

**RESEARCH ARTICLE**

## **Intermodal Transport Security: Need for an Integrated Approach**

**Nil Kula Degirmenci\*, Gul Denktas Sakar**

*Dokuz Eylul University, Maritime Faculty, Tinaztepe Campus, Buca, Izmir, Turkey.*

*\*Corresponding Author: E-mail: [nil.degirmenci@deu.edu.tr](mailto:nil.degirmenci@deu.edu.tr)*

### **Abstract**

Transportation industry has been facing challenges due to various security-related issues such as piracy, terrorism, thefts and accidents. Intermodal transportation as a system that incorporates many players, transportation modes, interchange points as well as various technologies can also be considered as an important platform for security-related problems. Although intermodal transportation is quite vulnerable to security-related risks, recent literature heavily focused on the security problems of specific transportation modes. Since intermodal industry consists of many operations, vehicles and actors, responding to security-related issues for each transportation mode only may not be sufficient. In the light of these, this study mainly aims to provide a framework for overall understanding of the security concept in the intermodal transportation chain. The study firstly focuses on the security dimension of each transportation mode that can be a part of an intermodal transportation chain by considering mainly legal, technological and economic factors. Then, a framework is suggested which identifies the main components of security in intermodal transport by focusing on the need for an integrated approach. Since the evaluation of security dimension in transportation industry is only limited to the industry projects and analysis of specific transport modes; mainly sea transport, it is believed that this study will provide significant contribution to the understanding and the evaluation of security concept in intermodal transportation system. This will be achieved through the identification of main security gaps in the system and the analysis of the intermodal transportation security concept. Moreover, some suggestions will be provided in the light of the factors mentioned in order to provide an overall intermodal security framework and an integrated approach.

**Keywords:** *Integrated approach, Intermodal transport, Security, Transportation modes.*

### **Introduction**

Supply chain management is an important concept in today's business systems due to its increasing importance in connecting and managing the related parties within the overall supply chain of a company. Supply chain management is defined as "the management of a network of relationships within a firm and between interdependent organizations and business units consisting of material suppliers, purchasing, production facilities, logistics, marketing, and related systems that facilitate the forward and reverse flow of materials, services, finances and information from the original producer to final customer with the benefits of adding value, maximizing profitability through efficiencies, and achieving customer satisfaction" [1]. Council of Supply Chain Management Professionals [2] states that supply chain management "encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities". These definitions

emphasize that supply chains include many functions and they are enormously affected by the changes and flows of materials, information as well as financial and service-related issues. Logistics management is one of the most important function of supply chain management in the global world. Increasing globalisation, developments in information technology, fierce competition between companies, growing demands of security and increasing awareness towards environmental issues have created considerable challenges for today's supply chain systems. As an important part of logistics, transportation has an improving role in achieving security in supply chain management.

Globalization has been accompanied (and facilitated) by the emergence of transportation systems that integrate the various modes [3]. The significant shift from "port-to-port" to "door-to-door" delivery reflects the fact that today's transport chain is fully integrated within the production system [4]. The task "turning

intermodality into reality” is one of the basic issues and one of the main measures of development of Common European Transport Policy (CETP) presented in the 2001 White Paper on Transport [5].

Due to its very nature, intermodal transportation is more complex than unimodal transportation because of the use of multiple modes, which are usually managed by different parties [6]. The priorities must be taken to ensure complete integration of different transport modes, as well as technical harmonization and interoperability between infrastructure and operational systems, particularly for containers [7]. The more “links” and “nodes” are involved in the chain of a container’s movement, the greater is the risk of tampering and the more are the opportunities for harmful activities [6]. Therefore the risks that engender transportation security cannot be achieved by focusing on a particular mode (rail, air, water, road). In this study, the authors have firstly examined the security concept in sustainable supply chains generally. As an important function of supply chain management, transportation and security concept in transportation have been examined by classifying security and safety related issues in transportation. After determining the security and safety related issues in transportation, the authors have focused on each transportation modes briefly, pointing out their weakest qualification regarding safety and security issues. International mandatory regulations and voluntary initiatives have been prepared for years by international organizations and governments to prevent safety and security related damages on transportation, therefore they will also be explained briefly in the study. Following that, the authors will examine the intermodal security approach in sustainable supply chains. Finally the authors propose a framework of an intermodal transport security including the deficiencies, drivers and initiatives of the system.

### **Security Concept in Sustainable Supply Chains**

In today’s supply chain systems, many external and internal factors affect the overall performance of the business. Risks are mainly considered as one of the factors that negatively impact the visibility of the supply chain. In order to examine the risk management in sustainable supply chains, “sustainability” in supply chain should be identified. According to Cetinkaya et al. [8], supply chain management will take on additional strategic tasks that extend its current scope and operations in the light of rapidly changing

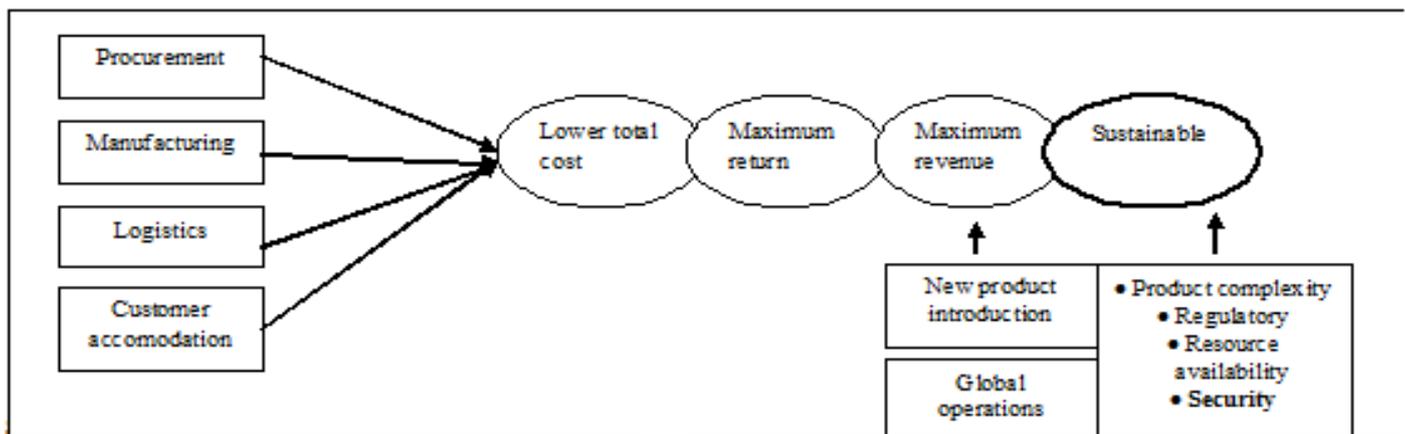
business environment. Sustainability is considered as one of the main factors that motivate many companies to adjust themselves to the requirements of changing supply chain systems and business environment. There has been an increasing awareness regarding the sustainability issues within the supply chains. Sustainability refers to an integration of social, environmental, and economic issues and is defined as “the strategic achievement and integration of an organizations’ social, environmental, and economic goals through the systemic coordination of key inter-organizational business processes to improve the long-term economic performance of the individual company and its value network” [9]. In the light of the definition, the effective management of economic, social and environmental factors should be considered as necessary needs for a sustainable supply chain. While the management literature mainly focuses on the economic, ecological, environmental perspectives of the sustainable supply chains, logistics literature discusses the sustainability concept according to various dimensions such as; development of environmental logistics strategies, environmental purchasing, carrier selection, improvement of fuel efficiency, safety in motor carrier, airline and rail industries etc. [9]. This multi-faceted approach of logistics literature to sustainability enables the evaluation of various factors that affect the sustainable supply chains.

