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Simulation Games to Study Transportation Issues and Solutions: Studies on Synchromodality

Ioanna Kourounioti[1], Shalini Kurapati[1], Heide Lukosch[1], Lóránt Tavasszy[1], and Alexander Verbraeck[1]

Abstract

In this paper we discuss the application of simulation gaming to study the behavior and decision making of stakeholders when confronted with complex transportation problems. The problem we tackle is synchromodal transportation. Synchromodality requires the vertical and horizontal collaboration of stakeholders in all the levels of decision making. To facilitate this, we develop four games designed in a way that meets the needs of decision makers in each level. We present both board and digital games and the results from the first gaming sessions with Dutch supply chain and logistics professionals.

Synchromodality is the "vision of a network of well organized and interconnected transport modes, which together cater for the aggregate transport demand and can dynamically adapt to the individual and instantaneous needs of transport users" (*1*). The required level of synchronization demands horizontal and vertical integration in the design and operation of intermodal transport and the provision of the necessary infrastructure to ensure the on-time and reliable delivery of goods (*2*). The complex nature of the freight transport system can be attributed to the existence of numerous interactions between numerous economic and political actors (*3*), which hinders the orchestration of transport modes and services. Conflicting and complicated decisions are made in all the freight transportation layers for enabling efficient services, infrastructure and assets (Figure 1, adjusted from Schoemaker et al.(*4*)).

One of the key issues that hinders the coordination between the different actors of the supply chain is the lack of information exchange between the actors both in the horizontal as well as in the vertical level. This lack of information exchange is partly due to the lack of collaboration between the stakeholders (*5*). To achieve the optimal level of synchronized services it is necessary to achieve the optimal collaboration between all the stakeholders in the supply chain (*6*). On the other hand, logistics and freight transport in general is a very complex and competitive environment (*3*). In order to bring the stakeholders together in such a challenging environment to understand the various issues and search for solutions we use simulation gaming as our main research method. The key merit of simulation games is that we can study the behavior and decision making of stakeholders, who would otherwise not interact in a real-life setting, in a safe, controlled and relaxed setting. In our studies we mainly used simulation games to study the issues faced by different stakeholders to arrive at synchromodal solutions for efficient transportation. We also apply games to explore solutions and policy measures to counter the discovered issues. In this paper we describe the five games developed for the stakeholders in each decision-making layer. The games presented below are developed in the context of a research project that uses them as a tool to study the behavior of stakeholders towards the complex issue of synchromodality.

This paper is structured as follows. First, we give a brief overview of the key literature findings in the area of the application of simulation gaming as a research method in complex systems such as transportation networks. Then we provide a detailed presentation on the games developed to address the synchromodal transportation issues. We discuss the first results from the gaming sessions and conclude the paper by presenting the points of future research.

