
# D2.6:

# Development of the NOVIMOVE serious transport game

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## List of abbreviations

| | |
|---|---|
| CEO | Chief Execution Officer |
| CO2 | Carbon Dioxide |
| GA | General Assembly |
| IWT | Inland Waterborne Transport |
| NOVIMOVE | Novel inland waterway transport for moving freight effectively |
| TEU | Twenty-foot Equivalent Unit |
| FEU | Forty-foot Equivalent Unit |
| ToR | Terms of Reference |
| WP | Work Package |


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## Executive Summary

This deliverable relates to deliverable 2.3 and 2.5. these deliverables provide the main simulation model and integration of the different NOVIMOVE innovations which acts as the main data input for the development of the serious game database. Deliverable 2.6 describes the NOVIMOVE serious game development. The game will help to generate these insights for current stakeholder (who can make use of the NOVIMOVE innovations) and future stakeholders (e.g., transport engineering, transport economics students).

The objectives are:

- To develop the Terms of Reference (ToR) for the development of the serious game based on the NOVIMOVE transport simulation model.
- To modify the NOVIMOVE logistics simulation model to become a serious game.
- To test/validate the working of the game with different stakeholders to see if the game behaves as expected.

The literature related to serious gaming has shown that gamification gives the opportunity to users to be part of a competitive environment and at the same time to expand their knowledge in the respective sectors. It has been proven that through gamification business goals can be achieved and the learning experience could be highly improved as well. This is useful for the dissemination of the NOVIMOVE innovations.

For the NOVIMOVE game, the choice has been made to develop two separate versions, where each one of them targets a different group - higher education students and industry stakeholders – and has a unique purpose for each group. The objective for the higher education students version is purely educational while the version for the industry stakeholders is for decision making support, strategic thinking and reduction of the overall transportation costs. Each version has been set up based on the users feedback and needs, which resulted in the development of the terms of reference (ToR) of the NOVIMOVE game.

Based on the ToR, the graphic user interface was developed, including connection to the website and the database. The users have the ability to experience the NOVIMOVE simulation model from the gaming side and get more information and insights about the NOVIMOVE innovations. Currently, only the industry professional version is available, while the higher master students version will follow shortly in a new update. The game will be continuously updated from March 2023 until June 2023. A new testing round, via stakeholder meetings, is foreseen by the beginning of September 2023 (after the summer holidays) as part of task 2.7.3.

Lastly, the validation and adoption approach is developed. For the first submission of this deliverable, only the main feedback of the NOVIMOVE game during the GA in Basel is collected. Once the other meetings will have been held, as part of Task 2.7.3, the feedback will be processed, and the game will be updated. Once the update is developed, also an updated version of D.2.6 will be submitted.


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# 1 Introduction

This deliverable describes the NOVIMOVE serious game developments. In the game, players can assume the role of actor in the model. The players will make decisions which will impact on each other and the overall performance of the Inland Waterborne Transport (IWT) container sector on the Rhine Alpine corridor. The game will help generate these insights for current and future stakeholders (i.e., transport engineering, transport economics students). The game will be tested by stakeholders.

The objectives are:

- To develop the Terms of Reference (ToR) for the development of the serious game based on the NOVIMOVE transport simulation model.
- To modify the NOVIMOVE logistics simulation model to become a serious game.
- To test/validate the working of the game with different stakeholders to see if the game behaves as expected.

The overall aim of the NOVIMOVE game is to provide an interactive dissemination tool for the NOVIMOVE innovations. The “serious games” can be used for both education and stakeholder consultations. In the first step, the ToR for the development of the serious games will be set and the serious game will be developed. The serious game will cover the Rhine-Alpine corridor. “Gamers” will be able to access this game through a web portal, where they will be able to create new scenarios with altered cargo volumes, fleets, locks & other waterway settings, while examining the effectiveness of the IWT container sector.

Part of the serious game is also an interactive animation that replays the game scenario, showing exact movement of individual ships through the waterway system throughout the scenario.

This deliverable is structured as follows. Section 2 develops the ToR for the serious game. Section 3 deals with the adjustment of the simulation model to convert it into a game, while Section 4 covers the testing and the validation of the game via stakeholder reflections. Finally, Section 5 gives the final conclusions of this deliverable.


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# 2 Developing the ToR for the development of the serious game based on the NOVIMOVE transport simulation model.

## 2.1 Introduction

A method that is becoming more popular in learning and decision-making using real life data is gamification or a serious gaming. Gamification is growing as a preferred training methodology and decision-making process because it increases the appeal of learning processes, innovation, fun, productivity, and the ability to retain knowledge and acquire new skills. Gamification is considered one of the top software trends (Morschheuser et al., 2017). A serious game is acknowledged as the use of game-design elements in non-gaming contexts (Deterding et al., 2011), enhancing a service with game-related features that support users' overall value creation (Huotari & Hamari, 2017). Gamification seeks to unite functionality and engagement (Morschheuser et al., 2017), to increase usability (Saha et al., 2012), productivity, and satisfaction (Rajanen & Rajanen, 2017), to create more enjoyable experiences (Liu & Santhanam, 2017), to drive behaviours (Rodrigues et al., 2014), and to produce positive business impact (Morschheuser et al., 2015).

There is a growing number of gamification applications in multidisciplinary areas such as commerce, environment and ecological behaviour, cartography, machine learning, software development, innovation, health and medical issues, politics, education, tourism, finance and funding, energy, mobility and transportation, accessibility, fashion, usability, risk management, and marketing (Baptista & Oliveira, 2019). As will become apparent in the conclusion, there is limited work that has been done in the maritime field regarding gamification. Therefore, it is a unique opportunity for our work to be innovative and offer the users a new experience with a chance to expand their knowledge in the maritime and transportation sectors.

Gamification in freight transportation and especially in IWT is equally important as the users-gamers will have the chance to create new scenarios with altered cargo volumes, fleets, locks & other waterway settings, while examining the waterway capacity. Each scenario can be compared with others, to see how they rank, and improve their own scenario by changing relevant parameters based on learned knowledge/findings. Additionally, the players would be able to make decisions which will impact on each other and the overall performance of IWT container logistics chain, and they will be able to address broader challenges by promoting collaboration between the stakeholders and aiming also at improving their performance goals in cost-effective, pleasant and a stress-free environment.

In order to develop the NOVIMOVE game, first a literature study dealing with gamification is performed (Section 2.2). Based on this literature study the ToR for the NOVIMOVE game is developed (Section 2.3).

## 2.2 Gamification literature

### 2.2.1 Introduction

For the literature review, around 30 papers, studies, journals, websites, and thesis were reviewed, mainly in two databases, ResearchGate and ScienceDirect between May 2022 and June 2022. The keywords which were used in this literature review were ‘gamification’ and ‘serious game’, along with a combination of ‘gamification’ and ‘maritime’, transportation’, ‘education’, and ‘e-learning’. The papers and studies which are presented in this work contain the latest ones regarding gamification, maritime, transportation, education, and e-learning. The majority of these studies have already conducted a thorough literature review of the serious game topic; therefore, they were considered very accurate of our scope of work.


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### 2.2.2 Literature analysis

Baptista & Oliveira (2019) in their work *Gamification and serious games: A literature meta-analysis and integrative model* had as a primary goal to synthesise earlier gamification findings and to identify the most utilised factors mentioned in the literature and their significance. Baptista & Oliveira (2019) used for their research keywords such as 'serious games', 'games for a purpose', 'productivity games', 'behavioural games', 'pervasive games', 'augmented reality games', as well as other grammatically equivalent terms such as 'gamified', 'gamify' and 'gamifying' with the expectation to cover all the relevant topics for their scope of work. Baptista & Oliveira (2019) chose to proceed with six variables, which act as precursors (ease of use, learning opportunity, socialness, hedonic value, attitude, and enjoyment) and with four parameters (dependency, usefulness, brand attitude, and intention). The results which came up showed that attitude, enjoyment, and usefulness are the most relevant predictors of intention to use gamification, while intention, enjoyment, and usefulness are the most relevant of the brand attitude towards gamification (Baptista & Oliveira, 2019).

Gamification is considered at the moment one of the most challenging areas of software engineering. Morschheuser et al. (2018) paper seeks to advance the understanding of designing gamification and to provide a comprehensive method for developing gamified software. Their work is one of the most influential to this literature review as it identifies important parameters that have to be taken under consideration in order for our serious game to be successful. The ultimate goal of a serious game is to affect its users, and act as a motivator for them towards activities or use of technology, and thereby, increasing the quantity and quality of the output of these activities (Morschheuser et al., 2018). Morschheuser et al. (2018) indicate that gamification has become popular for more than a decade now and has since been employed in a variety of fields such as in education, health management, enterprise systems and governmental services.

Morschheuser et al. (2018), through their research, indicate that a majority of gamification implementations from organizations are doomed to failure due to poor understanding of the gamification design process. Taking the example of enterprise systems, the most common game design elements include ranking lists, points, badges, leader boards, challenges, and progress evaluations and they have already been introduced to various forms of intranet systems and enterprise social software with the intention to increase knowledge sharing, usage of these systems and productivity within organizations (Morschheuser et al., 2018). According to Morschheuser et al. (2018), various studies report positive psychological and behavioural outcomes as a result of using a serious game; These outcomes are mainly motivation, social interaction, and performance. The evaluation of the outcomes shows that there is a recurring use of specific same game elements, such as points, badges, and leader boards. Morschheuser et al. (2018) state that "*Comprehensive challenges in the design process, little research on methods for designing gamified software and missing guidelines as for how to ensure the behavioural impact of the gamification design may be reasons that discourage designers from using the full potential of games and thus failing to successfully engineer gamified software. Game engineering is a complex process that involves multidisciplinary work across psychology, design, programming*".

As already mentioned, the act of gamifying a software aims for behavioural impact and not just entertainment. Gamification attempts to mimic these experiences by employing challenges that are matched in design and presentation to game challenges. The prevailing opinion is that games invoke motivation and influence behaviour because they satisfy user's intrinsic needs, such as the needs for relatedness, mastery, or autonomy. A profound understanding of the users, their motivation, and needs, as well as the characteristics of the operational context, is fundamental for engineering gamified software. Most of the experts recommend focusing on users' needs instead of business goals and stressed the importance of user involvement especially in the ideation and design phases to ensure that a gamification design addresses actual user needs and invokes motivational experiences. Experts


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and literature recommend testing gamification ideas frequently and as early as possible to determine early on whether the design underway is appropriate for the users and the usage context or whether changes are necessary before more profound investments are undertaken. According to Morschheuser et al. (2018) it is a key principle to involve and receive the support of stakeholders as early as possible and to ensure that all stakeholders in the engineering process share a common understanding of gamification and the goals of the gamified software.

Clear metrics are important to be able to evaluate and monitor the effects of gamification features and to determine whether adjustments in the game mechanics are needed (e.g., to prevent cheating or to balance mechanics). In addition, metrics are important to evaluate the success of a gamification feature regarding the intended objectives. Gamified software could fail if legal and ethical constraints are not considered in the design phase. This is essential to ensure no infringements to for example the intellectual rights of others, as is the case in any development work. the activities of the methods extracted from the literature and next reflected upon through expert interviews can be divided into seven phases: (1) Project preparation, (2) Analysis, (3) Ideation, (4) Design, (5) Implementation, (6) Evaluation, (7) Monitoring. The identification of goals should be focused on user needs and motivational problems, rather than on business objectives. Emphasis is on understanding the users, but the importance of understanding the context-specific requirements of the gamified software were largely neglected (Morschheuser et al., 2018). indicate that working with a multidisciplinary team, bringing together technical, game-design and psychological competencies during the analysis, ideation, and design process, has been suitable in user and context understanding (Morschheuser et al., 2018).

Warmelink et al. (2020) in their research focus in the given context on examining or considering motivation, enjoyment, and flow, as the main psychological outcomes of gamification, while individual performance and efficiency are the most commonly examined or suggested behavioural and organizational impacts. Warmelink et al. (2020) refer to gamification as the design approach that implements elements (affordances, mechanics, technologies) that are familiar from games in contexts where these elements are not commonly encountered.

First, all gamification applications are designed for their users' entertainment or enjoyment. Second, gamification applications are designed for particular external consequences, for example individual behaviour and activities or organizational performance. Workers' enjoyment and work satisfaction and, consequently, organizational performance could improve if gamification delivers its promise (Warmelink et al., 2020).

Warmelink et al. (2020) focus on the aspects of production and logistics operations which are addressed, what methodologies are employed, what motivational affordances are applied or considered, and what are the expected and measured psychological, behavioural, or organizational outcomes and impacts. Their work can be taken under consideration just for their conclusions as the field which the topic is related to is not part of NOVIMOVE scope, but the results could prove to be very important. As per the previous studies, Warmelink et al. (2020) mention that much of the gamification research and in many applications, the 'points, badges and leader boards' triad has been a common way of implementing gamification, despite the calls from scholars to widen the perspective. Gamification can be further broken down to three primary elements of interest (Huotari & Hamari, 2017): gamification design, intermediate psychological outcomes, and behavioural outcomes. The field of gamification research and development is encouraged to aim for more than performance or efficiency with the gamification designs and to target more ambitious outcomes, such as process or product innovation (Warmelink et al., 2020).

*The rise of motivational information systems: A review of gamification research (Koivisto & Hamari, 2019),* is considered as another of the most influential studies for our scope as it presents in detail important outcomes from various gamification related research papers. According to Koivisto &


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Hamari (2019), gamification refers to designing information systems to afford similar experiences and motivations as games do, and consequently, attempting to affect user behaviour. In their work, Koivisto & Hamari (2019) indicate that the results in general lean towards positive findings about the effectiveness of gamification, but the number of mixed results is remarkable. Furthermore, education, health, and crowdsourcing as well as points, badges and leader boards persist as the most common contexts and ways of implementing gamification. Incorporating the engagement and enjoyment of the gameful process into activities outside games is at the core of what commonly is titled gamification. A design approach of employing game elements into different types of systems and services, with the goal of affording gameful experiences (Koivisto & Hamari, 2019).

The analysis of domains in the body of literature shows that a clear majority of the empirical research on gamification is conducted in the domain of education and learning. Second largest category of empirical studies is health and exercise, followed by research papers relating to crowdsourcing. These three categories comprise over 70% of the empirical research in the current body of literature. The fourth largest category consists of various social behaviour and networking domains, followed by empirical studies which are related to the design and development of gamification services, as well as papers in the business and management domain (Koivisto & Hamari, 2019). The above shows that there is plenty of space for projects related to gamification that could be carried out in the maritime and transportation fields.

As mentioned in the previous research, Koivisto & Hamari (2019) once again verify that the analysis of the affordances employed in the reviewed empirical literature indicate that the triad of points, badges and leader board continues to dominate the landscape of gamification. Enjoyment and experiences of "fun" were the second most frequent psychological outcome featured in the empirical research papers. Similarly, gamification is commonly framed as a method for increasing motivation towards various activities and tasks. Further aspects such as perceived usefulness or effectiveness, or the ease of use or effort required to use a system were frequently examined as psychological outcomes. The recognition from others and the sense of relatedness with other system users were also frequently studied. The behavioural outcomes also reflect the popularity of education as the main domain for the study of gamification. Course or assignment grades, and other forms of measuring academic performance were among the behavioural outcomes that were more frequently studied. Grouping the results by domain shows that in the largest domain of education/learning, most of the studies reported fully positive results. Koivisto & Hamari (2019) mention in their work that in the current gamification research, progress and achievement-oriented affordances are clearly the most commonly used, whereas e.g., immersion-related affordances (such as narratives and avatars) are much less frequent. A competitive environment may potentially discourage users, and thus have detrimental effects on the activity that the gamification originally aimed to support. Gamification is a dynamic, cyclical, two-way process in which the technology, the users, and the contextual factors of the system all contribute to the outcomes which are achieved. Gamification affects the behaviour of the users, who continue the behaviour, but not as the same "clean slates" as when they first adopted the system (Koivisto & Hamari, 2019).

Following previous studies, Mekler et al. (2017) mention that industry professionals have taken notice of the gamification trend and have attempted to apply games' motivational potential to various non-gaming contexts to foster user engagement. Mekler et al. (2017) defines "gamification" as the use of game design elements in a non-game context. They indicate that "previous research in psychology provides ample evidence that certain forms of rewards, feedback, and other external events can have detrimental effects on intrinsic motivation" verifying once more that specific parameters are important to be part of a serious game. Mekler et al. (2017) work examines how points, leader boards, and levels, three of the most employed game elements affect need satisfaction, intrinsic motivation, and performance in an image annotation task. The implementation of game elements may indeed improve


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intrinsic motivation by satisfying users' innate psychological needs for autonomy, competence, and relatedness (Mekler et al., 2017).

Points, levels, and leaderboards, in particular, have become the poster children of gamification, due to their apparent connection to digital games and due to them being readily applicable to various non-game context (Mekler et al., 2017). Once again it is apparent that these parameters are crucial to the development of a serious game. Mekler et al. (2017) analyses which are factors are crucial for a serious game and for users. They analyse the connection between points, levels, and leader boards and to various other factors. Drawing upon causality orientation theory, they further find that users perform best when provided with a challenging, but attainable performance target (i.e., levels) instead of a moderate one (Mekler et al., 2017). Moreover, in contrast to points, levels/leader boards set clear performance targets for users to aspire to, which have been associated with further performance gains (Mekler et al., 2017). Mekler et al.'s (2017) work is extremely important as it indicates that:

- Points, levels, and leader boards significantly increase competence need satisfaction, compared to the plain condition.
- Levels and leader boards significantly increase competence need satisfaction, compared to the points condition.
- Points, levels, and leader boards significantly increase intrinsic motivation, compared to the plain condition.
- Levels and leader boards significantly increase intrinsic motivation, compared to the points condition.
- The effect of points, levels and leader boards on intrinsic motivation predicted in points 3 & 4 is mediated by competence need satisfaction.

The dependent variables were user performance (number of tags and tag quality), intrinsic motivation and satisfaction of autonomy and competence needs (Mekler et al., 2017). Mekler et al. (2017) mention that autonomy-oriented participants report more intrinsic motivation than control-oriented individuals and produce also significantly more tags. This conclusion is very important as it gives an important distinction between autonomy and controlled oriented individuals.

An important part of our scope is that the serious game will be developed for higher education students. Therefore, one of the most important studies which was reviewed and proven very helpful for providing insights for our scope is Topal & Karaca (2022). Gamification is important for e-learning as it can share the same digital environment with digital game components because it has the potential to increase the engagement of the learners in digital environment (Topal & Karaca, 2022). Topal & Karaca (2022) provided three different views on gamification:

- Utilization of games directly for marketing of goods and services;
- Creation of 3D virtual worlds for acquisitions of behaviour;
- Providing a method to train users in complex environments.

According to the above-mentioned view, gamification is the utilization of thought processes, mechanics, and dynamics for the engagement of users and problem solving (Zichermann & Cunningham, 2011). According to the definition by Werbach and Hunter (2012), gamification is to inlay the behaviour in a system into games that could trigger internal motivators through elements such as rewards, leadership tables, feedbacks, storytelling, etc. to obtain business goals such as improving user activity, social interaction or the quality and productivity of the behaviour. In short, gamification does not mean designing a game or turning the game into an educational one. It focuses on a problem or desired situation. The main focus is on providing engagement-commitment and motivation between the focused situation and the individuals. The aim of the gamification in education is to dissect the game elements that render computer games entertaining and to adopt and use these elements in educational instructional processes to improve the participation and loyalty of students for learning


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and educators for instruction activities (Simoes, & Redondo ve Vilas, 2013). This entertainment factor allows users or students to focus on solving real-life problems using the motivating potential of computer games (Lee & Hammer, 2011). Gamification offers opportunities to reduce the higher dropout-incompletion and low individual motivation rates in distance education conducted with digital technologies similar to e-learning (Sun & Rueda, 2012). Game designers attempt to ensure that the player reaches this emotional state (Zichermann & Cunningham, 2011). A successful gamification design should also try to make the users feel that way. Because making people reach this emotional state means perfect gamification. Csikszentmihalyi (2008)refers to seven main components of flow. These components are the following:

- Clear Tasks: Individuals should fully understand what they should complete.
- Feedback: The individuals need clear and quick feedback on their successes and failures.
- Concentration / Focus: The individuals should be fully involved and not distracted.
- An Achievable and Balanced Goal: The goal should be challenging and attainable by an individual.
- Control: The individual should believe that her or his actions have a direct influence on the task and should, therefore, control the result.
- Reduced Self-Awareness: Intense focus on the task leaves little room for the feelings of knowing what to do and doubt. The individual becomes a part of the activity.
- Altered Sense of Time: Time perception is distorted. The individual perceives the seconds as minutes and minutes as hours. Time passes very quickly without being noticed. A successful gamification design should pay attention to these issues.

According to Topal & Karaca (2022) the different types of users are defined as following:

- Explorer: View, explore, vote, rate, curate, review, express, share, greet.
- Achiever: Win, challenge, create, show off, compare, taunt.
- Socializer: Like, help, comment, give, tease, express, share, greet.
- Killer: Harass, hack, cheat, heckle, taunt, tease.

Successful game and gamification designs should include eight main motivational reasons: meaning, accomplishment, empowerment, ownership, scarcity, avoidance, unpredictability, and social influence (Topal & Karaca, 2022).

