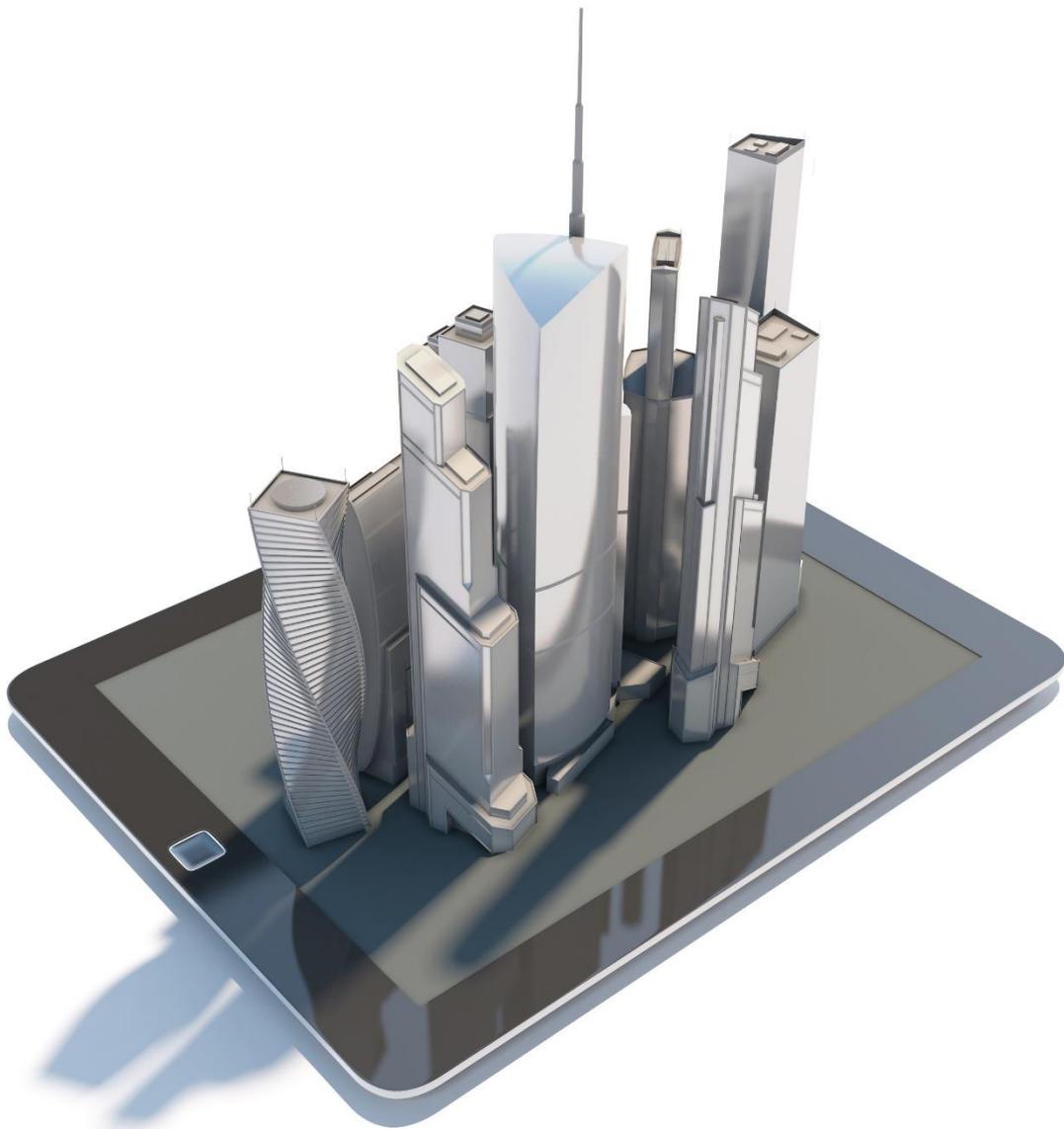


Playing with the future

Opportunities and risks of city building simulation and strategy games in spatial and urban planning



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Colophon

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Abstract

City building simulation and strategy games have become more and more popular the last decades. At the same time, serious gaming is gaining momentum in various fields of study. Temporary spatial and urban planning issues are becoming more integrated and complex, while the public participation, and a representative one, becomes harder to achieve. In light of these developments, this research sets out to explore how city building simulation and strategy games can be used in spatial and urban planning. This has been done using an extensive game analysis and a game experiment. The game analysis covers a multitude of city building and strategy games from the past decades to determine the changes in game characteristics and mechanics these games have undergone. Overall, games have become more complex, realistic, more co-operative oriented, with improved monitoring tools, game customisation options and mobile features.

A game experiment was conducted to find out how the participants reacted to playing a city building simulation and strategy game in a serious way. The lessons that emerge from the experiment are that games are fun to play, but should be of moderately complexity in order to provide insights in topics as complexity and decision-making processes. In addition, game simulations are able to provide useful insights and contributions to the (participatory) planning process. Three ways of using city building simulation and strategy games have been identified: an informative way, where information is provided to the citizens, an accessory way, where the games lower the participation threshold for possible participants and a hosting way, where the game invites (new) citizen groups to join the participatory planning process in a new way. However, the usage of game simulations is not without danger: there is a risk of a shift in focus from the problem or issue at hand to the game itself. If city building simulation and strategy games are to be used in planning processes, the primary function of these games should have been changed accordingly to suit their new role.

Keywords: serious gaming, city building and simulation games, participatory planning, Transport Tycoon, experimental research.

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Chapter 1 – Introduction

1.1 The popularity of city building games

On March the 5th, 2013, the last installment of Simcity in the similar game series was released by Electronic Arts. In the span of a couple of months up to two million copies of the game were sold (Malutef, 2013). Already from the start of the series in 1989, the series' developer Maxis had great success with selling city building simulation games. By 1992, over one million copies of the first game had been sold, resulting in expanding the game to a franchise with several sequels to the original game and a lot of additions to expand the core games even further. After the successful launch of the first SimCity game, more and more city building simulation games have been developed throughout the years since. Though the games can and do differ greatly from one another, all games revolve around the same concept: that of building, expanding and developing a city created and designed by the player. The popularity of these games is still increasing: on March the 10th, 2015, Paradox Interactive published its new city building simulation game Cities: Skylines. More than one million copies were sold in the month that followed (Game Informer, 2015). The increase in the popularity is even so strong that in the last years free to play games have been developed and published. These are often also playable on tablets and smartphones. Even though the game can be played for free, players have the ability to purchase in-game features. With these features, players can boost their city growth or construct special buildings, giving the player advantages over other players. As a result of an accessible, free to play basis game and the ability to play on tablets and smartphones, players can now manage and develop their cities anytime, anywhere.

Within the educational system city building simulation games start to appear. The goal of playing these games is however fundamentally different: whereas normally games are played for fun and relaxation, games played as an educational tool try to teach or clarify topics to the students playing them. Woessner (2015) has developed a governance simulation based on SimCity where the whole class can participate in at the same time. Woessner argues that games played at a classroom level are clever educational methods as the students are motivated to think about social organisation and come to insights as to why democratic governance is difficult to achieve. As a positive outcome of the simulation with SimCity, students become more enthusiastic to become politically active as the game entices the students more than traditional introductory political courses. "Although the use of SimCity-based simulations will not revolutionize political science and civics education, the selective incorporation of these sophisticated civic simulations has the potential to generate enthusiasm among otherwise disinterested students" (Woessner 2015, p. 363). Gaber (2007) supports Woessner in his argument. Gaber argues that, with help of the game, students of planning are better at grasping the complexity of planning decisions. He explains that this is due to the accessible nature of the game, as well as that the game corresponds better to the learning experience of the students.

SimCity is thus already being used as an educational learning tool. At the same time, students become more motivated to enhance themselves in these subjects and take upon the challenge to design better cities. However, would it not be possible to deploy these positive influence more broadly? Public and citizen participation is needed in spatial and urban planning activities (Mansourian et al., 2011). These activities provide a wide variety of different challenges of various natures, arising the need to draw upon various pools of knowledge and expertise of different disciplines.

Communication tools are needed to facilitate communication between the planners, inhabitants and stakeholders. Developments within the ICT-sector provide suitable possibilities to encourage public and citizen participation in spatial and urban developments. This is however not effortless: often enough certain citizen groups are excluded or absent (Michels & De Graaf, 2015). At the same time, contemporary spatial and urban planning issues are becoming more and more complex and integrated. Planning processes are immersed in uncertainties: De Roo (2007) uses the metaphor of playing a game of billiards on a heaving ship to illustrate this. Simulations and models have the ability to create more clarity as to how planning issues are to be resolved by creating and testing different scenario's. It is therefore interesting to explore which possibilities games as SimCity provide, both in the use of simulation tools for spatial and urban planning and as educational tools for students of planning.

1.2. Research objective and research questions

This research strives to achieve a better understanding in the mechanics and development of city building simulation and strategy games in general. The main objective of this research is however the exploration which possibilities city building simulation and strategy games could provide in acquiring insights in the decision-making processes of spatial and urban planning (if any), especially to planning students, and the (possible) conceivable risks associated therewith. The main research question is as follows:

How can city-building simulation and strategy games, in light of recent developments of games as SimCity and Transport Tycoon, be used to gain insights in decision-making processes (especially) acquired by students through the usage of city-building simulation and strategy games?

In order to answer this question, the following sub-questions has been devised to help answering the main research question:

- What are city building simulation and strategy games and how do these games work?
- Which developments have city building simulation and strategy games go through the past twenty to thirty years?
- Which insights in decision-making processes can planning students acquire through the usage of city building simulation and strategy games, and what are the chances and risks in doing so?

1.3. Structure of the thesis

In the following chapter, the theoretical framework will be laid out used in this research. It describes the relevant theories and ideas concerning games and spatial and urban planning. In chapter 3, the research method will be addressed as to how the research was conducted. The fourth chapter will show the results of the research, divided into two parts: the first part consists of an analysis of city building simulation/strategy games researched, the second part shows the result of the OpenTTD experiment conducted. The last chapter will conclude the research.

Chapter 2 – Theoretical framework

This chapter describes the theoretical framework of this research. The first part consists of a section describing game theory, followed by a section pointing out why games and gaming works. Next, the technical advancements that enable games and gaming will be discussed. After that, the current state of game simulations in spatial and urban planning will be pointed out, followed by a part that deals with issues as power and complexity and what this means for game simulations. Last, a conceptual framework is presented.

2.1. Game theory

This research will make use of game theory. Game theory provides a comprehensible analysis of “rational behaviour under circumstances of strategic interdependence” (Varoufakis 2008, p. 1256). Put differently, game theory deals with the interactions between people when a game is played (Binmore, 2007). Game theory is however not restricted to only the classic board games or the temporal video games but can be applied to a great extent of human society. It can be argued that games are played everywhere: car drivers play a traffic game, politicians a political game and sellers on the market a bargaining game. Game theory tries to predict the behaviour displayed by people in such games.

Game theory is used and applied in both scientific research as well as daily practice. Brams (2003) describes in his book how game theory works and can be applied in negotiations, making use of negotiation games. In his book, examples differ from a standard labour negotiation game to a negotiation game derived from the biblical story of God and Cain after Cain’s murder of Abel. Game theory is however also used in spatial and urban planning. Samsura et al. (2015) made use of game theory in their experiment to analyse the negotiations that take place in planning and land and property development, to examine and provide insights into the behaviour of the stakeholders in these processes. The usage of game theory in spatial and urban planning is not new: already in 1969, Rogers (1969) wrote an article about a game theory approach to tackle spatial and political problems that occur in international river basins.

The assumption made in game theory is that people who are playing the game are rational beings. In other words, love-sick teenagers act irrational as their course of action is dictated by emotions rather than reason. Within the games, players are confronted with problems of choice (Tadelis, 2013).