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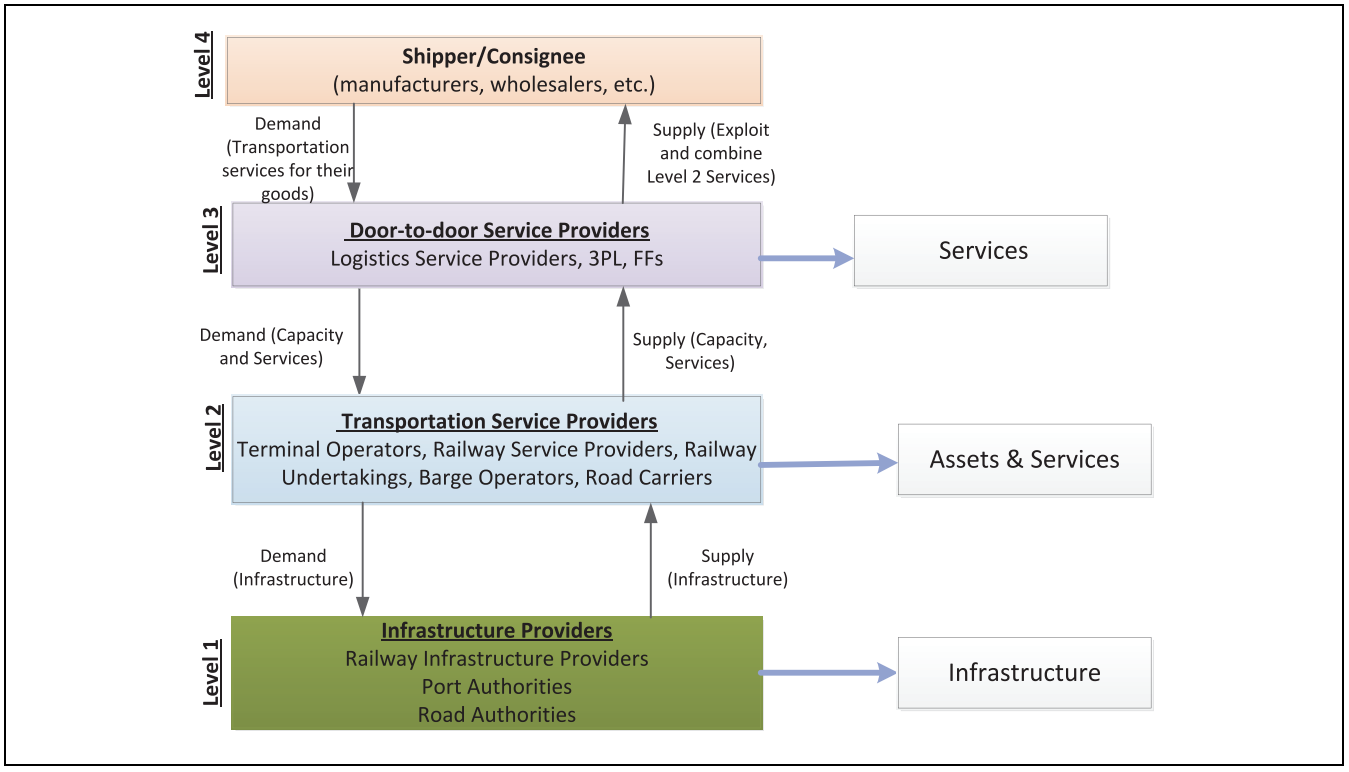

Figure 1. The TRAIL layer model for freight transport.

Background on Simulation Gaming as a Research Method

The modern era of simulation games began in the 1950s through the integration of military/war games, computer science, and operational research (*7*). Simulation games represent a real system at a certain level of abstraction, where participants have to abide by certain rules to win the game by managing their limited resources of money, time, and influence within the game (*8*). Making an analogy to the characteristics of a standard research method, the research problem is the game objective, the research environment is the game itself, and the experimental set-up is the game session. Data collection and data analysis can be done from observation and game logs. In the words of Greenblat (*8*), "The design of a simulation game itself is a systematic translation of understandings into an operating model, and the subsequent examination of the model through observation of play can lead to a refining of theoretical formulations and consequently to a higher level of social scientific understanding." Klabbers (*9*) claims that simulation gaming is an effective research method to study complex systems.

This vision was earlier shared by Duke (*10*), who proposed simulation gaming to study issues that are complex, future-oriented, and of a systems nature. The widely used research methods in the field of supply chain, transportation, and logistics are case studies, questionnaires, action research, modeling and simulation, and as a relatively new method, simulation gaming (*11–13*).

Simulation gaming addresses questions of human behavior in the context of organizational action, social change and technical development (*16*). It is well equipped to perform multidisciplinary research that integrates different perspectives, concepts, theories, data, information, methods, techniques, and tools from two or more disciplines to understand and solve problems for which solutions are beyond the scope of a single discipline (*16*). This approach is particularly suited to transport applications in which stakeholders with different perspectives and different information management regimes and solutions are present. Simulation games have been used for transport applications in works of several authors (*11, 17–19*). The works of these authors illustrate cases of how to design and apply simulation gaming for transportation issues. While Meijer (*11*) proposes a solution on a strategic level, Kurapati et al. (*17*) suggests the use of short games on operational level in transportation. Kurapati et al. (*18*) discusses the use of games for the governance of the transport system as a whole, and awareness for synchromodal transport solutions in particular. The cases show that simulation gaming can address challenges and issues of transportation on all three levels; strategical, tactical, and operational.

Table 1. Prominent Research Methods in the Field of Supply Chain, Logistics and Transportation

	Case studies	Surveys	Action research	Modeling and computer simulation	Simulation gaming
Pros	In-depth study into real world situations. Direct observations of real actions and communication of actors.	The ability to gather a large number of responses while giving little or no disturbance to the actual behavior of the respondents.	The involvement of actors in all stages of research bridges the gap between research and application.	Unlimited number of experiments can be conducted with different scenarios.	Observation of actual actions and behavior of participants is possible. The experiments can be repeated in a safe and controlled environment.
Cons	Low repeatability and low ability to generalize due to changing contexts and contextual bindings.	Truthfulness of responses, and involvement of participants cannot be known. Questions may be interpreted differently by different respondents.	Lack of standardization in research procedures and processes. Time-consuming. Loss of control of the research environment due to varying commitments of the actors.	Real data and observations are unavailable. Tacit knowledge of humans is hard to model.	A part of reality of the actual environment has to be compromised to enable playability of the related game. Complex, time consuming, and expensive.