- Meaning: Co-creator, elitism, narrative, higher meaning, humanity hero, free lunch, beginners' luck, destiny's child.
- Accomplishment: Points, fixed action rewards, badges (achievement symbols), leader board, quest list, progress bar, win prize, crowning, high-five, level-up symphony, step-by-step tutorial, boss fights, aura effect.
- Empowerment: Milestone unlock, general's carrot, choice perception, real time control, instant feedback, chain combos, boosters, voluntary autonomy, evergreen mechanics, blank fills.
- Ownership: Virtual goods, monitoring, collection sets, earned lunch, avatar, learning curve, recruitment, protection, build from scratch.
- Social Influence: Friending, seesaw bump, touting, group quest, thank-you economy, bragging, water cooler, mentorship, social treasure/gifting, social productivity.
- Scarcity: Moats, appointment dynamics, dangling, options pacing, price pacing, patient feedback, throttles, fixed intervals, countdown.
- Unpredictability: Rolling rewards, glowing choice, visual storytelling, mini quests, random rewards, sudden rewards, obvious wonder, mischief, oracle effect, Easter eggs.
- Avoidance: Visual grave, sunk-cost tragedy, FOMO, status quo sloth, evanescence opportunity, scarlet letter, weep tune, progress loss.


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The main point that needs attention in gamification design, other than game mechanics and dynamics, is the diagnosis of the problem that is needed to be solved by gamification and analysis of the context and the target audience related to the problem (Topal & Karaca, 2022). Target audience analysis is directly associated with the success of gamification (Bunchball, 2010). The dynamics are the elements in the background of the environment that can be understood when the big picture is viewed and support the gamification. Mechanics are the elements that allow players to exhibit higher engagement via motivation. The components are design objects in the foreground where the users interact.

- Dynamics: As mentioned above, dynamics are elements that do not appear directly in the gamification environment, but that is visible in the big picture. According to Werbach and Hunter (2012), the most significant dynamics are emotions (curiosity, competitiveness, frustration, happiness), constraints (limitations or forced trade-offs), narrative (a consistent, ongoing storyline), relationship (social interactions generating feelings of camaraderie, status, altruism), progression (the player's growth and development).
- Mechanics: Mechanics are the basic processes that enable users' engagement. According to Werbach and Hunter (2012), the most important mechanics are challenge (puzzles or other tasks that require effort to solve), competition (one player or group wins, and the other loses), chance (elements of randomness), cooperation (players must work together to achieve a shared goal), resource acquisition (obtaining useful or collectible items), feedback (information about how the player is doing), rewards (benefits for some action or achievement), turns (sequential participation by alternating players), transactions (trading between players, directly or through intermediaries), win states (objectives that make one player or group the winner—draw and loss states are related concepts).
- Components: Components can be referred to as more significant states of mechanics and dynamics. According to Werbach and Hunter (2012), the most important components are achievements (determined objectives), badges (visual representations of achievements), avatars (visual representations of a player's character), collections (sets of items or badges to accumulate), boss fights (especially hard challenges at the culmination of a level), content unlocking (aspects available only when players reach objectives), combat (a determined battle, typically short-lived), leader boards (visual displays of player progression and achievement), gifting (opportunities to share resources with others), points (numerical representations of game progression), levels (denied steps in player progression), social graphs (representation of players' social network within the game), quests (predetermined challenges with objectives and rewards), virtual goods (game assets with perceived or real money value), teams (determined groups of players working together for a common goal).

This model consists of following phases: define business objectives, delineate target behaviours, describe your players, devise activity cycles, do not forget the fun, deploy the appropriate tools. While gamification is considered an interesting and effective strategy to motivate students in education and instruction, implementing gamification as a method in education requires the scholars to study on and define gamification as an instructional strategy (Topal & Karaca, 2022). Points and awards may not motivate students and permanently change their behaviour without knowing the real causes behind our educational and instructional problems before implementing gamification applications. This is the most important aspect that should be considered in gamification designs (Topal & Karaca, 2022). Topal & Karaca's (2022) research is extremely useful for our scope as it identifies the most crucial factors that have to be taken under consideration when developing a serious game in education which is strongly linked to our purpose. Along with the other studies that have been presented so far, we were given an important insight on how we need to approach our scope.

With respect to the maritime sector, there is limited information about gamification applications and studies so far, thus this gives us the advantage of producing a unique piece of work. One of the most important studies which was reviewed, is omé Klock et al. (2021), who in their article describe the


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status quo of the gamification in freight transportation through a systematic literature review. Based on their results, they have outlined design recommendations and future research avenues, providing academic and practical contributions to the area. Even though their results imply that logistics and supply chain strategies are using simulation games for educational purposes, Wanick and Bui (2019) found no evidence that gamification would integrate logistics and supply chain management aspects (Tomé Klock et al., 2021).

Their review was the most comprehensive review undertaken when seeking to create an understanding of how gamification can improve freight transportation (Tomé Klock et al., 2021). Most studies focused on external logistics (60%). Together with the eight studies simultaneously gamifying external and internal logistics, 80% of the studies attempted to enhance external logistics by improving, for example, their safety, sustainability, or resilience. The majority of the studies proposed operational-level interventions, including planning and execution. Operational planning mainly pursued training users to handle complex situations such as disruptions at maritime ports or coordinating humanitarian logistics. According to Tomé Lock et al. (2021), strategic studies focused on long-term investments such as port or automated container terminal construction and highway design. Most studies focused on achievement components (41%), followed by immersion (19%) and social (18%) components, which is a pattern seen in gamification literature (Koivisto and Hamari, 2019). When analysing each affordance, challenges (14%), points (9%), role-play (9%) and cooperation (8%) were the most used (Tomé Lock et al., 2021).

The most common psychological outcomes include game experience, perceived learning, perceived usefulness and perceived reality, and the most studied behavioural outcome was efficiency. Gamification significantly improved knowledge acquisition regarding sustainability, while positive results had no statistical difference over knowledge retention. When analysing efficiency, there were statistical differences over some metrics (e.g., profit and operational costs), but others (e.g., time to complete tasks), while positive, had no statistical support (Tomé Lock et al., 2021). Simulation games were employed in all decision-making levels to address both psychological (i.e., game experience, perceived reality, perceived learning, fun, engagement, motivation, perceived usefulness, satisfaction and attitude) and behavioural (i.e., efficiency and resilience) shortcomings. Despite having majorly positive outcomes within the 12 operational-level interventions, three cases described mixed game experience results for simulation game interventions (Tomé Lock et al., 2021).

Pelegro's (2022) research was focused on using gamification for online education. The goal of this action research was to evaluate the effects of gamification on academic performance among Grade 6 online learners of Butuan Central Elementary School SSES in Mathematics (Pelegro, 2022). During the second quarter, gamification was used in both synchronous and asynchronous activities. The gamification elements, time plan, cycle, and core values were strictly adhered to. The means of two samples were computed to determine the level of academic performance between the pre-test and post-test. The data revealed that the pre-test mean value was 11.1833, indicating "Fair" academic performance. However, after gamification intervention, the mean post-test score increased to 24.4167, indicating "Very good" academic performance. Furthermore, based on the significance level and the p-value of 0.000, it was concluded that there was a significant difference in the level of academic performance of learners in Mathematics before and after the intervention. The findings suggest that the intervention's objectives were met. Thus, the gamification approach to online education is highly recommended. (Pelegro, 2022). Online learning also allows physically challenged students with more freedom to participate in learning in the virtual environment, requiring limited movement (Basilaia, 2020). The results demonstrate that the gamification elements contribute to higher learning outcomes while two user characteristics, agreeableness, and pre-training motivation, are important moderators of the links between the gamification elements and learning outcomes. The study findings indicate that a gamified system in consideration of user characteristics is an effective means to improving the efficacy of the e-learning environment (Pelegro, 2022).


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Pelegro (2022) notes that "while gamification is gaining ground in business, marketing, corporate management, and wellness initiatives, its application in education is still an emerging trend". According to Pelegro (2022), results show that most of the respondents prefer to get rewards during the learning process, follow by level, avatar, and points. Gamification in-game principals and themes such as acquiring virtual points or other currency and completing series of tasks or activities to advance to the next level, may be used in contexts other than gaming to provide fun and stimulation for the learner. Gamification can also be defined as a set of activities and processes to solve problems by using the characteristics of game elements (Pelegro, 2022). The gamification theory in education is that learners learn best when they are also having fun. Pelegro (2022) notes that "Not only this – they also learn best when they have goals, targets, and achievements to reach for, of course in a way the learner still perceives as fun. Gamification in learning involves using game-based elements such as point scoring, peer competition, teamwork, score tables to drive engagement, help students assimilate new information and test their knowledge. It can apply to school-based subjects but is also used widely in self-teaching apps and courses, showing that the effects of gamification do not stop when we are adult".

Pelegro (2022) visualizes the gamification with the following respective elements:

- **Core Values.** In today's world, it is more important than ever to instil values in our children. As educators, we are the most important and influential people in the lives of our students, and it is our responsibility to teach them core values so that they can grow up to be caring, confident, and respectful citizens of our country. Children absorb values as much as they are taught. If left without a good foundation of what values and good moral character looks like, it could negatively impact on the child's sense of right from wrong. These core values assist students in becoming more responsible and sensible over time. It enables them to gain a better understanding of life's perspective and lead a successful life as a responsible citizen. It also aids students in forming strong bonds with their families and friends. It helps students to grow in character and personality. It provides students with a positive direction in which to shape their future and even assists them in discovering their life's purpose.
    - ***Quality.*** When students have access to lifelong learning opportunities, they can demonstrate high quality core values. To succeed in their educational endeavours, students must actively participate in their learning both inside and outside the classroom. By honing their skills and confidence, students should be able to recall information accurately, think critically, comprehend deeply, apply knowledge practically, analyse thoroughly, evaluate honestly, and create freely.
    - ***Commitment.*** Commitment is a personal thing as well. It is a strong indicator of self-control, perseverance, and resilience. It is a quality that distinguishes the strong from the weak. People who are dedicated go above and beyond their comfort zones to achieve their goals. Once students have developed a sense of commitment, they will always be on time, respond quickly to activities, and actively participate.
    - ***Competence.*** This indicates that students have the ability to perform well in a task. They can perform a task or activities effectively. Students can ensure self-independence and self-reliance when doing schoolwork or even simple homework at home if they adhere to these values.
    - ***Teamwork.*** This is defined as students' ability to collaborate, communicate effectively, anticipate, and inspire confidence in one another, resulting in a coordinated collective action. Students learn how to listen to their leaders and coaches to perform their individual roles when working as a team. In order to function as a cohesive unit, students learn how to listen to one another.
    - ***Innovation.*** Students can take on new roles and responsibilities as active learners; they can engage in meaningful, authentic learning opportunities; and they can grapple with


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complexity. It also benefits education because it forces students to solve complex problems at a higher level of thinking. Innovation does not always imply the application of technology or the creation of new inventions, though these factors can help. Innovation entails a shift in thinking, which aids in the development of students' creativity and problem-solving abilities.

- ***Efficiency.*** This means that students achieved greatest educational output beyond expectations. Students become efficient and therefore better and more productive learners when they demonstrate these qualities: learn to prioritize, stay organized, don't procrastinate, and become a better note taker.

- **Points** are used in many games to quantify a player's progression through the game. Each time a player performs some type of action in a game system, the player earns experience points. The more you interact with a game system, the more experience points you earn. With this idea, the researcher adopted this concept to intensify gamification in online education. Similar to conventional grading schemes, game points systems reward students for completing various tasks, assignments, or assessments. Game points can introduce some useful affordances to learning environments, including limitless points, flexible goals, student choice, and tracking. Points can also be supplemented by academic rewards: when a certain point threshold is reached, a student might be given an extra week to submit an assignment or bonus questions on the next test. (Landers, 2015).
- **Badges.** Sometimes something tangible and symbolic can mean more than receiving points. Gamification badges are gamification elements in the form of rewards that represent a learner's achievements. Whether it's a student who just passed a test or a continuing education exam, gamification badges can be awarded to learners to show them that their accomplishments are recognized and appreciated, which can often motivate them to achieve even greater learning goals. If you're using gamification in your learning environment, keep in mind that the goal of gamification badges is to motivate learners rather than to provide them with extrinsic rewards. From a pedagogical viewpoint, the use of badges can help introduce innovation to the education environment and thus have a positive effect on promoting learning achievements (Reid et.al, 2015).
  - De Sousa Borges et.al., 2014 perform a systematic mapping review of 357 previous studies on educational gamification. The review identified seven categories that could be used to categorize such research. Based on the findings, the review concluded that the following seven features of gamification in education could improve the learning environment and improve learning performance.
    - Mastering skills: enhance or improve the learner's ability through complex and repeated activities that use gamification in education.
    - Challenge: aid the learner in actively participating in learning activities to improve their learning.
    - Guidelines: provide the theoretical background that helps with gamification setting in education context.
    - Engagement: maintain or promote the learner's interests in learning activities.
    - Learning improvement: reinforce the learner's learning activities through a gamified solution and maximize the outcomes of the learning process.
    - Behavioural change: encourage and facilitate changes in the learner's behaviours through the gamified system.
    - Socialization: provide an efficient learning behavioural change through the gamification for social activities such as communication and decision-making.
- **Leverage Leader boards.** In tracking points, teachers can use various 'checkpoints', 'levels' or Leader boards to give learners focus (and proportionate bragging rights when they achieve it). For example, when students reach an important milestone such as 100 points among others.


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Leader boards make games even more fun! Candy Crush wouldn't be half as addictive if we didn't know other players' scores. Without a little healthy competition, many games would soon become pointless (literally!), lonely and boring. Leader boards indicate who performs the best in a certain activity. Leader boards or high scores are used in most of today's games and gamified processes. The main purpose of a leader board is to boost engagement (Jan Jaap Savers, 2018). A leader board affects the players and enhances engagement through social comparison. Especially extraverted people report more positive experiences with leader boards. A leader board is a visual representation of a competition. Although leader boards are cost-effective, it is important to design and implement the leader board to encourage as many players as possible to engage in the competition. This entails not only focusing on the best scoring players, but also designing for the mainstream players within your company. Three aspects to keep in mind to correctly implement a leader board are:

- Make sure to promote the correct metric or indicator. When the scoring does not align with your company goals, a leader board can backfire.
- Do not alienate players who are not in the top ranks. The perceived gap between them and the top player can be demotivating. Slice your leader board to allow different employees rank high on different work aspects or skills. This can be done based on geography/location, on discipline or department, or per period. Resetting the leader board after a set period also gives new players a fair chance against more senior or veteran players.
- Measure the impact and success of your leader board implementation and iterate where needed (Jan Jaap Savers, 2018).

- **Receive surprise awards.** These should be given to learners for exclusive one-time opportunities. For example, learners who complete an entire learning module, or who are consistently the highest performing learner in their class or workplace, can be given awards. Essentially, a reward is given for completing a required action. However, what makes it interesting, is that users don't know what the reward will be. This is quite exciting because the unknown reward might be extremely valuable and help users to advance further in the game. Some online games offer a personalized breakdown of the player's performance at the end of each level – detailing enormous data such as achievements, points, strengths, weaknesses, and ways to reflect on their performance and compare with others. Teachers can do a similar thing – whilst students are levelling up, collecting points, and competing with one another, the teacher can be collecting data, tracking progress, and tailoring rules, rewards, and quests to motivate students further (Kanazawa, 2022).

### 2.2.3 Conclusions

It has become apparent from this literature review that the majority of studies and research reports positive psychological and behavioural outcomes as a result of using a serious game. The most common outcomes which were reported are motivation, social interaction, and performance.

When it comes to which elements the users seek to have in a serious game, the results show that points, badges, and leader boards are top of the list and are considered the triad of success for gamification. Most of the experts recommend focusing on users' needs instead of business goals and stress the importance of user involvement especially in the ideation and design phases to ensure that a gamification design addresses actual user needs and invokes motivational experiences. A profound understanding of the users, their motivation, and needs, as well as the characteristics of the operational context, is fundamental for engineering gamified software. The main point that needs attention in gamification design, other than game mechanics and dynamics, is the diagnosis of the problem that is needed to be solved by gamification and analysis of the context and the target audience related to the problem. Thus, it is very important to understand that the users should be involved in the early stages of the development process of a serious game as it is crucial for its success.


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The goal of gamifying a software is to affect behaviour and not only entertainment. The components of a successful serious game as defined by the literature review are clear tasks, feedback, concentration / focus, an achievable and balanced goal, control, reduced self-awareness and altered sense of time. Consequently, successful game and gamification designs should include eight main motivational reasons:

- Meaning;
- Accomplishment;
- Empowerment;
- Ownership;
- Scarcity;
- Avoidance;
- Unpredictability;
- Social influence.

Additionally, target audience analysis is directly associated with the success of gamification. A competitive environment may potentially discourage users, and thus have adverse effects on the activity that the gamification originally aimed to support but on the other hand users performed best when provided with a challenging, but attainable performance target (i.e., levels) instead of a moderate one. Gamification is a dynamic, cyclical, two-way process in which the technology, the users, and the contextual factors of the system all contribute to the outcomes which are achieved.

Most of the studies reported fully positive results for gamification in education. The aim of the gamification in education is to dissect the game elements that render computer games entertaining and to adopt and use these elements in educational instructional processes to improve the participation and loyalty of students for learning and educators for instruction activities. The entertainment factor allows users or students to focus on solving real-life problems using the motivating potential of computer games. The gamification theory in education is that learners learn best when they are also having fun. An important conclusion which comes from the literature review is that autonomy-oriented students report more intrinsic motivation and better results in terms of performance than control-oriented students.

Based on the literature review the following seven features of gamification in education could improve the learning environment and improve learning performance:

- **Mastering skills:** enhance or improve the learner's ability through complex and repeated activities that use gamification in education.
- **Challenge:** aid the learner in actively participating in learning activities to improve their learning.
- **Guidelines**: provide the theoretical background that helps with gamification setting in education context.
- **Engagement**: maintain or promote the learner's interests in learning activities.
- **Learning improvement**: reinforce the learner's learning activities through a gamified solution and maximize the outcomes of the learning process.
- **Behavioural change**: encourage and facilitate changes in the learner's behaviours through the gamified system.
- **Socialization**: provide an efficient learning behavioural change through the gamification for social activities such as communication and decision-making.

Gamification is important for e-learning as it can share the same digital environment with digital game components and has the potential to increase the engagement of the learners in a digital environment. Th results from the studies indicate that the gamification elements contribute to higher learning outcomes while two user characteristics, agreeableness, and pre-training motivation, are important


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moderators of the links between the gamification elements and learning outcomes. The study findings indicate that a gamified system in consideration of user characteristics is an effective means to improving the efficacy of the e-learning environment. A gamification approach to online education is highly recommended.

## 2.3 Developing the ToR to adapt the NOVIMOVE transport model to a game

### 2.3.1 Introduction

The ToR are used to set up the vision, the objectives, and the scope of the NOVIMOVE game. They are also used to provide instructions and directions for the developers on how to develop the serious game. The ToR are mostly based on the conclusions of the literature review: while using them as a guide, additional parameters have been taken into account by the project's stakeholders via discussion and via interviews. The target group of the serious game will be comprised by two different groups: the industry stakeholders and higher education students. It has been decided that two different versions of the serious game will be developed so the different needs based on the target group will be addressed. The game for the stakeholders group will provide less information and it will last less time than the other one; the aim for that latter version is to be linked to the strategy transport model of the NOVIMOVE project so it can provide valuable insights for the industry's stakeholders who are experienced professionals. The version which will be addressing the high education students aims at providing more information about the industry and expanding their knowledge and understanding of the market and the inland waterways.

### 2.3.2 Terms of Reference – Educational game

#### *2.3.2.1 Introduction*

The ToR for the higher education students version was developed with the assistance of a recent graduate from the Master's degree of Maritime and Logistics of the University of Antwerp. Mr. Wouter Schmidt provided valuable insights about the needs of that particular group. The information was obtained via an interview which lasted about 25 minutes and took place in Antwerp on 6$^{th}$ September 2022. Conversations followed up on the 29$^{th}$ of September and on the 18$^{th}$ of October for the validation of the work that has been produced. A transcript of the interview can be seen on the appendix C of this document.

#### *2.3.2.2 Duration of the game*

The gameplay will need to last at least two hours as per the advice of the users if it is a single session game. There would be additional time needed for completing the tutorial in the beginning of the game. The most preferable option would be for the game to act like a course split into three or four sessions; Each session will be lasting for at least an hour. Both options will provide the students with the opportunity to familiarize themselves with the game and gain additional knowledge of the industry and the market.

#### *2.3.2.3 Beginning of the game - Tutorial*

After launching the game, the logo of the project will appear and subsequently once the users log into the game, a tutorial will be in place among other options. The tutorial will provide detailed information to the user of what is the objective of the game, what to expect, the game rules, which items will be in place and a disclaimer. The tutorial will be mandatory for the user when they access the game for the first time and will become an optional feature, a bypass option will be in place, once the user completes the game.


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#### 2.3.2.3.1 Beginning of the game - Objective

The objective of the game is of an educational nature. The game will provide the opportunity to higher education students to expand their knowledge in the maritime industry and specifically in the inland waterways market. The students will have the opportunity to learn how the IWT market functions and how innovations can be implemented in the sector1. The game is competitive and is giving the freedom to the students to make their own decisions. It also promotes collaboration, learning activities, challenges, and socialization.

#### 2.3.2.3.2 Beginning of the game – User's Expectation

The user should expect to transport cargo from a deep sea terminal (Antwerp or Rotterdam) to an inland destination via an inland waterway using an inland vessel/barge and a truck or rail/truck for the final delivery. The user will have to complete five tasks in the tutorial phase to understand the physical operations of moving cargo via inland waterway transport, to achieve this. During the game, the user will have to calculate the cost for an IWT chain along with the transport costs of trucks or rail for the final delivery of the cargo and choose the right equipment for the all the operations. The game will be linked to IWT cost and the mode choice model2 which has been taught to the students and the user will need to make their own calculations for the transportation of cargo. Their results will be compared with the NOVIMOVE's model results at the end of the game. The users will have to pass a quiz at the end of each task. In order to finish the game all five tasks should be completed successfully. The user will earn points, rewards, and promotions for the aforementioned actions. The users will be able to watch the points that they have gathered during the game at the end of each task through a leaderboard in the game's website. Feedback will also be provided to the users as they advance in the game with respect to the calculation of the costs, the selection of the right equipment and their quiz answers. To summarise, the main task of the game will be to reduce the overall transportation costs which include the IWT and the final delivery and to complete each task successfully. Winner of the game will be the user that has collected the most points and has achieved the most promotions at the end of the final task.