As one of the important factors influencing the sustainability of the supply chain, risk management has been discussed by Carter and Rogers [9]. Shrivastava [10], stated that not only short-term financial results but also risk factors should be managed in the sustainable supply chains. As Christopher [11] discussed, higher levels of turbulence and volatility are existent in today’s supply chain systems which lead to increasing risk and vulnerability. This brings the concept of resilient supply chains which refers to the ability of the supply chain to cope with unexpected disturbances [11]. Resilient supply chains should be agile and capable of reacting quickly to unpredictable events in an uncertain environment [12]. In case of unpredictable events, many factors related to the security can be considered. In order to examine “security”, its diversity from “safety” should be noted. Idsø and Jakobsen [13], has identified that safety is; “protection against random incidents which happen as a result of one or more coincidences”, whereas security is; “protection against intended incidents which happen due to a result of deliberate and planned act”. Pearsall and Hanks

[14], have also described that security is; “the state of being free *from danger or threat*”, whereas safety is; “the condition of being protected from or unlikely to cause danger, risk or injury”.

Gladwin, Kennelly and Krause [15] highlighted, sustainable development must encompass the concept of security, which, “demands safety from chronic threats and protection from harmful disruption”. Supply chain security is defined by Bowersox, Closs and Cooper [16] as “the application of policies, procedures, and technology to protect assets, product, facilities, equipment, information and personnel from theft, damage, or terrorism and to prevent the introduction to the supply chain of unauthorized contraband, people, or weapons of mass destruction”. Fig. 1, shows the role of security and sustainability concepts in supply chain systems. Procurement, manufacturing, logistics and customer-related services mainly aim to achieve lower cost, maximum return and revenue as well as

sustainability. New product introductions and global operations bring significant challenges to the supply chain and may require some modifications in the design of the supply chains. Sustainable supply chains must mitigate, respond and recover from likely risks such as product complexity, regulatory challenges, resource availability and security threats [16]. Security threats are increasingly discussed in the supply chain management since they impact the visibility and the vulnerability of supply chains. According to the findings of World Economic Forum Supply Chain and Transport Risk Survey [17], more than 90% of those surveyed highlighted that supply chain and transport risk management has become a greater priority in their organization over the last five years. It is important to note that security measures are not only necessary to protect the loss of human life and material destructions, but also to eliminate any disruptions regarding the flow of goods within global supply chains [18].



Source: Bowersox et al., 2010

**Fig. 1: Role of security concept in sustainable supply Chain [16]**

Equitable level of security has been mentioned as one of the main indicators of the seamlessness of the holistic supply chain. It mainly evaluates whether all stakeholders within the supply chain have adequate and equitable security of cargo [19]. The security of the supply chain affects both the physical flow and the information flow from origin to customers. Since each link in the supply chain is dependent on the previous link in order to achieve continuity, synchronization and increased final customer service level [18], all related precautions should be considered in connecting each link in the supply chain. As Bowersox, Closs and Cooper [16] discuss, achieving security in the supply chain can be driven by brand protection and pressures from the government. Since the main aim in business systems is to achieve

customer satisfaction and increased brand recognition, any negative perceptions or fears of customers about product contamination may damage the brand.

As Banomyong [18] stated, the security issue is directly related to the performance measurement of any supply chain which means that “*all security conditions must be met and guaranteed in order for goods to move unhindered within supply chains*”. In order to implement performance measurement in the supply chain mechanisms and understand the main vulnerabilities, the main problem areas should be identified. Bowersox et al. [16] lists the main problems as the main consequences of supply chain security failures.

- Terrorist attack causes considerable disruption to customer delivery services,
- Reduced brand equity if customers believe attack was due to neglect,
- Loss of revenue leads to loss of investor confidence and sale of stock,
- Disruption could increase regulatory scrutiny,
- Terrorist attack could result in significant legal liability.

These negative outcomes of an insecure supply chain not only affects the organization and the customers, but also all the main actors within the supply chains such as the suppliers, retailers, wholesalers, distributors etc. as well as the main functions in the supply chain such as warehousing, inventory management, packaging, order management, transportation etc.

### Security Concept in Transportation

As a main function of supply chain, transportation security has a crucial importance on national economies and the global economy. Monroe and Stewart [20], define transportation as; “*the movement of traffic from one point to another*” whereas Hayuth [21] defines it as an organizational system which aims to transport goods and people from one place to another by balancing the economic gap between supply and demand centers.

US Research Council [22], has identified the dangers and threats regarding transportation security as; physical attacks (ex. Bombing), biological attacks (ex. Anthrax release), chemical attacks (ex. physical attack on railcar carrying toxics) and cyber attacks (Ex. attack on port power and telecommunications). In this study, security and safety related issues regarding transportation will be examined briefly, however the authors will especially focus on security related issues for intermodal transportation. Polzin [23], points the reasons of requirement of security in transportation as it;

- Is a critical element of the economy,
- Is a gathering place for groups of people, has symbolic and emotional importance,
- Provides a delivery means for people and products of terrorism,
- Includes institutions with licensing and enforcement responsibilities.

As a critical element of economy, all modes of transportation should be clean, without any gaps, in order to create a sustainable transportation market.

### Security Gaps in Transportation Modes

Transportation mode is; “*the method of transport for the carriage of the goods*” [20]. Some authors

[24] classify them as; road transport, rail transport, maritime transport, air transport and pipeline transport, where some [25] classify them as; land transport, air transport and maritime transport, by involving road transport and rail transport in the concept of land transport. As a decision variable of transport, unimodal transportation modes in this study have been classified into four main categories; land transport, rail transport, maritime transport and air transport. In the further parts of the study, as an integrated approach, multimodal, intermodal and combined transport terms will also be examined briefly.

Szyliowicz and Viotti [26], have identified the reasons of the gaps in transportation modes as;

- The lack of intergovernmental coordination, especially in regard to intelligence,
- The relationship between state action and the private sector,
- The only unit concerned with coordinating security across modes possessing by inadequate powers and resources,
- Little focus on law enforcement.

Polzin [23], points that the security concern in the performance of a transportation arises from “security risks” and calculates the “security risks” in transportation modes as; a product of the probability of an incident attempt times the vulnerability of the target times the damage costs of a successful breach of security ( $\text{Security Risk} = \text{Probability of Incident Attempt} \times \text{Vulnerability} \times \text{Damage}$ ).

There are several different types of safety and security-related issues / gaps related with transportation modes. Chatterjee [6], has classified them into three groups as; accidents / crashes, cargo theft and terrorist acts. Piracy, which mostly effects the maritime transportation, can be regarded as another type of safety and security related issue on transportation. According to the above definitions of security and safety; “accidents and crashes” should be regarded as safety related issue, where Chatterjee [6] has identified that the accidents represent unintentional failures on the part of drivers and/or vehicles or deficiencies such as roads and rail tracks and related controls such as air traffic control and signals, whereas cargo theft, terrorist acts and piracy should be regarded as security related issues in transportation.

In this classification, it should be noted that; piracy is an unlawful act against commodity whereas terrorism act is an unlawful act against human life. As a transportation safety related issue “accidents and crashes” play a very

important role, especially in road transport whereas road travel has by far the highest fatality risk per distance travelled while rail and air travel are the safest modes per distance travelled [27]. European Commission (EC) [28], has determined that in the EU region, as in the decade 1999-2008, there were on average 150.000 persons killed and about 5.5 million persons injured annually in more than 3.8 million road accidents.

Cargo theft is a transportation security related issue which especially road transport, maritime transport and rail transport is frequently facing. Theft has been a common problem with freight transportation throughout its history, and it includes a wide range of occurrences such as the piracy of ships, hijacking of rail cars and trucks, and theft of small items, which is referred to as "leakage" [6].

