# INTERMODEL EU

**Simulation using Building Information Modelling Methodology of Multimodal, Multipurpose and Multiproduct Freight Railway Terminal Infrastructures**

**Grant agreement: 690658**

**D8.4 – Assessment and validation workshops onsite at selected terminals with local specialists**

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## Statement of originality:

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

## Executive Summary

This document shows the results from the various evaluation activities of WP8 during the end of the project period (M25-M34).

The document acts as a complementary information to D8.3 (*Set of Key Performance Indicators for assessing and operating intermodal terminals (functional, economic and environmental perspective)*), where a methodology for alternatives appraisal during the design of multimodal freight terminals is stablished.

This document presents all the steps taken in order to implement selected methodology as well as all the complications that have surfaced along the way. A study of the collected data has been done in order to determine the appropriateness of the provided results on D8.3.

Moreover, as a final part of the projects, opinions from expert stakeholders included on the determined profiles (Operators, Investors and Public bodies) involved on any decision making of intermodal terminals have been collected with the objective of determining the usefulness of the presented platform and any possible improvements to the same.

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# 1 Introduction

## 1.1 Scope

Due to the character of the following document and it being a collection of complementary information presented along the deliverable 8.3, the scope is the same for both of them. Nonetheless, within this report no information regarding weighting of indicators will be studied but instead, a meticulous study of the carried out process has been done.

## 1.2 Audience

The document is public, of special interest to anyone with a view on logistics but more especially to those with an interest in planning and designing greenfield and brownfield container intermodal terminals. As a result, the reader will have a vision of the opinion of relevant actors with a say during the design process of an intermodal terminal on what are the most relevant design parameters to be considered.

This specific document will be useful to obtain an overview on the presented complications and limitations the procedure of weighting the most relevant indicators within an intermodal terminal might have.

Combined with its companion deliverable 8.3, the reader will have an overview of the relevant factors that are currently being considered during the planning and operation of intermodal container terminals.

## 1.3 Definitions / Glossary

Main definitions with glossary and abbreviations used in this document are:

**BIM -** This stands for Building Information Model. It is a shared digital representation of physical and functional characteristics of any built object, including buildings, bridges and traffic networks. The acronym is also increasingly used to define management and Building Information Modelling in general, referring to using model-based applications. (ISO 12911).

**Indicator** - Quantifiable value related to performance or environmental impacts/aspects.

**Investor -** Is defined as a private or public company which its main objective is to prioritize the profitability of their investments. Due to this, they are focused on the return on investment and timing of the same.

**PI -** Defined as the physical value used to measure, compare and manage the overall organizational performance.

**Key Performance Indicator -** Indicator that tells you what to do to increase performance dramatically. They represent a set of measures focusing on those aspects of organizational performance that are the most critical for the current and future success of the organization.

**Multi-criteria decision making -** This term is concerned with structuring and solving decision and planning problems involving multiple criteria. The main goal is to organize the given alternatives (from the most to the least preferred one) giving a support tool for decision makers.

**Operator -** Usually a private company with operational and economic objectives which organizes and runs de terminal operations. Their main objectives are to achieve and sustain profitability by operational effectiveness and efficiency.

**Public Body -** A local, regional or national government institution with its main objective as strategic development including, employment, environment and safety.

**Terminal:** In transport and logistics, terminal means a place where passengers or cargo is gathered before moving to transport. In seafaring context, terminal has a particular function in a port area, such as container handling, coal, oil, or passenger terminal. In a case of a small and specialized port, terminal could refer to an entire port.

**TEU:** The twenty-foot equivalent unit is a standard measure for a container for transporting goods, used to calculate how many containers a ship can carry, or a port can deal with.

## 1.4 Abbreviations

**AHP**: Analytical Hierarchical Process
**BASF:** Badische Anilin- und Soda-Fabrik
**BED:** Bedeschi
**CENIT:** Centre d'Innovació del Transport
**DE:** Derived Effects
**FGC:** Ferrocarrils de la Generalitat de Catalunya
**FS:** Financial Strength
**KPI**: Key Performance Indicator
**KW:** Kiruna Wagon
**OP:** Operational

## 1.5 Structure

- **Section 1:** contains an overview of this document, providing its Scope, Audience, various definitions and abbreviations and Structure.
- **Section 2**: presents a brief context of the deliverable in within the INTERMODEL project and the work-package.
- **Section 3**: includes the process used to select the candidates participated for the interview, and a study of the same.
- **Section 4**: provides an analysis of the obtained sample, studying its limitations and the effects this might have on final results.
- **Section 5**: presents expressed opinions by the interviewed stakeholders about both the project and the selected indicators.
- **Section 6**: overall conclusions of the deliverable are included.

## 2 Context of the deliverable

This deliverable summarizes the workshop/interview process conducted along the analysis performed in D8.3 of the INTERMODEL PROJECT. Overall 64 relevant stakeholders in the design process of intermodal terminals were contacted resulting in 29 interviews conducted. The output from the interviews was twofold:

A series of metrics on the relevance of specific indicators was collected using a scoreboard based on AHP (Analytical Hierarchical Process). Construction of the database and results obtained already discussed in D8.3 (*Set of Key Performance Indicators for assessing and operating intermodal terminals (functional, economic and environmental perspective)*).

A view on the meaningfulness of both the indicators selected and the results of the INTERMODEL project was obtained from discussing each indicator (and some that were missing) during each of the interviews. In some cases qualitative aspects beyond those measurable (either by INTERMODEL's simulations and BIM tools or from other sources) were discussed. The deliverable mainly elaborates on this second bullet point.

The involved partners with more than 4PM where BASF, VIAS, CIMNE-CENIT, DHL, BEDESCHI, ZNIK where their assigner participation can be seen on Figure 1. However, after the meeting held in Melzo/la Spezia (26-28 September 2018) FGC and KIRUNA WAGON decided to participate on the work-package as well.

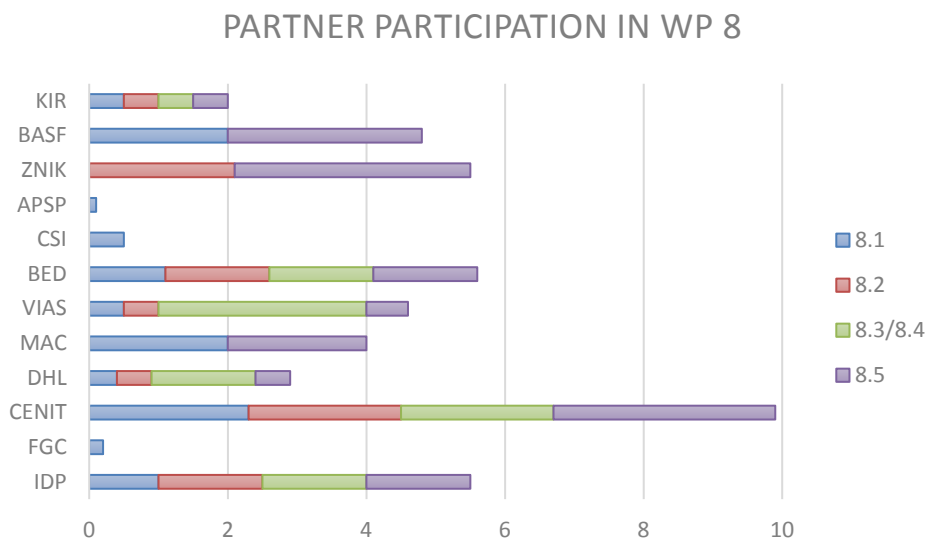



Figure 1. Partner participation along WP8 on persons-month per partner

The following deliverable can be considered as a complementary report on D8.3, since it encapsulates steps taken to determine the selected process to identify all relevant KPIs included in an intermodal terminal as well as the presented problems along the way. This way, a global perspective of the entire process is obtained, with its weaknesses and possible improvements to be considered.

In order to obtain suitable results for the projects, a set of interviews where designed to perform on a selected group of stakeholder profiles. These interviews include a collection of indicators for stakeholders to weight and evaluate with the objective of performing a multiple wise comparison between them.

As stated on previous deliverables (D3.1 – *Study of the state of the art and description of KPI and KRI of terminals, hinterland mobility and rail network*), five steps have been followed in order to determine the KPIs and PIs taken into account:

1. **Identification of the strategy and mission of the organization**

   The first step for selecting feasible KPIs and PIs is identifying the strategies that an organization would like to achieve. That is, the selection of those performance indicators must be aligned with the strategies in order to assess and monitor major decisions and measures related to each strategy.

2. **Identification of stakeholders involved**

   In order to make appropriate decisions it is really important to identify all those stakeholders involved and affected by those decisions. Thus, selected performance measures should take into account the different points of view.

3. **Identification of the different perspectives that should be considered in the performance system**

   The objective of identifying the different perspectives involved in the performance system is minimizing information overload by limiting the number of measures used. Actually, if forces managers and decision-makers to just focus on handful measures that are most critical for an organization.

4. **Identification of particular strategic goals**

The target of this stage is identifying those objectives that an organization's strategy is trying to achieve. For instance, under the strategy of increasing the operational efficiency a strategic goal could be the improvement of equipment productivity.

5. **Selection of effectiveness criteria and feasible KPIs and PIs set**

The selection of feasible KPIs and PIs will result in a comparative scoreboard which will be used to assess different terminal layouts, operational processes, allocation, type of equipment and materials, etc. Due to the importance of this stage, the authors have followed the sequential phase depicted in Figure 2.

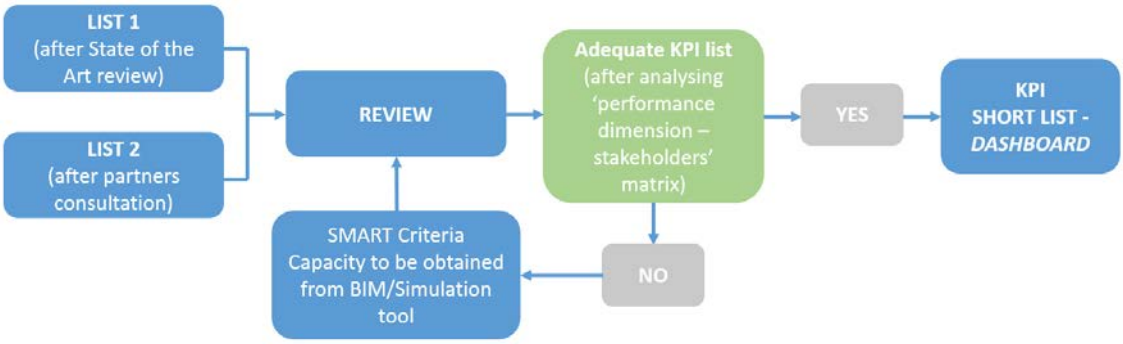



Figure 2. KPI & PI list methodology

After this initial KPI and PI identification, a long list of 40 indicators was defined. The procedure of selecting the most relevant indicators used on the interview process (tool selected to develop the proposed methodology for section 8.3) is described along this segment.

As Figure 1 shows, six partners where involved on the development of WP8 (BASF, VIAS, CIMNE-CENIT, DHL, BEDESCHI, ZNIK). Nonetheless, after the meeting held in Melzo/la Spezia (26-28 September 2018) FGC and KIRUNA WAGON decided to participate on the work-package as well, by doing their own interviews process in order to have some stakeholders from Sweden (for the case of KIRUNA WAGON) or as support and a contact source for other partners (for the case of FGC).

The work is centered in a preselection over the original list (long list from now on) of 40 indicators (KPIs plus PIs). A 3h workshop was held in la Spezia in 27th of September 2018 within the consortium where the 40 indicators where discussed thoroughly in two separate dimensions:

- Meaningfulness during the Design Decision making Process (DDP) for future terminals/upgrade of existing ones, based on the experience of the partners involved in the consortium and their complementary backgrounds.
- Potential grading of the remaining indicators: pass value (threshold that would be acceptable in a terminal with the characteristics of the one provided during the workshop), worst value to be graded (values below that number could be considered equally bad to the worst value provided) and best values to be graded (values over that number would be equally great).

For the first bullet point, indicators addressing similar characteristics of the terminal already showcased in another indicator were discarded in the final selection, to avoid duplicity during the assessment from selected stakeholders (to be made during T8.3).

Regarding the second bullet point, the values originally agreed upon were checked by members of the consortium after the meeting according to benchmarks on real terminals, being specially the case those in Melzo and la Spezia (information provided mainly from Contship, La Spezia Port Authority, Macomi and Bedeschi).

Once the long list of indicators was reduced and values regarding worst, pass and best performances of each of them where identified, the used tool for the methodology proposed on D8.3 was created; all details can be seen on Appendix III.

# 3 Candidate selection

## 3.1 Introduction

Intermodal terminals are the interface between different transport modes (mainly road, rail and sea traffic although air and inland waterway traffic is also relevant but not reflected in INTERMODEL project), and therefore, a wide variety of actors are involved on its regular operation. Not only that, different stakeholders might have a say during the design process of terminals. Usually those that will construct and operate it are the so-named *Terminal Operators*, however, there are other profile that have a say during the design of terminals (from new-from-scratch plans to small variations), at least by setting a series of thresholds that should be met or by defining surface, minimum traffic, and other sorts of requirements. Consequently, potential profiles to be questioned have

been identified and described in order to obtain an overall overview of the meaningful candidates to be consulted and interviewed during the project.

On the following section, the stated procedure for the selection of candidates is going to be presented, explaining the samples variety from various points of view, such as, profile variety, type and size of terminal… etc. in order to present a general idea of the sample selection process as well as the found complications along the way.

## 3.2 Profile definition

As an initial approach, all main actors participating on a terminals operation where identified as well as their main functions within the same. Three main profiles where selected for the process, grouping together all the main actors with a set goal and role within an intermodal terminal (Table 1).

**Table 1. Relevant actors and functions in freight terminals**

| Actors | Functions | |
|---|---|---|
| | **Hinterland / Rail network** | **Terminal** |
| **Public authorities** | | |
| *Planning agency* | Modal shift<br>Economic development of the metropolitan area | |
| *Port authority* | Modal shift<br>Port throughput | |
| **Operators** | | |
| *Rail operators*<br>*Haulage companies* | Volumes<br>Door-to-door transport | |
| *Shipping lines* | Haulage<br>Container logistics | Buffer |
| *Terminal operators (port, rail)* | | Management<br>Intermodal<br>Storage |
| *Freight forwarders* | Haulage | Consolidation<br>Deconsolidation<br>Buffer<br>Cargo added value |
| **Investor** | | |
| *Private companies*<br>*Investment organizations* | | Success in terms of financial result<br>Operating profitability |

Therefore, all the stakeholders that where contacted in order to participate on the project and provide their expertise opinion regarding intermodal terminal design and operation where identified as one of these profiles.

## 3.3 Sample selection

The partners with major contribution on WP8 and not a prominent role in leading the different work-packages of the project were asked to contribute to the interviewing process to provide a wide scope of potential interviewees from different European countries representing Mediterranean-West (Spain, Italy), Central (Germany) and Eastern (Poland) countries from the EU. In a second stage the participation of Sweden (Nordic country) was added to the sample.

The following partners were in charge of contacting the participants: Kiruna Wagon (KW), DHL, Bedeschi (BED), Ferrocarrils de la Generalitat de Catalunya (FGC), CENIT, Badische Anilin- und Soda-Fabrik (BASF), VIAS. Due to being from the same country (Spain), the last 4 partners where grouped together.

Before the profile contacting process started, the main objective for this part of the project was to obtain a sample as diverse as possible within the limitations the project presented. Some examples of the faced limitations have been the following:

- Difficulties to obtain possible contacts: the final number of possible contacts was not very large for all partners, especially when trying to reach out to companies or stakeholders outside the usual client list.
- Willingness of the stakeholders to participate on the project: not all the contacted candidates were willing to participate on the project. Reasoning behind this denial will be explained on following sections.
- Geographical barriers: due to the importance of doing face-to-face interviews, contacts located in proximity to the partners workspace location have been prioritized, focusing on possible contacts inside the city or nearby ones that have fast transport communication. Nonetheless, further away located stakeholders have also been contacted where the interviews has been performed via Skype call or similar.

Moreover, in order to have a good stakeholder sample representation, diversity was searched for both profile (Investor, Operator and Public body) and type of terminal

(seaport and dryport). According to the institution profiles of the corresponding partners involved on the process, selected stakeholder candidate samples from each of them has been very diverse: partners with a larger port terminal contact list have been able to interview profiles from seaport terminals, whereas partners with a rail-track background contacted with dryport stakeholders.

For the case of dryports, after some interviews, many interviewees could not picture themselves on the decision making of the terminals presented as example during the interview; with a capacity of 0.5 Mio TEU p.a. (more specifications are shown on the Support guide included as Appendix II), this terminal seemed as much larger than the ones operated by the interviewees. However, all interviews were performed taking into account characteristics of the individual terminals operated by the corresponding stakeholder.

On the other hand, apart from the interviews obtained from profiles in the European Union, additional expertise from stakeholders from other continents has been obtained. In this case, Bedeschi has provided information from an international company interviewed following the same methodology. This intel gives the opportunity to compare tendencies inside the EU on the matter.

## 3.4 Sample collection study

As it has been mentioned on D8.3, obtaining a reasonable number of successful interviews has been a challenge, specifically for some countries (Table 2 shows these results). Nonetheless, a large enough sample has been collected in order to confirm that the preliminary results lead to an appropriate choice of used methodology.

A large number of potential participants was contacted, and in many cases, once that initial barrier of contact was surpassed, stakeholders where keen on arranging a meeting in order to proceed with the interview process. Moreover, on cases where having a physical meeting was impossible, the interview was conducted under a Skype call, phone call or by sending the questionnaire via email.

Table 2. Specifications of the reached out contacts

| INTERVIEWS / COUNTRY | CONTACTED | AGREED | NOT ANSWERED |
|---|---|---|---|
| Italy | 13 | 5 | 3 |
| Germany | 15 | 3 | 2 |
| Poland | 1 | 1 | 0 |
| Spain | 30 | 18 | 7 |
| Sweden | 6 | 2 | 0 |
| **Total** | **64** | **29** | **12** |

As it can be seen on Figure 3, the success rate for the sample selection has not been very high; less than half of the total number of contacted candidates have accepted to participate on the project and from almost 20% of them there has been no further answers after first contact.

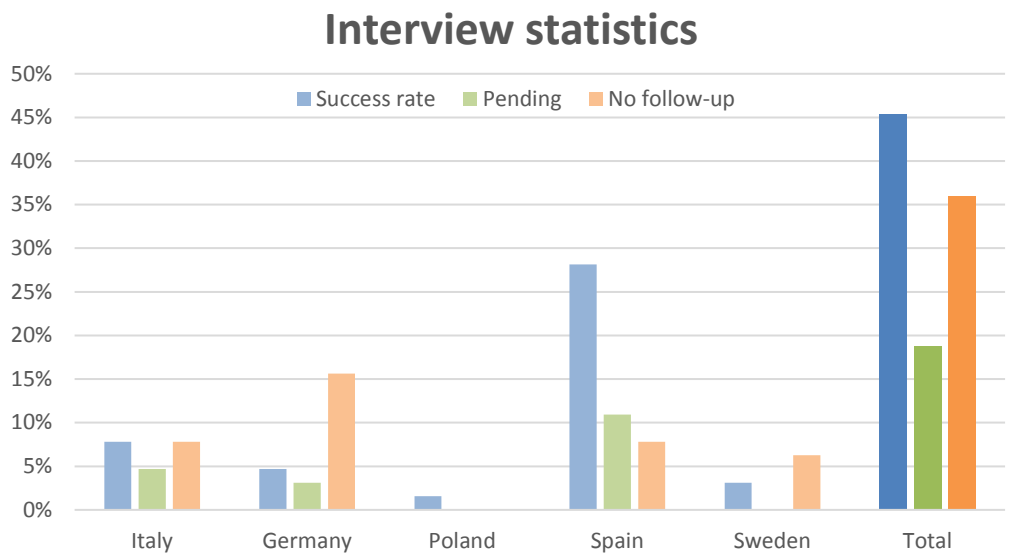



Figure 3. Statistics on the contacted interview results

There are several different reason on why there has been such a low percentage of success when collecting interviews:

- Loss of contact personnel within the selected companies.
- They were not interested on participating or could not participate on this type of project.

- Due to presence of competition in the INTERMODEL Consortium, they decided not to take part.
- Lack of time to conduct both a personal interview and a call interview.
- Lack of extensive knowledge from participants to provide significant answers regarding indicators from all dimensions.

All these results are obtained from the total number of interviews, showing participation rate from each country. Moreover, the country of Spain seems to show the highest success out of the five partners involved on the process, however, it must be mentioned that this country includes 4 different partners, and therefore their chances of obtaining a larger number of interviews were higher.

## 3.5 Drawbacks

Candidate selection is considered one of the crucial sections of the interview process; without and adequate sample size, obtained results are not valid since cannot be contemplated as a good representation of the opinion of all stakeholders for any type of intermodal terminal.

Overall, the main problem faced on this section of the process has been the low participation of the stakeholders; many stakeholders showed no interest and did not answer to that initial contact, and in some cases, even though after agreeing to participate, some stopped answering after some time. Additionally, trying to stablish a face-to-face interview was not always simple, adding an extra complication to perform the interview. For all these reasons, the desired sample size and variety has not been achieved.

Nonetheless, even if the participation has been low, all stakeholders that have agreed on doing the interview have shown great interest on getting to know the developments of the project as well as taking their time to provide the most adequate and justified answer to weight the KPIs. Moreover, some of them have even given suggestions on improving several aspects of the project, which will be presented on following sections.

# 4 Analysis of the sample

## 4.1 Introduction

Along the deliverable, all the steps taken in order to collect a suitable sample of interviews to determine the importance of certain indicators at intermodal terminals have been presented.

After all the process, a sample with a total of 28 interviews has been collected as a representation of intermodal stakeholders along different countries in the EU. Despite the found problems in candidate collection mentioned on the previous section, the sample has been considered as good, and stablished procedure has been followed according to the steps mentioned on the set methodology. This way, results shown on chapter D8.3 have been obtained.

However, these results are heavily influenced by the characteristics of the collected sample. Therefore, with the objective of developing a further study on the performed interviews, on the following section, a meticulous analysis of the obtained results has been performed.

## 4.2 Study of the sample

Taking into consideration the presented limitations on the collection of candidates to participate on the process, the expected main characteristics from the obtained interviews were to have both a variety on profiles and types of terminal. This would ensure that all points of view involved on any decision making within an intermodal terminal and all types of terminal are equally represented, and that consequently, obtained results are appropriate.

### Profile

According to the selected profiles, several opinions on the weighting of KPIs and PIs have been collected. Each country has had the option to reach out to a different number of stakeholder profiles, and through these contacts, final sample and results have been obtained. As it can be seen on Table 3, it has not been possible to gather a balanced number of interviews from all profiles; the number of interviews for profile defined as Operators has been larger than for the remaining two, reaching up to 50% of the total number.

As it's shown on Table 1, the profile defined as *Operators* include the largest number of profiles within its sub-category. Therefore, when determining on which profile the interviewed stakeholder belongs, there is a larger probability of them being included inside this profile.