The game will be an online game. This would offer the opportunity to the users to play simultaneously and compete in a "live" environment. An offline game will just show the performance of all the players and the final leaderboard after the user finishes all the tasks successfully. The cargo would be containers.

#### *2.3.2.4 Presentation of available equipment for the users*

The tutorial will give the user the opportunity to gain an understanding and explanation of the IWT cost model, the truck and rail costs and all the equipment that is being used during these kinds of operations in the supply chain process. Detailed information along with the respective photos about containers, deep sea ports, quay cranes, reach stackers, deep sea containers vessels, barges, inland waterways, locks, bridges, inland ports, trucks and rail will be presented to the user. The information provided below aims at the student's better understanding of the maritime industry and the inland waterways and might not be used in full context during the game.

The information about the above-mentioned parameters will include:

- ***Containers:*** Types of Containers

[1] This part of the course Hinterlandvervoer & Inland Navigation school taught at University of Antwerp.
[2] The cost calculations and the mode choice analysis are taught at different courses (Hinterlandvervoer & Inland navigation school) at which exiting models are used to teach the students the aforementioned concepts.


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- ***Deep Sea Ports:*** Quay Draught, Quay Capacity, Number of Quay Cranes, Number of mobile Cranes, Equipment, Capacity of Warehouse, Connectivity (Barges, Truck & Rail), Waiting Time, Anchorage
- ***Quay Cranes:*** Size, Capacity, Operation, Power
- ***Deep Sea Vessel:*** Size, Capacity, LOA, Draught, Engine Type, Fuel, Minimum number of cranes which need to be used for efficient loading and unloading
- ***Barges:*** Sizes, Capacity, LOA, Draught, Engine Type, Fuel
- ***Inland Waterways:*** Draught, Width of the channel, Total Distance, Number of Locks.
- ***Locks:*** LOA, Opening Slots, Time Constraints, Capacity
- ***Bridges:*** Air Draught, Permissible Barge Dimensions
- ***Inland Ports:*** Quay Draught, Quay Capacity, Number of Quay Cranes, Number of mobile Cranes, Equipment, Capacity of Warehouse, Connectivity (Barges, Truck & Rail), Waiting Time, Anchorage
- ***Trucks:*** Capacity, Fuel Type, Proper Utilization of this mode of transport
- ***Rail:*** Capacity, Fuel Type, Proper Utilization of this mode of transport

#### *2.3.2.5 Disclaimer*

The disclaimer would appear during the registration of the user on the website and in the tutorial and would refer to the purpose of the game, its intentions and the legal side of it. The disclaimer would make clear that the game is based upon scientific principles, professional judgment to certain facts with resultant subjective interpretations and that NOVIMOVE is not responsible for the usage of the game other than the intended use. Professional judgments expressed herein are based on the currently available facts within the limits of existing data, scope of work, budget, and schedule. The game cannot, and makes no attempt to, anticipate all changes to those conditions and circumstances, which occur after its date of issue.

#### *2.3.2.6 Starting the game*

Starting the game, the student will have to register their profile in the game's website by entering their email, their full name, a password, their organization (university), the gender, age group and their interests in the maritime industry. The registration of data is in line with NOVIMOVE guidelines on data management and ethics as described in deliverables D6.4, D7.1 and D7.2.

The interests will include but will not be limited to options such as operations, logistics, supply chain, transport economics, port economics, terminal operators, shipping etc.

A consent form will be in place. This will allow the users to opt out from sharing this information. In that case only the username and the password will be required. Once the user's profile is completed, the user would be able to download the game from the website and subsequently install the game and start playing it. The game will be a single player mode. A multiplayer mode will be considered for the future.

#### *2.3.2.7 Graphical User Interface*

The interface of the game would include an office which represents the management building of a terminal, a deep sea terminal where all the operations will be taking place and a screen where the user will be able to choose the origin-destination pair for which they would like to transport the cargo. Additionally, a separate screen will be in place in which the user will be getting their results in terms of graphs. The waterway route will be presented on a map with a red colour while when the barge icon is moving from task to task, the route will be turning into green colour, indicating that the specific part of the route has been completed successfully.

An icon representing a barge, or a small vessel will appear along the waterway corridor indicating to the user the distance that has been covered so far. Additionally, a truck icon and a rail icon will be


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present when the user switches to these modes of transport. The icons will be similar to the graphics that applications like Uber are using in their interfaces.

The starting point would be the deep sea terminal, either ports of Antwerp or Rotterdam which will be pinpointed on the map. The map will show the locations of the lock(s) along the way as well as the location of the inland terminal(s) and the final destination where the cargo will be delivered. The final destination will be an inland location in central Europe.

Once the user enters the terminal view option of the game, they will be able to observe the unloading of containers from a deep sea vessel to the terminal's quay by an STS crane, the movement of containers by a straddle carrier to the terminals yard and subsequently the loading of containers on an inland vessel. The users will be able to wander around the terminal area and they can get the technical characteristics of all the relevant equipment which is used in a deep sea terminal by collecting spinning diamonds. Once the user steps on a spinning diamond, the technical characteristics of the relevant piece of equipment which is nearby will appear on the screen along with a photo of the equipment.

The user will not be able to go to each location from the very first moment; the locations will unlock for further usage as the user completes the tasks. Once a task is completed successfully, the barge icon will be moving towards the next task on the map following the waterway route.

While the barge is passing by a lock, the user will have the option the observe the operations happening there in a similar way to the terminal view option. Additionally, the user will be getting the same information about the lock with the ones shared at the tutorial.

Similar experience would be in the inland terminal where the user would be able to watch the loading or unloading of the containers to a truck or a train in addition to the quay operations and the movement of containers in the port's yard.

There would be also an option for the user to communicate via text of voice messages to other users. Additionally, an icon for a menu option would be in place.

#### *2.3.2.8 Game Rules – Gameplay*

Once the game starts, the user will be receiving instructions at the main screen. A message will appear indicating the location where the cargo has to be delivered, the amount of cargo that has to be transported, the distance between the inland terminal and the final destination, the canal water draught, the air draught of the bridge and the size of the lock. In detail:

- The location will be a real place in inland central Europe;
- The amount of cargo would be expressed in TEU;
- The distance between the inland terminal and the final destination will be expressed in km;
- The canal water draught will be expressed in meters;
- The air draught of the bridge will be expressed in meters;
- The size of the lock will be expressed in meters.

The user will have to accept the mission by clicking a green button appearing right below the message saying "Accept". Once the user accepts the mission, the message will disappear, but the user will be able to access it at any point during the game via the menu.

Once the user accepts the mission details, they will be prompt to calculate the inland waterway costs and the mode choice based on the different sub-models presented in the tutorial and taught already to the students. In the final task, the students will need to calculate the final transportation costs based on the trucks or rail. For each task, the user will be getting a new screen in which (s)he will need to choose the right equipment for a particular task as indicated further below. The screen will be showing all the available options for the user along with the technical characteristics of the items. For example,


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when the user will be prompted to choose the right barge for transporting the containers, a photo of them will be available along with their technical characteristics; information which the user will need in order to make the right choice based on the instructions received at the earlier stage.

#### 2.3.2.8.1 Game Rules – Calculating cost and mode share IWT transport & choosing the right equipment

The starting point will be either Antwerp or Rotterdam. The respective cargo flows will be based on the ones which are already in use in the NOVIMOVE simulation model. Each time a user starts a new campaign, the game will generate new limitations for the parameters that are crucial for transporting the cargo such as the canal draught, the canal width, the air draught of the bridge and the size of the lock. The user will need to use the details of the mission for this task. For the final delivery of the cargo from the inland port, they will need to decide which mode of transport to select which will lead them to reducing the overall transportation costs. The options will be either trucks or rail. The total transportation costs from the deep sea terminal to the final destination will be compared at the end with the results of the NOVIMOVE simulation model.

Calculating the cost and the mode share of the IWT transport and the final delivery of the cargo will be the main task of the game. Choosing the right equipment for the operations will be in place just for educational reasons. This will give the opportunity to students to familiarize themselves with port operations and gain an understanding of the supply chain process.

#### 2.3.2.8.2 Game Rules – Score, Leaderboards & Points

Scoring system and leaderboards are very important. Each user will receive points for reducing the overall transportation costs which include the IWT and the final delivery and for completing each task successfully. Choosing the right equipment for completing the transportation of the cargo successfully will gain the user points as well. The user will be asked to choose the appropriate equipment which based on their experience and understanding is a better fit for each operation. A quiz at the end of each task will be included. This aims at testing the user's ability of understanding the game and the industry. The quiz will focus on questions about the operations that are taking place in each task and the technical characteristics of the equipment that is used in that particular part. The quiz will be comprised of five questions accompanied by images / photos of the equipment or operations and the user will need to achieve a score of at least 75% which translates to answering correctly four out of five questions. The user will be receiving a reward in terms of points after successfully completing the quiz. Once the user successfully completes the quiz, (s)he will be able to proceed to the next task of the game. The quiz questions will be focusing as aforementioned in the operations parts or the technical characteristics. The questions may ask users to identify the equipment of a port, select the right sequence in a supply chain process etc. Following the quiz and based on the score that the users will achieve, they will have the opportunity of getting promoted to an analyst, senior analyst, associate, director, and CEO. Each user will be starting the game as a Junior Analyst. A level up feature will be available in a later stage, thus when the user achieves a promotion the complexity of the game will be increased, making it more challenging for the users.

The total points that a user can gather during the game are 100. Each task consists of maximum 15 points. Once the user achieves 15 points he will get a promotion, thus:

- Analyst – 15 points;
- Senior Analyst – 30 points;
- Associate – 45 points;
- Director – 60 points;
- CEO – 80 points.


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Each quiz will reward the user with 10 points; each quiz question counts for two points. The user will need to get at least 8 points to proceed to the next task as mentioned earlier.

Choosing the right equipment for the ports operations with the first try will award the user with maximum of five points while failing to do that will award 2.5 points.

The total points that a user can achieve for each task (15 points):

- Answering correct all five quiz questions – 10 points (two points per question).
- Choosing the right equipment with the first try – five points (2.5 points for each try afterwards).

At the end of task 5 (see 2.3.2.8.3), the users calculation results, both the IWT and the final delivery, will be compared with the NOVIMOVE's model results. The users who will achieve the greatest reduction of costs and are closer to the model's output will receive a bonus of maximum 25 points based on their performance. Only the users which will achieve a respected cost reduction will be able to reach the CEO level.

#### 2.3.2.8.3 Game Rules – Tasks & Processes

The game will include five tasks:

1. Arrival at the deep sea port with a deep sea vessel and unloading of the cargo.
2. Loading the cargo to a barge and departure of the barge towards the inland port;
   a. Crossing the canal bridge;
   b. Using a canal lock.
3. Arriving at the inland port and unloading of the cargo.
4. Moving the cargo through the port's yard and loading it either on rail or on a truck.
5. Delivery of the cargo to the final destination;
   a. In the case that the user will choose to load the container on a train, there will be an additional step for the user to unload the containers at inland depot where it would be picked up from a truck.

**Task 1:** In task 1, an ultra large container carriers (ULCC) will be arriving at the deep sea terminal for unloading the cargo. The user will be prompt to calculate the inland waterway costs and the mode choice based on the different sub-models as explained in detail in the previous section. Subsequently, the user will need to choose which type of equipment is better suited for this type of operations.

**Task 2:** In task 2, the user will need to load the cargo on a barge. The user will be able to choose between two different types of barges based on the draught and the capacity of the barge. Limitations will apply as the air draught of the bridge, the canal draught and the lock size will be in place. In case the user chooses the incorrect size of a barge a message will appear urging them to switch to the other option.

**Task 3:** Task 3 will follow similar processes as with task 1. The user will need to choose suitable equipment for unloading the containers to the port's quay.

**Task 4:** In task 4, the user will need to use a reach stacker to move the container(s) from the port's quay to the ports yard and consequently to load them on a truck or move them to the rail terminal and load them on a train.

**Task 5:** Task 5 consists of the delivery of the container to the final destination. The user will need to select which mode of transport offers the service with the minimal cost. For the road service, it is assumed that the trucks are always available to serve the demand. The capacity for each train is set to 60 TEUs.


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#### 2.3.2.8.4 Completing the Game

At the end of each task, the leaderboard which is in the game's website will be showing to the users participating in the game their position at the table along with the total points that they have collected so far and their "job grade". Winner of the game will be the user that has collected the most points and has achieved the most promotions at the end of the final task. The users which will finish in the top 5 of the leaderboard will receive a certificate with distinction while the rest just a certificate for basic knowledge of the aspects of using the inland waterways for transporting containers.

### 2.3.3 Terms of Reference – Industry Stakeholders

#### *2.3.3.1 Duration of the game*

The gameplay time will not have a specific duration. The duration of the game will be set by the user; As the purpose of this game is not for educational reasons and it is not competitive, the users won't have any time limits.

#### 2.3.3.1.1 Beginning of the game - Tutorial

After launching the game, the logo of the project will appear and subsequently once the users log into the game, a tutorial will be in place among other options. The tutorial will provide detailed information to the user of what is the objective of the game, what to expect, the game rules, which items will be in place and a disclaimer.

#### 2.3.3.1.2 Beginning of the game - Objective

The objective of the game is decision making and strategic thinking. It will provide the opportunity to industry stakeholders to plan ahead their operations, test their planning techniques and strategies and discover cost efficient ways to improve the delivery of cargo. The game is giving the freedom to the users to make their own decisions based on the NOVIMOVE models and innovations. The aforementioned ultimately leads to cutting down costs of transporting cargo.

#### 2.3.3.1.3 Beginning of the game – User's Expectation

The user should expect the game to be linked to the NOVIMOVE's transport model and will feature all the innovations that have been included and approved in the project so far. Therefore, the user will be experiencing a serious game which will be similar to a test/simulation environment. The user should expect to transport cargo from a deep sea terminal (Antwerp or Rotterdam) to an inland destination via an inland waterway using inland vessels, barges and a truck or rail/truck for the final delivery. During the game, the user will be able to choose which innovation (scenario) of the NOVIME transport model is a better fit for their needs. The cargo flows which have been already in use in the NOVIMOVE model will be available.

#### 2.3.3.1.4 Presentation of the NOVIMOVE model and developments

The tutorial will give the user the opportunity to gain an understanding on how the NOVIMOVE model works, all the innovations that have been in place, what are the important parameters that need to be taken under consideration when choosing a strategy and the NOVIMOVE developments that aim to improve the IWT container performance and reduce the transportation costs.

The information about the above-mentioned will include:

- **NOVIMOVE Innovations**
  - **The enhanced load factors through cargo reconstruction:**
  - **Mobile Terminals for sea port operations**
  - **Smart Navigation System (SNS)**
  - **Dynamic Scheduling System (DSS)**
  - **Innovative inland vessels**


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For each innovation, a short description will be given in which the main objectives of the innovations are presented.

#### 2.3.3.1.5 Disclaimer

The disclaimer would appear last in the tutorial and would refer to the purpose of the game, its intentions, and the legal side of it. The disclaimer would make clear that the game is based upon scientific principles, professional judgment to certain facts with resultant subjective interpretations and the NOVIMOVE is not responsible for the usage of the game other than the intended use. Professional judgments expressed herein are based on the currently available facts within the limits of existing data, scope of work, budget, and schedule. The game cannot, and makes no attempt to, anticipate all changes to those conditions and circumstances, which occur after its date of issue.

#### 2.3.3.1.6 Starting the game

Starting the game, the user will have to register their profile in the game's website by entering their email, their full name, a password, their organization / industry (company), the gender, age group and their interests in the maritime industry[3]. The registration of data is in line with NOVIMOVE guidelines on data management and ethics as described in deliverables D6.4, D7.1 and D7.2.

The interests and the profession will include but will not be limited to options such as operations, logistics, supply chain, transport economics, port economics, terminal operators, shipping etc.

A consent form will be in place. This will allow the users to opt out from sharing this information. In that case only the username and the password will be required. Once the user's profile is completed, the user would be able to download the game from the website and subsequently install the game and start playing it. The game will be a single player mode. A multiplayer mode will be considered for the future.

### *2.3.3.2 Graphical User Interface*

The interface of the game would include an office which represents the management building of a terminal, a deep sea terminal where all the operations will be taking place and a screen where the user will be able to choose the origin-destination pair for which they would like to transport the cargo. Additionally, a separate screen will be in place in which the user will be getting their results in terms of graphs. The starting point would be any available terminal, based on the cargo flows coming from the NOVIMOVE simulation model. An icon for a menu option would be in place.

### *2.3.3.3 Game Rules – Gameplay*

The aim of the game is to act like a simulation environment of the real life operations. Therefore, the user will be getting a screen in which they will be able to choose an available origin-destination pair from the NOVIMOVE simulation model. The parameters which will need to be filled in by the user are the origin region and terminal and the destination region and terminal. Consequently, the user will have the option to choose which innovations (scenario) of the NOVIMOVE model would like to try based on the ones explained in the tutorial. The user will be receiving the results in terms of graphs in a separate screen in the game application. The user will be able to compare the different scenarios and end up with the most beneficial one.

[3] In the game a consent form is added. This will allow the users to choose if they want to share their data with us.


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## 2.4 Conclusions

Based on the literature review, it has become apparent that gamification is an important tool which is being used more and more nowadays in various sectors including transportation and can affect the behaviour of users in a positive way. Gamification gives the opportunity to users to be part of a competitive environment and at the same time to expand their knowledge in the respective sectors. It has been proven that through gamification business goals can be achieved and the learning experience could be highly improved as well.

In order for the serious game to be successful, the ToR have to be set in a proper way. That way, the users will get the full benefits of the process. In our case, the aim is to develop two separate versions based on the NOVIMOVE model and its innovations in the sector. Each one of them targets a different group - high education students and industry stakeholders – and has a unique purpose for each group. The objective for the higher education students version is purely educational while the version for the industry stakeholders is for decision making, strategic thinking and reduction of the overall transportation costs. Each version has been set up based on the users feedback and needs. Both versions are offering to their target groups an opportunity to achieve their individual goals and targets.


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# 3 Modifying the NOVIMOVE logistics simulation model to become a serious game

## 3.1 Introduction

This chapter describes the development of the serious game. The development of the game has gone through several phases as the modification of the NOVIMOVE logistics simulation model to become a serious game appeared to be challenging in some ways. The main challenge which had to be overcome was the results database (inputs & results from the model). An approach had to be found to link the simulation model with the serious game in a way which the results produced by the model to be easily available and accessible to the serious game for the new updates and for future versions. The solution which prevailed, is the development of an interim database in an Excel format which can be easily updated with the model results and be used at the same time as the serious game input. Setting up the game interface would be the second step for the development of the game. The gaming elements and a graphic user interface were the most important parameters which had to be taken under consideration. In addition, a website had to be developed which would act as a registration point for the users, as storing point for the game's latest version and as a scoreboard for the student's version. The game will be made available for anyone (free to access) who is interested in playing and using the game.

In the following sections, the development of the database and the game will be described, as well as the current status of it along with screenshots.

## 3.2 Development of the database

The NOVIMOVE logistics simulation model is set up on the logic of producing results between an O/D pair under a specific scenario. It was important for the game to maintain the same logic. Therefore, a database in an Excel format had to be developed in a way which the inputs and the results from the simulation model would act as inputs and results for the serious game as well. For that purpose, a Master table was created which holds all the results as per the main KPIs for each specific scenario. In that way, the Master table can be easily updated based on new results from the simulation model and as a consequence the inputs of the serious game. This approach provides freedom to the development of the gaming elements and other features as well as for future versions of the game without affecting the way it is created and structured.

As main KPIs for the game, five parameters have been chosen: 1)the total cargo that has been transported between an origin and destination pair in terms of TEU, 2) the total cost across the modes in million euros, 3) the total transports across modes in terms of journeys, 4) the total time across modes in terms of days and 5) the CO2 emissions across all modes in terms of tonnes per TEU. For each of these main parameters and their results, further analysis would be provided to the user by additional info and insights such as the following:

- Modal Split:
  - Costs per mode;
  - Time per Mode;
  - Cargo per Mode;
  - Emissions per Mode;
- Information at Terminal Level:
  - Total time;
  - Average loaded and discharged TEUs and others.


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These would be transformed from the Master table into 17 different groups of data, with a total of 76 results providing to the user important information.