A problem of choice consists of three elements: (1) the actions a player can choose from, (2) the outcomes and the (possible) results of these actions and (3) the preferences of a player to choose certain actions above others. Players chose for a strategy, a specific type of behaviour, thus attempting to achieve the best possible outcome with the best possible result for themselves. The outcome is measured in the amount of benefit the outcome generates for the player. Players therefore aspire maximal benefit, as maximal benefit provides the best outcome of the game for them. How badly a player wants to achieve a certain outcome is dependent on how much risk the player is willing to take (Binmore, 2007). At some time, a turning point takes place: the chosen strategy is exchanged for another, as the outcome of the new strategy has more benefit for the player than the first chosen strategy.

When all players, at the same time, choose a strategy that best suits the chosen strategies of other players a Nash-equilibrium arises. Characteristic of a Nash-equilibrium is the following circle reasoning: player A thinks that player B thinks that player A thinks that player B thinks... and so forth.

All games with an ending have at least one Nash-equilibrium. This, however, does not need to be achieved with solely pure strategies. Multiple Nash-equilibria can be found in the mixed strategies of the players (Binmore, 2007; Durlauf & Blume, 2010). A mixed strategy is a strategy wherein it is essential that the player randomly chooses between the available pure strategies that can be followed. In some games there is only one Nash-equilibrium, making use of a mixed strategy. This happens when no strategy has superiority over any other strategy. In other words, no strategy generates more benefit for the player than any other strategy. If one strategy would be superior over another by generating more benefit for the player, a rational player would never choose a strategy at random. The player has at least one strategy that generates more benefit than any other strategy: it would be therefore irrational to decide to follow the winning strategy only by chance. In the event of a worst-case scenario, meaning that a game of the player always results in undesirable outcomes, the player has the ability to improve the game using the minimax theorem (Binmore, 2007). The maximin theorem assumes there is a rational solution for the player in a game where a worst-case scenario always happens. According to the theorem, the player chooses the best possible strategy in the game to get as much benefit as can be generated. When a player is not able to win the game because his opponent knows which strategy the player is going to choose (thus the opponent always chooses a winning strategy opposite the chosen strategy of the player), the player can choose for a mixed strategy by varying between the pure strategies he can choose from. That way, the outcome (or benefit) for the player is not always negative (always losing) but neutral (always a draw).

Besides rational thinking, chance and time are also important aspects in game theory. Games become much more complex accordingly: it is no longer only important which player does which action (strategy) in a game, but also when he does it (Binmore, 2007; Durlauf & Blume, 2010). To keep an overview of the game, the analogy of the game tree is often used. The game starts at the stem of the tree, whereupon every action-moment (where a strategy decision is made) represents a ramification of the tree. The end of the game is depicted by one of the leaves of the tree, representing a certain outcome. By making use of backwards induction it is always possible to identify the maximin values of the players (Binmore, 2007; Tadelis, 2013). Through this method dominating strategies are being eliminated from the game. These are the strategies that, at certain points, are not the best strategies to choose for. Backwards induction also identifies all sub-games (all ramifications) of the game, though these sub-games and their Nash-equilibria do not necessarily have to be laid out on the game path, the route from stem to leaf on the game tree taken in the game. The sub-games however do play an important role: they define which game path will be taken. An opponent could choose a strategy in a sub-game that has an undesirable outcome for the player. The rational action the player takes is to choose a strategy that does not lead to that sub-game in the first place. The outcome that would have happened in the sub-game if said sub-game would have been played is the reason why a player chooses a certain strategy to alter the game path, preventing that that sub-game is being played in the first place. This way sub-games are important in influencing the game path that will be taken: not because of that these sub-games are not played, but because of what would have happened (the negative outcome) if they were played.

These core principles all occur in a variety of different game categories that can be distinguished in game theory. Games are often used as an example to illustrate the applicability of game theory. First, a distinction in categories can be made between co-operative and non-co-operative games, also known as conflict games (Binmore, 2007). Within co-operative games players work together, whether or not with binding agreements. An example can be found in the car driving game

where players have to choose to drive on the left or right side of the road. If player A chooses to drive on the right side, it is in everyone’s interest that player B also chooses to drive on the right: no collisions will happen between the players. Results table 1 depicts the outcomes of the driver game and shows how beneficial (or not) each outcome is for each player. The number in the top-right corner is the outcome of player A, the number in the bottom-left corner is the outcome of player B.

	Player A	Right	Left
Player B (opponent)			
Right		+1	-1
Left		-1	+1

Table 1: Outcome driving game (Binmore, 2007).

As table 1 depicts it is for each player the most beneficial to drive on the same side of the road. The benefit is at its maximum at the outcomes of ‘right, right’ and ‘left, left’. It is therefore smart for both players to come to an agreement on which side of the road to drive. These agreements do not necessarily have to be constructed in advance: they can also materialize spontaneously (Binmore, 2007).

In conflict games it is however not possible to make arrangements. The best known configuration of conflict games is the zero-sum game: a game where the sum of the outcomes in an outcome table always results in zero (Binmore, 2007). An example of a zero-sum game is the game of equal euros. Players in this game choose which side of a coin they will show to their opponent. Player A wins if both coins depict the same side of the coin, player B wins when the coins do not depict the same side. Outcome table 2 shows the outcomes of this game.

	Player A	Heads	Tails
Player B (opponent)			
Heads		+1	-1
Tails		-1	+1

Table 2: Outcome coin game (Binmore, 2007).

The table points out that there is always a winner and a loser, as well as that the sum of all outcomes in each cell results in zero. Games in this category are classic games like chess and checkers.

Another distinction can be made between games of complete and incomplete information (Binmore, 2007). In games of complete information has every player all information available to him to make a decision: he knows everything that has happened up until that point. Players in a game of incomplete information do not have all the information available to them. The player does not know everything that can be known. However, players are able to collect more information in a game using Harsanyi’s theory (Binmore, 2007). This theory assumes that every player in a game is of a certain type of player. Every player type has his own preferences and convictions, making it difficult to precisely predict which strategy a certain player type is going to follow. Each player type does however give signals to other players, which can help in identifying the type that player is. It is required though that these signals are true. If player A in a poker game has two aces in his hand and gives the signal of this

by telling so to his opponents, but does not bet money on the hand he claims to have, player B will pay player A no attention as a consequence. Player A does not receive any benefits with his claim as no attention is paid to him. If player A however does bet according to his claim and put himself at risk of losing the round, it becomes possible for player A to observe player B (or any other opponent) and judge what kind of player type he is by the actions player B will take.

Furthermore, a distinction can be made between sequential and simultaneous games. Players in sequential games play in turns, after one another. This means that players who execute an action later in the play round have a benefit over players who play earlier: later players gain information of the game through the actions of players who come before them. As later players thus have more information about the game than players who play their turn earlier, later players have the benefit to react to the actions of the earlier players of choosing a suitable strategy as a response to the strategies of the earlier players. In simultaneous games all players act at the same time. By playing simultaneously, players do not gain any benefits by acquiring more information of the game than any other player.

Predominantly in literature, a final distinction is made between symmetrical and asymmetrical games (Binmore, 2007; Tadelis, 2013). Within a symmetrical game, the chosen strategies of the players in regard to the chosen strategies of the other players determines the outcome of the game. In an asymmetrical game however, the strategy of a player is determined by the position of function of the player in the game. The most relevant types of games would be, based on the discussed categories, those that are co-operative, simultaneous, symmetrical and have incomplete information, or at least have one of these characteristics, as this combination of characteristics best represents the real world. In the next section the focus will shift from game theory to games and gaming themselves.

2.2. Why games and gaming works

There are a multitude of reasons as to why games and gaming works. The active substance, or the effects of simulation games, both intentional and unintentional and the necessary ingredients to run simulation games (Caluwé et al., 2008) consists according to Duke (2008) of a number of elements. First of all, game simulations work as a methodology as it promotes fellowship between a leader and a participant. It lowers barriers between the two and increases interest in the subject as the simulation replaces the classic expert and dummy method, where the expert tutors the dummy. In the classic dummy and expert method, the expert holds the reigns: he leads the discussion or lesson in the room and controls all activities. But as a result of this control, the attention of the dummy may deteriorate. As a consequence, there are a few opportunities for the dummy to check, challenge or contribute to the information given by the leader.

This is, in part, the second argument as to why gaming as a method works. Ideas are not merely linearly exchanged in a simulation, but come from different viewpoints from the different participants, making it easier for the players to put all information into perspective. Thirdly, game simulations provide the players a conceptual map which helps to integrate all available information into one logical whole. The problem is being visualised and the complexity of it is better comprehended when it is viewed as one great spider web. The fourth argument brought forward by Duke is that the players, temporarily, forget the daily worries and distractions. As a result, players become actively engaged with the game simulation. A fifth argument is provided by the possibility of simulations to orient themselves on the future. As simulations can be endlessly changed and run again, different prospects can be depicted and compared with one another. Sixth, game simulations are a useful tool for team-building. As players interact and may even have to co-operate with one another, reciprocal relations

can be strengthened, both in- and outside of the simulation. As the seventh argument, game simulations do work well with the millennium generation. This generation is used to work in teams while also being dependable on graphical and interactive mechanisms. Strengthening this reasoning is according to Duke reason number eight: the millennium generation has a shorter attention span and has an aversion to traditional lectures. Lastly, Duke holds the belief that it is primarily fun for people to play games and thus participate in game simulations. Duke argues that this is perhaps the most important reason as to why game simulations work.

For the purpose of this study this would mean that the impact of fun should not be underestimated: if a game is not able to provide enough fun for the players to enjoy playing the game, players will stop playing and the results of this research will probably differ significantly in outcome when another game is used that is able to provide enough fun for the players. However, it stands to reason that it is equally important that a game simulation is not too enjoyable to play as well when used for any other purpose than providing entertainment. When a game becomes too enjoyable to play, it is not unlikely that the attention of the player is lost into the game itself, rather than on the issue or problem the game tries to address. It would be dangerous to use games for (more) serious purposes if this effect of losing oneself in a game occurs (too often).

Game simulations can be useful in helping to create and design new policies. There is a need for policy analytical tools at policymakers to analyse complex problems and their complex multi-actor context. Present tools are not sufficiently able to deal with the unpredictable and irrational behaviour of people and organisations (Mayer, 2008). Mayer (2008) argues that game simulations have a couple of strengths when used as a new form of policy analysis. Game simulations are likely to be the only tool wherein real persons can intrinsically be a part of a model itself. It is possible to deal with both content and the multi-actor aspect of a problem at the same time. Another benefit of game simulations is their possibility to represent complex multi-actor systems and, once designed, to experiment with (Mayer, 2008). Two aspects play an important role: the manifestation and submergence of the simulation. Manifestation means that the behaviour of the whole system cannot be reduced to just the individual elements and rules of the system. The system is more than the sum of its parts. Submergence is that what makes it fun for the players to play the game simulation. Both have to be designed correctly in order for the simulation to work.

But how is it that games can be used in making new policies? What are the factors that make game simulations a (potential) successful tool in policy-making? According to Wenzler (2008), game simulations are effective and efficient in four issues. Firstly, game simulations are excellent tools in trying to understand the greater picture. With different scenario's in the simulation, it is possible to visualise different futures, thus helping to provide a holistic view of all (possible) changes and their consequences. Secondly, it is possible to experiment with different approaches and strategies. As a result, a better response to the real future can be formulated. Thirdly, game simulations create a shared intelligence between all players who play it. Players communicate more among each other, creating more insight and understanding of one another. The outcome of the simulation that is desirable to all becomes more likely to arise. Fourth, players obtain more self-confidence in being successful. By experimenting with game-simulations, the self-confidence of the players in their ability to adapt to the future grows. Thereby also grows the players' motivation and engagement to change. So, therefore players may transform from against change to accept or even promote change.