Note: Adapted from Popper (*14*), and Summer and Summer (*15*).

We will introduce the four games developed in our research study on synchromodality in the following sections.

Simulation Games on Synchromodality

Synchromodality is "the optimal, flexible and sustainable use of different transport modes in a network under the control of a logistics service provider, in such a way that the customer (client or freight forwarder) obtains an integrated solution for his (hinterland) transport." (*20*). To enhance the complex vertical and horizontal collaboration and information provision needs inherent with synchromodal transport we developed a game addressing the key decision makers in each level of the layered freight transport model as it can be seen in Figure 2.

Specifically to address the needs, problems and preferences of the stakeholders in the third layer, the SynchroMania game was developed. We designed two board games to address the issue of rail building and cooperation between rail service providers: Rail Cargo Challenge Rotterdam, and Rail Cargo Challenge Amsterdam. For the decision makers on the first level we developed the Modal Manager game in which infrastructure managers use information provision as a way to control traffic and increase the efficiency of the network. Finally, we are in the process of developing the Shipper's Game that investigates the shippers' preferences on the design of the synchromodal transport product. Some of the games have already been presented (*17*, *18*, *21*, *22*) but in this paper we focus on describing the approach of developing games that address the decisions made by the stakeholders in every layer of the logistic chain. The rest of this section provides a more detailed description of the games.

Modal Manager Game

The Modal Manager game is a so-called "microgame" and consists of different missions, representing a network of road, rail and barge transport routes together with the various intermodal terminals in a hypothetical transport corridor in the Netherlands presented in Figure 3.

The learning goal of the game is to investigate how infrastructure providers can apply different information management strategies to inform, advise and control traffic in the network to increase performance and network users' satisfaction. The objective is to raise the awareness of inframanagers; on using information and to understand how to apply different information provision strategies. In the game the player assumes the role of an infrastructure manager (inframanager) and has to deal with four logistic service providers (LSPs), A, B, C and D, who are automated agents. Each of the LSPs is modeled such that they make route choices based on their respective priorities: A is known for reliability, B for sustainability, and C for being cost effective. D introduces an element of randomness without a clear priority. The game can be configured to accommodate several points of origin and destinations for the containers. Container traffic enters the network from one specific origin and has a specific destination (*18*). During the