**Table 3. Number of performed interviews by country and stakeholder profile**

| PROFILE / COUNTRY | TOTAL | OPERATOR | INVESTOR | PUBLIC BODY |
|---|---|---|---|---|
| Italy | 5 | 4 | 0 | 1 |
| Germany | 2 | 1 | 1 | 0 |
| Poland | 1 | 0 | 0 | 1 |
| Spain | 18 | 8 | 4 | 6 |
| Sweden | 2 | 1 | 0 | 1 |
| **Total** | **28** | **14** | **5** | **9** |

Due to this observation, overall results, and by consequence partially some of the conclusions, will be influenced by this profile. As *Operators*, achieving and sustaining an effective and efficient operational processes in order to achieve profitability is their main objective; therefore, operational and financial aspects will be largely weighted as it has been presented on the previous deliverable.

Public bodies on the other hand, even though they have shown a large interest on the operational aspects of the terminal, their second priority is not as clear. They have a large concern for social and environmental aspects which differ from the obtained opinions from *Operators*. Moreover, due to the similarities on the set objectives of profiles defined as *Operators* and *Investors*, the differentiation compared to *Public bodies* increases.

This way, general final results cannot be considered as a good representation for all described profiles, since an equal amount of stakeholders on each of them has not be obtained. Nonetheless, all results that have been presents with a subdivision of the selected profiles will not be affected.

## Type of terminal

Additionally, apart from attempting to select an equal number of stakeholders from each profile, an equivalent number of interviews from each port type has been intended. Under this context, only two types of terminals have been presented: seaports and dryports. Seaports are defined as a coastal location with a harbor where ships dock and transfer goods to/from land, whereas dryports, are an inland intermodal terminals directly connected by road or rail

For this particular case, a uniform number of interviews has been achieved for each terminal type (see Table 4). Nonetheless, only one country has been able to obtain feedback from both seaports and dryports, and the final number for that particular country is not as balanced as it was hoped for.

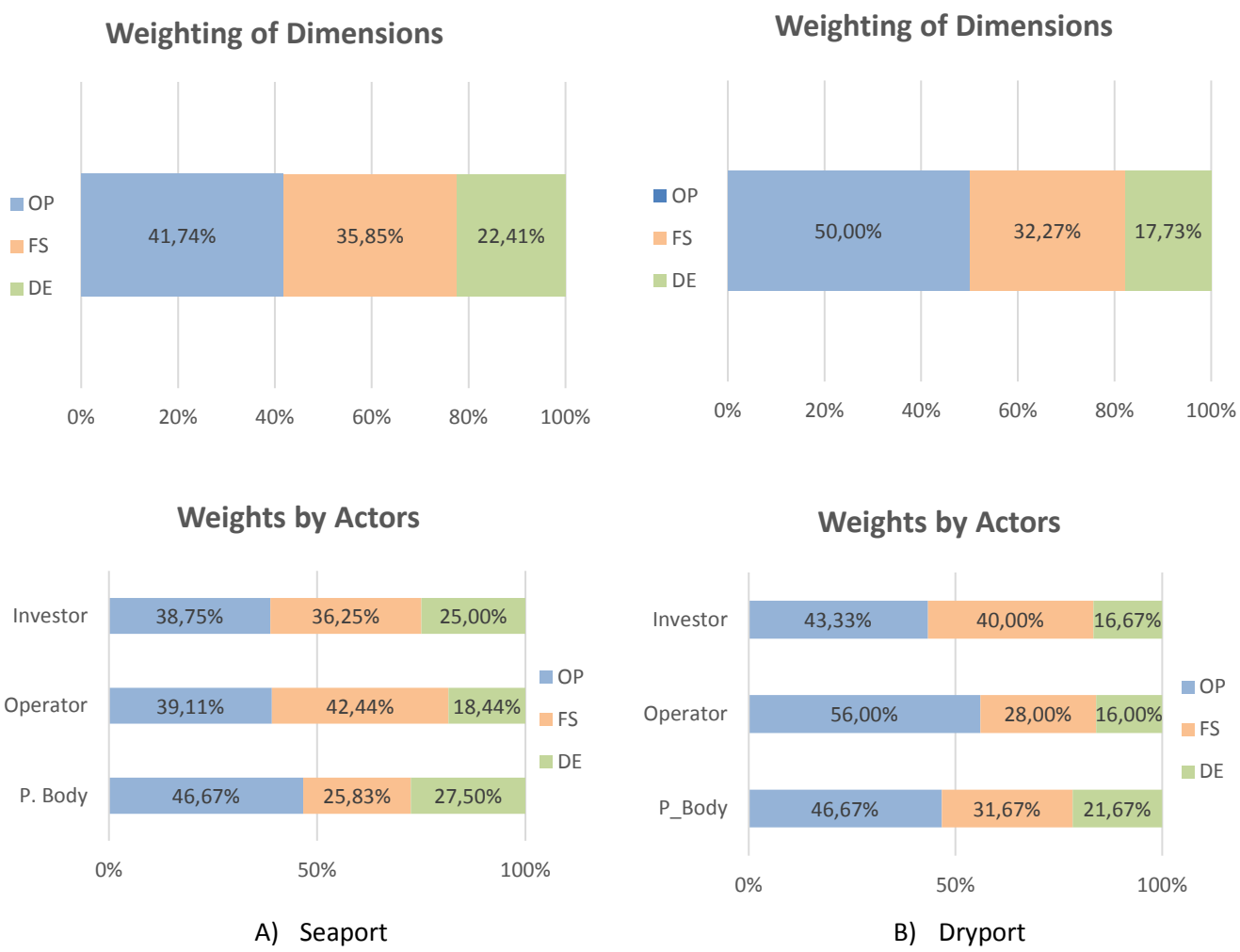
**Table 4. Number of performed interviews by country and type or terminal**

| PROFILE / COUNTRY | TOTAL | SEAPORT | DRYPORT |
|---|---|---|---|
| Italy | 5 | 5 | 0 |
| Germany | 2 | 0 | 2 |
| Poland | 1 | 1 | 0 |
| Spain | 18 | 11 | 7 |
| Sweden | 2 | 0 | 2 |
| **Total** | **28** | **17** | **11** |

However, due to having a different number of indicators for each type of terminal (19 for seaports and 18 for dryports), in order to use the modified AHP multiple wise comparison, a reevaluation of the dryport KPIs has been performed. Within this reevaluation, weighting assigned to these indicators has been modified accordingly: Firstly, an average value of the weights assigned to the KPIs only included on seaport terminals has been calculated; afterwards, the weight given to the dryport indicators has been reduced according to that previously calculated seaport terminal KPI average value with the objective of obtaining a suitable comparison between all indicators and both terminal types. Through this method, real weighting values can be obtained, and a real comparison is completed.

Even so, to verify that the used methodology to recalculate the final weights of the KPIs from dryport terminals, an additional exercise has been performed dividing the results obtained from the interviews by type of terminal.

As it can be seen on Figure 4. Weighting results expressed by dimensions, results for both types of terminals are quite similar. Furthermore, after doing a more detailed analysis of the results and dividing the weighting averages given by profiles, results show similar results for both types of terminals, with the only exception of the weight given to operational aspects by Operators. For the case of seaport terminals, a higher interest for financial aspects has been shown than for dryport terminals. This could be due to the larger investments that are placed on the equipment used for seaport terminals.




A) Seaport B) Dryport

Figure 4. Dimensions weighting results by actors. OP: Operational; FS: Financial strength; DE: Derived effects

With all this in mind, values obtained from dryport terminals have probably been modified though an appropriate method, excluding the possibility of having unrealistic results that show and exceeded value for those KPIs. Nonetheless, by having a lower sample of this type of terminal, final results might be influenced by the mindset of a seaport intermodal terminal stakeholder, and by consequence, reducing the variety and profile representation of the provided sample conclusions.

Nonetheless, a higher sample of dryport Operators would be needed in order to see whether the value given to operational aspects decreases.

## 4.3 Emerged problems

As it has been presented, the obtained samples has not been very homogeneous, there has been a higher number of interviews performed by a certain profile which could have consequences on the final results.

All three profiles have revealed different opinions for all KPIs, but *Operators* have shown the largest weighting diversity out of the groups. As Table 5 shows, standard deviation values for *Operators* are significantly higher that for the remaining two profiles: lowest values are shown for KPIs included on Effects on transportation network sub-dimension (TN2 and TN3) and even this values are higher than most of the ones obtained for *Investors*.

Table 5. Mean and standard deviation results

| | Mean | | | | Standard Deviation | | | |
|---|---|---|---|---|---|---|---|---|
| **Criteria** | Total | P. Body | Operator | Investor | Total | P. Body | Operator | Investor |
| **AU1** | 1,004 | 1,186 | 0,868 | 1,056 | 0,436 | 0,437 | 0,446 | 0,333 |
| **AU2** | 1,012 | 0,767 | 1,200 | 0,900 | 0,390 | 0,344 | 0,346 | 0,424 |
| **AU3** | 1,072 | 1,287 | 0,955 | 1,014 | 0,335 | 0,173 | 0,359 | 0,351 |
| **AU4** | 0,859 | 0,533 | 1,022 | 1,100 | 0,457 | 0,163 | 0,504 | 0,424 |
| **AU5** | 0,904 | 0,777 | 0,960 | 0,978 | 0,365 | 0,372 | 0,365 | 0,371 |
| **AU6** | 0,934 | 1,058 | 0,870 | 0,894 | 0,406 | 0,402 | 0,450 | 0,282 |
| **AU7** | 0,998 | 1,225 | 0,902 | 0,857 | 0,386 | 0,362 | 0,416 | 0,095 |
| **AU8** | 1,200 | 1,167 | 1,222 | 1,200 | 0,436 | 0,528 | 0,441 | 0,283 |
| **TR1** | 1,596 | 1,533 | 1,614 | 1,700 | 0,277 | 0,242 | 0,329 | 0,141 |
| **TR2** | 0,660 | 0,701 | 0,641 | 0,644 | 0,284 | 0,301 | 0,315 | 0,165 |
| **TR3** | 0,766 | 0,766 | 0,803 | 0,656 | 0,323 | 0,176 | 0,423 | 0,149 |
| **PR1** | 1,093 | 1,125 | 1,107 | 1,000 | 0,379 | 0,301 | 0,459 | 0,245 |
| **PR2** | 0,836 | 0,875 | 0,760 | 1,000 | 0,353 | 0,301 | 0,401 | 0,245 |
| **CS1** | 0,948 | 1,044 | 0,954 | 0,760 | 0,297 | 0,260 | 0,338 | 0,167 |
| **CS2** | 1,052 | 0,956 | 1,046 | 1,240 | 0,297 | 0,260 | 0,338 | 0,167 |
| **JG1** | 1,085 | 1,000 | 1,133 | 1,120 | 0,321 | 0,283 | 0,394 | 0,179 |
| **JG2** | 0,915 | 1,000 | 0,867 | 0,880 | 0,321 | 0,283 | 0,394 | 0,179 |
| **EV1** | 1,186 | 0,889 | 1,271 | 1,480 | 0,381 | 0,285 | 0,373 | 0,179 |
| **EV2** | 0,957 | 1,089 | 0,900 | 0,880 | 0,350 | 0,333 | 0,406 | 0,109 |
| **EV3** | 0,857 | 1,022 | 0,829 | 0,640 | 0,356 | 0,290 | 0,406 | 0,167 |
| **TN1** | 0,844 | 0,933 | 0,831 | 0,720 | 0,290 | 0,200 | 0,345 | 0,268 |
| **TN2** | 1,067 | 1,022 | 1,046 | 1,200 | 0,294 | 0,323 | 0,260 | 0,346 |
| **TN3** | 1,089 | 1,044 | 1,123 | 1,080 | 0,262 | 0,371 | 0,224 | 0,110 |

After seeing these results and the effects it might have on the outcome of the project, an alternative exercise was proposed: a study of the stakeholders with similar weighting answers within the Operators profile was performed, followed up with and analysis of the profile description from the grouped stakeholders, with the objective of determining any possible subdivisions inside the profile.

For this exercise, a new subdivision was created according to the initial weighting given by Operators to the Operational and Financial strength dimensions. Three main groups where created: operators who have given a higher weight to the operational dimensions, the ones that give equal weighting and the ones who weighted the financial strength dimension over the operational one.

Nonetheless, after doing this division in profiles, even at the sub-dimensions with a smaller amount of indicators, the standard deviation has increased (Table 6). There could be various reasons for this increasing such as, *Operator* priorities not being defined by the dimensions set with the literature, stakeholders from different countries have very different opinions on which are the most important indicators in an intermodal terminal… However, all these further reasons cannot be identified with the current data sample, so it is impossible to confirm or deny that the criteria used to create this stakeholder subdivision within the *Operators* profile is appropriate until a larger sample of interviews is collected.

**Table 6. Mean and standard deviation for Operator profile subdivisions**

| | Mean | | | Standard Deviation | | |
|---|---|---|---|---|---|---|
| Criteria | OP>FS | OP<FS | OP = FS | OP>FS | OP<FS | OP = FS |
| **AU1** | 0,897 | 0,769 | 0,933 | 0,382 | 0,548 | 0,611 |
| **AU2** | 1,000 | 1,133 | 1,467 | 0,346 | 0,306 | 0,306 |
| **AU3** | 1,009 | 0,828 | 1,000 | 0,427 | 0,288 | 0,346 |
| **AU4** | 0,867 | 0,800 | 1,400 | 0,416 | 0,600 | 0,400 |
| **AU5** | 0,876 | 1,178 | 0,867 | 0,408 | 0,384 | 0,115 |
| **AU6** | 0,913 | 0,996 | 0,600 | 0,415 | 0,640 | 0,200 |
| **AU7** | 1,051 | 0,969 | 0,467 | 0,411 | 0,397 | 0,115 |
| **AU8** | 1,133 | 1,267 | 1,267 | 0,503 | 0,416 | 0,577 |
| **TR1** | 1,576 | 1,600 | 1,667 | 0,503 | 0,346 | 0,231 |
| **TR2** | 0,630 | 0,800 | 0,667 | 0,148 | 0,283 | 0,503 |
| **TR3** | 0,864 | 1,000 | 0,667 | 0,282 | 0,566 | 0,306 |
| **PR1** | 1,057 | 1,300 | 1,333 | 0,341 | 0,346 | 0,416 |
| **PR2** | 0,943 | 0,700 | 0,667 | 0,341 | 0,346 | 0,416 |
| **CS1** | 0,829 | 1,200 | 1,000 | 0,269 | 0,200 | 0,529 |
| **CS2** | 1,171 | 0,800 | 1,000 | 0,269 | 0,200 | 0,529 |
| **JG1** | 1,000 | 1,333 | 1,3 | 0,416 | 0,306 | 0,424 |
| **JG2** | 1,000 | 0,667 | 0,7 | 0,416 | 0,306 | 0,424 |
| **EV1** | 1,228 | 1,450 | 1,133 | 0,373 | 0,191 | 0,577 |
| **EV2** | 0,914 | 1,050 | 0,667 | 0,515 | 0,300 | 0,115 |
| **EV3** | 0,858 | 0,500 | 1,200 | 0,320 | 0,200 | 0,529 |
| **TN1** | 0,829 | 0,750 | 0,667 | 0,373 | 0,412 | 0,577 |
| **TN2** | 1,086 | 1,000 | 0,667 | 0,302 | 0,283 | 0,577 |
| **TN3** | 1,086 | 1,250 | 0,667 | 0,254 | 0,192 | 0,577 |

Apart from the already mentioned variation on opinions *Operators* might have on the selection of most relevant KPIs, because of the large number of interviews performed by this profile, final results are influenced by their point of view. Described tendencies and result are mostly dependent of the opinions given by *Operators* and do not entirely reflect a true representation of all the decision making figures at an intermodal terminal.

# 5 Evaluation

## 5.1 Introduction

A meticulous and elaborated procedure has been followed in order to define the structure and scheme of the created interviews; all important indicators have been taken into consideration in order to fulfill the set objective of WP8.

Moreover, all partners have participated to select and contact the necessary stakeholders to participate on the project, providing a more XXX and expert opinion on the selected procedure. A wide variety of profiles from different countries have been interviewed with the objective of having diverse opinions on the matter in order to achieve an overall perspective.

After all these interviews, personal opinions from the interviewees has been asked on several topics; firstly, a general perspective on the importance of the selected indicators and whether any other should be considered; secondly, average values for indicators included in an intermodal terminal configuration have been defined; and finally, a global evaluation of the INTERMODEL project as a whole has been asked for.

All this information has been summarized and explained along the following sections of this deliverable, always respecting the agreed upon confidentiality of the interviewee. In order to ensure and maintain this confidentiality, GDPR form where collected from all participants, and they were asked to explain their opinion on the presented project as the entity they were representing.

## 5.2 Expressed opinions

As it has been mentioned on previous sections, doing a face-to-face interview gave the chance to discuss the INTERMODEL project with the participants and collect some of

their personal opinions on whether they considered and interesting and useful tool for the design of an intermodal terminal. Along this segment of the interview, several opinions arose, most of them coinciding on the same topics.

The design of an intermodal terminal is a very complex process, where many different aspects have to be taken into account. Not only indicators presented along the interview, but many others are fundamental; such as, the incoming traffic or the location of the terminal (no only sea or dry but the country is located in) since that would determine the price of labor or of container movement.

From this perspective, taking into consideration the way INTERMODEL presents the design of an intermodal terminal, these additional indicators cannot be included properly, since many social related aspects have to be considered, and the simulation does not give you the option. Moreover, some interviewees have argued that at their companies, they already have the manpower to calculate and design all processes given by the simulation, and therefore, they have no need on use this kind of tool. This behavior was emphasized even more as the size of the company increased; they have the opportunity to have more means to assume the amount of work calculating all the alternatives and processes included on the design of a terminal.

Furthermore, each terminal is different to the rest and it has to be adapted to the targeted market and its labor, social and administrative environment. Therefore, each terminal must be individually analyzed and it can´t be created through a general terminal creating tool. The main objective should be to decide what market is going to be targeted, which one can be targeted and how is it going to be done.

Nonetheless, not all companies have the possibility to hire the sufficient manpower to determine the entire design of an intermodal terminal and therefore, they have considered this tool as a good initial approximation of what the final design should be. The simulation gives the basis of what the terminal could or should be in a short amount of time, and that initial design can be further on studied and modified to adapt to any particularities the company may consider appropriate for each case.

On the other hand, an additional use could be as a possible decision making tool when doing any type of expansion or modification at an existing terminal. It would be an easy

way of comparing different scenarios without using and exceeded amount of personal and it would give the possibility of doing it in a very short amount of time.

However, previous concerns have mainly been mentioned by the profile defined as Operators. Other figures with a more supervising role at a terminal, like Investors and Public bodies, see it as a useful tool to assist them on several decision making processes such as, evaluation of any changes on existing terminals or quantifying cost and implications when determining the length of the concession.

Even though there have been some opposite opinions on the usefulness of the presented tool, a distrust towards the used algorithms used for the simulation of the terminal has been presented as well. Some companies have exposed that they would feel the necessity to check and calculate the accuracy and appropriateness of the used optimization algorithms in order to determine if it was the one that aligned to their set objectives for that specific terminal.

Finally, all interviewees have mentioned that many of the shown indicators on D8.3 have a large correlation between them and could not be and should not be evaluated as individuals. This correlation is not only between indicators inside individual sub-dimension but between different dimensions as well; for example, as it has been previously mentioned, operational and financial aspects are interwoven with each other. Depending on the assumed role of the interviewee and the in mind terminals characteristics, global operational and financial aspects of the entire logistics chain are prioritized over the ones of the terminal as an individual. For instance, some dryports operated by Public bodies have mentioned that loosing profit at a certain terminal is acceptable as long as it means an increase of traffic on certain ports associated to the same.

# 6 Conclusions

Overall, this report presents the followed steps taken to collect information and develop the proposed methodology in D8.3, showing all the complications found along the way and addressing any possible effects these might have on the final results. Therefore, this deliverable can be considered as a companion to D8.3 since their information are complementary.

At the beginning of the projects, when all preliminary steps where being defined, initial goals and timelines where stablished. However, once the entire process of defining the most relevant indicators started, certain complication arose that initially were not contemplated which are mentioned down below.

On the one hand, the process of contacting suitable stakeholders to participate on the project has been one of the main problems; more than half of the contacted actors decided to not take part on the projects (either by not answering or by refusing to participate). Moreover, most of the participants had to be obtained from contact lists of the partners involved on the INTERMODEL project, which are limited, resulting on a smaller sample of participants as it was wished for.

On the other hand, even though all partners made the effort to collects a sample as homogenous as possible, and up to a point this was achieved, due to the wide number of stakeholders included on each defined profile, expressed opinions for KPI weighting have been very diverse; especially for the case of Operators, the standard deviation values have been higher than it was hoped for. For this profile, an additional exercise has been performed, in order to create a subdivision within the already defined profile, however, due to the small sample size, it has been impossible to confirm if this exercise was successful or not.

Nonetheless, apart from obtaining weighting values for the preselected KPIs, one of the most important parts of the interviews was to collect intel from experts and possible future costumers of the presented tool regarding the developed process. On this matter, several concerns surfaced making the weighting process more complex than it was expected: correlation between indicators made the weighting process very complex since indicators from different sub-dimensions where dependent from each other.

As the final section of this projects, the usefulness of the designed tool has been studied. Taking into consideration the collected opinions of the interviewed stakeholders alone, this simulation tool does not seem to convince all participants. Many of them already have enough staff members to calculate all the necessary terminal alternatives when designing a new terminal and do not think that a generic simulation tool can take into account all the particularities each terminal might have. Nonetheless, all of them agree that INTERMODEL is the appropriate platform to compare different terminal expansion

alternatives in a short amount of time and without using a large amount of manpower. Moreover, since one of the concerns shown by the participants has been lack of options to adapt the simulation to certain particularities of each singular terminal (such as country of construction, several values for costs of the terminal like labor or land cost…), future studies for the project could be the implementation of this type of information into the platform. This way, it would create a more attractive service for the costumer.

# Appendix I

This appendix includes the collected minutes of some of the performed interviews for the weighting of indicators. Some sections have been modified in order to preserve the interviews privacy.

## Interview 1:

Firstly, the most relevant factors to take in to account when intervening on a new infrastructure project have been mentioned.

- **The active influence area** has been mentioned as primordial as well as its location within the territory (a good connection with transport infrastructures).
- **Demand** on the area is also a key decision factor: the import/export contracts of TEUs will be better compared to the transshipment one, since the former one transports the TEUs up to a specific port /terminal to distribute them along the region with demand.
- An authorized terminal is a positive aspect for the investment.
- It depends if the projects are **greenfield** or **brownfield**. Greenfields tend to be more "risky" even when the investment is a good opportunity; for example, Moll Nord at Valencia's port.
- On the other hand, following **Equators Principles** is essential. As a general rule, these principals are followed, however, in other countries, investors don't take as much in to consideration the social-environmental principles that these state.

Tanking in to account all 3 exposed dimensions, it has been emphasized that ***Operational*** and ***Environmental*** correspond to **inputs**, while ***Financial strength*** has been placed as an **output.** It has been decided that the relevance percentages would be 1/3 of each of them: profitability from an asset will be obtained as long as it's a good one.

When analyzing subgroup organization on the operational dimension, a higher percentage will be assigned to Capacity Efficiency. When an infrastructure starts to be used, the characteristics that affect it the most are a good location and a high volume absorption capacity; more than the quality service.

When grading the different KPIs, ***Labour Utilization Rate*** has been stood out since it produces the main costs of a terminal (specially, stevedores).

The last step presents conflict when choosing what is most important: social-environmental impact or economical profitability. Due to this, based on the idea that

there will always be profits, the terminal will be designed as environmentally friendly as possible. There are some cases where “being the greenest might not be profitable”, then, it’s important for the infrastructure to have a high use and therefore, be socioeconomically profitable.