A game simulation consists of four basic elements. These are context, players, the process through which the players are going through and the environment wherein the simulation takes place

(Wenzler, 2008). Every basic element, in turn, can be distinguished into four dimensions. The first basic element, context, consists of the dimensions of the nature of the problem and the problem definition, the objective to be achieved, the nature of the model as the base whereupon the game develops and the nature of the story that is being told. Players, as being the second element, are distinguished into for whom the simulation is being played, the level in the organisation wherefrom the players come, which roles the players play and which cultural background they have. The third basic element, the process, consists of the time period in which the game is played, what kind of interaction the players have among themselves, how the steps in the game are taken and which result indicators are being used to determine the outcome of the simulation. The last element, the environment wherein the simulation takes place, comprises of the amount of locations wherefrom participation to the game takes place, the nature of these locations, the degree of change the game material undergoes and the degree of realism of the representation of the game simulation.

2.3. Technical advancements

Proper technical facilities are necessary in order to run and play game simulations. Since the sixties of the last century, two different technologies, the communication technology and the computer technology, have merged, leading to the emergence of information and communication technology (Dicken, 2011). Digitalisation has been the most influential development in recent years. Major changes take place due to the rise of the internet and, more recently, the smartphone. People become more and more connected with one another through these changes. This is due to the increasing accessibility to personal computers and smartphones. In the Netherlands, only but a few do not have any access to a pc or the internet (CBS, 2013).

This development can be explained by the diffusion of innovations theory by Rogers (Rogers, 2003). It describes how an innovation is spread with the use of the life cycle of the product. The diffusion (spread) is distinguished into five stages, as illustrated in figure 1, being: the innovative, the early adoptive, the early majority, the late majority and the laggard fase. In the first stage, the product has only just been developed. The people who acquire the product in this stage are called innovators. These are people who want to own the newest, latest products and technologies. The product itself is still subject to major technological changes, as it is still in a development stage. In the second stage the product starts to grow. Pioneers is the next group of people to acquire the new product, following the innovators. The product starts to sell more and more. A switch is made to mass-production, in order to meet the rising demand. In the third stage the product reaches maturity. The precursors is the first large group of people to buy the product. The demand for the product is at its peak in this stage. From this stage on the product will not change drastically anymore. Only but a few significant changes will be made. From the fourth stage on demand will decline. The second large group, the runner-up's, will acquire the product, as the market is now well known with it. In the last stage of the cycle the product will come to an end. The laggards, the last group of people, will buy the product, though the product itself is actually already amortized. Demand of the product declines quickly and companies producing or selling the product are no longer able to sustain themselves on the market.

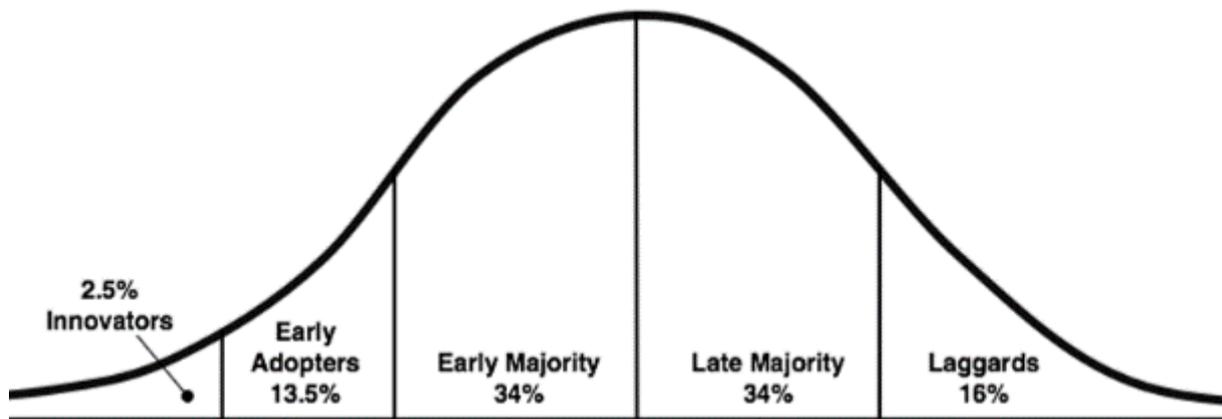


Figure 1: Rogers' theory of innovations

Simultaneously with the diffusion of innovations of personal computers and smartphones, these technologies do not only spread more and more widely, but their computing power also increases. Their increase in power to compute can be explained by making use of the law of Moore. In 1965, Moore predicted that the amount of transistors within an integrated circuit would be doubled every two years (Moore, 1965). Through this exponential growth all electrical devices with chips have become many times more powerful in a relatively short period. However, Moore also stated in 2010 that his law cannot be sustained indefinitely: "It can't continue forever. The nature of exponentials is that you push them out and eventually disaster happens" (Techworld, 2010). The disaster Moore is referring to is the limit to where up to the size of transistors can be pushed. The current size of transistors is getting close to the size of atom: a fundamental barrier that cannot be overcome, as the laws of physics act differently on that scale. Other technologies to build computers could present the solution to build even more powerful computers in the future. However, for the usage of game simulations there are no technical restrictions: temporary computing power is more than large enough to run game simulations, if given the correct hardware to operate on. The necessary

2.4. Game simulations in spatial and urban planning

A new differentiation that can be made are the serious games. Serious games, or game simulations, are games where the primary goal is not amusement or relaxation but to learn from it. They are "... applications using the characteristics of video and computer games to create engaging and immersive learning experiences for delivering specified learning goals, outcomes and experiences" (Freitas, S. & Jarvis, S. 2007, p. 9). This development of serious gaming already takes place in several areas and spatial and urban planning is no exception. Hanzl (2007) noticed that the information technology offers new potentials for citizen and public participation in spatial and urban planning. It provides a communication platform where the barrier of non-professionalism can be suppressed, allows for communication between distant locations and it permits a participatory management process. Experimental applications of serious games are 3D models, new computer games, communication platforms and the Participatory Planning GIS. However, the most potential for serious games in urban and spatial planning lies, according to Hanzl, in the use of collaborative software and groupware.

Poplin (2011) did research to the question if online games could be used to increase public participation at spatial issues. She made use of the Playful Public Participation concept. This concept aims to bring joy and satisfaction to the interaction between citizens and planners when dealing with a spatial issue. Playful Public Participation was used in the Nextcampus case, an online public

participatory game where the players were asked to help thinking about a possible relocation of a university campus. The conclusion of the research was that there is much potential to be gained in motivating people to participate through a game. Even so, an online game has to be simple in terms of structure and instructions in order to be successful. The challenge for future serious games lies in their design. The design has to be such that all kinds of players with varying (computer) skills, social and educational backgrounds are equally attracted to play the game (Poplin, 2013).

On top of the usage of serious games in decision making processes and public participation, serious games are used for educational goals as well. Gaber (2007) used SimCity as a learning tool in his classes to allow students to get more insight in the dynamic of decision making processes which they will encounter later in their jobs as planners. Thanks to the simulation, students achieve learning goals as system thinking, acquiring solution-oriented abilities and general planning skills. Lecturers of planning courses will profit from games as SimCity once these games are added as an extra teaching tool to the existing methods (Gaber, 2007). However, Gaber stresses out that SimCity and similar games are not panacea. The games have to be correctly taken into the curriculum in order to work and provide the benefits associated with them. Fine tuning the games to the right kind of student is key. Only when combined with realistic learning goals can the SimCity game simulation, and others, be regarded as a (proper) new teaching tool, focused on learning by doing as opposed to the classical knowledge transfer methods.

2.5. Game simulations and communicative planning, power and complexity

Game simulations can be used to increase public and civic participation of spatial and urban planning issues and at the same time are able to improve the participation process (Poplin, 2011). Not only do people like to play game simulations, but communicative planning approaches, approaches where actors and stakeholders try to approach one another to better co-operate with one another, with the goal to lead to a more desirable outcome, is a good method to deal with sustainable and equitable development and enhancing participatory planning in conventional representative democracy, as well as the increase in social diversity (Brand & Gaffikin, 2007). The role of the planner shifts from being an expert to being a mediator in these planning approaches. This is considered to be a good transformation: it allows for the possibility of more sustainable and fair spatial and urban developments by communication and negotiation. But at the same time, Brand & Gaffikin (2007) also note the tendency of an increasingly more individualistic and competitive world. A world that is becoming less and less collaborative. The question thus arises if communicative and collaborative planning approaches can still work in such a world.

Healey (2003) argues yes, collaborative planning is still possible. As long as planners remain to reflect critically on their own actions collaborative planning can continue to function. Since a power dimension is present in every social relation, when planners reflect critically on their actions, that power can be exercised to get things done instead of using that power to gain control over others. Though there is truth to the statement that, when planners critically self-reflect on themselves, planners become more aware of their power and how this power is (un)consciously used, it is not the whole story. There are other sources of power, next to that of the planner, that have to be taken into consideration.

Every actor in a communicative planning approach brings power along with him. And some actors have more power than others, a fact not to be neglected. Power is capable of defining its own reality (Flyvbjerg, 2003). It is not to say that there is no power in knowledge but rather that powerful

actors are capable to define their own reality to suit their own needs. In other words, powerful actors are capable of altering reality and its correspondence knowledge to a reality more suitable for themselves. Reality, in the face of power, is not to be taken for granted: 'the greater the power, the less the rationality' (Flyvbjerg 2003, p. 323). For communicate planning approaches, it means that the actors who wield the most power (could) decide which result of the planning process is most desirable for them and steer unto that outcome. In doing so, the democratic aspects of communicate planning approaches are dismissed.

Forester (1982) comes with a possible solution for planners to not only defend themselves from such power abuse, but the public interest as well. A truly democratic, communicative planning process can be created through his proposed concept of the progressive planner. This is a planner '...who can anticipate and counter particular efforts of influential interests that threaten to make a mockery of the planning process' (Forester 1982, p. 77). In short, a progressive planner is capable of anticipating and countering misinformation. Though good of intention, it is unlikely that every planner is able to perfectly predict where and how misinformation is spread. More experience as a planner could lead to some partial prediction of misinformation and power games in communicate planning approaches. Nevertheless, it would always remain difficult to protect other actors who cannot defend themselves against power abuse in power confrontations.

Power relations will remain, playing an important role in game simulations and the concept of serious gaming. It is naïve to think power relations will disappear when one uses game simulations in a communicative planning process. It is, in fact, a possibility that power relations only become more present in a game simulation than in other forms of communicative planning. The model where the simulation runs on can be easily altered or manipulated, certainly by those in power. And who decides what the true 'reality of the game is'? The planner, the participants, the financier or someone else? Powerful actors will keep trying to influence others and set the result of the simulation to their liking. As Flyvbjerg states: 'The rationality of power has deeper historical roots than the power of rationality' (Flyvbjerg 2003, p. 323).

In addition, there is another, more fundamental aspect that plays a role when game simulations are used in communicative planning approaches. Simulations and models, per definition, simplify the world in order to work. After all, models and simulations provide insight into the workings of the world by reducing and simplifying it to a few variables. By running the simulation or model on these few variables, interrelations and connections between factors and the variables can be made. However, reality is difficult to capture in models and simulations. Changes do not occur linearly in the real world (Duit & Galaz, 2008). By letting out pieces of reality out of the model different outcomes can occur between the game simulation and reality. As changes can occur spontaneously in reality, games are not able to identify them as simulations and models have simplified the reality on which they are based. Therefore, it is not possible for game simulations to predict everything. Especially through the combined processes of the reduced power of the state and a becoming more and more complex, intertwined and changing world (Young et al., 2006) 'has heightened the need for adaptation and flexibility in order to reduce vulnerability and secure vital resources of communities (Duit & Galaz 2008, p. 329). Simulation games can only predict certain trends so far: they are not flawless fortune tellers, capable of perfectly predicting the future.

