improve the performance of the CTU Code.

Strengths

- *Increased safety and security*. Safety and security are the focus of the CTU Code. Safety refers to the preservation of the transported cargo. Any accidents due to improper procedures result not only in damage to materials, but also in commercial damage and/or the loss of the relationship between buyer and seller (Promos Italia, 2021). Security refers to the importance of sensitizing all operators involved in packing, security sealing, cargo handling and transporting to carefully and diligently apply practical procedures to increase security in accordance with legislation and international agreements.
- *Avoiding the risk of contamination*. Environmental protection includes avoiding the risk of contamination/recontamination by soil, plants, plant products, debris, mold, fungi, slugs, ants and many other animals that can cause damage to cargo. Attention to cleanliness must be applied not only in the initial delivery of a clean container, but in every movement along the supply chain to avoid the risk of recontamination. A specific list of controls to be performed, such as those listed in the Quick Guide, can prevent the spread of invasive species and pests from one country to another. The IMO has estimated an economic impact of $1.3 trillion over 50 years from crop damage lost due to container-borne pests.[12]
- *Transparency of the information flow*. The CTU Code also emphasizes the importance of communication and the responsibilities of each person involved in the shipping process. Greater transparency in communication can prevent potential harm.
- *Risk management*. Damage prevention and management are fundamental topics, as emphasized clearly by Siat[13]. Damage can be accidental, such as that caused by adverse weather conditions, or can be dependent on human factors. In this respect, the guidelines provided by the CTU Code (Genoa Shipping Week, 2021) addresses two main aspects: (i) damage prevention management (the implementation of all those actions and recommendations aimed at improving the end result of transportation) and, (ii) damage management, ex post, which means that if the conditions and suggestions

[10] https://unece.org/DAM/trans/doc/2014/wp24/IMO_Circular_1498_-_Informative_Material.pdf.

[11] https://www.ttclub.com/-/media/files/tt-club/cig/cigctu-code–a-quick-guide-sep-2020.pdf.

[12] https://www.shippingitaly.it/2021/10/04/trasporto-container-protagonista-dellapertura-della-shipping-week-genovese/.

[13] Siat, italian insurance and reinsurance company.

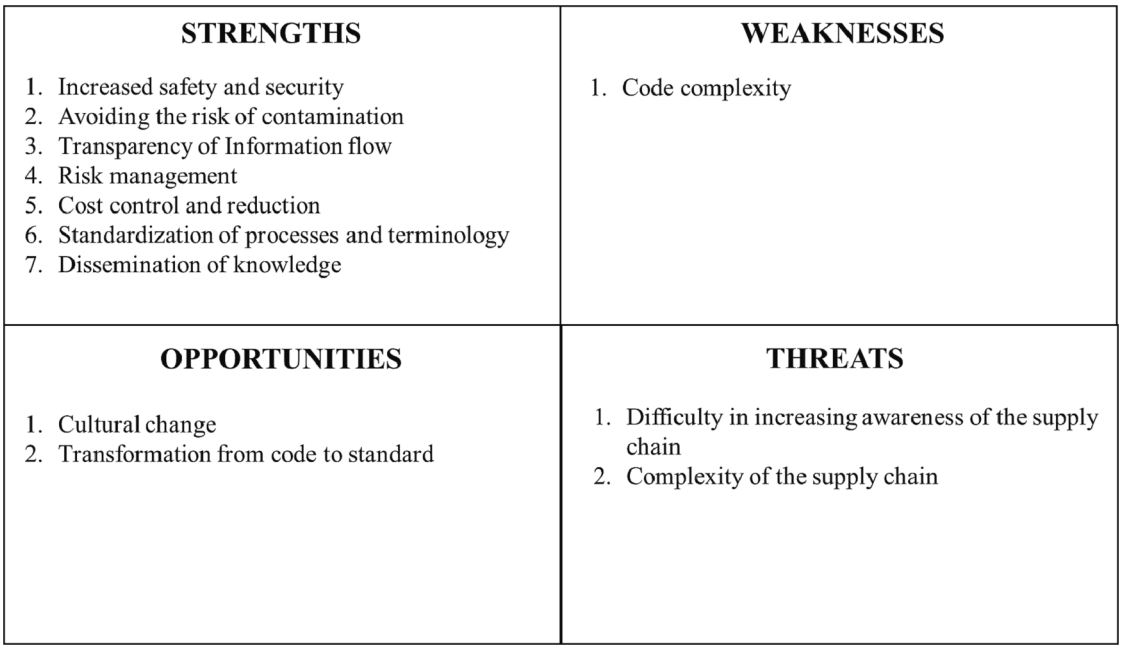

Fig. 2. CTU Code SWOT analysis.

outlined in the guide are followed, the possible dispute between buyer and seller will be facilitated.

- *Cost control and reduction*. To maintain company competitiveness, it is crucial to control and reduce costs along the entire supply chain. Costs that can be reduced are related to contamination, irreparable damage, contractual issues or insurance, as they are related to human-dependent damage.
- *Standardization of processes and terminology*. The CTU Code addresses the need to standardize processes in order to provide companies with guidance that will enable them to directly manage the flow of goods more quickly and with a greater awareness. The need for standardization covers not only operational steps, but also terminology in order to facilitate communication between parties and mitigate the risk of misunderstandings.
- *Dissemination of knowledge*. The CTU Code raises awareness of cargo safety and security issues among all stakeholders. It provides precise indications that make the CTU Code a scientific, cultural and practical dissemination manual.

Weaknesses

- *Complexity of the Code*. The Code is complex in terms of the issues addressed. Not all stakeholders are able to quickly and effectively apply it. In this regard, the Quick Guide is a first step towards making the CTU Code accessible to as many operators as possible, encouraging them to adopt the suggested best practices and enabling wider dissemination of information.

Opportunities

- *Cultural change* (mindsets of companies and the transportation sector). A reference guide for the entire supply chain is a key starting point for an improvement in the industry and a change in the culture of transportation, improving the relationships between supply chain actors and the results achieved.
- *Transformation from code to standard*. The CTU Code could also be used as a basis for national regulations and could become a model for internationally harmonized legislation in this sector.

Threats

- *Difficulty in increasing awareness of the supply chain*. The complexity of supply chain relationships around the world makes it difficult to change behaviors. There is a need for every player in the supply chain to understand the importance and usefulness of the CTU Code: without coordination between parties, recommendations will be ineffective.
- *Complexity of the supply chain*. Intermodal transport generates a number of problems in the management of the container that passes from hand to hand in the supply chain.

Research methodology

This section details the methodology used in this research (Fig. 3). Firstly, the methodological approach for collecting information and data was selected. After discarding the method of using focus groups due to the numerous commitments of the companies contacted and the pandemic period, the choice fell on the survey method. Research using surveys is one of the most practical ways to quickly gather valuable information directly from the stakeholders involved in a study, as well as providing useful insights.