Terrorism represents another group related with transportation security, through its all modes and is one of the greatest threats to democracy and freedom. Groups or individuals motivated to terrorize or injure people or the economy may well have transportation facilities as a target or a tool [23]. Transportation systems and networks are of fundamental importance to all countries so that it is not surprising that terrorist acts have involved airports and airlines of many countries, including, Israel, Spain, India, and South Korea [3]. Especially after 11th of September attacks, mechanisms to prevent terrorist attacks through air transportation, as a type of mass transit (according to the US Code article 5302, mass transit has been identified as transportation by a conveyance that provides regular and continuing general or special transportation), has gained high importance. The terrorist attacks in 11th of September 2001, show how vulnerable transport infrastructure is to sabotage. Besides air transport; ships, ports and the intermodal transportation systems are highly vulnerable to terrorist attacks and other depredatory acts [29].

The hijack of the cruise ship *Achille Lauro* on 7th of October 1985 and the attack on the tanker *Limburg* off Yemen on 6th of September 2002 can be given as examples of terrorism through maritime transport. Transportation facilities such as airports, terminals, tunnels, and bridges are often busy and crowded, and have become even more attractive targets since the trend in terrorist attacks has shifted toward inflicting mass casualties [3].

Finally, piracy is the last group related with transportation security. Acts of piracy and armed robbery against ships are of tremendous concern to International Maritime Organization (IMO) and to shipping in general. Therefore many legislations have been prepared to fight against piracy in order to ensure security on seas.

All transport modes now have to find the right balance between providing commercial openness and effective security procedures [30]. Whereas EC [28] proposes to: "make sure that the European Union (EU) is a world leader in safety and security of transport in all modes of transport and promote European safety, security, privacy and environmental standards worldwide through bilateral and multilateral cooperation". Below each transportation mode will be briefly examined regarding their security qualification.

### Road Transport

Road transport is by far the most preferred transport mode for passenger and freight transport in EU [28]. Road transport benefits from the road network which can be used to transport goods almost everywhere [31]. Even in the case of remote and relatively small locations, road transport is an essential transport mode, particularly for domestic and short-distance freight movements [32]. Thus, regarding organisation and performance, road transport can be regarded as much more simple and flexible transportation mode when compared with all other modes of transport. On the other hand, road transport is has some disadvantages especially on safety and security related issues.

Road transport has by far the highest fatality risk per distance travelled [27]. Road accidents caused 38,935 deaths (within 30 days after the crash) in 2001, comprising almost 97% of all transport deaths in the EU [27].

However since 2001 White Paper prepared by EC, which has identified the milestones to improve all modes of transport, including road transport, many improvements have been achieved. Also the EU set itself in 2001, the ambitious target of halving the number of road deaths between 2001 and 2010, while Latvia, Estonia, Lithuania, Spain, Luxembourg, Sweden, France and Slovenia have all reached the target [33]. shows the reduction in road deaths since 1970 in the EU15 and since 1990 in the EU27, the EU10 and Bulgaria and Romania (EU2).

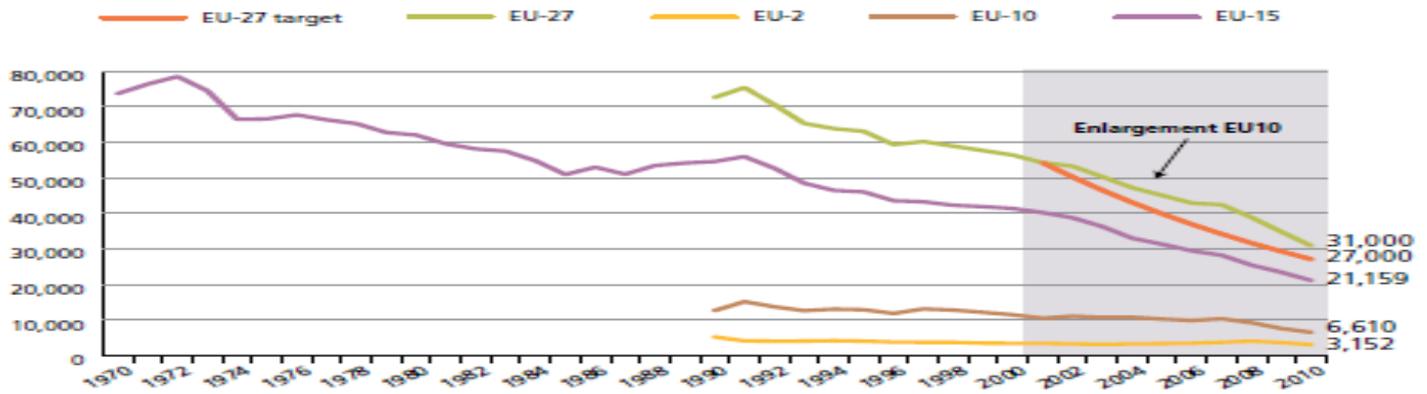


Fig. 2: Road Deaths Between 1970-2010 in EU [33]

According to the numbers of accidents and deaths occurred in road transportation, even there are positive improvements on preventing the accidents, it can still be mentioned that road transport has a great safety gap on this issue when compared with other transportation modes. Besides accidents and crashes, cargo theft and terrorist attacks (especially when there is mass transit) are also directed and violate the security order in road transportation. While, especially mass transit has been effected through air transport and rail transport modes which serve big masses such as trains and airplanes, road transport trucks that carry chemical products and busses that carry children have become targets for terrorist attacks by following the “crush the heart” notion [34].

### Rail Transport

Rail transport has relatively longer transit time and is not flexible compared to road transport, however it is suitable and economic for long distance journeys. Larger countries such as US, Canada or Australia prefer rail transport than road transport [28].

It can be stated that the congestion in road transport in those countries, shifts the users to other alternative modes of transport such as rail transport. Many countries have a single national railway company, which owns and operates both rail infrastructure and superstructure equipment [32]. For rail transport, the harmonization and supervision of safety certification are essential in a Single European Railway Area [28].

Accident and crash risks in rail transport are not as high as road transport. Besides, rail transport is the most safe transportation system when comparing the accident and crash risks with other transportation modes. The annual fatality risks for travelers of the railway systems in the countries of the EU show large fluctuations, but their moving averages seem to differ consistently between the countries. However it has been mentioned that these consistent risk differences are likely to be largely the result of differences in reporting and definition [27]. Figure 3 shows the rail passenger fatality risk 1970-2000 and forecast to 2010 for the 15 EU-countries.

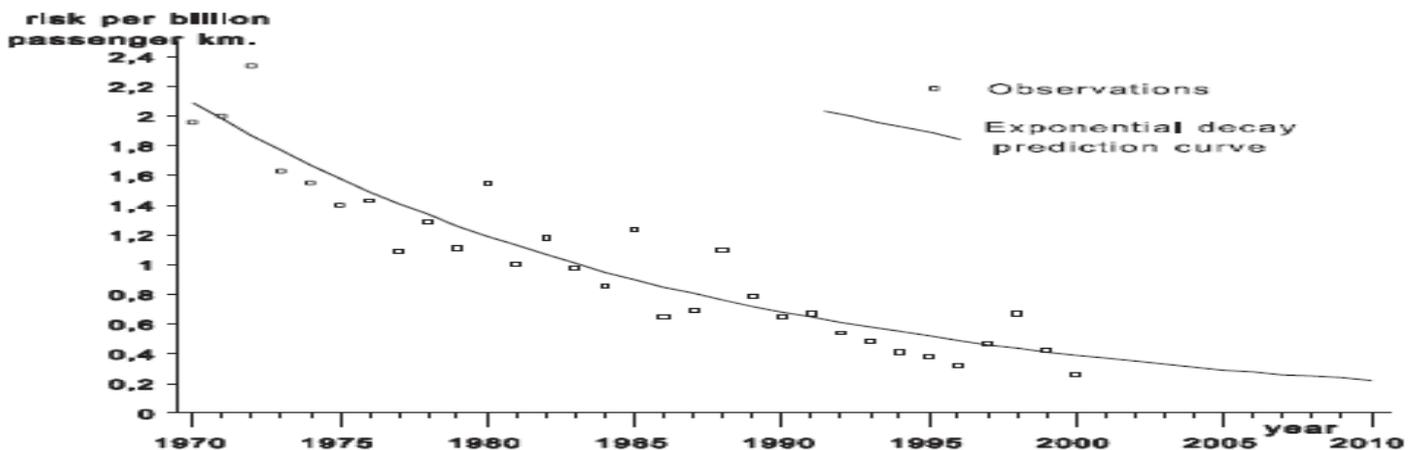


Fig. 3: Rail passenger fatality risk [27]