This is not to say that game simulations are not useful. Another positive point is that game simulations are able to provide insights into how processes work. Though not of every process and not always very good, players receive an impression on how a small part of the world works and what does

not. In addition, players are confronted with the complexity of reality. Admittedly in a simplified way, it nevertheless provides the players, especially over time when the game simulation is run, with new insights in exactly how much actors, factors and interests are present in spatial and urban planning issues: probably much more than what each player thought individually at the start of the simulation. Furthermore, players are able, by playing game simulations, to seek out solutions desirable, or at least acceptable, to all. "The key task of planners working in a complexity frame of references is to work with people in a participatory way in order to specify the range of possible futures and to try to establish the actions that will produce a future which is desired – with that desire specified through democratic processes" (Byrne, D. 2003, p. 177).

Game simulations can also mean something to planning theory. Contemporary planning theory operates in a spectrum with two opposites thoughts: technical rationality and communicative rationality (Roo, 2010). Technical rationality depicts the world as a positivistic one, where everything can be measured and known, providing absolute certainty. Communicative rationality however, depicts the world as one large uncertain entity, where "nothing is certain and that everything is subject to doubts, considerations and -in the end- nihilism" (Roo 2010, p. 25). However, most of the issues take place neither in the ideal corner of rational or communicative rationality, but somewhere in the middle between these two extremes. It is not unthinkable that game simulations could help in overcoming the two extremes towards the idea of becoming (Roo, 2010), "that enables entities in the system to maximise the benefits of stability while retaining a capacity to change" (Roo 2010, p. 32). In a sense, game simulations do just that: providing a stable game world to operate in which can be subjected to changes, both in the game world and to the game itself.

2.6. Conceptual framework

Based on the theories and ideas discussed before, a conceptual framework for this research has been developed. The criteria will be discussed in the next chapter and in chapter 4.

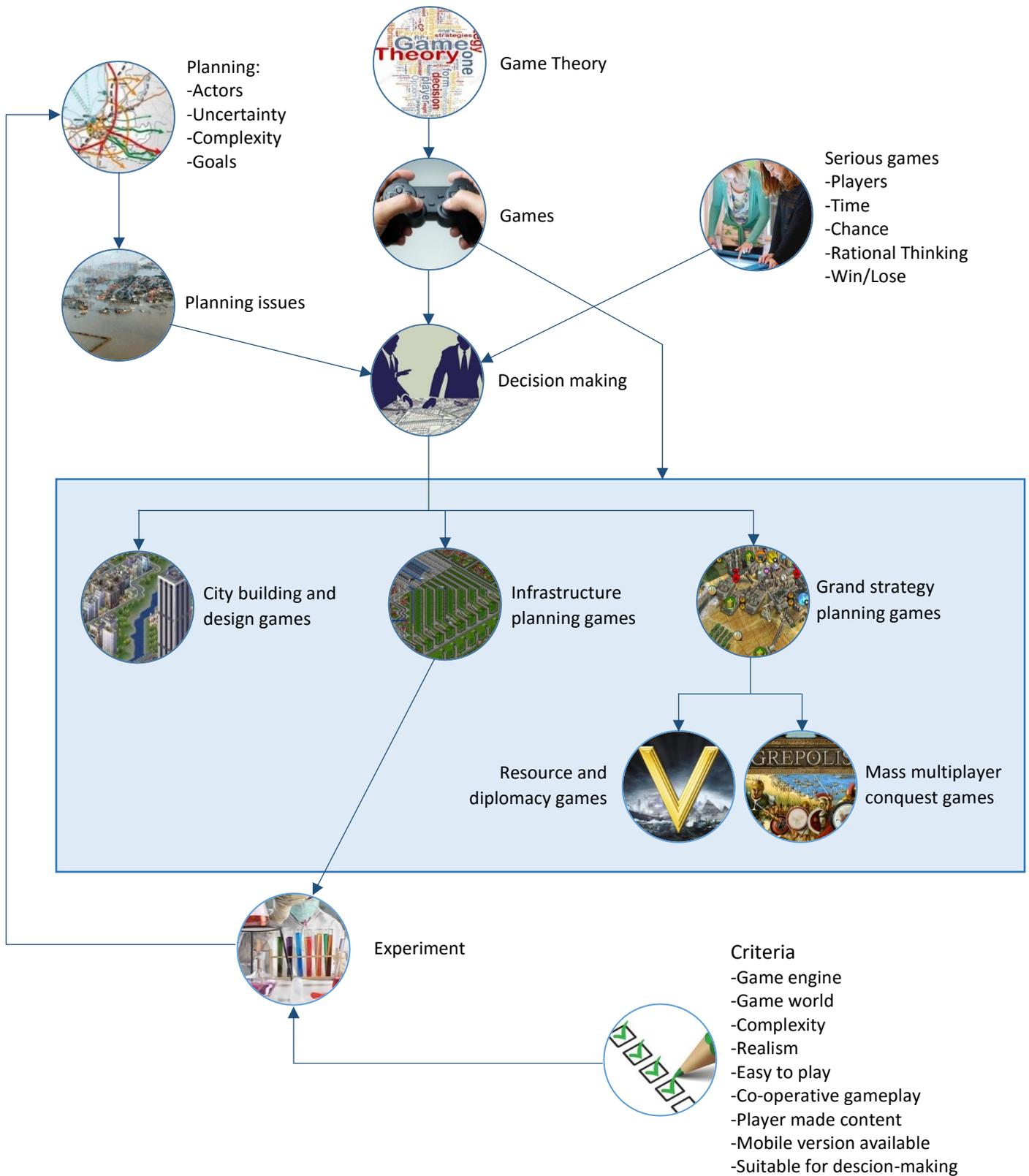


Figure 2: Conceptual framework.

Chapter 3 – Research design

This chapter covers the research design of the study. First, the methodology will be discussed, outlining the various methods used when conducting this research. Second, the methods will be further addressed in depth, beginning with the game analysis and followed by the experiment.

3.1. Methodology

As previously discussed in chapter one, there are some theories regarding the concept of use of game simulations within spatial and urban planning. However, overall progress is far from completion (Poplin, 2014). As stated before, this research tries to explore the possibilities, chances and risks of game simulations used in spatial and urban planning. To do so, a mixed-method methodology is used. For the first research question, a literature study has been conducted to determine how games operate and how and why they work, as mentioned in the previous chapter. To answer which developments game simulations have undergone the past decades, several game analyses have been carried out. These analyses allow for a good understanding of the games by playing them, supported by literature of these games. However, to chart the chances and risks, primary data has to be generated. One way to do so is through an experiment in combination with questionnaires. Questionnaires gather information about attitudes, behaviours and people's perceptions of a population towards a certain issue, problem or development (McLafferty, 2010). A thorough set of primary data can then be assembled, especially since the participants can experience the genre of city building simulation and strategy games first hand themselves in the experiment.

3.2. Game analysis

A game analysis is carried out to better understand a game. This is in correspondence with the objective of this research to determine how simulation games work and to which developments these games have gone through the past thirty years. A game consists of certain amount of layers: hardware, program code, gameplay, meaning, functionality, referentially and socio-culture (Konzack, 2002). In this study, the focus lies on the gameplay layer. This is also known as the structure of the game. From the study of games, or ludology, different game factors can be identified which are important to the gameplay of a certain game: positions, resources, space and time, goal(s), obstacles, knowledge, rewards and/or penalties (Konzack, 1999). Positions refer to the positions from which the game is perceived. This can be players but also audience or judges. Resources are the means available to the players to influence the game. Space is divided into virtual space and the real space; the virtual space takes place in the game itself. The real space, or the playground, is the space from the real world wherefrom the players influence the virtual space. Time is the time available before the game ends: this can either be indefinitely or set to a certain limit. Goals are the objectives needed to accomplish and win the game. Obstacles provide challenges which the players have to overcome in order to achieve the goals. Knowledge is divided into three types of knowledge: open knowledge, like the rules of the game and open information as statistics, hidden knowledge as the strategies of players and random knowledge, such as chance events or randomisation. Rewards and penalties focus are the means that can be won or lost in the game and can range from money to points and time, space or resources. By focusing on these aspects the structure of a game can be analysed.

The focus of this study is on the structure layer. Though it is more comprehensive to analyse all the different layers described above, these layers are not equally important (Aarseth, 2003). To accomplish the goal of understanding how city building strategy game simulations work and have

developed, researching the structure layer of Konzack is prioritised in this research. However, Aarseth uses a different set of layers: besides the game structure layer, which consists of the rules of the game and the simulation, another important layer can be identified: the game-world layer (Aarseth, 2003). This layer consists of the fictional content, level design and textures of a game. In order to successfully assess the changes over time in the city building strategy simulation game genre, both layers have to be researched in order to provide a comprehensive analysis.

According to Aarseth (2003) there are three ways to acquire knowledge of a game. One, the study of the design, mechanics and rules of the game, if possible by talking to the developers. Two, the observation of players that play the game and/or the reports and review of those players. It is then hoped that that knowledge is representative and that the players are competent in playing the game. Third, the game can be played by the researcher himself. Without the researcher playing the game itself, there is a liability to (severe) misunderstandings even if the mechanics are thoroughly studied. Only observing the action is not sufficient: the researcher is not put in the role of the audience, the player, of the game. In addition, more important, is the mental interpretation and exploration of the rules. If the researcher remains a non-player of the game, he cannot distinguish the functional and decorative elements of the game from one another. Therefore, some participatory research was necessary to conduct as well, whereby the researcher fully engages into the phenomenon of those who are affected by it (Breitbart, 2010). Specifically, next to the consulting the literature of a game, being game manuals, guides and walkthroughs, each of the games in this study has been played for at least some hours by the researcher, to ensure knowledge of the games is acquired from a range of different sources and perspectives.

The games were selected out of a list known city building simulation and strategy games (Wikipedia, 2016), by checking whether a game owned a predominant spatial element in combination with the ability to construct buildings, infrastructure and items by the player. The focus has to lie on the designing and creating of a new spatial environment. As a result, some games such as the Anno series and the Tropico series were not selected. Even though these series own a predominant spatial element, the focus is not only primarily on building cities but tends heavily towards economy and trade as well.

Each of the games in this study is analysed in the following manner. First, a general description of the game is given, stating information about the release date, developers and publishers and a short objective summary if applicable. Secondly, the game characteristics are analysed as described before. In this section, the building blocks of the game are described, like the game environment/game engine the game runs on, what kind of resources are available, which elements are important to progress and advance in the game and which tools are available for the player in to monitor this progress. Thirdly, the game mechanics are described. These are the rules of the game, explaining as to how the game progresses forwards, like the conditions required for population growth, how new technologies can be researched and how resources are generated and collected.

After each game is individually analysed, a broader analysis will be done in order to look for trends and developments the games have undergone over time. This will be performed through the use of a ranked system, where each of the games will be compared with the other to determine which games score best in certain categories, providing an indication as to which games hold the best potential for usage within spatial and urban planning. A five-point Likert scale will be used for this purpose (McLafferty, 2010) In addition, this will allow not only to answer as to how these simulation

games work, but also through which developments these games have gone. through the past twenty years, providing an insight in as to how these games have come to the status where they are now.

3.2. Open TTD Experiment

In order to answer the last research question an experiment was conducted. Experiments are an excellent tool in establishing causality, as well as providing the opportunity to study change over time (Bailey, 2008). Most people know little about games in general, let alone such extensive knowledge and/or experience of city building simulation games that they can provide suggestions or ideas to where these games could be used in spatial and urban developments and what the possible strengths and weaknesses are in that situation. An experiment provides the opportunity to let people become acquainted with a city building simulation game to some extent as well as providing data and insights as to how people think about game simulations in spatial and urban planning and the (possible) change of mind that occurs during this acquaintance. In addition, an experiment can be (better) controlled by the researcher and as a result benefit from needing a smaller sample size due to less extraneous errors and producing more faith in the results of the experiment (Bailey, 2008).