The next step was the drafting of the survey. As explained in more detail in section 4.1, theoretical studies on the best questionnaire structure were taken into account when designing the survey: (i) use a linear structure that is easy for respondents to understand, in order to ensure more effective answers; (ii) minimise questions in order to decrease response times; (iii) formulate most answers in closed form, in order to reduce ambiguity and increase the accuracy of the results.

The draft questionnaire was then submitted for verification to C.I.S. Co. and Cordstrap as experts in the field. This allowed corrections to be made to questions and response options, enabling the questionnaire to be improved and refined in a final version. After the experts' verification, a validation of the questionnaire was carried out by one of the companies interviewed. This company was selected on the basis of the indications provided by Cordstrap, a company which deals with cargo security and provides solutions to prevent cargo damage. Cordstrap chose the company for the validation because it was deemed the most reliable and willing to give constructive feedback on the questionnaire. This company provided feedback on the quality and appropriateness of

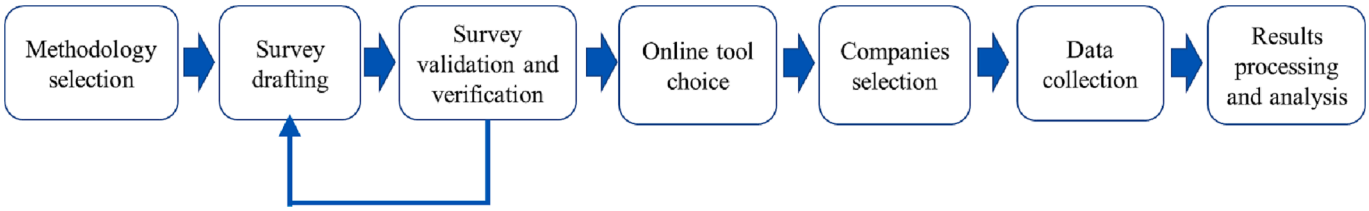

Fig. 3. The research methodology.

the questions, which allowed further improvement of the questionnaire prior to its actual administration to the other companies chosen for the purpose of this research.

The tool Limesurvey was chosen after analyzing the different online tools available for conducting surveys. This tool was the most appropriate for the purpose as it is an open source application with a high degree of freedom and customization of the survey. Limesurvey allows the formulation of different types of questions and the inclusion of ramifications depending on the answers provided, which ensures greater fluidity and flexibility of the questionnaire.

Once the questionnaire was constructed, the companies and business figures to whom it would be administered were identified. Since it was not possible to include all Italian freight transport companies in the analysis due to cost and time issues, a subset of Italian companies was defined. In order to define the sample of companies to be interviewed, Cordstrap was consulted. The choice was made bearing in mind that there are product sectors in which the implementation of the CTU Code is more useful and functional than in others, i.e. the food, beverage, steel and metals, chemicals, ports and logistics sectors (including companies that have no warehouse and rely on 3PL-Third Party Logistics). Products in these sectors are typically palletised or packaged in a standard way. The choice of companies to be interviewed also took into account their willingness to cooperate.

Data and information were then collected through the online tool chosen. The data was collected over a period of approximately one month. In a few cases it was necessary to contact companies to clarify any unclear answers.

Once the data collection phase was completed, an initial screening of the data was carried out, evaluating the number of responses obtained and their completeness. The data processing continued following the structure of the questionnaire. The results obtained were analysed and graphed using an Excel spreadsheet.

The last phase of the research involved the formulation of insights and recommendations based on the results obtained.

Experimental survey

To evaluate the practical implications and benefits of the CTU code, an empirical survey was conducted on a sample of 26 Italian companies. This section discusses in detail the structure of the questionnaire and the data collection phase.

Questionnaire design

Theoretical studies on the optimal structure of a questionnaire were considered in the questionnaire design phase (Glasgow, 2005). The questionnaire was iteratively modified based on feedback received from C.I.S.Co. and Cordstrap (verification phase). In addition, before administering the questionnaire to the surveyed companies, a test company was chosen to validate the questionnaire in terms of effectiveness and quality of questions (Price et al., 2015).

Subsequent administration of the questionnaire was performed online via the Limesurvey application, given the advantages of this tool (Sammut et al., 2021) and the limitations of a face-to-face approach due to the COVID-19 pandemic.

The structure of the questionnaire administered to the companies is provided below (the full text can be found in the Appendix 2). The questionnaire is divided into several sections, some of which are common to all respondents and others to only some. Most of the selected questions are closed-ended for greater accuracy of results and to maximize the response rate (Sataloff and Vontela, 2021).

Part I of the questionnaire includes four key sections: 1) *Type of commodity* handled by the interviewed companies; 2) *Critical commodity*. Identification of the most critical commodity, together with its type and the stage of the cycle; 3) *Business objectives; 4) Loading procedures*. This section contains a first question to understand whether there is a distinction in the company's procedures and choices based on the specific goods being handled. The second question of this section, on the other hand, is the fulcrum of the progress of the questionnaire: it is in fact a discriminator of the subsequent questions. From this stage onwards the questionnaire presents two distinct paths depending on whether the company uses a loading procedure defined by the company/based on experience or the CTU Code. This section is devoted to understanding whether there is a distinction in the company's procedures based on the specific commodity handled and which are the procedures used by each company.

Part II of the questionnaire considers two different cases, depending on whether or not the company uses the CTU Code. *For "Case 1-the company does not use the CTU Code"*, the survey is qualitative and aims to investigate the reasons for choosing not to use the Code (search for causes), as well as to provide essential information and suggestions for improvement for hypothetical future use of the CTU Code (through company training and knowledge dissemination). For "*Case 2- the company uses the CTU Code*", the survey is partly qualitative and partly quantitative, aimed at understanding the causes, effects, advantages and disadvantages of using the CTU Code.

The final part of the questionnaire is common to both cases, and allows respondents to enter personal data and any additional comments and material.

Data collection

The data collection phase took place from January 18, 2022 to February 28, 2022 through the use of the online tool Limesurvey. As shown in Fig. 4, the 26 companies that participated in the survey are based in the Italian regions of Piedmont (35%), Abruzzo (19%), Lombardy (15%), Emilia-Romagna (15%), Liguria (12%) and Campania (4%). As shown in Fig. 5, the type of activity carried out by the surveyed companies belong to two main categories: logistics and production. "Logistics" includes logistics operators such as forwarders and terminal operators, whereas "Production" includes all companies that supply raw materials or manufacture finished products. This second category has been further subdivided into: (i) Industry: industrial oil, wood, equipment, valves, belts; (ii) Food: flour, wine, canned tomatoes and vegetables, fresh produce; (iii) Energy: oil fittings; (iv) Packaging: wood and glass packaging; (v) Construction: cement; (vi) Chemistry: fertilizers, chemicals.