The interview was divided in to two session due to some technical problems with the model. The following information was collected via phone call on February 6th 2019.

Regarding the social commitment, the interviewed mentioned the importance of both KPIs: every terminal needs a set of service providers (indirect jobs) for it to perform correctly, but from his investor point of view, direct jobs are more important since they sow the profitability of the terminal.

When talking about environmental related KPIs, the interviewed repeatedly mentioned that his main focus is **economical profitability**, therefore, environmental issues are not a priority; the terminal must follow the minimum requirements stated on Equators Principles and not more.

As a final result, Terminal 1 is the one that best fits the interviewed interests and he has not made any modifications on previous weights after seeing the result. However, he has shown his concern about the bad result on the operational aspect of the terminal. On his point of view, for a terminal to be economically profitable, operationally has to be on point too (the smaller the unloading time of the boat the higher the profit since more boats can enter the terminal).

Finally, some reference values for Return on Investment and Profitability where asked to confirm if the chosen ones where accurate. Many variables have to be taken in to account when making this kind of statement, nevertheless, when considering an already built terminal, the Return of Investment should be around 10% and 4% for equity and debt respectively. For profitability, the debt margin should be around 22% and equity can be obtained by EBITDA (which would normally oscillate around 25-35%).

## Interview 2:

The interview has been mainly focused on railway intermodal terminals, even though some aspects referred to maritime terminals have been mentioned.

Knowing that the interviewed is the manager of 5 intermodal terminals connected with Barcelona's port, he mentions the importance of the terminals annual capacity. This capacity is translated as the TEUs **rotation** along the year, which depends on the capacity of the area contiguous to the train loading/unloading zones as well as the **depot capacity.**

If, at any point, the capacity reaches values close to 100% of the design capacity, there will be a problem for the terminals operations. The average time of stay at a port is a very important factor (container rotation), therefore, an **economic penalty** has been placed for time periods higher than a certain value; this means a higher prize for TEU storage. Empty container accumulation at the storage area of the port is not interesting and in many cases these are relocated to an inland terminal. As a conclusion, the depots capacity is a limiting factor of the terminal, implying a constant expansion of the terminals storage areas when container traffic increases.

Starting with the first part of the interview, the interviewed has emphasized different factors at intermodal terminals that are applied differently at maritime terminals.

There is a difference between maritime terminals and intermodal terminals on economic aspects: while ports are based on construction and a following concession, at intermodal terminals, the figure of the developer is usually the same as the operator. Intermodal terminals don't ensure a generation of benefits; in order to generate revenue, there is a **complementation of storage activities and loading/unloading** with other alternatives. On the other hand, the presence of potential investors on maritime terminals makes it necessary to obtain a certain benefit, even though, nowadays is not as high as previous years.

When talking about automatization of terminals, the design of new terminals is based on **semi automatization** to ensure operations, however, the complete automatization of the terminal has been dismissed as a profitable option due to the associated elevated costs.

Through the point of view of a port authority, the main interest is based on **loyalty traffic volume** throughout the port, this means, a good terminal operation as well as a financial sustainability will make a terminal more attractive. The operational aspects related to an adequate prize per service (prize for loading/unloading of a train or prize of a crane) are what influence the **competitively** between terminals.

At a port, the two principal efficiency factors are:

- A fast loading/unloading of boats.
- A fast retreat of containers, i.e., total time used for the carrier to turn in the pertinent documentation until the container is placed on the truck.

Going in to environmental sustainability, a differentiation between aspects to take in to consideration at a railway and a maritime terminal have been mentioned: given a low contamination of trains on inland terminals, it would not be as necessary to implement sustainable measures as at maritime terminals. Therefore, a higher importance percentage will be placed at operational and financial indicators, leaving a 15% of weight for socioenvironmental indicators.

Taking in to account the social aspect, the intermodal terminals entail a small number of workers, about 20 people considering a terminal with 160.000 TEUs. Moreover, a terminal has a larger influence on the generation of indirect jobs.

Environmentally, the main problem on intermodal terminals is the **noise**, giving their nearby location to urban nucleus (there is no indicator which includes this problem within the selected KPIs). Regarding the use of alternative energies, LNG reduces pollution but contributes at the same level on climate change. The interviewed doesn´t know about the energy consumption or the CO2 contamination generated per container, thus, the relevance of environmental indicators the same for all three.

The construction of a new intermodal terminal causes the base of the **development of the influenced area**: entails the creation of distribution centres and companies. Therefore, as well as having a direct connection with the generated occupation, it will also have an influence on the transport network of the surroundings increasing its congestion. Even though initially the traffic will decrease due to the use of the railway system to transport containers instead of using roads, the implementation of new

companies **will affect over the network**. The congestion created at the entrance of the maritime or dry port is not as relevant as the circulation alteration that these trucks may create at the road infrastructure adjacent to the terminal (or to nearby populations if there are any). On the other hand, it is very important that trains are available when temporal window dedicated to merchandise circulation.

Once finalized the section dedicated to the KPIs punctuation, the section dedicated to the application of results will commence, and the assigned weights to each indicator can be observed. From the 4 presented alternatives, the interviewed has decided that the most attractive option has been “Terminal 3” despite not being the option with the highest punctuation.

## Interview 3:

Due to the interviewee's profile as an inland terminal operator, the interview is based on railway intermodal terminals.

These terminals have the objective of offering a **public service**, meaning that they need to be **functional** and **efficient** on their operations. Moreover, another purpose to consider is **financial viability**: any economical loss is accepted in order to be competitive in the market concerned.

At operative level, the importance relays in both the infrastructure and the management. A good infrastructure design needs from an efficient management in order to reach a certain competitiveness, and vice versa. A proper equipment and performance are key aspects for assuring the efficiency of a terminal. Also**, employment creation** is important to activate the economic and social activity of the area adjacent.

Referring to the machinery, a terminal which operates by using reach stackers is much more economically efficient. Through the use of **leasing**, it permits to rent machinery to the corresponding supplier with a minimal investment and a practically non-existent risk. However, this fact depends on the type of activity which is hold in the terminal.

The Zaragoza maritime terminal staff are employed workers. The length of work shifts are 8 hours, with a total of 3 shifts per day. The terminal schedule starts from Monday at 6:00 AM to Saturday at 2:00 PM; the rest is considered as special time when the terminal is going to keep working if it is required by a client, thing that happens most of the time.

Inland terminals include two major areas:

- **Technical area.** This area is electrified and it is where the arrival/exit of trains to facilities of the terminal is regulated. Generally, the property of the area is owned by the main responsible of infrastructure management like Adif in Spain or SNCF in France, so the terminal activity is conditioned by the established schedule made by these managers, which restricts the circulation of trains. The Zaragoza maritime terminal is the owner of its own technical area, so they are able to plan their conditions of access to the terminal. This has provided the success to tmZ.

- **Loading and unloading area**. This area is not electrified and it is where the loading and unloading of containers from/to trains is done.

Freight volume is not as important as the management of this volume: the overall management model has to be adequate to the activity levels of the terminal, including a good organization in the storage area and track area.

Truck operations in is quite efficient. A total of 450 trucks pass through the terminal per day, spending an average time stay of 18 minutes. This fluidity of traffic permits that the same truck might be able of arrive-exit up to 5 times per day **(average value of 3 times/day)** and improve the economic efficiency because the truck stays as less as possible in the terminal.

Referring to loading and unloading trains, a major speed means a better efficiency. The usage of reach stackers makes possible to perform the activity quicker than with a rail gantry crane. On the economical side it is also more profitable.

On environmental issues, thery are starting to take into consideration the usage of hybrid reach stackers and replacing the current ones which work with diesel. With this fact, operational costs will be lower and pollution will be reduced. The concept of "hybrid equipment" was introduced recently, making that terminals renew up to a 40-50% of the existent machinery for other more sustainable with the environmental.

Zaragoza maritime terminal has contributed to reduce the **90% of container traffic** from road haulage as it has been transferred to rail transport.

To avoid the negative effects upon the adjacent infrastructure to the terminal, it has to be taking into account when designing the terminal not to produce **bottlenecks**. Enough space for manoeuvre and circulation of trucks should be estimated, assuring the correct integration on the road network. Moreover, the design has to consider the capacity of the general railway network for **adjusting the new time windows** committed to freight trains for the terminal. In case of having a short range of time, it should be considered to extend the technical area.

Coming again to the matter of employment, the terminal has around 22 direct workers. Currently, the annual activity is 350.000 TEUs. On the other hand, the influence of the

terminal's activities on the indirect jobs generated by them is bigger: it includes from the carriers to freight forwarders and shipping companies.

## Interview 4:

The following interview could have included the vision of an intermodal operator of a railway company, as well as the one of a terminal manager. Nevertheless, the interview has been carried out more focused on the point of view of the investor. Given the profile of the interviewee, the obtained conclusions will be about railway terminals or dry ports.

"If it is not operational, it does not sell". With this idea, the interviewee wanted to highlight the importance of the operational scope to obtain a good economical profitability. However, the financial side continues to be the most important when making a decision about the design or restructuring of the terminal. From the point of view of a strict business, environmental aspects are not relevant.

Going in depth on the operational indicators, the initial idea was to treat both subgroups (efficiency and time) with the same relevance, but finally, it was decided to increase the percentage related with the work capacity. However, costs influence the final benefit, so it was decided to divide 50% for each subgroup: profitability and costs.

Once analyzed aspects at a large scale, the relative importance between different KPIs of the same subgroup has been studied. This shows:

- The labour it is the most relevant at the moment.
- Trucks have been prioritized over trains.
- The ROI is the most noted by the investor.
- Given that one of the main objectives is to be competitive, it is necessary to prioritize the operation. As an operator, it would be interesting to consider operational costs.
- Energy consumption during the terminals activities has been marked as a priority.

The approach of investing on an inland terminal it's not necessarily accompanied by a strong financial interest, but by the idea of creating an additional business.

About the general costs of the terminal, the prices of crane movements per container would be between 20 to 30 euros. However, storage costs bill independently and depend on the time the container has been at the storage park. Fixed costs (or CAPEX) are lower than the operational ones (or OPEX), even though it will always depend on the

equipment used at each terminal. The conventional inland terminals, mainly use reach stackers, while when moving large volumes of containers, gantry cranes are used.

It is called into question the importance of the indicator related to alternative energies given that it would probably have 0 relevance compared to other indicators of the subgroup.

## Interview 5:

From the business viewpoint, it must be known where the investment shall be done. In the case of a port's project, it is determined the need of building the infrastructure from the Public Administration for private companies to take the operation and management of it.

This port is focused on the petrochemical industry and on the transport of hazardous goods. However, it does not generate enough containerized cargo to establish a high frequency of shipping lines and it does not make it sufficiently attractive for possible clients. These clients prefer to pay higher prices in the principal ports of the peninsula, like Valencia or Barcelona, as these ports move great volumes of cargo and have a huge area of influence (or **hinterland**).

Moreover, there are no regular lines for rail freight container since that containerized cargo is normally moved by road transport. On the other hand, around 20 up to 35 daily trains circulate from / to the maritime terminal carrying bulk goods.

Due to the capacity increment of vessels engaged to freight transport and to the breaking of calls in ports (each of them has a significant associated cost), it was concluded that is much more optimal to do loading/unloading operations in those ports where ship operators have settled their business. Therefore, although this port is perfectly designed to receive ship operators in its facilities and to offer all the required equipment for the handling of goods, even most competitive machinery than in other ports, this last port continues to have larger business volumes. Like them, there are other similar ports which have the function of port feeder for major European ports.

The Public Administration pretends to offer a service by the construction of a port; they do have more interest in bringing a large volume of goods than obtaining a profit from it. Even though performance activities are efficient, then costs will decrease. Efficiency and time are interactive: if processes are carried out in an efficient manner, time related to them will be lower. It must be taken into account the security factor meaning that being totally effective may imply a lack of security. Efficiency could be defined as the properly exploitation of resources and equipment.

The longer the vessels stay on the quay, the higher the profit made by the port and the associated workers to loading/unloading process; in exchange, ship operators and exporters will be affected by the higher transport costs.

OPEX may be reduced with use of certain measures and a result may be obtained almost immediate. In contrast, benefits will be noticed over time.

General rail network must not be affected by the interaction with the railway infrastructure from the port and its activity. The **preference of network occupancy** is for commuting trains, followed by passenger trains, leaving freight trains in the last position. For this reason, those trains arriving or leaving to/from the port cannot obstruct the general network.

Taking into account the judgements about the indicators, some aspects are remarked:

- It is necessary to have a sized storage area to fit all unloaded goods.
- Considering time, the most important to take into account is the loading/unloading for vessels. The railway could have more flexibility in terms of schedule as there are no fixed leaving times, or these times may be not that strict.
- The higher the ROI achieved, the faster the benefits will be obtained.
- The investment should be the most important in order to determine the basis of a project; exploitation could be defined once the infrastructure is built.
- At this point, both interviewees differ in their responses: while one of them thinks that in the employment creation, direct jobs are much more relevant than indirect with a punctuation of 6 against 4 respectively, the other actor believes the opposite. He supports that the port is more interested in indirect jobs created, generating an economic activity in the area due to the setting up of companies involved in the various logistical operations. An example of this is the truck driver who haul containers.
- The current regulation forbids Sulphur emissions to the atmosphere. It would be necessary to control the whole industry, not to blame vessels for causing pollution.
- Accesses to terminal have to be seamless: entries and exists should be unsaturated.

- If profit does not reach a 6%, it is not a feasible option to invest. What interests is a long-term depreciation as the longer the period, the more available time to pay.

As final result, Terminal 3 has received the highest score considering the previous responses. The interviewees agree with the obtained result.

## Interview 6:

The interview will be focused on inland terminals due to the great participation of both actors in the development of dry port projects.

Since client's interests must be satisfied, terminals have to be profitable. In the Spanish case, the terminals are smaller and equipped with **reach stackers** that involve a minor investment in equipment. Although, when planning new terminals, gantry cranes are being included into the design, regardless the actual size of the terminal. Its aim is a proper performance while increasing the volume of goods moved, leading to a progressive growing of the terminal and to an enlargement by stages of its infrastructure. Thus, gantry cranes would be able to receive the added volume in a future.

Explaining that there are three main groups for indicators, the most relevant as a planner is a good operational design due to the need of fulfilment of certain purposes already mentioned and offer the guarantee of an adequate efficiency at the same time as a good environmental behaviour. Relevance of each group is settled as: *Operational dimension* (50%), *Financial Strength* (30%) and *Social & Environmental* (20%) in order to achieve minimum environmental and sustainability standards.

A suitable sizing might prevent delays and reduce operational times, in certain circumstances. Given the level services, there is **the requirement of sizing** for meeting these goals. For instance, a fitted design might solve the problem of queueing for the access to the terminal.

Considering the cost-profit ratio, costs might be regulated in a more direct way. In contrast with the normal market costs, those costs related to a terminal might be balanced with them.

When referring to the socioenvironmental area, it requires to execute environmental repots while designing and it is compulsory to take into account the following aspects related with traffic effects: the capture of traffic levels from roads and their **conversion into railway transport**; the effect on the traffic network. On the other hand, social issues as employment creation is least considered.

Having an overview of these main groups where KPIs are listed, the interviewees have told that there are some issues to take into account when comparing the indicators:

- No saturation levels must be reached especially on the storage area utilization. It is important that the rotation index of TEUs (or UTIs) is high. In case of achieving high averaged levels of activity, it would **not be possible to accept peak levels of activity** as the terminal would not be capable to assimilate them. Equipment utilization is also relevant for a good operational behavior.
- Loading and unloading times for trains have greater importance than for trucks.
- From the private company point of view, it will be valued a larger profitability; considering the interviewees vision, as an example, it will be much more important the return on investment (ROI).
- Capital costs are related to ROI. The purpose must be to optimize the operational costs (OPEX) with respect to the investment.
- There not a clear difference between direct or indirect jobs generated. It does not interfere with the design of the terminal.
- There is a growing tendency in terminals of using electrical equipment, so any kind of fuel is consumed (including fossil fuel). In civil construction, it is required from the Technical Building Code to apply renewable energies. It would be possible that some installations were efficient by implementing some of these measures (solar panels…) in administration buildings within the terminal complex. Therefore, following a relevance scale of most important to less, the indicators will be ordered as: energy consumption > carbon footprint > alternative fuels utilization.
- The effect on the railway network is highly penalized, so this KPI must be considered as a priority among others. One of the basic objectives of an intermodal terminals is the conversion of road transport into rail. The congestion on access to the terminal might be regulated in the design.

Most of the answers giving with respect to KPIs correspond with the characteristics of Terminal 2, which is the most highly scored terminal from the proposed list of examples. In contrast, the interviewees considered that they would prefer a terminal which would combine attributes from T1 and T2, highlighting KPIs related with profit.

Regarding the design of a terminal, planning needs to be done taking into account the project's horizon year. At least, an 80% of terminal capacity, leaving the remaining 20% as margin to avoid empty movements (a terminal with 100% of performance is translated into a saturated one). During its service life, having a **50-60% of TEUs moved per year** with regard to the total capacity might be an appropriate value during the **service life** of the terminal.

A 75% on equipment's utilization is sufficient. As a general principle, movements are growing in a progressive way within the years, making it necessary to use machinery in a continuous manner or to acquire new equipment.

Railway infrastructure is essential for the terminal. Interviewee prefers a larger track area in order to have more capacity to move the trains. On the other hand, it leads to a major number of resources applied to tracks. From the concept of efficiency, an optimized design of the track are might reduce expenses in additional equipment and maintenance aspects. As a key issue, the loss of slots must be the minimum and tend to 0.

## Interview 7:

Due to the interviewee's profile related to port development projects, the questionnaire will be answered giving a clear view of maritime intermodal terminals.

From the designer point of view, the global performance of the terminal has a huge importance in comparison with financial and environmental issues. It must be underlined, therefore, that operational activities have a notable influence when considering costs, so the actor gives priority to operational costs, or so-called OPEX, before the fixed infrastructure costs generated.

Once the initial classification by main dimensions is done, the percentages assigned to *Operational*, *Financial Strength* and *Social and Environmental* groups are 40%, 35% and 25% respectively. The last value was given in order to fulfill certain minimum requirements of sustainability.

In a more specific way and within each sub-dimension, the principal aspects relating to ports design are introduced. For operational issues, the length of loading and unloading activities prevails over the own efficiency of these tasks. One of the main designing purposes is the optimization of time spend in port, particularly for vessels to be efficient when calling at ports.

Accordingly, the area available in the terminal must be adjusted to the existing demand to cope with traffic and to guarantee a greater speed.

Referring to financial matters, costs will be prioritised over profitability of the corresponding infrastructure. Profitability concerns more about marketing issues of the terminal.

Finally, the interviewee dealt with social and environmental dimension where the same percentages of relevance were assigned to social commitment and effect on the overall transport network, emphasising that sustainable actions on the environment are important.

Once having reached the point of assessing KPIs individually, it is noticed that certain indicators are much more interesting for the interviewee than others within the same subgroup such as:

- Equipment utilization (in particular, cranes usage) should preferably reach high levels, especially considering average time than peak time.
- A storage area more unoccupied in order to avoid empty movements of containers.
- Berth utilization has a direct link with daily cost, meaning that this is really important if comparing it with other KPIs within the group.
- There is no a clear opinion with respect to employment rates: efficiency and stevedores working periods.
- Referred to operational times, the first position is occupied by loading and unloading time for vessels, followed by train and trucks.
- The investment costs are determined by the decision of establishing a terminal; it is preferable to design it to obtain an operating efficiency (OPEX), giving priority to operational costs rather capital expenses (CAPEX).
- With a minimal gap between them, direct jobs will be stand out in comparison with indirect ones.
- One of the basis of the project would be designing to minimize the electric and energetic consume of the desired infrastructure.
- Prioritisation to guarantee a suitable rail transportation in contrast with the importance of reducing congestion due to the road transport by designing an over dimensioned area destined to rail to avoid the loss of time windows.

To conclude the interview, the results obtained from the views expressed during the questionnaire are shown to the interviewee by giving scores to the 4 terminals proposed as an example. It is obtained a higher value in Terminal number 2, which characteristics correspond to the actor's thinking. In contrast, she does not completely agree with economic values.

## Interview 8:

Given the professional profile of the interviewee, he will answer the questions from the point of view of a rail operator terminal.

The interviewees terminal is a dry port which can receive up to 4 trains of 750 metres or 5 of 400 and it has loading and unloading areas with rail gantry cranes (for the 4 rail tracks) and also reach stackers for the remaining stacks or to help the gantry geared tracks.

When referring to the rail network, trains coming either from Spanish territories (mixed rail line) or Paris (general rail line) need to go to the buffer area and change their tractor unit from electrified to diesel one. After, these trains are moved to the loading/unloading area through an operation that lasts 45 minutes (minimum value), since the train is to be reversed in order to enter the loading/unloading tracks. However, the current layout makes highly difficult to operate train already inside the terminal, meaning that whenever wagon units have to be fixed or replaced and moved from one track to another, the reception and expedition area of the terminal cannot be used to prepare trains to enter the loading/unloading tracks. This, plus the fact that ETA schedules not always are met and operations might take a bit longer, causes that, effectively, the terminal usually works at a 30% of its planned capacity due to operation constraints in its connection to the rail network.

The previous example shows that there is such a big difference between theory and practice. All need to be considered: handling and management capacity of the terminal, capacity to receive and manoeuvre trucks and trains and how easily connect is the terminal to the general rail network.

Geographical location of terminals is a relevant point to consider, particularly for dry ports in order to enhance commercial activities. But operational issues are essential for the correct performance of the terminal. In the city where the company is at, there are rail gantry cranes to perform loading and unloading operations. On top of that, due to the orientation of the terminal there is a weather issue which affects the efficiency of these equipment. Around 25 days per year, cranes cannot be used due to this characteristic wind, meaning that all trains scheduled need to be cancelled. A terminal that wants to become efficient needs to work every day. Reach stackers, which are much

cheaper and flexible (not operationally), could replace cranes and 2.000.000€ would be saved but it is worthy to invest in this type of equipment.

It must be underlined the importance that the interviewee is giving to effects from the rail network. Even though, the operational dimension has many relevant indicators as a well-performance of equipment, especially of cranes, combined with productive job from workers.

The technical area is managed by another company, meaning that they control when trains are getting access to the terminal facilities, and have a limited operating schedule, hindering the productivity of the terminal as a potential 24/7 one. Efficiency from activities are directly affecting the producing time of the terminal. Many steps are considered on the whole process: customer delivering/picking TEUs, operator moving them to the train, loading (or unloading) to train, arrival or departure of trucks, loading (or unloading) of trucks, etc. Truck and train times are equally relevant.

Depending on the terminal type considered, if public or private, there are different interests. Volume handled is much more important in a public terminal in terms of activity; a private terminal will have always in mind the profitability obtained from it. Profit is directly related with shareholders.

In social commitment, it is much more important to have happier workers and higher productivity than a huge number of workers but with less productive capacity. Terminal workers are necessary for the correct operation meaning than direct jobs stand out above indirect jobs. This is why not much stress was put in the 'jobs created' indicators

Consumed energy is the environmental indicator with major impact. Since it has a direct implication the operational costs of the terminal. Referring to renewable energies, electric machinery is starting to be incorporated into some terminals. Carbon footprint is only relevant for EU purposes, and is not that relevant, energy consumption or the efficiency of the equipment or fuel used are by far more relevant.