In order for the user to receive the results a valid O/D pair has to be chosen and the scenario under which they want to receive the results for. The same logic appears in the serious game, and it will be presented in the next section. In Figure 1, the User selection scenario is presented, along with an example (small part) of the Master table (Figure 2) and the results screen (Figure 3).

| Region | NUTS2 | Terminal | UNLOCode | Scenario |
|---|---|---|---|---|
| Brussels | BE10 | Antwerpen | BE ANR | Baseline |
| Antwerp | BE21 | Basel | CH BSL | TEU50%Increase |
| Limburg (BE) | BE22 | Stuttgart | DE STR | |
| East Flanders | BE23 | Mannheim | DE MHD | |
| Flemish Brabant | BE24 | Kehl | DE KEH | |
| West Flanders | BE25 | Weil am Rhein | DE WLR | |
| Liege | BE33 | Gernsheim | DE GHM | |
| Northwestern Switzerland | CH03 | Emmerich | DE EMM | |
| Stuttgart | DE11 | Emmelsum | DE ESU | |
| Karlsruhe | DE12 | Duisburg | DE DUI | |
| Freiburg | DE13 | Krefeld | DE KRE | |
| Darmstadt | DE71 | Dusseldorf | DE DUS | |
| Dusseldorf | DEA1 | Neuss | DE NSS | |
| Koln | DEA2 | Dormagen | DE DMG | |
| Koblenz | DEB1 | Leverkusen | DE LEV | |
| Trier | DEB2 | Keulen | DE CGM | |
| Rheinhessen-Pfalz | DEB3 | Bonn | DE BON | |
| Alsace | FRF1 | Andernach | DE AND | |
| Gelderland | NL22 | Koblenz | DE KOB | |
| Utrecht | NL31 | Trier | DE TRI | |
| North Holland | NL32 | Mainz | DE MAI | |
| South Holland | NL33 | Gustavsburg | DE GIG | |
| Zeeland | NL34 | Worms | DE WOR | |
| North Brabant | NL41 | Ludwigshafen | DE LUH | |
| Limburg (NL) | NL42 | Germersheim | DE GER | |
| | | Worth | DE WOR | |
| | | Straatsburg | FR SXB | |
| | | Neuf Brisach | FR NEF | |
| | | Tiel | NL TIE | |
| | | Nijmegen | NL NIJ | |
| | | Utrecht | NL UTC | |
| | | Zaandam | NL ZAA | |
| | | Amsterdam | NL AMS | |
| | | Beverwijk | NL BEV | |
| | | Velsen | NL VEL | |
| | | Alblasserdam | NL ABL | |
| | | Rotterdam | NL RTM | |
| | | Gorinchem | NL GOR | |
| | | Bergen op Zoom | NL BZM | |
| | | Moerdijk | NL MOE | |

| User selection | | | | |
|---|---|---|---|---|
| O_NUTS2 | O_Terminal | D_NUTS2 | D_Terminal | Scenario |
| BE21 | BE ANR | CH03 | CH BSL | TEU50%Increase |


Figure 1: Database - User Selection Scenario

| O_NUTS2 | O_UNLOCode | D_NUTS2 | D_UNLOCode | Scenario | Total_TEU | Total_Costs | Total_Tp | Total_Time | Total_CO2 | MS_TEU_IWT | MS_TEU_Road | MS_TEU_Rail | MS_Costs_IWT | MS_Costs_Road | MS_Costs_Rail | MS_Tp_IWT | MS_Tp_Road | MS_Tp_Rail | MS_Time_IWT | MS_Time_Rail | MS_Time_Road |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BE10 | NA | BE10 | NA | Baseline | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BE10 | NA | BE10 | NA | TEU50%Incr | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BE10 | NA | BE21 | BE ANR | Baseline | 23626.00 | 1.55 | 3820 | 27.138 | 0 | 0.299 | 0.701 | 0 | 0.439 | 0.561 | 0 | 0.928 | 0.072 | 0 | 0.012 | 0.988 | |
| BE10 | NA | BE21 | BE ANR | TEU50%Incr | 35444.00 | 2.31 | 5701 | 40.482 | 0 | 0.297 | 0.703 | 0 | 0.437 | 0.563 | 0 | 0.927 | 0.073 | 0 | 0.012 | 0.988 | |
| BE10 | NA | BE22 | NA | Baseline | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BE10 | NA | BE22 | NA | TEU50%Incr | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BE10 | NA | BE23 | NA | Baseline | 5930.00 | 0.48 | 2458 | 17.457 | 0 | 0.818 | 0.182 | 0 | 0.875 | 0.125 | 0 | 0.993 | 0.007 | 0 | 0.001 | 0.999 | |
| BE10 | NA | BE23 | NA | TEU50%Incr | 8869.00 | 0.72 | 3695 | 26.249 | 0 | 0.824 | 0.176 | 0 | 0.875 | 0.125 | 0 | 0.993 | 0.007 | 0 | 0.001 | 0.999 | |
| BE10 | NA | BE24 | NA | Baseline | 27250.00 | 1.26 | 8796 | 57.943 | 0 | 0.632 | 0.368 | 0 | 1 | 0 | 0 | 0.981 | 0.019 | 0 | 0 | 1 | |
| BE10 | NA | BE24 | NA | TEU50%Incr | 40902.00 | 1.9 | 13245 | 87.267 | 0 | 0.635 | 0.365 | 0 | 1 | 0 | 0 | 0.981 | 0.019 | 0 | 0 | 1 | |
| BE10 | NA | BE25 | NA | Baseline | 5371.00 | 0.42 | 988 | 8.231 | 0 | 0.341 | 0.659 | 0 | 0.524 | 0.476 | 0 | 0.94 | 0.06 | 0 | 0.009 | 0.991 | |
| BE10 | NA | BE25 | NA | TEU50%Incr | 8087.00 | 0.64 | 1476 | 12.29 | 0 | 0.34 | 0.66 | 0 | 0.516 | 0.484 | 0 | 0.94 | 0.06 | 0 | 0.009 | 0.991 | |
| BE10 | NA | BE33 | NA | Baseline | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BE10 | NA | BE33 | NA | TEU50%Incr | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BE10 | NA | CH03 | CH BSL | Baseline | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BE10 | NA | CH03 | CH BSL | TEU50%Incr | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BE10 | NA | DE11 | DE STR | Baseline | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BE10 | NA | DE11 | DE STR | TEU50%Incr | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BE10 | NA | DE12 | DE MHD | Baseline | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BE10 | NA | DE12 | DE MHD | TEU50%Incr | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BE10 | NA | DE13 | DE KEH | Baseline | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BE10 | NA | DE13 | DE KEH | TEU50%Incr | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Figure 2: Database - Master Table Example

| O_NUTS2 | O_UNLOCode | D_NUTS2 | D_UNLOCode | Scenario | Total_TEU | Total_Costs | Total_Tp | Total_Time | Total_CO2 | MS_TEU_IWT | MS_TEU_Road | MS_TEU_Rail | MS_Costs_IWT | MS_Costs_Road | MS_Costs_Rail | MS_Tp_IWT | MS_Tp_Road | MS_Tp_Rail | MS_Time_IWT | MS_Time_Rail | MS_Time_Road | MS_CO2_IWT | MS_CO2_Rail | MS_CO2_Road |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BE21 | BE ANR | CH03 | CH BSL | TEU50%Increase | 31309.0 | 3.1 | 1329.0 | 89.0 | 0.0 | 34.7% | 5.8% | 59.5% | 0.0% | 41.3% | 58.7% | 5.6% | 69.2% | 25.1% | 25.9% | 0.6% | 73.5% | 0.0% | 0.0% | 0.0% |

Figure 3: Database - Results

## 3.3 Development of the website and the game interface

The game's website acts as a registration point for the users among others, while the game interface is the environment in which the users will be playing the game. In Figure 4, one can see the first version of the website and the game main page.

The user will need to press the 'register' button when accessing the website for the first time. For all subsequent times, the user just has to log in.


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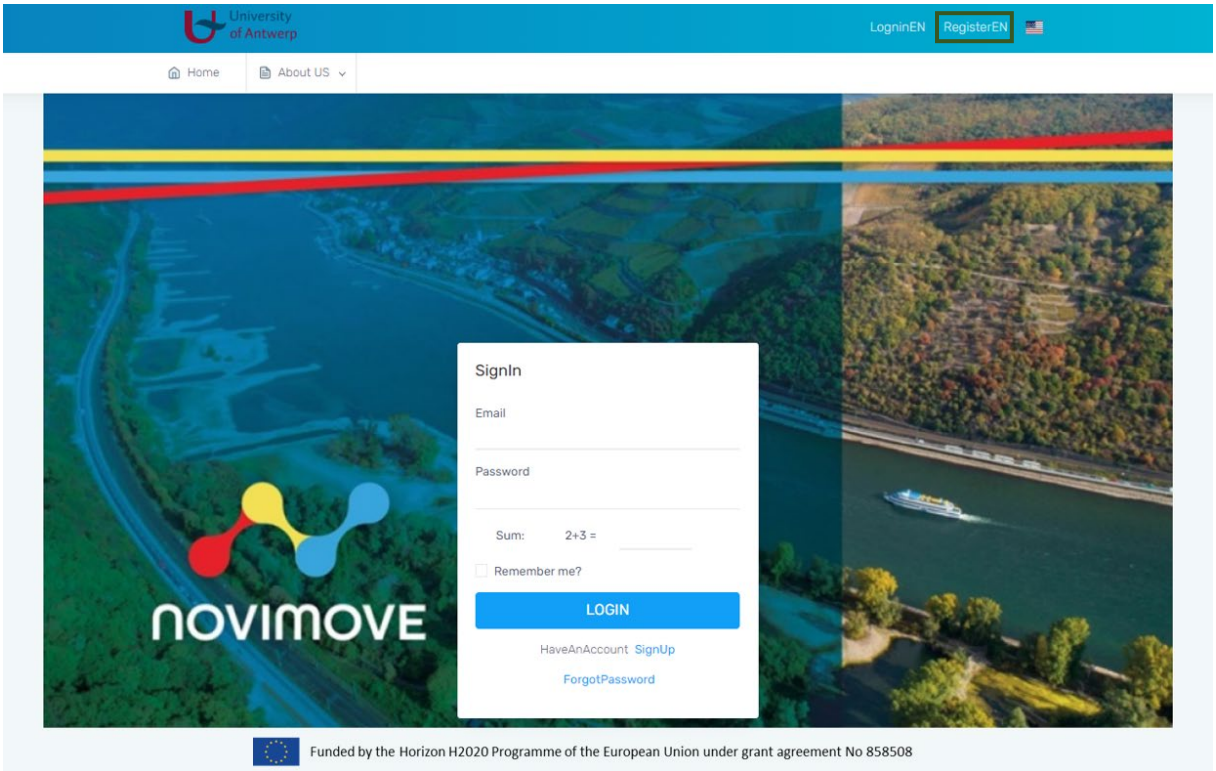


Figure 4: NOVIMOVE Serious Game Website

The game's website is a mandatory step for the users to go through if they want to download and play the game. On the website, the users will need to register, by adding their email and a password and consequently providing personal information such as gender, age group, profile type (professional or student) organization or company and interests in the maritime industry. In case the users do not complete their registration, they would not be able to download the game. This is a compulsory process. It has to be noted, that the users will be asked to consent in sharing the data with the University of Antwerp for statistical purposes, for improvement of the University's services and for future research. A screenshot of the registration screen can be seen in Figure 5.

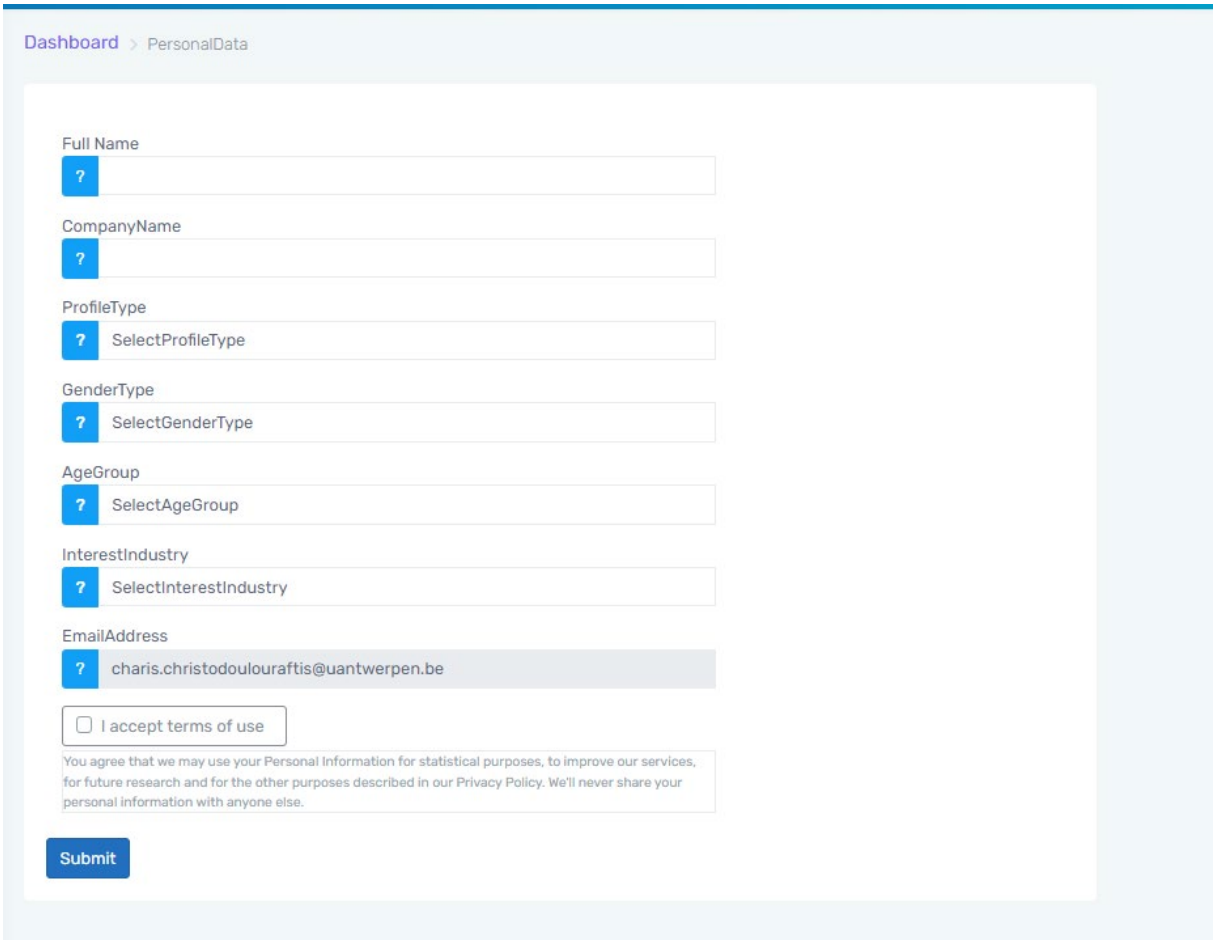


Figure 5: Registration Page for the NOVIMOVE Serious Game

Once the user completes the registration, (s)he will be able to download the game (Figures 6 and 7). At the current phase, the application of the game does not update itself with the latest version so the user will need to enter the website and download the latest version each time there is one available. The user will be notified in that case.

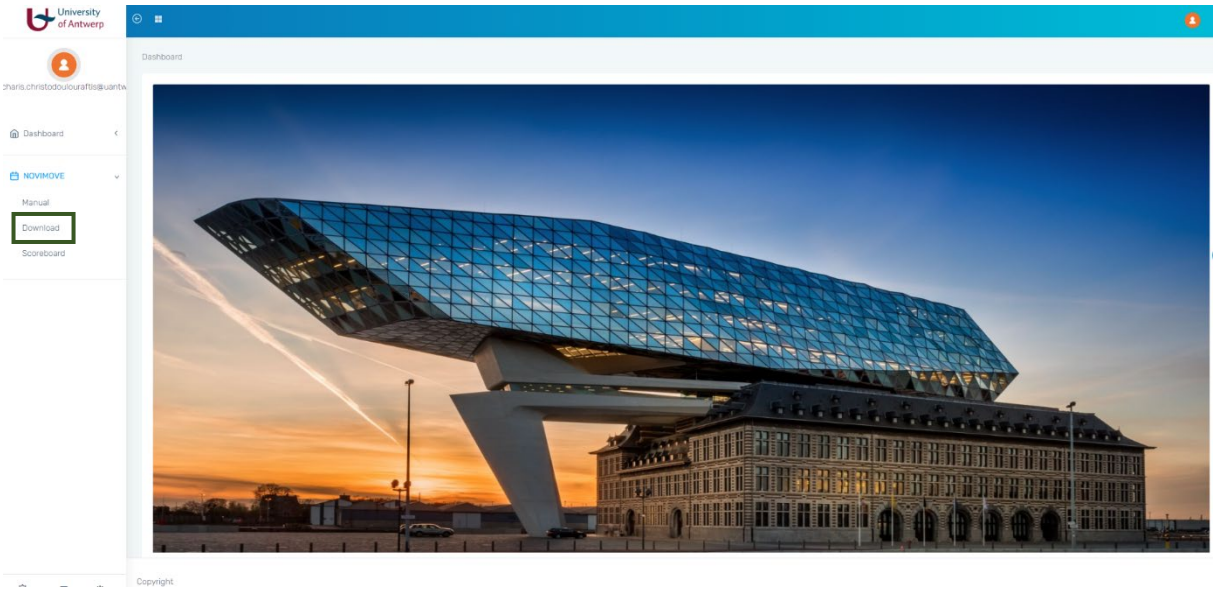


Figure 6: Download screen for the serious game (1)


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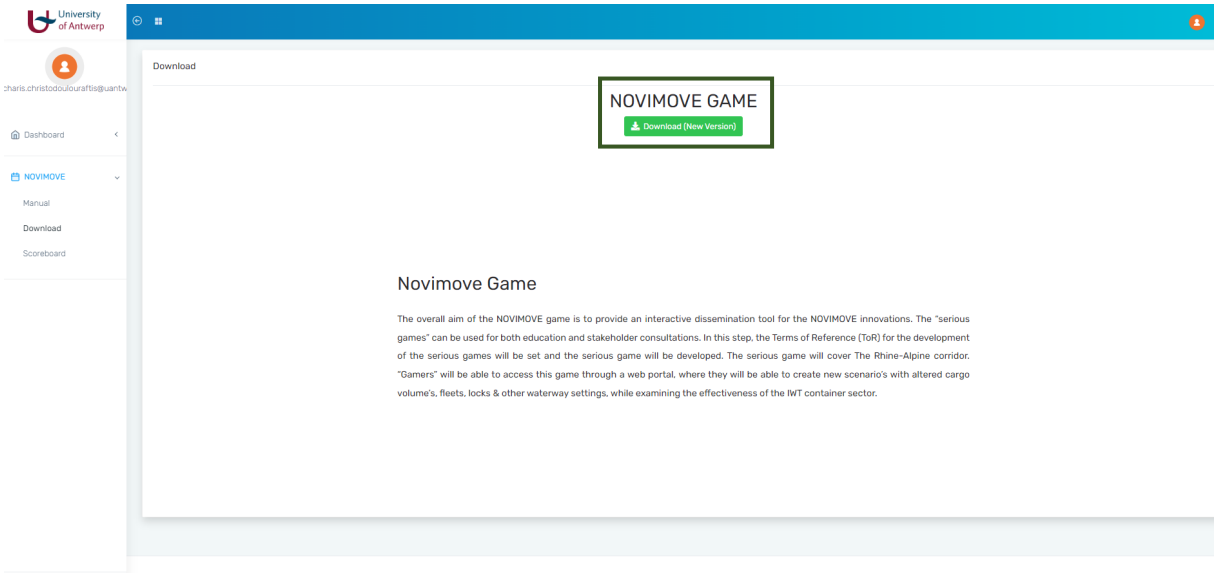


Figure 7: Download screen for the serious game (2)

The next step would be to install the game. The user will have the icons from Figure 8 on his/her desktop. Important note which has to be highlighted: the firewall of the user's personal computer will prevent them from running and installing the application; therefore, the user will need to "trust" it to bypass the firewall.


Figure 8: Installation of the game application

The NOVIMOVE icon is the installation application, while the vessel icon is the game application. The ship icon will appear and become available once the installation is complete.

The game interface is linked to the website's database. Thus, it is important for the users to use the same credentials which they have used to register in order to play the game. Otherwise, they will not be able to access it. As per the screenshot from Figure 10, the user will have three different options: to log in into the game, go back to the website and to close the application. The version which is currently depicted in the screenshots is the industry stakeholders version.


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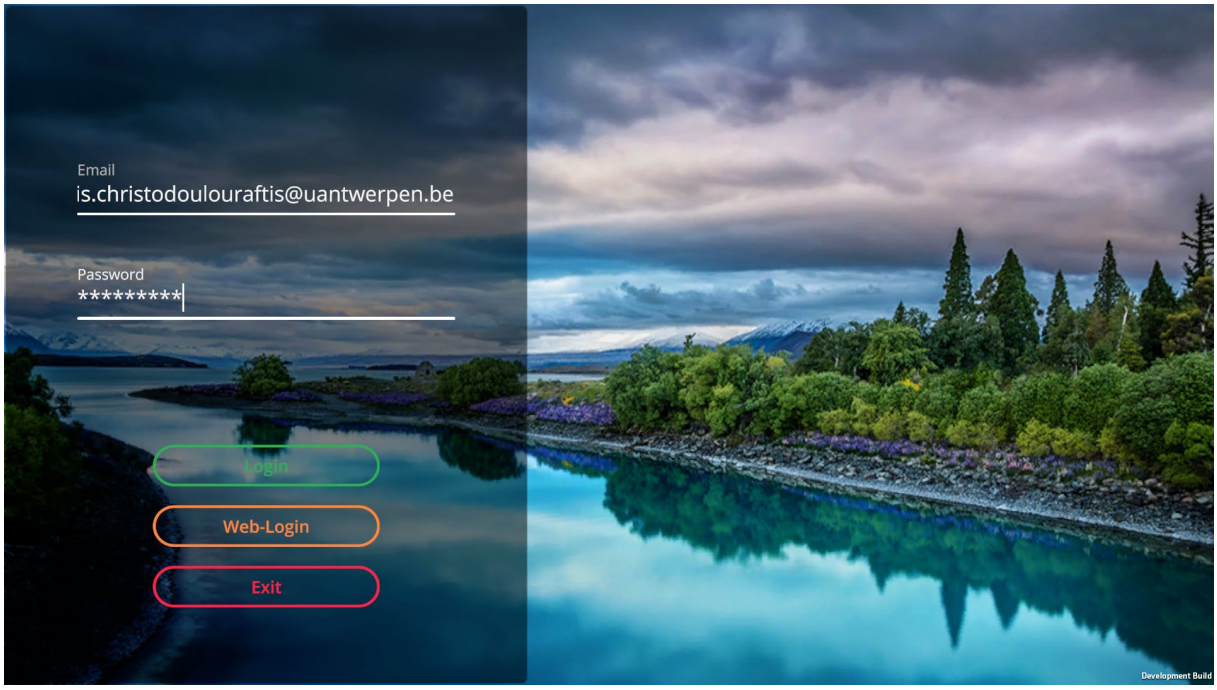


Figure 9: Serious Game application Main screen

After logging into the game, the user gets the Figure 10 screen. This screen shows the available levels of the game and the levels that have been achieved and completed so far. At this point, only level one is available. The rest of the levels would be available in future versions of the game. The users will need to choose level 1 to proceed to the main game interface.