The experiment design chosen for this research is the before and after experiment with no control group (Bailey, 2008), meaning that a questionnaire was held before and after the experiment. The pre-experiment questionnaire deals with the expectation of the subjects of the experiment and the post-experiment questionnaire evaluated both these expectations as well as the experiment itself (see Appendix A). The subjects all came from the course Planning and Infrastructure lectured at the University of Groningen as part of the study Technical Planning. The subjects were selected for a couple of reasons. Firstly, the subjects were no strangers to pc's and the digital environment due to their age, which stand at the core of the experiment. Second, the subjects represent the next generation of spatial and urban planners: they are interested in the fields of planning and have already acquired knowledge about certain issues, but have not yet fallen into common planning practices. As a result, these subject have (probably) a more open mind to new approaches than those who have become stuck in daily practices. Consequently, if these subjects do not find any (dis)advantages of using game simulations in spatial and urban planning, it is not likely that senior planners and non-planners would instead, also with Roger's theory of innovations in mind.

The experiment took roughly 90 minutes to conduct. The game simulation used was the Open source version of Transport Tycoon Deluxe, or Open TTD for short. Open TTD is based on the original Transport Tycoon Deluxe game, trying to remain as close as possible to the original source (Open TTD, 2014). It was selected for a couple of reasons. First, being open sourced, the game can be downloaded by all for free, in contrast to many other city building game simulations. Second, the game has multiple versions for different operating systems, making the game available to play for every subject selected as they only had to download the correct version corresponding to their operating system. Third, the game offers an easy-to-use in game tutorial, explaining how the game works and which actions the player has to make in order to competently play the game. Fourth, the game has a multitude of language interfaces, eliminating possible language barriers as players can select their preferred language to play with. And fifth, the game was fitting within the course with its focus on infrastructure.

As the experiment was conducted with one class of students attending the course Planning & Infrastructure, two different assignments were given to the students to choose from to execute as to learn more about the emergence and development of infrastructure networks. In one assignment the students had to create the largest city as possible while in the other assignment the students had to

acquire the greatest possible company value (see Appendix B). During both assignments the students had to take screen shots of their first transport connection and after every 5 years in the game simulation to depict the evolution of their infrastructure network. Each student performed his assignment with the same scenario.

The experiment took place in a lecture hall on the Zernike Campus of the University of Groningen. The students were required to bring their own laptops with them to the lecture hall to participate in the experiment. It was necessary to instruct the students to download and install the game themselves on their own laptops as the game could not be facilitated on pc's available on the campus due to university policy. Power strips were provided to ensure enough power was available for all laptops.

The experiment was announced beforehand to the students on Nestor (Blackboard). Students were instructed to acquire themselves with the game through an online guide and an in game tutorial. A short presentation was held before the experiment took place, explaining the goal and purpose of the experiment as well as the two assignments. In addition, a small tutorial was provided for the students on to how the game is played, giving those who had not prepared themselves the core basics of the game. Next, the questionnaire on the students' expectations was handed out and filled in where after the experiment itself started. During the experiment, assistance was provided to the students who had questions or experienced difficulties. At the end of the experiment, the questionnaire evaluating the game and the students' expectations was handed out, filled in and returned to the researcher.

A comparison between the students' accomplishments was drawn, rewarding the students who had the best results with a small prize. The completed questionnaires were imported into IBM SPSS statistics where a statistical analysis was conducted. The questionnaire itself consists of two parts, one filled in before and one filled in after the experiment. Part I can be divided into two sets of questions: the first set is composed of general questions, enquiring the participants about their gender, age, frequency of playing computer strategy games, the average duration of a game session, whether the participant has played Transport Tycoon before and whether the participant has played a similar game like Transport Tycoon before. These questions provide a general view of the participants' gaming behaviour. The second set covers questions about the experiment, namely the participants' expectations to which extent they agree or disagree with a proposition. A Likert-type five-point scale was used for this in order to compare the answers given by the participants more easily (McLafferty, 2010). This set can be further divided into groups of questions, namely the following: a motivational question, insight questions, contribution questions and end questions. The motivational question asks the participant to what extent he likes to play game simulations. This question is asked as fun is one of

Flevoland Scenario

The scenario used in the experiment was designed by the researcher. It comprised of a game map representing the province of Flevoland in the Netherlands, starting in the year 1980. All major cities were depicted in the scenario, as well as some additional fictional industries to improve the gameplay of the scenario, but the map did not possess any infrastructure in advance, letting the participants with the design and the decisions how to construct an infrastructural network.



Box 1: The scenario in the experiment

the, if not most, important aspects why games are played and can work. The group of insights questions consist of the propositions to what extent the participant expects to gain insights in the emergence and development of (infrastructure)networks, the complexity of (infrastructure)networks, the workings of models and to what extent game simulations provide valuable insights in spatial issues and the complexity and problems of a spatial issue. These questions are asked to determine if there can be lessons learned from game simulations. The third group covers questions about the beliefs of the participant to what extent game simulations can contribute to acquiring the learning goals of the education the participant is following, decision-making in spatial issues, public participation in spatial issues and drawing a larger audience into a spatial issue. These questions provide an indication as to how useful the participants belief game simulations can be used in spatial and urban planning. The last group, the end questions, consist of the questions to what extent the participant believes that game simulations can be taken seriously and to which degree game simulations divert attention from the problem. These questions are asked to determine the possible risks of the usage of game simulations.

Part II repeats the second set of questions from Part I, to see whether playing the game has influenced the participants' beliefs about game simulations in spatial and urban planning. An extra question is asked in the end group, namely to what extent the game was a good simulation of reality, to determine how realistic the game was experienced. The last set of questions were open evaluation questions: what did you like about the game simulation, what did you dislike about the game simulation, how could, according to you, game simulations be used in spatial issues and in which stage of the planning process could, according to you, game simulations provide a contribution. The purpose of these questions was to evaluate the experiment and ask the participants about their beliefs in the usage of game simulations.

The experiment could have been improved. First of all, the experiment is not necessarily representative for whole of society. The participants were all students following the same education. It is not likely that this will not influence the outcomes of the experiment in any way. In addition, the average age of the participants is relatively young, with most being in their early twenties. This age group has grown up with the digital world and the world of digital gaming. However, it is likely that older age groups may not have (fully) acquired themselves with the digital world, let alone the digital gaming world. Digital gaming tends to appeal young people more than middle-aged or elderly people. Again, it is not likely that this aspect does not influence the outcomes of the experiment. If the participants were more representative to society, it should be expected that those results would be different from the ones found in this set-up of the experiment.

Nonetheless, this is not to say the experiment does not yield any valid results: if young people with an affinity for (solving) spatial and urban planning problems, who know the digital world and (to some extent) the digital gaming world, have no positive response at all to using city building simulation and strategy games in spatial issues, it stands to reason that seasoned planners and decision-makers would have a similar, possibly an even stronger reaction as well, let alone the average citizen who participates in spatial planning. If negative results should be encountered as the outcome of this experiment, it can be argued that game simulations are better not used in game simulations as even the young, new generation of planners holds no value in such tools. Should this experiment yield positive outcomes though, it can act as a spring-board for further research to determine the extent to which the same responses resonate in other people of different ages and interests.

Chapter 4 – City building simulation and strategy games

This chapter discusses the games selected for the game analysis. The games are divided into three classes of games: (1) games that focus solely on city building and design, like SimCity, (2) games that focuses more on the infrastructural aspects of planning, like Transport Tycoon and (3) games that primary revolve around city building but include other aspects as well. This last class can be further divided into resource and diplomacy games like Civilization V and mass multiplayer conquest games as Grepolis and Forge of Empires. The first class will be described first, starting with the classic SimCity game up until the latest instalment in the SimCity series, SimCity, followed by Cities XXL and Cities: Skylines. Transport Tycoon starts the description of the second class, followed by Cities in Motion 1 and 2. The last class consists of Civilization V, Grepolis and Forge of Empires.

4.1. *SimCity Classic*

Simcity, later named as Simcity Classic, is the first city building simulation game in the Simcity series. The game was developed by Will Wright and published by Maxis (Bierend, 2014). It was released on the 2nd of February, 1989. The goal of the game is to design and build a city without any pre-set objectives (except when a player plays a scenario, where objectives are set to accomplish).

4.1.1. Game characteristics

Simcity Classic is a 2D overhead grid city building simulation game. As a grid system, this means that the map on which the game takes places is divided into squares, whereupon buildings and infrastructure can be placed, though they can be larger than one single square. Infrastructure can be built only horizontally or vertically across the map whereas buildings are just placed without an orientation. The players' view of the city is that of looking down on the city with as a bird view. The map itself is flat: there are no hills or mountains present, only trees and water. There is no option for building underground.

Since the game has no pre-set objectives (except in scenarios) there is no real goal for the player to achieve provided by the game (Albert, 2001). However, the player can go bankrupt if the player does not manage correctly his city, thus it can be argued that the 'one' goal of the game is to not go bankrupt, otherwise the player is dismissed as mayor and the game is closed: the player 'loses' of the game.

The most iconic characteristics throughout the entire Simcity series are introduced in this first instalment: the zoning of ground in the game. There are three types of zoning of which the player can designate: residential zoning, commercial zoning and industrial zoning (Electronic Arts, 1999). In the residential zoning, the inhabitants of the city live, constructing houses and apartments. Commercial zones represent the retail stores and services in the city, producing and providing goods and services to the city. Last, on the industrial zones warehouses and factories are realised and are the basic production areas of the city. These tiles of zoning consist of three by three squares on the game map. Only once a piece of ground has been assigned a zone, buildings will appear according to the designated zone. In addition to the zones, the player can construct an infrastructure network of roads, railroads and electricity cables. All of these infrastructures only take up one square per segment. There is however only one type of each of these forms of infrastructure: there are no highways, for example. Furthermore, there are the facility buildings which can be directly 'plopped' onto the map. These are the buildings of the police department, fire department, power plants, parks and stadiums. This category of buildings can benefit the city by combating crime and fire and provide leisure activities for the inhabitants. Last are two special buildings, the seaport and airport, which can be constructed within the game. These buildings function as boosters of development for commercial and industrial

zones.

In order to effectively manage the city, the player has access to a number of windows to monitor the city: a map window, wherein the whole city is displayed; a graphs window, wherein the development of population, crime, commerce, cash flow, industry and pollution can be displayed over time; a budget window, wherein the player can change the tax rate applied to the city and the budget for transportation, police and fire fighters; an evaluation window, where the public opinion is expressed if the mayor/player is doing a good job, which problems (crime, traffic, taxes or pollution) are considered the most urgent at the time and some overall statistics of the city as population, migration, city value and city category (village, town, city, capital, megalopolis).

4.1.2. Game mechanics

In order to grow a city in Simcity Classic, the player has to assign zones to the land and connect these zones with the transportation network and the electricity network to allow the construction of buildings on the assigned zones. Without a connection to these two networks, the allocated zone will not develop. As the city grows as time progresses per month in regular intervals, special buildings like churches, hospitals and water towers will be constructed on the zones, while others will be upgraded into higher and higher buildings, as long as the demand for a zone exceeds the offer available. The inhabitants, the so-called Sims, will start to have demands: the crime-rate needs to drop or a stadium needs to be built. In addition, throughout the game, the demands for the three types of zones will fluctuate according to the desires of the Sims: if a player wants to satisfy the demand for more residential zones and allocates land for this function, it will not be long before the demand for residential zoning will drop. However, a consequence could be that there are not enough jobs for all the Sims in the city and demand for industrial and commercial zones will rise. At the same, the player has to be aware of where he or she assigns zones or places buildings: residential zones next to industrial zones are will never be very attractive due to pollution, while residential zones next to parks will be. If commercial zones are being denied the construction of a seaport or airport, businesses can decide it is better to move to another city and will move away from the players' city. In addition, without a sufficient public transport network, streets become clogged with traffic, grinding the movement in the city to a hold, whereupon inhabitants start to leave the city as they can no longer move around. This is shown in the game by the number of cars occupying the street: little traffic shows an empty street, mediate traffic shows some cars and heavy traffic generates lots of cars. The mechanic behind these traffic levels is generated by the process of Trip Generation (Electronic Arts, 1999). Each generated trip starts at the origin zone (which could be any of the three available zones), then travels along the road or rail network and ends the destination zone, when a proper destination is reached. If no proper destination is reached, the trip fails. This is an indicator of inaccessibility of a zone and limits the city's growth: either because of the fact that the destination zone is too far from the origin zone or there are too many traffic jams prohibiting a successful trip.