The surveyed companies cover all types of goods, specifically 10% hazardous goods, 17% fragile goods, 21% perishable goods, 52% other categories of goods such as industrial equipment, exceptional loads, etc.

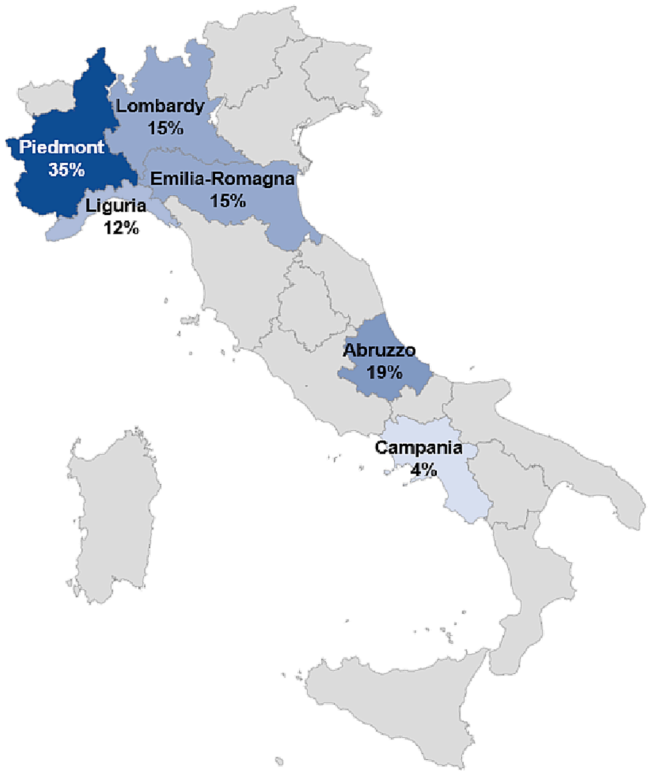

Fig. 4. Geographical location of the surveyed companies.

Results

This section illustrates the results obtained from the analysis of the data of collected through the questionnaires.

The flow chart in Fig. 6 shows the methodology by which the results were analyzed and follows the logic by which the questionnaire was structured. Specifically, Part 1, "General Findings," is devoted to analyzing information that pertains to all the companies surveyed and understanding what are the major critical issues encountered along the supply chain, business objectives and loading procedures. Part 2 is divided into two sections corresponding to the responses obtained from the two sub-samples of companies (i.e., using and not using the CTU Code): Case 1 and Case 2. Case 1 refers to companies not using the CTU Code; the reasons for not applying the CTU Code are highlighted. Case 2 relates to companies using the CTU Code: this part forms the heart of the research and analyzes the impacts generated by the application of the CTU Code, first overall and then in detail in terms of safety, cost, time, corporate image, and environmental impact.

Part I results

In order to verify the actual need for the use of the CTU Code, the first part of the questionnaire analyzed the critical issues encountered by the interviewed companies. All companies stated that they encountered critical issues in the supply chain. The biggest problems in loading processes concern: damaged goods (34%), additional time (23%), extra costs (23%), lost of cargo (10%) and penalty payments (10%).

The next questions explored the most critical supply chain stages in relation to the most critical commodity handled. The results obtained are provided in Tab.1. Loading of goods at origin and transport by sea appear to be the most problematic stages, while rail transport from the port of arrival to the destination company seems to be the only stage that does not present problems.

All companies reported at least one critical phase: specifically, 35% highlighted one critical stage, 54% two and 12% three or more out of the ten listed in Table 1.

The type of impact that inappropriate loading procedures had on the company's image was then analyzed: a negative or strongly negative impact was found in 85 percent of the responses obtained.

To adequately assess the impact of the CTU Code, the company targets were also investigated: all respondents were asked to rank the company objectives. Table 2 shows the results obtained for the whole sample of companies and also provides the specific breakdown of results for the companies that do and do not apply the CTU Code. It emerged that in all three cases the top ranking company targets are "operator safety" and "time reduction". This means that the choice to use the CTU Code is not dictated by any difference in corporate priorities.

The final set of questions addressed the loading procedures used by the companies. First, the questions investigated whether there was a difference in approach in loading procedures based on commodity category. It was found that 23% of the companies use the same procedures for all type of goods handled, 35% use very similar procedures, while 27% declared they use very different procedures for their products. The remaining 15% handle only one type of goods.

The results obtained show that the differences in handling of goods are related to the following aspects: (i) characteristics of the goods (type of cargo; weight: heavy loads require the weight to be distributed over the main structural components of the intermodal transport unit; dimensions; center of gravity: loads with a high center of gravity are prone to tipping and falling; ventilation: some loads require extra attention to avoid damage from condensation; relative humidity; temperature: some types of goods require transport at particular temperatures); (ii) type of handling required; (iii) specific type of packaging and overlap indications; (iv) specific customer requirements.

Regarding the type of procedures used for handling goods, it emerged that 3 (11%) companies used experience-based procedures, 8 (31%) used a company-defined procedure, and 15 (58%) used the CTU

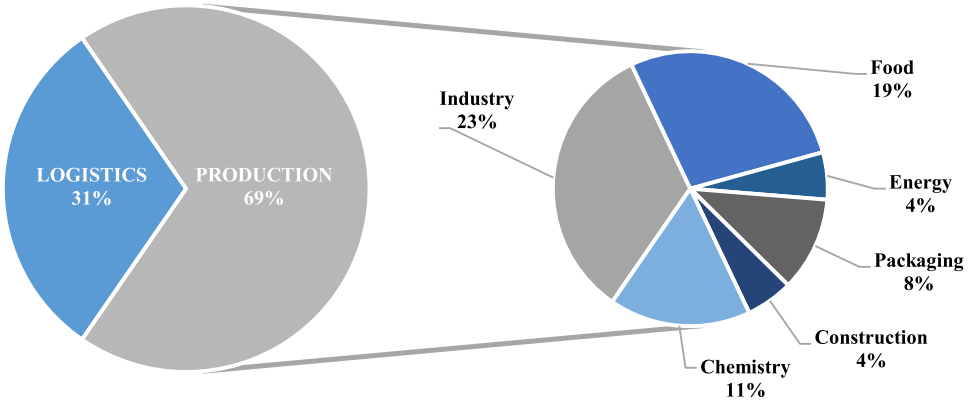

Fig. 5. Type of companies interviewed.