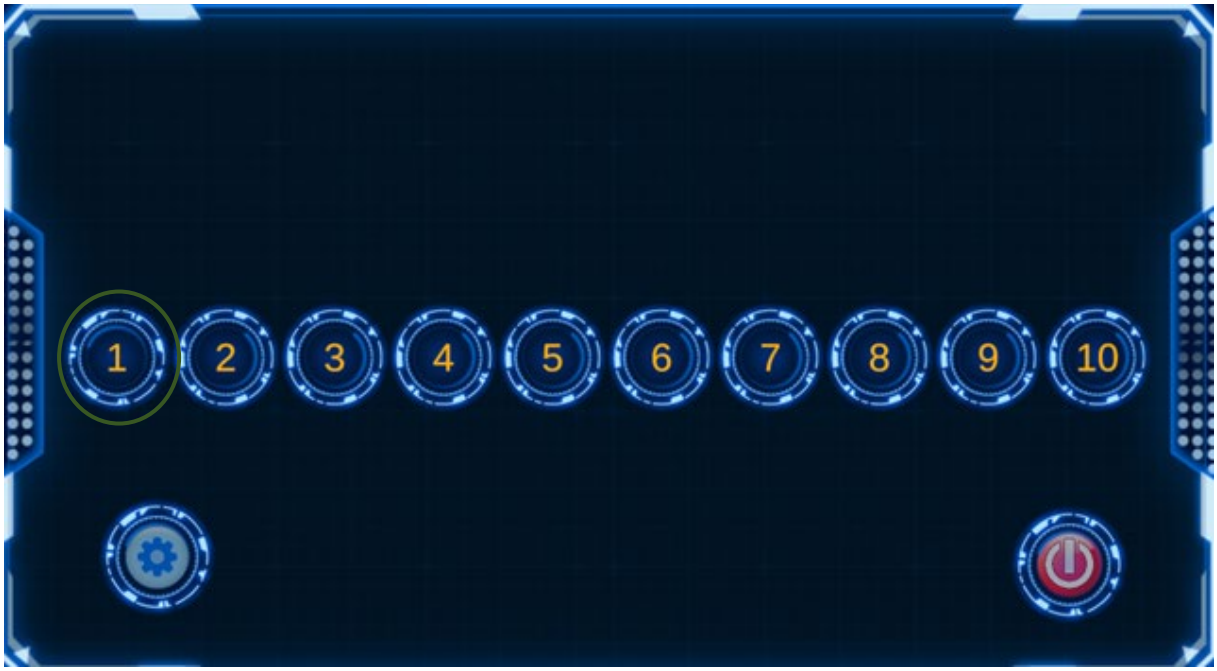


Figure 10: Levels Screen

In the section to follow, screenshots will be presented from each action button apart from the Tutorial. The information of the tutorial will be presented at the appendix A though, along with the quiz questions for the Master students version as per the ToR.


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1. The user is inside the **Port Management building of a terminal** (Figure 11). The office is comprised by several desks, chairs, rooms, books, and screens. In this area, the user can wander around the office. In the right of the screen, the user will be seeing 5 different icons. The user will be getting information messages each time they are selecting an icon. Each one acts as an action button for different purposes as per below (see numbers in Figures 11 and 12):


Figure 11: Office Screen (1)


Figure 12: Office Screen (2) – O-D Pair action button


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2. ***Tutorial*** – In this screen, the user will be getting information for all the equipment that is being used during the operations in the supply chain process as described in the ToR[4].

3. ***Selecting the O-D Pair*** – In this screen, the users will be selecting the O/D pair in order to get results for the transportation of cargo. Once the users enter this screen, a European map , similar to Google / Bing maps format, will appear (Figure 13). The available regions based on the NUTS2 categorization will be visible along with the respective terminals of each region. At the top of the screen, the selections of the user will pop up in circle icons. If the users are happy with their selections, they will need to click on the confirmation button (green tick in Figure 14) to get their results.

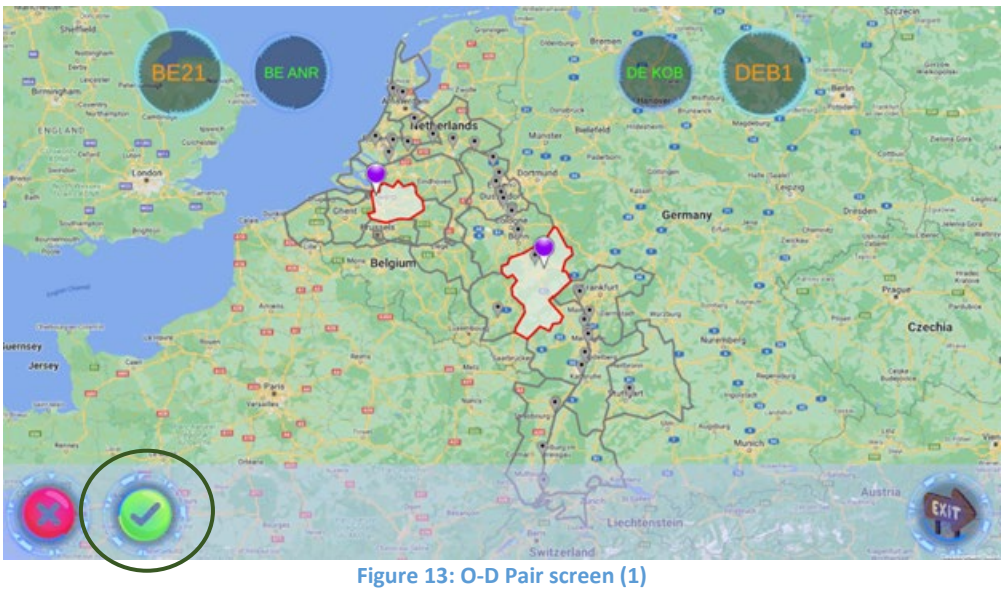


Figure 13: O-D Pair screen (1)


Figure 14: O-D Pair screen (2)

[4] The tutorial of the game can be seen in appendix A of the deliverable.


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4. ***Terminal View*** - In this screen (Figure 15), the user will be transferred outside the building in the terminal area, and they will be able to observe the operations in a deep sea terminal. More specifically the user will be watching a quay crane to unload a deep sea vessel and a reach stacker moving the containers either in the yard or to an inland vessel for transhipment (Figures 16 and 17). In the version ready by the end of June, the user will be able to "transfer" itself to the operator's seat of the STS crane and in the vessel's bridge to observe the operations.

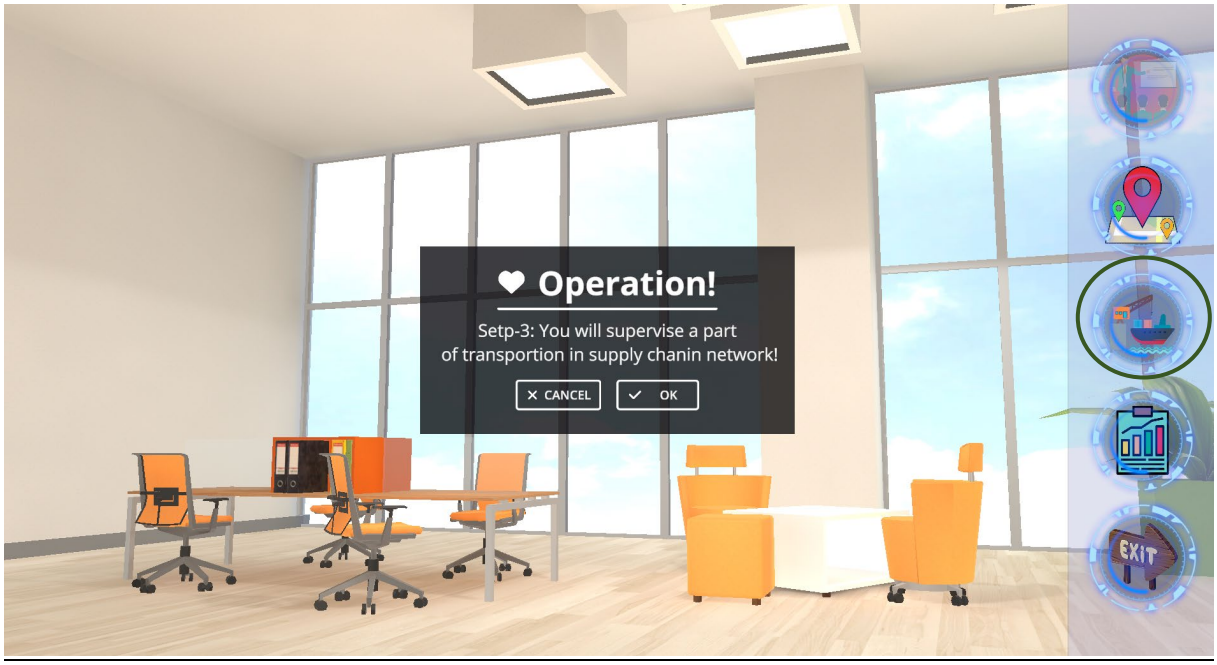


Figure 15: Office Screen (3) – Terminal View action button

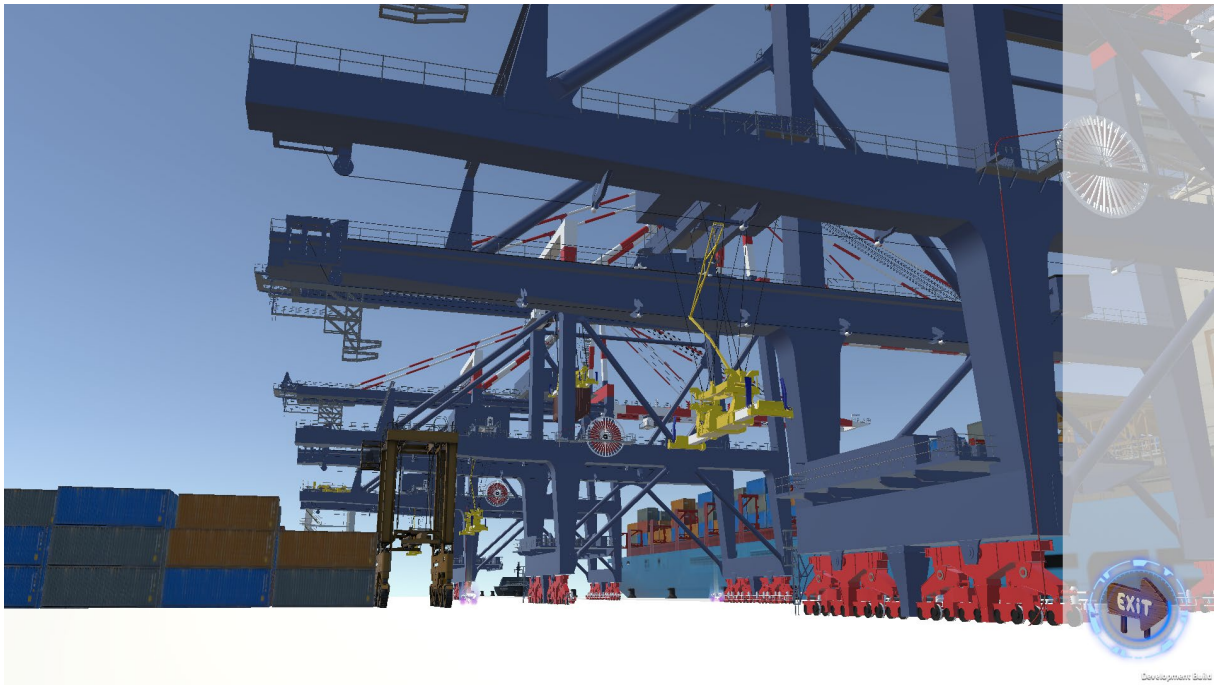



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Figure 16: Terminal View (1)

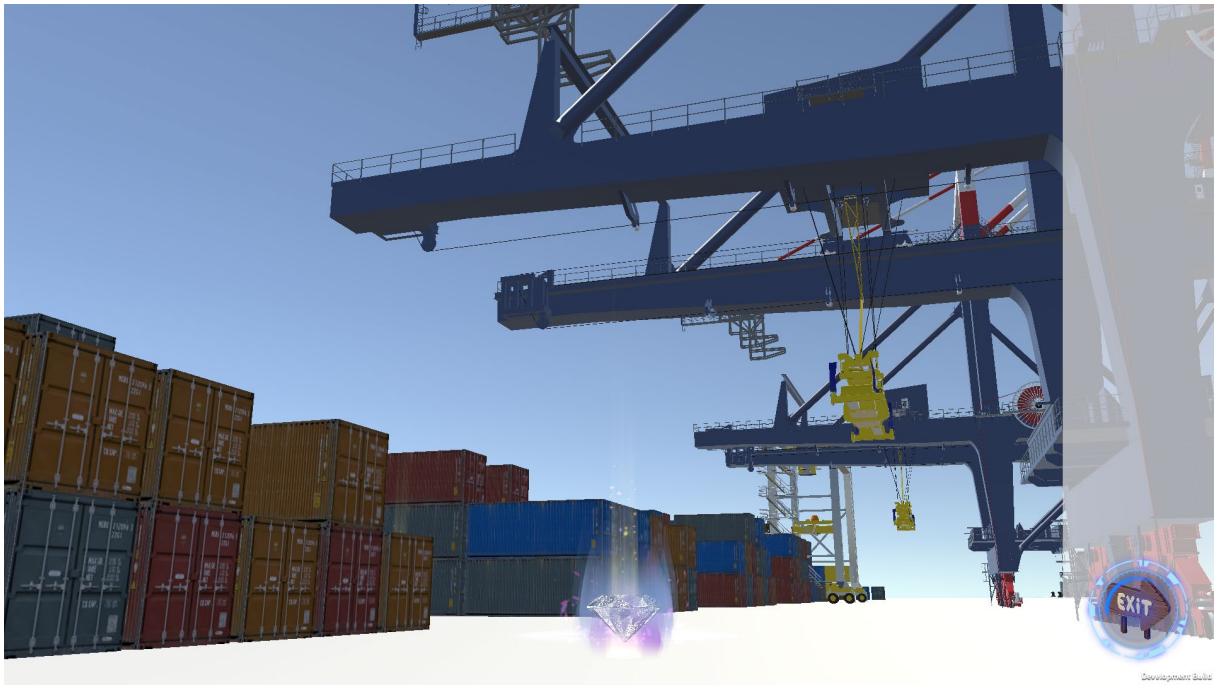


Figure 17: Terminal View (2)

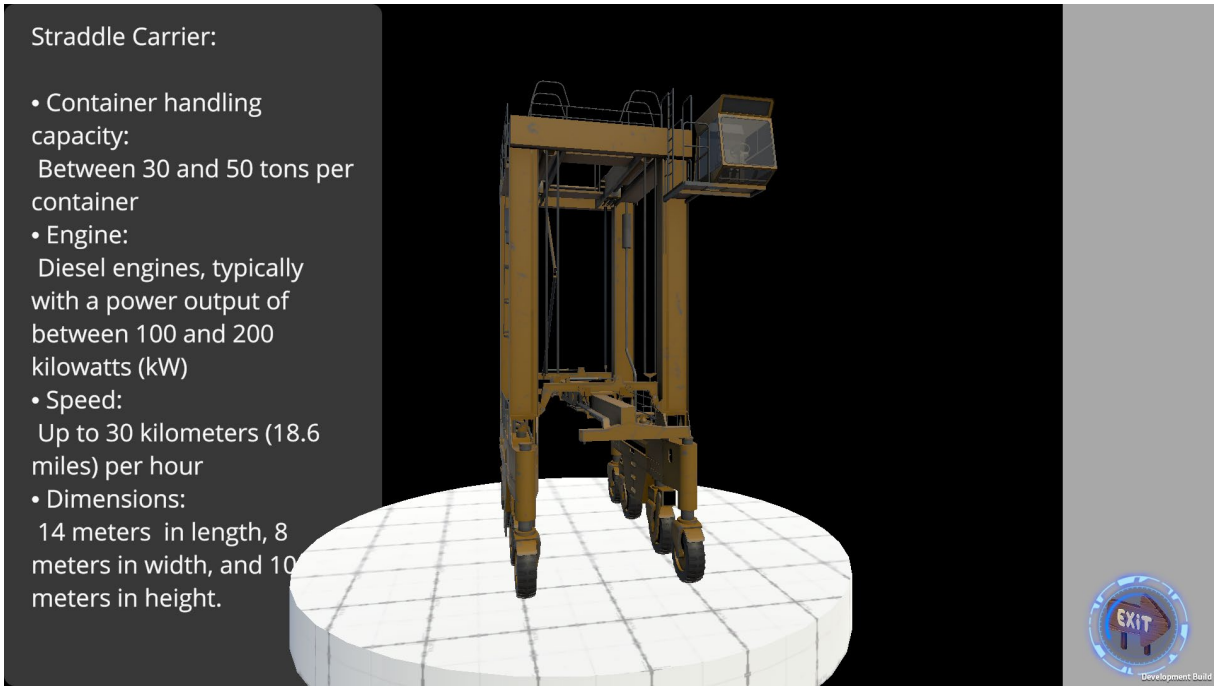


Figure 18: Terminal View (3)


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5. ***Results*** – In this screen, the user will be getting the results which are coming from the Master table in the form of graphs (Figure 18). The graphs will be grouped as per the main KPIs, as explained in the previous sector. At the top of the screen, five different icons will be present, as per the five groups described in the previous section (Figure 19). Each graph is illustrating the results per mode of transport, per scenario and the Delta (difference between the scenarios).

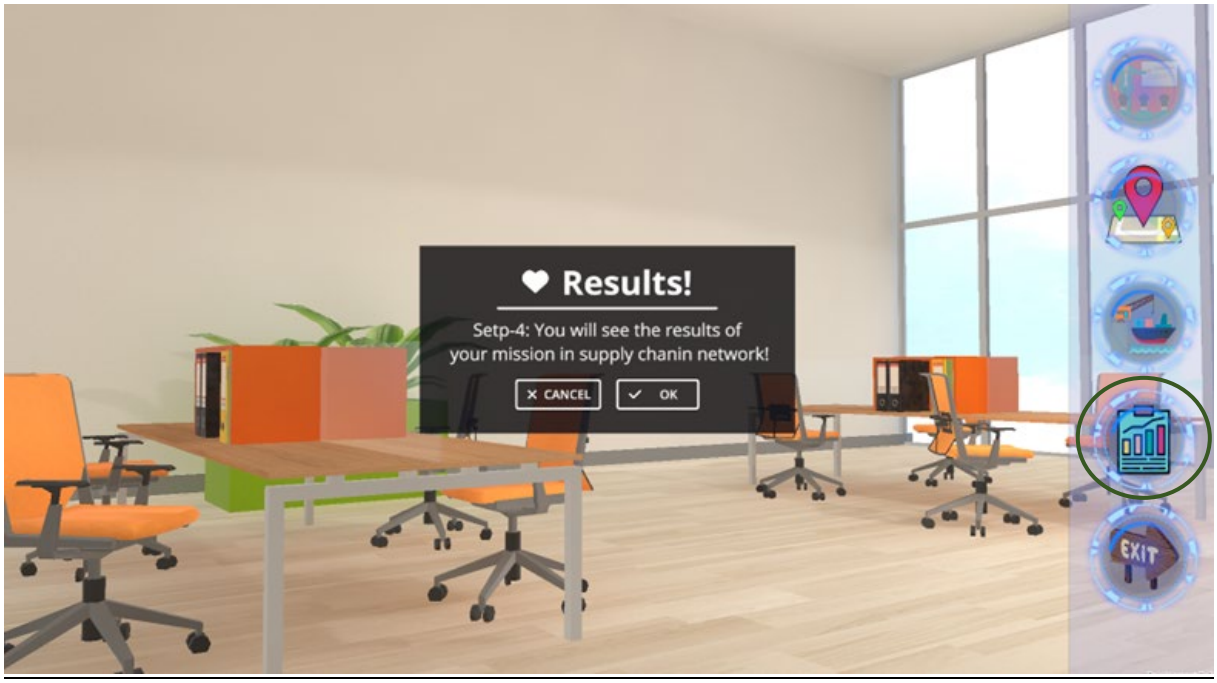


Figure 19: Office Screen (4) – Results Action button

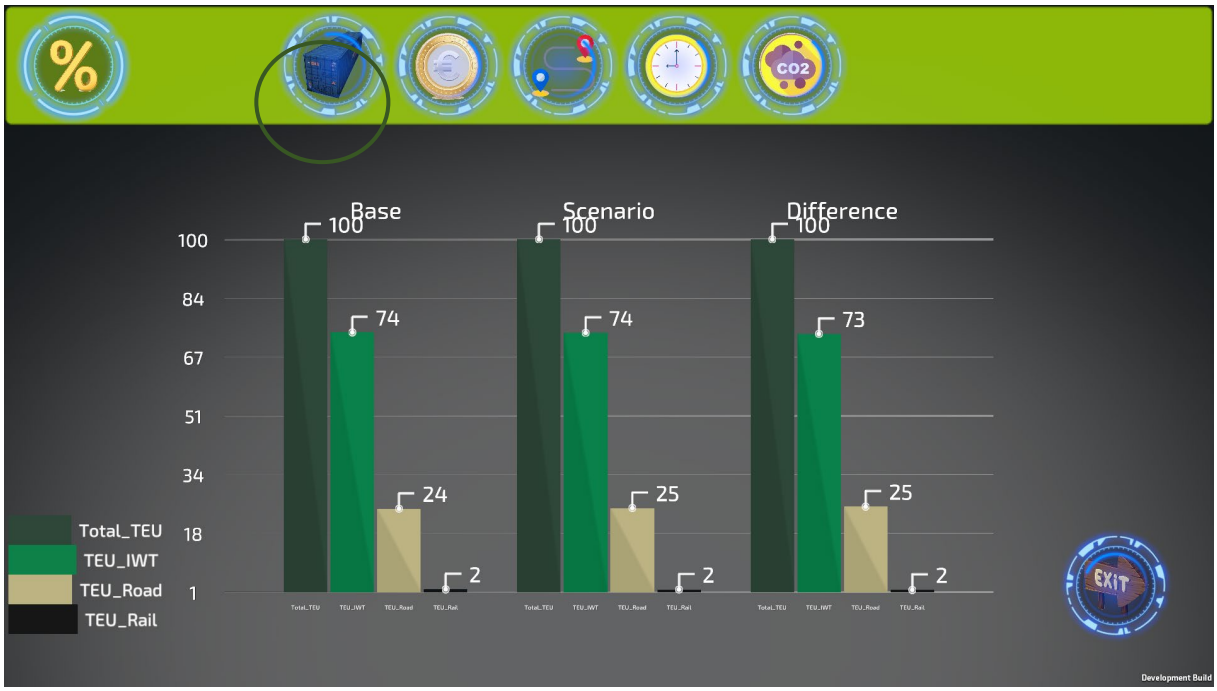


Figure 20: Results Screen


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6. ***Exit*** – This option is for the users to leave the game and close the application (Figure 20).