Furthermore, the player has to maintain a balancing act between the amount of tax needed to pay for (expensive) improvements to enhance the city and meet the Sims' demands and the amount of tax the Sims are actually willing to pay. Every action the player makes has either a direct or indirect consequence for the further development of the city. It was this design that made the game successful, with a focus on playability and excitement rather graphics (Albert, 2001).

While the player has 'God-powers', in that he/she can decide when, where and which type of building or zone is being placed and thus from the landscape to his will, the game has also some random events in the form of disasters, though some of them can also be manually inflicted. The disasters are: fire, flood, air crash, tornado, earthquake, monster and a nuclear meltdown. These

disasters can ravage the city and it is the players' task to react accordingly to each disaster and to rebuild the damaged parts of the city.

4.2. *SimCity 2000*

SimCity 2000 is the second instalment in the *SimCity* series. It was designed by Will Wright and Fred Haslam and released by publisher Maxis in 1994. As with the first instalment, the goal of the game was for the player to design and build a city.

4.2.1. Game characteristics

SimCity 2000 is a 2D dimetric grid city building simulation game. In contrast to its predecessor, the view of the game has gotten perspective instead of the overhead view in *SimCity Classic*, though it still makes use of grid system. However, different heights are now possible, as well as the option to go underground.

As being the sequel to the first *SimCity* game, most elements from the previous game have re-used in *SimCity 2000*. As before, the most iconic feature is the zoning tool. However, instead of placing pre-defined tiles of a zone type as in *SimCity Classic*, *SimCity 2000* works with zoning ground by marking individual squares on the game map, allowing for other shapes than just squares. And while there is no increase in variety of types of roads (though tunnels can be created), the options for the public transport network have increased in this second instalment. A bus depot can be placed, creating bus stops and busses across the city, as well as rail roads and rail road's depots and subway rails and subway depots. These two types of rail public transit can also be connected to one another. More power plants are available to the player and a new feature of the game is the ability to construct a sewage system consisting of water towers, pumps and pipes. In addition, more facility buildings are available: next to the fire department and police department, the player can now construct prisons, hospitals, schools, colleges, libraries, museums, small and big parks, zoos, stadiums and marinas. Rewards as the mayor's home, city hall and a statue are unlocked if the player reaches certain population sizes. The sea- and airport are also no longer predefined squares but zones which can be designated to squares on the map. To build the city, the game has developed a more extensive tools menu containing different headings wherein the player can choose which type of building he wants to build. For example, under the energy heading the oil power plant can be selected.

In order to monitor the city's progress, the player has some monitoring tools to his availability. The budget panel is one of the most important of these: in it, the player can change the tax rate and the allocation of budget towards emergency services, education, healthcare and transportation. However, as the player can now also issue city ordinances or take loans, the cost of these are also shown in this panel. The population panel shows a population tree, depicting how many Sims are living in the city, how healthy the inhabitants are and which EQ they possess (as an indicator of how well educated the Sims are). Furthermore, a graph panel is available showing how many residents, commercial and industrial buildings are present in the city. In addition, a diagram can be depicted which shows the player what kind of industries are operating in the city. Last, a small map of the *SimNation* can be drawn, showing how large the neighbouring cities are directly located next to the players' city. Finally, the player can investigate every building individually, thus getting insights in crime rate, pollution, land value and if the building is powered or watered.

A new feature in the game is the option to edit the terrain on a map before actually building a city (Bremer, 1994). In this mode, the player can change the terrain of the map by deciding if the player wants a coast and/or a river or not and change with sliders how much of the land should be covered by mountains, trees and water. In addition, next to these generation options, the player can place trees, forests, water and streams as he or she likes using the respective place buttons in the menu. Furthermore, the terrain can be changed on each individual land square and the sea level can be adapted according to the player's will.

4.2.2. Game mechanics

The mechanics of the game have become more complex than in *Simcity Classic*. Due to the fact that zones are no longer predesigned squares but can be designed to the players' wishes, zoned land tiles have to be in a radius of a road of about three to four squares (Humbad, 1996). It no longer suffices to just connect the whole zoned area with just one road if the zoned area is too big. In addition, if the player wants to create high density buildings, the buildings must not only have access to power, but to water and enough road connections as well, alongside a high enough land value of the zoned ground. Only then high density buildings start to appear on site. Land value can be raised by providing enough power, water, parks (or water and trees) and safety (thus enough police and fire departments and hospitals) to the zoned areas.

A new feature of the game is the possibility for the player to designate city ordinances. These ordinances have effect on the whole of the city and can have a multitude of positive effects: the legalized gambling ordinance for example creates extra income to the city, while a public smoking ban reduces the chance of fire and energy conservation saves energy, reducing the need for power slightly. The player can tweak his city on some aspects of the game by using these ordinances.

Still one of the most important mechanic of the game is the ratio of zones in the game, showed through the R(esidential), C(ommercial) and I(ndustrial) bars demand bars. These bars indicate how urgent new correspondent zones need to be assigned, or not. In a town under 10.000 inhabitants, the ratio of zones is around 4R, 1C and 3I, while cities between the 10.000 and 60.000 inhabitants require a ratio of 4R, 2C and 2I and above the 60.000 inhabitants the ratio shifts towards 4R, 3C and 1I (Humbad, 1996). Throughout the game, the ratio thus shifts from 3 industrial and 1 commercial zoned tiles per 4 residential tiles to 1 industrial and 3 commercial zoned tiles per 4 residential tiles. However, the demand bars can be influenced by raising or reducing taxes. If taxes for industrial zones are lowered, a higher demand for industry will be created.

Another important mechanic is the transportation of the Sims between different zones. Like in the first game, the Sims move between their residential zones and the commercial and industrial zones for work and shopping. The intensity of traffic on the roads is shown by the amount of cars on a segment: no cars means little traffic, some cars is medium and many cars means that the road suffers of heavy traffic. Other than in *Simcity Classic*, the options for the player to improve transportation across the city is no longer limited by only building more roads and rail roads. The player can now also construct subways and busses. Every public transportation needs vehicle depots to function, as they not only provide the vehicles but function as station or stop as well. When two rail depots are linked there automatically appear rail vehicles which will start to drive around the city. Bus stations only need to be placed roadside, but no vehicles will appear on screen, though they are shown in numbers if the player investigates the depots.

The game has regularly time intervals simulating one month at a time. However, the player only receives taxes at the end of each year. As time progresses in the game, new buildings become available for the player to construct: around 1950 the player gets the ability to construct airports and around 1980 the nuclear power plant is unlocked (Plant, 2013). It is also visible within the game that as time progresses in the game, buildings are modernized throughout the city.

4.3. *SimCity 3000*

Simcity 3000 is the third instalment in the *Simcity* franchise. It was developed by Maxis and published by Electronic Arts in 1999 (IGN, 2016a). The goal the game remains the same as with the earlier editions: construct and manage a city. A re-release of the game was released in 2000, introducing new features in *SimCity 3000*, called *SimCity 3000 Unlimited*, used for this research.

4.3.1. Game characteristics

Simcity 3000 is a 2D isometric grid city building simulation game. Plans were made for a full 3D environment but were scratched later in development (Gamespot, 2005). Instead, an enhancement of the engine and environment of SimCity 2000 was eventually used for the game. While the core has thus relatively remained the same, like designating zones and building roads and facility and utility buildings, a lot of changes have been made for the third instalment in the series. Roads for example can now be build no longer only horizontally and vertically across the tiles but also diagonally. The landscape itself is depicted more realistically. Instead of the brown colour depicted in SimCity 2000, the ground in SimCity 3000 is mostly green, and changes with different heights: beige for beach sand, green and brown for ground and white for snow. Also the depiction of heights has become more realistic instead of only flat or sloped (with everywhere the same steepness): now there are five different slope heights which can be rendered. In addition, a greater variety of trees can appear on the map.

Another new feature is that of designating different densities (low, medium and high) when the player zones an area (Electronic Arts, 1998). These differences in densities determine to which extend the types of buildings can be build. In medium densities buildings of a low and medium density can be constructed, but high density buildings cannot. A new type of industry, the agricultural industry, is introduced. The transportation options have however remained the same for the player: the player can construct roads, highways, rail road tracks and stations, subway rails and stations and bus stops. This is also true for the landscape options (planting trees, creating water and changing ground heights). However, when a new game is started the game automatically gives the player the chance to change the map lay-out: again with the three sliders for the amount of trees, water and mountainous areas, but also by a map whereupon the edges of the map can be change to water or land and in the centre to a lake, river, mountain or flat lands. In addition, the player can choose on what kind of predominant soil the map is going to have (desert, artic, temperate, Mediterranean) and which architectural type (American, European or Asian) the buildings will have. Furthermore, an extension has been made in the utility buildings. Next to the known power plants, water utility buildings and ability to construct an electric grid and sewage system, a garbage disposal system has to be built, in the form of landfills, recycling centres and incinerators. Other new buildings are an extension of types of leisure buildings as playgrounds, ponds and sport parks. Also landmarks like the Big Ben and the Arc de Triomphe can be placed in the city.

A completely new feature are the different advisors available to the player who give advice on how to further develop the city (Electronic Arts, 1998). There are seven advisors, representing the seven city departments: the financial department, the transportation department, the city planning department, the environmental department, the public safety department, the health, education and aura department and the utilities department. Each advisor points out suggestions to actions the player can make or addresses urgent problems the player needs to solve. Next to the advisors there are the petitioners who present certain actions to take to the player. Petitioners can range from local Sims to mayors from a neighbouring town and can offer a deal or express their complaints about certain issues. Neighbouring cities are important as they can offer critical resources needed for the player's city or can constitute a cash flow as a result of deals of power, water or waste disposal.

In order to monitor the city's progress, the player has, like the previous instalments, access to data maps, charts and graphs. Data maps show the overall happiness of the city, criminal neighbourhoods, density of buildings, power accessibility, flammability levels of neighbourhoods, land value, polluted zones, traffic densities, water accessibility and the location of zones throughout the city. Charts can depict the Educational Quotient of the inhabitants (how well educated the Sims are), the life expectancy of the Sims, the work force population and the total population, electricity statistics

as amount of types of power plants, how much in percentages each type is contributing to the city and how much the city annually uses, and the types of garbage disposal, how much each type is contributing and how much waste the city annually produces. Graphs illustrate information as the approval rating, pollution, crime rate, amount of residents, education and health over periods of time of one, ten or a hundred years. The information bar shows citywide information at a glance, while the news ticker provides messages ranging from suggestions from the advisors to emergency situations which acquire immediate attention.

Also present in SimCity 3000, like in the previous instalments, is the balancing act the player has to manage of ensuring a steady growth of his city by not making the taxes too high but also ensuring that enough money is made to cover all expenses and invest in new buildings, infrastructure and zones. The player can modify the taxes for each type of zone individually (RCI) and how much budget is allocated to each of the departments. Deals and ordinances can either positively or negatively influence the budget. However, if the player is in need of money, he/she can take out a loan to raise money (so called Simoleons) quickly, though loans have to be paid back over time with interest.

