The MIMIC construction logistics game: facilitating group discussion and understanding of construction logistics through gameplay

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Abstract. In order to facilitate discussion on construction logistic solutions in both homogenous and heterogeneous groups, the MIMIC CLS game has been developed, that allows players to negotiate transport routes and common logistics solutions surrounding an abstract construction area. Through game mechanics specially chosen to create appropriate friction between the players, discussion on the topics of the game is stimulated. The design process included significant amounts of testing and provided two key insights: the manner in which specific game design patterns influenced the game’s purpose, and the difficulties involved in creating, playing and presenting games for a target group with little or no experience of games. It was also evident that a designated game facilitator made it possible to further reinforce the impact of the game, and likely necessary to be able to use it in an appropriate timeframe. Future venues of work include the integration of the game and subsequent discussions into an overall workshop format.

1. Introduction and Background

Urbanization creates a need for urban development as more people and more economic activity takes place in cities. To handle this, land use in city areas change and construction activity for housing and commercial property as well as the infrastructure increases [1]. Construction transports represent approximately 20 % of the ton-kilometers in Sweden [2] and strains the infrastructure by competing with other types of transport [1]. The transports to, from and on construction sites also create disturbances in terms of noise, pollution, greenhouse gas emissions and congestion. To decrease disturbances and improve construction productivity construction transports need to be coordinated with the nearby society through a construction logistics setup [3] [4].

To develop such a setup, demands and needs of stakeholders, such as municipalities, citizens, shop owners, tourists, transporters and industry [5] must be taken into consideration. Earlier research shows however that there is a problem to reach consensus on what stakeholder needs/demands are most important [5]. It's worth noting the goal conflicts between stakeholders; private actors are driven by financial considerations whereas public authorities are driven by providing public values [6]. Effective participation requires a deeper understanding of the concerns of different stakeholders to ensure they feel they are heard in the decision process. However, in order to make this happen knowledge of construction logistics among stakeholders must increase [4]. This is the reason that we in the JPI Urban Europe projects CIVIC (Construction In Vicinities: Innovative Co-creation) started to develop a construction logistics game [7], which continued in the ongoing MIMIC project (Minimizing impact of construction material flows in cities: Innovative Co-Creation).
The game specifications were collaboratively developed within the CIVIC project group. A researcher in the project drove the process from the project perspective, had frequent meetings with the professional game designer about game design, and brought questions and crucial decisions back to the project partners to discuss. Among the project partners, we found the CIVIC game prototype to be playful, fun and have potential to support increased understanding of construction logistics and need for stakeholder collaboration.

Both projects focus on facilitating and supporting efficient, sustainable and broadly endorsed transport, from, and around urban construction sites. Both projects thereby primarily address UN’s global sustainable development goals number 11: “Sustainable Cities and communities” and number 17: “Partnership for goals”; secondarily they address number 9: “Industry, innovation and infrastructure” and 13: “Climate action”. Both projects aim to contribute to increased understanding among authorities of how different types of construction logistics affect the environment, urban traffic flows and mobility. The MIMIC project specifically aims to demonstrate how smart governance process (see Figure 1) can be used as an aid in the construction and city planning processes. Smart governance in city logistics is defined as control, planning and coordination of construction logistics through collaboration. The Smart Governance process is developed to be a scalable process that can help decision makers to evaluate the impact of different types of logistics scenarios during the construction process.

**FIG 1. The Smart Governance Process [7]**

**Aims and research approach**

In this case we seek to use a game to **facilitate group discussion on construction logistic setups (CLS’)** in order to potentially ease their implementation in construction projects, ranging from smaller projects to larger, multi-actor urban developments. The game will be used as part of a workshop on CLS, to be held with both homogenous (all participants come from the same group or company) and heterogeneous (participants are a mix from different actors involved in the project) groups. The mechanics and presentation of the game will serve to highlight potential issues when implementing CLS, exemplify several different CLS, and problematize the interaction between different actors.

The game seeks to achieve this through mechanics that force the players to cooperate if they want to achieve their goals, but at the same time hampering this cooperation in order to highlight the complex interactions between actors in real life. We believe that both recognizable aspects of the game (“Ha! This is exactly like in real life!”) and foreign aspects (“Bah! This is nothing like how it really is!”) will spark later discussion.

We turned to the world of games as a vessel to facilitate group discussion on common construction logistics solutions, later to be held in a workshop format. Games have been used in this manner before (see e.g. [8]) and continue to be a popular way to start off new groups (see e.g. [9]). They provide a
framework for interaction where group members can act within predefined commonly agreed upon boundaries [10]. In [11] it is argued that the theories of Collins [12] can be used to understand how games achieve this end, through the process of “group effervescence”.

