CROSS-COLLABORATIVE SUPPLY CHAINS: SERIOUS GAMING VIA A CASE STUDY

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Abstract –

Collaboration currently is crucial for stakeholders operating in the supply chain. Nevertheless effective and sustainable forms of inter- and intra-supply-chain collaboration are scarce in practice. Often this is caused by the false interpretation of conflicts of interest on sharing benefits or sensitive data about sales and orders. Serious gaming has shown its contributions to make stakeholders aware of such phenomena in different domains than the logistics domain. In this paper we show the development of a serious game based on extensive case study material on different logistic service suppliers (LSP) in Europe. After interviewing experts and collecting requirements we use a SCRUM agile setup to create a multiplayer serious game that has a game play with increasing complexity. The game starts with a "classical" single LSP level that offers order acceptance, truck -and resource planning and routing. In the final gaming level players experience the benefits of sharing orders and collaborative planning, but still with a competitive and realistic set-up. Players report this gradual gameplay show the positive effects and possibilities of collaborative planning.

Keywords: *Cross Chain Collaboration, Logistic Service Providers, Serious Gaming, Simulation, Supply Chain Management*

1 Introduction

Developing serious gaming has become a popular research area (Deterding et al. 2011), (Reeves and Read 2009), (McGonigal 2011). Companies see serious gaming as the next frontier, however serious gaming is not a holy grail in itself and its real contributions and efficacy should always be tried out. Serious gaming can stimulate the engagement between people and also motivate employees in changing a certain behavior (Zichermann and Cunningham 2011).

This paper presents our study to use some fundamental elements of serious gaming and to apply it to the context of supply chain management. We address the problem of how serious gaming can help in organizing the supply chain in a better way measured by efficiency and effectiveness of scare resources.

In our research we especially focus on the role of Logistic Service Providers (LSP). Collaboration is crucial for stakeholders operating in the supply chain (Van Laarhoven committee 2008). Managing collaboration is key to support their success and competitive advantage (Beardsley, Johnson, and Manyika 2006). An effective collaboration in the entire supply chain asks mutual investments from each entity in the chain. The idea of inter- and intra-supply-chain collaboration is an on-going topic in science and practice, however effective and sustainable forms of such collaboration are scarce in practice. The main reasons are: sharing benefits of collaboration in a fair way is far from trivial, and operational collaboration re-quires sharing sensitive data about sales and orders.

These phenomena also can be recognized in the domain of logistic simulations -and serious games. There are ample supply chain games available like variants of the classic MIT Beergame, but most focus around singular optimization paradigms and the amount of real collaborative planning games is scarce. Nevertheless the theoretical relevance is well explained and defined, because nearly 7% of all articles in major logistics journals used case studies to develop new theories and models (Näslund 2002).

In this paper we combine these two omissions and present a collaborative serious game to simulate a scenario in which sharing logistic resources can be played and tried out. Above all we intend to change the existing mental scheme from logistic planners that is focused on sub optimization for the individual node in the supply chain.

The practical relevance for this investigation came during several interviews with leading European LSPs. One of their main concerns, besides trust and gain sharing was how horizontal collaboration should impact their operational business? Furthermore the interviewees were interested in how to train the staff from the planning department in exchanging orders and trips with competitors? From these questions we formulated our research problem.

What is an effective serious game to both show and train the effects of collaboration between planners of various LSP's?

We used an agile approach with master students and PhD students to create various versions of this serious game and finally discuss this with the participants from the LSP's. We will further elaborate our research approach in section 3, and discuss our result sin section 4. First we will start with a short introduction on inter organizational systems (IOS) in the supply chain management domain as foundation for our simulation logic in the next section 2.

2 Supply Chain Management trends & drivers

2.1 Networked society and supply chain management

The world is increasingly becoming a networked society. To adapt to changing market dynamics, firms take a number of strategic actions. For one, a shift may be observed from companies optimizing their internal business processes into a more collaborative focus in which they focus on optimizing the supply chain as whole. In turn, this leads to organizations shifting from a strategy of competiveness to a more benevolent strategy. Consequently, organizations are working together to serve customers through mutually dependent and co-operative supply chains via coordination and collaboration.

An elegant definition of supply chain management (SCM) is the following definition given by (Mentzer et al. 2001): "the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole"

Besides the collaboration and coordination aspects in SCM there is always a duality between degree of service level, and cutting costs, however the environment is changing and the supply chain needs to adapt (Ivanov, Sokolov, and Kaeschel 2010).