4.3.2. Game mechanics

As SimCity 3000 is based on the core of SimCity 2000 the game works mostly on the same mechanics of the latter. Zoned land tiles will only construct buildings as long as it has electricity and a road no more than four tiles away. To enable full development on zones the tiles assigned to a zone needs to be watered as well, alongside with a high enough land value. Land value influenced by factors as pollution, crime levels and convenient (public) transportation options. Only when the land value is high enough, high density, more exclusive properties start to appear.

Also the trip generation system has remained: trips are still attempts to get from one point to another point in the city, a origin tile and a destination tile. (Kyle, 2002). Each transport method is expressed in method costs and divisor costs. The method costs is how much effort a particular method of transportation is needed, while the divisor determines how much the method is affected by traffic congestion, and is used to determine how well the transportation options are between one zone and another. While in SimCity 2000 traffic density was generated by the density of cars (none, some or many) on one segment of road, SimCity 3000 works with individual cars moving around the city who represent the traffic density on roads. The mechanic behind is that every trip that passes over a transportation tile, adds a value of 3 to traffic density. The maximum value of traffic density per tile is 255. However, Sims travel on a herding mentality: that is, Sims travel on routes with the most traffic. Only once the value of 165 traffic density is reached, Sims are annoyed enough that alternative routes are being sought.

What has been extended is the game mechanic of pollution and garbage. Pollution comes in two types: deposited pollution and area-effected pollution (Kyle, 2007). Deposited pollution only affects the specific tile on which pollution is deposited. Deposited pollution is represented in the game by garbage and radioactive contamination. Area-effected pollution affects a general area with pollution. Area-effected pollution is represented by air pollution and water pollution. Buildings and structures can generate air and/or water pollution and/or garbage, while other buildings and structures can reduce pollution: each building and structure has different values for the amount of pollution produced and the range wherein pollution is deposited. If there are not enough measures to get rid of garbage in the city (once the generation value of garbage exceeds 5000 units per month), garbage starts to accumulate in the city and on the streets. Landfills store garbage and once decommissioned, start to decay garbage at a rate of 4.9% per month (roughly 7 years to decay to 1% of the original contents), while other structures as incinerators and recycling centres can take up certain amounts of garbage each day. In addition, some ordinance, like the Mandatory Car Smogging

and the Clean Air ordinance reduce pollution of certain sources or even city-wide.

Utility and facility buildings like the police department, fire department, hospitals, parks and educational buildings cover only the area within a certain range of the building in SimCity 3000. Outside of the range of the utility building, the effect of the building (like lowering crime with the police department or making areas more attractive with parks) does not appear. In the case of a disaster, the player has to dispatch police officers or fire fighters. These can be dispatched even out of range of the departments, but will take longer to arrive. Disasters can occur spontaneously or the player can activate disasters himself. The following disaster can be activated: fire, tornado, earthquake, riots and UFO's, each with its own impact and range, causing different levels of destruction.

4.4. SimCity 4

SimCity 4 is the fourth instalment in the SimCity series. It was developed by Maxis and published by Electronic Arts in 2003 (IGN, 2016b). The players' goal in the game is construct and manage a city. The expansion pack called *Rush Hour*, was released in September 2003, which primarily covered more transportation possibilities for the player to construct.

4.4.1. Game characteristics

SimCity 4 is the first instalment in the series which uses primarily 3D graphics to render the game. The models in the game though are either flat rendered (as with the 2D graphics of the previous games) or a hybrid, meaning that the shape is rendered by a simple model and that textures are added to create details and a 3D image. But even though a 3D engine is used, the camera in SimCity 4 can only display images from a fixed trimetric orthographic projection (Electronic Arts, 2010). This to better ensure the performance of the game. This means that the 3D environment is restricted by a grid of squares, as was the case in the previous games.

A new enhancement of the game is that the game works on a larger scale than only city maps (Electronic Arts, 2003). The regions, already a part in SimCity 2000, play a much heavier role in SimCity 4. A region is a large piece of land, divided into multiple smaller city maps of different sizes, which can either be connected or remain independent from each other throughout the game once the player starts developing a city. The player can build several cities on different city maps in the region, though can only play in one city map at the time. The player can load existing regions, based on real-world areas, or create one himself.

Once the player starts to build a new city, the player goes through two of the three play modes available in the game. In the first mode, God mode, the player can change the landscape to his liking, using a wide variety of terraforming tools, making all sorts of mountains, valleys, gauges and rivers as well as seeding trees and creating fauna on the map. Once the player is satisfied with the map, the second mode starts when incorporating the city: mayor mode. In the mayor mode, some of the terraforming tools are still available, but at a price now. More importantly, the player now can construct his city by assigning the series trademarks' zones of residential, commercial and industrial areas. As was the feature in SimCity 3000, these zones have three different densities: low, medium and high. Different is that streets automatically appear in the zones if the drawn zone becomes large enough. Transportation options have been extended when compared with SimCity 3000: the player can construct normal roads and highways, but also one-way roads, streets, elevated highways, avenues, highway and elevated highway intersections. In addition, public transport options have also been from only busses, trains and subways: cargo trains appear in the game, as well as monorails, elevated rail road tracks and ferries, alongside with other buildings as toll booths and public parking garages. Other features, as the utility systems of power, water and waste, as well as public safety and civic systems as police and fire stations, jails, schools, colleges, hospitals, clinics, landmarks, parks and ponds have been broadened: new buildings have been added to the collection of buildings used in

SimCity 3000. For example, schools are now divided into primary schools, high schools and colleges and universities, along with different types of each: primary schools can be small or large. Especially the parks and recreational buildings have been extended with for example tennis courts, beaches, small, medium and large flower gardens. The range of these buildings which provide an active service (police stations, fire stations, healthcare and educational buildings) can boost their range of effect by increasing the budget for these buildings. Special buildings are earned through gaining certain population numbers or through business deals and provide unique buildings as the mayor's home and the city hall.

Other features which have been enhanced when compared with the previous instalment are the data views. Maps can still be drawn depicting information regarding issues as crime, fire hazards and educated inhabitants. However, the new feature of the mayor panel depicts the satisfaction of the Sims with the environment, traffic, health, education, safety and land value of the city very compressed: the player can see in an instance in which areas the situation needs to be improved. Also present in the mayor panel are the RCI-bars, showing the demand for the individual zones and the mayor rating of the player, which shows the player how well he is performing according to the Sims. New is the distinction made between the different sectors of buildings of each zone type. The residential zones have three wealth classes of low, medium and high incomes, the commercial zones is divided into a regular commercial sector and an office sector with also three wealth classes, while the industrial zones are divided into an agricultural sector, dirty and manufacturing sector and a high tech sector. Each of these sectors have their own conditions which have to be met before buildings of that sector appear in the zones. Each of these sectors and wealth classes can display their own bar in the RCI-bars scheme. The player has also the ability to gather information from graphs, representing issues as overall crime rate, population, jobs and pollution. The advisors introduced in SimCity 3000 have also reappeared along with the same categorization of departments, as well as the budget menu wherein the player can change taxes for each type of zone and zone sector and change the allocation of budget for public safety, healthcare, education and transportation. Also reappearing are the ordinance the player can issue to boost the city on specific issues. Urgent messages appear from the advisors when a situation requires the immediate attention of the player and suggestions which measure(s) the player needs to take to deal with the situation.

The last mode, the My Sim mode, is optional for the player to use. In the My Sim mode the player can question Sims and hear their opinion on the players' performance. Furthermore, the player can perform vehicles missions wherein the player needs to fulfil a task in order to earn a vehicle the player can drive in. In addition, the player can create his own Sim to live in his city.

SimCity 4 was the first game where there was third-party content available for the player to download and add to the game (Beebs, 2011). Popular are the Network Addon Mod (NAM) and the Building Architect Tool (BAT) to spice up the game, though the majority of content are buildings and lots, though some, like the NAM and BAT, do change some of the mechanics of the game itself.

4.4.2. Game mechanics

As with the previous instalments, assigning land to zones is not enough for the city to grow. A road connection, as well as electricity, is needed to start the development of zones. In order to attract wealthier classes and construct buildings of a higher density, the zones need to be watered and a high enough land value has to be reached before construction starts. However, each wealth class (low wealth, medium wealth and high wealth) has its own desires for zones. The High wealth class expects high wealth commercial and residential zones, along with high-tech industries to work in. In order to realise these conditions, the player has to construct high wealth areas, with parks, (very) low crime rates and good healthcare for example, in order to raise the zone's desirability for high wealth

residential and commercial zones (Kramer, 2003). Though every wealth class equally favours these facility buildings, the difference is made in the toleration of crime and traffic congestion. The lower wealth class tolerates less ideal circumstances than the high wealth class.

Demand is related to desirability. Demand is what keeps the simulation going. Different with SimCity 3000 is that demand is based on structures, not zones anymore (Kramer, 2003). Only when there is a demand for a certain type of structures will these structures appear on the corresponding zone types. Residential demand is created through workforce demand while commercial and industrial demand is created through business demand. Workforce demand is need of the commercial and industrial zones for workers. Each building of these zone types come with a fixed number of jobs, thereby creating demand for residential buildings. Business demand is generated by the need of the residential Sims to be provided with jobs from the commercial and industrial demands. As residential buildings are being constructed, jobs are demanded according to their wealth and educational levels. The mechanic works circular: jobs generates demands for housing which generates demand for jobs and so forth.

As for the traffic and transportation mechanic, the game has changed since SimCity 3000. The travel system is no longer based on distance and travel steps but on commute times and planning the best routes (Kramer, 2003). The Sims think in terms of how long it takes to get from one place to another. The trip system is however still present: trips are journeys made from zone type to another zone or a particular destination. However, a trip has to be made within a reasonable amount of time, fixed in the game with a maximum of two and half hours. Once a destination has been selected, the Sims will plan a route in the general direction of the destination. It is computed how much time it takes to cross each tile on the route of each transportation mode. Travel time increases with congestions, intersections and potholes. However, the Sims have three different travel strategies, which are dependent on their wealth class: the car strategy, wherein the Sims use only the car to get to their destination – mostly used by the high wealth class, the transit strategy, wherein the Sims favour mass transit instead of the car – mostly used by the low wealth class and the fastest strategy, wherein Sims favour the fastest means available – mostly used by the medium wealth class. When making use of the mass transit transportation system, time penalties occur when the Sims have to wait for a switch on another mode of transportation. When the Sims are not able to travel within two and a half hours from their starting point to a suitable destination, a no-job zot appears on their houses, indicating that that family will leave in approximately six months if the problem is ignored.

The mechanics for the utility buildings have also changed. In SimCity 4, every utility building now has monthly maintenance costs (instead of yearly in previous instalments), which increase over time as the building gets older and needs more resources to maintain. At the same time, older utility buildings produce less output than newer utility buildings and cease production once the lifespan of the utility buildings is depleted.

Another important mechanic which can drastically influence the performance of the city is the educational quotient mechanic, which has drastically changed since SimCity 3000. The educational quotient (EQ) depicts how smart the Sims are and runs from 0 to 200 (Kramer, 2003). Wealthier classes initially have a higher EQ than lower wealth classes. However, as time progresses, each Sim loses 0.2 EQ points per month. In order to combat this progress, the player has to build educational buildings, as a city with a general low EQ has significant more problems as heavy pollution and high crime rates than a city with a general high EQ. As mentioned before, these factors also contribute to the desirability of higher wealth classes, thus also lowering the (potential) tax revenues. Each education building boosts the EQ of Sims of certain ages: primary schools boost the EQ up to the age of 50, though the effect radically diminishes already at the age of 30 and onwards, for example. When enough education buildings are placed within the range of the house of a Sim, the Sims' EQ will rise as long as the buildings

have enough budget and are configured to the age of the Sim.

