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Intelligent Decision Support Systems for Compliance Options

A Systematic Literature Review and Simulation

Siva Venkata Prasad Patta

Faculty of Computing, Blekinge Institute of Technology, 371 79 Karlskrona, Sweden

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Contact Information:
Author(s):
Siva Venkata Prasad Patta
E-mail: sipa15@student.bth.se

University advisor:
Dr. Lawrence Edward Henesey
Assistant Professor, BTH
Department of Computer Science and Engineering

Faculty of Computing
Blekinge Institute of Technology
SE-371 79 Karlskrona, Sweden

Internet : www.bth.se
Phone : +46 455 38 50 00
Fax : +46 455 38 50 57

ABSTRACT

Context. The International Maritime Organization new rules in March 2016 regarding the weighing of containers for the safety of Life at sea have been in effect from July 2016. This project deals with the new rules and the best way to implement them in the already existing ways of weighing. The major issue that has been pointed out by the IMO as the reason for this drastic change is data tampering that is being done at all the ports.

Objectives. The project revolves around logistics and its adoption to the new rules. The objective of this project is to focus on minimizing data tampering to the lowest level possible.

Methods. To achieve the set goals in this project, Decision support system and simulation have been used. However, to get clear insight about how they can be implemented, a systematic literature review (Case Study incl.) has been conducted, followed by interviews with personnel at Kakinada port to understand the real-time complications in the field. Then, a simulated experiment using real-time data from Kakinada port has been conducted to achieve the set goals and improve the level of transparency on all sides i.e., shipper, port and terminal.

Results. A systematic literature review has been done on the concepts of Decision Support System and Verified Gross Mass. Interviews has been conducted with personnel from 3 major ports in India, and the answers have been carefully analyzed. The experiment conducted has been successful, but it has only been checked in simulated environment where there was an assumption that there will be no security breach in the process of accessing data or authentication.

Conclusion. The problem addressed in this project is the latest issue in the field of logistics which require a lot of improvement in the future. The concept of Verified Gross Mass is as new to a retailer as it is to a consumer. So, there has to be an increase in awareness for the project's reachability and also, a progress in healthier research is essential at this point.

Keywords: Verified Gross mass**,** International Maritime Organization, Safety of Life at Sea, Decision Support System, Simulation, Data Tampering, Support vector machine (SVM).

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1 Introduction

A Decision Support System (DSS) is a computerized information system used to support decision-making in an organization or a business [1]. A DSS let users scrutinize through and analyze massive amounts of data and compile information that can be used to solve problems to facilitate better decisions.

The International maritime organization (IMO) new rules for container weight have been in effect since July 1,2016. The new rules present a chance for improving the safety of ship and its personnel by avoiding accidents caused due to errors made in the container terminal. The International maritime organization (IMO) identified the reasons for the accidents to be data tampering performed regarding the container weight by the port personnel. Previously a case study has been conducted on the same issue. It also described an artificial intelligent system that makes use of the basic concepts in decision support systems along with the techniques of Multi-Agent System.

Based on a previously performed case study, the researchers identified that the data is being tampered at the container terminals. The container weight is not being verified at the terminal which sometimes leave the shipmaster with a vague assumption of the weight, which may eventually lead to accidents. So, to avoid such accidents, data tampering at the container terminals should be decreased to the least level possible.

The data that is being mostly tampered is the Gross Mass of a container. Gross Mass is termed as the actual weight of the contents in the container. The Gross mass is obtained by calculating the difference between the weight of the empty container and the total weight of the container with goods. International Maritime Organization made amendments in its rules which involve the use of Verified Gross Mass (VGM). Verified Gross Mass (VGM) can be termed as the gross mass of the container which is verified by the terminal before loading the container on the vessel. This concept decreases the chances of accidents as the chances of overloading the vessel are less [2].

This chapter also presents the aim and objectives of the research performed. This chapter presents the research questions formulated to solve the research problem identified. This chapter also presents an insight regarding the background and related work in the field of container transportation and Decision Support System (DSS).

1.1 Aim and objectives

The extensive aim of the research is to increase marine container terminal efficiency by using the concept of Decision Support System. In technical terms, the project aims to build a simulation model that can decrease the data tampering being done at the shipping terminal thereby preventing accidents.

Also, the project has been used to study how DSS could improve decision making in solving complex problems in the field of logistics, such as VGM. The topic of VGM has been

selected as the prime issue here because of its importance with the new regulations set up by the International Maritime Organization regarding the SOLAS Convention.

1.1.1 Objectives

- Perform a literature review on DSS, VGM.
- Prepare a format for the semi-structured interviews that must be conducted.
- Meet personnel at the ports to conduct interviews.
- Analyze the information collected from interviews.
- Analyze the differences of the current system with developed system to validate.

1.2 Research Questions

The research questions that are used to complete the research are presented below:

RQ1. How can DSS improve the decision making for problems as complex as VGM?

A literature review is performed to understand the concepts of DSS and VGM. A case study on the amendments adopted by the International Maritime Organization to its Safety of Life at Sea Convention [SOLAC] also helps to answer the research question.

RQ2. What is the impact of VGM on container port and terminal processes, in terms of physical handling and data flows, relating to data tampering?

The impact of verified gross mass on container port and terminal processes can be understood by conducting interviews from port officials who manage the inflow and outflow of container weights. Some personnel from Kakinada port, India as well as Chennai Port, India have been contacted regarding the issue and they have agreed to give an interview.

RQ3. How can simulation be used to create an application that could possibly minimize if not avoid data tampering?

A simulation model has been developed based on historical data of Kakinada Port, India. A web application has been developed to calculate the VGM of the container at the terminal. The results obtained from the simulation suggest that the data tampering can be reduced to a minimum level as the overloaded containers will be flagged and sent back to the shipper.

1.3 Background of DSS

Decision Support Systems incorporate learning based frameworks. A legitimately planned DSS is an intelligent agent–based framework proposed to help any manager incorporate valuable data from a blend of crude information, archives, and individual learning, or plans of action to recognize and take care of issues and decide.

The benefits of decision support systems include more informed decision-making, timely problem solving and improved efficiency for dealing with problems with rapidly changing variables [1].

A decision support system usually incorporates:

- Inventories of data resources (counting legacy and social information sources, solid shapes, information distribution centers, and information stores)
- Comparative deals with figures between one period and the previous information sources.
- Projected income figures considering item deals suspicions.

Development of DSS in Years

As indicated by Sol (1987) [3] the definition and extent of DSS has been relocating throughout the years: in the 1970s DSS was depicted as "a computer-based framework to help basic leadership"; in the late 1970s the DSS development began concentrating on "intuitive computer based frameworks which help chiefs' use information bases and models to tackle poorly organized issues"; in the 1980s DSS ought to give frameworks "utilizing appropriate and accessible innovation to enhance viability of administrative and expert exercises", and towards the finish of 1980s DSS confronted another test towards the plan of canny workstations [3].

Types of Decision Support System

Utilizing the association with the client as the standard, Ginzeberg [4] separates latent, dynamic, and helpful DSS. A detached DSS is a framework that guides the procedure of basic leadership, however that can't bring out express choice proposals or arrangements. A dynamic DSS can bring out such choice proposals or arrangements. An agreeable DSS takes into consideration an iterative procedure amongst human and framework towards the accomplishment of a merged arrangement.

Another scientific classification for DSS, as indicated by the method of help, has been made by Daniel Power:

a. Accessing all data resources, including legacy and social information sources;
b. Comparative information figures;
c. Projected figures considering new information or suppositions;
d. Consequences of various choice options, given past involvement in a setting.

Advantages of Decision Support System

- **Saves Time.** For all the types of decision support systems, researches have shown and substantiated reduced duration in decision making, expanded employee profitability and more timely available data needed for decision making. The time saving that have been archived from utilizing computerised DSS are significant. Researchers, however, have not shown if the decision quality continued as before or progressed.
- **Enhance viability.** The mostly discussed advantage of DSS is enhanced decision-making adequacy and better choices. Decision quality and decision-making adequacy are however difficult to record and measure. Most researches have analysed delicate measures like perceived decision quality as opposed to objective measures.

- **Improve interpersonal communication.** Decision support systems can enhance communication and coordinated effort among decision-makers. Data-driven DSS make "one version of the truth" about organization operations accessible to managers and henceforth, can encourage fact-based decision making. Enhanced data accessibility is frequently a noteworthy inspiration for building a data-driven DSS.
- **Cost reduction.** A few researches, particularly case studies have documented DSS cost saving because of less personnel usage for decision making.

Disadvantages of Decision Support System

Decision Support Systems can make focal points for associations and can have positive advantages, however building and utilizing Decision Support System can incur negative results in a few circumstances.

- **Monetary cost.** Decision Support System requires putting resources into data framework to gather information from many sources and examine them to bolster decision making. Some analysis for Decision Support System needs the progress of data analysis, measurements, econometrics and data framework. So, the cost is high to hire specialists to set up the framework.
- **Overemphasize decision-making.** Obviously, the concentration of those of us inspired by computerised DSS is on decisions and decision making. Implementing Decision Support System may strengthen the rational perspective and over-emphasize decision processes and decision making. It is important that the managers are educated about the more extensive setting of decision making and the social, political and emotional variables that effect hierarchical organizational success.

Failures, Uncertainties and Limitations in Decision Support System

Decision Support System has been incorporated into business for a long time. All, including business people, developers, and business experts concur that such frameworks are not great. DSS network has confinements which are as follows:

- **Mechanical learning of clients is required**

  The DSS networks have been easier to use; as of late, it remains an issue particularly for independent firms that face an absence of innovative information of clients. Most DSS still need specialized term learning for the analysis.

- **Difficult to Quantify Factors**

  In real world, a few values can't be accurate, and some are difficult to quantify. for example, future loan fees or interest rates, new legislation’s or product's time span of usability that may all be considered for analysis. Despite that, the DSS network may give a positive result, the person in charge(decision maker) must utilize their own judgment in settling on an official choice, i.e., the final decision.

- **Difficult to gather all related information**

Over the years, information has never been recorded accurately or information with errors or some information can't be recorded. In this way, the specific incentive from decision support tools might be not the same as what it ought to be.

1.4 Previous Research

Marine container terminal modelling and optimization is a vast field representing a complex modelling problem. Apart from that, there comes a high degree of problem specificity to a specific container terminal due to the differences in technology for the said marine container terminals. Thus, research has been performed on various aspects of container terminal modelling that has resulted in many publications in this area. The issues of simulation related to container terminals can be classified into one of the following classes:

- Berth allocation
- Berth allocation
- Vessel loading and discharge
- Container stacking operation
- Inter-terminal transport and other modes of transportation
- Simulation modelling of complete container terminals

1.5 Methodology and Tools

The modelling approach has been adjusted keeping the task in mind to complete the goal set out in the research. The methodology features the following steps:

1. Construction of hierarchically integrated models until a rational level of detailing has been arrived.
2. Creating an interface to input control parameters and monitoring and visualization of internal variables of the model.
3. Adjusting the control parameters of the models.
4. Creating sub-model blocks for scenario modelling, that is, analysing situations where input statistics might change.
5. Application for solving practical problems.

A logical model has been developed which serves as the basis for the simulation model represented. The structure of the logical model has been developed on-field through measurement and observations and from the management of Kakinada port. The input data that has been used for model development is Kakinada port database container statistics related to different containers shipped through the terminal. A web application has been developed based on DSS model and the results obtained by inputting the container details are presented in future section.

2 Systematic Literature Review

2.1 Introduction

Systematic Literature Review is performed to understand how DSS can improve the decision making for complex problems such as VGM. This is being done to precisely understand the concept of DSS and use it to solve the problem at hand respectively.

2.1.1 Context

Decision Support System (DSS) in simple terms can be expressed as the applications/ computer programs that facilitate the users to make business related decisions, through analysis of the business data. The history of such intelligent computer programs dates to the mid-1960s when the world got to know about them for the first time. since their inception, decision support systems have proven to be a diverse field in technology and successful attracting a lot of scientists and researchers. Thus, the field has seen a lot of technological advancement in the form of modern computerized applications and frameworks that can help understand these systems, and then build them. In present day terms, the entire legacy of the decision support systems can be classified into five categories. They are:

1. Communication-driven decision support systems
2. Data-driven decision support systems
3. Document driven decision support systems
4. Knowledge-driven decision support systems
5. Model-driven decision support systems

The origins and evolution of the decision support systems have been clearly identified and described in [5]. Distinct from the above discussed classification of the decision support systems. In his research during 1980, Alter suggested that the decision support systems could also be classified based on the operations that they perform. Alter's classification of the decision support systems is as follows:

1. File drawer systems- Such systems facilitate us to access the data items.
2. Data analysis systems- Such systems make use of task specific tools and allow us to manipulate the data.
3. Analysis information systems- Using such systems we can access certain small models, and databases that are decision-oriented.
4. Accounting and financial systems- These models allow us to compute the results of certain business, and finance related decisions.
5. Representational models- These models make use of simulations and predict the consequences of the actions performed, as the result.
6. Optimization models- Models that generate optimum solutions based on a set of pre-defined constraint, and thereby providing guidelines.

7. Suggestion models- These models are best-suited for a well-understood task, as they can process a suggested decision logically, and thereby assist in the decision-making process.

2.1.2 Background

The use of Decision Support Systems to develop applications has been on rise since its inception in 1980. This usage includes the development of applications that support the management at different levels in an organization, regarding aspects such as financial management, strategic decision-making, and decisions regarding operations. Many studies have been conducted to identify the areas where Decision Support Systems can be used to develop applications [Alavi & Joachimsthaler, 1990, Eom & Lee, 1990a, Eom, 2002, Arnott & Pervan, 2005]. The major areas for DSS applications that were identified in these studies involved manipulation of quantitative models, access and analysis of large databases, and group decision making support. The development of applications is different for each category of the decision support systems in the present-day terms.

Communication – driven DSS

This kind of decision support systems make use of data communication and networking technologies. Using this they allow the decision makers to collaborate and communicate regarding the decision. The main purpose of such systems is to help the users organize meetings and collaborate. Some of the most commonly used technologies to deploy such systems are web clients/ web servers [6].

Data – Driven DSS

These decision support systems focus on granting the users the access to manipulate the data. This data can either be internal company data, or in some cases, external real-time data. The functionality provided by these systems can vary from the simplest file system that can be accessed with queries, retrieval tools; to the highest levels of functionality such as On-line analytical processing. Examples of such systems include, system databases that can be accessed through queries.

Document – Driven DSS

These systems can be used for analysing and retrieving documents in the storage of the computer using certain data processing tools. These documents can be textual, audio, video, image, or hypertext documents. An application of Document-driven DSS systems can be to search for a specific information on a web page using certain identifiers or keywords.

Knowledge – Driven DSS

Knowledge-driven DSS systems are a specialized computer system that can be used to solve problems with expertise. Such decision support systems are generally used to provide advice and help the management of a business. Usually such systems are deployed using client/server, stand-alone computers, software.

Model – Driven DSS

Model-driven DSS systems can be best suited when there is a need to analyse the decisions, or when we need to choose from multiple options. These models provide access

and/or allow the manipulation of financial, optimization, and simulation models. The most basic functionality provided by such models can be a simple quantitative model. The model-driven DSS systems have limited data, and parameters that are defined by the decision makers to help them in situational analysis [7]. These models do not need large databases. These systems are widely used by business managers, staff, and people that directly interact with the organization.

In this thesis, we focus on solving the complex logistic problems such as Verified Gross Mass (VGM). We would like to investigate the ways in which Model-driven DSS systems can be used to solve the VGM problem.

Building a MDSS

Every model driven DSS system is tailored to meet certain objectives, and to serve a purpose. Hence, it is vital to identify as to which model we would like to use in our study. This leads us to an important step, that is "Modelling", which consists of a series of steps that must be followed to identify the model that is apt for the task at hand.

Modelling

Modelling is the part where we identify the desired model with which we want to build our MDSS. The steps that exist with in modelling are as follows:

1. Assumptions and Forecast

These are the predictions about aspects such as time, and risks involved. These predictions are different and may vary for each situation. Assumptions are extremely useful when dealing with situations of uncertainty. The two types of analyses that can be assumed while designing a model driven DSS are:

Static analysis: The static analysis is a short-sighted analysis that is more suitable for the situations where the decisions are stable and consistent throughout the entire process.

Dynamic analysis: "Dynamic analysis is a testing program or a software system in the real-time. this method considers that the situation changes over time, due to any reason, such as cost, rules and regulations, time etc" [8].

For any given situation, there are three factors that must be analysed, as to decide which is the best assumption for the given situation. These factors are:

Certainty: In which adequate information is available, and which tends to lead us to optimal solutions.

Uncertainty: Where the information is highly dynamic, and constantly varying, and there by cannot be relied upon. In such cases, it is more vital to acquire as much information as possible.

Risk: If there arises a case where the information is lacking, a "what if" analysis is used to aid the decision makers [9].

2. Model types

A model-driven DSS can either be an individual model, or a combination of the below models.

i. Explanatory/ Descriptive model: This model describes why things tend to happen the way they do?
ii. Contemplative model: This model, using a certain set of parameters, can predict the results.
iii. Algebraic model: Solves complex equations in a high-level modelling system and can also optimize equations and/ or variables at the same time in concurrent simulations.

3. Simulation models

Using simulation models alongside DSS allows us to run experiments, through which we can replicate the real-world scenarios in a controlled environmental set up. This involves a sequence of actions that must be followed, that usually involve identifying the problem, evaluation of results etc. The characteristics of simulation models are as explained below [10].

- Try to imitate reality
- Perform what-if analysis
- Are descriptive tools for forecasting
- Repeat experiments to obtain an optimized estimate of impact of certain actions
- Aid in solving extremely complex problems
- Form elementary relationships and interdependencies among variables
- Are made for one problem and aren't suitable for another problems
- Reduce the time taken in decision making

The below are some of the situations where we can apply the simulation models.

- Manpower planning and assignment
- Inventory control
- Reliability and replacement
- Sequencing and scheduling
- Stock-in and stock-out
- Queuing and congestion

There are three types of simulation models. They are:

- *Probabilistic*: In probabilistic simulation models, the independent variables are identified, and are regarded as the probability distribution of the values.
- *Time dependent/ Discrete*: The precise time of occurrence of an event is taken into consideration in these models.
- *Visual simulation*: This method makes use of animations and visual aids, to develop a better understanding of the situation.

2.2 Review Questions

The following review questions where considered when literature was being selected.

1. ***Every field has been using the advancement in technology to secure their data and its flow in many ways. How far has logistics improved in this area?***

There has been a tremendous change in technology over the past years. No stone has been left unturned when it comes to decreasing the work involved and optimizing it to a better level. There are concepts like Steganography (the science of concealing information within different types of media, such that only the sender and the receiver are aware of its exact location) [11] and Cryptography (the practice and study of techniques for secure communication performed over unsecured channels) [11] in existence. The fact that methods of securing data have been improved over the years can be considered, though the argument is that all these methods also use text as the secret key to protect data, and that secret key is an ancient concept where there has been no advancement. The research done in this field has helped in improvising the technique of wrapping text into an efficient key but has not really left the root of the concept and developed into something else.

Researchers confidently accept the fact that "Biometrics is the most feasible solution when it comes to securing data" [12]. But, this is not the truth. It is not quite a success when compared to the secret key technique. For the concept that a biometric passkey cannot be duplicated by any means, it can be applauded. But there lies a huge drawback in the very existence of this so-called perfect solution. The Biometrics method of securing data is not reachable to the public far-and-wide as the secret key method. Its' setup takes a large amount of time and investment. It is not merely a-software, which can just be installed, and the data can be secured. Looking at this we need to find a better way of securing the data.

One Time Password is a key that is used to authorise a single transaction, on devices supporting this facility [13]. This method of securing information and avoiding any kind of mistakes as far as possible is a huge leap taken from the usual static passwords, which have been in use for long. But this password generated could not be of any use and prove to be a major setback if the device, which is synced to receive the dynamic code is lost [13]. Also, there is a chance of cracking down the algorithm used to generate the OTP's. Logistics currently uses the technology of OTP [13] for transfer of data, but a better solution can be proposed.

2. **Verified Gross Mass is a renewed concept that has been brought into the limelight by the International Maritime Organization for Safety of Life at Sea. How are the current shipment agencies/ port areas coping with the new rules?**

The new rules by IMO for SOLAS have brought a 180 degree turn in weighing containers for the present situation. Coping with these changes has been a considerably difficult task as there are thousands of ports that need to follow these rules all over the globe and making appropriate changes to match the scenario will be a tough task for any person responsible.

However, coping with them is a completely different concept as it will involve more than two different ports for every case. Keeping this in mind, an interview has been conducted with reference to the literature review and the case study for a clearer picture about the state of art.

3. **Artificial Intelligence has always been paired with Decision Support System for efficient construction of any security mechanism, in recent times. How far is the progress of DSS in the field of logistics, and how is that helpful to the task at hand?**

Increasing global competition, new manufacturing philosophies, and development in information technologies have led to restructuring and reengineering in manufacturing arena with the sole objective to enhance the competitiveness of manufacturing organizations [14]. This led to greater recognition of the importance of logistics. According to Fawcett and Clinton [1996], developing an efficient and effective logistics can provide a competitive advantage and it would allow manufactures to produce and deliver more competitive product/service package as desired by their customers [14]. In competitive advantage: According to value chain concept of Porter (1985), competitive advantage cannot be understood by looking at a firm as a whole [15]. It stems from many discrete activities a firm performs in designing, producing, marketing, delivering, and supporting its product. Each of these activities can contribute to a firm's relative cost position and create a basis for differentiation [15].

Presently, logistics has been identified as having the potential to become the next governing element of corporate strategy to create value for customers, generate cost savings, enforce discipline on marketing and external production flexibility. As Copacino and Rosenfield[1987] have stated, "Logistics has been recognized not only as a group of important functions, but as function that have important strategic impacts as well" [16].

4. Simulation goes hand-in-hand when DSS is involved. Which model could be decided as the most useful in relation to VGM, according to most researchers?

Simulation is a broad term that refers to an approach for imitating the behaviour of an actual or anticipated human or physical system [17]. The terms simulation and model, especially quantitative and behavioural models, are closely linked [17]. From my perspective, a model shows the relationships and attributes of interest in the system under study. A quantitative or behavioural model is by design a simplified view of some of the objects in a system. A model used in a simulation can capture much detail about a specific system, but how complex the model is or should be depends upon the purpose of the simulation that will be "run" using the model [18]. With a simulation study and when simulation provides the functionality for a DSS, multiple tests, experiments or "runs" of the simulation are conducted, the results of each test are recorded and then the aggregate results of the tests are analysed to try to answer specific questions [19]. In a simulation, the decision variables in the model are the inputs that are manipulated in the tests.

Sometimes an effort to provide decision support an actual small-scale model or ecosystem is built and then it is "used in a simulated environment". For example, a physical model of an airplane may be built so that it can be tested in a wind tunnel to examine its design properties[20]. Today a computer simulation might be used in place of a "physical model" for much of the design testing [21]. The case "Product development decision support at Lockheed Martin" by Silicon Graphics Staff posted at DSSResources.COM October 16, 2002 is an example of this use of simulation [21].

2.3 Review Methodology [Literature Review]

2.3.1 Refining search strategy

- The articles used in the Systematic literature review are collected from the scientific database "Engineering Village" where articles from IEEE and Google Scholar were considered.
- So, my initial keywords are: *Decision support systems, Simulation and multi-agent-based systems*.
- Later, the article publication timespan was limited to 1997-2017.

After observing the previous search results an exclusion criterion is applied, and 50 papers are listed out from the obtained results. While listing out the papers I have gone through the abstract introduction and conclusion of those papers to extract information such as field of study, year, problem type and the method used to solve that problem. It helped me in getting new keywords for searching the articles.

This process is repeated by improving the keywords and initial search presented only few related papers. The keywords used in the second search are: DSS concepts, Multi-objective optimization; Multi-criteria decision making; Decision support systems; simulation-based optimization and data mining. This process resulted in 45 papers which were reduced to 30 on further filtering.