Terminal 2 proved to be the best scored from all the proposed examples. It is a coherent result if taking into account the responses given by the interviewee. There was no need to fine tune the answers.

## Interview 9:

The interview has been focalised to inland terminals, as the interviewee is involved in the design phase of railway terminals from a public point of view. Essentially, new terminals are not being built. Instead, renewal operations are applied to existent terminals.

From operational factors that have been already defined, they are transferred to the design and combined to create diverse options of terminals. Furthermore, a socioeconomic study is performed in order to evaluate the financial and environmental issues. A certain importance is given to these aspects as it is necessary to attract funding or financing. To summarize, the operational dimension got a 50% of relevance while the financial dimension was assigned a 20% and the socioenvironmental dimension a 30%.

Expressing an opinion from the public sector's perspective, the main interest is the operational part of a terminal. The financial, social and environmental parts are not that important for them.

From an operational side, the main idea is the capacity of the terminal and the used resources. The capacity of trains, cranes performance and storage capacity of TEUs are used for the design. After, time conditions and opening times are fixed in order to observe if the terminal has the capacity that is actually required. Therefore, time is conditioned by the capacity which is demanded for the infrastructure.

In the case of the city of the company, on the basis of the current container moves (150 000 TEUS) plus the dry port, they need to open 14 hours a day, 6 days a week. 6 days a week. Even though **time** is not a parameter for the interviewee, it is strictly related to capacity.

Economically, the importance lies on the costs (not on benefits). But there is an attempt to attract the private sector for the lately model involving intermodal and railway part. Therefore, the private sector is going to have an interest on the benefits from the project. Interviewees company is in charge of providing the whole railway infrastructure (from tracks to cranes) while the private stakeholder implements the resources needed.

When talking about socioenvironmental issues, the jobs generation takes a 10% of relevance while the rest shares a 90 % in equal parts.

The design process is made in phases and each design is associated to a period of certain years. An observation of captured traffic is made, with the corresponding curves of capacity and their evolution in time. Thus, by the addition of a crane or a symmetric module to the one that is being done, it is possible to increase or even duplicate the existing capacity. When a certain level of capacity is reached, the terminal needs to be enlarged and the following phase of planning starts.

There are some terminals in Spain which use gantry cranes, as the volumes moved required this type of crane. The interviewee mentions that there is a strict control when referring to equipment, especially to gantry cranes. While the port sector includes 20 movements per hour, inland terminals just include 15 movements per hour.

About the usage of storage area, there is “transfer or short stay area” where containers can stay up to 7 days; afterwards, they are moved to a “long stay area” which is further the gantry crane not to interfere the terminal activities.

Railway tracks need to be constantly in use. The necessary time to load/unload a train of 150 metres is between 2-4 hours. When trains are prepared, they are moved to an associated railway track where they can wait until the moment of departure.

Use of cranes is the most relevant factor as it is the main constraint: at the point when the service cannot be provided with the existent equipment, it is necessary to duplicate the railway track. It is more a duty than a parameter.

There are two types of labour: employers from the company which are tending to decrease in number or from operator.

Railway times are already settled. Normally, it is tended to oversize in order to provide a good service. But trucks are conditioned to those activities needed to enter the terminal, such as review of documentation (maritime terminals do not have this step). It is important that the truck time spent on the terminal is as low as possible.

The only economical aim is not to lose money during the operation (gross result tending to 0).

In the design, the main factor is to take into consideration the carbon footprint. New designs or renewals include electrified terminals which not require shunting or diesel locomotives, as electrical tunnels will move the trains. This is clearly related with the

carbon footprint. For the energy consumption per TEU, this level of detail has not been reached yet.

There is a little oversizing of the technical area in order that all trains are ready for the departure. Specially, the roads congestion is analysed and the corresponding accesses to high capacity roads. An informative study is performed to notice the volume of heavy goods vehicle which are going to entry/ exit the terminal. Within the terminal, movements are done in just one way not to cross with trucks going in the opposite direction, interrupting a smooth traffic.

Due to the responses given by the interviewee, the best terminal is Terminal 1. It is required to mention that Terminal 3 could be a better adjustment to the expressed opinion, as there is an improvement of operational times, generated jobs and transport network effects, even though it is worse economically and environmentally.

## Interview 10:

Due to the interviewee's profile as an inland terminal operator, the interview has been centred on an inland railway terminal.

When deciding the weights of the large dimensions of terminal (operational, financial strength), compared to other interviews, a high weight has been given to social and environmental issues (20%). This is due to the importance of the **effects in transportation network** for the interviewed. In Spain, due to having two rail widths, the congestion problems can be solved between the two, however in other countries, a delay can result on having to postpone the departure of the cargo to the next day.

At a financial strength level, the concern about **terminal profits** is much higher than costs; costs are not negligible, but the "cost" of losing profit due to a delay accumulation of transported goods is far more important.

To analyze the relevance of the sub-dimensions of the operational aspects, an example terminal has been explained to have as a reference, due to the difference on preferences depending on the characteristics of a terminal. Due to the large dimensions of the example terminal (much larger than any other terminal in Spain), the higher weight would have been placed on time related issues (since the terminal would not have any capacity related problems). Nevertheless, when redirecting the question to the topic of focusing on a **new terminal**, the weights assigned by the interviewed are equal for each sub-dimension.

When analyzing the different KPIs, the interviewed has repeatedly argued his answers strictly on the **operational point of view**, detaching his decisions from any effects that his actions might have in the terminal internally. Due to this, his answers for each group of KPIs have been the following:

- Inside the capacity efficiency of the terminal, the maximum weight has been placed for **storage area utilization** as well as **rail track utilization** and followed by a medium relevance of terminal throughout. The other KPIs, don't directly affect the operational side of the terminal, therefore, they are not as important. For example, having low scores for equipment and labor utilization might increase the terminals costs and consequently increase the price of the

operational fair, however, the interviewee is willing to pay a higher fare if it ensures no delays on his cargo.

- Due to **door to door services** the company provides, the importance of time related issues are equal for rail and truck since both of them are connected (if the train comes has a delay the truck won't be able to leave and vice versa).
- For profit and cost related KPIs, for the reason mentioned at the beginning of this section, the interviewees opinions are indifferent on these topics, therefore they have been left as they are.
- A higher importance has been placed on **indirect jobs** since the interviewee himself is part of it.
- Regarding environmental topics, clients have started to as ask for information related to the **energy consumption** and **carbon footprint** of the transport. Since this can determine whether to stablish the service or not, a higher importance has been placed on those two KPIs. Moreover, an increase on clients' interest about the subject are expected on the future, which justifies the higher weight.
- Following his initial statement, the interviewee prioritizes again on **avoiding delays** on access roads to the terminal as well as maintaining an **easy entry and exit** from rail network.

After all the weighting of KPIs and as a final step of the interview, when showed the characteristic of the optimal terminal for the interviewees preferences, he strongly agreed with the obtained terminal and no modifications where done to the results.

**NOTICE:** It's important to mention that the profile of the interviewee is not entirely coincide with the previously defined profile of a *terminal operator*, however, his point of view has been taken in to consideration for the study always keeping in mind this remark.

## Interview 11:

Considering the interviewee's profile, the interview will be conducted on a basis of a maritime terminal. Knowing that the design of a terminal is with the basis of a port which is going to be connected to an inland terminal, there are many issues affecting the overall planning. As being a maritime terminal, there is a private funding.

Some terminals are built from scratch but not a lot. Mainly, projects are related with the enlargement of existing terminals in order to upgrade the system or to renew the infrastructure. As there are terminals with an increased handling of goods, it is required an expansion of capacity in new phases to cover the work.

In a first instance, operational area is the most relevant aspect from the point of view of the administration (50%), while sharing the rest of points in equal parts of 25% for economical and socioenvironmental areas.

A major use affects the turnaround time of vessels. But the interviewee thinks that an infrastructure may have different capacities with regard to its management; also, the design favours or penalises. It means that with an efficient management leads to an increment of quality and times might be reduced.

The key problem about increasing capacity is translated into the quality of the service. It is not only a matter of having less time available for operations but how efficient are them.

On economic aspects, costs are considered more important than benefits. The perspective taken into account is viewing the port as a node, meaning that these costs are switching costs. At times, business is not located in the nodes but in the supply chain. In the port, the key aspect is the cost given as the revenue will be calculated based on it. Then, the terminal is an attribute in the logistic chain which needs to minimize costs.

In the particular case of the railway sector, the commerce is not the rail transport as it might be unprofitable. Cargo is the factor that gives the benefit. With an efficient railway system, if it is possible to capture a line while having losses in the overall business, the new regular train line will provide the main income for the transport of cargo.

From the socioenvironmental area, the respondent considers that environmental issues and effects on the existing transportation network should be highlighted in contrast with jobs generated.

Having a first look on the operational indicators, the interviewee has reached the conclusion that these KPIs are not independent among them. Therefore, a response is conditioned by the assessment of other indicators. A high occupation of space, tracks and berths will lead to an occupation of equipment and labour. In a maritime terminal, the most important is the turnaround of vessels.

Return of investment is the factor to takin in mind from the Administration point of view. The drawback of CAPEX is due to a high investment; in an immediate though, OPEX are more relevant. Moreover, direct jobs have a priority over indirect jobs which are difficult to quantify.

Environmental indicators are interrelated: it exists a direct proportion from energy consumption to carbon footprint generation.

Considering the interests of a terminal, indicators known as “easiness of entry and exit from rail network” and “delays produced on access to the terminal” are valued with 6 points of relevance, reducing the importance of the congestion in the adjacent transport network.

On the validation step, the answers given by the respondent has resulted in Terminal 2 as the best terminal. It is noticed that the indicators of average (equipment and labour) are low in comparison with others. In contrast, use of storage rail track and berth are large as well as service quality referred to turnaround times. Also, there is a good affectation to traffic on the surroundings and within the terminal, with medium environmental care. Although the equipment and labour utilization is not bad; the average is a bit lower. It is commented that equipment should have a higher rate of usage. Otherwise, the characterisation of Terminal 2 corresponds to the opinions expressed during the interview.

While doing the interview, the respondent has underlined the difficulty or the fact that the parameters or variables are related among them.

## Interview 12:

Even if the interviewee has expertise enough to answer the questionnaire for both a sea port and a dry port, the interview will be conducted on a basis of a maritime terminal. However, he has also asked to specify his point of view as a profiled expert, meaning, if he should answer the interview as his actual role at his company (being its shareholders a pension fund with financial aim, it will suppose a higher weighting of the financial category) or of a more purely operational aspect. The final decision is to weight the KPIs as an operator, therefore, evaluating with a higher score financial aspects.

When talking about **time related** KPIs, from an operational point of view, his obligation is to give the client the minimum satisfaction that reaches his/her expectations. Due to this, he has considered of a higher importance the efficiency of the terminal over the time-related matters.

Inside the financial category, **equal importance** for both subgroups is given, arguing that you shouldn't have to prioritize one over the other since both are **interdependent** form each other; for example, at a terminal in Yibuti, costs where very low whereas the billing was much larger and it wasn´t due to a relation between the two, there were other factors that made this increase on billing (such as countries risk factors). Having an inverse relationship between the two of them is not a necessary condition.

At the final group (Social and environmental), a high weight has been given to the effects on the **transportation network** since this might have some negative effects on the city, collapsing its entrances. The first impact that you might have after a misperformance are not the vessels but trucks entering the terminal informing that they are not happy with the service. Also, the transportation network is **directly related** to environmental aspects, therefore, by reducing the effects on the network you also reduce the environmental impact.

Going in to specific indicators, at the capacity efficiency category, all KPIs related to **labor utilization** are of high importance due to the high cost of labor in Spain and the few existence of automated terminals; specially the average. On the other hand, he considers that the importance of the **storage area and berth utilization** should be the same; the job of a terminal operator is to align all subsystems inside the terminal, therefore, if you assume there will be a subsystem that might have preference on one

or the other you will lose that alignment. All aspects have to be taken in to consideration when evaluating these KPIs, on one side the length of berth and on the other the area of storage of the terminal; depending on these characteristics, the weight of each KPI should change accordingly.

When comparing KPIs related to environmental issues a higher weight has been given to the energy consumption per TEU and the carbon footprint per TEU since it doesn´t really matter the origin of the energy as long as it has no impact on the carbon footprint.

As a final part of the interview, the interviewee has evaluated all the values placed for a pass terminal. Many changes have been made to all the values, adjusting them to a values similar to the so called "BEST" type of terminals specified on the Support Guide. All the values are specified at the excel file. However, some comments about several KPIs have been highlighted:

- The value for labor utilization is **not high enough**: the interviewee argues that the minimum percentage should be 85% trying to aim to 100%. He even criticizes the maximum value at the Support Guide.
- When talking about turnaround times, he has reduced all the time values. Also, **he doesn´t agree on the measurement criteria** used, aka, the average value; for example, a 30 minute average turnaround time for trucks could be quite good, but you could have some values for 5 minutes and other for 4 hours being this last one not a good service. The average is not enough, the **dispersion of the data collection** is needed in order to have a good evaluation of these KPIs.
- On the social commitment subcategory the main problem are the **units**: jobs/MTEU. The interviewee specifies that it shouldn´t be per TEU but per **movement**; all that doesn´t imply capacity it should be measured in movements, since terminals move containers and not TEUs.

## Interview 13:

The interview has been conducted on a basis of a maritime terminal.

When analyzing the general weighting of the large groups specified for the different KPIs (Operational, Financial strength and Social and environmental), from an operators point of view, because of being a **private business**, the most important group of the three is the financial one; nobody will invest in a project that has deficit. Therefore, profit is the most important group, nevertheless, it's impossible to have profits if there's not a sustainable operative. These two **are always related** and they can´t be divided in to two separate categories. Finally, the social aspect of a terminal is not very important. However, the environmental aspect of the same it's more and more important when designing a terminal.

The interviewee mentions that the terminal must meet some **minimum operational values** for it to be profitable and competitive with the rest of terminals and even if a large investment is done, without a good operation this investment will be lost. Nevertheless, this operation plan is always translated in to a business plan, since, return of the investment and profits of the terminal are always the main focus, making the operational aspects as a smaller subcategory inside that business plan.

Looking more in to small subcategories, inside the group of financial strength, profits are the most relevant. As long as there is a profit costs are irrelevant, even though they are related; for example, if the cost of the terminal is very high, the profit will decrease unless there is a large charge per container.

His main point of view is centered on this concept; **profitability** is the most important KPI of all and all the rest are important on a lower subcategory but because alterations on those KPIs have the effect on reducing or increasing the profitability of the terminal. For instance, if the turnaround times of all transport modes are not good, the only way to make the terminal interesting is to reduce the price, while, if the terminal is very efficient operationally speaking (meaning a higher investment due to having more resources), it will be possible to charge an extra for the service. The objective is to find the **equilibrium** between the two and specially finding what your market target is; if your objective is to serve a low rated service for a low price it will interest a different

client that if you offer a high quality for a high price service. This type of target can also vary from country to country.

As a conclusion, the following statement is made: each terminal is different and it has to be adapted to the **targeted market** and **its labor, social** and **administrative environment**. Therefore, each terminal must be individually analyzed and it can´t be created through a general terminal creating tool. The main objective should be to decide what market is going to be targeted, which one can be targeted and how is it going to be done.

## Interview 14:

Given that the role of a port is to facilitate that cargo is moved and transferred, operational indicators should be the most relevant to consider when planning any investments in intermodal container terminals. Therefore, stress has been put in the operation indicators, disregarding specially those involved with externalities (social, environmental and network effects).

Within the operational indicators, the port authority would be much more concerned that the final user of the port are happy and willing to use it. This is why that time-related indicators are arguably the most important indicators to consider. Better service quality brings associated increase in traffic and revenue.

All indicators oriented to the productivity of the seaside are the most relevant in all cases, it is of paramount importance to reduce times and provide better use of the berth infrastructure, more than anything else. The shipping companies are the ones that end deciding to what port they are calling. This is especially true for transhipment terminals like the one the interviewee works at. Productivity at peaks is not relevant, a terminal is not planned considered peaks but average values.

The relative importance of rail or truck turnaround times (stressing once more that the most important quality indicator is ship turnaround time) depends on how inland connectivity is managed. In any case, train turnaround time should be less important since it is not as relevant as truck time for the performance of the supply chain, at least in most cases.

For the financial strength part, profit is more relevant to its point of view. A port authority in Spain is funded with traffic, cost is relevant but to a lesser degree. Between benefit and ROI, ROI is more relevant. For costs, given that we are talking of a terminal during its design stage, stress should be placed on CAPEX, OPEX will vary once the terminal enter into operation.

Externalities are not that relevant during the design. They are factors to be considered but will not change the design unless the effect is harmful. Among the three sub dimensions, the social return is the most relevant. A Port Authority has the compromise to look forward the wellbeing of the citizens in the area. Among the job generation

indicators, more stress to be put to direct jobs: easier to quantify and with a direct effect on the daily operation of the port.

Regarding environmental indicators, carbon footprint is the most relevant of the three, the other two will ultimately lead to a reduction on carbon footprint (and their goal is to reduce it).

For effects in the network, congestion at the accesses is far more important than the other two, it has a direct derivate to the turnaround time for trucks which is relevant in an import/export terminal. Congestion of the overall network is important as well (facilitates accessibility to the port) whereas delays in the rail part, again are not seen as that relevant, considering that rail supply chains are not that time constrained.

Overall Terminal 2 seems to be the better (agrees with the weights being calculated), since it enforces operational-quality indicators as well as storage/rail track/berth use. The main drawback would be on financial indicators, but as long as they are not far away from the average/pass value it is not seen as a big issue. To summarize, stress should be placed into (in that order):

- Vessel turnaround time
- Trucks for import export and their turnaround time
- Financial strength
- Network accessibility
- Other returns

## Interview 15:

At the beginning of the interview, after a brief initial explanation, they mention that most terminals are already constructed, so this tool should be used for modifications and terminal expansion works.

The port authority of the city where interviewed company is at, built the intermodal terminal which now is operative and has four branches to the railway terminal. Even though it has the necessary infrastructures the don´t make much use of them. However, is not a connectivity issue but a **commercial one**; they have the necessary infrastructures and the connectivity between them, but traffic along them is very discontinuous since not a high demand of this type of transport.

The project was presented to the interviewees explaining its main objectives and developments from the last years. Afterwards, different profiles where presented as well as a brief explanation of the interview.

They mention that a terminal, without a good operative it would not be a terminal and therefore, it should be one of the most important dimensions; however, financial and operational aspects must go hand in hand, so the same weighting has been assigned to both of them.

Their main goal is to have an **efficient terminal**; the service given to costumers must be the best possible, but that cannot be obtained with adequate equipment and labor utilization. At a financial level, on their opinion, benefits should be prioritized, but without having very elevated costs (60%, 40% respectively). Finally, when talking about externalities of the effects the terminal might have over society, interviewees explain that their company has a very **strong environmental policies**, and therefore, they give it a very high importance. Moreover, due to the external infrastructures they have near the terminal, they do not have many traffic related problems. Therefore, a lower weight has been given to this last sub-dimension, giving equal importance to the other two.

As the second part of the interview, relative importance of each KPI inside its corresponding sub-dimension is weighted. When talking about KPIs related to capacity efficiency, **movements within the terminal** is considered of most importance: without any movements (referring to the terminals throughput) there won't be any equipment or labor utilization. Since their main job is to operate vessels, berth utilization is very

important; there is no point on having a large number of movements at the terminal if there are no vessels arriving or leaving the terminal. Finally, they are more interested on having an average use of equipment and labor utilization than giving a higher importance to peak hours.

Given the current situation of the terminal, rail transport of containers is not prioritized. They haven't worked much with trains, only on singular occasions, which is the reasoning behind the low weighting given to this KPI. Even if the hub is there in Tarragona due to commercial issues it's not used as it should be (they have an easy connection to the container yard, and there are no spacing issues). Moreover, they have several studious showing distance and time measurements of container transport, both by train and truck and the latter one has more positive results than the former one by a large difference. In the case of enhancing rail transport it could open a wide range of options of connecting Spain with Europe.

Regarding financial aspects, return of investment and profitability are equally weighted since both of them are linked to each other.

Inside the environmental sub-dimension, some costumers have started to ask **about energy efficiency certificates**. For example, some demand that trucks transporting containers to their facilities are not diesel fueled, they should be fueled by LPG, electricity…etc. Lately there is a strong tendency on demanding the use of alternative fuels. Moreover, by improving this, the other two KPIs will improve.

The terminal has an **oversized design**, it could fit up to a billion TEUs and right now it is not even close its maximum capacity. Furthermore, the port has a large number of accesses to the terminal and enough space inside the same to manage all the incoming traffic without affecting the nearby road network. Due to this, all three KPIs have the same weighting.

As the final part of the interview, Terminal 4 has been the terminal with the highest score after all the responses given by the interviewees. Both agree with the obtained results.

## Interview 16:

The interview has been conducted on a basis of a maritime terminal.

The project presentation was shown to the interviewee, explaining an overview of the main goals and set objectives planning to achieve with the work package regarding the weighting of KPIs within an intermodal terminal. After the explanation, his main concern was about the dimensions and type of terminal; depending on whether the terminal was a hub of a gateway, operational aspects inside of the same would be very different. Moreover, having an automated terminal or not would not only change how its operational aspects but it would be financially limited as well. For example, in a not automated terminal, a higher number of movements per hour does not mean having a higher benefit since it would mean a higher stevedore cost; for this case 60% of their costs are stevedores.

Once finished explaining details regarding terminal size and type to have in mind when answering the weighting questions for KPIs, general dimensions have been addressed giving a start to the weighting process. On his personal opinion, Operational aspects have the highest weighting over the three given dimensions, however, they are **closely followed** by financial aspects. Therefore, he has given 45% and 35% weighting respectively.

When analyzing the presented sub-dimensions, inside operational aspects, a higher weighting has been given to time related matters (aka. Turnaround time of the different types of transport modes) since even though both sub-dimensions are considered important, **quality of service** is higher on their priority scale; their main goal is to have clients content.

On the other hand, sub-dimensions within financials aspects are equally weighted by the interviewee. Terminal design is a sector where **large investments** are done and **low benefits** are obtained, therefore, both profits and costs are equally critical for this operator.

Finally, regarding social and environmental aspects of the terminal, a slightly higher weighting has been placed on social commitment.

Interview was followed by individual KPI weighting within the same sub-dimension, in order to determine their relative importance inside the subgroup. For the case of Capacity efficiency related KPIs**, Berth utilization** is the interviewees number one priority. Moreover, labor utilization has also a high importance since the terminal is not automated, however, **equipment utilization** is prioritized over labor, especially the **average** use of the equipment. The main objective of the terminal is for the berth to be used as much as possible and for the machinery to be working as long as possible since they are the largest investment the terminal has to face.

When talking about time related KPIs, turnaround time of vessels is considered as extremely important compared to the remaining KPIs in the same sub-dimension. The **largest transport mode** will determine the terminals moving pace, and therefore, since vessel service time will have the highest turnaround time, it will be the most critical KPI. The interviewee has also mentioned that if the presented scale would have allowed to place a higher importance for this KPI he would have given it.

Moving on to profit related KPIs, a higher weighting has been given to Profitability, explaining how lately, **investments tend to be lower**, and therefore, their return is more achievable.

Regarding cost related KPIs, the interviewees has mentioned that CPEX will never generate any benefits. However, when OPEX are controlled, some profit can be generated. He also mentions that personal inside the terminal has been reduced and replaced by equipment. Therefore, equal weighting has been placed for both KPIs.

