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Enhancing Awareness on the Benefits of Supply chain Visibility through Serious Gaming

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Abstract. Improving both efficiency and security in international supply chains requires a new approach in data sharing and control measures. Instead of managing supply chain risks individually, supply chain partners need to collaborate in order to exchange cargo information and implement control measures on the level of the entire supply chain. Governmental agencies, having access to this up-to-date and complete information, can implement alternative risk assessment policies, resulting in less disruptive ways of supervising entire trade lanes. However, this paradigm shift requires awareness of these supply chain visibility concepts and increased collaboration between partners in a value chain. In order to disseminate these new concepts and initiate cooperation between key stakeholders, a serious game called ‘The Chain Game’ was designed, implemented and evaluated.

1 Supply Chain Visibility

One of the main challenges that international intermodal container logistics faces today is how to balance efficiency and security. Efficiency is one of the key performance indicators businesses are aiming for in order to have competitive advantages. In contrast, governmental agencies, such as customs at border control, have to maintain a high level of security to protect citizens and business partners against unlawful practices. However, increased efficiency and increased security are goals that may oppose each other. For example: in order to reach maximum efficiency, disruptive governmental interventions are undesirable from the business perspective, whereas maximum security is reached by high inspection rates and heavy enforcement measures applied to all incoming and outgoing containers. In current day practice, most organizations in a value chain manage their supply chain risks individually, by applying a combination of the 4Ts: transfer, terminate, tolerate and treat. Risk transfer practices are very mature and widely applied by the more powerful chain actors. The weaker chain actors often cannot transfer such risks and pressure on margins forces

them to tolerate certain risks. If risk treatment is being considered, it is often done through internal control measures.

Research in supply chain dependencies, vulnerabilities and resilience proposes an alternative approach, one that considers the risks from the perspective of the entire supply chain, instead of from each individual fragment of the chain. Risk based control and supervision seems the way forward, targeting high risk consignments and concentrate inspection effort on the targeted categories, whilst applying alternative less disruptive ways of supervision to the rest. This concept of *Supply Chain Visibility* [1] takes the needs of both governmental agencies and businesses in the chain into account. The basic idea is a data sharing concept that is built on integration of existing data processing systems. This so-called 'Data Pipeline' is used by business companies for end-to-end supply chain visibility, to ensure high data quality and data completeness and efficient connectivity to community systems. Customs and other authorities can connect to the Data Pipeline through a dashboard interface and use selected data for reporting purposes, such as customs declarations. It also allows them to piggy back on the validated and enriched supply chain data and advance the risk analysis and assessment they used to perform on data from declarations. An advantage for all parties is that all available information is up-to-date, since the data itself is fed by the originator of data and only retrieved by authorized users. Time-consuming search for additional information concerning a single transport could be avoided and additional data sources (from container security devices for example) could enrich the data sets without revision of company-wide or governmental data bases.

In theory this Supply Chain Visibility concept can benefit all actors within a supply chain. This approach may not only lower costs for the business partners in the supply chain because of increased data sharing efficiency, but may also have customs recognize that the corresponding trade lane partners are 'in control' of the major risks in their supply chain, resulting in less disruptive interventions from the authorities. However, some required steps need to be taken in practice to operationalize this approach. Most importantly, trade lane partners need to collaborate in implementing both the data sharing concept and additional chain control mechanisms. Examples of control mechanisms on the level of the entire chain are partner screening and coaching, applying technologies for container integrity (e.g. Container Security Devices) and data validation procedures, either through physical checks (e.g. a tallyman checking the packing list information) or by comparing data from different sources (three-way match). A second important step is new policy from the governmental agencies, that allows less disruptive interventions based on a different way of risk analysis.

Creating awareness of the aforementioned concepts and control mechanisms, having key stakeholders in a value chain recognize the benefits of such an approach and initiating collaboration to put these concepts into practice proves to be a difficult and time consuming process. In order to speed up the concept development cycle but also to disseminate the research findings we implemented an alternative approach: a serious game. We believe the characteristics of serious gaming, which allows stakeholders to have concrete experiences with the innovative concepts in interaction with each other, will disseminate the research successfully and will initiate collaboration for future implementation of supply chain visibility.