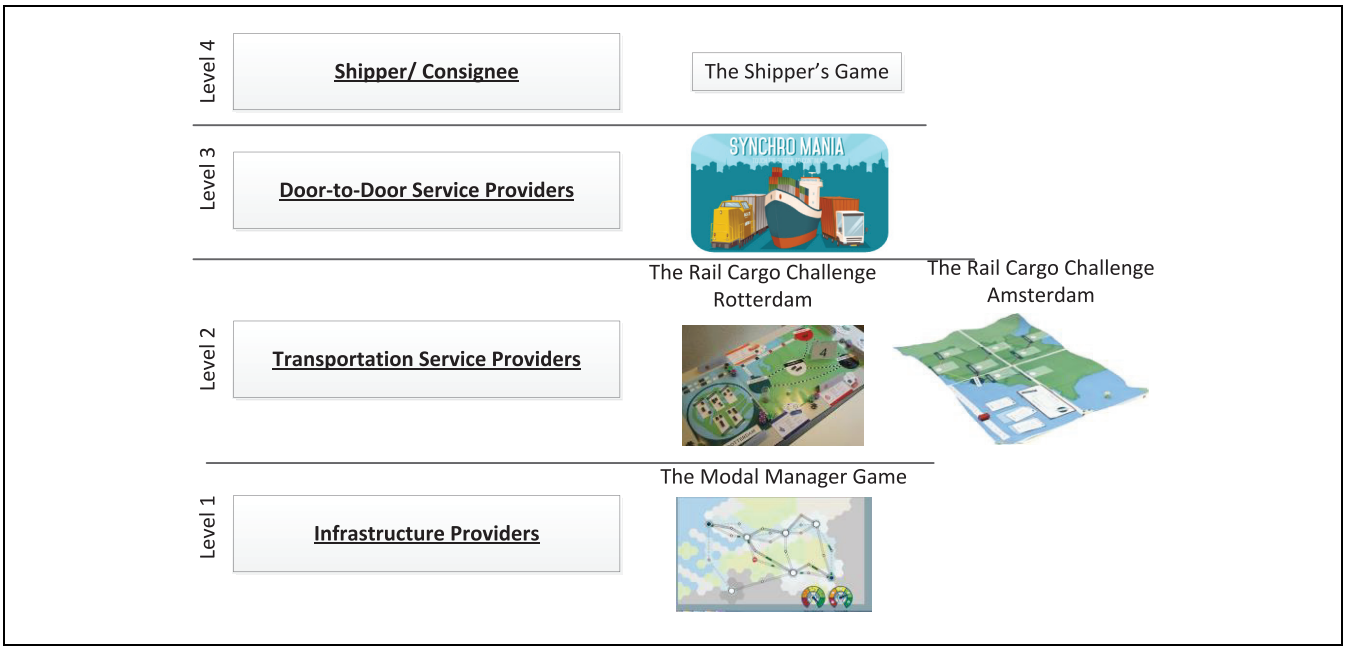

Figure 2. Games per layer.

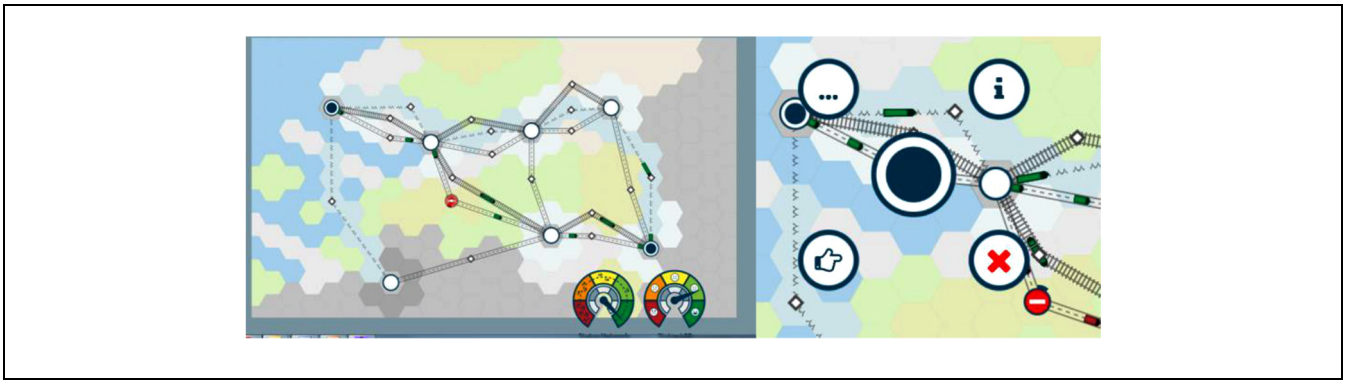

Figure 3. Screenshot and commands of the Modal Manager Game.

game the stress on the capacity of network as well as planned and unplanned disruptions are communicated to the player. Specifically, the player knows the position, the duration and the time that a planned disruption will occur. Unplanned disruptions pop up randomly in the network and their duration is communicated to the player. Projections of expected congestion levels in all the network links, starting from a free-flow and going up to a totally congested link, are also indicated to the players. At the end of the game the players must ensure that all the containers are delivered to the final destination on time. The goal of the game is to pay attention and maintain a good happiness level of the LSPs (the right metric in the right image in Figure 3) and a high overall network performance (the left metric in the right image in Figure 3). This introduces a dilemma to the player to balance network efficiency and happiness levels. The tools at the player's disposal are the different strategies for the provision of information. Specifically, the measures at the players' disposal are (also illustrated in Figure 3, left image):

- **Inform**: The inform option corresponds to a network information system that provides generic information about disruptions displayed and accessible to all LSPs. Based on this information the LSPs can decide whether to take an alternative route or continue on the same route. The interpretation of the information is subjective, and its consequences are unknown to LSPs.
- **Advice**: With this option the inframanager shares only relevant information to relevant LSPs by

explaining the consequences of the final choice of the LSP. Inframanagers must pay attention to the amount of the advice they provide in order not to create information overload and decrease the dissatisfaction of the agent LSPs.

- **Direct**: The inframanager enforces a certain route to the LSP. To ensure the optimal utilization of the direct command the inframanager has to assess the current situation of the network and predict the future congestion levels on the network links.