As the final part of the interview, final scoring for the designed terminals has been presented. For this case, Terminal 4 was considered as the most appropriate terminal according to the interviewees answers. After seeing the results, a higher weighting has been placed on berth and equipment utilization.

## Interview 17:

The following interview has been conducted to an expert on terminal design.

Firstly, before starting the design of a terminal, main objectives have to be set: it has to be decided whether local benefit are to be achieved or benefit of the logistics chain. However, the design of a terminal has to be centered on obtaining an **economic income**, as long as this is obtained, the rest of benefits are an added plus. On the other hand, its location and whether it's an automated terminal will change operative aspects within the same. For example, he has mentioned that humans are unpredictable on their actions but they can provide a higher productivity.

The interview process has started with the weighting of the general dimensions; for this case, interviewee has emphasized the importance **financial aspects** have when a terminal is being designed. All aspects of the terminal are determined according to a profitable terminal; the other two dimensions are not as important. Only minimum criteria stablished by port authorities, European agreements…etc. regarding social and environmental aspects are followed. Additional benefits (such as having a green terminal, a more efficient terminal operationally speaking…) will only be considered as long as the profitability of the terminal is not affected. He agrees that a good operative of the terminal will have to be achieved in order to obtain economic benefits (both of them are codependent), however, financial aspects are the priority.

Regarding the different sub-dimensions, asset utilization will be prioritized in order to **maximize the existing resources** while quality of service will only be improved if necessary once the minimum services are provided. When talking about sub-dimensions inside financial aspects, even if costs are important and should be contained, profits should be the main concern. Finally, all KPIs included on effects in transport network **affect truck arrival** to the terminal, which will be important in order to have a balanced transport chain. Job generation is not pursued by the interviewed profile and therefore, a low weighting has been placed on this sub-dimension.

As a third step on the interview, relative importance has been assigned to each individual KPI within the same sub-dimension.

*Capacity efficiency:*

- Labor utilization rate is important since is one of the largest costs of the company, however, importance has been placed only for **average**, and not peak time.
- Rail track utilization is not as important since that transport can be replaced by trucks. Nonetheless, it's necessary to have the option of rail transport just in case the customer demands it.
- The amount of **equipment** determined for the design of the terminal should be dimensioned for **peak hours** for it to be capable to stand the amount of movements and traffic at all times. However, this might change depending on the type of terminal being studied. For example, at the port of Barcelona, average equipment utilization is very low (since the terminal is closed on the weekends and at night), so the terminal must be ready to stand the incoming traffic at peak hours. On the other hand, the terminal in Algeciras, average rates are prioritized since it's a terminal that works 24-7.
- Storage area utilization is the most important KPI in the sub-dimension. As mentioned earlier, financial aspects are of most importance for the interviewee and by not using the maximum storage capacity, part of the initial investment placed on the terminal is going to waste.

*Time-Related:*

- Turnaround times of vessels have the highest importance out of the three KPIs. Vessels **cannot wait** for anyone else, and therefore they should be prioritized over the rest.
- Train have **time restricted windows** to follow, and cannot wait outside the terminal like trucks can (even though officially they are not allowed either). However, a higher percentage of containers is transported by trucks, ending on the same weighting placement for both of them.

*Profit:*

- Both KPIs on this sub-dimension have been weighted equally.

*Costs:*

- CAPEX is more important than OPEX. Since future operational expenditure forecasts are never met, it's important to **reduce the initial investment** to the

minimum in order to avoid extra costs. Moreover, the size of the company should also be taken into consideration, since it would determine the initial investment it can overtake.

*Social commitment:*

- Since the interviewee is not interested on job generation he has no criteria on weighting the KPIs on this sub-dimension.

*Environment:*

- Taking into account that profitability of the terminal is the main objective, energy consumption per TEU has been given the highest weighting.
- Carbon footprint per TEU has also been prioritized (but at a lower scale) since port authorities demand some **limits** on the matter.

Effects on transport network:

- As a terminal designer, the interviewee mentions that his concerns only reach all aspects included **within the terminal** and the accesses of the same; all indicator referring to external issues are not as important.
- All queuing outside the terminal must be avoided in order to not have a bottleneck at the entrance. Public authorities demand that al queuing must be done inside the terminal.

As the final section of the interview, a higher score has been placed on the "most appropriate" terminal out of the presented ones according to the weighting given along the entire process. For this case, Terminal 4 has obtained the highest score.

After this section the interviewee has given some opinions about the presented project. He has found difficult to understand where the project would fit when designing a new terminal, explaining that their train of thought followed to determine a design is very different of what INTERMODEL presents. He thinks that the shown simulations would be useful to see how a change within the terminal my affect the same, or for small terminals that do not have a large group of people working only on terminal design. He also mentions that he wouldn't trust the algorithms behind the simulation and might want to implement his own.

## Interview 18:

The first stage of the interview is carried out introducing the Intermodel Project sharing a PPT presentation. In details, are analysed the main final objects of the project and the reason of the interview itself.

Morover, the project is better analysed clarifying page by page not only the procedural aspects, but also defining the meaning of each KPI, as reported in the "Support Guide for the Interview Process" (very useful the Potential FAQ).

The interview goes on asking to the person interviewed to provide some information about his reality, in order to better understand the reference area.

The ideal location of the port in which it operates and its own location, which allows a strategic proximity to the access ways by sea, rail and land, are an excellent base for the loading and unloading operations, also favoring a penetration logic into the production areas of northern Italy and also southern Spain.

In order to continue to occupy an important position in a very competitive market, the Company has recently completed investments allowing more storage capacity of standard containers as well as to serve ships with a width up to 20 rows of containers. Many other Investments for the continuous IT updating mean that takes place in real time in order to facilitate a quick and safe transit of goods inside the terminal.

The Interviewed points out that, since he's a Port Terminal representative, will focus on the filling of the document and, particularly, on the operative aspects, even though he's fully aware of the environmental safety. That's why he gave 10% to the SOCIAL & ENVIRONMENTAL sheet 1. Weighting SEA.

The split quotes of said 10%, more importance to the social impact factors that activities such as the port ones require, in particular in those cities where the port is strictly connected with the urban pattern.

Nevertheless, the interviewee focuses on the terminal productivity and financial tools, allowing the carrying out of the activities and accomplishment of some KPI.

Effects in transportation Network is another main issue widely discussed during the interview in view also of the recent events that affected the city.

The event affected inevitably the terminal, using mainly a road traffic, not on rails. Last but not least, also the railway line has been out of service for long time. That's why the KPI "Congestion on Road Network" has a rank of 7.

Another main topic during the interview is "Social Commitment", sheet 2.5. the person interviewed points out that his opinion is highly based on his experience and on the specific problems occurring every day in a Port Terminal.

This port strictly complies with laws and standards restricting the ports operator freedom in personnel selection. They are forced to contact the Dockworkers Company. This affect the selection and the skills of the people involved in the terminal activities.

A lot of idle time affects remarkably the terminal productivity, due to personnel shift rotations or ineffective organization among the different units.

More freedom of choice to become independent to reach quality standards and so efficacy is the main purpose of the interviewee.

With reference to sheet "Choice EXP Sea", the interviewee shows Terminal 5 as his ideal terminal adding manually the KPI he considers more in line with his opinions.

## Interview 19:

At the beginning of the interview, the interviewee clarified some points as included also in the excel file.

All data into this interview are under the responsibility of the information provider as indicated under the tab "company/institution/position", the provider is a legal employee in force at the company since March 2000.

Then interviewee explained his specific role into the group: he is the leader company of company, which manages a range of different activities.

He manages with his team, made of user customer service/finance and operational, all the sales/commercial activities for the company in the Ocean sector.

The competence area is Nord East of Italy, direct clients and local forwarder.

As the one of the world's largest container shipping companies, they move 12 million containers every year and deliver to every corner of the globe.

Following the detailed description of the Intermodel project (aim, members, features), thanks also to the ppt presentation, we started the interview and the excel file filling.

Here below the comments highlighted by the interviewee on some specific KPI.

Sheet 2.1 CEfficency

**Intermodal terminal throughput**: A Shipping Company performance is related to the reliability of the full service pocket equal to track+ramp+rail, so the KPIindicators impact, basis the utilization/transit (throughout) of intermodal terminal has a low impact, Shipping Company buy from the supplier a full service which includes also the rail transport part.

**Labour Utilization Rate (Peak Time and Average):** This feedback is based to the whole labour costs (on board, on yard, agent, subagent, employees, management, network, group, subsidiaries)

**Storage Area Utilization:**

Usually Shipping Company manage the agreement with terminal authority for all terms linked to free time storage, if we need to reply basis a KPerformanceIndicator, the

impact is minimal as we take the agreement fixed with terminal and we transfer to our network (customers) the costs of demurrage and detention tariff, the agreement fixed with terminal usually match with the conditions that terminal fix also with our competitors.

**Rail Truck Utilization/Berth Track Utilization**: Shipping Company Performance is mainly based to Ocean product, we have service to/from a specific CY/Yard terminal location, and than the local country suppliers are involved with the rail track/Line, we buy from local supplier the service and we offer rail combined carrier haulage to our customers, of course more rail track are provided by local suppliers means more business opportunity and more carrier haulage, by the way for a Shipping Company finally the impact is low as the focus is the CY points structure which allow us drive more capacity into a specific area.

**KPI Related to Dry Port:** Reply is based Shipping Company analysis, so all point has the same relevance at Sea and dry port, or course the Beth item excluded from Dry Port ID

Sheet 2.2 Time

**Turnaround Time (vessels):** Shipping Company Vessel reliability is the 01st indicator For Performance at Sea Port

**Turnaround time (rail) and Turnaround Time (truck)**:

Rail service transfer directly the full container to/from Ramp Rail terminal to/from CY Container Yard Port/load Port, so the round trip of rail product need to be considered with higher score vs Truck product, all Truck product is basically more reliable in spite of rail product, but we need to clarify that this feedback is not based on a view of one worst or one better, our position is based to the handling of service, all truck product has less operation impact vs rail product, move goods all truck means of course is a value added service and means higher costs, but both are strategic and focal for a shipping company and our customers network, the answer for a maintenance of the average score need to fix rail at 6 (the consequence that vessel for us cannot be less than high tier) and truck at 2, but again wish to underline about reason which is linked to the fact that it goes without saying truck service turning out with higher reliability and the operation required minimal action vs rail service

Sheet 2.6 Env

**KPI Energy Consumption per TEU, Carbon Footprint per TEU e Use of Alternative fuel from total consumption:**

the feedback to these three points is oriented to the maintenance of average score at 0, but we need to say that performance is strictly impacted by bunker costs, environmental and all International Maritime Organization rule with commercial implication into this challenge / from January 01st 2020 the IMO will require to all carrier switch to fuels with maximum Sulphur content of 0,5%, when today the cap is 3,5% - The interviewee fully support this regulation and of course this will be a significant benefit both for environment and for human health / this fuel (0,5% Sulphur) called LOW SULPHUR is more expansive and experts on market analysis estimate an additional costs for shipping industry may be more than 30 billion USD / so the compliance with this rule means for carrier high cost for fuel more expensive, installation of scrubber means all vessel fleet need to be in dry dock so will be idle fleet, investment costs, more complex fuel handling, project of new built vessel as could be too expensive a full retrofit / so finally we planned 2019 strategy with a preparation of 2020 rule compliance, so our costs increase transferred to our network with a full clear explanation of the challenge and strategy and also with clear view of a possible significant variation depending of fuel price and length of travel --- so we are in a very strange position to fix a real Indicators of performance based on fuel, the standard bunker and carbon fuel have impact, the low Sulphur as well has impact, based on tomorrow view we can fix at 4 both standard and carbon, and low Sulphur at 7 underline the real human/earth benefit for the future

Sheet 2.7 Network:

**KPI Easiness of entry and exit from highways, rail network and Delays produced – roads:**

Average at 5 to maintain score / Shipping Company has marginal impact, the topics are linked to local industry, the high efficiency of these three indicators could be of course more helpful for Shipping profit, by the way the focal activities of Shipping is oriented to Ocean product reliability and the impact become from Ocean transport, than Shipping industry need high level service operated by terminal, than rail, truck, off dock, customs, warehouse and all others logistic service...

## Interview 20:

The first stage of the interview is carried out introducing the Intermodel Project sharing a PPT presentation. In details, are analysed the main final objects of the project and the reason of the interview itself.

Moreover, the project is better analysed clarifying page by page not only the procedural aspects, but also defining the meaning of each KPI, as reported in the "Support Guide for the Interview Process" (very useful the Potential FAQ).

The interview goes on asking to the person interviewed to provide some information about his reality, in order to better understand the reference area.

The interviewed company was founded in 19XX, is nowadays lead by a long-experience team in maritime field. Said experience has been acquired through important relationships with ship-owners, commercial, logistics and operative point of view. Moreover, as shipping agency, we provide all the necessary documents for loading/unloading of dangerous goods. Headquarters is strategically positioned, a few steps away from the main customs and easy to reach from the main highways.

They operated in three different fields: maritime, customs and logistics.

Let's start with the interview, concerning sea and dry ports both. The importance in both cases, given to the operation is 60%, which is easily understandable, since he's an operator. Financial Strength reaches the 30% and only 10% for social and environmental aspect. With reference to this last point, is more clear the rank of 40% to the Effects in Transportation Network. Score even more significant concerning Dry Ports.The evaluation of social and environmental aspects reaches an average rank of 5. More interest on OPEX cost.

# Appendix II

This appendix includes the support guide used during the interview process.

## Performance Dimensions: Identification

According to the decision-making method chosen, shortlisted indicators are distributed between operational, financial and social-environmental dimensions. It has been considered appropriate to structure indicators into subcategories according to their existing bond to facilitate pairwise comparison.
INTERMODEL framework is built upon three dimensions defined as:

**Operational Dimension**
Operational indicators are directly focused on how efficient are the processes performed in the terminal by considering the resources used and also how effective of producing the desired result. It involves 2 subgroups of indicators, expressed in terms of percentages and time:

- Capacity Efficiency
- Time-related

It is expected that the stakeholders identified as OPERATOR will put the stress in this dimension.

**Financial Strength Dimension**
Financial indicators are mainly related with the profitability of terminal operations and activities. It is considered the capacity of turning investments into revenues and benefits, as well as the use of resources to generate services and increase shareholder value.
The dimension is split in 2 groups:

- Profit
- Costs

It is expected that the stakeholders identified as INVESTOR will put the stress in this dimension.

**Social and Environmental Dimension**
Social and environmental indicators are focused on the environmental impacts on the surrounding area of the terminal as well as the enhancement of social responsibility, promotion of employment and implementation of sustainability in intermodal freight terminal performance. Moreover, it introduces indicators related with the affectation of the previous transport system which influence on the competitiveness of corresponding terminal/s.
It is divided in 3 subgroups:

- Social Commitment
- Environment
- Effects in Transportation Network

It is expected that the stakeholders identified as PUBLIC BODY will put the stress in this dimension.

## Roles of Interviewees

**Investor**

The investor is a private or public company which is primarily interested in maximizing the profit of their investments. Investors evaluate alternative investment options on the basis of return on investment (total amount of return and timing). Other aspects which could have an influence would be level of security of the investment and potentially additional aspects as value added to the society (e.g. European Development Bank) or type of the business (e.g. environmental conscious investment funds).
Focus: return on investment and timing.
Example: Pension or investment funds, European Investment Bank, European Bank for Reconstruction and Development.

**Operator**

The operator of terminals is usually a private company with operational and economic objectives. An operator is interested to achieve and sustain effective and efficient operational processes in order to achieve profitability. Operators have to organize and run the terminal operations within the given requirements, which are defined by laws, regulations and contractual agreements with their customers and suppliers.
Focus: operational effectiveness and efficiency to achieve and sustain profitability.
Example: Contship Italia as operator of a dry port operator; APM or BEST (Hutchison) terminals in Barcelona, Companies managing public terminals (FGC), Deutsche Bahn (DB).

**Public body**

A public body can be a local, regional or national government institution. An objective of a regional government could be to strengthen or support the regional competitiveness by developing the local infrastructure. Another objective of a public body could be to improve the living conditions by reducing negative environmental impacts of industries, congestion and risks for the citizens while maintaining high levels of quality employment. Typical examples are municipalities and metropolitan/regional planning authorities and port authorities with the responsibility of strategic planning.
Focus: Strategic development including, employment, environment and safety.
Example: CIMALSA (public company), Port Authority of La Spezia, Puertos del Estado (Spain), RAM Rete Autostrade Mediterranee, Ministries of Transportation and infrastructure.

## Typology of Terminal

Since a container transport network involves more than one traffic network such as maritime, road, rail or inland waterway traffic, intermodal terminals may have different networks associated to them.

On a general basis, indicators have been defined considering intermodal freight container terminals. Even though, there are some involved directly with maritime ports as their definition is based on vessels and the corresponding equipment associated.

For a correct assessment of the KPIs, a distinction between maritime terminals and inland terminals has been done. Therefore, the grading process has been performed for both sea port (gateway terminal) and dry port (railway and truck terminal) taking into account the main factors of each type.

An example case for both types of intermodal terminals has been proposed in order to clarify the vision of the terminal for grading the KPIs. Case A represents a sea port while Case B is describing a dry port.

**CASE A**

**Sea port / gateway terminal**

Manual terminal

| | |
|---|---|
| Capacity: | 1.5 Mio TEUs p.a. |
| Modes of transportation: | rail and truck and ships |
| Number of berth: | 2 |
| Length: | 1100 m |
| Depth: | 16 m |
| Dwell time: | 3 days |
| Operating hours: | 24/7 for sea port<br>14/6 for land |
| Transhipment below 20% | |

*Any other values are average*

**CASE B**

**Dry port / railway and truck terminal**

| | |
|---|---|
| Capacity: | 0.5 Mio TEU p.a. |
| Modes of transportation: | rail and truck |
| Number of rail tracks: | 3 |
| Length: | 750 m |
| Operating hours: | 14/6 |

*Any other values are average*

**Potential FAQ**

**Q) What type of project is it, greenfield or brownfield?**
A) A brownfield project has been considered.

## Definition of KPIs

A total of 23 shortlisted KPIs have been identified for sea port terminals; 19 KPIs in case of dry port terminals (those are pointed out in the general list).

Table 1. Indicators taken for a seaport terminal per dimension and subdimension

| **OPERATIONAL DIMENSION** | |
|---|---|
| **Capacity** Efficiency | 1 - Intermodal terminal throughput |
| | 2 - Equipment utilization (peak time) – *only for sea port case* |
| | 2 - Equipment utilization (average) |
| | 4 - Labour utilization rate (peak time) – *only for sea port case* |
| | 4 - Labour utilization rate (average) – *only for sea port case* |
| | 5 - Storage area utilization |
| | 6 - Rail track utilization |
| | 7 - Berth utilization – only for sea port case |
| Time-related | 8 - Turnaround time (vessels) – *only for sea port case* |
| | 8 - Turnaround time (rail) |
| | 8 - Turnaround time (trucks) |

| FINANCIAL STRENGTH DIMENSION | |
|---|---|
| Profit | 10 - Return on investment - ROI |
| | 11 - Profitability |
| Costs | 32 - Capital Expenditure - CAPEX |
| | 33 - Operational Expenditure - OPEX |

| SOCIAL & ENVIRONMENTAL DIMENSION | |
|---|---|
| Social commitment | 15 - Direct jobs sustained by terminal activities |
| | 16 - Indirect jobs sustained by terminal activities |
| Environment | 20 - Energy consumption per TEU |
| | 21 - Carbon footprint per TEU |
| | 39 - Use of alternative fuels from total consumption |
| Effects in transportation network | 18 - Congestion on road network |
| | 19 - Easiness of entry and exit from rail network |
| | 22 - Delays on access roads to the terminal |

**Intermodal terminal throughput (ID #1)**

Terminal throughput is based on the planned capacity of the infrastructure (not its current usage). It is a measure of the activity related with imported, exported or transshipped cargo. Terminals have the aim of maximize equipment and labour productivity while achieving as much throughput as possible. It is understood that 100% of planned capacity can only be achieved in rare occasions, so usually lower values would be obtained.

*Range of values considered (WORST/PASS/BEST):*

***Seaport and dry port terminals***

| | | |
|---|---|---|
| **50** | **75** | **100** |

***UNITS:***
*% of throughput over planned capacity*

**Equipment utilization on peak time (ID #2)**

Item or type of equipment use deployed in effective way over a specific period. It is defined as the proportion of time that the equipment was deployed effectively over the busiest working period (peak time). Total working time is understood as the sum of time for equipment preparation, reparation of machinery and container movements. When

the equipment is poorly maintained, the performance might be affected in a negative way.
It is understood that:

- Equipment is set (no new cranes will be purchased/deployed to adapt to the variations in the demand in a day to day basis).
- Total availability time is 24h. If stated differently by the stakeholders please introduce it as a comment.

**Potential FAQ**

**Q) What equipment should be considered?**
A) For SEAPORT terminals, it refers to % of use of QUAY CRANES.

**Q) What is meant for peak time?**
A) (Only if asked) take peak time as busiest hour of the day.

*Range of values considered (WORST/PASS/BEST):*

***Seaport terminal***

| | | |
|---|---|---|
| 60 | 75 | 90 |

***UNITS:***
*% working time during busiest hour of day*

**Equipment utilization on average (ID #2)**
Item or type of equipment use deployed in effective way over a specific period. It is defined as the proportion of time that the equipment was deployed effectively over the busiest working period (peak time). Total working time is understood as the sum of time for equipment preparation, reparation of machinery and container movements. When the equipment is poorly maintained, the performance might be affected in a negative way.
It is understood that:

- Equipment is set (no new cranes will be purchased/deployed to adapt to the variations in the demand in a day to day basis).
- Total availability time is 24h. If stated differently by the stakeholders please introduce it as a comment.

**Potential FAQ**

**Q) What equipment should be considered?**
A) For SEAPORT terminals, it refers to % of use of QUAY CRANES, for DRY PORTS it refers to % of use of GANTRY CRANES.

*Range of values considered (WORST/PASS/BEST):*

***Seaport terminals***

| | | |
|---|---|---|
| 35 | 50 | 70 |

***Dry port terminals***

| | | |
|---|---|---|
| 60 | 75 | 90 |

***UNITS:***
*% working hours (including repair and maintenance) over 24h*

**Labour utilization rate on peak time (ID #4)**
The utilization of labour is related to operational personnel, stevedoring gangs, basically. Labour needs to be monitored to know productivity per man-hour over a measured period. So, it is how effectively the available staff is working during peak time. During peak time the values are expected to be close to 100%.
Generally, it is directly related with KPI #3 because labour handles and oversees the equipment performance of the terminal unless it is an automated one.
For this specific case it refers to stevedoring gangs. In many ports (Spain at least), stevedoring gangs are contracted for times multiple of 6h, that is, contracts always take 6h, meaning that if an operation takes 15h in total, the gang will charge (and work) 18 hours in total. Therefore, achieving a 100% of labour utilization is difficult, unless productivity is reduced to fit with the time.

**Potential FAQ**

**Q) What personnel is it standing for?**
A) Most critical one is considered to be stevedores doing loading/unloading operations from ship to shore and viceversa (maritime terminal).