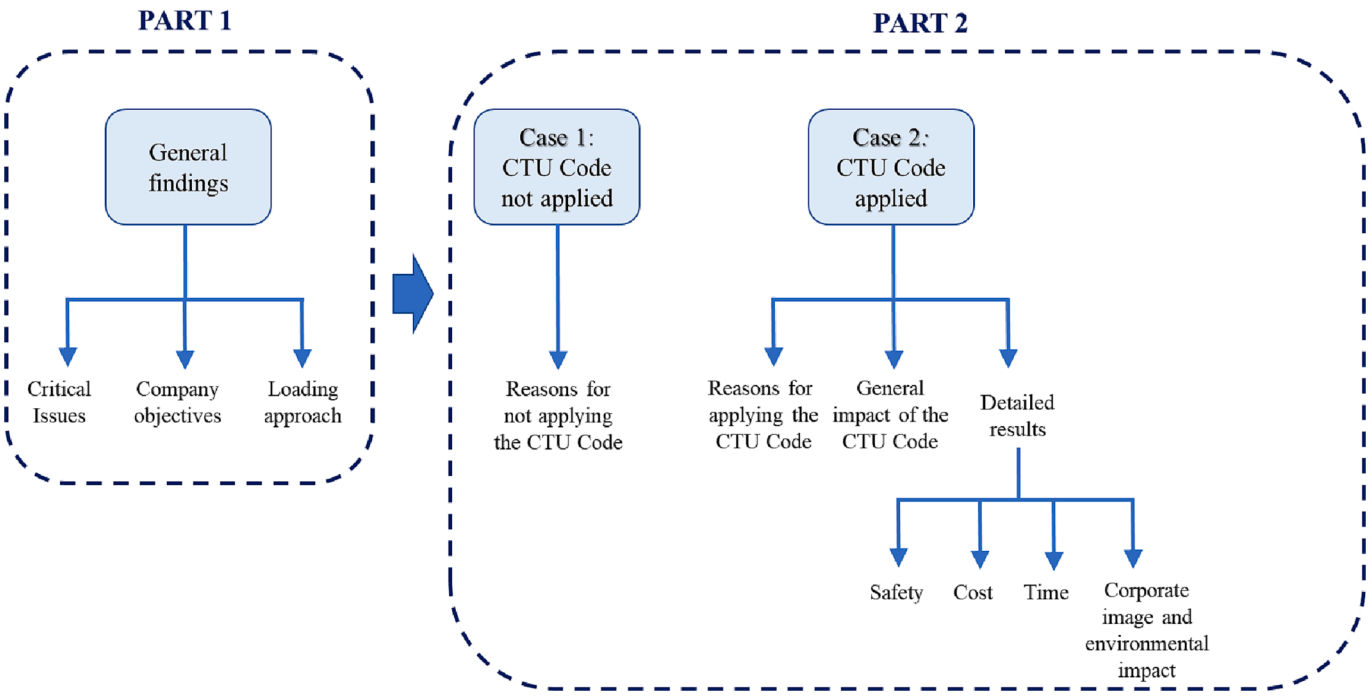

Fig. 6. Flow chart analysis of the results.

Table 1
Stages of the goods handling cycle and number of times criticality occurred.

Phase of the supply chain	Frequency
Loading of cargo at origin	16
Road transport from the company to the port of departure	4
Rail transport from the company to the port of departure	1
Handling in the port terminal of departure	4
Loading of cargo on ships in the port of departure	1
Maritime transport	14
Unloading of cargo in the port of arrival	1
Handling in the port terminal of arrival	2
Road transport from the port of arrival to the final destination	6
Rail transport from the port of arrival to the final destination	0

Table 2
Ranking of company objectives.

Ranking	Whole sample of companies interviewed	Sample 1: companies that do not apply the CTU Code	Sample 2: companies that apply the CTU Code
1	Operator safety	Operator safety	Operator safety
2	Time reduction	Time reduction	Time reduction
3	Avoid damage to the goods	Company reputation	Avoid damage to the goods
4	Company reputation	Avoid damage to the goods	Company reputation
5	Cost reduction	Avoid contamination risks	Avoid complaints
6	Avoid complaints	Cost reduction	Cost reduction
7	Avoid contamination risks	Avoid complaints	Avoid contamination risks

Code.

The majority of companies chose a standardized process linked to procedures agreed upon within the company or given by the guidance of the CTU Code. Only a minority adopted a method based on the experience of the operators. Therefore, the importance of process planning and a standardized method is widely perceived to benefit the entire supply chain.

Fig. 7 shows the geographical origin of the companies surveyed, distinguishing between case 1 and case 2. The colors highlight the product categories considered in the two cases.

Part II – Case 1

Fig. 8 shows the reasons that led some companies to not use the CTU Code for their procedures. It was observed that, although all the companies interviewed were familiar with the CTU Code, the main reason given for not using it was that they did not desire to (64%).

Of the companies that did not desire/consider to apply the CTU Code, 22% did not consider using it at all, while the remaining 78% felt that they already had a satisfactory company procedure for the proper loading of goods.

As shown in Fig. 8, 27 % of the companies cited as their reasons for not using the CTU code the fact that it was too burdensome to implement in terms of company resources required (means and operators), and instead valued the increased safety of goods and people and reduced damage to goods as positive aspects and possible benefits.

Part II – Case 2

The companies using the CTU Code were asked to provide one or more reasons that led to choosing to use it. Fig. 9 shows the expectations for using the CTU Code. Among the main motivations are not only “increased safety” and “cargo damage reduction”, but also aspects related to corporate image and agreement among supply chain actors. The first two factors are easier to assess and identify, unlike reputation, which is absolutely crucial but often difficult to quantify. The weight accorded to “agreements with other actors in the supply chain” suggests that cooperation among the various stakeholders should be fostered. “Environmental impact” is often underestimated but crucial for avoiding contamination risks.

60% and 40% of companies stated that they have achieved respectively a very high and high number of advantages by applying the CTU Code. To qualitatively assess the impact of the CTU Code, companies