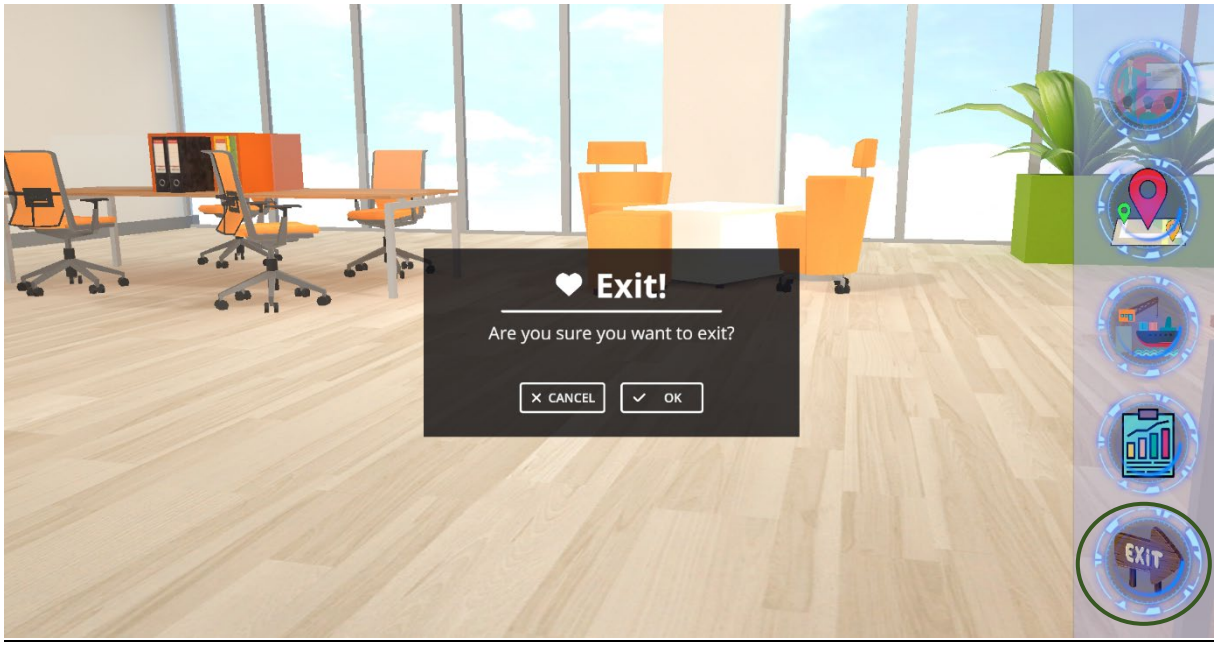


Figure 21: Office Screen (5) – Exit Action button

## 3.4 Conclusions

This chapter described the development of the serious game along with the challenges which had to be considered. For the development of the game, the main obstacle was to create a link between the simulation model and the game interface. This has been overcome by developing a database in the form of an Excel file which holds all the results of the model for each different scenario based on five main parameters. As per the serious game, a website which acts as a registration and a storing point for the download of the game and as a way for users to track their scores in the students version was created. Moreover, the graphic user interface was developed (currently in a preliminary phase) and it's connected to the website, the database, and the ToR. The users have the ability to experience the NOVIMOVE simulation model from the gaming side and get more information and insights about the maritime industry as they play. It has been highlighted that at the moment, only the industry professional version will be available, while the higher master students version will be ready by the end of June 2023 in a new update.


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# 4 Validating and testing of the NOVIMOVE game

## 4.1 Introduction

This chapter describes the main validation and testing approach of the NOVIMOVE game is. The testing and validation are done in different iterations and is aimed to further improve the game, the interface and the player experience of the game.

This chapter first describes the validation approach. After that, the outcome of the stakeholder meeting is presented, which should reflect in recommendation in the improving the game. Section 4.4 describes the main adjustments to the game , while the last section provides the main conclusions of the chapter .

## 4.2 Validation approach

The NOVIMOVE game validation will be done in several rounds via different stakeholder meetings. The first one will be organized at the NOVIMOVE GA in Basel. First, the first presentation of the NOVIMIVE game will be given. From the reflections of NOVIMOVE partners and external stakeholders, a first update of the game is foreseen.

Also, extra validation rounds are foreseen. This will be done by different stakeholder meetings that will be organized locally in Antwerp or Rotterdam or will be done via an online Webinar. The main contact details for the stakeholders are collected and will be used to invite the stakeholders for the meetings. The developed invites can be seen in appendix C.

Based on the reflections of these stakeholder meetings, an extra update of the game is foreseen.

Giving the timing of the deadline for this deliverable online, the main reflections of the Basel meeting are included. The other updates of the stakeholder meetings are foreseen before the end of summer 2023. Then also an update of the deliverable is foreseen.

## 4.3 Stakeholder meeting

For the validation of the NOVIMOVE game we foresee three main stakeholder meetings. The first one will take place at the GA in Basel during a main NOVIMOVE meeting. In this meeting, the first feedback is collected. The second and third round of feedback is foreseen.

### 4.3.1 NOVIMOVE GA BASEL

The main comments that were collected from the GA are:

Main comments from the audience:

1. Are the registration details needed to get the game? Can't this be made optional. This might increase the uptake of the game.

*Reply to the comment: The registration will be changed by removing the mandatory registration and do it optional. For example, once they get the results, we could ask the users to fill in some personal details (similar to the ones that we have already on the website) to help us with our research and for any future research and potential projects. This would be optional.*

2. Is there a direct link to the simulation model?

*Reply: The simulation model is linked to the game via the master table database in the excel file. There is no direct link to the game. However, an option in later versions of the game could be offered for users to submit a request to get results for a very specific route or for a specific amount of cargo which they*


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*would like to "transport". Once we receive their request, we would forward it to the System Navigator guys and get back to the users in a two weeks' time.*

3. It might be more interesting for the game not to only use the observer role, but to also give the players a mission. If the mission is fulfilled the player can get points, and eventually win the game.

*Reply: Indeed, this is would be a good addition. I will consult with the develop (Boukani) if it's possible to give to the user's access to the available equipment by operating them for example. Unloading cargo from the deep sea vessel to the quay by using the STS crane or driving the straddle carrier etc.*

4. It might be interesting to add multiple players in the game where people can work together.

*Reply: This was part of the original idea. I will consult with Boukani about this. Maybe in future versions of the game.*

Smaller / detailed comments:

5. Explain the download process on the website, so that the user can understand what to do.

*Reply: We should add the detailed process to the manual online indeed.*

6. Explain in the game were the player needs to go to. Maybe add an arrow on the ground in the game to show the direction.

*Reply: As there is no "mission" at the moment there is no point of doing this. This is linked to the comment about the user not being just an observer in the game. We'll need to develop different missions for the users.*

7. Also explain that not all OD pairs are in the game

*Reply: We need to fix this issue.*

8. Only use the diamonds for the student game version and change the diamond into a nautical element (i.e., a buoy, or a steering wheel)

*Reply: Sure, fair comment. Obviously, in the professionals version we will not have them collecting diamonds and similar stuff. This is only for the students version.*

9. Add an environment of a small inland terminal + lock (but this is still work in progress).

*Reply: We will have this addition by the end of May.*

### 4.3.2 NOVIMOVE external Stakeholder meeting 1

The main responses of this meeting will be added after the meeting has been held. The stakeholder meetings are also foreseen in Task 2.7.3 which deals with the collecting of reactions / validation via stakeholder meetings of both the obtained results of the case study and the **NOVIMOVE serious game**.

### 4.3.3 NOVIMOVE external Stakeholder meeting 2

The main responses of this meeting will be added after the meeting has been held. The stakeholder meetings are also foreseen in Task 2.7.3 which deals with the collecting of reactions / validation via stakeholder meetings of both the obtained results of the case study and the **NOVIMOVE serious game**.

## 4.4 Adjustments to the NOVIMOVE game

The main adjustments to the NOVIMOVE game will be presented when all the stakeholder meetings have been taken place. The feedback will result in a plan for action to improve and adjust the developed game.


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Also, the NOVIMOVE game will be further populated with new data from the main simulation model. As not all NOVIMOVE innovations are developed fully yet, an update is also needed. This update is foreseen in the game setup via the NOVIMOVE game database.

## 4.5 Conclusions

In this chapter, the main validation and adoption approach are discussed. For the first submission of this deliverable, only the main feedback of the NOVIMOVE game during the GA in Basel is collected. Once the other meetings will have been held, this feedback will be processed, and the new version of the deliverable will be submitted.


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# 5 Conclusions

This deliverable describes the development of the first version of the NOVIMOVE serious game. The overall aim of the NOVIMOVE game is to provide an interactive dissemination tool for the NOVIMOVE innovations, where the game can be used for both education and stakeholder consultations.

The review of the literature indicates that gamification provides users with the chance to engage in a competitive environment while also expanding their knowledge in specific fields. It has been demonstrated that gamification can effectively support business goals and greatly enhance the learning experience. This aspect is particularly valuable for promoting the dissemination of innovations within NOVIMOVE. The decision has been made to create two different versions of the NOVIMOVE game, each aiming at different target groups: higher education students and industry stakeholders. Each version serves a specific purpose for its respective group. The higher education student version is designed primarily for educational purposes, whereas the version for industry stakeholders focuses on decision-making, strategic thinking, and reducing transportation costs. Both versions have been developed based on user feedback and specific user needs. Both versions are offering to their target groups an opportunity to achieve their individual goals and targets.

The game development was a challenge. The main obstacle was to create a link between the simulation model (NOVIMOVE WP2 simulation model) and the game interface. This has been overcome by developing a database in the form of an Excel file which holds all the results of the model for each different scenario based on five main parameters. As per the serious game, a website which acts as a registration and a storing point for the download of the game and as a way for users to track their scores in the students version was created. Moreover, the Graphic User Interface has been developed (currently in a preliminary phase) and it’s connected to the website, the database, and the Terms of Reference of the game. The users have the ability to experience the NOVIMOVE simulation model from the gaming side and get more information and insights about the NOVIMOVE innovations. Currently, only the industry professional version will be available (as it is needed for dissemination of the NOVIMOVE results) while the higher master students version will be ready by the end of June in a new update.

Concluding, the validation and adoption approach has been developed. In the initial submission of this deliverable, feedback has been collected primarily from the GA in Basel. Following the completion of other meetings, as outlined in tasks 2.7.3, the gathered feedback will be processed and used to update the game accordingly. Also, not all innovations are fully developed yet in the project, which means that new data, generated by the NOVIMOVE simulation model, will be uploaded in the game if this becomes available. By incorporating all the NOVIMOVE's innovations into the game, it will allow users to interact with and experience the innovations first-hand. This can generate a greater understanding of the value and potential of the innovations. Consequently, showcasing how the NOVIMOVE innovations solve specific challenges or improve existing processes, it can effectively communicate the advantages to potential stakeholders in an interactive way. By that means, the serious game can effectively stimulate market uptake of the NOVIMOVE innovations.


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# Appendix A: Tutorial for the Serious Game

**Container:**

A container is a large, standardized metal or composite box used for transporting goods by ship, truck, or train. Containers are typically rectangular in shape and are designed to fit together like building blocks to maximize space on ships, trains, and trucks. They come in various sizes, but the most common sizes are 20 feet and 40 feet long, with a standard height and width. The unit of measurement of containers is typically the twenty-foot equivalent unit (TEU) or forty-foot equivalent unit (FEU). These units are used to measure the capacity of a container ship or the number of containers that can be carried on a train or truck. A TEU is based on the size of a standard 20-foot container, which is approximately 6.1 meters (20 feet) in length. An FEU is based on the size of a standard 40-foot container, which is approximately 12.2 meters (40 feet) in length. Containers are made of strong, durable materials that can withstand the rigors of transportation and handling, such as steel or aluminium. They are designed to be stackable, weather-resistant, and secure, with locking mechanisms that prevent unauthorized access to the goods inside. The use of containers in shipping has revolutionized the transportation industry by enabling goods to be transported more efficiently, securely, and cost-effectively. Containers allow goods to be easily transferred from one mode of transportation to another without the need for additional handling, reducing the risk of damage or loss of the cargo.

The technical specifications of containers can vary depending on the manufacturer, but here are some common technical specifications:

- Size: Containers are available in various sizes, but the most common sizes are 20 feet and 40 feet long. Standard height is usually 8 feet 6 inches, but some containers are available in high-cube versions with a height of 9 feet 6 inches.
- Material: Containers are typically made of steel or aluminium, although some may also be made of composite materials. The thickness of the steel used in a container can vary depending on the intended use and the manufacturer.
- Weight: The weight of an empty container can vary depending on its size and material, but a standard 20-foot steel container typically weighs around 2,200 kilograms (4,850 pounds).
- Payload capacity: The maximum weight of cargo that can be loaded into a container, including the weight of the container itself, is referred to as the payload capacity. This can vary depending on the container's size and type, but a standard 20-foot container typically has a payload capacity of around 28,000 kilograms (62,000 pounds).
- Door type: Containers typically have two doors at one end that can be opened to load or unload cargo. The doors can be either single or double and may have locking mechanisms to ensure the security of the cargo.
- Ventilation: Some containers may have ventilation systems to regulate the temperature and humidity inside the container, which is important for certain types of cargo, such as fruits and vegetables.
- Certification: Containers are typically required to meet certain standards and certifications, such as those set by the International Organization for Standardization (ISO). These standards ensure that the container is safe and suitable for transportation by sea, rail, or truck.


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**Deep Sea Port:**

A deep sea port is a port that can accommodate large ocean-going vessels, including container ships, bulk carriers, and oil tankers, which require deep water and ample space for manoeuvring. Typically, a deep sea port has a deep draft, meaning the depth of the water is sufficient to allow these large ships to safely dock and load or unload cargo. Deep sea ports are often strategically located near major shipping lanes, where they can serve as a hub for global trade and transportation. These ports may have specialized facilities for handling different types of cargo, such as container terminals or bulk cargo terminals, and may also have infrastructure for intermodal transportation, such as rail or road connections to inland transportation networks. The minimum draft of a deep sea port depends on the size and type of ships that the port is designed to accommodate, as well as the local water depth and conditions. In general, a deep sea port should have a draft of at least 12 meters (39 feet) to be able to accommodate large ocean-going vessels. However, some ports may have deeper drafts to accommodate even larger ships, such as those used in the oil and gas industry.

To handle the large ships that use deep sea ports, specialized equipment is required. This equipment may include:

- Cranes: Large cranes are used to load and unload containers, bulk cargo, and other types of cargo from ships.
- Container handling equipment: This includes container gantry cranes, straddle carriers, and reach stackers used to move and stack containers within the terminal.
- Forklifts and other handling equipment: Used for moving general cargo, such as palletized goods, bags, and drums.
- Tugboats: Tugboats are used to assist large ships in manoeuvring within the port and to tow barges and other vessels.
- Pilot boats: Pilot boats are used to transport harbour pilots to and from ships, as they guide the ship through the port.
- Dredgers: These are used to maintain the water depth of the port and to remove sediment and debris that may accumulate over time.
- Navigation aids: These include buoys, beacons, and other markers used to guide ships safely into and out of the port.

The technical specifications of a deep sea port can vary depending on its size, location, and intended use, but here are some common technical specifications:

- Depth: A deep sea port is typically defined as a port with a depth that allows it to accommodate large vessels. The minimum depth for a deep sea port is generally considered to be around 12 meters (39 feet), although some ports may have deeper channels to accommodate even larger vessels.
- Berths: A deep sea port typically has several berths or quays where vessels can dock to load or unload cargo. The number and size of berths will depend on the port's capacity and intended use.


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- Quay cranes: Quay cranes are essential equipment at a deep sea port, allowing cargo to be loaded and unloaded from ships. The number and size of quay cranes will depend on the size and capacity of the port.
- Storage yards: A deep sea port typically has large storage yards where containers and other cargo can be stored while awaiting transportation. The size of the storage yards will depend on the port's capacity and intended use.
- Connectivity: A deep sea port needs to be well-connected to the transportation network to facilitate the efficient movement of cargo. This may include road and rail connections, as well as access to airports and other transportation hubs.
- Security: A deep sea port must have adequate security measures in place to ensure the safety and security of the cargo and personnel. This may include surveillance cameras, access control systems, and other security measures.
- Environmental considerations: A deep sea port must also take into account environmental considerations, such as the impact of dredging on the seabed, and the management of waste and other pollutants.

The Port of Antwerp is one of the largest ports in Europe and has multiple container terminals operated by different companies, such as PSA Antwerp and DP World Antwerp and. Each terminal has its own unique technical specifications, equipment, and operational procedures. PSA Antwerp container terminal technical specifications can be seen below:

- Depth: The water depth at the terminal is 16 meters (52 feet), which allows it to accommodate the largest container ships.
- Berths: The terminal has seven berths, with a total quay length of 4,200 meters (13,780 feet). The berths are equipped with fender systems to protect ships during berthing.
- Quay cranes: The terminal has over 60 quay cranes, with lifting capacities ranging from 50 to 100 tons. The cranes are equipped with advanced computerized systems that enable them to load and unload containers quickly and efficiently.
- Container storage: The terminal has a total storage capacity of 9.3 million TEUs (twenty-foot equivalent units), with a current utilization rate of around 80%. The terminal is equipped with automated stacking cranes, straddle carriers, and other container handling equipment.
- Road and rail connections: The terminal has direct connections to major highways and rail lines and is served by a network of barge terminals that enable cargo to be transported inland via the extensive Belgian waterway system.
- Environmental considerations: The terminal is committed to sustainability and environmental responsibility. It has implemented several initiatives to reduce emissions and promote clean energy, including the use of electric cranes and vehicles, and the construction of a solar panel array on the terminal roof.


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**Quay Cranes:**

Quay cranes, also known as ship-to-shore (STS) cranes or container gantry cranes, are large cranes that are used to load and unload cargo from ships at a container terminal or a deep-sea port. Quay cranes are typically mounted on rails that run parallel to the quay (the platform where ships dock), allowing them to move horizontally along the length of the quay. They are equipped with a spreader beam that can be lowered onto a container, locking onto the container's corner castings, and lifting it from the ship's deck. The crane can then move the container to a waiting truck, railcar, or another ship, or place it in a storage yard. Quay cranes are typically operated by highly trained crane operators who use a combination of visual cues and computerized systems to accurately position the crane and load or unload containers from the ship. They are essential equipment in a modern container terminal, enabling the rapid movement of cargo between ships and the transportation network. Quay cranes come in different sizes and configurations, with lifting capacities ranging from 50 to 100 tons or more, depending on the size of the ship and the cargo being handled. They are built to withstand the harsh marine environment and are designed to operate safely and efficiently in all weather conditions.

Common technical specifications of container quay cranes:

- Lifting capacity: Container quay cranes typically have a lifting capacity ranging from 40 to 100 tons, with some newer models having a capacity of up to 150 tons.
- Outreach: The outreach of a container quay crane refers to the distance from the crane's centreline to the centreline of the ship. The outreach of a typical quay crane ranges from 30 to 70 meters (98 to 230 feet), depending on the crane model and the size of the ship it is designed to service.
- Hoisting speed: The hoisting speed of a container quay crane refers to the rate at which it can lift or lower containers. Typical hoisting speeds range from 40 to 120 meters (131 to 394 feet) per minute.
- Trolley travel speed: The trolley travel speed refers to the rate at which the crane's trolley can move along the length of the crane beam. Typical trolley travel speeds range from 150 to 300 meters (492 to 984 feet) per minute.
- Gantry travel speed: The gantry travel speed refers to the rate at which the crane can move along the quay. Typical gantry travel speeds range from 30 to 120 meters (98 to 394 feet) per minute.
- Height: The height of a container quay crane typically ranges from 30 to 40 meters (98 to 131 feet) above the quay.


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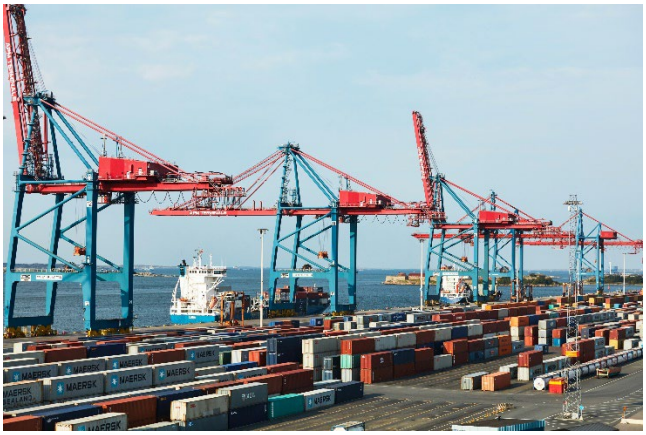
- Power supply: Container quay cranes are typically powered by electricity, either from the local power grid or from on-board generators. Some newer models are equipped with regenerative braking systems that enable them to generate electricity during the lowering of containers, which can be fed back into the power grid or used to power other equipment on the terminal.
- Automation: Many container quay cranes are equipped with advanced computerized systems that enable them to operate more efficiently and safely. These systems can include automated container positioning, anti-collision systems, and remote monitoring and control.