**Q) What is meant for peak time?**
A) (Only if asked) take peak time as busiest hour of the day.

*Range of values considered (WORST/PASS/BEST):*

***Seaport terminals***

| | | |
|---|---|---|
| 60 | 80 | 100 |

***UNITS:***
% of time effectively working over total time contracted

**Labour utilization rate on average (ID #4)**
The utilization of labour is related to operational personnel, stevedoring gangs, basically. Labour needs to be monitored to know productivity per man-hour over a measured period. So, it is how effectively the available staff is working on average.
Generally, it is directly related with KPI #3 because labour handles and oversees the equipment performance of the terminal unless it is an automated one.
For this specific case it refers to stevedoring gangs. In many ports (Spain at least), stevedoring gangs are contracted for times multiple of 6h, that is, contracts always take 6h, meaning that if an operation takes 15h in total, the gang will charge (and work) 18 hours in total. Therefore, achieving a 100% of labour utilization is difficult, unless productivity is reduced to fit with the time.
Depending on the country regulation the values are expected to vary a bit (if stevedores are not contracted ad hoc and are available during the whole day. Please write down any specifications on the local usual operation detected during the interview in that regard.

**Potential FAQ**

**Q) What personnel is it standing for?**
A) Most critical one is considered to be stevedores doing loading/unloading operations from ship to shore and vice versa (maritime terminal) and stevedores managing train gantry cranes for dry ports.

*Range of values considered (WORST/PASS/BEST):*

***Seaport terminals***

| | | |
|---|---|---|
| 35 | 50 | 70 |

***Dry port terminals***

| | | |
|---|---|---|
| 60 | 80 | 100 |

***UNITS:***
% of time effectively working over total time contracted.

**Storage area utilization (ID #5)**

Average storage yard occupation when compared to the maximum number of containers the terminal can fit. It is calculated by storage capacity in piles and slots, considering that usually not all slots can be stowed to its maximum height to allow some empty spots for container repositioning. Number of storage slots occupied are compared with the total number of available slots according to the storage yard's design capacity. The design capacity is based on footprints and stacking height.

When the storage surface is full of containers, there is a difficulty to reach some of the containers and extra (rehandling) moves need to be done. Therefore, high terminal occupation is usually translated into lower equipment efficiency, and as a consequence in case of a low rotational index of containers. Ideally, the value should be kept below 70-80%, numbers higher than that do not provide a benefit per se. It is more interesting to achieve low stay of containers at the terminal than reaching high storage utilization rates.

Range of values considered (WORST/PASS/BEST):

***Seaport terminals***

| | | |
|---|---|---|
| **40** | **70** | **85** |

***Dry port terminals***

| | | |
|---|---|---|
| **50** | **75** | **100** |

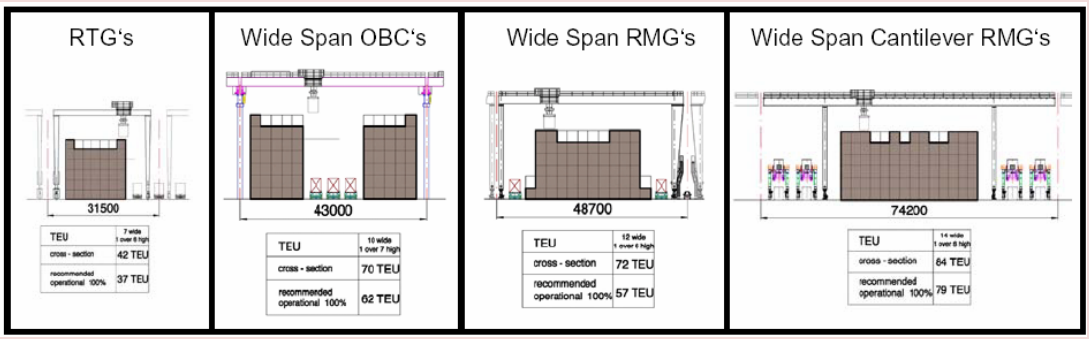
***UNITS:***
% - average number of TEUs at the terminal over total storage capacity (number of available slots)

**Potential FAQ**

**Q) How is storage capacity calculated?**

A) Is rows x height minus some slots for maneuvering purposes.

Depending on the terminal height will vary (gantry cranes allow heights up to 5 containers whereas reach stacker terminals can deal with 2-3 maximum).




**Summary area utilisation of stacking systems**
**(Based on stacking modules including transport lanes)**

| | # ground slots / hectare (TEU / ha) | Max. stacking height | Absolute max. stack capacity (TEU / ha) | Typical average operational filling rate (%) | Recommended maximum filling rate in peaks (%) | Average stack capacity (TEU / ha) | Peak stack capacity (TEU / ha) | **"Ball Park" figure (TEU / ha)** |
|---|---|---|---|---|---|---|---|---|
| Reach Stacker, block 3-wide/3-high | 258 | 3 | 774 | 55 | 85 | 426 | 658 | **425** |
| Straddle Carrier 3-high (1over3) *Spacing 4.1 m between containers* | 265 | 3 | 795 | 60 | 80 | 477 | 636 | **475** |
| RTG 6-wide (1 over 4) | 268 | 4 | 1072 | 60 | 75 | 643 | 804 | **650** |
| RTG 7-wide (1 over 5) | 286 | 5 | 1430 | 55 | 75 | 787 | 1073 | **800** |
| RMG 9-wide (1 over 4) - *Transfer at the end of the module* | 384 | 4 | 1536 | 70 | 85 | 1075 | 1306 | **1075** |
| RMG 12-wide (1 over 6) *Transfer parallel to the module* | 291 | 6 | 1746 | 60 | 85 | 1048 | 1484 | **1050** |
| WSG 18-wide (1 over 5) + *Buffers alongside 3-wide / 3-high* | 337 | 5 | 1685 | 65 | 85 | 1095 | 1432 | **1095** |
| OBC 9-wide or MT 10-wide (1 over 4) *Transfer at the end of the module* | 432 | 4 | 1728 | 70 | 85 | 1210 | 1469 | **1200** |
| MT-stacker (8-deep / 7-high) | 375 | 7 | 2625 | 65 | 90 | 1706 | 2363 | **1700** |

**Note:**
- **The recommended filling rate depends on the stacking strategy and the required workability**
- **The typical average operational filling rate is the filling as experienced in many terminals**

Source: Weischeman (2004)

**Rail track utilization (ID #6)**

The measure reflects the amount of time that the rail tracks for loading/unloading are occupied out of the total time available. That is, total time with a train on the track (either loading/unloading or idle) over total time of availability (normally 24/7/365 if not stated differently and for a justified reason.

Range of values considered (WORST/PASS/BEST):

***Seaport terminals***

| | | |
|---|---|---|
| 20 | 40 | 60 |

***Dry port terminals***

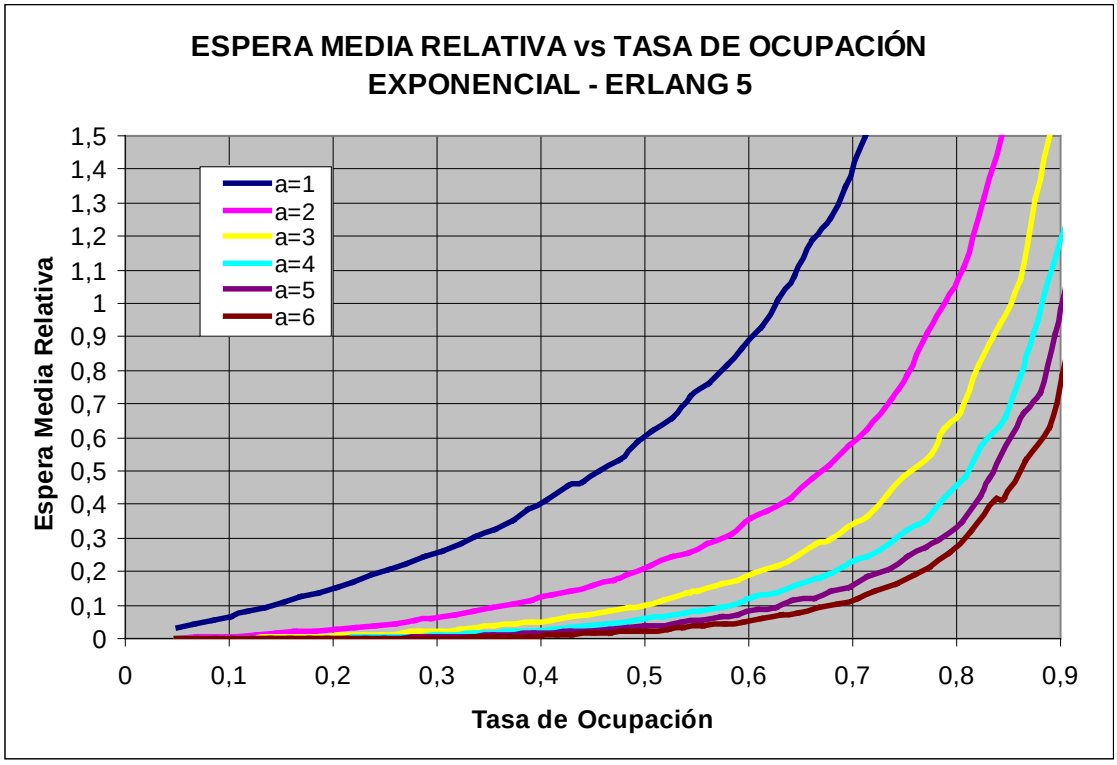
| | | |
|---|---|---|
| 35 | 50 | 90 |

***UNITS:***
% - occupation time of rail tracks over total time available (average of all rail tracks)

**Berth utilization (ID #7)**

The measure reflects the amount of time that a berth is occupied out of the total time. It is based on average berth meters in use by vessels. Mooring points are not considered. Please stress that meters occupied are being used and not overall berth (e.g. if a ship of 120m is berthed in a quay of 150m, only 80% of the berth is occupied at a given moment).

TIP: Values should be rather small. It has been demonstrated that containerships usually behave like Poisson distributed events, meaning that (using queue theory) in a terminal that can only fit 2 or 3 vessels at once, berth occupancies of 60% increase vessel turnaround times in 20%, on average, and ideally those should be close to zero (see figure below).




Range of values considered (WORST/PASS/BEST):

***Seaport terminals***

| | | |
|---|---|---|
| **30** | **60** | **85** |

***UNITS:***
% of meters occupied on berths over total available length (average of all berths)

**Turnaround time – vessels (ID #8)**

Elapsed time between a vessel arrives and departures from port. Referred to the moment a vessel is moored at berth (from when the first lash is tied to when the last lash is untied). Therefore, it includes more time than the mere loading/unloading operations, although those should correspond to the majority of the operations: bunkering, supplying, and all SOLAS (IMO, International Maritime Organization regulation) obligations take place during that time.

In addition to all of these, times spent anchoring but not berthed (i.e. waiting to have an available berth where to dock) is included as well.

It is usually linked with the effectiveness of cranes (both quay and yard cranes) as well as the % of berth occupation.

**Potential FAQ**

**Q) What vessel should be considered as "average"?**
A) Values in the grading used consider vessels with 12,000 TEU capacity and 1,500 – 2,000 movements (including loading and unloading). Use that reference value in mind when assessing how well a specific terminal (in step 3 of the interviews) is performing

Range of values considered (WORST/PASS/BEST):

***Seaport terminals***

| | | |
|---|---|---|
| 36 | 20 | 8 |

***UNITS:***
Hours (average value)

**Turnaround time – rail (ID #8)**
Elapsed time between a train arrives and departures from port. Referred to the moment a train is in the landside transfer area, although loading/unloading operations not necessary would have started yet. Therefore, loading and unloading operations plus waiting, train operations monitoring and shunting times are considered.

**Potential FAQ**

**Q) What train (how many movements) are being considered as average?**
A) Values in the grading used consider trains 450m long 70 containers (TEU) on them. Keep that reference value in mind when assessing how well a specific terminal (in step 3 of the interviews) is performing

Range of values considered (WORST/PASS/BEST):

***Seaport terminals***

| | | |
|---|---|---|
| 10 | 6 | 2 |

***Dry port terminals***

| | | |
|---|---|---|
| **8** | **4** | **2** |

***UNITS:***
Hours (average value)

**Turnaround time – trucks (ID #8)**

Elapsed time between a truck arrives and departures from the terminal. Includes from the moment the truck arrives at the queue to access the gates of the terminal (not the port ones) until it leaves the terminal through its gates. Therefore, delivery and receipt operations plus circulation within the terminal plus gate processing at entry and departure plus queueing/waiting are all considered and included.

Range of values considered (WORST/PASS/BEST):

***Seaport terminals***

| | | |
|---|---|---|
| **4** | **1** | **0.5** |

***Dry port terminals***

| | | |
|---|---|---|
| **0.75** | **0.5** | **0.25** |

***UNITS:***
Hours (average value)

**Return on investment – ROI (ID #10)**

Return on an investment relative to the investment's cost. Considered for the whole terminal expenditure and not only its equipment.

Range of values considered (WORST/PASS/BEST):

***Seaport and dry port terminals***

| | | |
|---|---|---|
| -5 | 5 | 20 |

***UNITS:***

% of benefit over the cost of the investment

**Profitability (ID #11)**

The objective is to evaluate the ability of the terminal's business to produce a return on an investment based on its resources. Terminal's profit through revenue minus total expenses in relation to business size.

Range of values considered (WORST/PASS/BEST):

***Seaport and dry port terminals***

| | | |
|---|---|---|
| 0 | 4 | 10 |

***UNITS:***

% of profit relative to revenue

**Capital Expenditure – CAPEX (ID #32)**

Sum of expenses in physical assets such as properties, buildings and equipment. All life time of the terminal (or concession time if land is publicly owned) are to be considered. It is calculated as total yearly cost during the time of operation of the terminal and its equipment divided by the total TEUs moved in a given year.

**Potential FAQ**

**Q) When talking about maintenance, what is included in CAPEX?**

A) The maintenance costs included inside CAPEX are the ones related to maintenance of infrastructures.

Range of values considered (WORST/PASS/BEST):

***Seaport and dry port terminals***

| | | |
|---|---|---|
| 180 | 150 | 120 |

***UNITS:***
€ /TEU – total CAPEX over total number of TEUs

**Operational Expenditure – OPEX (ID #33)**
Sum of normal terminal operating expenses including business, facility and personnel running costs. Staff costs and energy are expected to be the larger costs to account for. It is measured as total operating costs for a given year divided by the number of TEUs processed during that same period of time.

**Potential FAQ**

**Q) When talking about maintenance, what is included in OPEX?**
A) The maintenance costs included inside OPEX are the ones related to equipment maintenance.

Range of values considered (WORST/PASS/BEST):

***Seaport terminals***

| | | |
|---|---|---|
| **40** | **35** | **25** |

***Dry port terminals***

| | | |
|---|---|---|
| **47** | **43** | **31** |

***UNITS:***
€ /TEU

**Direct jobs sustained by terminal activities (ID #15)**
Amount of employment directly sustained and/or created by terminal activities in a given moment or over a given period. Jobs is a measure of the number of jobs required to produce a given volume of production. Describes the direct contribution of terminal activities to the creation of employment. Referred mainly to stevedores, maintenance personnel and horizontal transportation drivers.
Note that it refers to fulltime jobs, part-time employment must be considered as a fraction of a yearly job sustained. Seasonal positions should also be multiplied by the % of time those are effective.
Range of values considered (WORST/PASS/BEST):

***Seaport and dry port terminals***

| | | |
|---|---|---|
| **50** | **100** | **200** |

***UNITS:***
Jobs per million of TEUs processed in a given year

**Indirect jobs sustained by terminal activities (ID #16)**
Amount of employment indirectly sustained and/or created by terminal activities at a given period, within a given geographical area. Work places is a measure of the number of jobs required to produce a given volume of production.
Describes the indirect contribution of terminal activities to the creation of employment within a certain region. Several applications exist: upstream economic activities (sectors supplying terminal activities); downstream economic activities, mostly referred to as induced employment; strategic or catalytic effects: linked to the attraction of specific activities due to the presence of the terminal.
Range of values considered (WORST/PASS/BEST):

***Seaport and dry port terminals***

| | | |
|---|---|---|
| **75** | **150** | **500** |

***UNITS:***
Jobs per million of TEUs processed in a given year

**Energy consumption per TEU (ID #20)**
The aim is to measure the environmental improvement according to changes in modal and the efficiency of the operations at the terminal (less unproductive movements, shorter operations, less empty equipment returns), overall resulting in a better management of the terminal with positive effects both, environmentally and cost-wise. Registers usually only consider energy consumption of cranes (bigger energy consumers at a terminal), please take that in consideration when assessing the weighting provided during the 3rd step of the interview.
Range of values considered (WORST/PASS/BEST):

***Seaport and dry port terminals***

| | | |
|---|---|---|
| **30** | **10** | **2** |

***UNITS:***
KWh/TEU – energy consumed by crane over nº TEUs handled (average of all cranes)

**Carbon footprint per TEU (ID #21)**

The aim is to measure the impact that terminal activities have on the environment of the region. It is usually calculated directly linked with Energy consumption, but including fuel usage (that can sometimes be neglected in the previous indicator) and should also consider other operations related with retrieval and delivery of containers.

Range of values considered (WORST/PASS/BEST):

***Seaport and dry port terminals***

| | | |
|---|---|---|
| **40** | **15** | **5** |

***UNITS:***
Kg of $CO_2$ / TEU

**Use of alternative fuels from total consumption (ID #39)**

Percentage of alternative fuel consumption from total energy consumed. Referred not to the sources of the electricity being consumed but to the fuel being used by the equipment at the terminal (for instance LNG powered reach stacker cranes).

Range of values considered (WORST/PASS/BEST):

***Seaport and dry port terminals***

| | | |
|---|---|---|
| **0** | **20** | **100** |

***UNITS:***
% of alternative fuels consumption over total consumption on a terminal

**Congestion on road network (ID #18)**

When a new terminal is established in the territory, an increment on traffic volumes on the network occurs due to the circulation of trucks to the infrastructure. This fact is translated to an affectation on the network in terms of density which means an increase on the number of vehicles per kilometre. This indicator is focused in a more local scale as each entrance/exit might have different levels of congestion.

Range of values considered (WORST/PASS/BEST):

***Seaport and dry port terminals***

| | | |
|---|---|---|
| **100** | **50** | **0** |

***UNITS:***
Veh/km – number of vehicles per kilometre in entries/exits from highways (on average)

**Easiness of entry and exit from rail network (ID #19)**
This measure is referred to the number of slots that have missed their respective time-window, meaning that there will be a delay on the delivery. Usually it is caused by a non-optimal performance of the previous stages of the supply chain. % of missed time-windows.
Range of values considered (WORST/PASS/BEST):

***Seaport terminals***

| | | |
|---|---|---|
| 30 | 10 | 0 |

***Dry port terminals***

| | | |
|---|---|---|
| 70 | 40 | 10 |

***UNITS:***
% of missed slots over the total scheduled slots

**Delays on access roads to the terminal (ID #22)**
High use of the infrastructure connected to the freight terminal might alter the ease of entry into the terminal. Congestion leads to longer waiting times and delays of trucks. Due to the variability of access lengths to terminals, the indicator is referred to average delayed time per kilometre.
Range of values considered (WORST/PASS/BEST):

***Seaport and dry port terminals***

| | | |
|---|---|---|
| 30 | 15 | 0 |

***UNITS:***
Sec/km - average delay time per kilometer on terminal access.

## Interview Structure

Though these interviews, the relevant factors acting in freight terminals are analysed from different perspectives. As stated in previous documents, respondents who are going to take part in the process pertain to three main groups which are named as investors, operators and public bodies.
By using the Excel file provided, identified KPIs for maritime and inland terminals are going to be assessed through a three-step procedure – weighting, rating and choosing – in order to assign a weight and calibrate the listed indicators.
The interview starts with an evaluation on relevance performance based on groups and subgroups where KPIs are distributed. This step is based on allocating percentages to estimate the relative weight of these groups (and subgroups). The following is a point assignment to all KPIs through a relevance scale.
In order to calibrate weights obtained from previous stages, a third round where respondents have the opportunity of testing how their answers are reflected in reality is performed.
Respondents observe how their own weights are used to score different examples of intermodal terminals with their corresponding KPIs turned into values. Therefore, they are able to change their first answers and see the effect on every of the examples proposed.
The following Excel file is set up in different sheets comprehending the mentioned KPIs valuation steps.

### Basic information

Interviewees need to fill in the first sheet of the document with their personal details such as company or position, among other factors. Their respective characterization into operator, investor or public authority role should be done. GDPR requirements need to be fulfilled and the corresponding documents have to be signed.

| INTERVIEW - Weighting of Key Performance Indicators and Calibration | |
|---|---|
| RESPONDENT INFORMATION | |
| Role Assumed: | |
| Company / Institution: | |
| Position: | |
| Country: | |
| Gender: | |
| Other Information: | |

Figure 5. Details of respondents

## STEP 1. Weighting of Dimensions and Sub-dimensions

In order to make clear the role of the listed KPIs, they are classified into subgroups regarding to their function in an intermodal terminal. There are 7 sub-dimensions in total. Also 3 main dimensions have been identified for a further organization in which the different subgroups have been divided into.

The goal of this step is to identify the relative importance of each group or subgroup depending on the point of view of the type of stakeholder. The procedure to follow, as set out in the figure shown below, is:

- The respondent should give percentages to the three main dimensions (Operational, Financial Strength, and Social & Environmental) up to 100% overall.

- The respondent should give percentages to subgroups within the same dimension:

1. Operational Dimension: distribute 100% between capacity efficiency and time-related.
2. Financial Strength Dimension: distribute 100% between profit and costs.
3. Social and Environmental: distribute 100% between social commitment, environment and effects in transportation network.

| 1 | PERFORMANCE RELEVANCE by DIMENSIONS | |
|---|---|---|
| | Give percentages due to their importance | |
| | DIMENSION | % |
| | OPERATIONAL | |
| | FINANCIAL STRENGTH | 100% |
| | SOCIAL AND ENVIRONMENTAL | |

| 2 | PERFORMANCE RELEVANCE by SUBDIMENSIONS | | |
|---|---|---|---|
| | Give percentages due to their importance | | |
| | DIMENSION | SUBDIMENSION | % |
| | OPERATIONAL | Capacity Efficiency | |
| | | Time-Related | 100% |
| | FINANCIAL STRENGTH | Profit | |
| | | Costs | 100% |
| | SOCIAL AND ENVIRONMENTAL | Social Commitment | |
| | | Environment | 100% |
| | | Effects in Transportation Network | |

Figure 6. Assignment of relevance to main groups and subgroups

**Just fill in those cells highlighted in yellow in both tables.**

**There are two sheets for this step: one for each type of terminal (in case the respondent just wants to answer about one). Specify which terminal/s has/ve been appraised.**

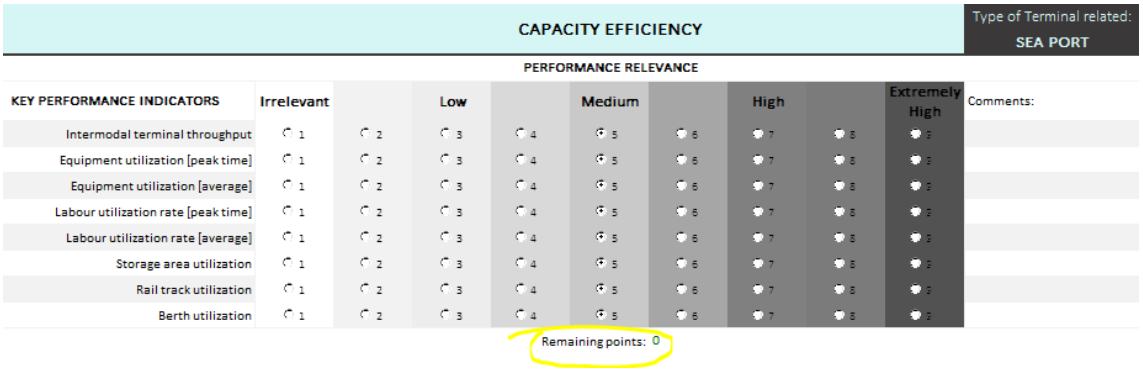
## STEP 2. Rating of KPIs

Respondents need to choose an option from 1 to 9 to evaluate the performance relevance of each key performance indicator. Having a relevance scale as a support, respondents designate the value which fits the most to each KPI taking 9 as extremely important on performance and 1 as irrelevant, considering the importance of a KPI from the group with respect to the others.