2 Serious Gaming

Serious games have proven to be an excellent medium to explain and teach complex concepts through experiential learning in a wide variety of domains. A well-known example is strategic war games that have been used in military training for centuries. At least since the mid-19th century the use in the military tactical training of officers has been documented [2, 3]. Business simulations, which can be simple board games or massive computer games, are commonly used in management education [4, 5]. An almost classic example for this is the Beer Game, which was created in early 1960s at the MIT's Sloan School of Management [6] and is still used in management education to have players experience the bullwhip effect. Technological progress has allowed for more complex and realistic simulators, such as flight simulators, nautical simulators, crane simulators or driving simulators.

Simulation games and simulators are commonly used to allow students to experience situations which are too costly, hazardous or unethical to experience in the real world. Simulation games are very useful to understand complex problems through experiential learning: experiencing the effects and dependencies of own behavior is a very strong learning method. Simulation games allow making mistakes in a safe environment and thus learning by trial and error [7]. This invites players to try new strategies and challenge long-standing patterns of behavior. In "The Chain Game" we use this to guide the players to try more collaboration.

The use of (computer) games in education - either especially designed for education or commercial off-the-shelf (COTS) games - is growing [8, 9, 10]. The learning theories which can be identified in games include well known theories of learning such as Gagne's "Conditions of Learning theory", Gardner's "Theory of Multiple Intelligences", Skinner's "Operant Conditioning theory", Thorndike's "Laws of Effect", Maslow's "Hierarchy of Needs theory" and Kolb's "Experiential Learning Model". Also incorporated are learning approaches like active learning, experiential learning and situated learning [11].

Probably the most compelling point about games is their ability to motivate and engage, far better than other teaching methods. Prensky believes that games "are the most engaging intellectual past-time that we have invented" [8]. In studies, participants report to have more interest in simulations or games than in classroom instructions. This correlates with the participants investing significantly more time in learning with games [7], [9], [11]. For our dissemination we take advantage of the engaging and interest raising nature of games. Buckley and Anderson identified three common characteristics which make games so compelling [13]:

1. Being in control: Players work at their own ability level and speed and repeat material as needed.
2. Feedback and rewards: Games give immediate feedback. Additionally most games reward behaviors and actions by the player which are "positive" according to the in-game logic particularly. This increases the frequency of this behavior and teaches a positive attitude towards the content of the game.

3. Challenge and mastery: Games challenge players but remain doable. They keep the balance between too hard and tedium, giving the player feelings of self-efficacy.

Since games are an engaging medium for explaining complex systems, they can be very useful to create awareness for new concepts, such as the data sharing concept of Cassandra, with key stakeholders. Serious gaming allows meaningful interaction with both a relevant representation of the world and between key stakeholders, allowing them to analyze the situation from different perspectives and create a shared understanding of the challenges [14]. As such, gaming can play an important role in the transformation process needed to eventually implement these concepts.

3 The Chain Game

Given the goals we hope to achieve, explaining the complex and abstract concepts of supply chain visibility and initiating collaboration between key stakeholders in supply chains, we believe serious gaming is a very suitable medium – more so than reports or presentation material. In modern supply chain logistics stakeholders face multidimensional problems with complex side effects and non-linear dependencies. A game typically is a simplified world, reducing this complex multidimensional problem to its essentials in order to showcase only the relevant parts. This section describes *The Chain Game*, the serious game that was designed to transfer the abstract chain visibility and chain control concepts into practical examples and to allow players to experience the effects of the researched innovations, even though the exact effects (in reality) are not yet known.

The starting point for designing The Chain Game is the goals that should be achieved after playing the game. These learning goals were defined as follows:

1. Players understand that collaboration between supply chain partners is needed in order to operationalize the concept of supply chain visibility. Additionally, collaboration will have benefits on the performance of the supply chain, but the investing partners will not necessarily receive the gains, so discussion on return-on-investments is necessary. In general, the performances of businesses within one chain are interdependable.
2. The concept of supply chain visibility and the underlying innovations need to be disseminated. The players (typically key stakeholders in a supply chain) need to understand the broader picture of supply chain visibility, but also understand typical control measures they could implement.
3. Implementation of the supply chain visibility concepts will increase robustness of the entire supply chain as risks are more easily mitigated and governmental agencies will apply less disruptive supervision measures.

These requirements are used to design components such as the world model (cause and effect), physical setting, narrative (i.e. scenario and storyline), aesthetics, but also the game session (i.e. the process of game play). This design is an iterative process in which play-testing is key: by trying out the game, the designers can observe whether

the goals are reached and interaction and user experience are what they hoped for. In the sections below, we explain how the design meets the initial requirements.