When providing information, the inframanagers have to make a trade-off between LSP satisfaction and performance of the network. The overall goal of the game is to explore which measures are taken (decision-making of the players), and what affects the game KPIs which are the network performance, measured by the average delays in the network, the number of containers that arrive at their destination on time, and the user satisfaction measured by LSP satisfaction and trust levels. A complex algorithm measures the trust level of LSPs based on the accuracy of information provided by the inframanager. The game has several complexity levels. In the first level of the game, the player controls only one modality within the synchromodal network and operates in a situation which reflects the current situation of managing the network of one mode. In the second level, the player is still in charge of one mode but has to consider the preferences of LSPs while choosing the different measures. In the final game play level, the player is a "super modal manager" who can manage all three modalities.

The game is played by the infrastructure providers of different modalities. The Modal Manager is not designed to be played alone but will be a part of a workshop which starts with a briefing lecture about corridor management by the facilitator. The participants fill in a pre-game questionnaire that collects their demographic information, their expectations from the workshop and their current attitudes towards synchromodal corridor management. Then they play different missions. After each mission, the facilitator invites the participants to reflect on the game play and relate it to real-world applications.

At the end of the workshop the participants are asked to reflect on the following:

1. Reflect on advantages and disadvantages of the current practice of information provision as a way to manage the network.
2. Understand the need to move from operational focus (disruption management) towards a more tactical perspective to balance performance and client satisfaction.
3. Deal with capacity limits through the communication of congestion levels to the network users.
4. Opportunities to communicate and cooperate with LSPs.
5. Opportunities of collaboration with other mode inframanagers.
6. Understand the opportunities and challenges of synchromodality.

Several workshops using the Modal Manager game have been planned together with the infrastructure managers of the Dutch transport networks in winter 2017 and spring 2018.

Rail Cargo Challenge Rotterdam Board Game

The key research objective of the Rail Cargo Challenge Rotterdam (RCCR) is to assess the attitudes and behavior of stakeholders in the freight transport domain with respect to the efficient bundling of containers to be transported to their final destination using rail. The RCCR is a multiplayer table-top board game, set in the environment of a sea port corridor connecting Rotterdam to several destinations in Europe. To construct the new Maasvlakte 2 port extension the port authority had to guarantee a 18% increase in the rail transport share (*23*). The biggest hindrance to this is the dispersed nature of the terminals in the port area. The game was designed in collaboration with the stakeholders from the Port of Rotterdam and addresses the problem of bundling freight from the three terminals in Maasvlakte (*24*). The roles in the game are two competing rail operators who can transport freight using rail by charging a price to shippers. The shippers organize the transport of the container from various container terminals in the port. In the first round of the game, there are three terminals: A, B and C.

Each shipper has order cards that denote the number of containers that need to be transported, the terminal in which they are stored, their destination and the time limit for transporting them. The rail operators have to pick up freight from different terminals in the port at a predefined or negotiated price. However, rail operators have limitations in picking up containers and cannot serve all the terminals. Each rail operator throws a dice to determine the number of terminals that the player's train will be able to visit. All rail operators and shippers start with 50 tokens representing money. The rail operators can arrange trains with capacity of 10 containers each. Each train costs 10 tokens. The shippers can make arrangements with the rail operators to pick up their containers from a terminal—the terminal where the container is allocated is indicted on the order card—for a specific price. For each shipment (order card) that is successfully delivered via rail the shipper receives 4 tokens. On the other hand, if a shipment is not sent by rail then it has to

be sent by truck to the final destination, but this option is more expensive. The rail operators will benefit most if they can manage to fill up all their trains to full capacity and make sure they can pick up shipments from the terminals as agreed with the shippers. If the dice is in their favor, and they are able to transport all containers as planned on time they receive 4 tokens per shipment. If they fail to do so, then they have to pay additional tokens to truck the shipments. An extra mechanism inserted in the game is the reputation of the port. If shippers and rail operators do not succeed in delivering the containers at their final destination on time then the reputation of the port is reduced and fewer shipment cards are given to the players in the next round. This mechanism was inserted in the game to make players understand the importance of cooperation. If player does not cooperate shipments will not be delivered, the reputation will go down and clients are lost from the port. In the subsequent rounds the situation becomes even more complex when two new terminals open up in the port, that makes the starting position of the containers more scattered across the port, while the rail services and frequency remain the same (*21*).