Subgroups are split into different sheets. Though, every KPI within the same subgroup can be scored from 1 to 9, but considering that the total scoring should not exceed a certain value. On the bottom part of the list, there is a cell where the remaining number of points is available.

Based on the obtained local weights and the assigned percentages to each subgroup and group, global weights of KPIs are calculated automatically on a separate sheet. Global weights are necessary for the completion of the following stage.

**Some KPIs are different for SEA and DRY Terminals. For this reason, in some sheets KPIs have been specified for which type are them. If it has not been detailed, then they are the same for both terminals.**



CAPACITY EFFICIENCY

Type of Terminal related: SEA PORT

PERFORMANCE RELEVANCE

| KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|
| Intermodal terminal throughput | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| Equipment utilization [peak time] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| Equipment utilization [average] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| Labour utilization rate [peak time] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| Labour utilization rate [average] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| Storage area utilization | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| Rail track utilization | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| Berth utilization | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

Figure 7. Relevance Scale [1 to 9] for KPIs

## STEP 3. Choice-Based Experiment

Since the aim of the project is to define the most decisive factors acting in freight terminals, the present stage will help to validate the previous weighting of KPIs.

Using the stated preference technique, four examples of intermodal terminals with KPIs turned into real feasible values and their corresponding units are outlined. Also, it is proposed a terminal with average values for all the indicators, called "Pass Terminal".
A brief summary of context for the 4 terminal scenarios is presented below:

| **Terminal 1** |
|---|
| Throughput Level: **High** |
| Freight terminal with a large amount of movements per year but also with a high rotation index, meaning that containers are not stored for long periods on the yard. It is assumed that the terminal is located in an urban area which implies a possible congestion on the network due to the high traffic levels that can be reached. Medium tariff per TEU as operational expenses are quite high. |
| **Terminal 2** |
| Throughput Level: **Low** |
| Freight terminal with a short number of movements per year. Containers have a low rotation index since they are stored for lengthy periods of time. Equipment usage is high and operational times are quite efficient, even though the movements' level is low (equipment might be oversized). It is assumed that the terminal is located in a newly developed area which leads to a small alteration on the traffic network of the area. Low income as tariff per TEU is low. |
| **Terminal 3** |
| Throughput Level: **High** |
| Freight terminal with similar characteristics as Terminal 1. Even thought, peak times are smoother so that there is a most effective use of resources. It implies a reduction on turnaround times. It is less economically efficient as it is not as competitive as other terminals. High social standards as there is a notable impact on jobs generation. In contrast, a low utilization of renewable energies on vehicles and a greater environmental impact makes it less "green". |
| **Terminal 4** |
| Throughput Level: **Medium** |
| Freight terminal with a medium throughput and the rotation index of containers is on average. Equipment utilization has low-medium levels of efficiency and storage yard is not working at full capacity (medium-low levels of use). In contrast, the financial part assumes optimal values meaning an economic development. Low environmental impact and movement on transportation network is less smooth than in other examples. |

Global weights obtained from the previous stage are applied for the calculation of a global score for the five cases to see which the best option is. If respondents do not agree with the result, global weights might be changed for more significant ones according to their own judgements. Changes can be made either on the **highlighted cell in yellow** for individual KPIs or going back to **step 1** where dimensions and sub-

dimensions are rated and modify the percentages. It depends on the respondent's willingness to assign a higher or lower importance: a whole group of KPIs or just one.

1) Modify weights until you agree with final scores of terminals:

| KPI | Intermodal terminal throughput | Equipment utilization [average] | Labour utilization rate [average] | Storage area utilization | Rail track utilization | Turnaround time (rail) | Turnaround time (truck) | Return on Investment | Profitability | CAPEX | OPEX | Direct jobs sustained by terminal activities | Indirect jobs sustained by terminal activities | Energy consumption per TEU | Carbon footprint per TEU | Use of alternative fuels from total consumption | Congestion on road network | Easiness of entry and exit from rail network | Delays on access roads to the terminal | TOTAL SCORE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| initial weight | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 50.00% | 50.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | |
| modified weight | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 50.00% | 50.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | |
| PASS Terminal | 75 % | 75 % | 80 % | 75 % | 50 % | 4 h | 30 min | 5 % | 4 % | 150 € | 43 € | 100 jobs/MTEU | 150 jobs/MTEU | 10 KWh/TEU | 15 kg CO2 /TEU | 20 % | 50 veh/km | 40 % | 15 sec/km | 5.00 |
| Terminal 1 | 94 % | 86 % | 75 % | 100 % | 90 % | 8 h | 34 min | 12.5 % | 6.5 % | 150 € | 43 € | 150 jobs/MTEU | 150 jobs/MTEU | 20 KWh/TEU | 27.5 kg CO2 /TEU | 20 % | 62 veh/km | 55 % | 23 sec/km | 5.00 |
| Terminal 2 | 56 % | 75 % | 80 % | 100 % | 50 % | 2 h 30 min | 23 min | 4 % | 2 % | 180 € | 37 € | 63 jobs/MTEU | 94 jobs/MTEU | 10 KWh/TEU | 15 kg CO2 /TEU | 20 % | 12 veh/km | 18 % | 4 sec/km | 4.00 |
| Terminal 3 | 94 % | 79 % | 85 % | 95 % | 90 % | 7 h | 30 min | 8.75 % | 2 % | 150 € | 45 € | 150 jobs/MTEU | 413 jobs/MTEU | 25 KWh/TEU | 33.8 kg CO2 /TEU | 5 % | 37 veh/km | 33 % | 11 sec/km | 4.00 |
| Terminal 4 | 75 % | 71 % | 75 % | 70 % | 60 % | 5 h | 34 min | 16 % | 6.5 % | 142.5 € | 37 € | 125 jobs/MTEU | 238 jobs/MTEU | 15 KWh/TEU | 21.25 kg CO2 /TEU | 20 % | 62 veh/km | 48 % | 19 sec/km | 6.50 |

Figure 8. Configuration of terminal scenarios (dry port case)

In case there is a modification on a single KPI (or a few of them), the value increased (or decreased) should be compensate by arranging the difference with weights from other KPIs.

On the right of the table, there are specified the scores concerning to each dimension (Operational, Financial Strength and Social & Environmental) in order to get a quick information about the strength and weak areas of terminals as shown in Figure 5.

| TOTAL SCORE | OPERATIONAL SCORE | FINANCIAL SCORE | SOCIAL & ENV. SCORE |
|---|---|---|---|
| 5.00 | 5.00 | 5.00 | 5.00 |
| 4.68 | 4.18 | 5.50 | 4.33 |
| 5.12 | 6.74 | 3.67 | 5.00 |
| 4.63 | 4.79 | 4.00 | 5.14 |
| 5.23 | 4.20 | 6.67 | 4.77 |

Figure 9. Score values for dimensions of all examples

As an alternative exercise, respondents have the chance of suggesting an intermodal terminal configuration which is called Terminal 5, where values for all KPIs can be freely chosen. Therefore, starting from a "Pass Terminal" configuration of feasible values, respondents can change them if they do not agree with the already proposed ones.

**2) Propose your own terminal:**

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Terminal 5 | 75 % | 75 % | 80 % | 75 % | 50 % | 4 h | 30 h | 5 % | 4 % | 150 € | 35 € | 100 jobs/MTEU | 150 jobs/MTEU | 10 KWh/TEU | 15 kg CO2 /TEU | 20 % | 50 veh/km | 40 % | 15 sec/km |

Figure 10. Propose a terminal (for dry port case)

# Appendix III

This appendix includes the Excel file used for the weighting of indicators during the interview process.

## INTERVIEW - Weighting of Key Performance Indicators and Calibration

### RESPONDENT INFORMATION

| | |
|---|---|
| **Role Assumed:** | |
| **Company / Institution:** | |
| **Position:** | |
| **Country:** | |
| **Gender:** | |
| **Other Information:** | |

## STEP 1: Weighting of Dimensions and Subdimensions

### Case: Sea Port

1

PERFORMANCE RELEVANCE by DIMENSIONS

Give percentages due to their importance

| DIMENSION | % |
|---|---|
| OPERATIONAL | |
| FINANCIAL STRENGTH | 100% |
| SOCIAL AND ENVIRONMENTAL | |

2

PERFORMANCE RELEVANCE by SUBDIMENSIONS

Give percentages due to their importance (per group)

| DIMENSION | SUBDIMENSION | % |
|---|---|---|
| OPERATIONAL | Asset utilization | |
| | Quality of service (time) | 100% |
| FINANCIAL STRENGTH | Profit | |
| | Costs | 100% |
| SOCIAL AND ENVIRONMENTAL | Social Commitment | |
| | Environment | 100% |
| | Effects in Transportation Network | |

## STEP 1: Weighting of Dimensions and Subdimensions

### Case: Dry Port

1

| PERFORMANCE RELEVANCE by DIMENSIONS | |
|---|---|
| Give percentages due to their importance | |
| DIMENSION | % |
| OPERATIONAL | |
| FINANCIAL STRENGTH | 100% |
| SOCIAL AND ENVIRONMENTAL | |

2

| PERFORMANCE RELEVANCE by SUBDIMENSIONS | | |
|---|---|---|
| Give percentages due to their importance (per group) | | |
| DIMENSION | SUBDIMENSION | % |
| OPERATIONAL | Asset utilization | |
| | Quality of service (time) | 100% |
| FINANCIAL STRENGTH | Profit | |
| | Costs | 100% |
| SOCIAL AND ENVIRONMENTAL | Social Commitment | |
| | Environment | 100% |
| | Effects in Transportation Network | |

Operational Dimension

## STEP 2: Rating of KPIs

### ASSET UTILIZATION

| KPIs related to Sea Port | | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| CE1 | 1 | Intermodal terminal throughput | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| CE2 | 2 | Equipment utilization (peak time) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| CE3 | 2 | Equipment utilization (average) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| CE4 | 4 | Labour utilization rate (peak time) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| CE5 | 4 | Labour utilization rate (average) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| CE6 | 5 | Storage area utilization | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| CE7 | 6 | Rail track utilization | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| CE8 | 7 | Berth utilization | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

| KPIs related to Dry Port | | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| CE1 | 1 | Intermodal terminal throughput | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| CE3 | 2 | Equipment utilization (average) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| CE5 | 4 | Labour utilization rate (average) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| CE6 | 5 | Storage area utilization | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| CE7 | 6 | Rail track utilization | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

Operational Dimension

## STEP 2: Rating of KPIs

### QUALITY OF SERVICE (TIME)

| KPIs related to Sea Port | | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| TR1 | 8 | Turnaround time (vessels) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| TR2 | 8 | Turnaround time (rail) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| TR3 | 8 | Turnaround time (truck) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

| KPIs related to Dry Port | | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| TR2 | 8 | Turnaround time (rail) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| TR3 | 8 | Turnaround time (truck) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

Financial Strength Dimension

STEP 2: Rating of KPIs

## PROFIT

| | KPIs related to Sea Port | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| PR1 | 10 | Return on investment - ROI | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| PR2 | 11 | Profitability | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

| | KPIs related to Dry Port | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| PR1 | 10 | Return on investment - ROI | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| PR2 | 11 | Profitability | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

Financial Strength Dimension

## STEP 2: Rating of KPIs

### COSTS

| KPIs related to Sea Port | | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| CS1 | 32 | Capital Expenditure - CAPEX | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| CS2 | 33 | Operational Expenditure - OPEX | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

| KPIs related to Dry Port | | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| CS1 | 32 | Capital Expenditure - CAPEX | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| CS2 | 33 | Operational Expenditure - OPEX | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

Social & Environmental Dimension

## STEP 2: Rating of KPIs

### SOCIAL COMMITMENT

| KPIs related to Sea Port | | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| SC1 | 15 | Direct jobs sustained by terminal activities | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| SC2 | 16 | Indirect jobs sustained by terminal activites | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

| KPIs related to Dry Port | | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| SC1 | 15 | Direct jobs sustained by terminal activities | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| SC2 | 16 | Indirect jobs sustained by terminal activites | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

Social & Environmental Dimension

## STEP 2: Rating of KPIs

### ENVIRONMENT

| KPIs related to Sea Port | | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| EV1 | 20 | Energy consumption per TEU | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| EV2 | 21 | Carbon footprint per TEU | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| EV3 | 39 | Use of alternative fuels from total consumption | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

| KPIs related to Dry Port | | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| EV1 | 20 | Energy consumption per TEU | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| EV2 | 21 | Carbon footprint per TEU | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| EV3 | 39 | Use of alternative fuels from total consumption | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

Social & Environmental Dimension

STEP 2: Rating of KPIs

EFFECTS IN TRANSPORTATION NETWORK

| KPIs related to Sea Port | | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| TN1 | 18 | Congestion on road network | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| TN2 | 19 | Easiness of entry and exit from rail network | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| TN3 | 22 | Delays produced on acces roads to the terminal | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

| KPIs related to Dry Port | | | PERFORMANCE RELEVANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | KEY PERFORMANCE INDICATORS | Irrelevant | | Low | | Medium | | High | | Extremely High | Comments: |
| TN1 | 18 | Congestion on road network | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| TN2 | 19 | Easiness of entry and exit from rail network | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| TN3 | 22 | Delays produced on acces roads to the terminal | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

Remaining points: 0

STEP 3: Choice Experiment

**Case: SEA PORT**

**1) Modify weights until you agree with final scores of terminals:**

| | KPI | Intermodal terminal throughput | Equipment utilization [peak time] | Equipment utilization [average] | Labour utilization rate [peak time] | Labour utilization rate [average] | Storage area utilization | Rail track utilization | Berth utilization | Turnaround time (vessels) | Turnaround time (rail) | Turnaround time (truck) | Return on investment | Profitability | CAPEX | OPEX | Direct jobs sustained by terminal activities | Indirect jobs sustained by terminal activities | Energy consumption per TEU | Carbon footprint per TEU | Use of alternative fuels from total consumption | Congestion on road network | Easiness of entry and exit from rail network | Delays on access roads to the terminal | TOTAL SCO | OPERATIONAL SCORE | FINANCIAL SCORE | SOCIAL & ENV. SCORE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | initial weight | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 50,00% | 50,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | | | | |
| 100,00% | modified weight | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 50,00% | 50,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | | | | |
| | PASS Terminal | 75% | 75% | 50% | 80% | 50% | 70% | 40% | 60% | 20 h | 6 h | 1 h | 5% | 4% | 150 l | 35 l | 100 jobs/MTEU | 150 jobs/MTEU | 10 KWh/TEU | 15 kg CO2 /TEU | 20% | 50 veh/km | 10% | 15 sec/km | 5,00 | #¡DIV/0! | 5,00 | #¡DIV/0! |
| | Terminal 1 | 95% | 86% | 65% | 75% | 46% | 85% | 40% | 85% | 36 h | 6 h 30 min | 1 h 15 min | 12.5% | 6.5% | 150 l | 35 l | 150 jobs/MTEU | 150 jobs/MTEU | 20 KWh/TEU | 27.5 kg CO2 /TEU | 20% | 62 veh/km | 20% | 23 sec/km | 5,00 | #¡DIV/0! | 5,00 | #¡DIV/0! |
| | Terminal 2 | 55% | 75% | 43% | 80% | 42.5% | 85% | 50% | 60% | 9 h | 3 h | 36 min | 4% | 2% | 180 l | 30 l | 63 jobs/MTEU | 94 jobs/MTEU | 10 KWh/TEU | 15 kg CO2 /TEU | 20% | 12 veh/km | 2.5% | 4 sec/km | 4,00 | #¡DIV/0! | 4,00 | #¡DIV/0! |
| | Terminal 3 | 95% | 79% | 65% | 85% | 65% | 81% | 50% | 85% | 30 h | 6 h | 1 h | 8.75% | 2% | 150 l | 37.5 l | 150 jobs/MTEU | 413 jobs/MTEU | 25 KWh/TEU | 33.8 kg CO2 /TEU | 5% | 37 veh/km | 7.5% | 11 sec/km | 4,00 | #¡DIV/0! | 4,00 | #¡DIV/0! |
| | Terminal 4 | 75% | 71% | 39% | 75% | 39% | 63% | 40% | 66% | 22 h | 6 h 30 min | 1 h 15 min | 16% | 6.5% | 143 l | 30 l | 125 jobs/MTEU | 238 jobs/MTEU | 15 KWh/TEU | 21.25 kg CO2 /TEU | 20% | 62 veh/km | 15% | 19 sec/km | 6,50 | #¡DIV/0! | 6,50 | #¡DIV/0! |

**2) Propose your own terminal:**

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Terminal 5 | 75% | 75% | 50% | 80% | 50% | 70% | 40% | 60% | 20 h | 6 h | 1 h | 5% | 4% | 150 l | 35 l | 100 jobs/MTEU | 150 jobs/MTEU | 10 KWh/TEU | 15 kg CO2 /TEU | 20% | 50 veh/km | 10% | 15 sec/km |

STEP 3: Choice Experiment

**Case: DRY PORT**

**1) Modify weights until you agree with final scores of terminals:**

| | KPI | Intermodal terminal throughput | Equipment utilization [average] | Labour utilization rate [average] | Storage area utilization | Rail track utilization | Turnaround time (rail) | Turnaround time (truck) | Return on Investment | Profitability | CAPEX | OPEX | Direct jobs sustained by terminal activities | Indirect jobs sustained by terminal activities | Energy consumption per TEU | Carbon footprint per TEU | Use of alternative fuels from total consumption | Congestion on road network | Easiness of entry and exit from rail network | Delays on access roads to the terminal | TOTAL SCORE | OPERATIONAL SCORE | FINANCIAL SCORE | SOCIAL & ENV. SCORE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | initial weight | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 50,00% | 50,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | | | | |
| 100,00% | modified weight | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 50,00% | 50,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | 0,00% | | | | |
| | PASS Termina | 75 % | 75 % | 80 % | 75 % | 50 % | 4 h | 30 min | 5 % | 4 % | 150 l | 43 l | 100 jobs/MTEU | 150 jobs/MTEU | 10 KWh/TEU | 15 kg CO2 /TEU | 20 % | 50 veh/km | 40 % | 15 sec/km | 5,00 | #¡DIV/0! | 5,00 | #¡DIV/0! |
| | Terminal 1 | 94 % | 86 % | 75 % | 100 % | 90 % | 8 h | 34 min | 12.5 % | 6.5 % | 150 l | 43 l | 150 jobs/MTEU | 150 jobs/MTEU | 20 KWh/TEU | 27.5 kg CO2 /TEU | 20 % | 62 veh/km | 55 % | 23 sec/km | 5,00 | #¡DIV/0! | 5,00 | #¡DIV/0! |
| | Terminal 2 | 56 % | 75 % | 80 % | 100 % | 50 % | 2 h 30 min | 23 min | 4 % | 2 % | 180 l | 37 l | 63 jobs/MTEU | 94 jobs/MTEU | 10 KWh/TEU | 15 kg CO2 /TEU | 20 % | 12 veh/km | 18 % | 4 sec/km | 4,00 | #¡DIV/0! | 4,00 | #¡DIV/0! |
| | Terminal 3 | 94 % | 79 % | 85 % | 95 % | 90 % | 7 h | 30 min | 8.75 % | 2 % | 150 l | 45 l | 150 jobs/MTEU | 413 jobs/MTEU | 25 KWh/TEU | 33.8 kg CO2 /TEU | 5 % | 37 veh/ km | 33 % | 11 sec/km | 4,00 | #¡DIV/0! | 4,00 | #¡DIV/0! |
| | Terminal 4 | 75 % | 71 % | 75 % | 70 % | 60 % | 5 h | 34 min | 16 % | 6.5 % | 143 l | 37 l | 125 jobs/MTEU | 238 jobs/MTEU | 15 KWh/TEU | 21.25 kg CO2 /TEU | 20 % | 62 veh/km | 48 % | 19 sec/km | 6,50 | #¡DIV/0! | 6,50 | #¡DIV/0! |

**2) Propose your own terminal:**

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Terminal 5 | 75 % | 75 % | 80 % | 75 % | 50 % | 4 h | 30 min | 5 % | 4 % | 150 l | 43 l | 100 jobs/MTEU | 150 jobs/MTEU | 10 KWh/TEU | 15 kg CO2 /TEU | 20 % | 50 veh/km | 40 % | 15 sec/km |

# Appendix IV

This appendix includes the presentation used to present the project during the interview process.


INTERMODEL
INTERMODEL PROJECT INTERVIEW
European Commission
Pau Morales Fusco & Míriam Benítez
CENIT (CIMNE)
HORIZON 2020
Simulation using Building Information Modeling Methodology of Multimodal, Multipurpose and Multiproduct Freight Railway Terminal Infrastructures

# TABLE OF CONTENTS

# 1. CONTEXT AND TEAM

INTERMODEL

## About the project

Funding: Horizon2020 MG 8.4 Project (GA 690658)

Goal: Develop an integrated decision support platform to assess multimodal, multiproduct and multipurpose freight rail terminals with Key Performance Indicators based on BIM methodology regarding both design and planning as well as operating phases through the whole life-cycle of the terminal (8th dimension).

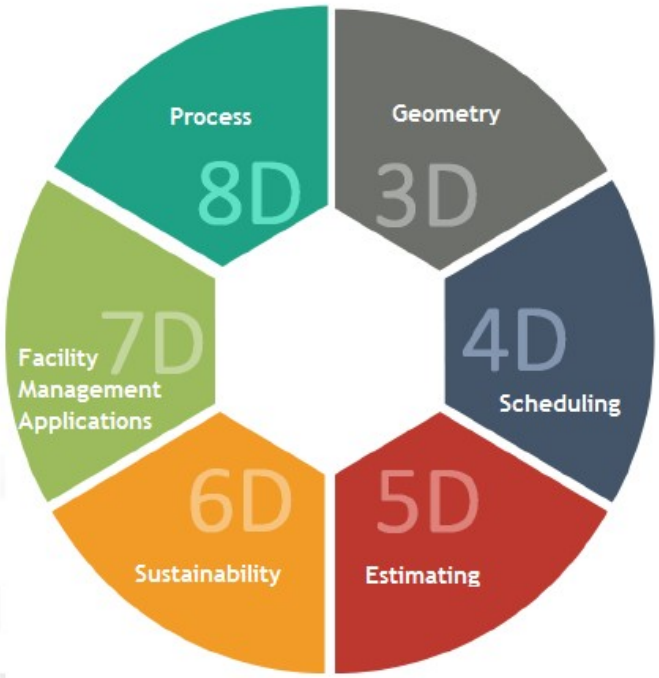
4 pilot cases: Melzo container inland terminal
La Spezia container seaport terminal
2 virtual terminals

Duration: 3 years (September 2016 – August 2019)

# 1. CONTEXT AND TEAM

INTERMODEL

## BIM Dimensions




- 3D MODEL
- 4D TIME
- 5D COST
- 6D EFFICIENCY & SUSTAINABILITY
- 7D FACILITIES MANAGEMENT
- 8D PROCESS

# 1. CONTEXT AND TEAM

## Objectives

- Improve decision making in multimodal freight terminal networks and supply chains.
- Develop planning platform (decision support tool) combining design capabilities from BIM with simulation operations software.
- Conduct comparative study assessing and evaluating alternative designs developed for greenfield and brownfield terminals, either inland or maritime, with the outputs generated by BIM – virtual design.
- Support decision making both in the fields of design and planning as well as operating phases through the whole life cycle of the terminal.
- Reduce the operational burden of the intermodal terminal on the surrounding area and on the existing logistics network regarding functional, economic and environmental dimensions, thus improving citizen's quality of life.