In this research we see three types of IOS: vertical, horizontal and (Hillegersberg et al. 2004). Horizontal IOS links a homogeneous group of organizations in order to foster their mutual cooperation. A vertical IOS links organizations that play unique different roles in a value chain e.g. from raw material, manufactures, Logistics Service Providers (LSP), and retailer. A Cross-IOS is an IOS that is both horizontally and vertically linked. Cross linkages are the most ambitious one of the three types. Horizontal or vertical by itself are already complex, however cross linkages add an extra dimension to coordination and collaboration (Hong and Kim 1998), (Hillegersberg et al. 2004).

2.2 Challenges in supply chain management

In recent years the playing field of the European logistics branch of supply chain management activities has been going through considerable changes (Cruijssen 2006); (European Commissission 2003). (Cruijssen 2006) describes five challenges, which have a significant impact on the design and execution of logistics activities within SCM:

1. Globalization and increased competition;
2. Environmental management;
3. Increasing costs of road network usage;
4. One-stop-shopping and heightened customer expectations;
5. Information and communication technology.

Nearly 70% of LSPs in Benelux plan to implement horizontal cooperation in the next 5 years, but at the same time 30% to70% of the strategic alliances fail (EyeForTransport 2010).

Many supply chains are not ready to cope with the world we're entering (Hillegersberg and Grefen 2010). The supply chain needs to become more agile, to create a higher efficiency. Dynamic environments, customer demands, changing market circumstances, security, collaboration, and sustainability are elements supply chains increasingly have to deal with. Organizations in the chain need to manage this type of complexity (Frizelle 2004).

3 Methodology

We adopt design science methodology of (Hevner et al. 2004) in this research. The problem environment for our design assignment can be defined by the retail supply chain domain, which is elaborated in section 2. We deploy the following steps to operationalize this design process.

A) Problem & relevance analysis

First we deploy a focused literature study into the specific problem setting, but combine and share our findings with an extensive research project case study in the logistic sector accompanied with several expert reviews with several European LSPs. The results are published in other work Dalmolen et al. (2013) and sets the relevance of this design study. The interviews are conducted within the Dutch subsidiaries of these companies. These interviews where also used for retrieving the requirements of the game. We ranked and aggregated the requirements from these interviews and put these in perspective of our literature analysis findings, shortly described in section 2. From this we see that especially the cross-linking of the horizontal and vertical supply chains defines the draft lay-out of the serious game. This lay-out includes an existing realistic logistic simulation model and a gaming scenario -and gaming elements that match the learning objectives of the planners of these LSP's. We will further explain these in section 4.

B) We use the outcomes of A) as design input and requirements for our serious game. We develop the game in a 10 week Master course for approximately 50 logistics -and IT students. These students are shortly before their Master of Science assignment and have elaborate experiences in programming Operations Research algorithms and simulations in especially the logistics domain. This team is coached by three senior lecturers (including two of the authors) with ample scientific and practical experience in the logistic and serious gaming domain. We subdivide the group in two teams of 25 students, each responsible for one logistic serious game. This paper deals with the development process of one game only. The two groups of 25 students also take the role of tester and peer reviewer of each others game.