The game is part of a gaming session at the end of which participants reflect on the opportunities and challenges of rail bundling and on the importance of cooperation to increase the port throughput as well as the demand for the shippers and services of the rail operators. A related game for the Port of Amsterdam will be discussed in the following paragraph.

Rail Cargo Challenge Amsterdam Board Game

The Port of Amsterdam Challenge Game (RCCA) was also designed to address a similar problem for freight bundling in the Port of Amsterdam. The learning goal of RCCA is to raise the awareness of players about the benefits of cooperating to consolidate freight from the different terminals in the port area. The biggest issue regarding rail freight bundling raised by Amsterdam Port Authority is the existence of five different specialized terminals in the port area. Each terminal handles a specific type of cargo and does not collaborate or exchange information with the other terminals. At the moment a shuttle train service operates in the port that reaches all the terminals. Due to the lack of collaboration half-empty trains circulate around the port without a schedule creating traffic issues in rail network. Amsterdam Port Authority expects that coordination between the terminals to bundle freight will increase the efficiency of rail transport within the port and the productivity of the port in general. Therefore, this board game aims at bringing the terminal operators together and raising their awareness about the benefits of collaborating and consolidating transport.

In the game each player acts as a terminal operator who has to store a number of loads in the terminal and ensure that they are transported to their final destination using rail. At the beginning of the game each terminal already has some existing infrastructure and is specialized in a certain type of cargo. Some of the terminals have certificates that permit them to handle either inflammable cargo, chemicals or grains. Each terminal is given a shipper/client card that shows the name of the client, the type of cargo that the client handles, the final destination that the cargo has to be transported to and the profit that the player can make for the delivery of each unit of cargo. In addition, the player is given one of the following roles:

1. **Logistics expert.** This player faces no delays in the train.
2. **Train expert.** This player starts first putting together trains and has a discount.
3. **Marketing expert.** This player is the first one to choose new shippers.
4. **Infrastructure manager.** This player is the first to buy and has discount to purchase new infrastructure.
5. **The lobbyist.** This player is the first to buy and renew certificates and has a discount on the purchase and the renewal of new certificates.

After storing all cargo in the terminals players must start the procedure to transport them to their final destination. They have two options: the first option is the shuttle service which is much more expensive but guarantees the on-time delivery in any destination; or the player can put together a train that can have up to three destinations. Each train has capacity of 10 containers and costs 13 tokens (the train expert pays 10 tokens for the train). The player can collaborate with the rest of the players to fill all the available capacity in the train. The train expert is the first to put together a train while the logistics expert has no delays. After booking trains the players throw the dice for each destination of the train to randomly see if the train is delayed. For each delay an additional token is charged. Then all the transported contracts are reimbursed and players can buy new infrastructure and certificates. Afterwards five new shippers are inserted on the game board. The players choose a new shipper (they keep their old one) and the next round starts. In should be noted here that in the case that a shipper's contract is not delivered then the reputation of the port goes down and one shipper is removed from the board for the next round. The reputation mechanism points out the importance of collaboration between the terminals to serve all the clients and increase the traffic in the port. The higher the number of rounds the more complicated the game becomes since the players have to store all the cargo in

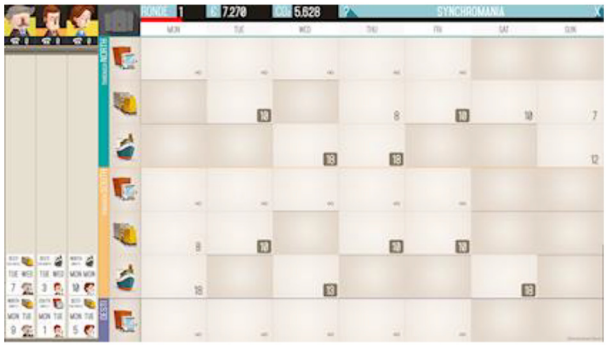

Figure 4. SynchroMania planning screen shot.

their terminals and make sure that they book transport services to deliver their cargo to the final destination on time.

The game is part of a gaming session at the end of which participants reflect on the benefits of cooperating to improve not only the competitiveness of their terminal but also of the Port of Amsterdam as a whole. The fourth game in our study is called SynchroMania and will be discussed next.