# 1. CONTEXT AND TEAM

INTERMODEL

## Who we are

Partnership

IDP engineering · environment · architecture

cenit Science for Transport

DHL

BASF We create chemistry

FGC Ferrocarrils de la Generalitat de Catalunya

Autorità di Sistema Portuale del Mar Ligure Orientale PORTI DI LA SPEZIA E MARINA DI CARRARA

VTT

KIRUNA WAGON Bigger, Stronger, Faster

BEDESCHI

„NORTH - SOUTH" LOGISTICS & TRANSPORT CLUSTER

MACOMI Systems Simulation

VIAS

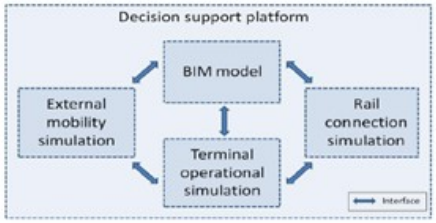
contship italia group

Viasys

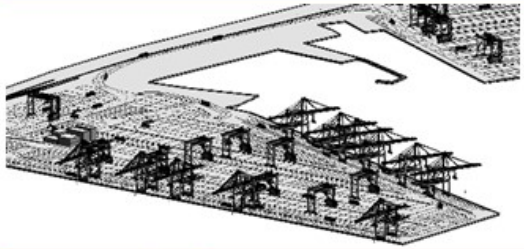
## 2. WORK DONE

INTERMODEL

### Decision support system architecture







+

SQLite

Simulación Operaciones en Terminales

+

Simulación de tráfico terrestre y ferroviario

BIM

+

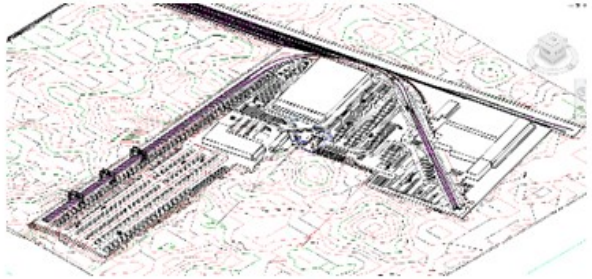
+ KPI´s

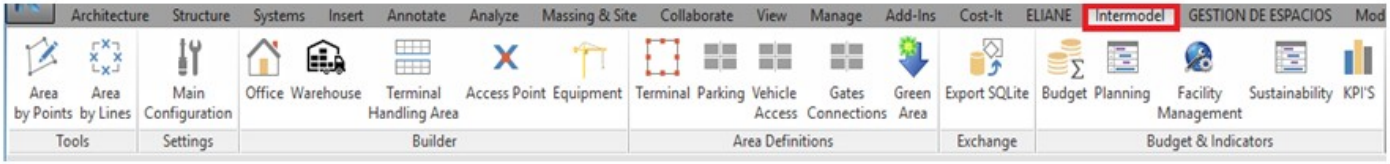
# 2. WORK DONE

INTERMODEL

## BIM modelling (example)

- Design and configuration of terminals
- Improvements introduction to terminals
- Planning, budget and management

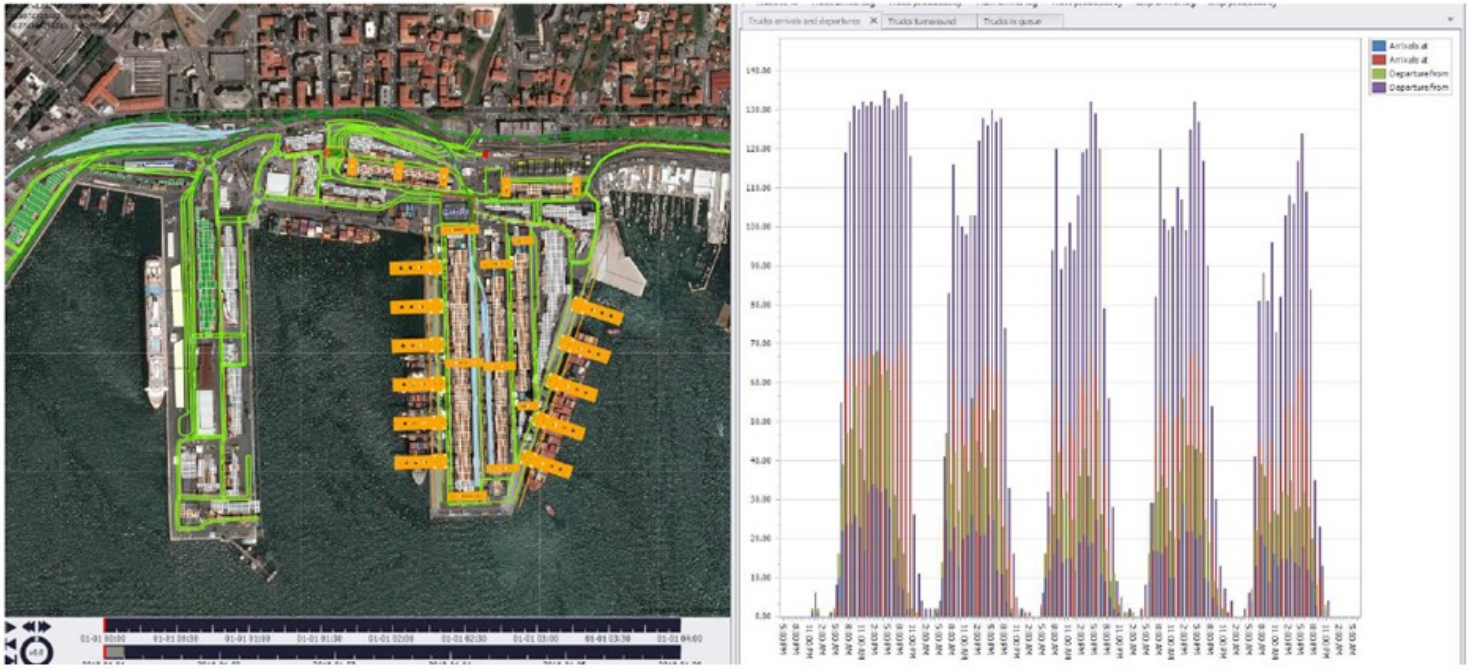





# 2. WORK DONE

INTERMODEL

## Operational simulation (example)

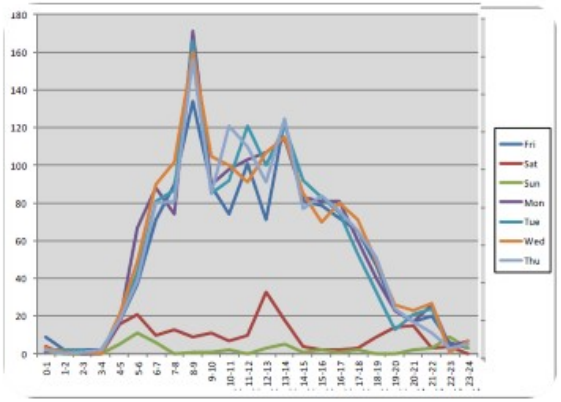


# 2. WORK DONE

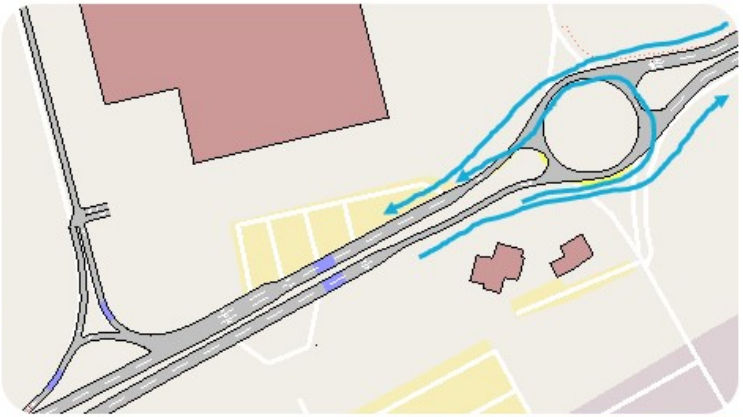
INTERMODEL

## External traffic simulation

| | | |
|---|---|---|
| [07.00-08.00] | 90 | 13 |
| [08.00-09.00] | 134 | 9 |
| [09.00-10.00] | 89 | 11 |
| [10.00-11.00] | 74 | 7 |
| [11.00-12.00] | 101 | 10 |
| [12.00-13.00] | 71 | 33 |

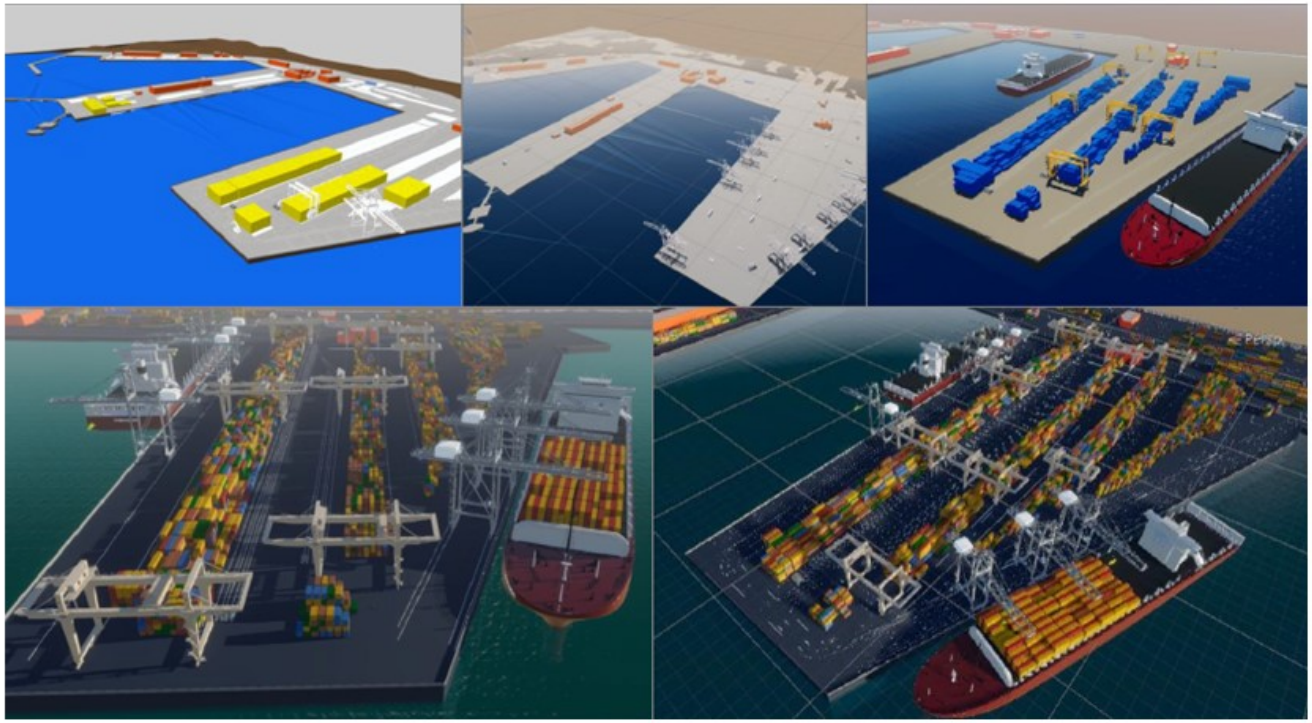






## 2. WORK DONE

### Visualization



Port of La Spezia, Italy

# 3. KPIS AND INTERVIEW DEVELOPMENT

INTERMODEL

## Performance Evaluation

OPERATIONAL (Function Based)

| Subcategory | Indicators group | Main sources used |
|---|---|---|
| Productivity/ utilization | Quay productivity/use<br>Terminal area productivity/use<br>Storage area use<br>Equipment productivity/use<br>Gate utilization<br>Berth occupancy<br>Labor productivity/use | Ferreira & Sigut, 1993;<br>Hicham Hakam, 2015;<br>Le-Griffin & Murphy, 2006;<br>Marlow & Paixão, 2003;<br>Talley, 1994;<br>UNCTAD, 1976 |
| Time-related | Turnaround time<br>Waiting time<br>Service time<br>Maneuvering time<br>Berthing time<br>Idle time<br>Cut-off time<br>Dwell time<br>Total time delays<br>Time for administrative procedures | Chung, 1993;<br>Ducruet, Itoh, & Merk, 2014;<br>Langen et al., 2007;<br>Le-Griffin & Murphy, 2006;<br>Marlow & Paixão, 2003;<br>Mat Tahar & Hussain, 2000;<br>Nam, Kwak, & Yu, 2002;<br>Pachakis & Kiremidjian, 2003;<br>Suarez-Aleman et al., 2013;<br>UNCTAD, 1976;<br>Vitsounis, 2012 |

# 3. KPIS AND INTERVIEW DEVELOPMENT

INTERMODEL

FINANCIAL (Cost Based)

| Subcategory | Indicators group | Main sources used |
|---|---|---|
| Investment and funding | Infrastructure construction<br>Equipment purchase<br>Profitability<br>Turnover<br>Revenues/Expenditures | Chung, 1993;<br>Ferreira & Sigut, 1993;<br>Talley, 2006;<br>UNCTAD, 1976 |
| Costs and pricing | Labour costs<br>Equipment costs<br>Infrastructure costs<br>Maintenance costs | Ferreira & Sigut, 1993;<br>Marlow & Paixão, 2003;<br>Talley, 2006;<br>UNCTAD, 1976 |

QUALITY OF SERVICE (Customer Based)

| Subcategory | Indicators group | Main sources used |
|---|---|---|
| Safety and security<br>Flexibility<br>Reliability and service care<br>Accessibility and connectivity | Time-related<br>% of loses or damage<br>Delays/wrong delivery<br>Employees qualification<br>Train/vessel delay in departure (%)<br>Schedule reliability | Agerschou, 2004;<br>Awad-Núñez, González-Cancelas, Soler-Flores, & Camarero-Orive, 2015;<br>Ballis, 2004;<br>Dragović et al., 2006;<br>Fourgeaud, 2000;<br>Henesey et al., 2003;<br>Huynh & Walton, 2005;<br>Marsden et al., 2007;<br>Notteboom, 2006 |

# 3. KPIS AND INTERVIEW DEVELOPMENT

INTERMODEL

ENVIRONMENTAL AND SUSTAINABILITY

| Subcategory | Indicators group | Main sources used |
|---|---|---|
| Accidents<br>Noise<br>Air pollution<br>Climate change<br>Water pollution<br>Habitat loss<br>Hydrologic impact<br>Energy consumption<br>Sprawl<br>Congestion<br>Resource efficiency | Number of transport accidents, fatalities, injured, polluting accidents, etc.<br>Crash casualties cost<br>Air pollution emission<br>Embodied emission<br>Noise pollution<br>Impervious surface coverage<br>Habitat preservation<br>Community livability<br>Water pollution<br>Use of renewal fuels<br>Energy efficiency<br>Vibrations<br>Mode split | Hanaoka & Regmi, 2011;<br>Litman, 2007,<br>Litman, 2016;<br>Marsden et al., 2007;<br>Savelson et al., 2008 |

SOCIOECONOMIC

| Subcategory | Indicators group | Main sources used |
|---|---|---|
| Economic impact<br>Return on investment | Value added per ton<br>Employment per unit of land<br>Value added per publicly invested euro<br>Terminal value added | European Sea Ports organization (ESPO), 2010;<br>Ishaq Bhatti et al., 2014;<br>Langen et al., 2007;<br>Ricci & Black, 2005 |

# 3. KPIS AND INTERVIEW DEVELOPMENT

INTERMODEL

## Selection of Stakeholders

| Actors | Functions | |
|---|---|---|
| | Hinterland / Rail network | Terminal |
| **Public Authorities** | | |
| **Planning agency** | Modal development shift<br>Economy of the metropolitan area | |
| **Port authority** | Modal shift<br>Port throughput | |
| **Operators** | | |
| **Rail operators**<br>**Haulage companies** | Volumes<br>Door-to-door transport | |
| **Shipping lines** | Haulage<br>Container logistics | Buffer |
| **Terminal operators (port, rail)** | | Management, Intermodal , Storage |
| **Freight forwarders** | Haulage | Consolidation, Deconsolidation, Buffer, Cargo added value |
| **Investor** | | |
| **Private companies**<br>**Investment organizations** | | Success in terms of financial result<br>Operating profitability |

# 3. KPIS AND INTERVIEW DEVELOPMENT

INTERMODEL

## Selection of KPIs – Simulation Results

**Operational Indicators**

- 1. Intermodal terminal throughput (volume)
- 2. Equipment utilization
- 3. Gate utilization
- 4. Labour utilization rate
- 5. Storage area utilization
- 6. Rail track utilization
- 7. Berth utilization
- 8. Turnaround time
- 9. Waiting time
- 28. Manoeuvring time
- 29. Service time
- 30. Berthing time
- 31. Idle time (equipment)

**Financial Indicators**

- 10. Return of investment (ROI)
- 11. Terminal's profitability
- 12. Operating efficiency
- 13. Operating revenues per unit
- 14. Operating benefits per unit
- 15. Direct jobs sustained from terminal activities
- 16. Indirect jobs sustained from terminal activities
- 17. Road and rail track maintenance cost
- 32. Capital expenditures (CAPEX)
- 33. Operational expenditures (OPEX)
- 34. Corrective maintenance cost - equipment
- 35. Preventive maintenance cost - equipment
- 36. Corrective maintenance cost - structures
- 37. Preventive maintenance cost - structures

**Quality Indicators**

- 18. Easiness of entry and exit from highways
- 19. Easiness of entry and exit from rail network
- 22. Delays produced (reliability) - road
- 23. Delays produced (reliability) – railway
- 36. Waiting time / turnaround time

**Environmental Indicators**

- 20. Energy consumption per handled unit
- 21. Carbon footprint per unit
- 24. CO, NOX, SOC, PM emissions
- 25. Population exposed to high levels of traffic noise
- 37. Use of alternative fuels from total consumption

**Safety Indicators**

- 26. Number of road accidents
- 27. Number of railway accidents
- 38. Accidents related to hazard cargo

*KEY PERFORMANCE INDICATOR (KPI)*
*PERFORMANCE INDICATOR (PI)*

*NOT IN SIMULATION*
*POSSIBLE TO GET FROM SIMULATION (additional calculation model required)*
*(EASILY) FROM SIMULATION*

# 3. KPIS AND INTERVIEW DEVELOPMENT

INTERMODEL

## Interviews - Steps to Follow

KPIs to include in Decision Support tool

23 KPIs for Sea Port
19 KPIs for Dry Port

**Step 1:** Rate dimensions & subdimensions
**Step 2:** Rate indicators

**Weighting**
*by pairwise comparisons*

QUESTIONNAIRE

**Step 3:** Choose the most preferred terminal scenario

**Calibration**
*(stated preference-ish)*

CHOICE-BASED EXPERIMENT

# 3. KPIS AND INTERVIEW DEVELOPMENT

## KPIs Assessed

| | |
|---|---|
| **OPERATIONAL DIMENSION** | |
| Capacity Efficiency | 1 - Intermodal terminal throughput |
| | 2 - Equipment utilization (peak time) – *only for sea port case* |
| | 2 - Equipment utilization (average) |
| | 4 - Labour utilization rate (peak time) – *only for sea port case* |
| | 4 - Labour utilization rate (average) – *only for sea port case* |
| | 5 - Storage area utilization |
| | 6 - Rail track utilization |
| | 7 - Berth utilization – only for sea port case |
| Time-related | 8 - Turnaround time (vessels) – *only for sea port case* |
| | 8 - Turnaround time (rail) |
| | 8 - Turnaround time (trucks) |
| **FINANCIAL STRENGTH DIMENSION** | |
| Profit | 10 - Return on investment - ROI |
| | 11 - Profitability |
| Costs | 32 - Capital Expenditure - CAPEX |
| | 33 - Operational Expenditure - OPEX |
| **SOCIAL & ENVIRONMENTAL DIMENSION** | |
| Social commitment | 15 - Direct jobs sustained by terminal activities |
| | 16 - Indirect jobs sustained by terminal activities |
| Environment | 20 - Energy consumption per TEU |
| | 21 - Carbon footprint per TEU |
| | 39 - Use of alternative fuels from total consumption |
| Effects in transportation network | 18 - Congestion on road network |
| | 19 - Easiness of entry and exit from rail network |
| | 22 - Delays on access roads to the terminal |

# 4. INTERVIEW

INTERMODEL

## Scenarios used for weighting

### CASE A
### Sea Port / Gateway Terminal
(manual terminal)

| | |
|---|---|
| Capacity: | 1.5 Mio TEUs p.a. |
| Modes of transportation: | rail, truck and ships |
| Number of berth: | 2 |
| Length: | 1100 m |
| Depth: | 16 m |
| Dwell time: | 3 days |
| Operating hours: | 24/7 for sea port<br>14/6 for land |
| Transshipment: | Below 20% |

*Any other values are average*

### CASE B
### Dry Port / Railway and Truck Terminal

| | |
|---|---|
| Capacity: | 0.5 Mio TEUs p.a. |
| Modes of transportation: | rail and truck |
| Number of rail tracks: | 3 |
| Length: | 750 m |
| Operating hours: | 14/6 |

*Any other values are average*

# 4. INTERVIEW

INTERMODEL

## Scenarios for choice-based experiment:

### Terminal 1

- ↑ Throughput
- ≈ Equipment/labour use
- ↑ Use of facilities (berth, rail, storage)
- ↓ Turnaround times
- ↑ Economic indicators
- ↑ Social Return
- ↓ Environmental Impact
- ↓ Effects on network

### Terminal 2

- ↓ Throughput
- ↓ Equipment/labour use
- ↑ Use of facilities (berth, rail, storage)
- ↑ Turnaround times
- ↓ Economic indicators
- ↓ Social Return
- ≈ Environmental Impact
- ↑ Effects on network

### Terminal 3

- ↑ Throughput
- ↑ Equipment/labour use
- ↑ Use of facilities (berth, rail, storage)
- ↓ Turnaround times
- ↓ Economic indicators
- ↑ Social Return
- ↓ Environmental Impact
- ↑ Effects on network

### Terminal 4

- ≈ Throughput
- ↓ Equipment/labour use
- ↓ Use of facilities (berth, rail, storage)
- ↓ Turnaround times
- ↑ Economic indicators
- ↑ Social Return
- ↓ Environmental Impact
- ↓ Effects on network


QUESTIONS?
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