2.3.2 Search Strategy

The initial data extraction is designed based on the different questions and topics that have discussed in this study. By this we can relate the papers to the literature review. After forming the keywords and then reviewing the papers the list of papers was selected.

2.3.3 Include/Exclude Criteria

A combined search on IEEE Explorer and Inspec has been done and a list of 30 research papers were selected accordingly.

Inclusion Criteria

- Studies that discussed about various DSS and simulation models have been selected.
- Studies that relates to DSS and simulation to logistic were selected.
- Research done from last 20 years i.e., (1997-2017) are selected due to the regular research in that field.
- Research based on other fields in which DSS and simulation with multi agents are mainly used to solve the research questions were also considered.

Exclusion Criteria

- Some studies that are completely irrelevant to the DSS and simulation with respect to logistic were not considered.
- Articles that doesn't have the full access were not considered.
- Papers that relate to the old research in this filed were not considered because they lacked future work.

2.3.4 Quality Assessment Criteria

The articles that we selected are graded as low, high and moderate based on their quality criteria that we considered. Research questions are explained as follows:

QC 1: How related is this scope of DSS and simulation presented in the paper?

QC 2: How effective is the solution proposed using DSS and simulation in the paper?

QC 3: How much is the logistics issue discussed in the paper related to the paper at hand?

QC4: How efficiently problem regarding the calculation of VGM being solved Multi agent simulation?

The articles selected for SLR have been graded as low, moderate, high and high based on how related to the topic of search they are. The quality criteria on how the literary articles have been assessed are listed in table 2.1 below.

Table 2.1: Quality Assessment of the literature

Papers listed	QC1	QC2	QC3	QC4
[1]	high	high	low	low
[2]	high	high	high	moderate
[3]	high	high	moderate	low
[4]	moderate	moderate	low	low
[5]	high	high	low	low
[6]	high	moderate	low	low
[7]	moderate	moderate	low	low
[8]	moderate	moderate	low	low
[9]	high	high	low	low
[10]	high	high	moderate	low
[11]	moderate	high	low	low
[12]	high	high	low	low
[13]	moderate	high	low	low
[14]	high	high	high	low
[15]	high	moderate	moderate	low
[16]	moderate	moderate	low	low
[17]	moderate	high	moderate	low
[18]	moderate	high	high	low
[19]	high	high	moderate	low
[20]	high	high	low	low
[21]	moderate	moderate	low	low
[22]	high	high	high	moderate
[23]	high	high	high	low
[24]	high	high	high	high
[25]	low	low	high	high
[26]	high	high	high	moderate
[27]	high	high	moderate	low
[28]	high	high	moderate	low
[29]	moderate	moderate	moderate	low
[30]	moderate	moderate	high	high

2.3.5 Data Extraction Process

The selected literature has been read, rephrased and answers to all questions are given in the data extraction form. Systematic literature reviews were then done after retrieving the relevant content from the selected literature. This is shown in the *Figure 2.2* below.

The questions that have been posed to assist in data extraction are:

Q1. What is the paper focusing on

Q2. What kind of problems are discussed in the paper?

Q3. What are the approaches used to solve the problems?

2.3.6 Validation of the Protocol

A companion was asked to retest the search results for verifying the protocols. Companion got the same search results as was retrieved earlier.

2.3.7 Include and Excluded Studies

In the initial phase, the search for literature needed for the study started from formulation of key words and it showed different papers related to decision support system and simulation and their current practices in the companies. Some papers even included their gradual growth with time and their development in the recent times to meet the current facing challenges. However, some studies are excluded as they are addressing the decision support system and the concept of simulation proposed but failed to solve the issues and the concepts which are not applicable to the current problem which I have been working to solve.

List	QC1	QC2	QC3
[1]	Simulation – based optimization and data mining.	Data mining and DSS	A flexible production cell has been proposed in cloud-based system architecture using Flexible Pattern Mining algorithm
[2]	Lack of coordination in the field of logistics.	Logistics and Decision Support System	An innovative approach based on the extensive use of simulation and virtual reality in a web environment as a wired DSS.
[3]	Challenges for development in a new production system- layout and control logic.	Customer-Driven Manufacturing using simulated DSS; case study	Data integration, automated simulation model creation and updates, visualization of results for interactive and effective decision making are presented.
[4]	An argument that existing approaches are inadequate to generate high quality results in multi-objective optimisation.	Data mining and simulation	A distance-based data mining approach for the solution sets is generated from simulation-based optimisation.
[5]	Survey of a prior research on a model driven DSS built using decision analysis, optimisation and simulation techniques.	Model driven DSS	The implementation has been done using spread sheets and web technologies, issues associated with the user interface and behavioural and technical research questions have been utilized.
[6]	Decision support system is provided to schedule patients waiting for elective surgery in public hospital system.	Multi Agent DSS using simulation techniques	A simulation model has been developed to address the problem. It can be used as an operational tool to match hospital availability and patient need. It also reports the performance of the system and compares the effectiveness of alternative policies in this multi-criteria decision environment.
[7]	5 algorithms have been developed and evaluated.	Decision making methods	The algorithms have been examined in terms of two evaluative criteria-consistency and stability of the respective methods.

[8]	The relevance of DSS research, DSS research methods and paradigms, the judgement and decision-making theoretical foundations of DSS research, the role of the IT artifact in DSS research, the funding of DSS research, inertia and conservatism of DSS research agendas, DSS exposure in general "A" journals, and discipline coherence.	Decision support systems	The discussion of each issue is based on the data derived from the article content analysis. Several suggestions are made for the improvement of DSS research. These relate to case study research, design science, professional relevance, industry funding, theoretical foundations, data warehousing, and business intelligence.
[9]	Quantitative models embedded in a Decision support system(DSS).	Model – Driven DSS	Focus on model-driven DSS built using decision analysis, optimization and simulation technologies, implementations using spread sheets and web technologies; issues associated with the user interface and behavioural and technical research questions
[10]	This study consists of a decision matrix input of N criteria weights and ratings of L alternatives on each criterion.	Multi attribute DSS and Simulation experiment	Comparative performance of 8 methods using simulation techniques. The 8 methods are: Electre, Topsis, MEW, SAW, and four versions of AHP
[11]	Decision making using fuzzy sets.	Multi – Attribute decision making	Multi attributes decision making using intuitionistic fuzzy sets is investigated, in which multiple criteria are explicitly considered to generate optimal weights for attributes, and the corresponding decision – making methods have also been proposed.
[12]	The evolution of DSS technologies and issues related to DSS definition, application, and impact.	DSS	Presents four powerful decision support tools, including data warehouses, OLAP, data mining, and Web-based DSS. Issues in the field of collaborative support systems and virtual teams are presented. This paper also describes the state of the art of optimization-based decision support and active decision support for the next millennium. Finally, some implications for the future of the field are discussed.
[13]	Reviews and summarizes recent technology developments, current usage of Web-based DSS, and trends in the deployment of such systems.	Web-based DSS	Largely focused on applications and implementations, and only a few articles examine architectural issues or provide design guidelines based on empirical evidence.
[14]	DSS offering different services and aiming to integrate logistics management and decision support for multimodal transportation systems.	Model-based DSS	The proposed DSS is devoted to managing logistics networks in order to synchronize different transportation means by using the modern information and Communications Technology tools and by taking into account environmental aspects.

[15]	Empirical, laboratory-experiment-based evaluation of the effectiveness of debriefing in the context of interactive learning environments.	Empirical simulation	A comprehensive model consisting of 4 evaluation criteria are developed and used: task performance, structural knowledge, heuristics, and cognitive effort. On these criteria, debriefing versus no debriefing are compared.
[16]	Presents an overview of multi-agent system models of land-use/cover change (MAS/LUCC models).	Simulation in multi-agent systems	Authors review alternative LUCC modeling techniques and discuss the ways in which MAS/LUCC models may overcome some important limitations of existing techniques.
[17]	Approaches developed to optimize simulated systems	Simulation optimization	concentrate on the metaheuristic black-box approach that leads the field of practical applications and provide some relevant details of how this approach has been implemented and used in commercial software.
[18]	If statistical learning algorithms can be effectively deployed in an Intelligent Decision Support System (IDSS) to reduce idiosyncratic risk in private equity investment decisions.	Intelligent Decision support system	By comparing confusion matrices of 6 statistical learning classifiers, it has been shown that logistic regression can reasonably discriminate between investments that yield rates of return that are attractive, intermediate, or poor. An IDSS has been developed based on these results.
[19]	The need to provide sustainable, quality dental services in a complex environment given fluctuations in dental graduate numbers, migrations, attritions and activities.	DSS using System Dynamics	DSS developed using VENSIM software-expandable and flexible. It can be used to monitor future changes in dental workforce and provide a comprehensive and structured policy analysis to policy-makers and health managers, within the Ministry of Health Malaysia.
[20]	Effective and efficient crowd control tactics can keep the safety of both the innocent public and the crowd who are involved with (violent) collective behaviors.	Agent based modelling and simulation	To devise and test crowd control tactics, a decision support system called SimCrowdControl has been developed using the technique of agent – based modeling and simulation
[21]	Emergence of Expert Systems in DSS	Integrated Expert Systems and DSS	Examines possible connections between the two technologies and discusses some issues related to their integration.
[22]	Application of multi-agent-based simulation for evaluating container terminal management operations.	Multi-agent-based simulation	performance from the container terminal manager's perspective and how to improve the understanding of the factors of productivity and how they are related to each other. A simulation tool called SimPort has been used for the evaluation

[23]	Advanced Decision Support System (DSS) able to assist the policy makers in exploring the influences on market take-up of different transport Technologies under various exogenous scenarios and policy options and in assessing the energy and environmental impacts of these technology mixes.	Integrated Decision Support System	To implement the decision-making analysis a newly developed evaluation methodology has been integrated into the DSS. The method, called NAIADE, allows decision-makers to evaluate complex choices on the basis of enhanced access to information of different types.
[24]	A classification of the decision problems that arise at container terminals.	Logistics and DSS	An overview of relevant literature is presented. Quantitative models from this literature, which try to solve the problems are discussed.
[25]	Loading containers with cartons of non-uniform size and presents an analytical model to capture the mathematical essence of the problem.	Logistics and DSS	The container loading problem is formulated as a zero-one mixed integer programming model. It includes the consideration of multiple containers, multiple carton sizes, carton orientations, and the overlapping of cartons in a container. This model is then extended to formulate some special container loading problems. Numerical examples are used to validate the model.
[26]	Major seaports are facing a challenge to manage their container operations both effectively and efficiently.	Intelligent DSS and Simulation	Efficiently. We have designed and developed an interactive computer simulation model to support the logistics planning of container operations has been developed.
[27]	Certification is becoming increasingly more important as M&S applications are used more and more for military training, complex system design evaluation, M&S-based acquisition, problem solving, and critical decision making	Modelling and Simulation	Planning and managing such measurements and evaluations requires a unifying methodology and should not be performed in an ad hoc manner.
[28]	To address specific features of a simulation discrete or continuous decisions, expensive or cheap simulations, single or multiple outputs, homogeneous or heterogeneous noise- various algorithms have been proposed in the literature	Simulation Optimization	Simulation optimization refers to the optimization of an objective function subjected to constraints, both of which can be evaluated through a stochastic simulation

Table 2.2: Data Extraction Chart

Papers which deal with DSS and simulation in the field of logistics are mainly considered. Papers that deal with Model – Driven DSS and continuous versus discrete simulation were also taken in consideration. Papers related to intelligent and multi-agent support systems are reviewed even if they are not related to the current field of study because the proposed Simulation model should use an Intelligent DSS to take decisions autonomously depending on the situations and it should also be working with a different agent in the port simultaneously. A flow chart depicting the included and excluded studies is presented in figure 2.3 below.

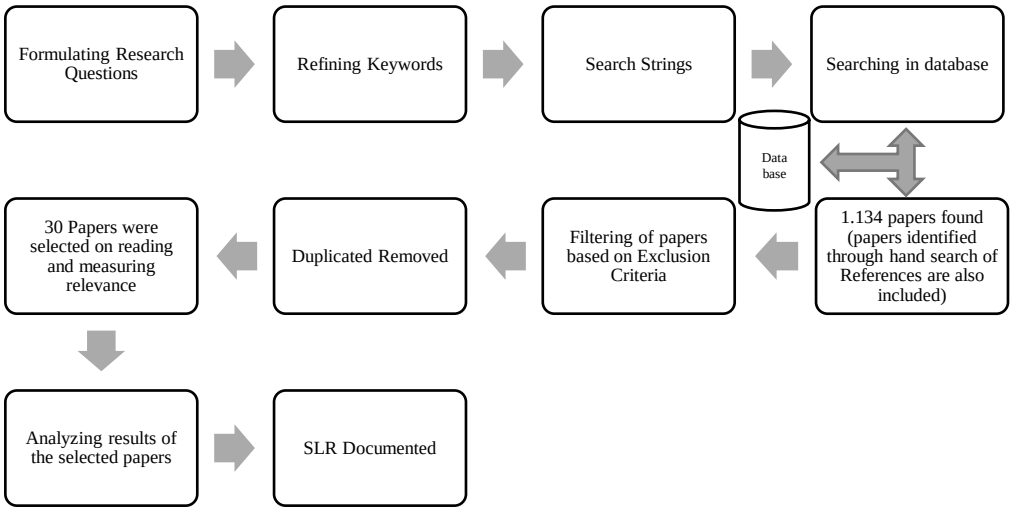


Figure 2.3: Flow Chart depicting the Included and Excluded studies

2.3.8 Limitations

There weren't many limitations in the prospective of research. But searching and filtering of the literature was a huge task. There has been so much work from 1980's and further about Decision Support System, proving the vastness of the subject once again. As explained in Include/exclude criteria and included/excluded studies, literature selected for reviewing was mostly done in recent times. It has been chosen to stay close to the changing and transforming technology in our daily life.

2.4 Review Methodology [Case Study]

A case study is a record of a certain activity, event or any problem that needs addressing on a real or a hypothetical situation including the complexities that would be encountered. Case studies help in understanding the complexities of real-life scenarios. According to Kardos and Smith (1979), a good case study has the following features:

i. It is taken from real life (true identities may be concealed).
ii. It consists of many parts and each part usually ends with problems and points for discussion. There may not be a clear cut off point to the situation.
iii. It includes enough information for the reader to treat problems and issues.
iv. It is believable for the reader (the case contains the setting, personalities, sequence of events, problems and conflicts)

Case studies are a great way to tell the world about the product's services. They go beyond simple testimonials by showing real-life examples of how well one can satisfy a customer's needs and help them accomplish their goals.

2.4.1 Discussion

Summarizing the learnt facts about Verified Gross Mass after the case study has been done, some of the most important facts have been jotted down below.

The consequences of mis-declaring the gross mass of a packed container can be far-reaching. Discrepancy between the declared gross mass and the actual gross mass of a packed container go unnoticed, it could have an adverse impact on the safety of the ship, seafarers and shore-side workers, by leading to incorrect vessel stowage decisions and potentially collapsed container stacks or loss of containers overboard [22].

The International Maritime Organization stated that "The Maritime Safety Committee (MSC), at its ninety-fourth session (17-21 November 2014), adopted, inter alia (among other things), amendments to Safety of Life at Sea (SOLAS) regulation VI/2 (see resolution MSC.380(94)), to require the mandatory verification of the gross mass of packed containers"[23].

In addition to the amendments to SOLAS regulation VI/2 and with a view to establishing a common approach for the implementation and enforcement of the SOLAS requirements regarding the verification of the gross mass of packed containers, the Maritime Safety Committee approved the Guidelines regarding the verified gross mass of a container carrying cargo (MSC.1/Circ.1475) [23].

The above mentioned SOLAS amendments introduce two main new requirements:

- The shipper is responsible for providing the verified weight by stating it in the shipping document and submitting it to the master or his representative and to the terminal representative sufficiently in advance to be used in the preparation of the ship stowage plan [23]; and
- The verified gross mass is a condition for loading a packed container onto a ship [23].

The verification of the gross mass can be achieved by either of two methods:

- Weighing the packed container [24]; or
- Weighing all packages and cargo items, including the mass of pallets, dunnage and other securing material to be packed in the container and adding the tare mass of the container to the sum of the single masses, using a certified method approved by the competent authority of the State in which packing of the container was completed [24].

2.5 Limitations

Work related to VGM is new in the market. The methods have drastically changed recently; so, finding relevant literature proved to be tougher task than finding literature for DSS. While the other case was another extreme of having unlimited literature, this was a case where I had to work on very limited information and find out as much as I can to conduct the experiment.

3 Interviews

The interviews have been conducted to formulate a solution for the second research question in this project, which is to find the impact of VGM on container port and terminal processes, in terms of physical handling and data flows, relating to data tampering.
The interviews have been transcribed below.

3.1 Interview 1 – Chennai Port

1. **What were the previous techniques of weighing containers?**
   When we worked with previous techniques, there was no method to officially guarantee VGM. Some of the previously used methods were weighing at port, weigh at point of packing etc. For example, when weighed at port the machines that record the container weighed were not always verified.
2. **How different are the methods from the new ideas of weighing?**
   The new ideas are more thought about and are a result of much research which was conducted in this field. Now we are required to measure the weights in stacking yards. This is more efficient as it gives ample time for stowage plan to be optimized before actual loading is carried out.
3. **Do you think it is a good idea to suddenly make changes in policies that have been in practice by the whole industry of logistics for years? Please support your choice.**
   Yes, I think new changes should be embraced, new changes not always mean complete overhaul in previous practices as the goal here is just to improve efficiency and strictly regulate safety. As the shipping industry, here has seen tremendous growth and to cope up with increasing requirements its necessary that we consider new methods and better alternatives.
4. **How are you(professionally) coping with the new rules by the International Maritime Organization with respect to the SOLAS act?**
   We have a verified weighing machines which give us VGM. The supply chain has been made more accountable so that verified container weights are obtained accurately and in a timely manner.
5. **Has it been difficult to adapt to the new techniques? Please motivate your answer with a why/how.**
   Much document handling must be done as sometimes the VGM is provided by third parties. Sometimes congestion happens at terminal because of miscommunication inside the supply chain on the VGM. The tare weights printed on sides of containers may not be accurate sometimes.
6. **Can you think of any other possible suggestions or improvements in the current weighing system that could have been better with respect to the SOLAS act?**

When a container is ready to be loaded into a ship but its VGM is not available it becomes difficult to transport it. More relaxation must be given in case of weight discrepancy

7. **Do you think weight tampering of containers is still happening, even with the new rules in action?**
   No, it is difficult to get away undetected.
8. **In your opinion, why does weight tampering happen. Could you please state your reasons and any ideas on how it can be controlled?**
   For reduction in the transportation cost, weight tempering is done by shippers. VGM regulation is a big step towards controlling such activities.
9. **Please give any suggestions you can think of about authentication mechanisms for the database to prevent weight tampering issues.**
   Agricultural and forest products may vary in weight due to humidity and there should be a special category for such goods and their VGM.

3.2 Interview 2 – Kolkata Port

1. **What were the previous techniques of weighing containers?**
   The containers were generally weighed at the port before loading if they are not packed. But sealed containers were not weighed again.
2. **How different are the methods from the new ideas of weighing?**
   SOLAS implements weighing of containers at just the shipper sites. They are not weighed again at loading time in the port. This is a good way of avoiding bottlenecks at the loading sites.
3. **Do you think it is a good idea to suddenly make changes in policies that have been in practice by the whole industry of logistics for years? Please support your choice.**
   Yes, it is definitely a very good idea since it concerns the safety of people. The lives of workers are of paramount concern for any company and any policy that results in their betterment must be applied immediately.
4. **How are you(professionally) coping with the new rules by the International Maritime Organization with respect to the SOLAS act?**
   Implementing this is a relatively difficult process. The shippers bear the brunt of it since it is their responsibility to use the certified equipment and appoint an authority. Only a few shippers have readily implemented the techniques, and this creates imbalance in the market. We face problems when it comes to certifying the shippers as we need to keep regular tabs on their authenticity.
5. **Has it been difficult to adapt to the new techniques? Please motivate your answer with a why/how.**
   Only a few shippers have readily implemented the techniques, and this creates imbalance in the market. We face problems when it comes to certifying the shippers as we need to keep regular tabs on their authenticity.
6. **Can you think of any other possible suggestions or improvements in the current weighing system that could have been better with respect to the SOLAS act?**

I don't think there is scope for any further tampering now since any such anomaly can be exactly traced back to its origin.

7. **Do you think weight tampering of containers is still happening, even with the new rules in action?**
   Weight tampering is an issue of corruption and vested interests. The shippers try to pass of their containers as lighter than they are. In case of smuggling rings, they add their smuggle goods to the containers illegally and discretely and may also move the goods in off-shore exchanges which results in load imbalance in the carrier ship. Hence both heavier or lighter containers can pose risks to the transport operation. This can only be controlled by practices such as VGM.
8. **In your opinion, why does weight tampering happen. Could you please state your reasons and any ideas on how it can be controlled?**
   The root problem is ultimately the people. Corruption is the single most dangerous problem in any situation and people must change their mindset.
9. **Please give any suggestions you can think of about authentication mechanisms for the database to prevent weight tampering issues.**
   End to end encryption of information may be useful in maintaining strict security of data.

3.3 Interview 3 – Mumbai Port

1. **What were the previous techniques of weighing containers?**
   APM Terminals, Mumbai previously employed two weighing procedures, Method 1 that involves weighing the laden container in its entirety and Method 2 that allows the shipper to weigh the goods, packaging, and securing materials separately and add that to the tare weight of the container. Previous techniques do not make it mandatory for the terminal operator to recheck the VGM provided by the shipper. Proper weighing facilities may not be ready or available close to the port and there are chances that containers may arrive at the APM Terminal, Mumbai gates without the VGM. The weighing activity is with the lifting equipment and the captured information will be relayed through our Terminal Operating System.
2. **How different are the methods from the new ideas of weighing?**
   APM Terminals, Mumbai previously used to carry out the weighing process off-site to avoid congestion at terminals. "The container should preferably be weighed at the stuffing point/freight station/inland depot or en-route to the port/terminal."
3. **Do you think it is a good idea to suddenly make changes in policies that have been in practice by the whole industry of logistics for years? Please support your choice.**
   The purpose of the VGM regulations is to assure the safety of the vessel, as well as that of the dock workers and other cargo handlers by affirming that container ships loads are balanced and distributed properly to prevent a shipwreck. Indian ports are adapting for a global SOLAS rule starting 1 July 2016, which mandates shippers to verify and declare the weight of a container before loading it on a ship for export. India's maritime regulator, the Director General of Shipping (DGS), which is tasked

with implementing the rule in India, has given more time to shippers to comply with the requirements.

4. **How are you(professionally) coping with the new rules by the International Maritime Organization with respect to the SOLAS act?**
   The IMO advised maritime administrations and port state control authorities worldwide to be "practical and pragmatic" for three months beginning 1 July 2016, by allowing packed containers that are loaded on before 1 July to be shipped to their final port of discharge without a VGM. There are people who have formed a company for weighing services who are saying they will charge Rs.15,000 for first registration. Another company says they will charge Rs.1.5 lakh to install the software program in the office of shippers. APM Terminals Management has announced plans to offer weighing services at their facilities in India as part of a worldwide roll-out to smooth out the process.
5. **Has it been difficult to adapt to the new techniques? Please motivate your answer with a why/how.**
   Jawaharlal Nehru Port Trust, told that it is looking to carry out weighing to produce the VGM, using its yard cranes, within the terminal. The main difficulty is, terminals are not asked to submit the weight to the shipping lines. Shipper should declare the weight. Life will become easier if they tell the terminals to weigh the container and declare the weight
6. **Can you think of any other possible suggestions or improvements in the current weighing system that could have been better with respect to the SOLAS act?**
   Shipping are charged a fee of $70 to convert manual VGM to electronic. It costs more than the freight in some places. Some container freight stations (CFS) are saying they will charge Rs.2,600 a container for issuing weight certificates. Once VGM is put on terminals, the rates won't go up because at least the terminals at major ports (owned by the union government) are regulated by the Tariff Authority for Major Ports or TAMP. There will be some form of oversight.
7. **Do you think weight tampering of containers is still happening, even with the new rules in action?**
   The tolerance level of variation on weight need to follow rules laid down in the Indian Legal Metrology Act, 2009. "The maximum permissible error of the verified gross mass of the containers obtained at different weighbridges is therefore required to be governed as per the provisions of the act. in case of discrepancies in weight and depending on the tolerance levels, it would be regarded as a criminal offense.
8. **In your opinion, why does weight tampering happen. Could you please state your reasons and any ideas on how it can be controlled?**
   Smugglers illegally transporting goods in the disguise of registered standard goods result for weight tampering to avoid getting caught by local authorities. Transporters also prefer to tamper the weight to avoid surcharges and taxations.}
9. **Please give any suggestions you can think of about authentication mechanisms for the database to prevent weight tampering issues.**

An easily implementable software must be used with electronic weight bridges for the VGM process. This helps in speeding up the weighing process with minimum room for error.