3.1 Benefits of Collaboration

In order to show the effects of collaboration and initiate discussion between key stakeholders, we needed multi-player gameplay. The Chain Game has a fixed amount of five roles, of which each plays part of an international supply chain: two sellers, two freight forwarders and one buyer. The goal within the game is to create highest value for the own company, based on three key performance indicators (KPIs). In order to do so, players can invest in innovations from their limited resources. Innovations are either individual (conform the internal control measures) or collaborative (in which case collaboration obviously is necessary) and will improve specific KPIs of specific companies in the chain.

Interdependence between players is designed in the game model in multiple ways. First off, investing in collaborative innovations will increase chain value more than individual innovations on the long term. However, the collaborative innovations do not necessarily benefit the players that have invested in them: they may benefit one player more than the other, may benefit a player that has not invested at all or may even decrease company value of an investing player. These effects can be reduced by the players themselves, as they are allowed to share their benefits with each other. This game mechanic stimulates investing in collaborative innovations, but also supports discussion on return-on-investment. Additionally, the fact that the players are (collectively) responsible for implementing innovations and they almost immediately see the effects of their actions contributes to the game characteristics 'Being in control' and 'Feedback and Reward' as described by [13].

Second, company value is not only based on the key performance indicators of the *own* company, but also on the performance of the chain as a whole. But the performance of the chain depends for a large part on the weakest link of that chain. As a result, players need to convince other players to improve certain KPIs, conveying the message that chain partners are highly interdependent.

3.2 Disseminating Concepts

The supply chain innovations are made available as *actions* to the players of the game. This forces the players of The Chain Game to become familiar with the concept of Supply Chain Visibility: they are required to think about the value of the innovations in the context of their working environment and will experience the necessity to cooperate in order to create greater supply chain visibility. The innovations are focused on custom-related interruptions, in line with the research goals of the Cassandra project, and described on an abstract level, in such a way that they have an effect on one or more KPIs of one or more roles. The effects of an innovation are not disclosed until the innovation is implemented, creating the challenge for the players to understand these innovations and estimate their effects if they want to master the game (as described before [13]). As they are trying to implement the best possible innovation

for their company, the main goals of the game are achieved: communicating the concept of supply chain visibility, understanding of the underlying innovations and discussion within the supply chain on these innovations.

An example of a supply chain visibility concept is 'Exception Reporting', which is made available as collaborative innovation to the players of The Chain Game (see fig 1). For 'Exception Reporting' three investors are required: both freight forwarders are forced to invest, and a third one (either one of the sellers or the buyer) also needs to contribute to implement this innovation. As described before, the companies that invested in the innovation are not necessarily the companies that receive the (dis)advantages: 'Exception Reporting' not only improves the KPIs for both investing freight forwarders, but also the buyer, whether he invested or not. An important step in clarifying the concepts to the players is explaining the argumentation of the effects, which is done by a game facilitator. In the case of the 'Exception Reporting' innovation, the reason for the impact is described as follows: "Exception Reporting provides the Freight Forwarders with early warnings for expected errors, allowing them to take measures in an early stage. This will give them more control over their business and they will have the ability to reduce the negative consequences, which is also of interest for the Buyer."

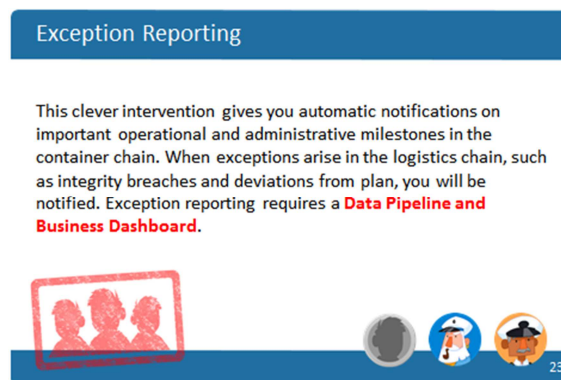


Fig. 1. An example of a chain innovation card

A big challenge of designing The Chain Game was that insufficient data is available on the exact effects of these innovative concepts, so it was not possible at this point to create a simulation model that predicts the effects on a detailed level. However, the innovations were already described on an abstract level in the CASSANDRA Project deliverables [15]. As the goal of the game is to create awareness about this knowledge, a qualitative model suffices to create this awareness and support discussion about the various concepts. As a result, the effects of each innovation were established by interviewing subject matter experts in a series of workshops to come to the content model of The Chain Game. In total, the effects of 6 individual innovations and 26 collaborative innovations were estimated and implemented this way.