Using games for purposes other than entertainment has been an ongoing discussion in game studies for quite some time [13] and several different terms have been used to describe said games - “gamification” [14], “serious games” [15], and “games with a purpose” [16] among them.

In design research several iterations of the design cycle as well as maintaining a balance between design and evaluation of the developing design artefact are emphasized as important [17]. For developing the game we have used an action design research approach [18] [19], meaning that the research process contains the interwoven activities of shaping an artifact framed by an organizational context during development and use [18]. In action research, the immediate application of findings is a way to carry out the research through both data collection and testing and the research process is a learning process, where one of the most important learning outcomes is increased and improved participant experiences [20].

Group psychology has been studied by a number of different researchers over the years, providing several theories on how groups are formed and dissolved, why they behave as they do, problematic and positive group behavior and much more [21]. For the purposes of this project we are interested in both inter- and intra-group behavior, although we will mainly be focused on the latter, seeking to affect the former.

2. The MIMIC CLS Game
This section contains a short description of the game, the player roles, their goals and an overview of the game turn; something on facilitating the game, and an overview of the design process.

Fig 2 ongoing playtest with the playtest prototype, where significant congestion is visible

2.1. Description
The MIMIC CLS game depicts an abstract, generic construction area where multiple companies construct several different properties. At game start no common solutions are in place and limited routes are prone to congestion, causing fatal delays in the delivery of materials. 2-4 players take on the roles of builders, attempting to deliver materials to the construction sites while preserving their bottom line. Each builder also receives a hidden agenda, or “direction” for their company. One player takes the role as the city, looking to minimize disturbance to the environment, enacting ordinances and suggesting common logistical solutions.
The game runs over six turns, and each turn begins with a random event, showcasing some of the more common happenstance occurrences at construction projects, often encouraging preparedness and changing the conditions of the turn.

Next, the players have the opportunity to suggest 1-3 logistical solutions, after which the builders secretly bid their level of commitment to each solution - if the combined bids reach a stated threshold the solution goes into effect, if not, the CLS is delayed to the point of uselessness and discarded. The city ends its turn by choosing whether to issue a new ordinance, potentially impacting the builders for the rest of the game.

The builders then have three minutes to plan their delivery routes, without conferring. When they are done, or the time runs out, they place trucks on routes according to their plan. If a stretch has more trucks than its congestion limit, there is congestion, and deliveries are delayed. Provided there is an intact route, builders then deliver materials to their building sites, finishing building stages if they have enough.

Each turn ends with cleanup (players take their trucks back) and every second turn scoring of points for finished construction stages. At the end of the sixth turn scoring, players tally up their points to see who the better builder is, while the city is evaluated on the basis of total disturbance caused by the construction.

2.2. Testing

Given that testing is important in game design [22], this project has included as much testing as resources (primarily time and access) has allowed, and many lessons have been learned during the project. The main takeaway has been on designing a traditional board game for non-gamers, the problems that crop up and how to tweak the design accordingly. There have been five types of testing throughout the design process:

**Personal testing**: The most common form of test was run by the designer himself, playing the game solo with a single person taking all the roles, usually to test basic mechanics. Given the “prisoner's dilemma” [23] style of many of this game’s mechanics, this type of testing gave very little data beyond the immediate operation of the mechanics.

**In-house testing**: tests conducted with fellow researchers of the project. This allowed us to try viability of mechanics that require several players to function as intended and required to see if the gameplay seemed to spark conversations on the subject matter.

**External testing** was conducted with people connected to project partners, in order to elicit feedback on the game and gameplay as a whole. This is also where some of the main findings started to appear regarding play with and design for inexperienced players.

**Experienced players testing** was made to contrast with the inexperienced groups and because their experience makes them invaluable when it comes to spotting faults and “exploits” in the game, easily overlooked by designers. Even if they are not representative of the target group, their feedback is vital for quality assurance. The main problem of this type of testing is that it is resource-intensive.

**Target group testing** is the most important and the most difficult to arrange, and the development of the game could certainly have benefited from more of this. We have been fortunate to have been able to conduct testing with several target groups throughout the project, but were not able to collect test data in a systematic manner from all these groups.

3. Results

Work with the game revealed two main areas where the process contributed to our understanding of the methods involved; the relation between specific mechanics and the game’s purpose, and the difficulties encountered when playing and presenting games for people with little game experience.