4 Simulation Model Development

This chapter deals with the creation of simulation model using Netbeans7.4 IDE and JDBC as backend. The parameters of the model have been based on the historical data of containers from Kakinada port.

4.1 General Approach to Simulation

All the existing mathematical models of marine container terminals known till date lack addressing to parameters of the terminal resources explicitly, thus resulting in a missing link between resource unit performance and its marginal influence on the productivity of the terminal. Thus, it can be said that these models work in a space of abstract parameters, for instance, variable coefficients in regression models, rendering it not suitable to create realistic detailed micro-simulation models. However, a constantly growing number of container freight calls for maximal terminal performance. Thus, several questions arise that are vital for terminal management:

- Why cannot the existing system reach performance that is close to that of the lowest link in the logistics chain?
- How is the efficiency of the technological chain affected by the number of tug-masters?
- What are the new resources that would be optimal if a re-engineering takes place?

According to the author, the existing publicly available models of marine container terminals have not been able to cover these questions. Therefore, a need for MCT models that is capable to address these questions 'what if' scenario testing.

4.2 Level of Detailing

The most important task in modelling is to choose a reasonable level of abstraction of the logistic model so that the model is comprehensible to the end-user retaining its explanatory capacity. The steps involved to decide the level of detailing required are problem definition, system definition and input data preparation.

- ***Problem Definition*:** The research problem that needs to be solved is reducing the data tampering to the minimum level during the transportation of containers from terminal.
- ***System Definition*:** The system components that need to be analysed are defined during this step. In this case, the system components that the researcher is interested is the Gross mass of the container and verification of the gross mass at the terminal end to check if the data provided by the shipper is true
- ***Input Data Preparation*:** The data required for the project is collected and broken down to fit the experiment. In this case, the weight of the containers and their contents is the basic data required. This data regarding various containers and their contents is collected from Kakinada port. This raw data is then filtered and broken down into useful data that could be used during the execution of the application.

4.3 Developing Logical Structure

The core steps involved to develop a logical structure for the simulation are conceptual model formulation and deciding on the experimental design.

4.3.1 Conceptual Model Formulation

After gathering the required data, a clear understanding of the system components that are being analyzed are drawn out. In this case, there are four modules which are considered important and act as an aid to avoid data tampering in ports. The modules are as below:

- ***Shipper module***: The shipper is fully responsible to weigh the packed container (Stowage plan for containers) or to weigh its contents. Further, the Shipper packing the container cannot use a weight someone else has provided, except "if the individual, original sealed packages that have the accurate mass of the packages and cargo items clearly and permanently marked on their surfaces, do not need to be weighed again when they are packed into the container.
- ***Port module***: This module is capable of performing operations like checking Imported Containers, exported containers and View all imported containers with total invoices. If a packed container is weighed at the load port, that weight is to be used for vessel stow planning. Any discrepancy between a packed container's gross mass declared prior to the verification of its gross mass and its verified gross mass should be resolved by use of the verified gross mass.
- ***Terminal module***: Terminals and carriers need to agree on how situations are going to be handled when a marine terminal receives a packed export container that does not have a signed shipper weight verification, as there will be a need to process such containers at the terminal in order to obtain the weight of such containers and use such weights in the vessel stow plan.
- ***Ship master module***: The ship master will check all the cargo into specified container and convert this into export port.

4.3.2 Design

This step involves a design of how the interaction takes place between the modules and how the data flows from one module to other. Experimental design involving the 4 modules and the dataflow between the modules is presented in figure 4.1 below.

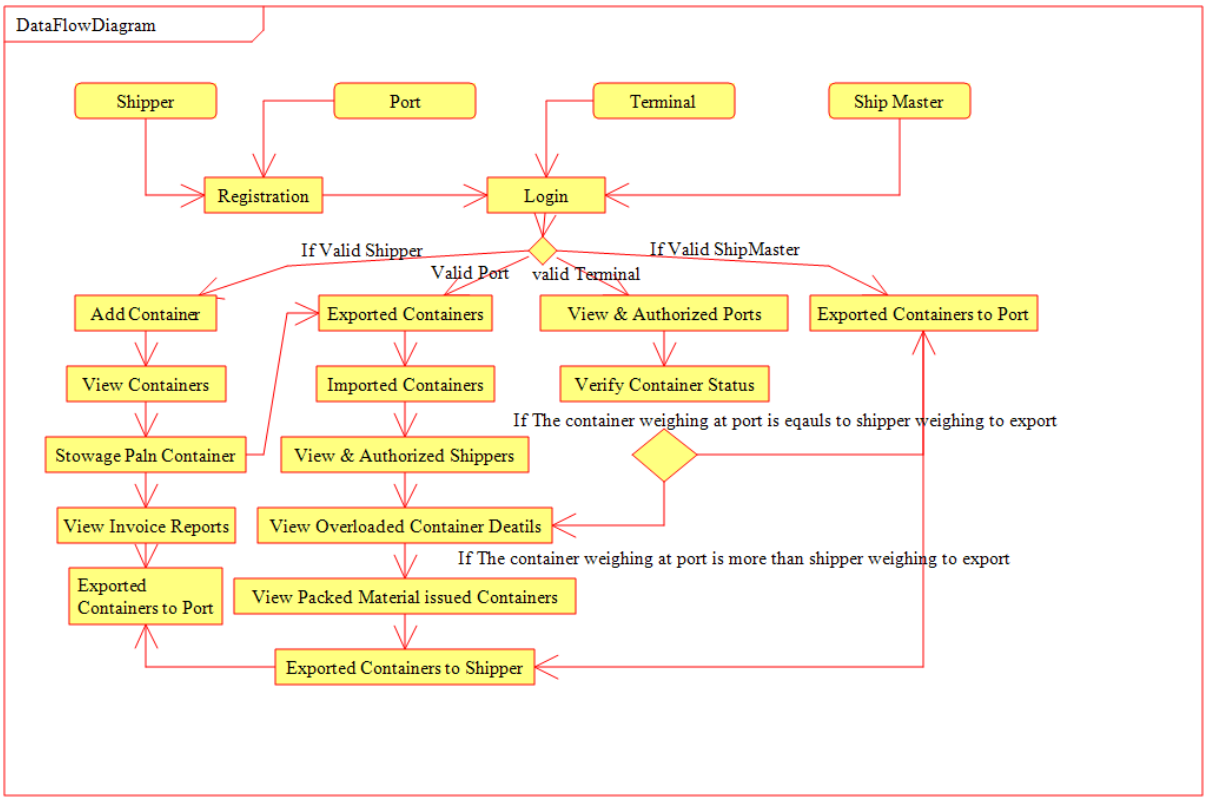


Figure 4.1: Experimental design

4.4 Model Output

This section presents a description of the various programming languages used to create the web application required for the simulation and also presents the implementation of the application which would generate the results that would help in solving the research problem.

4.4.1 Model Translation

During this step, the experimental design is executed by developing an application with the above modules and data flow using various programming languages. The software components used in this research to create the application are as follows:

- Operating system : Windows XP/7/8/10.
- Coding Language : JAVA 1.8
- Application Category: Web Application
- Database : MYSQL 5.1.44
- Web server : Apache Tomcat 8.0
- Other Tools : SqlYog607
- FrontEnd : HTML, CSS, JavaScript, servlets and JSP
- BackEnd : JDBC

4.4.2 Simulation Implementation

Once the application is prepared using the above programming languages, it is executed. The input for the application is the weight of the containers obtained from the

Kakinada port during the initial steps of the simulation process. The application makes use of Decision support system as well. The decision support helps the terminal to decide if the container is overloaded or not. The total code involving the decision support is presented in annexure A, and the real-time functionality of the web application developed is presented in annexure B. The main part of the code used for decision making is presented in figure 4.2.

```
<td>Max Gross Weight:</td>
<td> <input type="text" name="a1" value="<%=rs1111.getString(5)%> KG's"
readonlyonkeyup="alp1(this)" onkeydown="alp1(this)" />  </td>
<%if(count2>count1){%>
<td>Container Status :</td>
<td><blink><font color="red"><B>Packing Materials Missing</b></font></blink></td>
<%Statement st3=connection.createStatement();  st3.executeUpdate("update upload set
status='missing' where status='waiting' and id='"+tid+"'");}else{if(count2<count1){%>
<td>Container Status :</td>
<td><blink><font color="red"><B>Overloading</b></font></blink></td>
<%  Statement st3=connection.createStatement();  st3.executeUpdate("update upload set
status='Overload' where status='waiting' and id='"+tid+"'");}else{%>
<td>Container Status :</td>
<td><blink><a href="allowedship.jsp?<%=(String)session.getAttribute("cid")%>"><font
color="brown"><B>Allowed to Ship</b></font></a></blink></td>
```

Figure 4.2: Section of decision-making code

In this first module i.e., shipper module, consider that there are n numbers of shippers. Shipper should register before doing any operations. Once shipper registers, their details will be stored to the database. The port can view the shipper's details such as Shipper ID, Company, Mobile, etc. and port authorizes the shippers. After Authorization successful, he has to login by using authorized shipper id and password. Once Login is successful shipper will do some operations like, Add Container, Stowage plan for containers, View Containers, and View all exported containers with total invoices. Then the shipping agent will assign Hauler to handle the container to the port. All the containers inside the shipper yard are handled by private carriers. The necessary data to move the container by the carrier are communicated through local agents. Container discharged from the Vessel or loaded into the Vessel is also communicated through agents. All the carriers are equipped with VMT (Vehicle Mounted Terminal) to handle the data. The shipper is fully responsible to weigh the packed container (Stowage plan for containers) or to weigh its contents. Further, the Shipper packing the container cannot use a weight someone else has provided, except "if the individual, original sealed packages that have the accurate mass of the packages and cargo items clearly and permanently marked on their surfaces, do not need to be weighed again when they are packed into the container. And fatherly the shipper exported container to port for signing.

4.4.3 System Testing

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, assemblies and/or a finished product. It is the process of exercising software with the intent of ensuring that the software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

4.4.3.1 Unit Testing

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

Test Strategy and Approach

Field testing will be performed manually, and functional tests will be written in detail.

Test Objectives

- All field entries must work properly.
- Pages must be activated from the identified link.
- The entry screen, messages and responses must not be delayed.

4.4.3.2 Integration Testing

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects. The task of the integration test is to check that components or software applications, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

4.4.3.3 Acceptance Testing

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

5 Result and Analysis

The project aims to find if data tampering can be minimized using Decision Support System and Simulation techniques in logistics by adhering to the current rules made by the International Maritime Organization.

5.1 Analysis: Systematic Literature Review

The SLR was intended to find gaps between DSS and Simulation in the field of logistics. The information collected henceforth was planned to be used in the development of Simulation model developed later as the experiment.

However, the concept of VGM is new in the field of research and can only be understood in depth after the case study. So, the discussion about VGM has been presented there. Discussion about DSS has been presented in this section.

Decision Support Systems (DSS) are a specific class of computerized information systems that supports business and organizational decision-making activities [25]. A properly designed DSS considered in this thesis to be an interactive software-based system which is intended to help decision makers compile useful information from raw data, documents, personal knowledge, and/or business models to identify and solve problems and make decisions [26].

Typically, information that is required for decision support application would be:

- Accessing all of your current information assets, including legacy and relational data sources, cubes, data warehouses, and data marts [27].
- Comparative sales figures between one week and the next [27].
- Projected revenue figures based on new product sales assumptions [27].
- The consequences of different decision alternatives, given past experience in a context that is described [27].

The people who are in a position to solve structuring errors are usually upper managers of some kind [28].With DSS, there's an extreme focus on solutions that are not only adaptable to changes in environment but are flexible and facilitate easier decision making. Decision support systems help those in positions of authority compile enough information to make an informed decision about changes in policy, implementation and so forth. Data included in such a system usually covers things like inventory, projected cycles of revenue based on trends in sales and comparative figures in sales from one cycle to the next [28].

An example where DSS can be applied is the case of Verified Gross Mass, which has gained enormous attention lately due to the concerns of safety, such as heavy containers falling, or hurting and even killing workers.

5.2 Analysis: Interviews

The interviews made with different personnel suggest that new authentication methods would be an advantage to our case.

Q1. What were the previous techniques of weighing containers?

Analysis: It can be deduced from the interviews that there have been different techniques for weight measurement in practice and there was no proper authentication for that as well. I think this is where data tampering would have been most possible as there are many hands involved in the processes and having no proper proof of the weight of container would be an asset to tamper with the data.

Q2. How different are the methods from the new ideas of weighing?

Analysis: Prior to the new rules set up by IMO, there was no concept of Verified Gross Mass or any particular way to measure the containers apart from the weight bridge method. So, it is analyzed that the new ideas of weighing can be considered as very different from the original idea.

Q3. Do you think it is a good idea to suddenly make changes in policies that have been in practice by the whole industry of logistics for years? Please support your choice.

Analysis: It can understand that though the new method is very different from the primitive methods, it is ultimately for the Safety of Life at Sea. Statistics show that there has been a lot of life loss because the weight carried by containers is much more than they allowed weight on it. And, if this can be resolved, around 7% of the loss can be stopped, which is a good step and a supportive motivation to the change in policies.

Q4. How are you(professionally) coping with the new rules by the International Maritime Organization with respect to the SOLAS act?

Analysis: From the answers given by personnel in the interview, it can be procured that coping with the new rules is a lot difficult than it is given on paper. There are people who are not very well-versed with new technology, so something understandable by everyone would be suitable to make it is easier for them.

There is no need to implement separate lift and drop or more complex weighbridge-based processes. This gives ports and terminals the opportunity to obtain a VGM for each container without any additional operational cost If a container turns up to a terminal without a verified weight it cannot be loaded onto the vessel [29]. By installing a container weighing system on site, any potential issues of containers being stranded at the terminal need not be a worry.

Q5. Has it been difficult to adapt to the new techniques? Please motivate your answer with a why/how.

Analysis: According to the new regulation, at least in principle, on what needs to be done to achieve compliance, it is also unambiguous on who is ultimately responsible: Container VGM determination can be subcontracted to a third party by the shipper, but the shipper remains responsible for regulatory compliance.

Under the SOLAS requirements, the shipper named on the ocean bill of lading is the party responsible for providing the maritime (ocean) carrier (master) and the terminal operator (terminal representative) with the verified gross mass of a packed container. The carrier and the terminal operator must not load a packed container aboard a ship unless they have the verified gross mass for that container [29].

Due to the complexity of the international supply chain, the entity identified as the shipper on the bill of lading may not have direct or physical control over key elements of the process by which verified gross mass is determined. A shipper in such circumstances should be aware of their responsibilities and ensure that arrangements are in place to obtain and provide a verified gross mass in compliance with these international and national regulations [29].

Q6. Can you think of any other possible suggestions or improvements in the current weighing system that could have been better with respect to the SOLAS act?

Analysis: From the interviews taken, it is seen that almost everyone is satisfied with the current regulations with respect to the weighing system and data tampering. So, developing this can be a priority soon for further researches.

Q7. Do you think weight tampering of containers is still happening, even with the new rules in action?

Analysis: As an international issue, SOLAS regulations state that VGM weighing equipment, for both method one and two solutions, must meet national certification and calibration requirements. There is no provision in SOLAS for any margin of error. Shippers using compliant weighing equipment and procedures will obtain VGM values that are well within any national tolerances adopted for enforcement purposes.

So, when there are any tampering situations happening, it would be taken in as a criminal offense and is therefore, suggestible that such things are avoided as much as possible.

The new ruling will be officially enforced by the maritime authorities of individual nations, whose implementing regulations will vary depending on country and region [29]. The real-world enforcement seems most likely to be carried out directly by the container lines and terminal operators, who are obligated not to load a container without the certified VGM document accompanying it. National enforcement agencies may implement measures to satisfy themselves that compliance is achieved, which could include documentation checks, auditing or random weight checks.

Compliance with this obligation by the carrier and terminal operator may result in commercial and operational penalties, such as delayed shipment and additional costs if the shipper has not provided the verified gross mass for the packed container. As a commercial issue, penalties may involve repacking costs, administration fees for amending documents, delayed or cancelled shipments [29].

Q8. In your opinion, why does weight tampering happen. Could you please state your reasons and any ideas on how it can be controlled?

Analysis: From analysis of the answers, it can conclude that there is different reason for the case. Some of which can still not be contained by the organizations; but reportedly, they state that there is an improvement which is a huge relief to many officials, as they can avoid being in clumsy situations due to the regulations from IMO.

Q9. Please give any suggestions you can think of about authentication mechanisms for the database to prevent weight tampering issues.

Analysis: There have been different suggestions that were given by the personnel based on their real time experiences in the field. Ultimately, there are two things that should receive the maximum focus of all issues. First, the SOLAS rules require the shipper to communicate the verified gross mass as part of an official shipping document. It must be signed by a person duly authorized by the shipper, with a first and last name, not just a company name. The signature may be an electronic signature or may be replaced by the name in capitals of the person authorized to sign it [29]. The second, the VGM and signature can be part of the shipping instructions communicated via electronic data interchange (EDI), or be contained within a separate communication including a hard copy document [29]. In either case, the document should clearly highlight that the gross mass provided is the verified gross mass.

5.3 Analysis: Experiment

Simulation:

The Simulation was performed by developing a web-based application to check if there is any possibility to avoid data tampering during the transportation of the containers. The application was developed and implemented. The researcher presented only 2 cases in this document i.e.,

- When the loaded container weight is higher than the weight submitted by the shipper.
- When the loaded container has weight lesser than the weight submitted by the shipper.

The initial steps in both the cases involve registering the shipper and the port details in the portal. Once the shipper has given the clearance from port they can start exporting and importing containers. In case of exporting a container, the shipper must first add the container details such as container id, total capacity, dimensions and tare weight of the container. A table of the portal requesting the container details is presented in below.

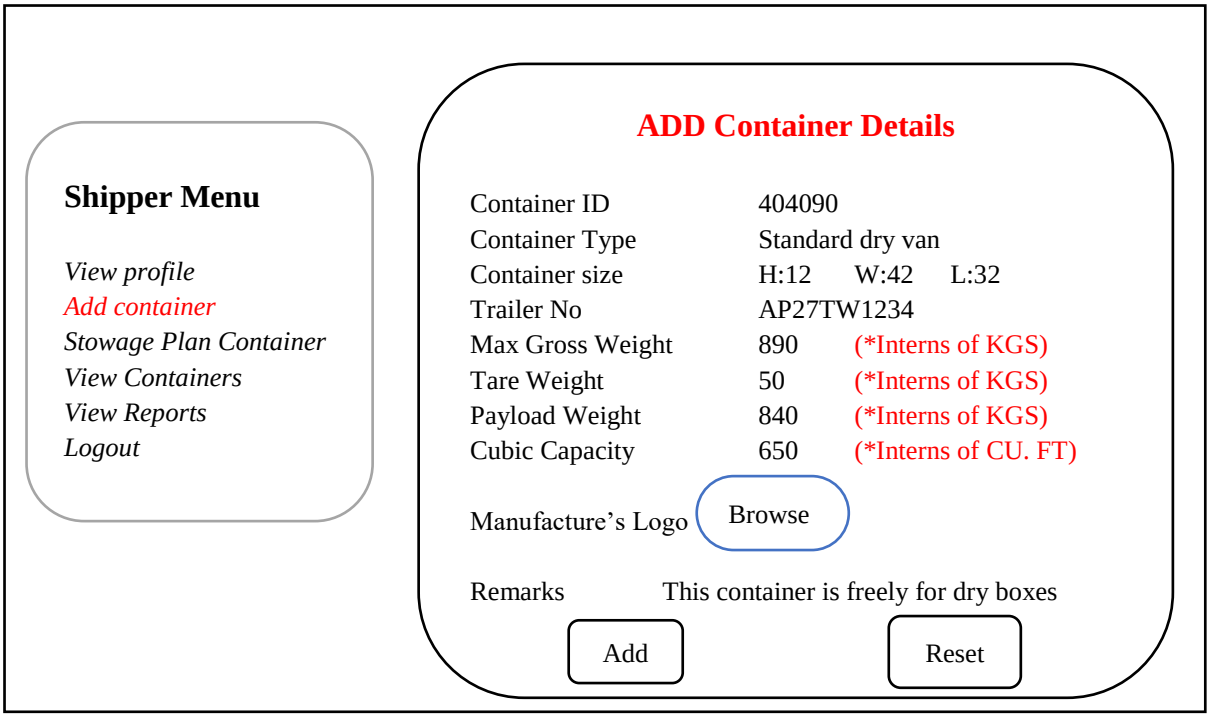


Table 5.1: Updating container details

Once the Container details are added to the portal, the container can be used by the shipper to export/import items to/from various ports. The shipper then must present the details of the items being exported such as the item being sent, weight of the items and the number of cartons of each item. The portal requesting the stowage plan of the container is presented in table 5.2 below.

Shipper Menu

View profile
Add container
Stowage Plan Container
View Containers
View Reports
Logout

Stowage Plan for container ships

Please enter container ID Find Details

Search Results

Max Gross Weight	890	(*Interns of KGS)
Tare Weight	50	(*Interns of KGS)
Payload Weight	840	(*Interns of KGS)
Cubic Capacity	650	(*Interns of KGS)

Port ID 684866(Raviraja)

List of Cartons in the container (349213)

Packing Material	Weight (in Kg's)	Description	No. of Cartons
Chemicals	200	Very sensitive	23
Metal Goods	150	Keep in care	15
Jewellery	100	Keep in care	12
Rubber Goods	50	Very sensitive	19
Paper Goods	40	Keep in care	18
Clothing	30	Keep in care	13

Save Stowage Plan

Table 5.2: Stowage plan for the contents in the container

Case 1: Weight of loaded Container at terminal is more than the weight submitted or tampered by the shipper or port.

Port Menu

View profile
Export Container
Import Containers
View Shipper
Logout

List of Cartons in The Container (404090)

Gross Weight: 890 Kg's	Tare Weight: 50 Kg's	Payload Weight: 840 Kg	Cubic Capacity: 650 CU.
Packing Material	**Weight (in Kg's)**	**Description**	**No. of Cartons**
Chemicals	200	Very sensitive	23
Metal Goods	150	Keep in care	15
Jewellery	100	Keep in care	12
Rubber Goods	50	Very sensitive	19
Paper Goods	40	Keep in care	18
Clothing	30	Keep in care	13

Verify Container Weight

Table 5.3: Received Container details from Shipper at the port

Port Menu

View profile
Export Container
Import Containers
View Shipper
Logout

Tally the Cartons in The Container

Gross Weight: 890 Kg's	Tare Weight: 50 Kg's	Payload Weight: 840 Kg	Cubic Capacity: 650 CU.
Packing Material	**Weight (in Kg's)**	**Description**	**No. of Cartons**
Chemicals	200	Very sensitive	23
Metal Goods	150	Keep in care	15
Jewellery	100	Keep in care	12
Rubber Goods	70	Very sensitive	23
Paper Goods	60	Keep in care	20
Clothing	40	Keep in care	14

Export Container

Table 5.4: Port updating Cargo details

As show in the above *tables 5.3&5.4*, the shipper should enter the details of the cargo that will be loaded into the container for shipping portal into the system. In the same way port

must cross check the details with the shipping material that they received from the shipper and should enter the data into the port portal. Sometimes data tampering can be done either by shipper or port. In both the case the data entered will be monitored at the terminal before the container make it way to the ship.