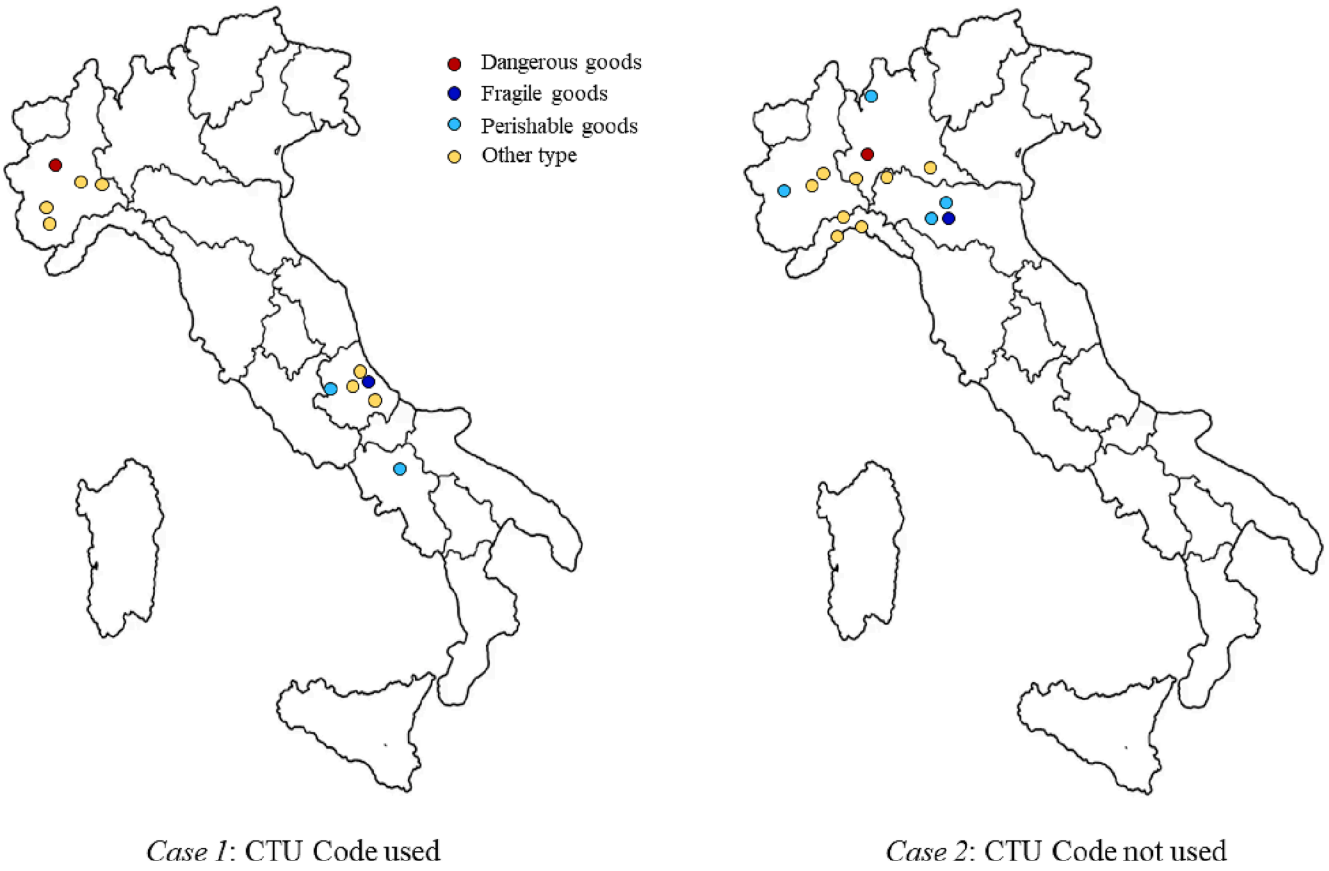

Fig. 7. Geographical location and product categories for Case 1 (left) and Case 2 (right).

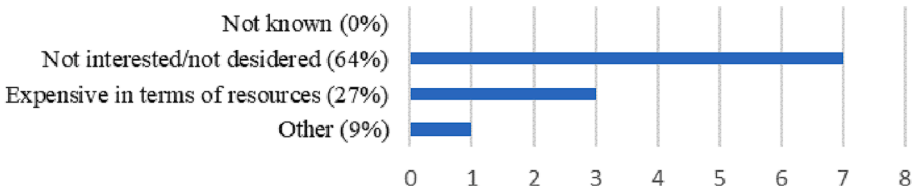

Fig. 8. Reasons for not applying the CTU Code.

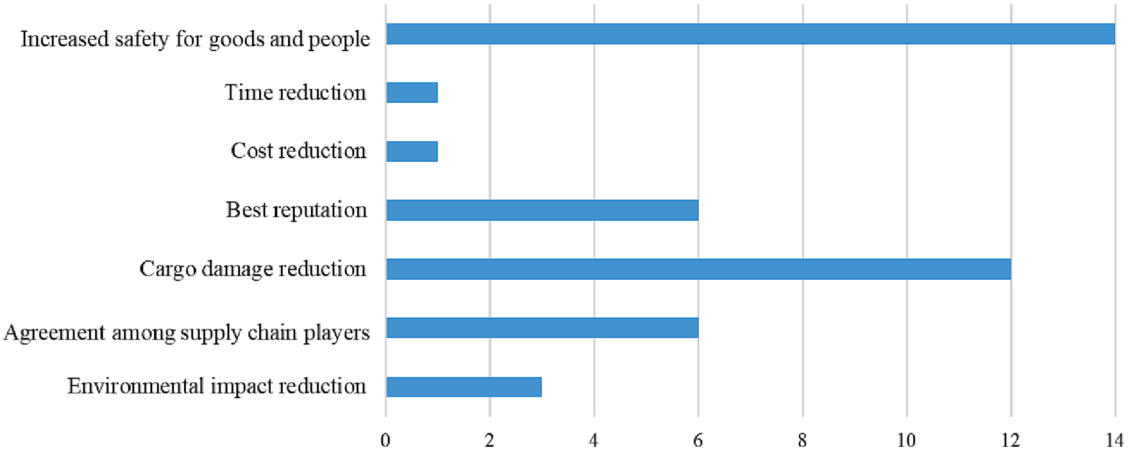

Fig. 9. Reasons for applying the CTU Code.

were asked to indicate changes in some of the parameters under investigation. The results obtained were collected in Fig. 10, which represents the impacts on the entire sample of companies.

As shown in Fig. 10, 100% of companies highlighted a reduction in damage to goods; more than 90% highlighted an increase in safety, an increase in reputation, a reduction in loading accidents and a reduction in environmental impact. About 80% benefited from the point of view of chain coordination, and about 70% showed a reduction in costs. With regard to time, however, the results are less clear-cut. This could depend on the difference between the time needed to implement the already implemented company procedure and the time needed to implement the CTU Code. In some cases, procedures already adopted by companies require shorter implementation times. Other reasons for irregular results about time could depend on how long the individual company applies the CTU Code: as with all new procedures there is always a learning curve that may require more time in the beginning.

Fig. 11 focuses on two KPIs, time and cost, to investigate their impact on the specific type of company interviewed. It shows that there is almost always a reduction in cost regardless of company type; only 4 companies report unchanged costs. In relation to time, it is observed that a minority of the companies interviewed (only 5) report an increase in time resulting from the application of the CTU code. In particular, this occurs in most cases for companies dealing with food production and logistics.

In Fig. 11 and in the following tables, the ID number represents the individual company surveyed; however, in some cases, not all companies are included as there are some that do not apply the CTU code and thus are excluded from the specific analysis.