As rail transport is accepted as the most safe transportation mode from the side of accident and crash risks, the same can not be implemented from the side of security. Grounding that rail transport is a type of mass transportation, its qualification of being a target through terrorist attacks would not be underestimated. There have been numerous significant terrorist attacks against rail targets, including the following: the August 10, 2001, attack in Angola that killed over 250; the March 11, 2004, attack in Madrid, Spain, that killed over 190; the July 7, 2005, attacks in London, that killed over 50; the July 11, 2006, attack in Mumbai, India, that killed over 180; and the February 17, 2007, attack on the Samjhauta Express, a train traveling from India to Pakistan, that killed over 60 [35]. Besides, as a transportation security related issue, cargo thefts are also seen in rail transport. Rail freight can be shipped in convoys, and surveillance enhanced on both rail lines and nearby arterial roads [36]. While most cargo carried by rail is very difficult for passengers to access, the rail lines themselves are comparatively unsecured [37].

States, especially the ones that use rail transportation predominantly, determine national strategies in order to reach the top secure level. US Department of Strategy, in the national degree, has developed US's national strategy regarding rail transport as; reducing the risk associating with the freight rail transportation of potentially dangerous cargoes and increase the resiliency of the freight rail network, in order to actualize the objectives of reducing the vulnerability of the cargo and the network and reducing the consequences of the attack. In order to achieve this strategic goal, the strategic methodology has been determined as cooperating with industry and government stakeholders to identify and implement programs and processes to achieve measurable reduction.

### **Air Transport**

Air transport is not as flexible as road transport or not secure as rail transport, however has the advantage to actualize the transport in less time when compared with all other modes. Besides this, air transport has a very strategic importance by vitalizing the awareness of security concept in transportation. 11<sup>th</sup> of September 2001 terrorist attacks have been actualized through air transport and have become a milestone date for the improvement of measurements to ensure security in transportation modes.

EC, with its 16.12.2002 dated 2320/2002 numbered regulation has declared that; "the criminal acts committed in New York and Washington on 11<sup>th</sup> of September 2001 show that

terrorism is one of the greatest threats to the ideals of democracy and freedom and the values of peace, which are the very essence of the EU and the protection of the citizen within the EU should at all times be ensured in civil aviation by preventing acts of unlawful interference". In this regulation, article 2 defines, "aviation security" as the combination of measures and human and natural resources intended to safeguard civil aviation against acts of unlawful interference. In order to ensure the security, the regulation has proposed the member states should authorize an institution for the local risk assessment and adopt a national civil aviation security programme in order to ensure the application of the common standards.

Terrorism is the current, but not the only, safety – security related issue in air transportation. The frequency of accidents and crashes are not as high as road transport in air transport, however when the accident occurs, the high level of damages are frequently inevitable. Air transport fatality statistics refer mainly to scheduled flights, because air travel fatalities on unscheduled (charter) flights are only partially reported by international air transport organisations [27]. There are large variations in the annual death number of air passengers on scheduled flights within the EU. After 1980, four years had more than 200 fatalities and five years showed no deaths; the four years of 1996 to 1999 inclusive had an average of about 35 crew and passenger deaths, while 2000 had zero and 2001 had 117 fatalities (2001 was the worst year since 1989 with 247 deaths) [27]. However between 2000 and 2009, 65 lives has been lost by over EU [28].

Operating and pre-operating tests, especially in the North Atlantic and the Mediterranean sectors, have shown the potential for improving safety by means of more precise positioning information and better communications [5]. EC [28], suggests the adaptation to new technologies and obviously, international cooperation with main partners would contribute a lot to the development of air transport security worldwide.

### **Maritime Transport**

Shipping has been one of the key stepping stones to economic growth and prosperity throughout its history. 80 % of world trade is carried by sea whilst short-sea shipping carries 40% of intra-European freight [38]. However, "the terrorist threat shows no signs of decreasing and ships and ports alike will continue to face the threat of terrorist acts. Moreover, very serious concerns about acts of piracy and armed robbery at sea persist. A further difficulty relates to incidents involving people smuggling, trafficking and

stowaways” [38]. The emergence of the risks in maritime transportation can be grounded in three factors respectively; vulnerability, threat and consequence [39].

EC [40], with its 31.03.2204 dated and 725/2004 numbered regulation has declared that; “intentional unlawful acts and especially terrorism are among the greatest threats to the ideals of democracy and freedom and to the values of peace, which are the very essence of the EU and the security of EU shipping and of citizens using it and of the environment in the face of threats of international unlawful acts such as terrorism, acts of piracy or similar, should be ensured at all times”. In this regulation article 2 defines “maritime security” as the combination of preventive measures intended to protect shipping and port facilities against threats of intentional unlawful acts. In order to ensure security in maritime transportation, article 3 of the regulation requires; the application of special measures to enhance maritime security of Convention on Safety of Life at Sea (SOLAS) and Part A of the International Ship and Port Facility Security (ISPS) Code, in accordance with the conditions and with respect to the ships, companies and port facilities.

With the aim to provide security culture, EC [38], has determined the following aims to ensure security in maritime transport:

- Supporting the implementation of international security measures, cooperating closely (especially on continuous training of seafarers),
- Contributing to the international efforts to secure the international supply chain,
- Contributing to safer shipping in the afflicted piracy areas, protecting international shipping lanes against any acts that might disrupt the flow of traffic, establishing resilience plans,
- Working together to ensure adequate improvements to the ISPS Code,
- Promoting cooperation between European maritime training institutions for upgrading seafarers’ competences.
- Adapting requirements to the prerequisites of today’s shipping.

Terrorism and piracy are not the only safety – security related issues regarding maritime transportation. Tankers and ships of more than 6 million kg cargo capacity have a casualty risk per million nautical miles that is more than twice as high as for all vessels (about 2.8 compared with about 1.35), while the casualty risk for ferries and roll-on/roll-off container ships is almost half of that risk for all vessels [27]. In recent years, the

EU and its Member States have been at the forefront of improving maritime safety legislation and promoting high-quality standards. The aim is to eliminate substandard shipping, increase the protection of crews and passengers and reduce the risk of environmental pollution [30]. The risk of accidents due to traffic concentration in Europe’s main sea lanes is particularly high in bottlenecks such as the Straits of Gibraltar or the Ushant Traffic Separation Scheme [5]. However, technologies are developing in the maritime sector: automatic vessel identification and monitoring systems, the development of standardised telematic exchange, the availability on the market of black boxes and such developments suggest a whole range of applications, not only in the areas of safety and pollution control but also for a general improvement in traffic conditions at sea and in ports [5]. In order to ensure safety in maritime transportation, EC [30], aims to; improve the quality of European flags, review legislation on port state control, amend the directive on traffic monitoring, improve rules relating to classification societies, develop a harmonized European framework for accident investigation, improve the effectiveness, objectivity and transparency of investigations, make investigating bodies more independent, introduce regulations ensuring fair compensation to passengers in the event of an accident and introduce a directive on ship owners’ civil liability coupled with a mandatory insurance scheme.