3.3 Chain Robustness

One of the promises of increased supply chain visibility is that the supply chain will be less sensitive to incidents that may occur. To communicate this message, incidents occur regularly to test the current state of the supply chain. Incidents typically have a negative effect on one or more KPIs of one or more companies, but implemented innovations may (partly) mitigate these effects. The effects of an incident and the mitigating innovations for each incident have been established by the subject matter experts, similar to the effects of the innovations. An example of an incident is 'Cargo Theft': "Cargo has been stolen from trucks that were on their way from the Seller to the seaport. Trucks are totally emptied by this criminal organization." It has a negative effect on the freight forwarders, the seller and the buyer with the following argumentation: "Both of the Freight Forwarders are held responsible for their lack of security measures for their part of transportation. Their reliability is severely damaged and they have to compensate the costs of the theft and therefore their capability weakens. The Buyer doesn't get its raw product in time, which means that yet again, there will not be enough of his product available for retailers. This hurts the perceived reliability of the Buyer. The Seller is afraid to lose clients and quickly offered to deliver new cargo at cost price." The innovation 'Exception Reporting' discussed before mitigates 25% of these effects.

A second game mechanic that gives players the feedback on the state of their supply chain is the role of Customs. Customs is strongly interested in supply chain visibility, since they profit from additional information in a way that checks on data might be executed in less time. Therefore, the partners in the supply chain may gain advantages in relation to Custom checks if they provide a certain degree of visibility. Ideally, Customs perceives the supply chain as a *trusted trade lane*, a concept strongly related to supply chain visibility. These dynamics reflect in the game by having Customs to perform a risk assessment on the state of the supply chain at the end of each game round. The risk assessment decides if a physical check of the goods is performed. Such a check has negative effects on the reliability of all stakeholders of the entire supply chain, since goods transported may be delayed for days. However, a number of innovations in the game that are of interest to Customs will have the supply chain proceed towards the certificate of trusted trade lane. Each implementation of one of these innovations decreases the probability of a physical check.

4 Evaluation

The final version of The Chain Game was disseminated by playing it with two groups of stakeholders: consultants of a large accountancy firm and managers of Dutch Customs. The goal of the play sessions was to both evaluate and disseminate the game with stakeholders. The game was evaluated by a questionnaire; additionally, observations during the reflection phase are also used for the evaluation. A play session consisted of 20 minutes of introduction, 10 game rounds (75 minutes), filling in the questionnaire and 30 minutes of reflection. The goal of the evaluation was to assess whether the game is valuable for creating supply chain visibility awareness and

to make an inventory of possible opportunities to apply the game. The questionnaire consisted of 3 questions (see Fig. 2) that needed to be scored on a 5-point Likert scale (1 = *totally disagree* to 5 = *totally agree*), and the following open questions:

- What part of The Chain Game should stay the same?
- What part of The Chain Game should be adjusted?
- Which (business) opportunities do you see for this game?
- Any further remarks?

4.1 Results

In general it can be concluded that both groups are convinced The Chain Game has value in creating awareness for supply chain visibility. Fig. 2 on the next page shows the results of the three closed questions – the results of question 3 (as shown in Fig. 2) show that both groups are fairly positive about using The Chain Game in their own working environment: the 64% of the consultants are positive (27% negative) and 55% of the Customs group are positive (0% negative). We believe these score may be toned down somewhat by the fact that these groups were not the primary audience for The Chain Game. For example, Customs does not have an active playing role in the game and for consultants the focus on customs-related interruptions covers only a part of their work. On the other hand, socially desirable answers may also have influenced the results, as the questionnaire was hardly anonymous.

The answers to the open questions and the observations of the game facilitators show that both groups are positive about the way of using a game to raise awareness and understanding for complex information. This was also easily observed: players were drawn into the game from the first round on and the game could keep the attention until the final round, for more than an hour. Additionally, the interactivity and direct feedback was praised by both groups, allowing players to quickly gain insight in the effects of certain innovations. Finally, from the group of consultants several people mentioned they were drawn to the digital and visual implementation.