Based on the data shown in Fig. 10, Fig. 12 illustrates the results from another point of view: the effect of CTU Code is highlighted for each factor following the “traffic light logic”. Specifically, green highlights a positive effect, orange no effect and red a negative effect. For example, considering the safety factor, an increase represents a positive effect and is therefore highlighted in green; by contrast, a decrease in cost is considered a positive effect and therefore highlighted in green.

After this first general survey, more information was collected in order to assess the following four indicators: safety, cost, time, and corporate image.

Safety

Damage to goods is one of the main critical issues encountered by companies. To quantitatively assess the actual impact of the CTU Code on safety, the number of accidents and damaged goods were compared as a percentage of the volumes handled in a year. The results that emerged show a zeroing of damaged goods after the implementation of the CTU Code. Cargo accidents show a similar trend as cargo damage: they zero out following the application of the CTU Code. In the SWOT analysis in Section 3, safety and security were highlighted as the strength and focus of the CTU Code. From the results obtained, it can be deduced that the role of the CTU Code for safety and security is fundamental and highly impactful for companies.

Costs

The variables considered to investigate costs are penalties (as an annual value) and extra-costs (as a percentage of turnover). Table 3 compares pre and post use of the CTU Code. Both penalties and extra costs are found to be drastically reduced in some companies and even reduced to zero in others. Incorporating safety as a strength provides economic benefits: it amounts to ex-ante risk management that saves on extra costs and penalties resulting from damages.

Time

All surveyed companies that experienced a change in time were asked to detail the changes attributable to the following factors: individual unit loading time, communication, waiting time due to damaged goods, waiting time due to lost goods, dead time. What emerges is a decrease in dead times regardless of the increase or decrease in the overall time parameter: reducing dead time for a company means being more productive and efficient. It is a testimony that standardization of processes, homogeneity of procedures along the chain and process control enable better handling and loading of goods. When there is an increase, the reason is primarily related to an increase in the loading time of the single unit of damaged goods waiting (Fig. 13). When there is a decrease, for three out of five companies surveyed, there is a decrease in all factors.

From an organizational point of view, resource management was also evaluated. With the same volumes handled, no changes were found in the number of resources employed in terms of vehicles, company

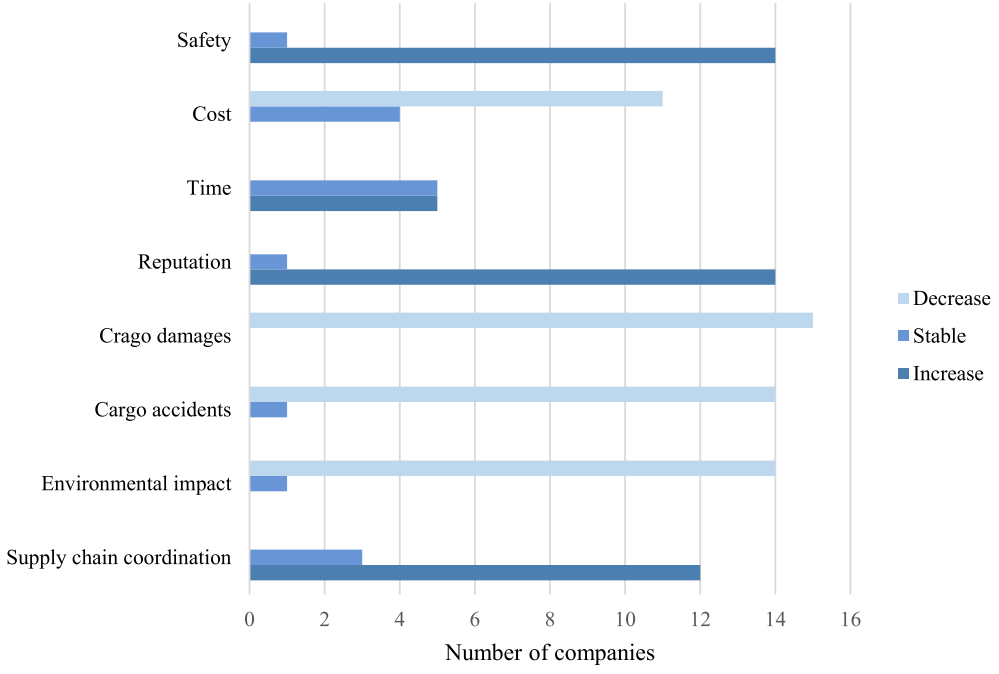

Fig. 10. Generated impacts by applying the CTU Code.

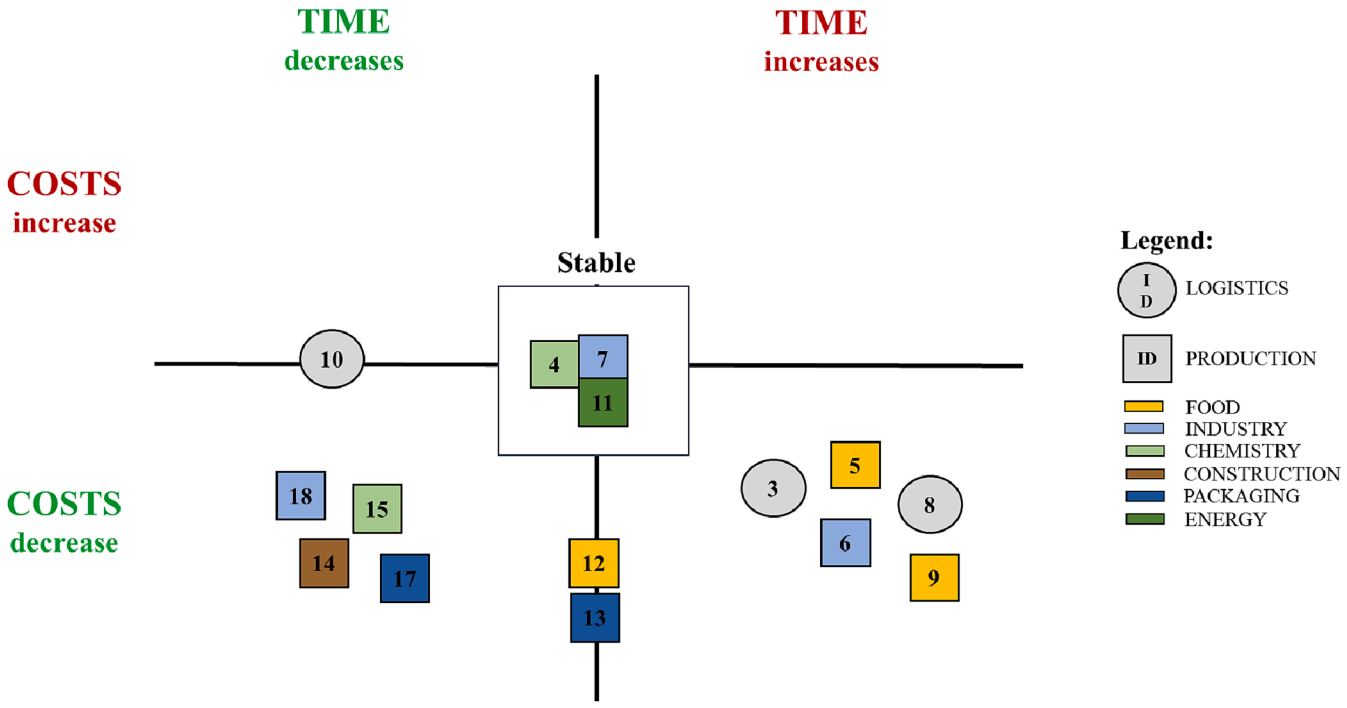

Fig. 11. Impacts (time and costs) generated by the application of the CTU Code in relation to company type.