### **International Mandatory Regulations and Voluntary Initiatives Related with Security Assurance in Transportation**

Regulation of transport has long been essentially international in character. Due to its character, difficulties are encountered in finding the proper place for the common transport policy in between the international rules prepared by established organizations and national rules prepared by states. Consequently, for some years now (especially after 11th of September 2001 attacks), certain countries, such as US, have been implementing national transport accords, particularly in the maritime or aviation sector, to protect specific interests. The EU has followed closely in US’s footsteps in order to guard against catastrophic accidents at sea or to abolish inappropriate rules on aircraft noise or on compensation for passengers in the event of accidents [5]. Especially in the field of maritime transport, EU has been active in recent years, legislating to improve security at ports and at sea to complement international efforts in this important area [30].

In this part of study, the international mandatory regulations and voluntary initiatives regarding the safety and security issues of transportation modes will be examined.

### International Mandatory Regulations

The raised threat of terrorism, piracy and theft and occurrence of accidents through transportation modes has exposed the global response. As transportation has global characteristics, it has been obligatory to prevent the safety and security related issues on transportation internationally. Especially after the terrorist attacks in the US, IMO has adopted a new Chapter XI-2 in SOLAS and the ISPS Code. However it should be noted that most of the national regulations, especially which are accepted by US, has effected the transportation sector worldwide.

SOLAS has been adopted on 1<sup>st</sup> of November 1974 by the International Conference on Safety of Life at Sea, which was convened by IMO, and entered into force on 25<sup>th</sup> of May 1980. SOLAS, in its 5<sup>th</sup> chapter regulates safety of navigation and in its 10<sup>th</sup> chapter regulates safety measures in high speed craft. SOLAS only covers the ships themselves and the parts of port terminals in which ships are loaded and unloaded. Therefore, to enhance security at European ports further, IMO put forward further proposals, which must be fully implemented by Member States by June 2007. ISPS Code, on enhancing port security, aims to bring a coordinated approach to security matters in ports as a whole and requires a port security assessment, a port security plan, a port security officer and a security authority to implement the security plan and to guarantee an effective link between decision makers and security 'on the ground'[30]. It includes detailed requirements for governments and port authorities to improve security at port facilities, based on security assessments and plans covering issues such as cargo monitoring, inspection and control of access [30].

The ILO/IMO Code of Practice (COP) on Security in Ports was adopted by United Nation's International Labor Organization (ILO) in March 2004 and by the IMO in May 2004. The COP extends consideration of port security beyond the immediate ship port interface into the larger port and is intended to be compatible with the provisions of the ISPS Code. The objective of COP has been defined in its 1<sup>st</sup> article as; enabling governments, employers, workers and other stakeholders to reduce the risk to ports from the threat posed by unlawful acts. The COP addresses port security policy, assessment and plans, related tasks and roles and security awareness and training.

### Voluntary Initiatives

Besides international mandatory regulations to arrange security related issues in transportation, there are "voluntary initiatives" regulated in national levels which effect the transportation mechanism worldwide. Especially after container revolution in 1960s, container has become the crucial element for transportation [41]. Door-to-door container transport involves multiple stops (such as cargo stuffing areas and container terminals), where containers are stored and handled, and open transport infrastructure (such as highways and rail stations), which can be accessed by different parties [42]. As container security involves a number of firms in a container transport chain [43], it would be difficult for different parties to capture the required data to conduct an efficient and effective risk assessment without using advanced technology [44].

Under continuing pressure to secure containerized cargo shipments from terrorist threats, with the aim to enhance security, US Bureau of Customs and Border Protection has developed the 24-hour advance cargo filing rules, the Container Security Initiative (CSI) and the Customs' Trade Partnership Against Terrorism (C-TPAT) program [45]. In its 17.02.2004 dated "*Comments in Response to Customs and Border Protection's Request for Information Regarding Smart and Secure Containers*" named paper, World Shipping Council (WSC) has mentioned that; "*the objective to develop and deploy technology that can be used for security screening before vessel loading at foreign ports, could be effected with the 24 Hour Rule and CSI initiative*" [46].

The CSI, a US Customs program based on various technologies and computerized information databases, was launched in January 2002 and places US Customs inspectors at the twenty top foreign ports (which handle almost 70% of America-bound containers) so that they can check the containers before they leave for a US port. To facilitate the detection of potential security threats as possibly as possible, four main elements are included; (i) the use of automated information to identify and select containers that pose a risk, (ii) pre-screening of containers identified as posing a risk before they arrive at US Ports, (iii) the use of detection technologies to quickly prescreen containers that pose a risk and (iv) the use of smarter temper-evident containers [47]. The CSI is a national voluntary precaution againsts security related issues whereas it has gained international characteristics. By November 2002, eleven of the top twenty ports (Le Havre, Rotterdam, Singapore, Vancouver,

Halifax, Montreal, Antwerp, Hamburg, Bremerhaven, Hong Kong, Yokohama, Tokyo, Kobe, and Nagoya) were participating in the CSI [3].

C-TPAT is a voluntary initiative that seeks to develop cooperative container transport security relationships between the security agent and the firms in a container transport chain (e.g., importers, terminal operators, and carriers) [48]. With C-TPAT, Customs and Border Protection and partner firms in the container transport chain are working together to improve container security. The purpose of this initiative was basically to widen the security perimeter as much as possible so that US importers could transport their goods within a system of secure partnerships with transport, storage and manufacturing companies and thereby enhance container security right along the supply chain from origin to destination [42]. C-TPAT enforces carriers and shippers to use “smart” containers where a hardened bolt seal and an electronic sensor are used to detect whether a container has been tampered with in transit [45]. The benefits

associated with the participation of C-TPAT include speedy cargo clearance at US ports [49]. Besides C-TPAT and CSI initiatives, the US Customs and Protection Bureau implemented the measure known as the 24 hour rule, whereby all vessels heading to a port in that country have to submit a cargo declaration at least 24 hours before cargo is laden aboard the vessel at the foreign port [47].

Fig. 4 shows the present secure transportation model between producer and buyer in marine transportation. ISPS, CSI and C-TPAT applications are focused on reducing the likelihood of terrorist related incidents within application areas and not to strike a balance between efficiencies within the supply chain networks and requisite security assurances. Therefore it should be noted that other unimodal transportation modes (such as road transport, rail transport and air transport) or, in case of an integrated approach, interchange points between various modes will be out of the protection application.

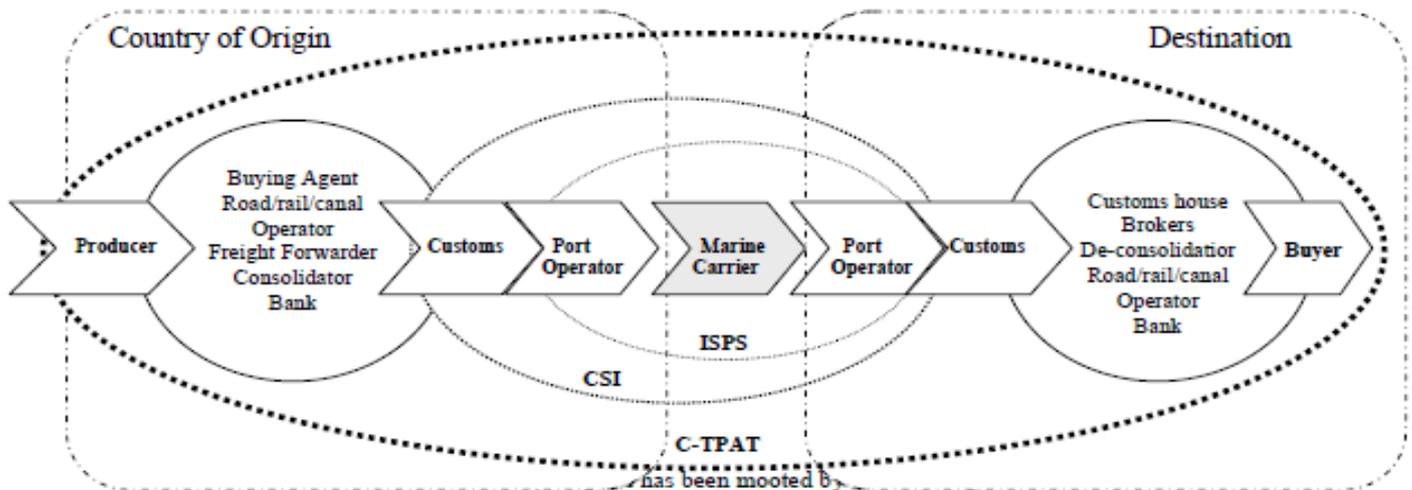


Fig. 4: Secure transportation model between producer and buyer [50]

## The Role of Intermodal Transport Security Measures in Sustainable Supply Chain

Supply chain includes a number of key flows as: physical flows of materials, flows of information that provide information for the supply chain and flows of resources (people, equipment etc.) [51]. Transportation as one of the main activities within the supply chain is mainly involved in the flows of materials and it is the movement of product from one location to another as it makes its way from the start of a supply chain system to the end customer. Due to the increasing service levels of logistics service providers and the expectations of customers in the light of global

production and operations, more efficient, reliable, integrated and environment friendly transport solutions have been needed.