3.1. Specific mechanics and their relation to the game’s purpose

3.1.1. Player Roles
Initially, the game included three separate roles - the city, the builder and the subcontractor, each with different gameplay. This was abandoned quickly, as the game became too complicated with too many moving parts. Instead, from the first prototype onwards, we settled on only two roles - the City and the Builder. While more player roles, representing more of the actors encountered in construction, might have created a better simulation, a faithful simulation is not among the stated purposes of the game, and playability would have suffered as a result. With City and Builder roles there is enough asymmetry to create a play dynamic between the lone but powerful City, and the several Builders.

3.1.2. Allocating Agendas
Differentiating the Builders by giving them dissimilar agendas was planned from the initial brainstorming session, and similar mechanics are common in many commercial board games – see e.g. [24]. Besides providing uncertainty as to which player might be in the lead, this also serves the purpose of illustrating, and thus inspire discussion on the fact that all construction companies in real life do not have the same perspective - some are long-term, some are short term, some have a green profile, some do not, etc. The aim is that players experienced with the construction industry will recognize some of the agendas and be able to compare them to their real-life experiences. The separate agendas also serve to illustrate that cooperation isn’t necessarily easy, but rather fraught with difficulty [25], and that just because an actor says something, this is not necessarily true.

3.1.3. Bidding on Construction Logistics Setups
Continuing the thread from above, the bidding on CLS’s is another mechanic designed to show that cooperation can be difficult, that actors have different levels of commitment to joint solutions, and might even attempt to take advantage without necessarily pitching in as much effort themselves. The mechanic as such is a classic game theory problem [26] where the option that is best for the individual actor in the short term, bidding as little as possible, is negative for the collective, and thus in the end likely a net loss for the individual in the long term. This is however not necessarily so, as some builders might be in a position where they will have more or less benefit from a specific CLS, and it is this tension that is aimed to spark debate and discussion on these matters in real life.

3.1.4. Plan and Place
The “plan and place” mechanic of planning routes is another Game Theory mechanic where players that insist that it is “their way or the highway” likely will lose many transports to congestion. However, testing has shown that a “bully” approach - “either I get my transports through or no-one will” can work under the right circumstances, which immediately sparked a lively debate on the respective “power level” and “negotiation” tactics of real-life companies.

The ban on communication during planning proved necessary to achieve the desired tension; even with time constraints players were very adept at negotiating routes and access (likely because some have such experience in real life) making congestion and tension disappear from the game completely. Initially, one of the CLS allowed players to communicate freely, but this quickly created a situation where gameplay was vastly different in games where this CLS was implemented and where it was not.

3.1.5. Winning Conditions
While specific winning conditions are absent from many “games with a purpose” (see e.g. [27]), we felt it necessary in this case because we wanted to goad players into pushing towards individual victory, or else the game theory parts of the game mechanics would have fallen flat. The City does not share the Builder winning conditions, and is evaluated according to the amount of disturbance created by the construction project as a whole, which can create problems if the City player isn’t invested enough in keeping Disturbance down (which happened in a few of the test cases).

While “winning conditions” and “victory” are abstract game concepts, they appear close enough to the real life competition among construction companies and dynamic between the city and the company
(which isn’t competitive per se, but certainly has competing goals at times) to fuel debate on what winning is or means in “real life”.

3.2. Making and presenting games for non-gamers

One of the most interesting takeaways from the production process (and what will undoubtedly remain actual as the project matures) was the difficulty of designing and presenting games for players with very low game-literacy, as mentioned earlier. Lacking time to teach game literacy from the ground up, the presentation and early turns of the game had to bridge a wide knowledge gap. In cases where this failed, some players remained insecure over the course of the entire game, leading to an overall unpleasant experience and sometimes balance issues, as these players did not compete as fiercely for routes.

We identified the following rough groups of players who provided a challenge to the facilitator:

**Very inexperienced** - these were the players that had the least game literacy, having no experience with board games beyond the occasional “family game” during their childhood. Basic game concepts like “turn” and “victory point” or questions such as “how can a game work without dice?” often needed to be explained by the facilitator. Sports metaphors proved very useful in this - “a victory point is like a goal”. Lack of knowledge and insecurity often caused visible distress, or in some cases when players did not report their lack of understanding, problems leading to nonsense moves later during play.

**Too careful** - while the game is tolerant towards different strategies and play styles, inexperienced players are sometimes careful beyond these tolerances. Examples include not planning any truck deliveries because of fear of making a mistake/causing a congestion, not speaking when negotiating because of politeness, being unnecessarily yielding to other players, etc. To preserve balance the facilitator needed to coax the player to take some risks, and above all, downplay the problem of failure in games.