Both groups believed that more time should be reserved for the facilitator to explain the effects of innovations. Sometimes, the effects of innovations or incidents were challenged by a player, but this does not really stand in the way of the goal of the game: creating awareness. Discussion about the effects in real-life situations are a consequence of the fact that the model is an estimate of subject matter experts and not evidence-based. This means innovations sometimes had effects that the players did not expect. This cannot be resolved in the game, as effects need to be undisclosed to force players to think about the meaning of innovations. However, it is necessary for the game facilitator to take sufficient time for the argumentation *behind* the effects that take place. An expert opinion supports relevant discussion and counters players' frustration. Additionally, some game design choices have resulted in the omission of factors that can be of importance in the real world. For example, the number of players is fixed, in order to keep the game economy as simple as possible (i.e. a player can basically invest only in one innovation each turn). As a result, stakeholders cannot enter or leave a logistics chain, an action that can have big effects in the real world. This pragmatic choice was made to keep the game playable within a few hours.

Somewhat related is the *game process*: in the play sessions, hardly any reflection on the adopted strategy was possible during the playing of the game because of the fast pace during these sessions. As a result, players were not able to reflect upon the played innovations, the expected and the real effects and the underlying model. This prevented them in creating a broader understanding and forming and adjusting their strategy. Particularly the group of consultants requested one or two reflection phases during the game, in order to improve understanding, which can easily be adjusted by pausing the game after 3 or 4 rounds.

Interestingly, the group of consultants believed the game to be strongly focused on Customs-related innovations, while the group Customs would like a more active role for Customs in the game. The game can be improved for the consultants by adding taxes- and legislation-specific innovations; this is no problem from the perspective of the game design, as long as the effects are sufficiently realistic and in balance with each other. However, it will change the focus of the game, which was primarily aimed at Customs-related interruptions. Making Customs interactive in the game is more difficult to implement, since this would mean adding a new role that is even more asymmetrical to the roles that already exist in the game.

A number of different **opportunities** were put forward during the play sessions. The group of consultants believed the game can be played with companies to raise awareness about supply chain visibility and on the impact Customs can have on supply chains. Both groups believed the game can provide insight in the interdependence between supply chain partners and the importance of jointly investing in innovations and prevent weak links in the chain. Finally, Customs believed the game can be used as learning tool in management studies related to logistics.

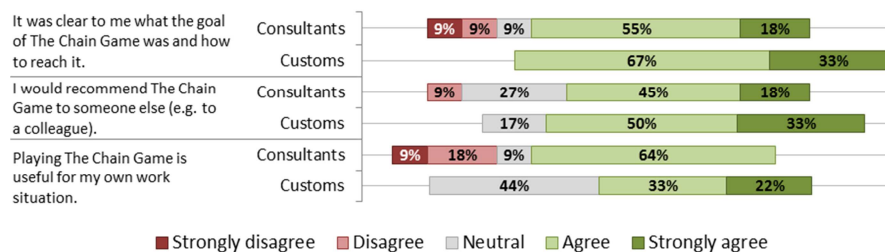


Fig. 2. Results of the evaluation questionnaire

5 Conclusions

Disseminating the concepts and ideas concerning supply chain visibility is a challenge, as they are abstract and hard to grasp. Additionally, future implementation of these concepts require both support and collaboration of a multitude of stakeholders, hence awareness within this group of stakeholders is essential to effectuate innovations. In order to explain the complex concepts and initiate collaboration between stakeholders, a serious game named The Chain Game was developed. The goal of The Chain Game is to have players experience the effects and advantages of increased

supply chain visibility. The serious game focuses on a variety of innovative concepts, which can be implemented by the main actors in a supply chain. Feedback consists of the effects of these innovations on a supply chain level. A qualitative game model was built by a team of game designers and subject matter experts, as little evidence-based data is available as of yet.

The fully digital serious game has been tested by stakeholders in two pilots. Both groups evaluated the game as valuable in raising awareness on the subject of supply chain visibility with stakeholders and believed it can act as a supporting tool in bringing the necessary parties together. Additionally, the game can be used as learning tool in management studies related to logistics. An important observation during the tests is the crucial role of the facilitator as subject-matter expert: he needs to have the time and the knowledge to explain the argumentation behind the presented effects during the game. If this precondition is met, The Chain Game can provide an excellent starting point for further discussion on the future of supply chain visibility.

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