The role of new transport solutions which provide cost effective options, different route planning opportunities and reliable transit times as well as safe and secure transport options has become more important for the supply chains. In the light of these, global sourcing policies of companies, just-in time inventory control and changing demand from the customers of transport service providers have all had an effect on the emergence of new transportation systems such as intermodal

transport, which involves the use of more than one mode to form an integrated transport chain in an environmentally sustainable manner [52]. Container proved to be the means by which the same cargo can be transported on all modes during the same shipment, with minimal adaptation of carrier technology. Suddenly it became possible to transfer cargo; quickly, safely and cheaply from one mode of transportation to another, between air or ocean and overland portions of a door-to-door international shipment [53].

There are various definitions and concepts related to the use of more than one mode in freight transportation. They are sometimes used interchangeably and sometimes in different contexts and definitions such as intermodal, multimodal, combined and through transport [52]. Intermodal transport is defined as *“the movement of goods in one and the same loading unit or vehicle, which uses successively several modes of transportation without the handling of the goods themselves in changing modes.”* [54]. It can be inferred from this definition that containers may be one of the most important units to be used in intermodal transport. The advent of containerization in the 1960s triggered the development of the liner shipping business and containers, as the main unit of cargo packaging. This has shaped not only the nature and the volume of transported cargo, but also the size of ships and specialization [32]. Hence, the main advantage brought about by containerization is

the development of door-to-door and intermodal transport operations. Since this study mainly focuses on the intermodal security concept in sustainable supply chain systems, untized form of transport which is basically intermodal transport will be used as the main concept.

The definitions proposed here are certainly not uniform or decisive. For instance, in the US the term “intermodal transport” or “combined transport” might be used instead of multimodal transport [55]. 1980 Multimodal Transport Convention (MTC) has defined “multimodal transport” as; *“means the carriage of goods by at least two different modes of transport on the basis of a multimodal transport contract from a place in one country at which the goods are taken in charge by the multimodal transport operator to a place designated for delivery situated in a different country”*. According to the European Agreement on Important International Combined Transport Lines and Related Installations (AGTC) article 1/a the term “combined transport” is defined as; *“the transport of goods in one and the same transport unit using more than one mode of transport”*. Figure 5 shows the general concepts used in integrated transportation terminology. “Multimodal”, “intermodal” and “combined” transport according to the definitions replaced in “Combined Transport Terminology” prepared by UNECE, in order to fix the literature regarding the integrated approach;

<p><b>Multimodal Transport:</b> Carriage of goods by two or more modes of transport.</p>
<p><b>Intermodal Transport:</b> The movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes.</p>
<p><b>Combined Transport:</b> Intermodal transport where the major part of the European journey is by rail, inland waterways or sea and any initial and/or final legs carried out by road are as short as possible.</p>

**Fig. 5: General Concepts of Integrated Transport [56]**

Intermodal transport should be considered as an overall system rather than just the physical movement of goods and the costs related to this movement. Intermodal transport also aims to achieve technical, commercial, legal and management framework by integrating all the parties involved in the supply chain. Intermodal transport offers the services related to a full range of transport modes and routing options by allowing them to coordinate various logistics functions such as storage, finance, distribution etc. to achieve efficient relationships with all the

members of supply chain [57]. As Cambra-Fierro and Ruiz-Benitez [58] state, intermodal transport considers material flows, shipping operations, transportation infrastructures, informatics operations, telecommunication infrastructures, and auxiliary activities linked to logistics. Due to the existence of many factors, actors and management systems within the intermodal transport, the vulnerability of the intermodal transport to possible risks and security threats can be considered more than the risks and threats for unimodal systems. Specifically in terms of many functional and institutional arrangements

within intermodal transport chain as well as supply chains, the process of implementing security measures becomes more complicated. As Bichou and Evans [59] states, *“the combination of intersecting functional and institutional arrangements across the supply chain makes it almost impossible for a single actor within a single channel to effectively trace and monitor operations across different channels”*. Even for a typical movement of a maritime container, involvement of 25 parties and a large number of flow configurations across the maritime network could be possible [60]. This could possibly be more complex in case of an intermodal transport chain which mainly includes at least more than two modes of transport mode.

### **A Framework for Intermodal Transport Chain Security**

Integrated transport solutions have been widely discussed and needed in new supply chain designs, namely resilient and sustainable supply chain systems. Vulnerabilities at the supply chain may occur at the commodity, supplier, supply chain partner, supply chain facility, cargo transporter, personnel, and information levels [61]. Since transport function plays a very strategic role within the supply chain, and transport networks are high value targets for terrorists since they are accessible and visible [62], the main focus on the intermodal transport security will be discussed in this section. For an intermodal transport system to be operated in a secure way, some factors can be discussed within the framework as seen in Fig. 6.

#### ***Supranational and National Drivers***

IMO, International Maritime Bureau (IMB) and other groups such as the World Customs Organisation (WCO) have jointly supported processes that enhance regulatory coverage of safety and security within the world trading system. For instance IMO launched a number of security measures including changes to the SOLAS Convention that specifically focuses on ship security with updated requirements for compliance with the ISPS Code [50]. As explained above, both SOLAS and ISPS Code have been prepared to prevent safety – security related damages on maritime transport by arranging the requirements that a ship and a port should fulfill. Moreover, some ship-owning associations, such as BIMCO, INTERTANKO and INTERCARGO can be mentioned as influential lobby groups as well as individual ship owners who may also make a contribution through their flag states which have the voting power at the IMO [63]. However there are no other international mandatory regimes,

prepared by supranational bodies, to regulate safety - security related issues on other modes of transportation. The consequence of non-existence of international mandatory regimes that regulate safety – security related issues on other modes of transportation and intermodal transportation, endangers biggest security and safety gaps.

Apart from supranational drivers, national governments also implement security measures in order to eliminate possible threats and risks. Applications of US play an important role in the implementation of security measures. US promote a series of voluntary trade programmes by aiming increased security of trade into North American seaports and indirectly into other major trading nations [50]. Moreover, CSI initiative requires an inbound container or cargo from foreign ports be pre-inspected [64]. As mentioned above, C-TPAT and 24 Hour Rule have been also adjusted as a national voluntary initiative in US to arrange security related issues, however affected the worldwide applications in maritime transportation.

#### ***Technology Harmonisation/Interoperability***

Emerging technologies provide some capabilities to help companies to protect their supply chain and intermodal transport chain. Sarathy [65], lists some of the technology-related solutions for achieving secure supply chain as; supply chain personnel identification and controlled access to supply chain nodes; secure loading of containers and verification with electronic manifests; software for automated targeting of suspect containers; use of RFID tags for containers in order to monitor the process during transit and loading/discharging, keeping a record of who has had access to the container at warehouses, at the dock, at loading and unloading, and in transit; as well as continuously recording the physical locations of containers and individual items; and communication among transportation modes, containers, and supply chain networks, linked to supply chain database management, with use of encryption and data security.