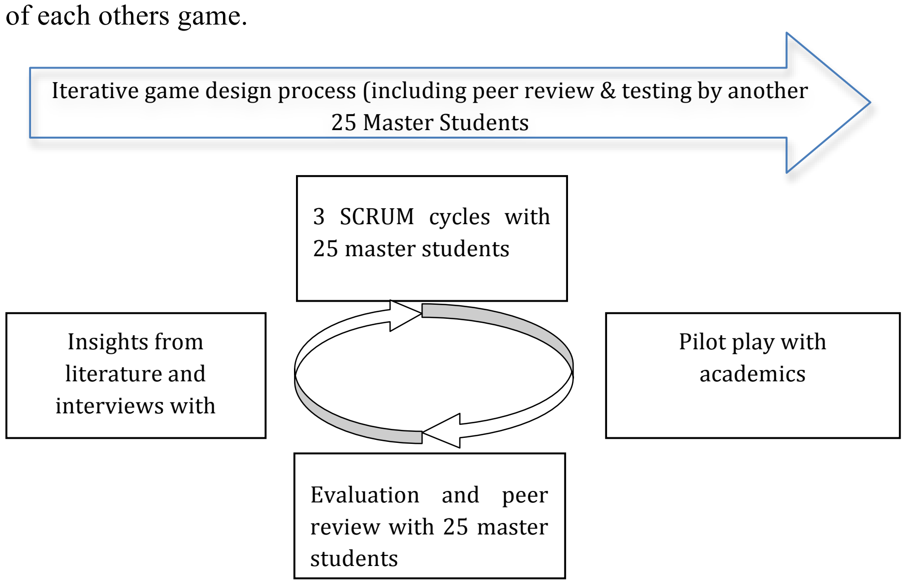

Figure 1 *Research design*

C) We adopt SCRUM as our main agile development methodology (Keith 2010). We follow cycles of 2 weeks in which three product builds are created. In order to test our serious game on its practical applicability we deploy the serious game during in three cycles in which another 25 Master students and three academics test and peer review the serious game on its playability, rigor (validity and quality of the logistic model) and documentation. Multiple attributes of these three topics are inspected and analyzed by the teams. We asked all involved students to keep a diary during the design process and finally write a personal reflection on their individual contributions in the game development process, but also to identify their learning contributions and reflect on the development process

D) One important step in design science is the solution validation. Informal discussions with experts from industry as well as academia, iteratively improved the game in three cycles until it finally reached its current format. During the method design process we also collected feedback from experts in the field. Before each subsequent development cycle a revision session was organized in which the review outcomes are shared and used as input for the next cycle.

4 Serious Game

4.1 Serious gaming requirements

We use some basic foundations for serious gaming and simulation (Aldrich 2009) and extend these with the specific requirements for this serious collaborative planning game. The Cross Chain Control Center (4C) has been proposed by the Dutch logistics industry and research community as a defining next step in supply chain management to help overcome the challenges faced (Van Laarhoven committee 2008). It is one of the leading pillars of the Dutch logistical top institute Dinalog (Van Laarhoven committee 2008). Still, the term 4C has not yet been accurately defined, which potentially results to confusion and disagreement over its contents. The entire concept in itself is a complex collaboration between partners and competitors in the supply chain and one of our game objectives is to explain the concept by a playful, but easy accessible gameplay, and secondly to make the participants aware of the possibilities of the 4C sharing and collaboration concept.

Based upon the findings from our literature review, the case study and the interviews (section 2) we derive the following main requirements for our serious game:

- The game should support realistic planning operations for two or more LSP's. It should contain normal supply chain planning operations, but extend this to cross chain planning with a limited set of real products
- Main player role is a professional planner at an individual LSP. The main data and working routines should match as best as possible normal operations for these players.
- The game should contain multiple levels with an increasing amount of complexity from "normal" singular operations for each participating LSP towards sharing of orders.
- The Game should also include a multiplayer mode that includes the prior requirement, but also includes planning of routes, sharing and exchanging of orders between various players and multiple negotiation.

4.2 Game logic -and model

In the limitations of this paper we will not specify the entire simulation model, but explain the gaming logic. We have built the simulation/ game in a SAAS environment at Forio.com and algorithms are available upon request.

The final result incorporates extensive functionality like single player, multiplayer and game administration to adjust complexity and selected parameters. In a condensed way the game is best described as follows:

The player is a planner for an LSP. In his player role he provides a planning for the LSP based on their own transportation resources, trucks and collaboration contracts with partners: A player first links orders to a truck, and secondly designs a route for pick up -and delivery. Collecting and delivering multiple packages is possible as long as the capacity of the truck is not exceeded. Planning horizon is one week, whereas simulation time for one week is 5 minutes.

Routing, product -and resource data all stem from a real dataset of a large food producer in the Netherlands. We converted the data to guarantee anonymous data. The simulation incorporates real location and routing data of three production locations, and three distribution centres. This increases the reality of the game to the LSP planner. Truck usage and mileage are cost drivers; inefficient route planning yields excessive overtime and therefore more cost. Accepting orders results in revenue. The aim is to maximize profits. In the beginning levels of the game adverse can be transported by an external party (charter) at fixed, relatively high cost. Later in the game collaboration with a second player becomes possible, allowing orders to be shared or exchanged between the players possibly resulting to a favourable schedule for both.

Playing the levels one after another shows that the 4C form of 'cooperation' is difficult, as both players do not have complete information about the order file from each other (this complies to real legislation of competition authorities) and because both players normally use their individual scheme to create a plan mainly based on optimising their individual planning. But in the perspective of the entire supply chain this combination of individual planning is far from optimal. Figure 2 underneath displays the drag and drop functionality. Loads, slotting and routing all can be done by drag and drop showing the planner the effects of his actions and planning in: routing (on the map), capacity, kilometres and possible penalties.