**Deep Sea Vessels:**

A deep sea vessel, also known as a deep sea ship or ocean-going vessel, is a type of large cargo ship designed to transport goods across the world's oceans. These vessels are typically designed with a large carrying capacity, powerful engines, and advanced navigation systems to withstand the rigors of long-distance travel and adverse weather conditions.

Here are some technical specifications of a typical container deep sea vessel:

- Size: Container deep sea vessels are some of the largest ships in the world, with lengths of up to 400 meters (1,312 feet) and widths of up to 60 meters (197 feet). They can have multiple decks with a total cargo capacity of up to 24,000 TEUs (twenty-foot equivalent units).
- Draft: The draft of a container deep sea vessel refers to the distance between the waterline and the bottom of the ship's hull. These vessels typically have a draft of between 12 and 16 meters (39 to 52 feet), allowing them to navigate deep ocean waters.
- Engines: Container deep sea vessels are powered by large diesel engines, with power outputs of up to 100,000 horsepower. These engines are designed to provide the necessary propulsion to move the ship through the water, as well as power the ship's auxiliary systems.
- Speed: Container deep sea vessels typically have cruising speeds of between 20 and 25 knots (23 to 29 miles per hour), although some vessels can travel at speeds of up to 30 knots (35 miles per hour).
- Navigation systems: These vessels are equipped with advanced navigation systems, including GPS, radar, and sonar, to ensure safe and efficient navigation in all weather conditions.
- Environmental considerations: Many container deep sea vessels are designed with environmental considerations in mind, such as the use of fuel-efficient engines and the implementation of measures to reduce emissions and protect marine life.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**Cargo Barge:**

A cargo barge is a type of flat-bottomed boat designed for transporting goods on rivers, canals, and other inland waterways. These barges typically have large open decks with minimal superstructure and are often pushed or towed by tugboats. In Belgium, the most common type of cargo barge is the spits barge. These barges are relatively small and narrow, with a maximum length of 38 meters and a beam of 5.05 meters. They have a maximum draft of 2.5 meters and can carry up to 350 metric tons of cargo. In the Netherlands, cargo barges are typically larger and more varied in size and design. The most common types of barges include the Kempenaar, which has a length of 52 meters and a beam of 6.6 meters, and the Rijn-Hernekanaal barge, which has a length of 86 meters and a beam of 9.5 meters. These barges can carry up to 2,000 metric tons of cargo. In Germany, cargo barges are also diverse in size and design. The most common types of barges include the Rhine barge, which has a length of up to 110 meters and a beam of up to 11.4 meters, and the Danube barge, which has a length of up to 185 meters and a beam of up to 11.4 meters. These barges can carry up to 3,500 metric tons of cargo. All of these barges are designed to operate on inland waterways and are subject to regulations and standards set by their respective countries. They are typically constructed of steel and are equipped with navigation and safety equipment such as radar, GPS, and life-saving appliances. They may also be fitted with specialized equipment for handling specific types of cargo, such as tanks for liquid cargo or hatches for dry bulk cargo.

Container barges in Belgium, the Netherlands, and Germany are designed to transport containers on inland waterways. These barges are typically larger and more specialized than general cargo barges, with features such as container securing systems and hatch covers. Here are some typical technical specifications of container barges in this region:

- Length: typically between 80 and 135 meters
- Width: typically between 11 and 16 meters
- Draft: typically between 2.5 and 3.5 meters
- Air draft: the height of the barge from the waterline to the highest point when fully loaded is typically between 6 and 7 meters
- Container capacity: varies widely depending on the size and configuration of the barge, but can range from a few hundred to several thousand TEUs (twenty-foot equivalent units)


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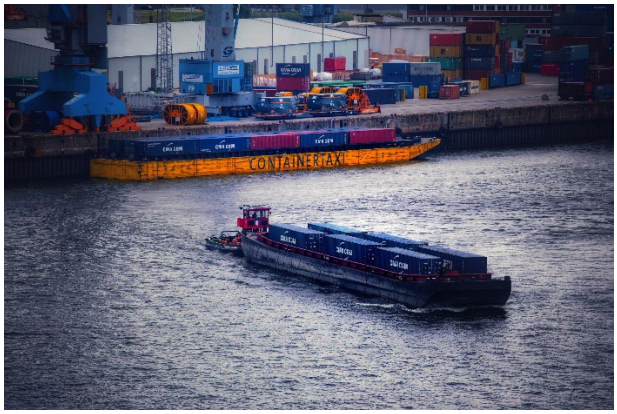


**Inland Waterways:**

An inland waterway is a body of water, such as a river, canal, or lake, that is used for transportation or shipping of goods and passengers within a country or a region, rather than on the open sea or ocean. Inland waterways are important for the transportation of goods that are not time-sensitive, as they are often slower than other modes of transport such as air or road. Inland waterways can be used for the transport of bulk goods such as coal, oil, and grain, as well as for the transportation of large goods such as vehicles and machinery. They are also used for recreational purposes such as boating and fishing. An overview of the inland waterways in Belgium, The Netherlands, and Germany, along with some of their specifications:

**Belgium:**

- The River Scheldt: The River Scheldt flows from France into Belgium and flows through the cities of Antwerp, Ghent, and Terneuzen. It is a tidal river and has a depth of up to 12 meters.
- The River Meuse: The River Meuse flows from France into Belgium and flows through the cities of Liege, Namur, and Charleroi. It is also a tidal river and has a depth of up to 3.5 meters.
- The Brussels-Scheldt Maritime Canal: This canal connects the Port of Brussels to the River Scheldt and has a length of 14 kilometres. It has a depth of 4.5 meters and can accommodate vessels up to 1,350 tons.
- The Albert Canal: The Albert Canal connects the River Scheldt with the River Meuse and has a length of 129 kilometres. It has a depth of 3.4 meters and can accommodate vessels up to 2,500 tons.

**Netherlands:**

- The Rhine: The Rhine is a major river in Europe and flows through the Netherlands, Germany, and Switzerland. It is one of the most important inland waterways in the Netherlands and has a depth of up to 9.1 meters.
- The Waal: The Waal is a distributary of the River Rhine and flows through the cities of Nijmegen and Tiel. It has a depth of up to 6 meters and can accommodate vessels up to 2,800 tons.
- The Amsterdam-Rhine Canal: This canal connects the Port of Amsterdam to the River Rhine and has a length of 72 kilometres. It has a depth of 6.7 meters and can accommodate vessels up to 2,000 tons.
- The Twente Canal: The Twente Canal connects the cities of Almelo and Hengelo and has a length of 65 kilometres. It has a depth of 3 meters and can accommodate vessels up to 600 tons.


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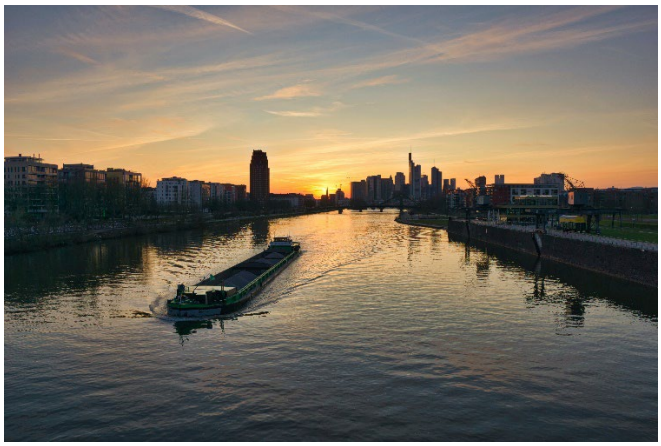
**Germany:**

- The River Rhine: The River Rhine is the longest and most important inland waterway in Germany. It flows through the cities of Cologne, Bonn, and Frankfurt and has a depth of up to 3.5 meters.
- The River Elbe: The River Elbe flows through Germany and the Czech Republic and has a depth of up to 1.6 meters. It is connected to the Port of Hamburg by the Elbe Lateral Canal.
- The Dortmund-Ems Canal: This canal connects the cities of Dortmund and Emden and has a length of 269 kilometres. It has a depth of 4.25 meters and can accommodate vessels up to 1,350 tons.
- The Kiel Canal: The Kiel Canal connects the North Sea to the Baltic Sea and has a length of 98 kilometres. It has a depth of 12 meters and can accommodate vessels up to 235 meters in length and 32.5 meters in width.



**Inland Waterways Locks:**

An inland waterway lock is a mechanism that is used to raise or lower boats or ships between different water levels in a canal or river. It is essentially a watertight chamber with gates at either end that can be opened or closed to allow boats to pass through. As a general estimate, the typical time that a barge spends at a lock is usually between 20 minutes to 1 hour. During peak periods of traffic, such as during harvest season or when there is a high demand for goods, waiting times at locks can increase.

Belgium:

- In Belgium, the locks on the Albert Canal have a length of 136 meters, a width of 16.8 meters, and a depth of 4 meters. They can accommodate vessels with a length of up to 110 meters and a width of up to 11.4 meters.
- The locks on the River Meuse have a length of 185 meters, a width of 12.5 meters, and a depth of 3.5 meters.

Netherlands:

- In the Netherlands, the locks on the main rivers have a length of between 120 and 270 meters, a width of between 16 and 25 meters, and a depth of between 3 and 4 meters.
- The locks on the Amsterdam-Rhine Canal have a length of 225 meters, a width of 24 meters, and a depth of 3 meters.
- The locks on the IJsselmeer have a length of between 45 and 50 meters, a width of between 6 and 14 meters, and a depth of between 2.5 and 3.5 meters.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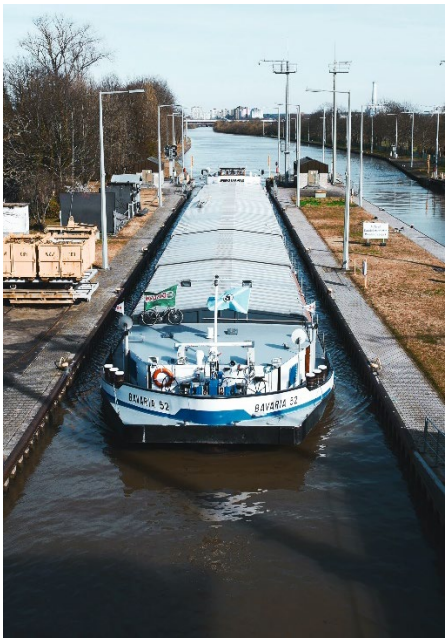
Germany:

- In Germany, the locks on the main rivers have a length of between 190 and 270 meters, a width of between 12 and 24 meters, and a depth of between 4 and 5 meters.
- The locks on the Kiel Canal have a length of 305 meters, a width of 36 meters, and a depth of 13.5 meters.
- The locks on the Dortmund-Ems Canal have a length of 190 meters, a width of 12 meters, and a depth of 4.25 meters.



**Bridges**

Bridges are an important component of inland waterways, as they allow vehicles and pedestrians to cross over the waterway without obstructing the flow of boat traffic. There are several types of bridges that are commonly used on inland waterways, including:

- Fixed bridges: These are bridges that are fixed in place and do not move to allow boats to pass through. They are typically used in areas where there is sufficient clearance for boats to pass underneath.
- Swing bridges: These are bridges that can be swung open horizontally to allow boats to pass through. They are often used in narrow waterways where there is not enough clearance for a fixed bridge.
- Lift bridges: These are bridges that can be lifted vertically to allow boats to pass through. They are often used in areas where there is not enough clearance for a fixed bridge or where there is a high volume of boat traffic.
- Bascule bridges: These are bridges that can be raised and lowered by counterweights to allow boats to pass through. They are often used in areas with a high volume of boat traffic, such as ports and harbours.

Inland waterway bridges in Belgium, Netherlands, and Germany are designed to meet specific technical specifications to ensure the safe passage of boats and ships. The technical specifications can vary depending on the location and type of bridge, but typically include requirements for the height, width, and weight capacity of the bridge, as well as the clearance required for boats to pass underneath. Additionally, many inland waterway bridges are equipped with signalling and communication systems to ensure the safe and efficient passage of boats. Some of the key technical specifications include: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Belgium:

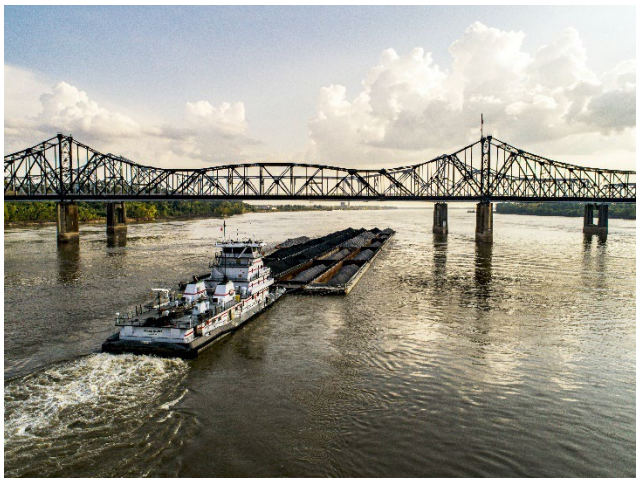
- The clearance height of bridges over the Albert Canal is 9.10 meters, while the clearance height of bridges over the River Meuse is 6.70 meters.
- The width of bridges over the Albert Canal is 50 meters, while the width of bridges over the River Meuse is 30 meters.
- The maximum weight capacity of bridges is 60 tons.

Netherlands:

- The clearance height of bridges on the main rivers is typically around 12.50 meters, while the clearance height of bridges on the Amsterdam-Rhine Canal is 5.50 meters.
- The width of bridges on the main rivers is typically around 36 meters, while the width of bridges on the Amsterdam-Rhine Canal is 12 meters.
- The maximum weight capacity of bridges is 45,000 tons.

Germany:

- The clearance height of bridges on the main rivers is typically around 7.50 meters, while the clearance height of bridges on the Kiel Canal is 42 meters.
- The width of bridges on the main rivers is typically around 110 meters, while the width of bridges on the Kiel Canal is 100 meters.
- The maximum weight capacity of bridges is 40,000 tons.



**Inland Ports**

An inland port is a logistical hub located along an inland waterway, such as a river or canal, that allows for the transhipment of goods between different modes of transportation, such as ships, trains, and trucks. Inland ports are often located in areas that are not directly connected to the sea but are still important for trade and transportation.

In Belgium, the Netherlands and Germany, there are several inland ports. These ports are connected to the sea through a network of canals and rivers, and they offer a range of logistical services, including storage, handling, and transhipment of goods. Technical specifications of these ports include:

Belgium:

- Port of Brussels: located in the heart of Brussels, this inland port offers a range of logistical services, including warehousing, handling, and distribution of goods. It has a total area of 103 hectares and is connected to the sea through the Brussels-Scheldt Canal.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- Port of Ghent: the third-largest port in Belgium, with a total area of 3,700 hectares and 45 km of quays. It is connected to the sea through the Ghent-Terneuzen Canal and can handle all types of cargo, including containers, bulk cargo, and liquid cargo.
- Port of Liège: The port is located on the River Meuse and is the third-largest inland port in Europe. The port covers an area of 2,800 hectares and has 34 km of quay walls that can handle vessels up to 9,000 tons.

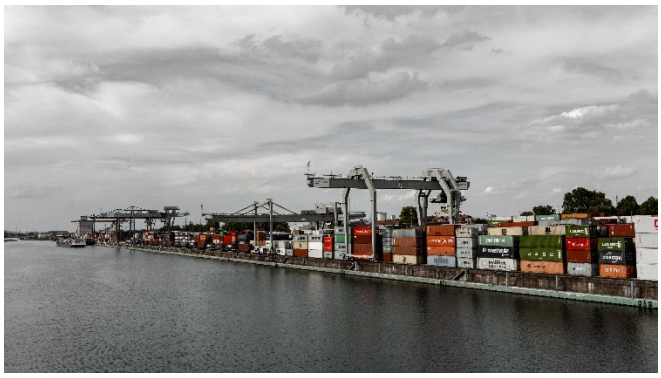
Netherlands:

- Port of Amsterdam: The port is located on the North Sea Canal and is the fourth-largest port in Europe. The port covers an area of 650 hectares and has 19 km of quay walls that can handle vessels up to 15,000 tons.
- Port of Groningen: The port is located on the Winschoterdiep canal and is the largest inland port in the northern Netherlands. The port has a total area of 200 hectares and can handle vessels up to 1,500 tons.
- Port of Nijmegen: Located on the River Waal, the port has 12 km of quay walls and handles around 1.5 million tons of cargo annually.

Germany:

- Port of Duisburg: The port is located on the Rhine River and is the largest inland port in the world. The port covers an area of 1,150 hectares and has 21 km of quay walls that can handle vessels up to 290 meters long and 11.45 meters draft.
- Port of Mannheim: The port is located on the Rhine River and is the second-largest inland port in Germany. The port covers an area of 200 hectares and has 7.5 km of quay walls that can handle vessels up to 135 meters long and 3.8 meters draft.

In general, inland ports in these countries are equipped with modern infrastructure, including quay walls, docks, cranes, and warehouses, to facilitate the efficient handling of cargo. They also provide a range of value-added services, such as customs clearance, logistics management, and container handling.



**Container Trucks**

Container trucks, also known as container chassis or container trailers, are designed specifically for transporting shipping containers overland. Container trucks come in different sizes and capacities depending on the size of the container they are designed to transport. The most common container sizes are 20-foot and 40-foot, and container trucks are typically designed to carry one or two containers at a time. The weight capacity of container trucks can range from 30,000 to 80,000 pounds, depending on the truck's axle configuration and the local regulations.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**Rail Containers**

Container locomotives, also known as container trains, are specialized locomotives designed for transporting intermodal containers on rail tracks. These locomotives are typically used for long-distance transportation of cargo between ports, rail yards, and inland terminals. Container locomotives are designed to pull trains of multiple intermodal containers, which can be stacked on top of each other to maximize efficiency and capacity. These locomotives are equipped with specialized couplings and brakes that allow them to securely transport large numbers of containers. Some container locomotives are also equipped with advanced technologies, such as GPS tracking and automated braking systems, to improve safety and efficiency. Many modern container locomotives are also designed to be more environmentally friendly, with features such as reduced emissions and fuel consumption. Container locomotives come in a variety of sizes and configurations, depending on the specific needs of the railway and the cargo being transported. Some locomotives are designed for short-haul trips between local rail yards, while others are designed for longer, cross-country trips. Overall, container locomotives play a critical role in the global logistics industry, providing a cost-effective and environment-friendly way to transport intermodal containers between different modes of transportation, including ships, trucks, and trains.

Example of transporting containers via rail. The Port of Antwerp, located in Belgium, has an extensive rail network that connects the port to various destinations in Europe and beyond. The rail network at the Port of Antwerp is operated by a number of companies, including Lineas, H&S Container Line, and Euroports. There are several rail terminals within the port area, including the Main Hub Antwerp terminal, which is the largest and most important rail terminal in the port. The rail network at the Port of Antwerp is connected to the European rail network, with direct connections to destinations in Belgium, the Netherlands, Germany, France, Switzerland, Italy, and beyond. The port is also connected to the Rhine-Alpine and North Sea-Mediterranean corridors, two of the nine European Union corridors designated for freight transport. The rail connections at the Port of Antwerp offer several advantages for shippers, including faster transit times, lower costs compared to road transport, and reduced carbon emissions. The port has made significant investments in its rail infrastructure in recent years, with the goal of further improving rail connectivity and increasing the share of cargo transported by rail.