Interoperability concept is widely discussed in the intermodal research by mainly focusing on the ability of different transport modes and actors to work together in the overall intermodal transport operations. This concept can also be discussed in the technological evaluation of the intermodal transport chain. Sarathy [65], pointed out that information technology should be linked to supply chain and security considerations. According to Sarathy [65], companies have to set data and communication standards for supply chain security, to facilitate inter-operability, so that data captured can be shared and communicated

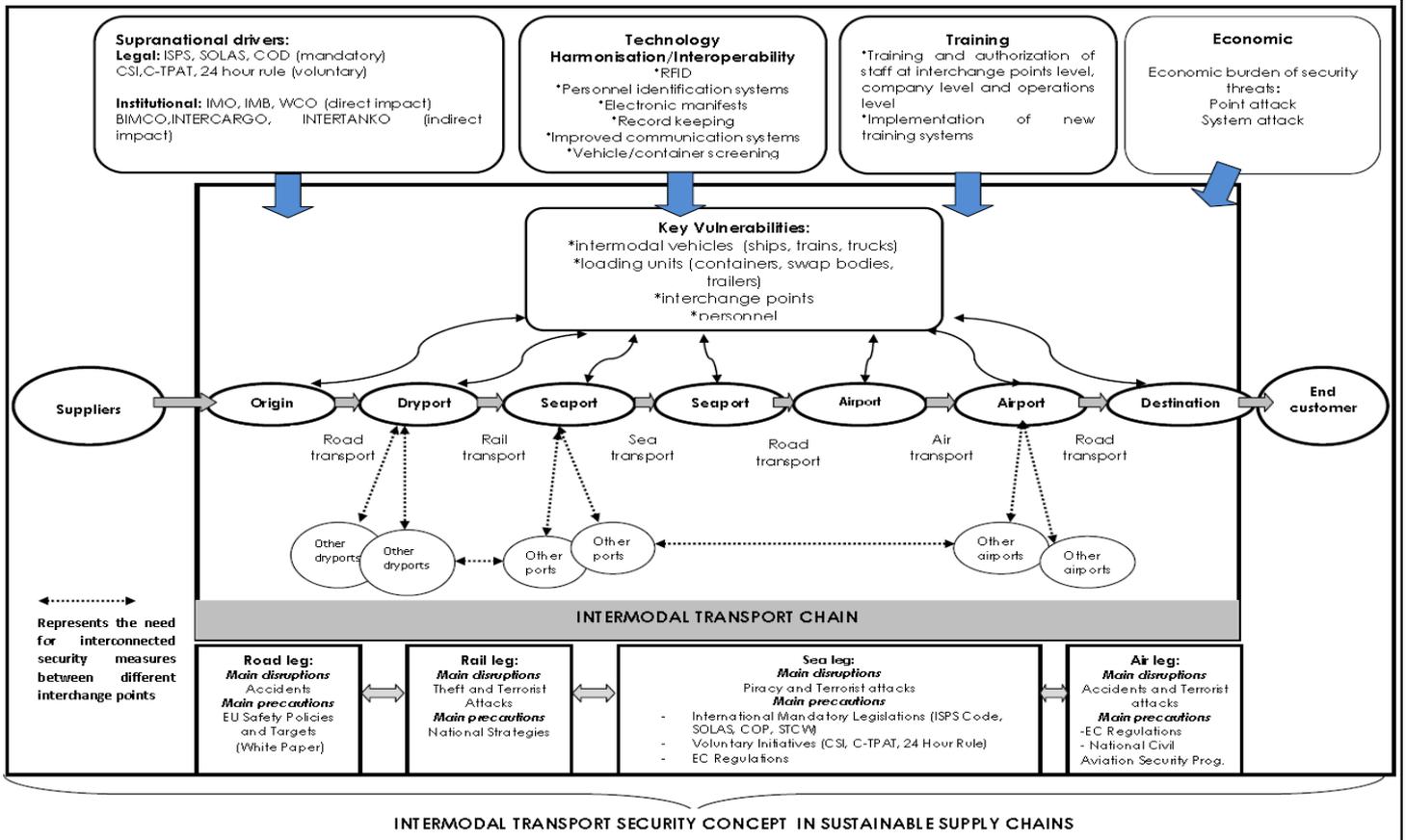


Fig. 6: A framework for intermodal transport security

across software packages, databases and supply chain partners, government and other interested parties. This could also be the same for intermodal transport chains that interoperability of the main technological systems/software to be applied to all loading units, vehicles and interchange points used in the overall system may provide visibility and control over the intermodal transport chain.

**Training**

The key element in prevention and proper response to security threats is being considered as operators, drivers, ships crew and personnel who are well trained and prepared to act when they experience dangerous or threatening situations [34]. As people dimension can also be considered as a serious threat to overall supply chain system, training and authorization of staff remain a critical issue. On this account, legal instruments on transportation, especially on international maritime transportation, have given importance on this issue. Whereas COP, as explained above, addressed security awareness as well as training of the staff. Besides, Standards of Training, Certification and Watchkeeping (STCW) Convention, prepared by IMO on 1975 and updated on 2010, prescribes minimum standards relating to training, certification and

watchkeeping for seafarers which countries are obliged to meet or exceed. According to Russell and Saldanha [60], a suitable security system should ensure the exclusion of any unauthorized personnel from being involved in supply chain activities that could leave supply chains vulnerable to illegal activities. Training of personnel can be classified under three dimensions as; the training of staff at interchange points such as stevedores, operational staff at various ports, dryports or airports; company level (staff working at airlines, ship management companies, logistics service providers, road or rail transport companies etc.) and lastly the operation staff who is actively involved in the management and operation of the vehicles and the loading units such as drivers, crew and operators of specific vehicles. Moreover, there is an increasing need for the implementation of specific training programmes for the personnel. Hence as Dennis [41] highlighted; in the absence of a systematic and verifiable program of external certification and oversight, insufficient rigor and a lack of consistency may render maritime security education and training less effective than it should be. As Tarr, McGurk and Jones [34] point out, simulation allows employees to encounter a terrorist situation and then initiate an immediate

action by offering training in a realistic, virtual situation. They also added that computer based games can attract the attention of young staff by proving training modules and increasing their awareness.

### ***Economic Factors***

Economic consequences of a possible security threat may impact the whole intermodal transport chain as well as the supply chain. As an example, Roske [66] indicated that if a port was damaged by the explosion of an atomic weapon, this might cause 100 billion dollars in port lock-out losses as well as 5.80 billion dollars in port recovery losses. Considering other interchange points in the intermodal transport systems such as dry ports, logistics centres, freight villages and specialized intermodal rail terminals, the main economic consequences would also be the same and serious. The scope of the economic consequences of a possible security threat can be discussed whether it is directed to a specific point in the intermodal transport or any facility or location that would affect the overall intermodal transport chain. It can be expected that an attack to a very strategic hub port in the intermodal transport system could be very severe compared to an attack for a truck. If the intermodal transport chain as well as the supply chain system is well-adjusted and managed, a shift from one hub to another alternative hub nor port, terminal or warehouse should be planned. This may eliminate any negative outcomes of the attack and serious delays in transit times of goods.

### ***Key Vulnerabilities***

As sources of security risks, three main components can be mentioned as; cargo (using cargo to smuggle people and/or conventional, nuclear, chemical or biological weapons; vessel (using the vessel as a weapon or means to launch an attack) or people (using fraudulent seafarer identity to support of terrorist activities)[67]. As seen in Figure 6, key vulnerabilities have been classified as vulnerability of transport vehicles, loading units, interchange points and personnel.