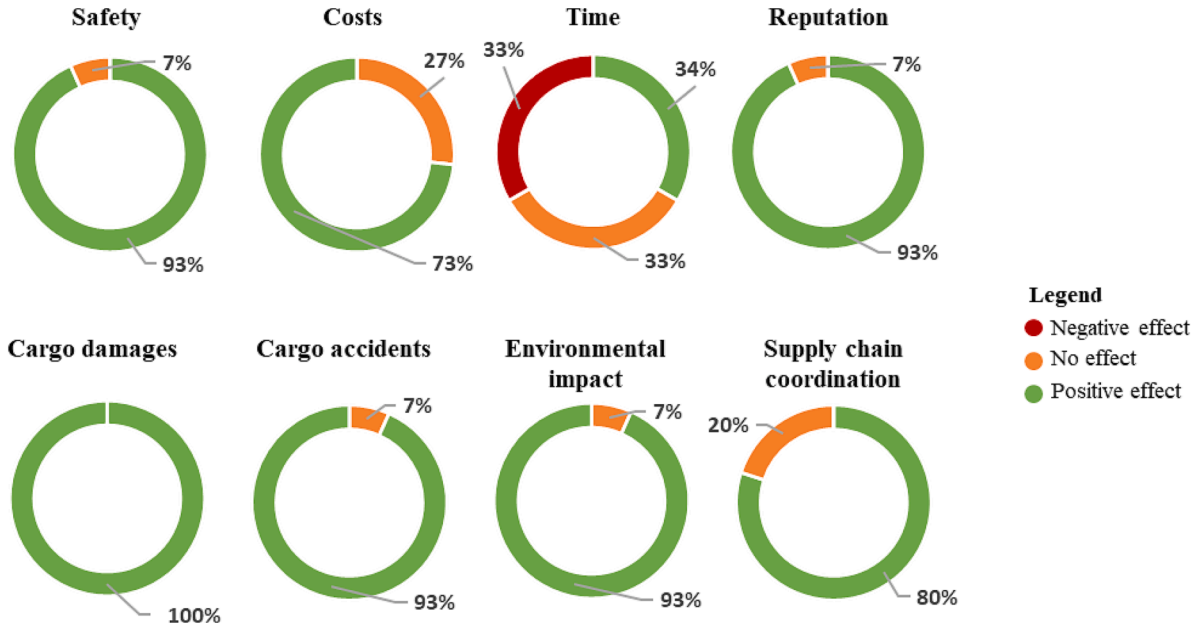

Fig. 12. Effect generated by each factor analyzed.

operators and third-party operators (except for one company, i.e. ID 5 in Table 4, which, however, does not represent a significant change). Table 4 refutes the hypothesis of the companies that do not apply the CTU Code in the belief that it is too burdensome in terms of company resources required.

Corporate image

The main advantages obtained in terms of corporate image are a growth of corporate identity and a reduction of lost customers. Table 5 shows the variations in lost customers pre- and post- application of the CTU Code. A zeroing of lost customers in response to increased reliability and management of goods appears evident.

As described above, the CTU Code also provides guidance in relation to contamination risks and the handling of dangerous goods in order to avoid harm to people, goods and the environment. The fact that 90% of responding companies reported a decrease in environmental impact is undoubtedly a positive result. In particular, the advantages obtained in terms of environmental impact through the application of the CTU Code concern obtaining sustainability certifications (67%), less contamination of goods (25%), and less impact in the case of hazardous goods (17%). For companies, obtaining sustainability certifications affords corporate reliability and growth in identity, bringing customer loyalty. In short, a virtuous circle is created that increases company competitiveness. The results of the survey also highlighted an increase in the

Table 3
Annual costs, annual penalties, and extra costs (% revenues) pre and post CTU Code.

Company ID	Penalties Pre CTU Code (€)	Penalties Post CTU Code (€)	Extra Costs Pre CTU Code (%)	Extra Costs Post CTU Code (%)
3	50,000	5000	8	5
5	10,000	1000	5	3
6	40,000	0	4	0
8	100,000	5000	5	2
9	100,000	1000	3	0
12	100,000	0	1	0
13	100,000	1000	3	0
14	50,000	0	2	0
15	60,000	0	5	0
17	20,000	0	1	0
18	40,000	0	0.1	0

coordination of the supply chain for 80% of the companies: for 40% it represents one of the reasons for using the CTU Code, for another 40% it is an unexpected positive effect or one not assessed beforehand. The CTU Code also focuses on the importance of communication and accountability: increased transparency provides benefits in terms of communication between parties, as well as damage prevention.

Discussion

The following considerations can be drawn from the results of the survey. As far as the companies that do implement the CTU Code are concerned, the results show that its use has several advantages: firstly, in terms of supply chain security, as evidenced by the substantial elimination of damage and cargo incidents, which are close to zero; secondly,

Table 5
Lost customers pre and post CTU Code application (% total customers).