After filling the container goods details in the system, the port exports container to the designated port by selecting the Export container option, the below shown window pops up where the port personal can select the details of the importing port and then upload the container details into the system.

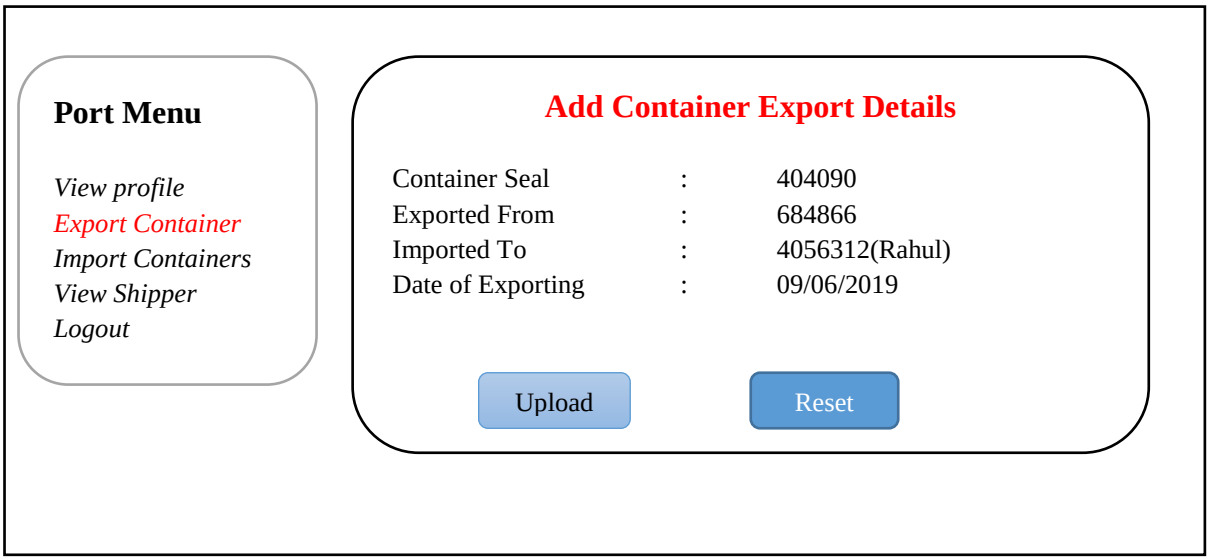


Table 5.4.1: Port Uploading Container details to terminal

The details received from shipper and port will be sent to the terminal where the system tally's if the details given by the concerned parties are same or tampered. If the system identifies any excess cargo, then it immediately alerts the terminal by displaying the "Overload" warning. It also displays the difference in weight from the shipper and the port. Then the terminal puts the package status in "*hold"* and it will redirect the package to the port to sort out the issue.

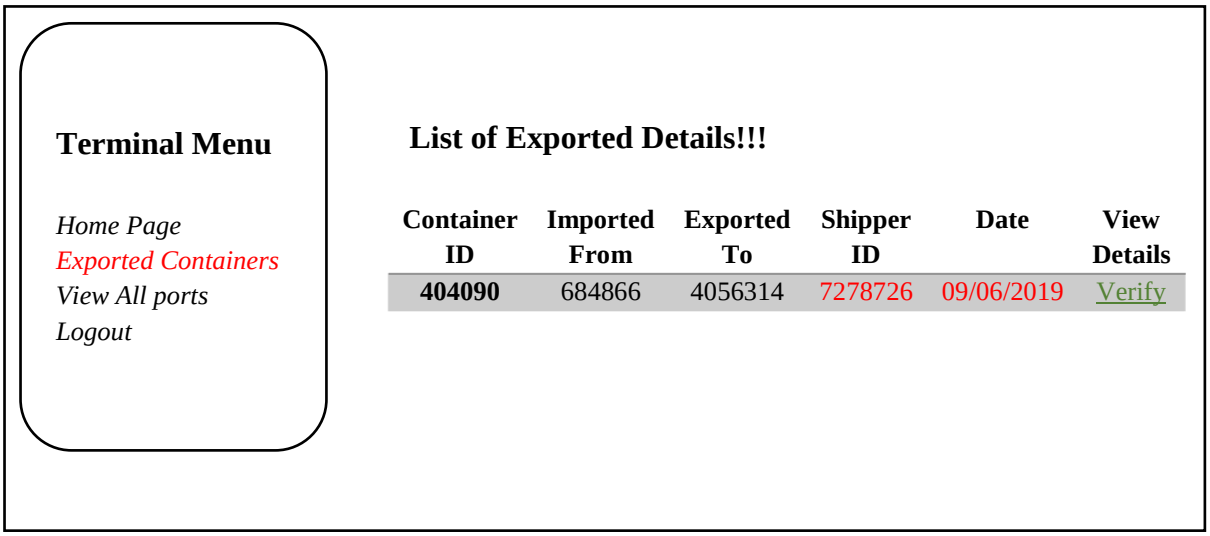


Table 5.5: Terminal receiving container details

Terminal Menu

Home Page
Exported Containers
View All Ports
Logout

Port Imported Container Details

Packing Material	Weight (in Kg's)	Description	No. of Cartons
Chemicals	200	Very sensitive	23
Metal Goods	150	Keep in care	15
Jewellery	100	Keep in care	12
Rubber Goods	70	Very sensitive	23
Paper Goods	60	Keep in care	20
Clothing	40	Keep in care	14

Shipper Imported Container Details

Packing Material	Weight (in Kg's)	Description	No. of Cartons
Chemicals	200	Very sensitive	23
Metal Goods	150	Keep in care	15
Jewellery	100	Keep in care	12
Rubber Goods	50	Very sensitive	19
Paper Goods	40	Keep in care	18
Clothing	30	Keep in care	13

Container ID	:	404090	Imported weight at port:	620Kg's
Container Size	:	12*13*32	Actual Weight at shipper:	570Kg's
Tare weight	:	50Kg's	Weight Difference:	**-50Kg's**
Container Type	:	High cube dry van	No. of Cartons at Port:	107
Trailer No	:	AP28TW1234	No. of Cartons at Shipper:	100
Max Gross Weight:		890Kg's	Container status:	**Overload**
Pay load Weight	:	840Kg's		
Cubic Capacity	:	650 CU FT		

Table 5.5.1: System displaying over weighed container to port

After the container is sent back, port personal can check the details of the container by logging into the portal under “Overloaded container Details” section.

Port Menu

View Profile
Export Containers
Import Containers
View Shippers
Logout

List of Overloaded Container Details!!!

Packed By	Exported To (Port)	Container ID	Date	Status
684866	4056314	404090	09/06/2019	Overload

Missing Packed Material Container Details!!!

Packed By	Exported To (Port)	Container ID	Date	Status

Table 5.6: Port verifying the overloaded container details

Purpose: In this case the system detects data tampering by identifying the overloaded container. It prevents the overloaded container from boarding the ship, which is the prime purpose of this project.

Case 2: Weight of loaded Container at terminal is less than the weight submitted by the shipper.

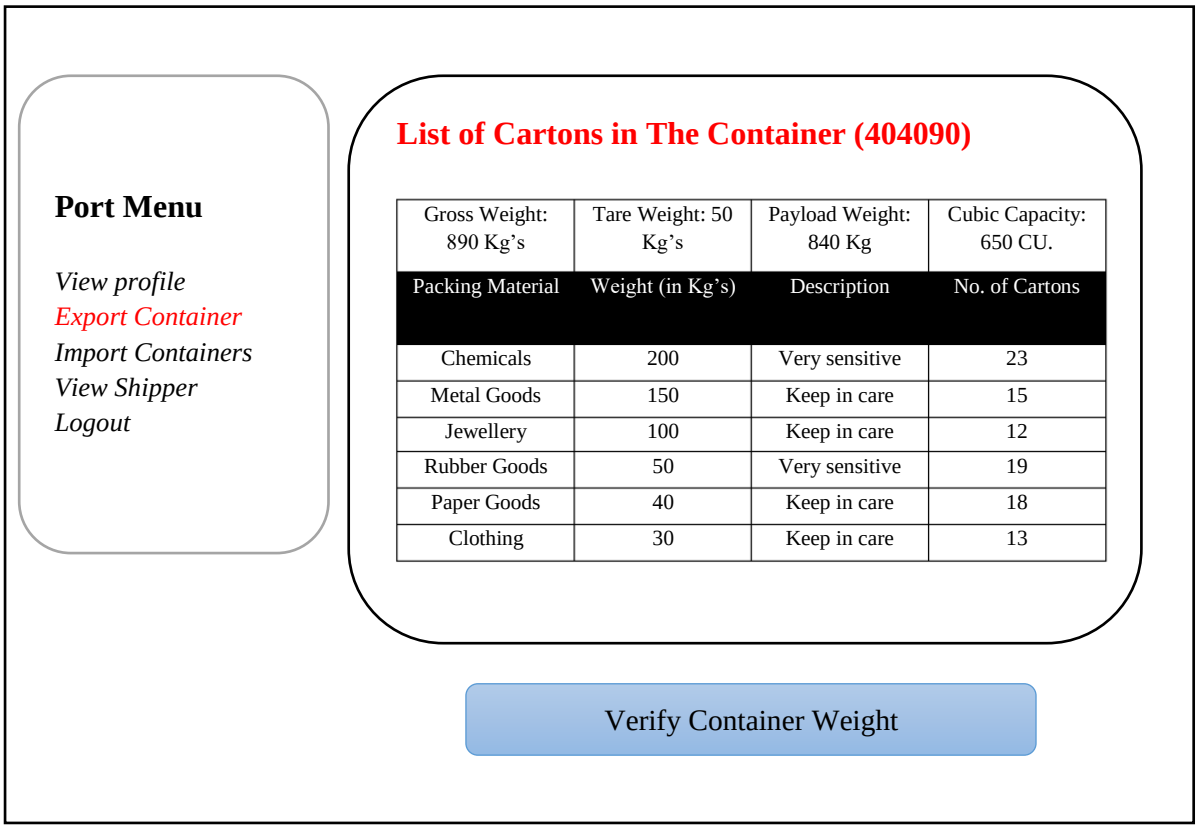


Table 5.7: Received Container details from Shipper at the port

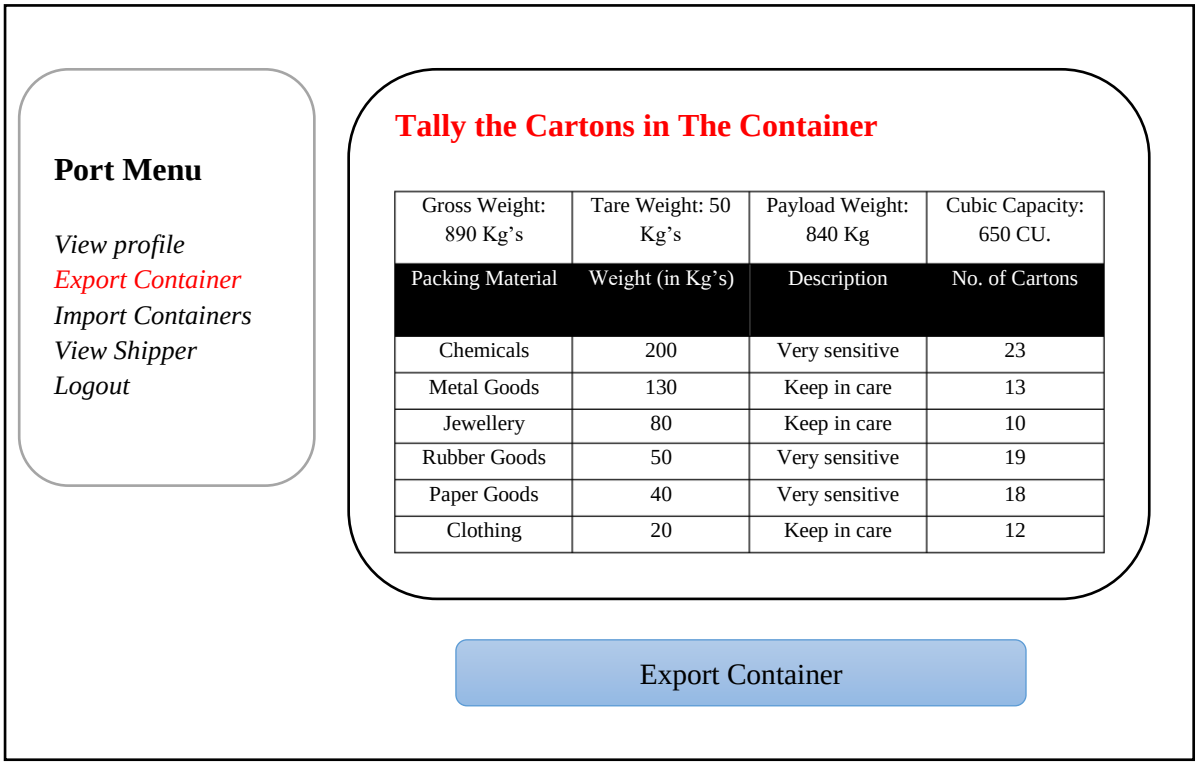


Table 5.8: Port updating Cargo details

As show in the above *Table 5.7&5.8,* after registering into the system and providing the container details the shipper should enter the details of the cargo into the system. The same way the port must cross check the details with the shipping material that they received from the shipper and should enter that data into the system.

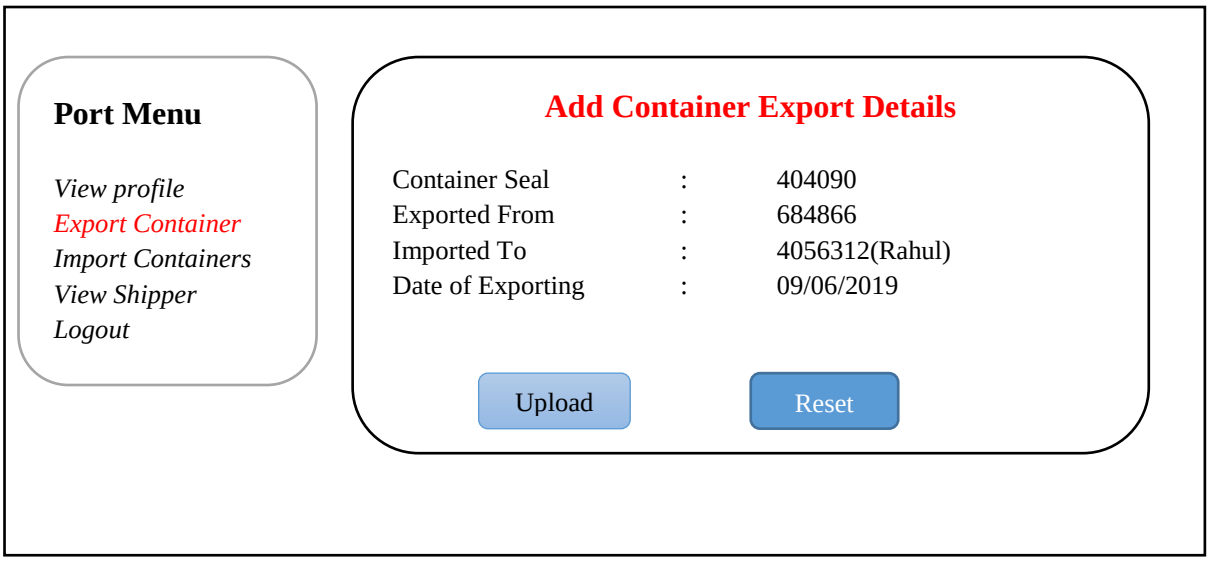


Table 5.8.1: Port Uploading Container details to terminal

After updating all the details of the container, the port personal adds the container in the exporting list by selecting the export container option in the portal. As show in table 5.8.1, port personal uploads the container by selecting the option provided in the portal

The data received from shipper and port will be sent to the terminal where the system tally's if the details given by the concerned parties are same or not. If the system identifies any missing cargo, then it immediately alerts the shipmaster by displaying the "*Packing Materials Missing*" it also displays the difference in weight from the shipper and the port. Then the terminal must redirect the package to the port to sort out the issue.

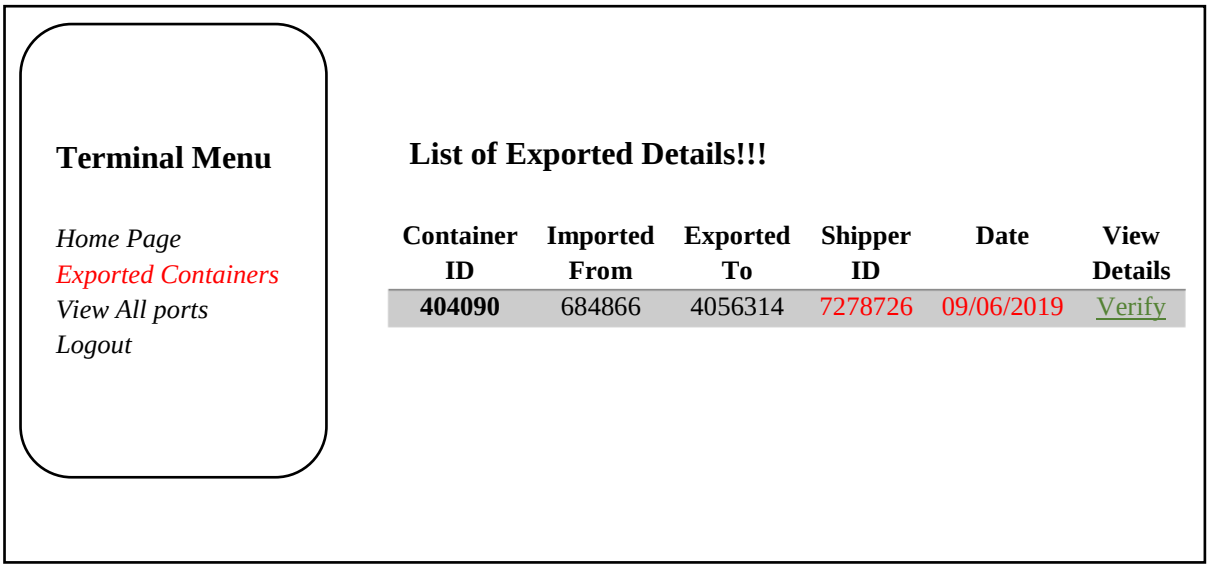


Table 5.9: Terminal verifying container details

Terminal Menu

Home Page
Exported Containers
View All Ports
Logout

Port Imported Container Details

Packing Material	Weight (in Kg's)	Description	No. of Cartons
Chemicals	200	Very sensitive	2
Metal Goods	150	Keep in care	3
Jewellery	100	Keep in care	4
Rubber Goods	50	Very sensitive	5
Paper Goods	30	Very sensitive	6
Clothing	20	Keep in care	2

Shipper Imported Container Details

Packing Material	Weight (in Kg's)	Description	No. of Cartons
Chemicals	200	Very sensitive	23
Metal Goods	150	Keep in care	2
Jewellery	100	Keep in care	12
Rubber Goods	50	Very sensitive	1
Paper Goods	40	Very sensitive	2
Clothing	30	Keep in care	3

Container ID	:	404090	Imported weight at port:	520Kg's
Container Size	:	12*13*32	Actual Weight at shipper:	570Kg's
Tare weight	:	50Kg's	Weight Difference:	**50Kg's**
Container Type	:	Standard dry van	No. of Cartons at Port:	95
Trailer No	:	Ap28TW1234	No. of Cartons at Shipper:	100
Max Gross Weight:		890Kg's	Container status:	**Package Materials Missing**
Pay load Weight	:	840Kg's		
Cubic Capacity	:	650 CU FT		

Table 5.9.1: Terminal displaying missing packages in the container

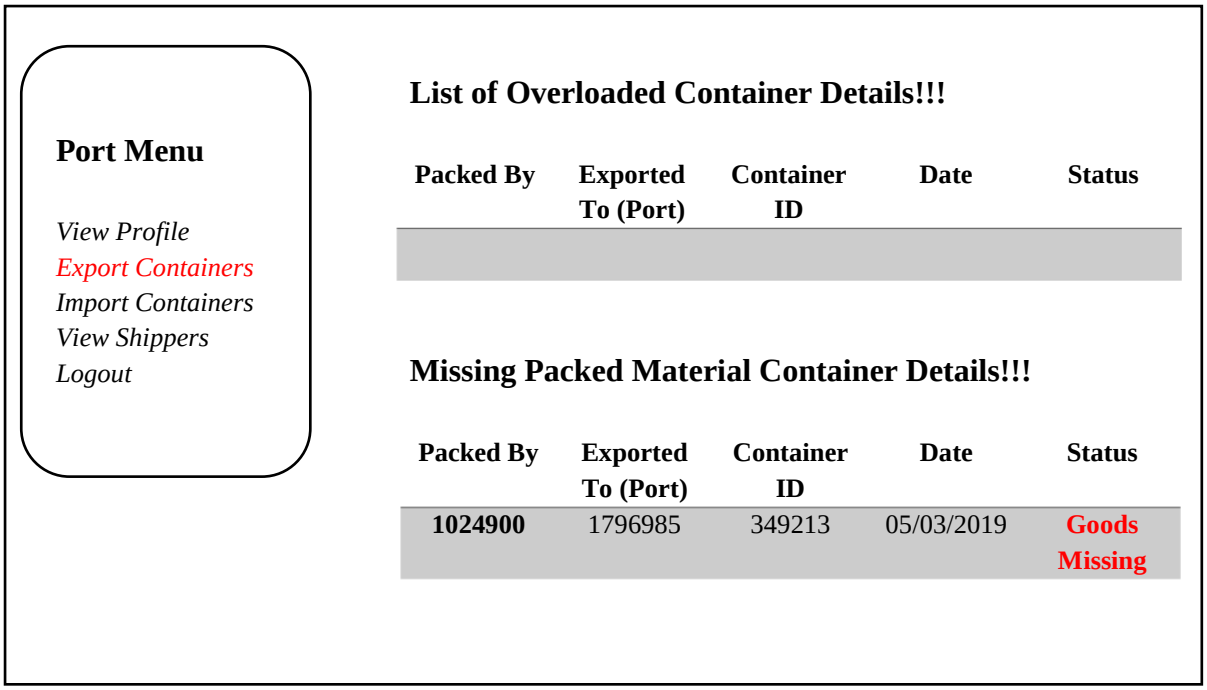


Table 5.10: Port verifying the Missing goods container details

In the Table 5.10 the details of the container that came back from terminal for missing good container can be viewed by the port personal under "Missing Packed Material Container Details!!!" To sort out the issue, port and shipper should recheck all the details and make sure not miss any details and reenter the in the system.

Purpose: This method not only detects data tampering but helps in sorting cargo missing issues in the port.