**Vulnerability of Transport Vehicles and Loading Units:** The vulnerability of ships at sea to piracy and sea robbery depends on factors such as the type of ship, its size, speed, freeboard and voyage [63]. Containers are also vulnerable since they can be used to transport illegal immigrants, firearms and other weapons, smuggled goods and weapons of mass destruction (WMD) [64]. Trailers as important loading units in intermodal transport are also vulnerable. As Ball and

Rusteberg [68] mentioned, the mobility of trailers as well as their relatively high value, and the significant volume transported by rail make them important targets for thieves often associated with organized crime. Also railways represent a significant portion of an intermodal transport chain since they provide cost effective solutions by minimizing the possible risks of congestion, environment and noise pollution and accidents compared to road transportation. Trains as one of the main transport vehicles in intermodal system are considered extremely vulnerable to terrorist attacks [34]. Main attempts made in order to increase the security levels in railway transportation, specifically trains, were to increase the security of information systems and property, training and inspection of certain shipments, employee training and inspection of priority tracks, tunnels and bridges [34].

**Vulnerability of Interchange Points:** The events of 11 September 2001 highlighted the vulnerability of many aspects of the transport system, in particular the weaknesses in links among modes along the transport chain and the need for a coordinated security approach among modes. Marlow [62] identifies that many of the security concerns relate to activities and participants at the origin and destination stages of the supply chain and since these companies are smaller companies operating on tight margins and without the capability or capacity for rigorous security measures, the level of threat may increase specifically at these points.

As mentioned at the economic consequences of possible security threats, all interchange points within the intermodal transport system can be mentioned as the key vulnerable points. These can be briefly summarized as seaports, inland/dryports, freight villages, airports, logistics centers, warehouses, specialized intermodal terminals. The common characteristics of all these points are that there is a transfer of cargoes between different modes of transport and vehicles and certain amount of time is spent during these transfers. These processes make the vehicles, cargoes and the interchange points vulnerable to any security threats. With regards to the security measures at intermodal terminals, Ball and Rusteberg [68] indicated that security at intermodal terminals tends to be reactive to current criminal activity, rather than proactive or preventive. They highlighted the importance of the physical design and daily operating procedures in the intermodal facility in preventing the possible threats and some critical factors such as psychological deterrence, physical

security measures and procedural checks and balances were suggested as the main strategies

for managing the possible threats in intermodal terminals. Two key links in many supply chains, as air transport together with airports and maritime transport with seaports have been considered as the main vulnerable points which have applied intense levels of security in the form of rules and measures with detailed, legally binding specifications and checks [69]. Ports are considered as very strategic interchange points both in intermodal transport systems and advanced supply chain systems. Hence, making ports secure provides considerable benefits to the whole intermodal transport network.

However, Banomyong [18] argues that making only one port or limited number of ports secure is not sufficient since only a uniform level of security in all ports will decrease the risk of disruption to global supply chains. This is also same for intermodal transport chains as well. In response to possible security threats, ports and terminal operators make some investments in security, namely related to fencing, CCTV systems, scanners, training, additional security personnel, etc. Any improvements in port security are paid by the port authorities and terminal operators and the cost must be shared by all chain stakeholders. Thus, “security surcharges” are passed to the port’s clients in order to share those costs [70].

**Vulnerability of Personnel:** Apart from mentioned vulnerable factors, personnel as discussed in the training section as operational personnel, personnel at the company and at the interchange points are also considered as the parties that can be affected due to any possible threats.

### ***Intermodal Security Outcomes***

An efficient and secure maritime supply chain can help build and sustain the competitiveness of internationally traded products by reducing transit time, reducing transport costs, and increasing reliability and cargo security. However, if the movement of freight is resumed, it would probably operate under new security restrictions that would not only add heavy costs but might even lead to gridlock because of the lack of excess

capacity that now characterizes the “intermodal system” [71]. In fact, security and safety related issues on other modes of transport (such as rail transport, road transport) and, in case of an integrated system, on interchange points haven’t been regulated by any mandatory international regimes. Since the intermodal system is characterized by a lack of agreement on responsibility and overlapping claims to jurisdictional authority, policymakers in national governments and supranational organizations confront substantial challenges in such areas as port security and piracy [3]. This may create a two-tier system where priority of access will be given to recognized secure maritime supply chains and non-secure hub centres or interface points will lose out in term of competitiveness [18].

Intermodal transportation which faces more security and safety related issues than unimodal transport systems, has not been regulated by any international mandatory legislations. EU [69] with its “Report on Enhancing Supply Chain Security” proposed to enhance supply chain security in order to provide greater protection for all European freight transport against possible terrorist attacks and draw a “secure operator” scheme by setting them up in the member states. However this mechanism can not be effectively operated without the support of any international and national mandatory legal drivers, technological and economical improvements and educational trainings. These priorities are the most important instrument by shaping the legal, technical and organisational basis, and at the same time creating a favourable environment for intermodal transport development. Since intermodal transportation is mostly the outcome of private initiatives seeking to capture market opportunities, it remains to be seen to what extent public strategies can be reconciled with a global intermodal transport system which is flexible and footloose [72]. Therefore a secure intermodal system will promote the competitiveness of global transport and trade application.

### **Conclusion**

Each single transportation mode has specific security gaps in accordance with its own nature and these security gaps endanger the

sustainability and development of transportation. There are currently specific security measures for single transport modes whereas those measures have been implemented by supranational and national bodies in order to regulate safety and security related issues. However, “regulating” may not be sufficient for the improvement of overall achievement regarding security as well as optimum cost and increased transportation service levels. Besides technological and economical improvements and educational trainings should take place in the security management system as indicated in the framework of the study. Moreover, focusing on only unimodal transportation modes does not meet the expectations of today’s containerized transportation industry. There should be mandatory regulations and voluntary initiatives that regulate the safety and security issues regarding intermodal transport services. Security initiatives are now being considered part of the key logistical activities but it is at the same time one of the most problematic activities, especially in an international context. If the security activity fails to perform, this will surely impact on the competitiveness of global supply chains. Lee, Hau and Whang [73] indicated some of the consequences of supply chain disruptions (whether caused by security-related causes or other reasons), as increased cost; delivery disruption; interruptions in the smooth flow of product and service; time delays; uncertainty. When the increasing importance and the use of intermodal transport services is considered, the unexpected and unfavorable effects of insecure applications within the intermodal transport chain will directly influence the overall supply chain as well as the sustainability of the supply chain.

In accordance with the main aims of the study, this research basically attempts to identify the main need for an integrated approach for security measures in intermodal transport. Since the role of intermodal transport in supply chain system is considerably important due to the main benefits obtained

through the use of intermodal transport solutions, any possible risk to this specific transport chain may affect the flow of information, people and goods negatively. Hence, the literature review supported the view that there is a very limited academic research conducted on the security concept in intermodal transport compared to unimodal transport security measures. This explains the originality of this research that no similar research has been noticed in terms of presenting the main factors affecting the intermodal transport chain as well as the main vulnerable points.

As for further research, a more detailed investigation of risks and security threats in specific vulnerable points such as intermodal terminals, rail yards etc. in the intermodal transport can be suggested. Since this research is original in its content and the character, a detailed literature review was needed in the development of a framework. Hence, next step would be the employment of different research methods such as a focus group or Delphi study by bringing the different actors in the intermodal transport chain in order to understand their ideas, the main problems they experience in their operations as well as the strong and the weak points in specific intermodal transport systems. Moreover, in-depth interviews could be conducted with the different parties in the intermodal transport chain in order to collect the main variables of a truly secure intermodal transport chain.

The survey study would also be the next step of this research with the use of variables obtained as a result of qualitative interviews, focus groups or Delphi study. The main motivation for such survey study would be to construct a specific sample of users or suppliers of intermodal transport services and understanding their awareness degree regarding the security variables. This could be applied for a specific intermodal transport chain, a country or for a region.

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