SynchroMania

SynchroMania is a digital game that addresses decision makers on the third level (Figure 4) mostly aiming at freight-forwarding companies and LSPs. The objective of the game is to make players understand the complexity of planning orders to the available modes and services to transport all the cargo on time. The long-term goal of the game is to persuade shippers to leave the mode of transport free for the LSP to choose. In the game, players take over the role of the planner and they are asked to optimally place orders, coming from three different customers, into three modes of transport (truck, rail and barge) based on customer's demands, mode's services and space availability. In each round limited time to assign the orders to the specific route and the modality dictated by the client is given. Every round represents a weekly time horizon and a specific time is given to each day. At the beginning of every day new order cards are generated. The mode, the number of containers, the client who places the order, the route (north route or south route), and the pick-up day and the delivery day are written on the card. The player has to plan all the orders and deliver them on time, using the mode and the route indicated on the card. This task is very complicated because there are restrictions on the available capacity of the modes and the frequencies of services. The player has the option to call the client and ask him for flexibility in the characteristics of the shipment. An algorithm generates the possible negative or positive replies of the clients. After the end of every round additional degrees of freedom, in the forms of action cards purchased to increase flexibility, are provided to the players. After a round finishes key performance indicators (KPIs) that calculate costs, CO_2 emissions and customer satisfaction are applied to evaluate players' performance. During the discussion that follows every round the scores are compared, and players discuss their chosen tactics. Based on the insights given in the discussion players can change their tactics in the next round (*22*).

At the end of the game during the debriefing session the players are asked to reflect on (*25*):

- the advantages and disadvantages of synchromodality;
- the difficulties of the planning activities of planners;
- the effect on the work of planners and sales employees;
- the way decisions influence the efficiency in the network.

All the games are part of an on-going research project. We will present our initial findings from the workshops organized using the games so far on their impact on stakeholders in the Dutch transport domain.

Design and Outcomes of Gaming Sessions

The challenges for the development of synchromodal freight transport solutions are due to complexity of the transport system that comprises numerous and often competing stakeholders (*24*). As a first step to engage stakeholders we have developed a series of games that refer to problems faced in the different layers of decision making. All the games are part of a gaming session in which during briefing and debriefing sessions players are enabled to reflect on what they experienced in the game, and to translate this back to alternative solutions. We recorded player attitudes through pre- and post-game surveys, in-game logs, and observer notes.

In the rest of this section we will summarize the key findings from the gaming sessions that were carried out using the simulation games described in the earlier sections.

Modal Manager Game

Two sessions have been carried out using this game with 16 participants. During the briefing of the sessions participants were introduced to the issues of network infrastructure management with a special focus on

information exchange and disruption management. In every round the type of information management strategy (informing, advising, directing) influences the likelihood that the LSPs will follow the information. It also affects the ability of the inframanager to maintain the capacity of the network without congestion. Participants were then asked to reflect on the effectiveness of the measures toward efficient traffic management despite the disruptions. They all highlighted the importance of information provision as a means to deal with disruptions (planned and unplanned ones) in the network. They also stressed the innovative nature of information management strategies in the game as a tool to steer the traffic. Participants were very enthusiastic about the game and pointed out that they had fun while they learnt about the importance of collaboration and coordination between the different means of transport to provide a more efficient and less disruptive transportation of goods in the network. The overall refection is that the gaming sessions can successfully contribute to the learning goal of the game.

RCCR Board Game

We organized a game session with 20 participants who were professionals in the Dutch logistics industry at a transport conference held at Tilburg, Netherlands. The session comprised three parts:

1. Briefing and pre-survey—The game master gave a brief introduction on the background of the game and requested the participants to fill in a pre-game survey. In this survey, the participants were asked about their attitudes towards freight bundling together with their demographic information.
2. Game-play—The game play lasted one hour, and two rounds of the game were played.
3. De-briefing and post-survey—During the debriefing participants discussed their post-game experience and filled in a survey to measure the change in attitude of the players related to freight bundling using rail.

The results of the pre-survey state that the 76% of the respondents agreed that rail bundling would increase rail efficiency by decreasing the amount of trains traveling empty or half empty. They also believed it could lead to lower costs and overall improvement of the sustainability of freight transport. The design of an efficient rail network, with optimized and synchronized schedules that permitted the consolidation of freight could increase the benefit of train modal share. According to the respondents, the promotion of collaboration between the different stakeholders had been a critical point. On the other hand, professionals highlighted the challenges they expect to face when consolidating freight. For them, information and data sharing are the biggest hindrances in freight bundling together with legal issues. Bundling is complex because it requires mode coordination, capacity availability, and synchronization of modes and services to align transport containers within the given time constraints. After the end of the session 15 out of 20 participants agreed that the game gave them an insight on rail bundling and helped to reflect on the challenges and opportunities related to freight consolidation. Significant modifications were not observed regarding their opinions on rail bundling They continued to believe that cost reduction, environmental benefits, and higher rail efficiency are amongst the most important advantages of rail bundling. This could be partly attributed to the fact that the participants were already predisposed towards synchromodal solutions since they were managers and executives of transport companies and not involved in the actual operations. On the other hand, the majority of respondents highlighted the importance of designing e-solutions to enhance the provision of essential information for the scheduling of services and to the related legal issues.