**Too aggressive** - the other side of the coin are players who take a too aggressive stance, looking to win at the cost of other’s enjoyment. This is less problematic, and given the nature of the game can serve as a good basis of discussion - “if a construction company acted like this in real life, what do you think would happen?” - but overly aggressive players also tend to stretch the framework of the game, and can make other players uncomfortable, especially those who have yet to internalize the magic circle [28].

**Too invested** - players who are too invested in the game took the game “too seriously” seemingly thinking that their conduct in the game reflect on themselves to a degree that it does not. These players would become distressed at perceived failures, seek to shift blame onto the game and fellow players, in turn causing distress in other players. While the root causes might be similar, these differ from the “too careful” group in that the behavior is significantly more disruptive, and that the facilitator needed to “cool” rather than “heat” the interactions.

**Not invested enough** - on the other hand, players who are not invested enough refuse to step into the magic circle of the game [28] and “make the goals of the game their own”. They could be uninterested in the subject matter, lack interest in games altogether (or have an interest that places them above such “simple” games), or use disinterest to protect the ego against failure. This group is usually particularly resilient to interventions by the facilitator, who has to see if it is possible to engender interest in the game, or at least prevent a disinterested facade to belittle the experience of the other players.

**Non-compliant** - for experienced players, it rarely needs to be stated that players are supposed to follow the rules, and not budge or break them during play. But for people who do not view games as a “serious” (not to be confused with the serious in “serious games”) activity (or mainly an activity for children) this might not be as important, and somewhat like children’s games, where rules can be negotiable and might change significantly during the game [29]. During testing there appeared several instances where players would not comply with the stated rules, arguing that it was of “little importance” or that it “was more fun this way”, to the point of stating that “a little cheating makes for a more exciting game”. Needless to say, this creates problems in the execution of the game and can cause significant tension between the players and needs to be addressed by the facilitator as soon as it is noticed.
Boundary testers - a “boundary tester” does not play the game as intended, instead stress-testing an aspect of the game to see what happens; exploring the limits of the game. (As an example, one of the testers bet all their money on the first card, and thus didn’t have any money for the rest of the game). While this is less of a problem in games that are single player (such as computer games) or is meant to be replayed several times, it becomes more of a problem when a game is only going to be played once (such as in this case). Unorthodox strategies can unbalance the game and put a player in a position where continuing the game might seem fruitless, both which lead to an unsatisfactory experience. There is however little the facilitator can do in this case, as it is usually too late to rectify once discovered.

In general, working with these testers has highlighted the need to challenge the developers own biases on how a game should be presented and understood, and develop a greater understanding of the breadth of experience levels that are out there; something which is often lost when working with games, as one assumes that most people interested in games also will have some experience. It is also of great interest to see the “magic circle of play” at the edges, where it is still negotiated and not taken as fact from the moment the players sit down, as is often the case with more experienced players.

3.3. Limitations
As with so many research projects, the project’s biggest hurdle was undoubtedly access to testers, especially from the target audience. Most of the time invested has been directed towards locating, contacting and scheduling test players, who were almost exclusively professionals with constrained schedules and limited time, with little or no hobby interest and/or experience with the design of games. People with such interest/experience were easier to recruit, and while they provided invaluable insights, ultimately the game wasn’t designed with them as a target group. In the end it was clear that the closer the testers were to the target audience, the more difficult they were to recruit.

Compounding the problem is that it is often difficult to describe exactly what the testing experience will be like before playing, and testers showing up with the wrong expectations can have an adverse experience to the testing session as a whole. There is a vast difference between playtesting (testing during the development of a game, to ensure quality) and “testing a game” (testing after a game has been completed, to see if it is any good) and potential testers often confuse the two.

4. Conclusion
We set out to create a game to facilitate discussion on construction logistics setups, and learned vital lessons on the difficulties encountered when designing for a game-illiterate audience. Further research will include how to integrate the game into the Smart Governance Process (Figure 1), where the game will be part of a workshop process. When developing this workshop process, an important research question is how to combine the game with other tools developed in the MIMIC project. The next step will be to evaluate the workshop designs, including the tools, and how it helps to increase the efficacy and learning regarding CLS. Another possible future research is to test how the CLS cards developed for the game can be used to initiate discussions on possible actual logistics setups in upcoming projects. Here we see a potential of using the game cards as a possibility of widening the discussion and bringing up ideas that widen the solution span among project managers.

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