General Case:

If all the data received from shipper and port are same, then "*Allowed to ship*" message will be displayed in the system. Then the terminal allows the container to be exported and forward the container details to shipmaster as shown in below table5.11*:*

Terminal Menu

Home Page
Exported Containers
View All Ports
Logout

Port Imported Container Details

Packing Material	Weight (in Kg's)	Description	No. of Cartons
Chemicals	200	Very sensitive	23
Metal Goods	150	Keep in care	15
Jewellery	100	Keep in care	12
Rubber Goods	50	Very sensitive	19
Paper Goods	40	Keep in care	18
Clothing	30	Keep in care	13

Shipper Imported Container Details

Packing Material	Weight (in Kg's)	Description	No. of Cartons
Chemicals	200	Very sensitive	23
Metal Goods	150	Keep in care	15
Jewellery	100	Keep in care	12
Rubber Goods	50	Very sensitive	19
Paper Goods	40	Keep in care	18
Clothing	30	Keep in care	13

Container ID	:	404090	Imported weight at port:	570 Kg's
Container Size	:	12*13*32	Actual Weight at shipper:	570 Kg's
Tare weight	:	50Kg's	Weight Difference:	**0 Kg's**
Container Type	:	Standard dry van	No. of Cartons at Port:	10
Trailer No	:	Ap28TW1234	No. of Cartons at Shipper:	43
Max Gross Weight:		890Kg's	Container status:	**Allowed to Ship**
Pay load Weight	:	840Kg's		
Cubic Capacity	:	650 CU FT		

Table 5.11: system displaying the exporting container details

In the below table 5.11.1, the terminal is uploading the container to the shipmaster for exporting by filling the required details in the portal after successfully verifying the container.

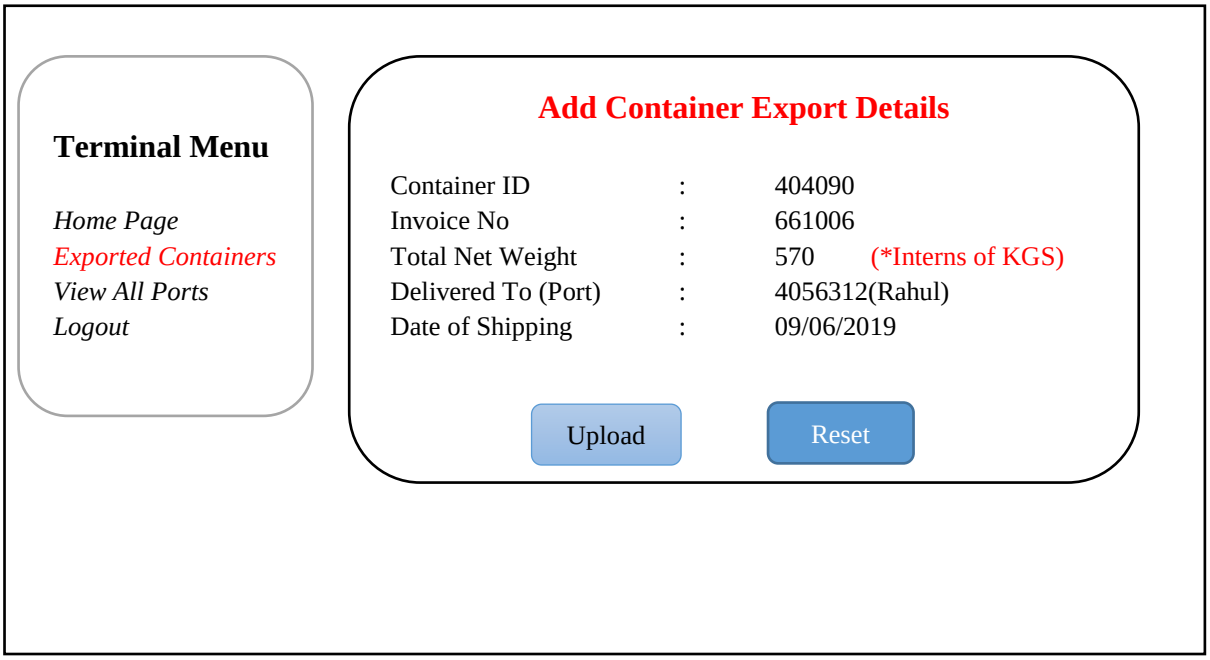


Table 5.11.1: Terminal uploading Container details to Ship Master

The shipmaster can verify the details of the container that is to be exported by logging into *"ship master login page"* providing the credentials give to him. After logging into the system, he can fetch the details of the container under "List of Exported Container Details" section and view the invoice of the container as show below.

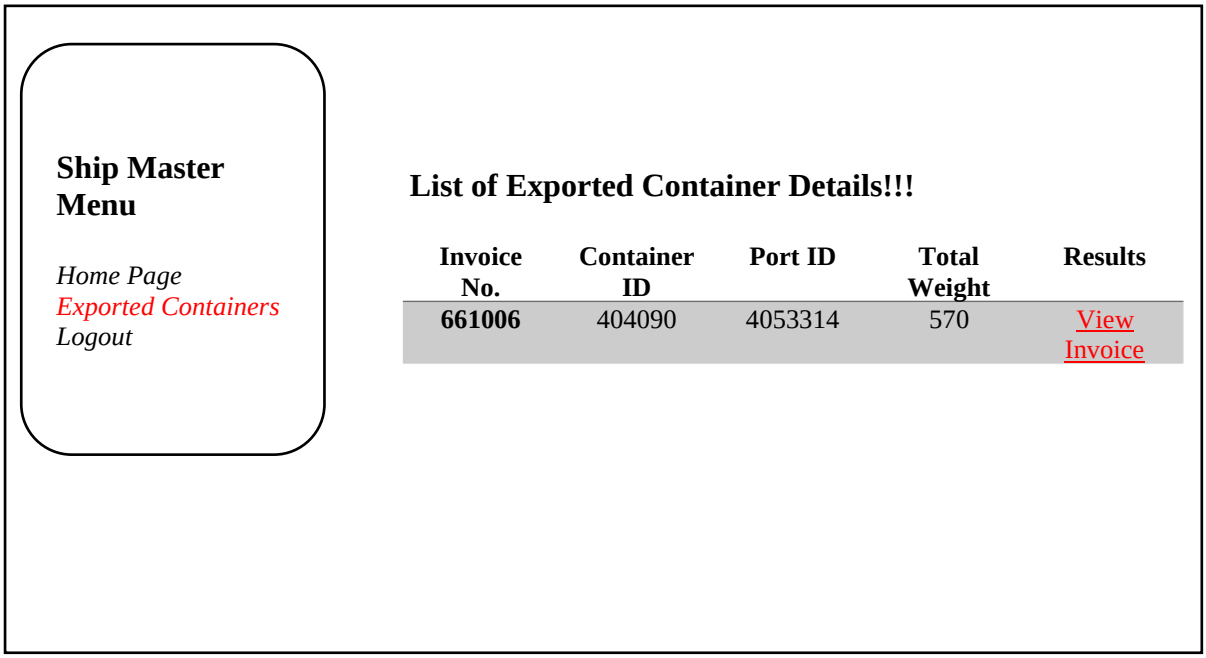
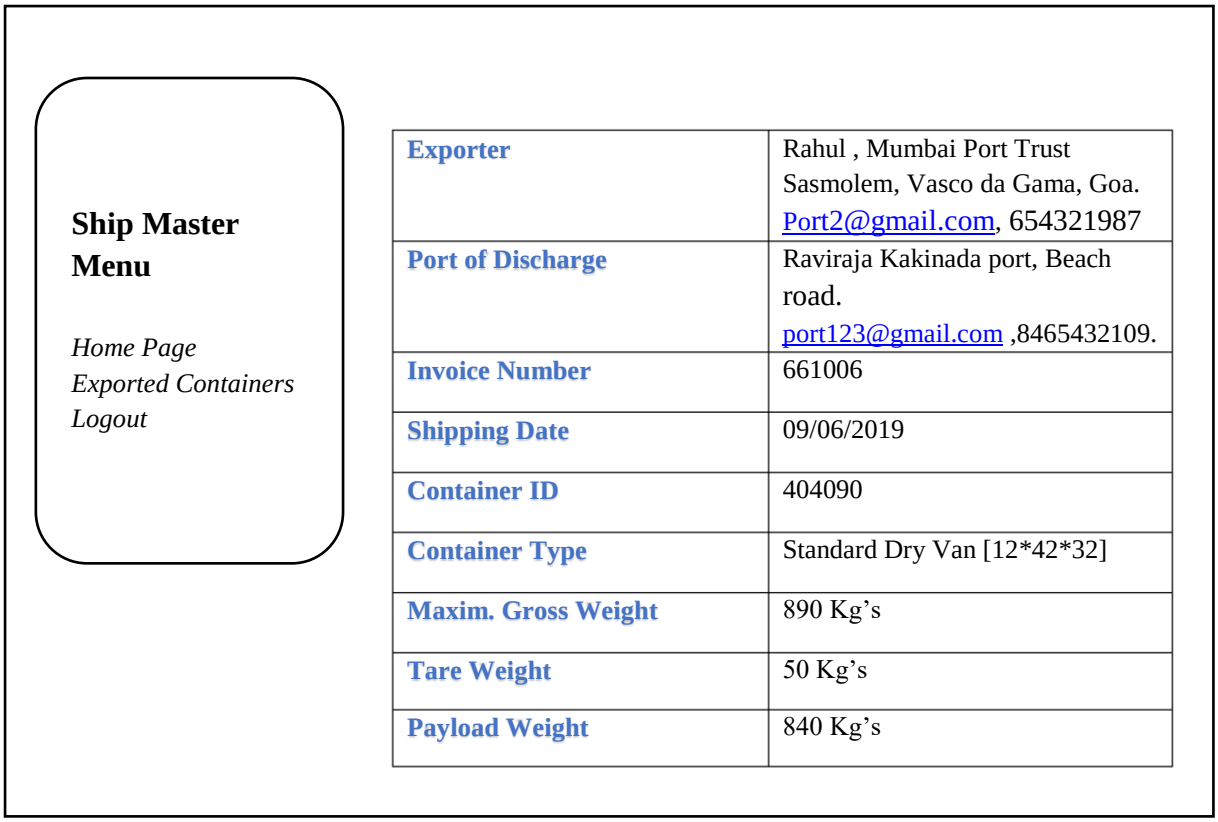


Table 5.12: Ship Master verifying the details of the Exporting Containers



Exporter	Rahul , Mumbai Port Trust Sasmolem, Vasco da Gama, Goa. Port2@gmail.com, 654321987
Port of Discharge	Raviraja Kakinada port, Beach road. port123@gmail.com ,8465432109.
Invoice Number	661006
Shipping Date	09/06/2019
Container ID	404090
Container Type	Standard Dry Van [12*42*32]
Maxim. Gross Weight	890 Kg's
Tare Weight	50 Kg's
Payload Weight	840 Kg's

Table 5.13: Ship Master viewing the details of container

Container Delivery:

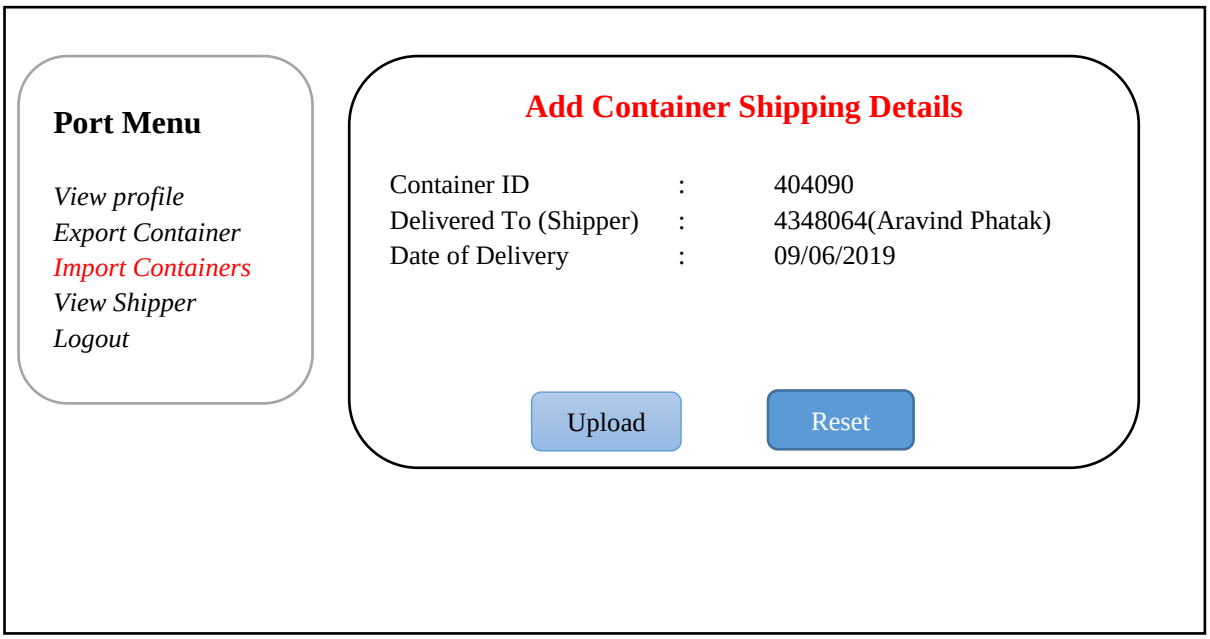


Table 5.14: Port 2 updating the delivery details of the imported container

After receiving the container at the destination port, the container is all set to be delivered to the consigned party by updating the details of the receiver.

Conclusion: Thus, the system developed can handle multiple process that are happening in the port and store all the data in the database.

5.4 Feasibility Study

The feasibility of the project is analyzed in this phase and a business proposal is put forth with a very general plan for the project and some cost estimates. During system analysis, the feasibility study of the proposed system is to be carried out. This is to ensure that the proposed system is not a burden to the company. For feasibility analysis, some understanding of the major requirements for the system is essential[30].

Three key considerations involved in the feasibility analysis are

- Economic Feasibility
- Technical Feasibility
- Social Feasibility

ECONOMICAL FEASIBILITY

This study is carried out to check the economic impact that the system will have on the organization. The amount of fund that the company can pour into the research and development of the system is limited[30]. The expenditures must be justified. Thus, the developed system as well within the budget and this was achieved because most of the technologies used are freely available. Only the customized products had to be purchased.

TECHNICAL FEASIBILITY

This study is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand on the available technical resources. This will lead to high demands on the available technical resources. This will lead to high demands being placed on the client[30]. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

SOCIAL FEASIBILITY

The aspect of study is to check the level of acceptance of the system by the user. This includes the process of training the user to use the system efficiently. The user must not feel threatened by the system, instead must accept it as a necessity. The level of acceptance by the users solely depends on the methods that are employed to educate the user about the system and to make him familiar with it[30]. His level of confidence must be raised so that he is also able to make some constructive criticism, which is welcomed, as he is the final user of the system.

6 Conclusion and Future Work

6.1 Conclusion

Decision support systems are a set of tools made to assist in decision-making activity. This project shows DSS and Simulation can help the current scenario in logistics. The new rules concerning VGM at ports has bought critical changes in working at the port area. we have simplified this by implementing a web - application using DSS and Simulation(Support Vector Machine). The developed model is a solution to most of the "what if..." scenarios in the field of logistics with respect to describing container weights. To make the project more usable, the developed model can be linked with the weight equipment to directly register the weight would help identify data tampering by more accurately tracking the weights and it also save time to the port.

6.2 Future Work

Based on the analysis, there are certain changes that could be done to the application to make it more advanced and accurate. The following are some of the feature that can be added in the system for further development of the project.

- Linking this application to the weighing equipment in the port to record the values directly can help the application run more accurately.
- Also, adding a section to record the max baring capacity of a ship depending on the route it travels can also minimize the risk of getting over weight.

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Annexure A:

T_Verification.jsp

```
<%@ page import="java.sql.*"%>
<%@ include file="connect.jsp" %>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<meta http-equiv="Content-Type" content="text/html; charset=utf-8" />
<!--
        Template 2047 Brown Field
        by www.tooplate.com
-->
<title>PPI : List Users</title>
<meta name="keywords" content="" />
<meta name="description" content="" />
<link href="css/tooplate_style.css" rel="stylesheet" type="text/css" />

   <script type="text/javascript" src="js/swfobject.js"></script>
        <script type="text/javascript">
      var flashvars = {};
      flashvars.xml_file = "photo_list.xml";
      var params = {};
      params.wmode = "transparent";
      var attributes = {};
      attributes.id = "slider";
      swfobject.embedSWF("flash_slider.swf", "flash_grid_slider", "440", "220", "9.0.0",
false, flashvars, params, attributes);
   </script></head>
<body>

<div  style="width:610px;">
  <!-- end of forever header -->
  <div id="tooplate_main">
     <div style="width:600px;">
          <div class="post_box">  <div style="background: #00a9ff;border: 1px solid
red;border-radius: 20px;width: 600px;height:280px;">

                        <%
                                String username =
(String)application.getAttribute("uname");
                        String sid = (String)session.getAttribute("sid");
                                application.setAttribute("imageuname", username);
                            int count1=0;int count2=0;int count3=0;int count4=0;
                %>

                <form action="portweighing1.jsp" method="post">
```

Annexure A:

```
<h2 align="center">Port Imported Container Details:-</h4>
 <table align="left"   border="1">

          <tr bgcolor=#333333 align="center" style="color: white">
          <th align="center">Packing Material </th>
          <th align="center">Weight (in Kg's)</th>
       <th align="center">Description</th>
       <th align="center">No.of Cartons</th>

   </tr>

    <%   //name, userid, pass, mail, age, loc, sex, time_
       String
u=null,st=null,en=null,intr=null,dot=null,dy=null,nop=null,sta=null,toc=null,key=null;
       String tid=request.getParameter("mid");
Statement st1=connection.createStatement();

ResultSet rs1 = st1.executeQuery("select * from upload where id='"+tid+"'");
if(rs1.next()){
   session.setAttribute("pid",rs1.getString("source"));
   session.setAttribute("cid",rs1.getString("containerid"));
   session.setAttribute("sid",rs1.getString("shipperid"));
}

Statement st11=connection.createStatement();
ResultSet rs11 = st11.executeQuery("select * from portcontainers where
portid='"+(String)session.getAttribute("pid")+"' and
containerid='"+(String)session.getAttribute("cid")+"'");
while(rs11.next()){
                  count1=count1+rs11.getInt(3);
                  count3=count3+rs11.getInt(5);
 %>
 <tr>
 <td> <input type="text" name="a1"  value="<%=rs11.getString(2)%>" readonly
onkeyup="alp1(this)" onkeydown="alp1(this)" />  </td>
       <td> <input type="text" name="b1" value="<%=rs11.getString(3)%>" readonly
onkeyup="num(this)" onkeydown="num(this)"/>  </td>
       <td> <input type="text" name="c1"  value="<%=rs11.getString(4)%>" readonly
onkeyup="alp1(this)" onkeydown="alp1(this)" />  </td>
       <td> <input type="text" name="d1" value="<%=rs11.getString(5)%>" readonly
onkeyup="num(this)" onkeydown="num(this)"/>  </td>
      </tr>
       <%} %>


 </table></div><BR>
  <div style="background:darkorange;border: 1px solid red;border-radius: 20px;width:
600px;height:280px;">

<h2 align="center">Shipper Imported Container Details</h4>
```

Annexure A:

```
<table align="left"   border="1">

        <tr bgcolor=#333333 align="center" style="color: white">
        <th align="center">Packing Material </th>
        <th align="center">Weight (in Kg's)</th>
      <th align="center">Description</th>
      <th align="center">No.of Cartons</th>

   </tr>

    <%
    Statement st111=connection.createStatement();
ResultSet rs111 = st111.executeQuery("select * from stowageplans where
shipperid='"+(String)session.getAttribute("sid")+"' and
id='"+(String)session.getAttribute("cid")+"'");
while(rs111.next()){
count2=count2+rs111.getInt(3);count4=count4+rs111.getInt(5);
    %>
        <tr>
      <td> <input type="text" name="a1"  value="<%=rs111.getString(2)%>" readonly
onkeyup="alp1(this)" onkeydown="alp1(this)" />  </td>
      <td> <input type="text" name="b1" value="<%=rs111.getString(3)%>" readonly
onkeyup="num(this)" onkeydown="num(this)"/>  </td>
      <td> <input type="text" name="c1"  value="<%=rs111.getString(4)%>" readonly
onkeyup="alp1(this)" onkeydown="alp1(this)" />  </td>
      <td> <input type="text" name="d1" value="<%=rs111.getString(5)%>" readonly
onkeyup="num(this)" onkeydown="num(this)"/>  </td>
     </tr>
      <%}%>
</table>
  </div><BR>
   <div style="background: greenyellow;border: 1px solid red;border-radius: 20px;width:
600px;height:370px;">

<h4></h4>
   <table bgcolor="" cellpadding="5" align="left" cellspacing="5" width="630"
border="0">

    <%
    Statement st1111=connection.createStatement();
ResultSet rs1111 = st1111.executeQuery("select * from containers where
containerid='"+(String)session.getAttribute("cid")+"');
while(rs1111.next()){

    %>

        <tr>
      <td>Container ID:</td>
      <td> <input type="text" name="a1" value="<%=rs1111.getString(1)%>" readonly
onkeyup="alp1(this)" onkeydown="alp1(this)" />  </td>
```

```
      <td>Imported Weight at Port:</td>
      <td> <%=count1%> KG's </td>

      </tr>
    <tr>
      <td>Container Size:</td>
      <td> <input type="text" name="a1" value="<%=rs1111.getString(3)%>" readonly
onkeyup="alp1(this)" onkeydown="alp1(this)" />  </td>
       <td>Actual Weight at Shipper:</td>
      <td> <%=count2%> KG's </td>
      </tr>
       <tr>
      <td>Tare Weight:</td>
      <td> <input type="text" name="a1" value="<%=rs1111.getString(6)%> KG's"
readonly  onkeyup="alp1(this)" onkeydown="alp1(this)" />  </td>
      <td>Weight Difference:</td>
      <td> <font color="brown"><B><%=(count2-count1)%> KG's"<b></font></td>


    </tr>
    <tr>
      <td>Container Type :</td>
      <td> <input type="text" name="a1"  value="<%=rs1111.getString(2)%>" readonly
onkeyup="alp1(this)" onkeydown="alp1(this)" />  </td>
      <td>No.of Cartons at Port :</td>
     <td> <%=count3%> </td>
    </tr>
    <tr>
      <td>Trailer No:</td>
      <td> <input type="text" name="a1" value="<%=rs1111.getString(4)%>" readonly
onkeyup="alp1(this)" onkeydown="alp1(this)" />  </td>
      <td>No.of Cartons at Shipper :</td>
     <td> <%=count4%> </td>
    </tr>

    <tr>
      <td>Max Gross Weight:</td>
      <td> <input type="text" name="a1" value="<%=rs1111.getString(5)%> KG's"
readonly  onkeyup="alp1(this)" onkeydown="alp1(this)" />  </td>
      <%if(count2>count1){%>
       <td>Container Status :</td>
      <td><blink><font color="red"><B>Packing Materials
Missing</b></font></blink></td>
     <%Statement st3=connection.createStatement();  st3.executeUpdate("update upload set
status='missing' where status='waiting' and id='"+tid+"'");}else{if(count2<count1){%>
       <td>Container Status :</td>
      <td><blink><font color="red"><B>Overloading</b></font></blink></td>
      <%  Statement st3=connection.createStatement();  st3.executeUpdate("update upload
set status='Overload' where status='waiting' and id='"+tid+"'");}else{%>
     <td>Container Status :</td>
```

```
      <td><blink><a
href="allowedship.jsp?<%=(String)session.getAttribute("cid")%>"><font
color="brown"><B>Allowed to Ship</b></font></a></blink></td>
       <td> </td>
      <%Statement st3=connection.createStatement();  st3.executeUpdate("update upload set
status='allow' where status='waiting' and id='"+tid+"'");}}%>
    </tr>

       <tr>
       <td>Payload Weight:</td>
       <td> <input type="text" name="a1"  value="<%=rs1111.getString(7)%> KG's"
readonly onkeyup="alp1(this)" onkeydown="alp1(this)" />  </td>
       </tr>
     <tr>
       <td>Cubic Capacity:</td>
       <td> <input type="text" name="a1" value="<%=rs1111.getString(8)%> CU.FT"
readonly  onkeyup="alp1(this)" onkeydown="alp1(this)" />  </td>
       </tr>
       <%}%>
</table>
       </div>
                  </div>
</form>
          <div class="cleaner"></div>
  </div> <!-- end of main -->
 <div id="tooplate_main_bottom"></div>
</div> <!-- wrapper -->

</body>
</html>
```

Connect.jsp

```
<title>PPI : Database Connectivity</title><%@ page import="java.sql.*"%>
<%@ page import="java.util.*" %>
<%
        Connection connection = null;
        try {
                Class.forName("com.mysql.jdbc.Driver");
                connection =
DriverManager.getConnection("jdbc:mysql://localhost:3306/intelligent_decision","root","ro
ot");
        String sql="";
        }
        catch(Exception e)
        {
                System.out.println(e);
        }
%>
```

Annexure B:

Below are the Screen shots of the actual working of the developed web application in real-time:

Case 1: Weight of loaded Container at terminal is more than the weight submitted or tampered by the shipper or port.