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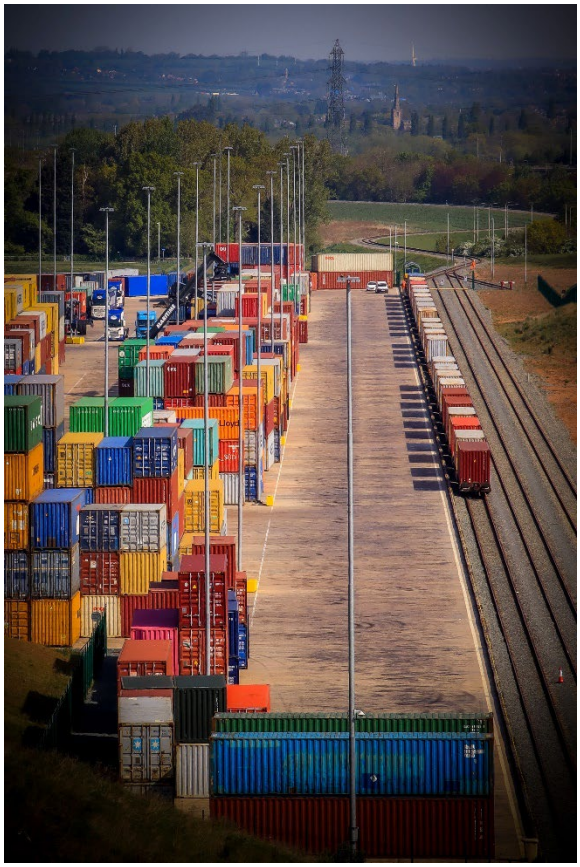


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## Appendix B: Quiz for the Master Students Version

**Stage 1: Arrival at the deep sea port with a deep sea vessel and unloading of the cargo.**

1. What is the process of unloading cargo from a deep-sea vessel called?

a) Transshipment
b) Loading
c) Discharging
d) Loading and unloading

*c) Discharging - Discharging refers to the process of unloading cargo from a vessel, which can involve using cranes or other equipment to remove the cargo from the ship and place it onto the dock or other transport vehicles.*

2. What is the term used to describe the space in which a deep-sea vessel can be safely docked?

a) Pier
b) Quay
c) Berth
d) Dockyard

*c) Berth - A berth is a designated space in a port or port where a vessel can safely dock, load or unload cargo, and receive services such as fuelling and maintenance.*

3. Which of the following statements is true about deep-sea vessels?

a) They are typically smaller than coastal vessels
b) They have shallower drafts than coastal vessels
c) They are designed for long-distance travel
d) They are not capable of carrying containerized cargo

*c) They are designed for long-distance travel - Deep-sea vessels are typically larger than coastal vessels and are designed to travel long distances across open seas. They have deeper drafts and are capable of carrying larger amounts of cargo than coastal vessels.*

4. Which deep sea port in Europe is the largest in terms of total cargo volume and containers?

a) Rotterdam
b) Amsterdam
c) Antwerp
d) Hamburg

*a) Rotterdam - The Port of Rotterdam in the Netherlands is the largest port in Europe in terms of total cargo volume and containers. It is a major hub for shipping and trade, connecting Europe with other parts of the world. In 2021, the total cargo volume was 469.4 million tonnes, and the container throughput was 15.9 million TEUs.*


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5. Which German city is considered the "inland port capital" of Europe?

a) Duisburg
b) Hamburg
c) Berlin
d) Frankfurt

*a) Duisburg - Duisburg is a city in western Germany that is considered the "inland port capital" of Europe. It is located at the confluence of the Rhine and Ruhr rivers and is a major transportation hub for shipping cargo by barge and rail throughout Europe. In 2021, the total cargo volume was 57.4 million tonnes.*

**Stage 2: Loading the cargo to a barge and departure of the barge towards the inland port.**

1. What is an inland vessel?

a) A type of truck
b) A type of container
c) A type of ship
d) A type of warehouse

*c) A type of ship - An inland vessel is a type of ship that is used to transport goods on inland waterways, such as rivers, canals, and lakes. They are designed to navigate shallow waters and low bridges and typically have a flat bottom and a shallow draft.*

2. What is the term used to describe the process of transferring cargo from one mode of transport to another?

a) Transloading
b) Cross-docking
c) Intermodal transport
d) Consolidation

*a) Transloading - Transloading is the process of transferring cargo from one mode of transport to another, such as from a truck to a train or from a ship to a truck. This is done at a transloading facility, where the cargo is temporarily stored and then loaded onto the next mode of transportation.*

3. What is a canal lock used for?

a) To regulate the flow of water in a canal
b) To prevent ships from colliding with each other
c) To lift or lower vessels between different water levels
d) To provide access to the shoreline

*c) To lift or lower vessels between different water levels - A canal lock is a device used to lift or lower vessels between different water levels in a canal. It works by filling or emptying a chamber with water, which causes the vessel to rise or fall to the desired level. Canal locks are necessary in canals with varying water levels to allow ships to pass through safely.*


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4.What is the name of the artificial waterway that connects the Rhine river to the Maas river?

a) Waal river
b) Main-Danube Canal
c) Lek river
d) Albert Canal

*d) Albert Canal - The Albert Canal is an artificial waterway in Belgium that connects the city of Antwerp on the Scheldt River with the city of Liege on the Meuse River. The canal was constructed between 1930 and 1939 and is an important shipping route for goods traveling between the Port of Antwerp and the industrial region of Liège.*

5. What is the maximum allowable width for a barge transiting the Dutch and Belgian inland waterways?

a) 8.2 meters
b) 9.5 meters
c) 10.8 meters
d) 12 meters

*b) 9.5 meters - The maximum allowable width for a barge transiting the Dutch and Belgian inland waterways is 9.5 meters. This is because the locks on these waterways have a maximum width of 12.5 meters, and the barge must have enough clearance on either side to avoid hitting the lock walls.*

**Stage 3: Arriving at the inland port and unloading of the cargo.**

1. What is the purpose of an inland port?

a) To serve as a hub for cargo transport by road and rail
b) To provide direct access to the sea
c) To store cargo for long periods of time
d) To process cargo for export

*a) To serve as a hub for cargo transport by road and rail - The purpose of an inland port is to serve as a hub for cargo transport by road and rail. Inland ports are located on rivers, canals, or other inland waterways, and are designed to connect the transportation networks of different regions or countries. They can provide access to larger sea ports, as well as offer storage and processing facilities for cargo.*

2. What is the difference between a sea port and an inland port?

a) An inland port is located closer to the sea than a sea port
b) A sea port is typically larger than an inland port
c) An inland port is typically located on a river or canal
d) A sea port is typically used for domestic cargo transport

*c) An inland port is typically located on a river or canal - The main difference between a sea port and an inland port is their location. A sea port is located on the coast and provides direct access to the sea for ships to load and unload cargo. An inland port, on the other hand, is located on a river, canal, or other inland waterway and provides a connection between the coast and the inland transportation network. Inland ports are typically smaller than sea ports and are designed to handle a different type of cargo.*


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3. What is the most common mode of transport used to move cargo from an inland port to its final destination?

a) Rail
b) Truck
c) Airplane
d) Ship

*b) Truck - The most common mode of transport used to move cargo from an inland port to its final destination is by truck. Inland ports are often located near major highways or other transportation networks, making it easy for trucks to transport goods to their final destination. Rail is also a common mode of transport, especially for long-distance shipments or for cargo that is time-sensitive.*

4. What is the name of the Belgian inland port that is located on the Albert Canal?

a) Brussels
b) Antwerp
c) Liège
d) Ghent

*b) Liege - The Port of Liege is an inland river port located in the city of Liege, Belgium, and is one of the largest inland ports in Europe. It is situated on the Meuse River and provides a strategic gateway for goods coming from or going to the major markets in Europe. The port has a range of facilities to handle various types of cargo, including container terminals, general cargo terminals, and bulk terminals. It handles a wide range of goods, including steel products, chemicals, fertilizers, grains, and consumer goods, and is an important hub for the distribution of goods to the Benelux countries, Germany, France, and beyond. The port has excellent connectivity with major road, rail, and waterway networks and is committed to sustainable development, implementing various measures to reduce its environmental impact.*

5. Which German inland port is located on the confluence of the Rhine and Main rivers?

a) Mannheim
b) Frankfurt
c) Cologne
d) Karlsruhe

*a) Mannheim - The German inland port that is located on the confluence of the Rhine and Main rivers is Mannheim. Mannheim is one of the largest inland ports in Europe and serves as a hub for cargo transport by water, rail, and road. It is a major centre for the storage and processing of chemicals, as well as for the handling of containers and other cargo. The Port of Mannheim is the second-largest inland port in Germany and handles around 8.4 million tons of cargo annually. The port is connected to both the Rhine and Neckar rivers, which makes it an important hub for both domestic and international cargo transport.*


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**Stage 4: Moving the cargo through the port's yard and loading it either on rail or on a truck.**

1. What is the primary purpose of a port yard?

a) To store cargo before it is loaded onto a vessel
b) To provide space for cargo to be sorted and consolidated
c) To facilitate the movement of cargo between different modes of transport
d) To provide access to customs facilities for cargo inspection

*b) To provide space for cargo to be sorted and consolidated - The primary purpose of a port yard is to provide space for cargo to be sorted and consolidated. Port yards are typically large open areas within a port where cargo is temporarily stored before being loaded onto a vessel, sorted and consolidated for onward transport, or processed for customs inspection. They are essential components of a port's logistics infrastructure and play a crucial role in the efficient movement of goods between different modes of transport.*

2. What is the maximum allowable weight for a truck transporting containers in Belgium?

a) 34 tonnes
b) 44 tonnes
c) 54 tonnes
d) 64 tonnes

*b) 44 tonnes - The maximum allowable weight for a truck transporting containers in Belgium is 44 tonnes. This weight limit is in place to ensure the safety of the roads and bridges in Belgium, as well as to reduce the impact of heavy trucks on the environment.*

3. What is the term used to describe the process of loading cargo onto a rail car?

a) Lashing
b) Securing
c) Stowing
d) Chocking

*c) Stowing - The term used to describe the process of loading cargo onto a rail car is stowing. Stowing involves placing cargo in the rail car in such a way as to ensure that it is secure and will not shift during transit. This is important to prevent damage to the cargo and to ensure the safety of the rail car and its occupants.*

4. What is the name of the rail freight terminal located in the port of Antwerp that primarily handles container traffic?

a) Deurganckdok Terminal
b) Kieldrecht Terminal
c) Beverdonk Terminal
d) Berendrecht Terminal

*a) Deurganckdok Terminal - The name of the rail freight terminal located in the port of Antwerp that primarily handles container traffic is the Deurganckdok Terminal. This terminal is one of the largest and most modern container terminals in the world, with a capacity of over 3 million TEUs per year. It is*


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*equipped with state-of-the-art technology and equipment to ensure efficient and safe handling of containers.*

5. Which German inland port is the largest rail freight hub for container transport in Europe?

a) Hamburg
b) Rotterdam
c) Antwerp
d) Duisburg

*d) Duisburg - The German inland port that is the largest rail freight hub for container transport in Europe is Duisburg. Duisburg is located at the confluence of the Rhine and Ruhr rivers and has excellent connections to the European rail network. It is the world's largest inland port and handles over 3.5 million TEUs of containerized cargo per year. The port has extensive rail infrastructure, including a large number of rail yards and terminals, and is a key hub for the transportation of goods between Asia and Europe.*

**Stage 5: Delivery of the cargo to the final destination.**

1. What is the function of a container freight station (CFS) in the supply chain?

a) To provide customs clearance and inspection services for containers
b) To provide warehousing and storage services for containers
c) To load and unload containers from vessels and trucks
d) To provide transportation services for containers between different ports

*b) To provide warehousing and storage services for containers - A CFS is a facility that is used for the temporary storage of goods, consolidation of cargo and transloading of cargo from one mode of transportation to another. CFSs are typically located near ports or other major transportation hubs and are used to consolidate small shipments into larger ones.*

2. What is the term used to describe the person or company that arranges transport for cargo?

a) Carrier
b) Freight forwarder
c) Broker
d) Shipper

*Freight forwarder - A freight forwarder is a person or company that arranges for the transportation of cargo on behalf of the shipper. They are responsible for arranging the logistics of the shipment, including booking transport, preparing documentation, and handling customs clearance.*

3. What is the most common Incoterm used in international trade?

a) FOB (Free on Board)
b) CIF (Cost, Insurance, and Freight)
c) EXW (Ex Works)
d) DDP (Delivered Duty Paid)


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*a) FOB (Free on Board) - FOB is the most commonly used Incoterm in international trade. It indicates that the seller is responsible for the goods until they are loaded onto the shipping vessel. Once the goods are on board, the responsibility and risk are transferred to the buyer.*

4.What is the maximum allowable weight for an inland vessel transporting containers in Belgium?

a) 1,500 tonnes
b) 2,500 tonnes
c) 3,500 tonnes
d) 4,500 tonnes

*c) 3,500 tonnes - Inland vessels in Belgium can transport up to 3,500 tonnes of cargo, including containers. This limit applies to vessels on all inland waterways, including rivers and canals.*

5. What are some of the factors that can affect the cost of transporting cargo from an inland port to its final destination?

a) Distance to be travelled
b) Mode of transport used
c) Type of cargo being transported
d) Time of year
e) All of the above

*e) All of the above - The distance to be travelled can have a significant impact on the cost, as longer distances may require more fuel, more drivers, or more time, which can all add to the overall cost. The mode of transport used can also affect the cost, with different modes having varying costs per unit of cargo. For example, transporting goods by truck may be more expensive than by train or barge. The type of cargo being transported can also affect the cost, with hazardous materials or oversized loads requiring special handling and equipment, which can be more expensive. Finally, the time of year can also impact the cost, as seasonal demand fluctuations can affect the availability of transport equipment and affect pricing.*


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# Appendix C: Interview with the recent graduate from the Masters degree of Maritime and Logistics of the University of Antwerp. Mr. Wouter Schmidt

***WS***: When you're playing the game itself, on the screen of the application, when you see for example the different types of barges that you can use, when you hover over it with your mouse, you can click on an information button like a small button and when you click on it you can find all the information about the barges and that can be, the information can be quite extensive as it's not in your face right when you start the application and it's more like you want to have more information, here it is; like the general characteristics of the barges such as the length, the DWT ,the capacity; you can put in the application but when you want more information you can put the information button and extend.

***CCR***: Do you think this should be mandatory for users or optional to click on it and get the additional information? Bear in mind that the aim is for students to acquire more knowledge in the industry, and you know that it is a matter of perspective of course but should it be mandatory so the students to get the information or to have the option to get this.

***WS***: I think it should be mandatory for the students to understand. I will keep the example with the barges, that they understand the barges and their technical characteristics and know that for example a barge that transports containers cannot hold dry bulk cargo; the general characteristics they should understand, the more in depth information regarding the barges should be more as an add-on. It shouldn't be mandatory reading.

***CCR***: Maybe it would be good to get the add-ons as you said while you're playing the application; so, at the beginning you start with basic knowledge, let's stick with barges for example; and as you play on you get more and more and more. Because I think the user after a point understands better the environment and what he is doing so it would be easier for him to focus on additional information rather than getting them in the first hand from the beginning. What do you think about this?

***WS***: Definitely, sure. It's impossible to, when you're learning the obligation to read all the add-ons and all the extra information, I think it would be a wise decision to learn as they play on also regarding the extra information. In the beginning, the users should have, they should want a tutorial on how to play the basics and when you understand the game, when you need to make a route, just learn how to make a route and when you have that understanding you can go to the next step, to get the cargo, loading / unloading and just go step by step and when you have the player complete all those different tasks you can draw them in to the game. I think it really depends on how long the game should take. 2 hours probable, the session that they will be doing.

***CCR***: That's a good question actually. I haven't thought about this. What do you think? 2 hours should be enough? And you are thinking that you should be able to complete it in one go rather than having for example chapters starting with the first bit and then moving to the next one? What do you think?

***WS***: Good, I think that's good.

***CCR***: What would you prefer? Let's say if you have the chance to have something like that in your masters would you prefer to have that in one go like an one session or a two weeks course?

***WS***: If you can make it, in to, like for example in my masters I had the course of the maritime business game and the nice thing about it was that we had two or three sessions of getting to know the program and working with it. I think when you can have it as a course it will be very good to have like a two week or maybe 4 or 5 sessions to the program itself; then you can really build your own, have your own experience with the program instead of when you have a two hours session that I was thinking about I didn't realize it was going to, that it could be a course. So when you have a two hour session you can work with the program but I think it could be impossible to finish it all to really accomplish something; but when you have a session you can you as a master of the application can say that at the


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end of the class the team which did the most transports or transported the most cargo in terms of value or being more efficient depending on the parameters that you put, that would be nice if that can be part of the serious game. For it to be a complete course.

***CCR***: So, talking about the scoring and the leaderboards and things like that, so having something to show what you've achieved, how do you think that should be? Do you think you should be earning points in the different phases of moving the cargo or using the routes or to get the total score at the end of your strategy. Because is about also strategy right; using the best strategy in moving the cargo (***WS***: the fastest etc.).

***WS***: I think, there should definitely be distinction between the amount of cargo that you transport and the value of the cargo. If you can have that distinction, I think the tons/km is important line the amount of cargo that is transported every km. Because then you can have, then you can compare the 3 different transport modes with the tons/km and see which group has the more tons/km and next to that you can have the value of the cargo. When a group is transporting not the most amount of cargo but the most value you can have two winners. The person with the most ton/km and the person with the highest value of cargo.

***CCR***: Do you think you should be getting information about how you are doing during the game or just at the end?

***WS***: During the game.

***CCR***: Having like milestones to achieve.

***WS***: Milestones would be nice, but you can start by giving an overview of the amount of cargo that is transported over the amount of the km that you have done. Because that is giving you the feeling of accomplishments when you get the cargo from point A to point B and when you see your counter go up, when you complete a task, it means that you have completed it. But when you have it at the end you are not sure if you have completed the task. Having a counter while you play the game would be crucial, I think, just a very simple one.

***CCR*:** Going back to the interface and the options actually. Do you think it should be complex from the beginning, I mean having to choose between let's say Antwerp and Duisburg or like a smaller route where you get the feeling of what you need to do to familiarize yourself with the game.

***WS***: Second one I think, but short so you understand how to plan your route. And then you can have like a bigger map.

***CCR***: Do you think you should get all the different routes or start from a short one and get to bigger one, you already said that this would be better, but I mean having all the different routes in the water ways, do you think that would help?

***WS***: Well, it depends. Can you use smaller barges or just one type?

***CCR***: That's another thing. So, based on what the user wants to see and what we want them to achieve, most probably we should give them the option to use all the different modes in terms of sizes as well. So, I mean it would be good for the user to start with a bigger barge and realize that a part of the canal is narrow so they need to change the size, they need to unload the cargo, they need to load it again or there is a lock where the barge cannot fit. So, would that be of interest to you?

***WS***: Yes, but because the persons which will have limited time to spend on the game, it would be nicer, when you want to put a barge on a canal when there is the lock or there is a draught that is too shallow the program itself should indicate that beforehand, before you get the cargo going because in the maritime business game you could buy a container ship, get a bulk contract, grain for example, and you can arrive at the port and then it just didn't start loading and then you have to realize that I bought a container ship, I need to sell it again and will lose million of dollars. So, you learn from your mistakes


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of course but when you have so limited time those mistakes can cost you the game. An when you just pick a barge and try to put it into a river that wouldn't fit in, the game itself should tell the users, just to give them the quick, the instant learning process instead of having the delayed learning progress. Because you don't have time to really let the player understand everything about everything when you just give them a quick trial error and that would be more effective than having the whole process.

***CCR***: Do you think that should be in the beginning like the tutorial? About the challenges that the industry is facing in this kind of circumstances. I mean you may face like low water draught, canal locks etc.

***WS***: I think this should be at the beginning but also when you choose a bigger barge that won't fit in the canal, the game should alert you about this.

***CCR***: I would like the different options in terms of barges sizes when you start the game; not have 10 different barges but at least 2 to understand the differences.

***WS***: Big one and small one. It all depends on how complex you want to make it. I think you should start really simple with development just to make sure that you can continue your vision with the game instead of having everything at once. Make it more complex as you go, but for the game itself 2 or 3 barges should really be enough. When you start really easy, like in the tutorial start really easy and then in the end when you end with 3 barges and a truck or a train maybe then I think you have enough, it would be complex enough.

***CCR***: Going back to the interface, we've talked already about having one route and maybe the other won't add much value. So, I was thinking of it as checkpoints, for example the route Antwerp to Duisburg, during this route to have 5 or 6 or more checkpoints where you would be able to achieve the first leg of the route (as part of many legs in the same route) and get additional information at the end of the loading point and getting the score as well as you mentioned. How do you find this?

***WS***: Good, if you can say, start loading, departed, arrived, and unloading as 4 different milestones that the player can also realize where the shipment is going, then you can put everything in between if you want. Like having those 4 checkpoints, it's really important for the player to know when the shipment has arrived and the rest of these milestones. If you could that, I think it would be more than enough.

***CCR***: Do you think there should be tests as well, so when achieving, when completing the first route for example, the first leg of the route, do you think there should be like a questionnaire or something that would act like a small test or an exam of the knowledge that you have obtained so far. To check if you are in a position to continue.

***WS***: Yeah, good idea. Just a small test, sure.

***CCR***: Do you think that would be boring for users?

***WS***: No, I don't think so. When it's as short test and when the questions are obvious for someone who read the important things just like for example what two types of barges are there or like can you choose this barge for that transport, just like a really obvious question or questions then NO, it shouldn't be a problem. It's still educational for educational reasons, so a quiz would be a good idea.

***CCR***: From your side, could you suggest of adding anything to a game like that?

***WS***: Not really, I think I mentioned it all. Make it easy in the beginning and make it more complex as you go. I think that before you can really start developing you should know how long the game is going to take, how much time you can have. The best thing is that you have a full course of the game to worst scenario is to have just two hours to explain that really makes a big difference of course. Is a really big difference of having a two hours game and three sessions of two hours game. So, I would start with that and then build around the time scale.


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## Appendix D: Invite for NOVIMOVE GAME stakeholder meetings

Invite text NOVIMOVE GAME stakeholder meetings

The potential advantages of Inland Waterborne Transport (IWT) as a low-energy and low CO2 emitting mode of transportation are currently not fully utilized due to deficiencies in the logistics system. Inland container vessels experience delays at seaport terminals, resulting in long waiting times. Furthermore, suboptimal navigation on rivers and waiting at bridges and locks further contribute to time loss. Additionally, the logistics system is affected by low load factors of containers and vessels, leading to unnecessary transportation of high numbers of containers and trips.

To address these challenges, NOVIMOVE is actively developing multiple innovations. The primary goals of these innovations are to improve container load factors, reduce waiting times at seaports, enhance river voyage planning and execution, and facilitate seamless passages through bridges and locks. These innovations are being evaluated through a simulation model.

To showcase the results of the simulation model and demonstrate the impact of these innovations, we have developed the NOVIMOVE game. The purpose of this game is to provide interested parties with an interactive interface to explore the main outcomes of the simulation results. To validate the game interface, we are organizing two stakeholder meetings.

During these meetings, we, the project partners, will introduce the game and its interface. We are eager to learn from your insights and opinions regarding the game we have developed and explore opportunities for further improvement. These meetings aim to foster constructive discussions and gather valuable feedback.

To ensure that all participants have a common starting point, this document has been prepared. We kindly request you to follow this link to register for the meetings: www.novimove.eu/game

Thank you, and we look forward to your participation.

Sincerely,

Edwin van Hassel
University of Antwerp

Charis Christodoulou Raftis
University of Antwerp


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