Figure 2 *Gameplay overview*

This leads to the final result of playing the game, where in the end it is shown that in these cases two or more players may well have to rely on joint planning, prepared by a "Cross Chain Control Center. In such a case the joint profit increases and the mileage decreases. This phenomenon is explained to the players by multiple feedback mechanisms after each playing round in a dashboard. In this dashboard the players receive feedback via both playful incentives (points and badges) as well as via often used KPI's in this domain (used truck capacity, planned traveling distance, empty kilometres, penalty cost, revenue and profit) (see figure 3 underneath)

Figure 3 *Dashboard screen giving feedback over the performance after each round*

4.3 Results

Our project has two main outcomes that also replicate parts of A to D formulated in section 3, our research approach: First, the game itself, including technical documentation and instruction playing level. Secondly, the learning results of the participating students and lecturers. In the 10 weeks of developing our game we have collected multiple gaming experiences and results. We have created three builds and used the scrum cycles to increase the complexity and functionality one after another. i) First, the students got used to the SAAS environment and created the basic logistic planning simulation engine. ii) In the 2nd build the students corrected for many errors in the engine during the addition of the gameplay. We learned that especially the addition of the gameplay and testing explicated many of the errors. The gameplay mainly included challenges of efficient route -and package planning versus limited resources in time, space and fuel. During this 2nd build this was all, single player. iii) Finally in the last 3rd build the students created the multiplayer environment. The results of playing this game build by multiple players, both academic professionals as well as Master students in the logistic domain show the current game is mature enough for a first round of playing with real logistic professionals. This is planned in the near future. Testing players report they obtain a realistic feeling for the complexity of this phenomenon due to the increasing levels, but also due to the singular assignments in the game (accepting and/or sharing orders, and planning routes.)

Considering the second research objective: thanks to the agile way of working we were able to reflect during and after the process with the students. The students perceived the SCRUM way of working in the beginning as very challenging and in some cases even very frustrating. But this was mainly due to the group size and also because this way of working was completely new to them (although all students have been studying for more than 4 years). 90% of the students' reflections criticized this set-up, but also actively contribute with improvement proposals to e.g. organize SCRUM with larger groups by subdividing work packages and by the use of digital backlog tools like scrumwise.com. At the end of the course the significant majority of the students report to have learned substantially due to the multiple reflexion moments and also due to the repetitive testing and building.

5 Conclusion & Discussion

The "cross chain control center" paradigm is a challenging one for LSP's. This paper describes a part of the collaborative research project between science institutes and logistic professionals to look into the possibilities of serious gaming. Our main objective of this paper was to investigate the effective design for serious game to both show and train the effects of collaboration between planners of various LSP's. Using an agile design science approach we both learned content as well as process wise.

Content wise: we have shown that an advanced sharing algorithm combined with an intuitive user interface is possible and mature master students (in the logistics and IT domain) together with PhD candidates and senior scientific staff play the game according its intentions objectives and also that first indications are present that the game is a convincing argument for players that still think in the classic paradigm of sub optimization in the logistics supply chain. The players see the advantages of sharing goods, get better insight in the trade off between realizing the maximum amount of orders.

The game encourages collaborative planning with planners from different organizations, however the game is currently not able to implement real-time orders/trip data. In the future this needs to be developed, so this game can be used by organizations that have the intention to collaborate. The planners will get a more realistic view. And also have a comfortable feeling, because the data – the customers, trucks are familiar. This goes hand-in-hand with the intention to validate the game with more LSP organizations. Thirdly, the game should be extended with manufactures and retailers based on real data in a comfortable environment for the involved organizations.

Process wise: the agile way of working both had its advantages as well disadvantages. Due to the cyclical set-up we ware able to refine requirements and problem setting very thorough. This resulted in a relevant and realistic game set-up also perceived by a first inspection from professionals in the field. On the other hand the SCRUM set-up had its limitations in group size. The increased complexity due to the 25 participating team members caused that the team sometimes lost efficiency and we often had to calculate extra time to coordinate between the different work packages. Due to the fact that this game was created in an educational setting there was an extra focus and time for reflection. This was extra appreciated by the students and the reported the learning by doing significantly improved their learning results.

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