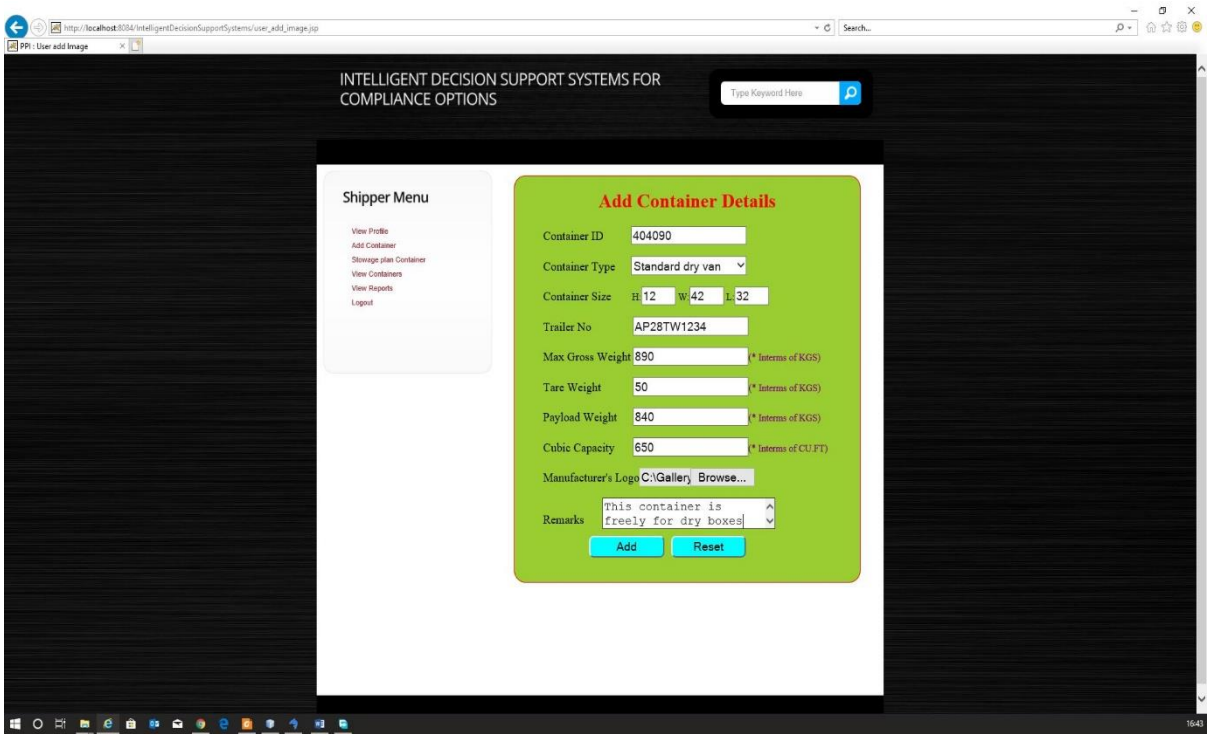

figure 1: Updating Container details

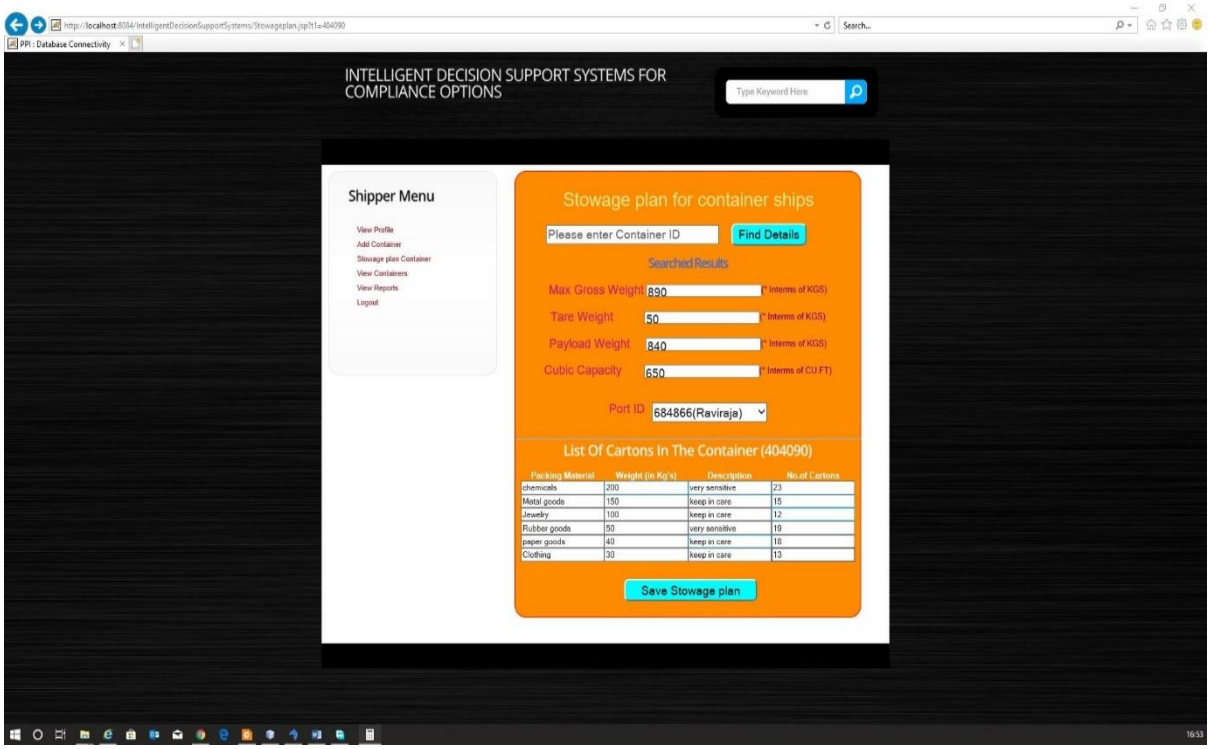

figure2: Stowage plan of the container

Annexure B:

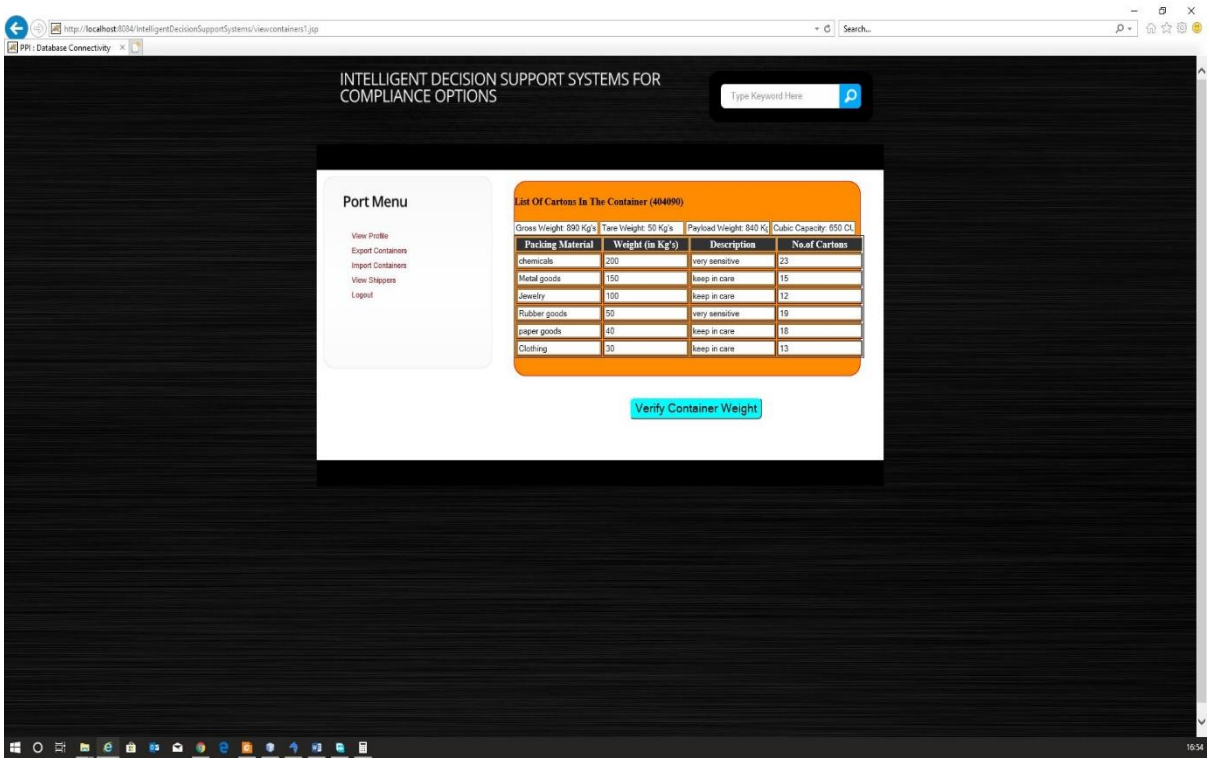

figure 3: Received Container details from Shipper at the port

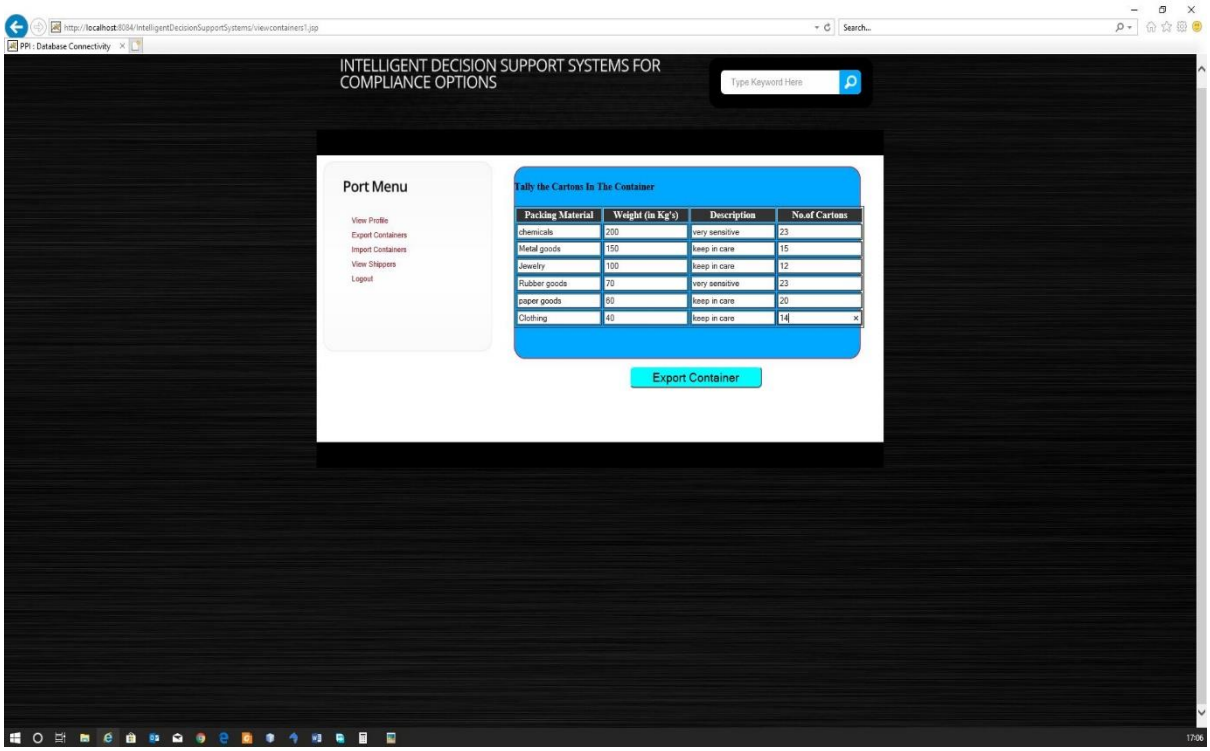

figure 4: Port updating container details

Annexure B:

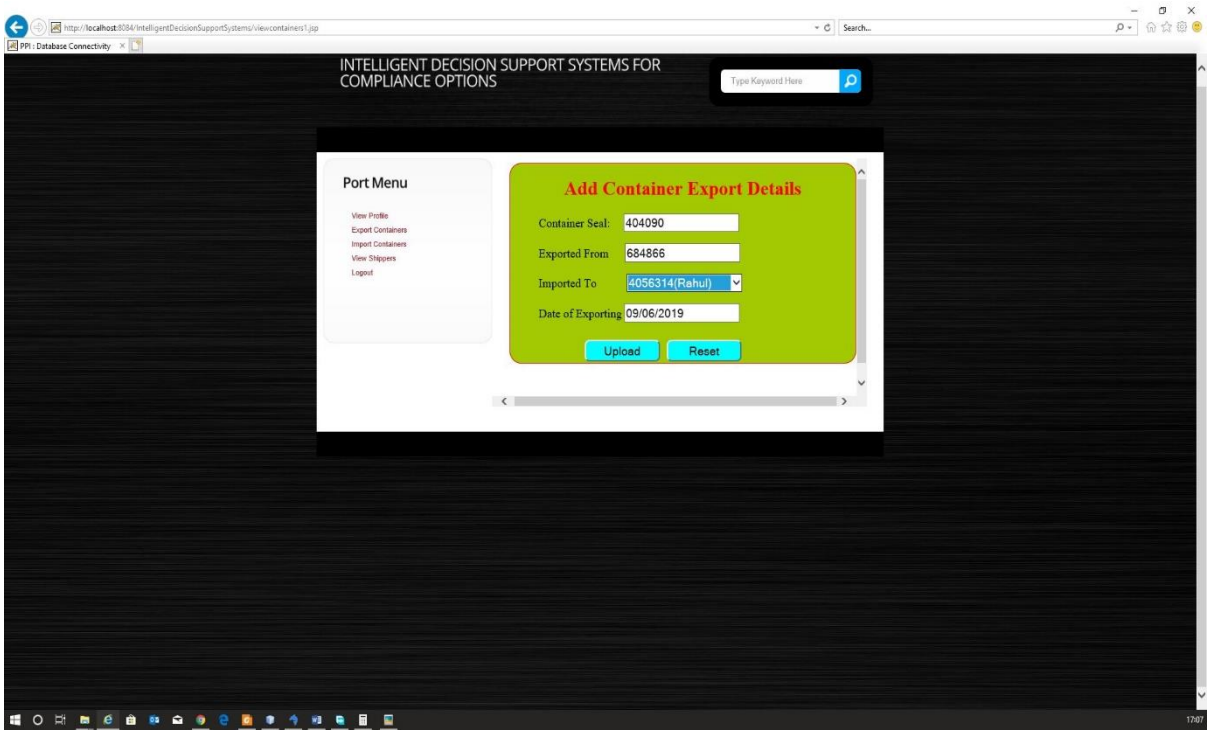

Figure 5: Port uploading container details to terminal

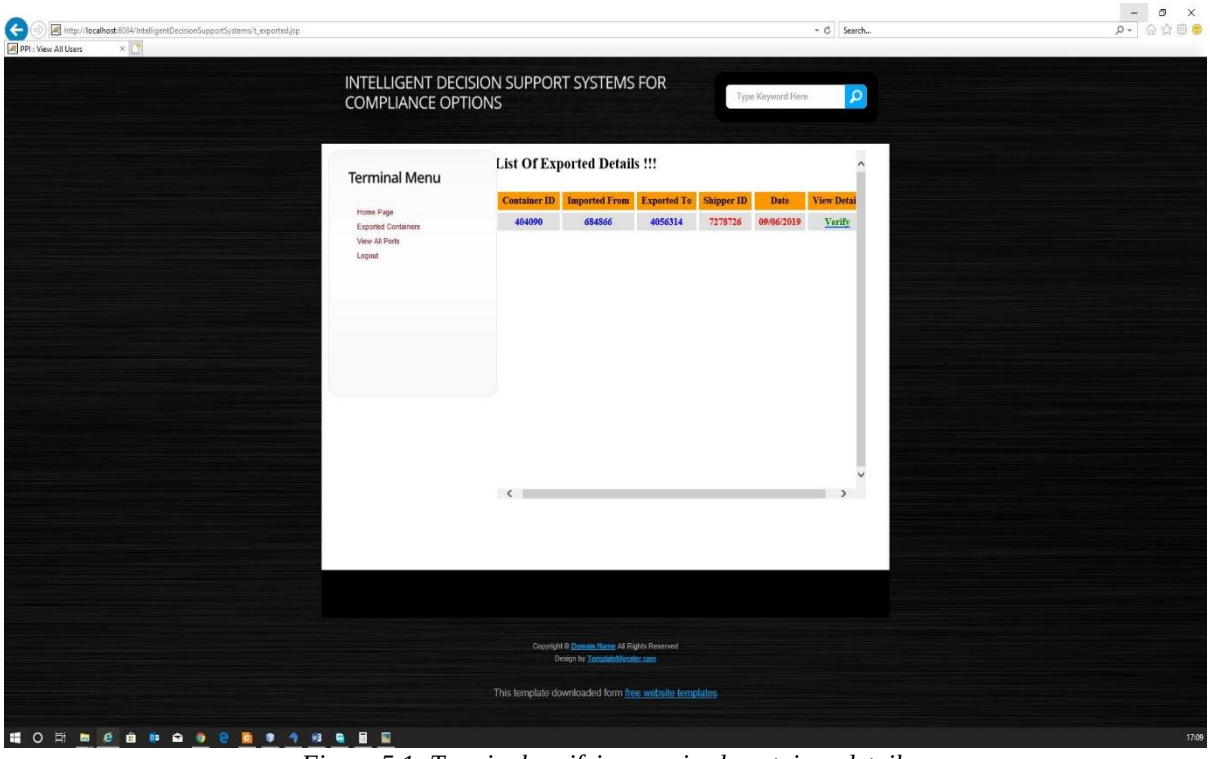

Figure 5.1: Terminal verifying received container details

Annexure B:

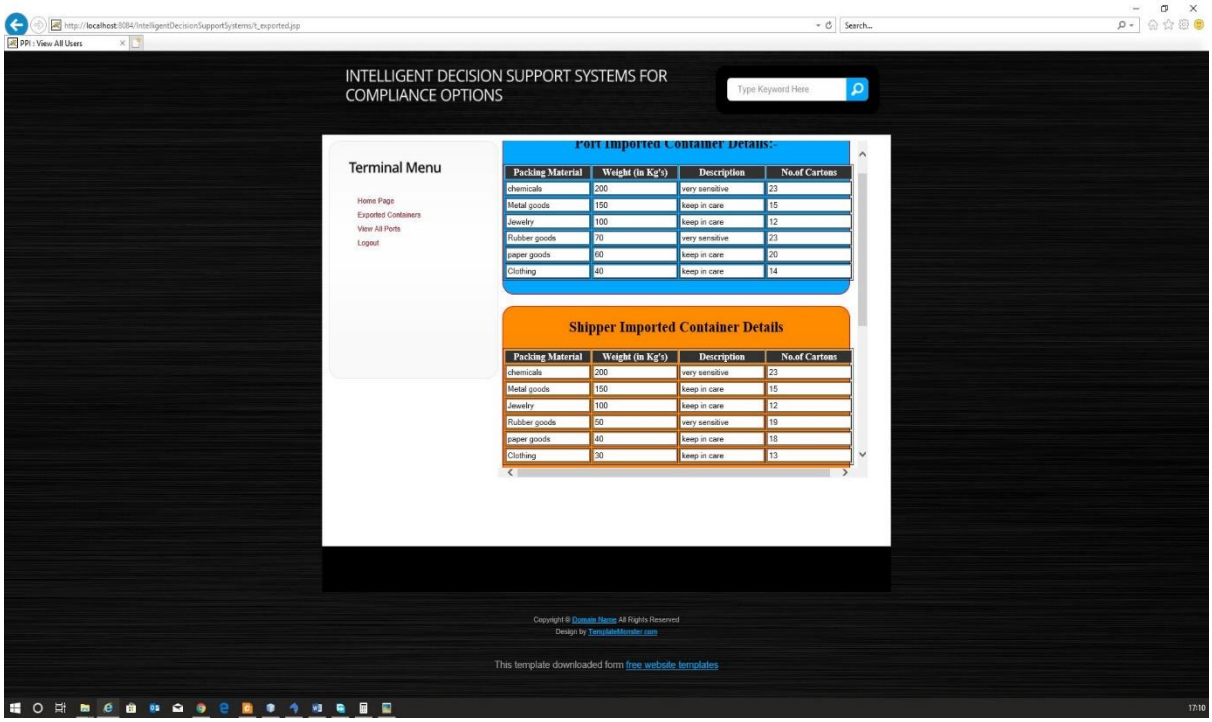

Figure 5.2: Details of container received form both shipper and port

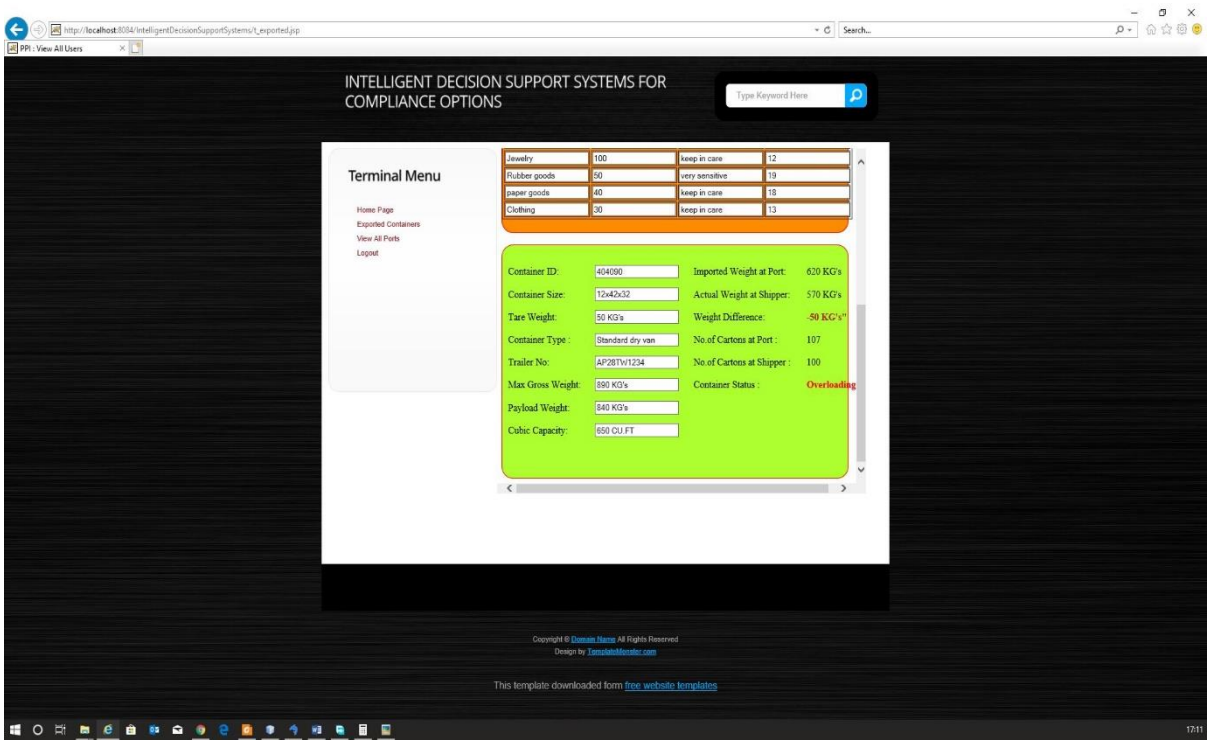

Figure 5.3: System displaying overload container with details

Annexure B:

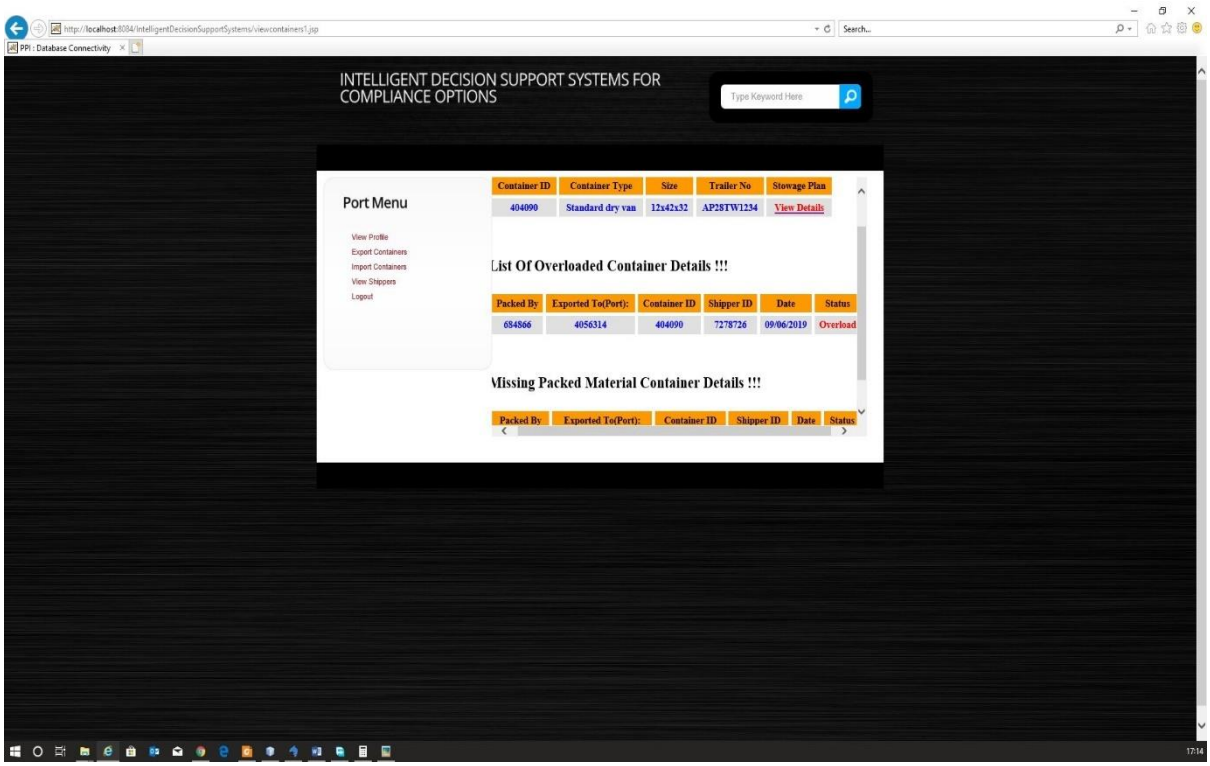

figure 6: Port verifying the details of the over weighed container

Case 2*:* Weight of loaded Container at terminal is less than the weight submitted by the shipper

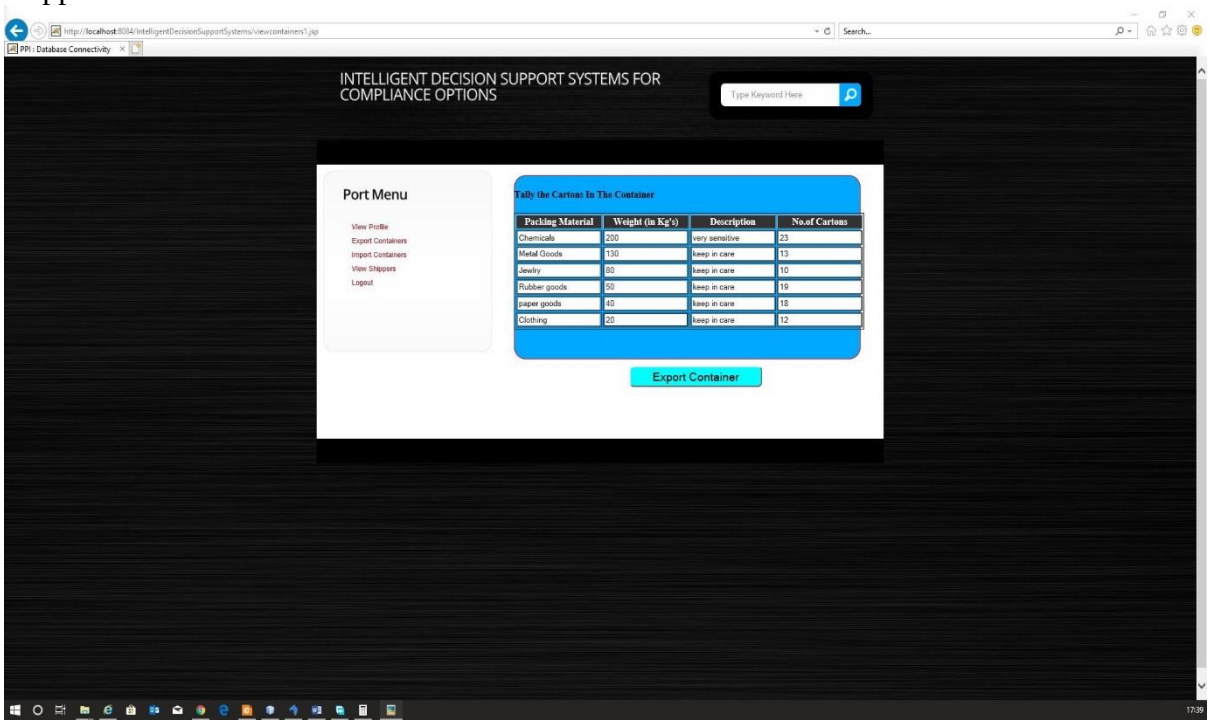

Figure 7: Port updating Cargo details

Annexure B:

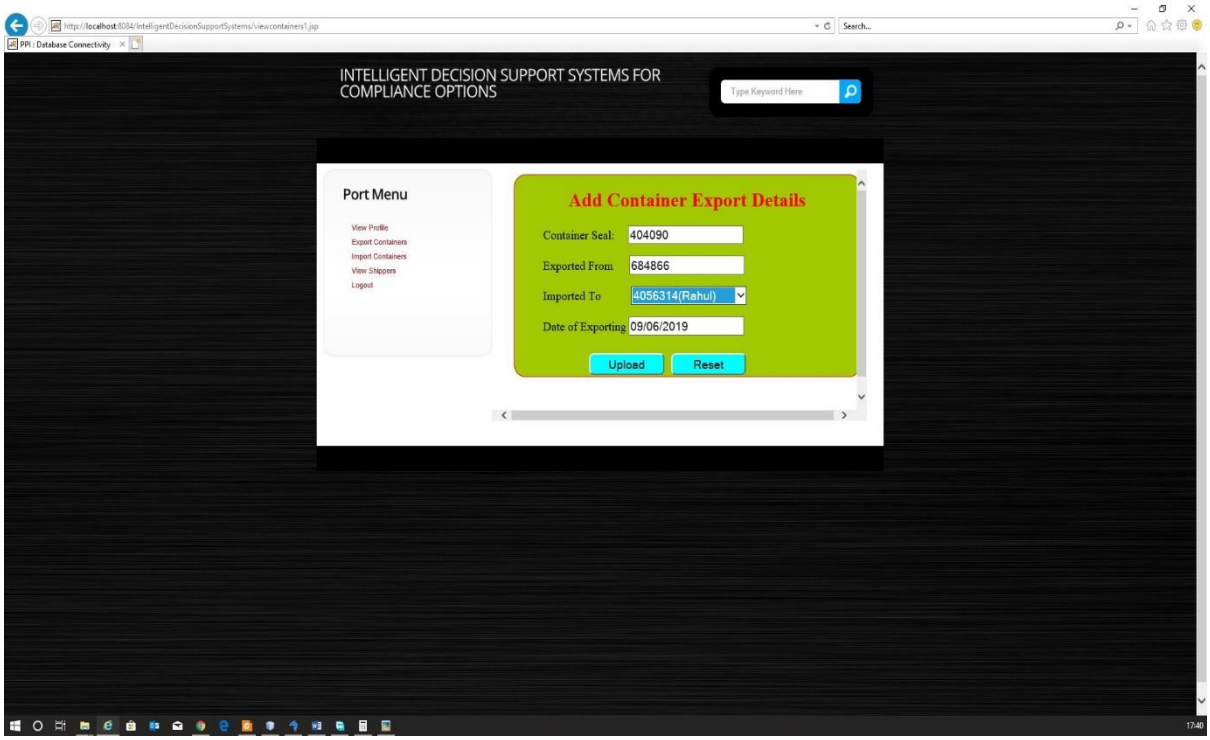

figure 8: Port Uploading Container details to terminal

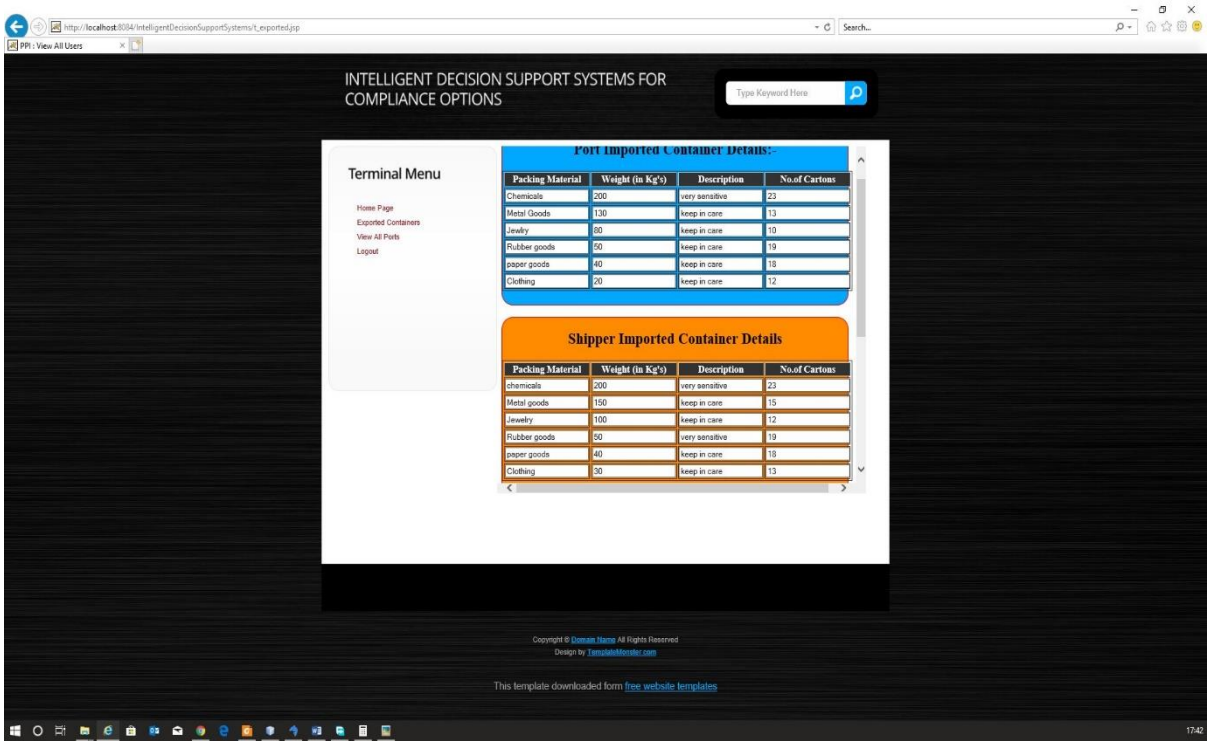

figure 9: Terminal verifying container details received

Annexure B:

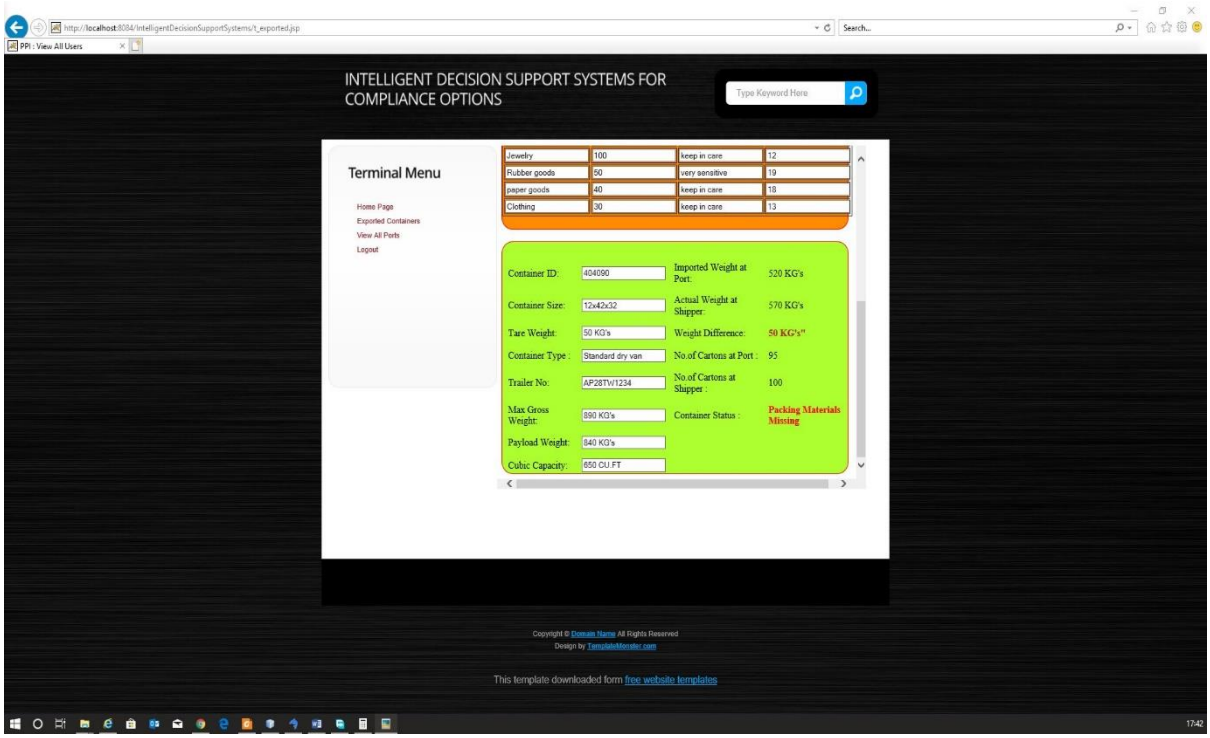

figure 9.1: Terminal displaying missing packages in the container

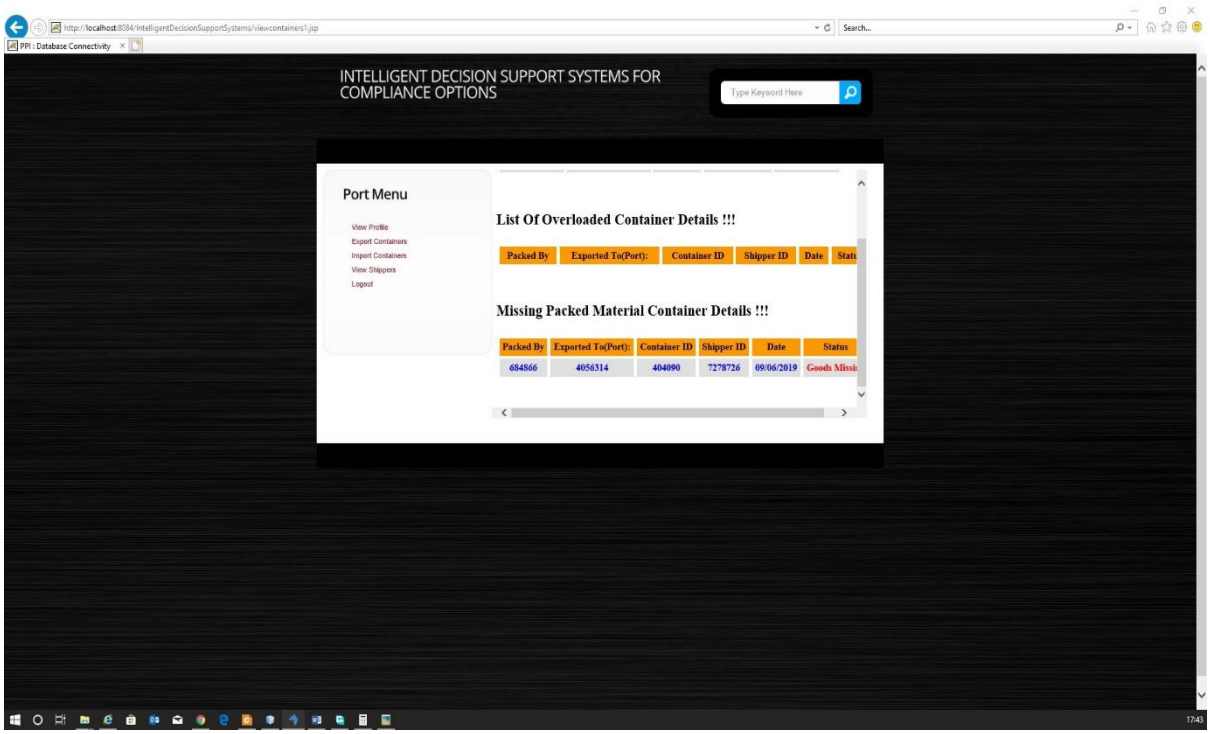

figure 10: Port verifying the Missing goods container details

General Case:

If all the data received from shipper and port are same, then "*Allowed to ship*" message will be displayed in the system. Then the terminal allows the container to be exported and forward the container details to shipmaster as shown in *below figure 11*.

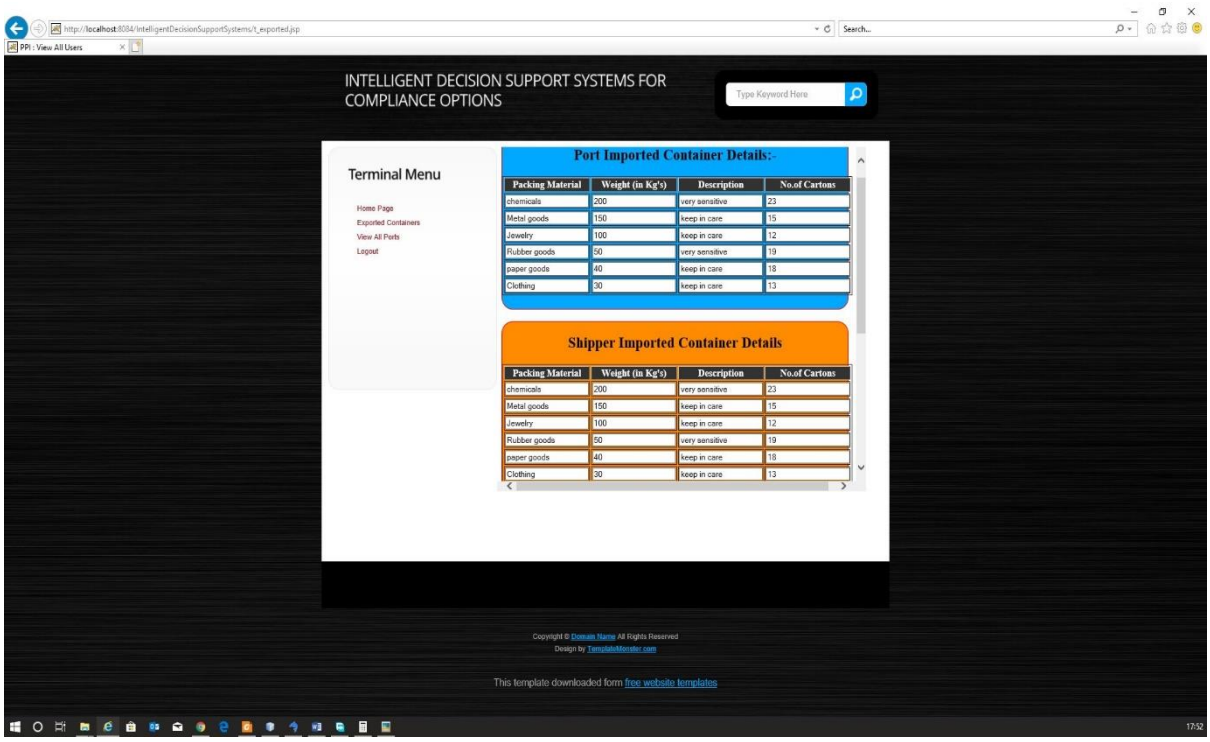

figure 11: *system displaying the exporting container details*

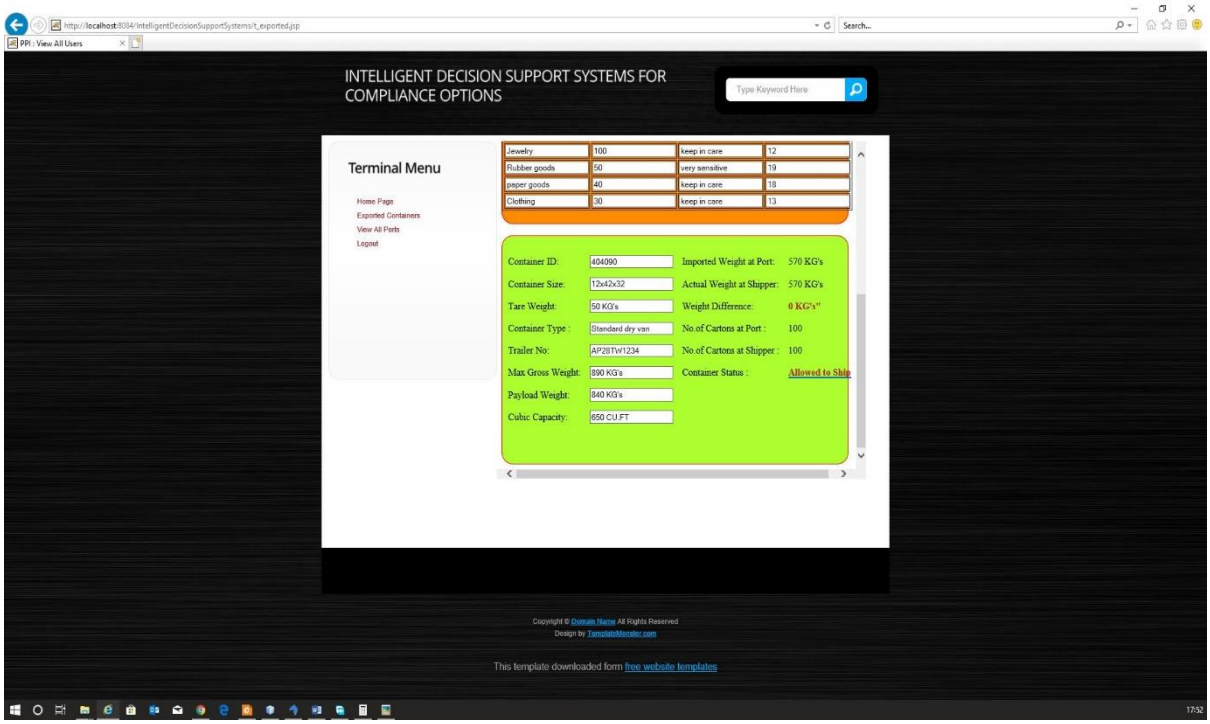

figure 11.1: Terminal giving clearance to the container for shipping

Annexure B:

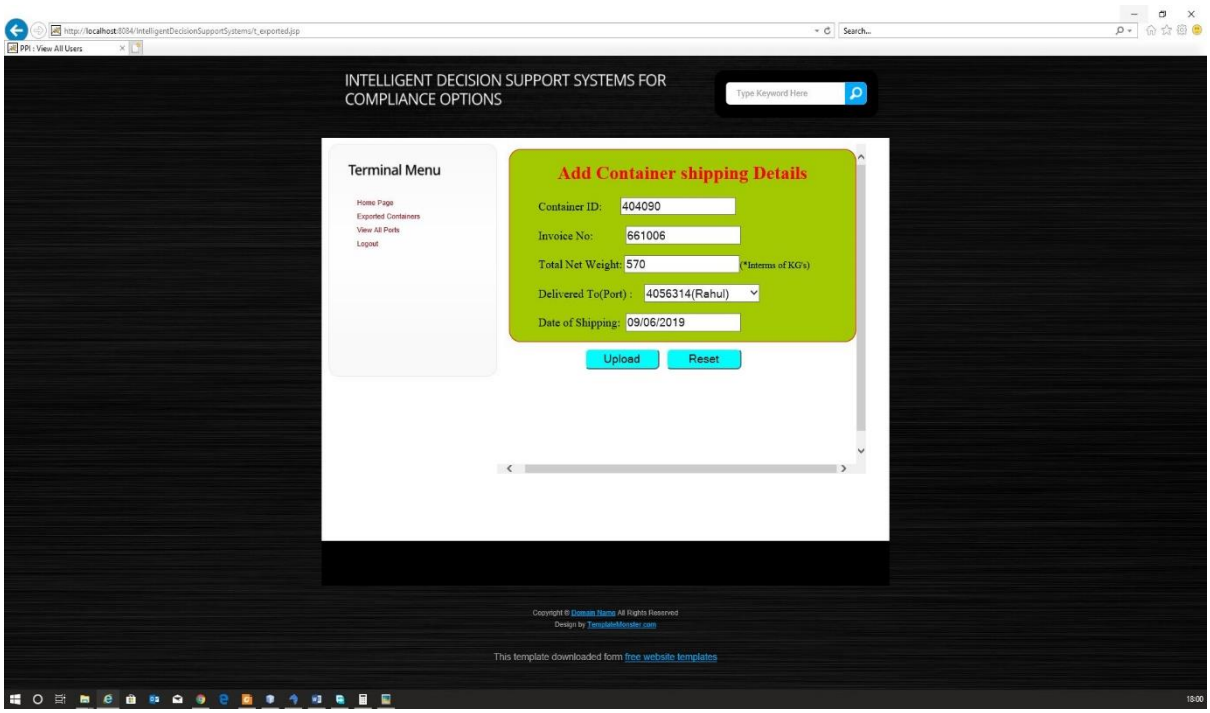

figure 12: Terminal forwarding the container to shipper master for export

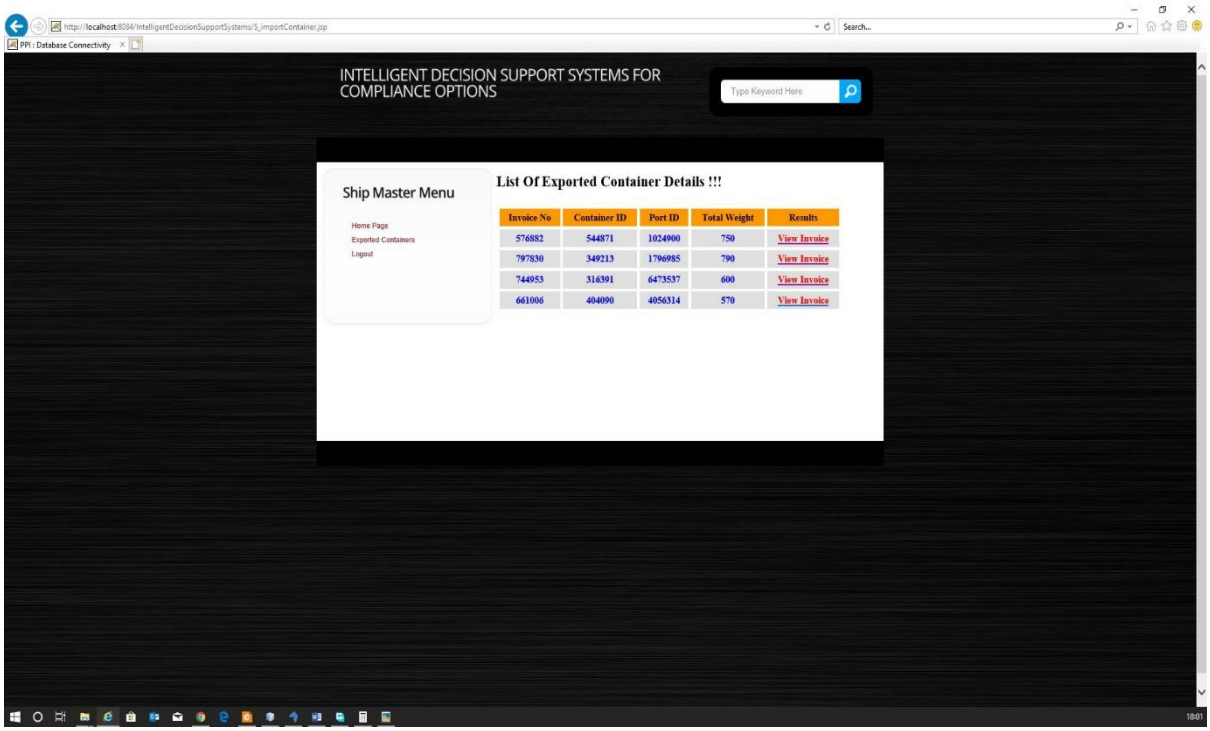

figure 13: Ship master verifying the details of the exporting containers

Annexure B:

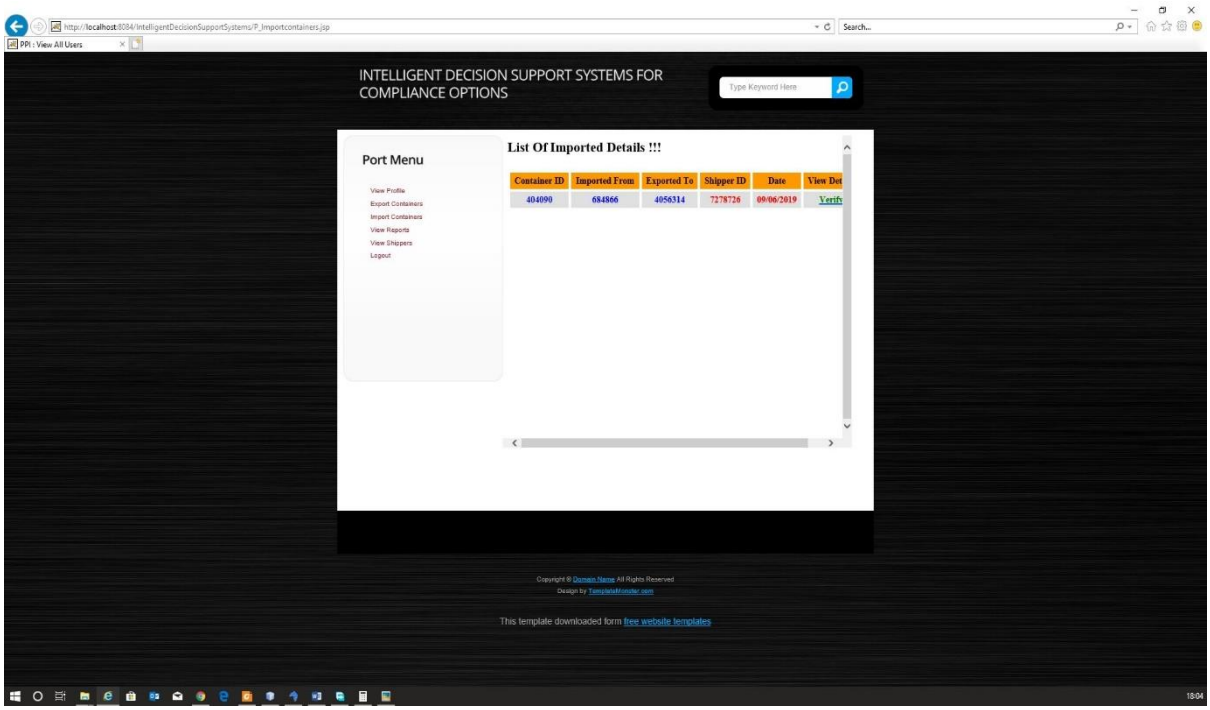

figure 14: Consignment received at port 2

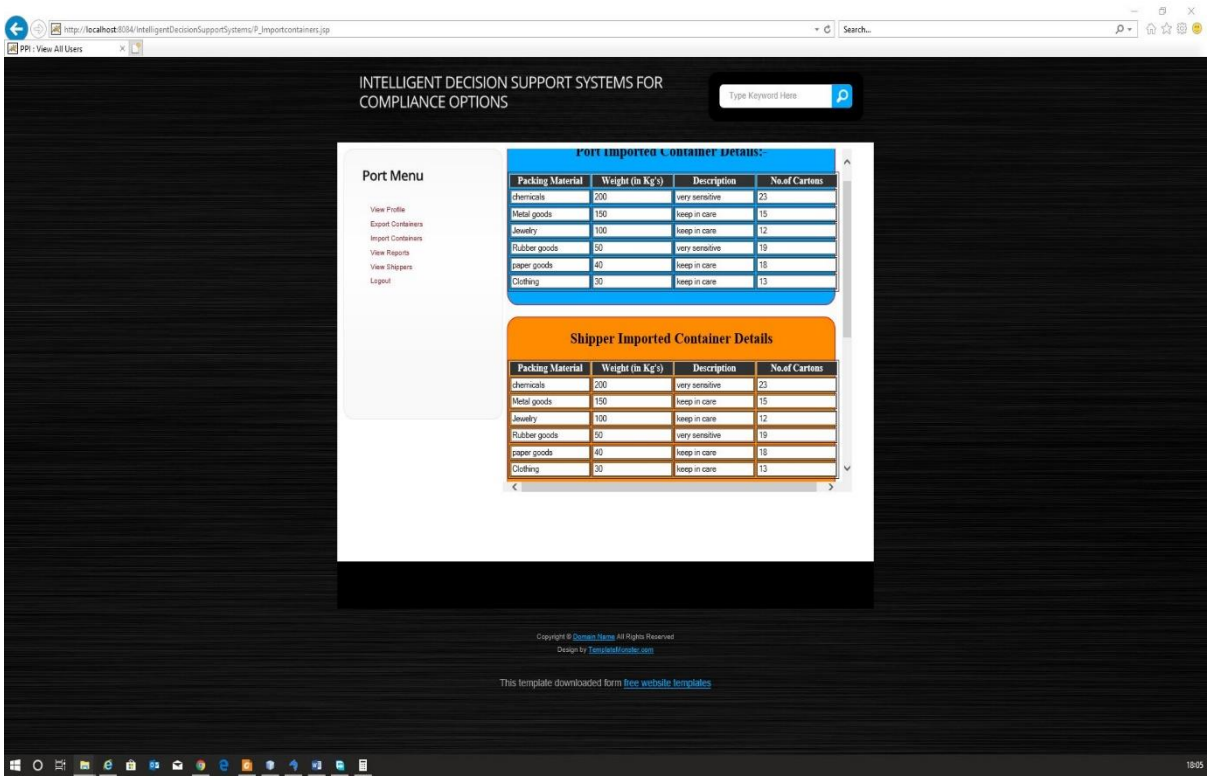

figure 15: Port 2 verifying the details of the received consignment

Annexure B:

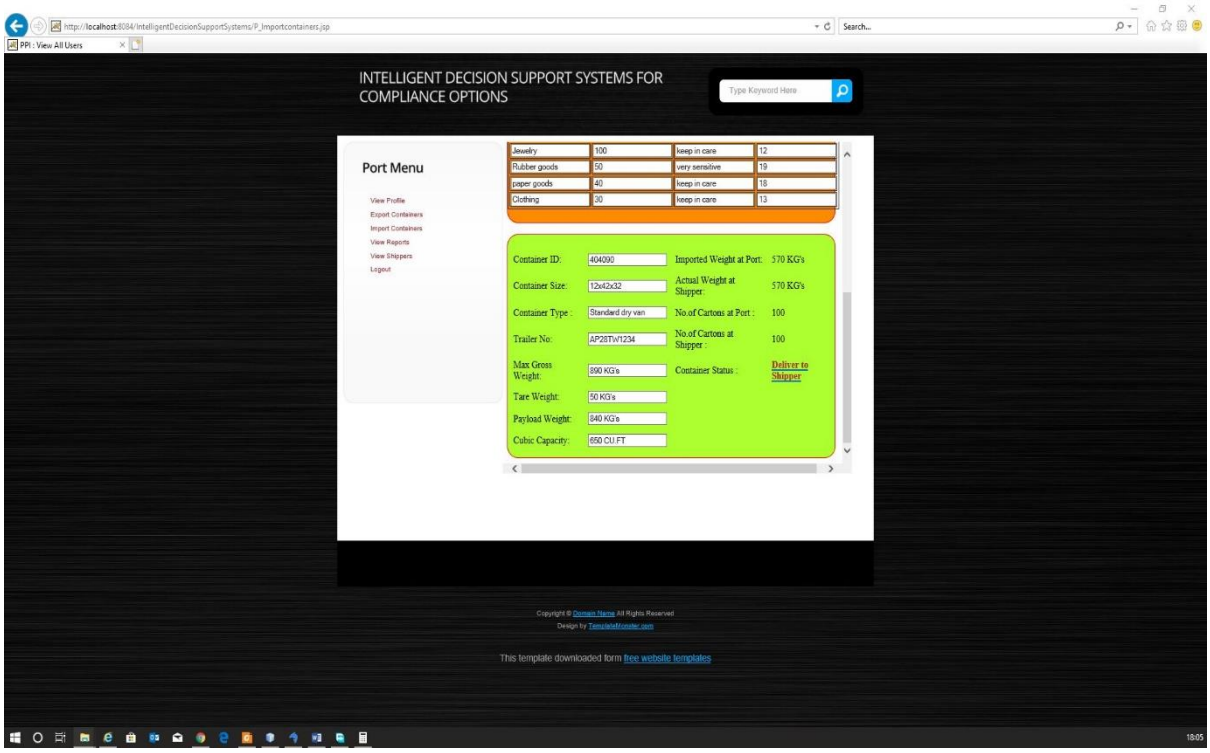

figure 15.2: After verification delivery to consigned party

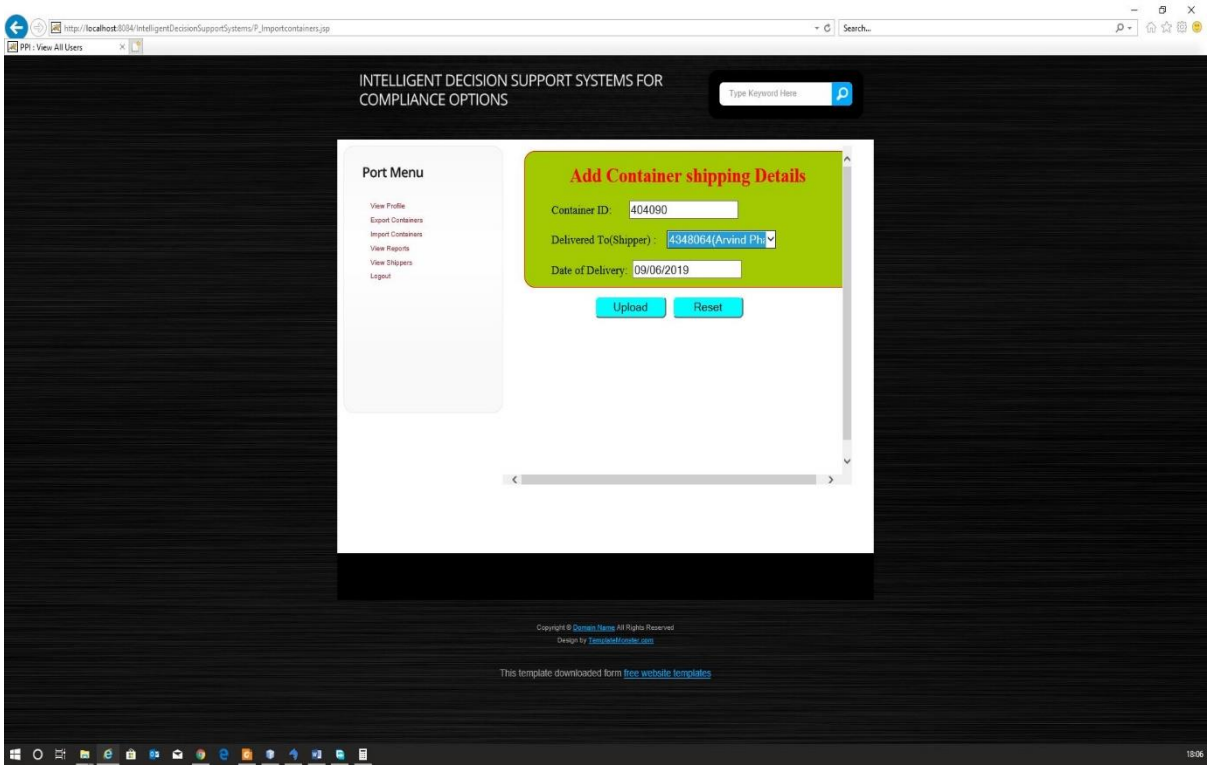

figure 16: Port 2 updating the delivery details of the container

Annexure B:

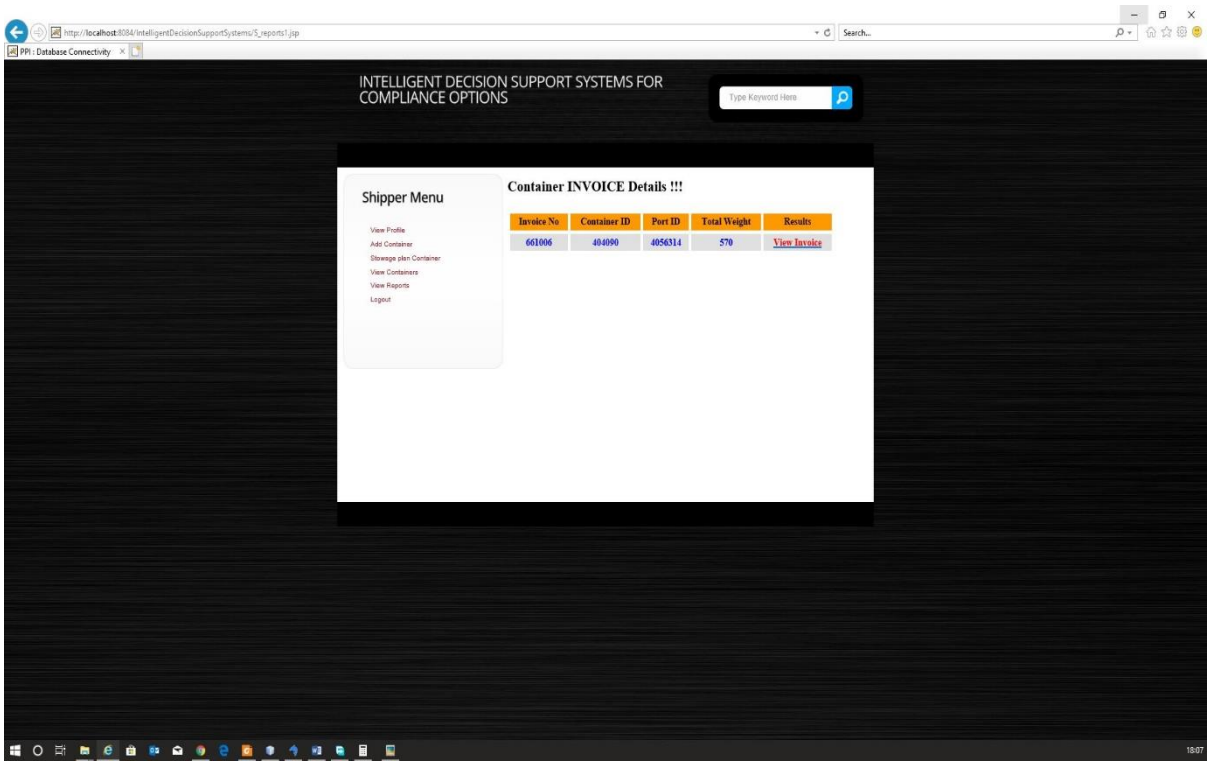

figure 17: Container deliver details provided to both the shipper and receiver

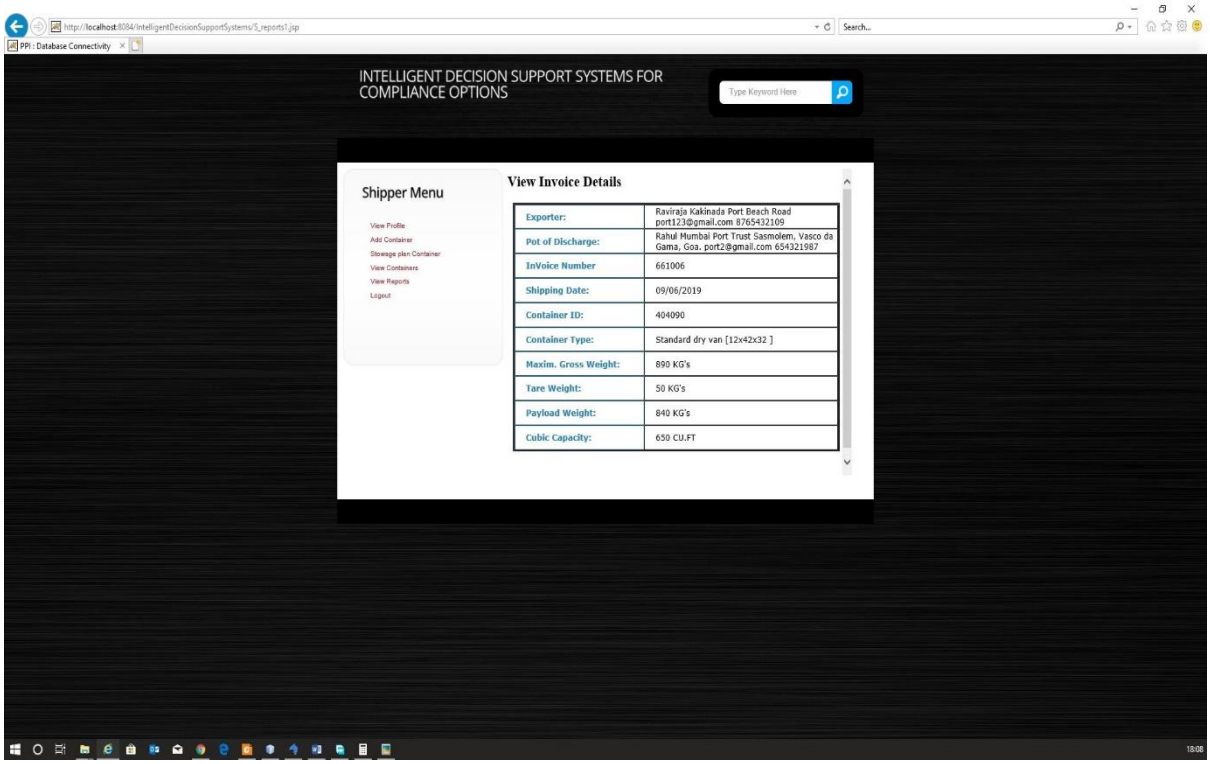

figure 18: Invoice details of the container