Company ID	Lost Customers Pre CTU Code (%)	Lost Customers Post CTU Code (%)
3	2	0.1
5	0.1	0.0
6	1	0
9	1	0
10	2	0
11	1	0
12	1	0
13	1	0
14	5	0
15	3	0
18	0.1	0

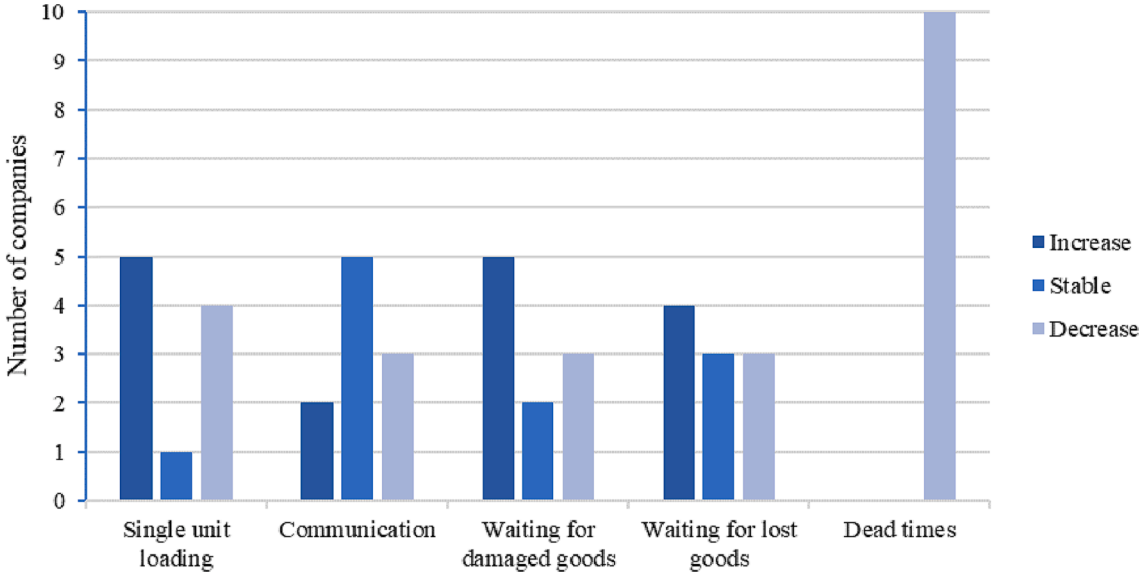

Fig. 13. Time variations after the CTU Code application.

Table 4
Company resources pre and post CTU Code application.

	Pre-CTU Code				Post-CTU Code			
Company ID	Number of means/vehicles	Number of company operators	Number of third party operators	units of time	Number of means/vehicles	Number of company operators	Number of third party operators	units of time
3	5	25	5	hour	5	25	5	hour
4	2	2	0	hour	2	2	0	hour
5	1	1	0	hour	1	2	0	hour
6	2	2	0	hour	2	2	0	hour
7	2	2	3	day	2	2	3	day
8	3	5	1	hour	3	5	1	hour
9	2	2	0	day	2	2	0	day
10	4	4	2	day	4	4	2	day
11	2	2	0	day	2	2	0	day
12	2	1	1	day	2	1	1	day
13	2	2	2	month	2	2	2	month
14	2	2	0	day	2	2	0	day
15	1	2	0	day	1	2	0	day
17	4	2	2	day	4	2	2	day
18	2	2	0	day	2	2	0	day

among the companies that do implement the CTU Code, 70% showed a significant reduction in costs, while the remaining 30% experienced unchanged costs. In both cases, this belies the claims of companies that do not apply the CTU Code because they consider its application too costly.

For all companies surveyed, there was a significant improvement in terms of additional costs and penalties. In addition, the companies highlighted a reduction in insurance costs, as the CTU Code decreases damage to goods but also accidents (even serious ones) and damage to means of transport and handling equipment. The benefits are also evident in terms of time: for the companies applying the CTU Code, there was a reduction in the time component attributable to downtime, thus ensuring greater efficiency in the supply chain. Some food and logistics companies interviewed reported an increase in time due to the use of the CTU Code. This could be due to the fact that those interviewed work in operational departments. Their view could therefore be limited to the operations of securing and loading goods: if only these operations are considered, the time most likely increases. However, if a global view of the entire supply chain is adopted, the overall time taken by companies probably decreases, as the time taken to deal with issues such as customer complaints, damage to goods or stopovers at ports is reduced. In fact, the application of the CTU Code reduces cargo downtime in port following inspections to ensure the stability of the ship.

It should also be emphasised that the use of the CTU Code allows companies to avoid potential claims from customers in the event of accidents. Moreover, its application is a guarantee of safety for goods, operators, vehicles and the environment, irrespective of the specific means of transport used. This is even more important when companies sell their goods using certain Incoterms, such as 'ex-works', under which the company delegates the management and control of the transport chain to the buyer and, therefore, does not know which mode of transport will be used, with the risk of damage to the cargo if certain means of transport are used instead of others.

In addition, the company's image and competitiveness can also benefit from the application of the CTU Code. The company's reliability and its improved process control in terms of costs, time and safety can lead to greater customer loyalty.

The guidelines defined in the CTU Code can also lead to greater environmental sustainability (found by 90% of the companies surveyed), which is also beneficial for the company's reputation and competitiveness.

With regard to the companies that do not apply the CTU Code, it emerges that they have never considered the option to implement it or consider it too costly to implement. It is possible that the non-compulsory nature of the Code leads them to underestimate its importance. In light of this, it is crucial to raise awareness of the benefits of the CTU Code.

Conclusions

Incorrect cargo loading and handling procedures result in safety and security problems for goods and operators at every stage of the supply chain, as well as increased costs and time and negative corporate image. Through a set of standardized procedures, the application of the CTU Code substantially reduces the damage that can occur to goods, means of transport and people and, as a result, brings significant benefits to the companies that use it. The present study is the first to investigate the benefits of the CTU Code. To assess the advantages of implementing the CTU code, this paper analyzed the output of a survey administered to a selected sample of 26 Italian companies handling different categories of goods. The results have highlighted that the companies applying the CTU code can benefit from decreased time and costs, as well as improved safety, environmental impact and corporate image, also resulting in increased competitiveness on the market.

The findings from this study represent valuable input in terms of the practical implications of the CTU Code and raising awareness among companies about the usefulness of applying it.

To date, the application of the Code is not mandatory. To encourage companies to apply it, it could be useful to award a quality certification to those that use it.

The limits of this research are mainly related to the number of companies interviewed, which could be increased, and the level of detail of the topics analyzed. However, as this is the first study to provide evidence of the benefits to companies deriving from the application of the CTU code, it provides a first important contribution to this research field.

Further research could analyze the degree to which the CTU Code is used in different geographic areas. In addition, the impact of the application of the Code over time could be evaluated, to understand whether the benefits obtained were immediate and/or constant over time and whether there is some sort of learning curve. Moreover, research could be extended to other actors in the supply chain, such as insurers, investigating the topic from the perspective of cargo damage management and cargo incidents.

As suggested by the Networks & Logistics Section of UNECE's Sustainable Transport Division, a further possible future research direction could be to test the validity of the CTU code in a real-world environment for a defined transport route, with different transport modes, involving all stakeholders in the supply chain.

CRediT authorship contribution statement

Giovanna Bruno: Data curation, Writing – original draft, Visualization, Formal analysis, Investigation. **Giordano Bruno Guerrini:** Validation, Resources, Supervision. **Claudia Caballini:** Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing, Visualization, Project administration, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trip.2023.100826.

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