RCCA Board Game

The RCCA has many similarities to the RCCR game therefore we designed a similar gaming session for these two games. We organized a session with 15 managers from the terminals in the Port of Amsterdam. During the briefing the game master introduced the game and the issue of cooperation to bundle freight between the terminals in the Port of Amsterdam and participants filled in a pre-game questionnaire on their characteristics and their attitudes towards freight bundling and cooperation between the terminals. The game play consisted of five rounds and in the debriefing players reflected on their experience and filled in a postgame survey. The analysis of the questionnaire data showed that 13 out of 15 participants highlight the importance of communication between the terminals to facilitate freight traffic. From the answers in the postgame questionnaire we observe a switch in the opinion of the players; they all say that they strongly agree about the importance of cooperation. This change of opinion proves the successful design of the game.

SynchroMania Game

SynchroMania is also played within a workshop with briefing and debriefing sessions. During the briefing the game master explains the idea of synchromodality and the game rules. During the different rounds of the game

participants compare their scores and discuss their game tactics. During the debriefing the players are given a questionnaire about their characteristics, attitudes and their opinions on the factors that can influence the adoption of synchromodal transport. We have collected data from 59 participants in two different sessions. The results of the questionnaire analysis proved that the awareness towards synchromodality was raised since 72% stated that after the playing the game they gained more awareness of the importance of flexibility while 48% agreed that they understood the importance of synchromodality. Interesting discussion between representatives from different sectors was generated and 64% agreed that they had enjoyed the session and the game.

Conclusions and Further Research

The main objective of this paper is to present a series of games that were developed to raise awareness towards synchromodality, a freight transport innovation expected to increase the efficiency of freight transport. Research shows that the horizontal and vertical collaboration between stakeholders is a prerequisite to achieve the synchronisation of the different modes and increase modal shift toward more environmentally friendly modes of transport (*1*). We used simulation gaming as our key research method to study the behavior and decision making of stakeholders of a complex system such as a transport network in a safe and controlled environment. Games offer participants an interactive, immersive, and motivating environment to express their attitudes and preferences. We have designed five games to help stakeholders understand the key challenges and opportunities offered by synchromodal transport. The results of the gaming sessions have shown a positive attitude change towards synchromodality after playing the games. The games we developed are both digital and board games. The principle advantages of the board game are the social cohesion and interaction offered by the board game environment. Participants have a shared view of the game environment and can interact naturally. The physical elements of the board game such as tokens, cards and pawns increase the fun element of an otherwise serious play. Board games also produce rich qualitative data. In combination with well-designed briefing and debriefing sessions board games can be very valuable research instruments even in today's digital era (*26*, *27, 28*). A simulation metamodel has been developed using the design of the game where the choices of the players are inserted, and their effects are calculated. On the other hand, the digital games are a source of a lot of quantitative data that can be used to model the decisions of the players. Using the data from SynchroMania we try to use games as survey instruments and use them to model decisions. We have also developed simulation metamodels shown in Visser et al. (*24*) using the qualitative observations to create a computer simulation model of the board game to give quantifiable insights into the decision making of the stakeholders as if the game has been played few thousand times.

In future work we will try to organise more gaming sessions and collect more data to better understand the behavior of players. Through the application of games, answers to critical questions regarding synchromodality will be given. In addition, we have already started developing a game that investigates the preferences of shippers regarding the services and the costs of the synchromodal product. Finally, data will also be used to develop models shown in Visser et al. (*24*) that can be used to predict the future evolution of the behaviour of stakeholders.

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Author Contributions

The authors confirm contribution to the paper as follows: study conception and design: Kourounioti, I.; Kurapati, S.; Lukosch, H.; Tavasszy, L. and Verbraeck, A; data collection: Kourounioti, I. and Kurapati, S.; analysis and interpretation of results: Kourounioti, I. and Kurapati, S.; draft manuscript preparation: Kourounioti, I.; Kurapati, S.; Lukosch, H.; Tavasszy, L. and Verbraeck, A. All authors reviewed the results and approved the final version of the manuscript.

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