Major disasters as erupting volcanoes, meteors, tornados, robot attacks and earthquakes no longer happen spontaneously in SimCity 4 (Kramer, 2003). The player can choose to inflict these disasters himself in the God-mode of the game, but are no longer randomly generated. Minor disasters as fires, riots, pipe bursts, power plant explosions and arson however are still simulation triggered, depending on how well the player performs on level as funding and crime rate. When these disasters happen, the player has to send out emergency services to deal with the disaster, though destruction on the scale of the God-mode destructions are rare.

4.5. SimCity

SimCity is the latest instalment in the SimCity series at the time of this research. It was developed by Maxis and published by Electronic Arts in 2013 (Philips, 2012). Like in the previous games, the player has the task to construct and manage a city, though it is seen as a reboot of the series as there is gap of ten years between SimCity 4 and SimCity (Mallroy, 2012).

4.5.1. Game characteristics

SimCity is the first game in the series to have a full 3D environment. The creativity of the player is no longer restricted by an isometric grid of squares which can only have one function. The player can construct every building, structure or asset as he likes. As a result of this, other typical characteristics from previous instalments have also changed.

Zoning still lies at the core of the game. However, there are only three types of zones to assign: residential, commercial and industrial and zones can only be assigned directly next to a road. The density of the buildings is now dependent on what type of street the player has constructed: low density roads, medium density roads or high density roads (Knight & Bradshaw, 2013). While high density roads allow the construction of any type of building, low density roads only allow low density buildings. Roads also carry, in addition to traffic, power, sewage and water in the game. Every road can be constructed freely using one of the following drawing tools: the straight line tool, the rectangular road squares tool, the arc tool, the circle tool and the free mode tool. Road can, once built, be upgraded or downgraded to higher or lower density roads, as every road has the same width. Next to the roads are the avenues: the only difference lies in the maximum amount of traffic that can pass. Customization of the city does not stop here however: every building which has to be placed, like utility, public safety, education and healthcare building, can be modified to the players' desires. Each of these buildings starts with the main building, which can then be expanded with extra power generators, classrooms or patient wings.

The region, introduced already in SimCity 2000 and expanded in SimCity 3000 and SimCity 4, has gotten a predominant role in SimCity. Due to the limited amount of space on the map to build on, the player can choose to specialise his city and sell raw resources and/or services to other cities within the region, as the player can claim multiple cities on the region and switch between them when playing in that region. Specialisation can be made in one of the following categories: mining, drilling, trading, electronics, culture and gambling (Electronic Arts, 2013). Mining extracts raw resources as coal and iron ore, while drilling focusses on the extraction of oil. The speciality of trading allows for storage import and export of resources. Electronics is the speciality of manufacturing advanced electronics as processors. Culture and gambling specialisations attract tourists visiting the city and may provide a substantial cash flow. However, when a player constructs a large capacity for education for example, can also be regarded as a specialisation of the city. Further collaboration between cities is needed in order to construct 'great works'. These are massive projects which contribute to the entire region once completed, like a massive solar power plant or an international airport, producing large amounts of electricity or contributing massively to tourism respectively.

To provide the player with the necessary information to make decisions, a helpful user interface is designed. If a player wants to construct a new utility building for water production, the screen changes to a white, blurred world wherein the density of available ground water is clearly visible, providing the player with the data needed to make the decision where to put the utility building (Sliwinski, 2012). This feature occurs with every building placement or when data is specifically made visible by the player. With the help of animations and color-coded visuals it is instantly shown how efficiently city functions are running at the moment.

New is the ability to go multiplayer in the game. Every player can claim a different city map and create and maintain his city or cities simultaneously with others, developing the region together.

4.5.2. Game mechanics

At the base of the game is the mechanic of the RCI-zones. The residential zones provide workers for the industrial and commercial zones, while commercial zones provide freights for the commercial ones and the commercial zones provide happiness for the Sims living in the residential zones (Knight & Bradshaw, 2013). Each zone also generates tax revenue. As mentioned before, zones no longer regulate the density of the buildings being constructed on the zones: this is regulated by the roads constructed. Residential zones grow in density as long as the Sims are happy enough about their homes. This means that every building needs power, water, jobs and a certain desirability, according to the wealth class. Like in previous instalments, there are three wealth classes: low wealth, medium wealth and high wealth class. When residential buildings are close enough to commercial buildings, the happiness of the Sims will increase and eventually construct denser buildings. If the land value is raised by constructing parks and civic buildings, higher wealth classes start to appear in the residential zones close by. Higher wealth classes have less tolerance for pollution and crime than lower wealth classes. Commercial zones work much in the same way. Commercial business however depends on desired incomes to increase the happiness and to start developing denser buildings. They accumulate their income from Sims that do not work in the commercial building and from visitors outside the city. Industrial buildings also follow the desired income principle: the happiness increases as long as enough shipments are sent towards commercial buildings. To increase desirability of industrial buildings, parks need to be constructed in the proximity. In doing so, higher educated Sims start to work, producing less pollution than low educated industrial buildings.

In order to educate the Sims, educational buildings need to be present in the city or the region, with enough capacity to enrol students (Knight & Bradshaw, 2013). Sims are picked up in school busses placed on the road and taken to the nearest educational building. However, the type of educational building does not matter: young Sims do not have to go only to primary school, but can attend high schools and colleges instead.

Transportation in SimCity happens all the time. The Sims travel from their residents to their jobs and back or go shopping, while at the same time freights are being transported from industrial buildings or from outside the city to commercial buildings and visitors from out of town walk around sightseeing (Knight & Bradshaw, 2013). Traffic can congest on the roads as the Sims move from one place to another, disrupting the economy of the city when Sims no longer can arrive at their job, commercial buildings no longer get supplied and emergency units cannot arrive in time anymore. Mass transit reduces the stress put on the roads. Busses, street cars, park & ride areas, trains, ships and airplanes are available to the player. The happiness of the Sims using the mass transit system depends on the travel time necessary to get to their destination. However, high wealth Sims do not use mass transportation modes as their means of preferred transportation is the car.

Utility buildings work according to the mechanic of excess or deficit (Knight & Bradshaw, 2013). Each building requires a certain amount of power and water and produces a certain amount of sewage and garbage. Power is generated by different types of power plants, which either run on renewable or finite resources. Finite resources can be supplied from outside the city at a cost. Water is pumped out of ground water, which needs to be clean. If not clean, the Sims get sick as they consume polluted

water. Sewage needs to be pumped away of the sewer system while garbage is picked up from each building. Each of the utility buildings has a maximum capacity of either producing or disposing: when the maximum capacity is reached, either a second utility building needs to be placed or the building needs to be expanded to ensure further development of the city.

Disasters are a returning feature of the game and can occur naturally or manually (Knight & Bradshaw, 2013). Natural disasters as earthquakes and tornadoes are dependent on the geographical location of the city (mountainous or plains, respectively). Emergency vehicles however, in contrast to the previous instalments, need not be sent out to the disaster, as the vehicles are dispatched automatically.

Table 3 provides an overview of all the SimCity games of the series discussed in this research. The best game to choose for decision-making processes in planning would be SimCity 4. Although this version does not necessarily provide the most complexity in the series, it provides the most relevant mechanics concerning planning when compared with the latest version (at the moment) of SimCity, which tends to focus not primarily on planning but aesthetics of cities as well. Furthermore, SimCity has significantly smaller map sizes than SimCity 4, restricting the designing of (more) realistic sized cities. SimCity Classic is rated as least suitable for decision-making as it provides only some basic planning mechanics when compared with the other versions. In the following paragraphs the rest of city building and design games will be discussed.

	Game Engine	Game World	Complexity		Realism	Easy to play	Co-operative gameplay	Player made content	Mobile version available	Suitable for decision-making
SimCity Classic	2D	Square grid	+/-	+/-	++	n/a	n/a	No	--	
SimCity 2000	2D	Square grid	+	+/-	+	n/a	n/a	No	-	
SimCity 3000	2D	Square grid	+	+	+	n/a	+/-	No	-	
SimCity 4	3D	Square grid	+	+	+	n/a	++	No	+/-	
SimCity	3D	Open	++	+	+	-	+	Yes	-	

Table 3: Summary SimCity series.

4.6. Cities XXL

Cities XXL is the fifth and latest instalment in the Cities XL series. It was developed by Monte Cristo and published by Focus Home Interactive in 2015 (Metacritic, 2015). While the first Cities XL was developed and published by Monte Cristo in 2009, Focus Home Interactive acquired the franchise in 2010, and released Cities XL 2011 and Cities XL 2012 in 2010 and 2011 respectively (Metacritic, 2010; Metacritic, 2011), and a platinum edition in 2013 (Metacritic, 2013) but made few changes throughout the instalments, and are widely accepted as updates and/or expansion packs of Cities XL rather than completely new games.

4.6.1. Game characteristics

Cities in Cities XXL are built from the planet view. The planet view depicts the planet whereupon maps can be loaded to start new cities. Each map has different characteristics as amount of flat land, fertile land, suitable locations for the holiday industry and oil reserves. Once a map has been selected, the

player can start to construct his city. This happens in a full 3D environment. There is, unlike SimCity, no zoning tool to assign land to a function. Instead, the player has to assign individual plots of land whereupon a building is constructed once the conditions are right. There are different types of plots which can be placed: residential, industrial, commercial and public services plots. Residential plots are divided into four categories: unskilled workers, skilled workers, executives and elites. Unskilled workers work primarily in the primary (farming) and secondary (industrial) sectors, though some also work in the tertiary sector (retail, leisure) and are the least demanding category of workers with regards to city services and quality of life. Skilled workers work in every sector and are more demanding. Executives work in the tertiary sector (offices, department stores) and desire high quality city services and a good quality of life. Elites work also primarily in the tertiary sector and are the most demanding class of workers. There are different building densities: low density, medium density and high density buildings. These are built on the corresponding density plots selected as the player constructs his city. In addition to residential plots, there are industrial plots, which can provide farms, heavy industries, factories, high-tech industries and offices and retail plots which provide shops, hotels and leisure activities. Each type of building has its own plots.

Next to these plots there are the utility buildings which are placed directly on to the map. These buildings provide either electricity, water, waste treatment or fuel necessary for the city to develop and keep the inhabitants and industries happy. Public services consist of city halls, health services, schools, police services, fire rescue services and environmental buildings. These buildings provide services to develop the city further and keep the inhabitants happy and safe.

Road types are numerous in the game. Roads differ in costs, maximum vehicle flow per minute and decorations. Highways can later in the game also be constructed. Construction happens with the help of road construction tools: the straight road tool, the eight-point road tool (making roads using angles of 45 or 90 degrees) and the curved road tool. The player is also allowed to construct bridges and tunnels, though construction costs and maintenance are more expensive. Furthermore, the player has the option to construct a mass transit system using busses and metros. In order to construct a mass transit system, first the company's headquarters needs to be built along with a terminal wherefrom vehicles are sent out to the stops or stations constructed by the player.

Last are the blueprints. These are megastructures which can be constructed in the city and although they require large amounts of money, resources and time to finalise, they provide great bonuses to the city.

To ensure a steady development of the city, the player has been given analytical tools to analyse the growth of the city. One is the demographic statics, depicting immigration rate and unemployment rate of the different citizens' classes. In addition, satisfaction indicators are given, showing whether the general population or the selected class is satisfied or dissatisfied with the current circumstances. Opinion polls can be undertaken to reveal the main problems a class is struggling with, thereby indicating the best way to resolve the problem. Display filters show data directly on screen while moving around in the city. The filters which can be selected show population, satisfaction, economy, environment, resource or public transport statistics.

4.6.2. Game mechanics

To grow a city it must have a steady influx of people coming to the city. Only if there is enough work for the citizens they will migrate to the city, as the basic element of satisfaction is work (Zgud, 2016a). However, other buildings which contribute to the satisfaction of citizens are shops and leisure buildings. If a player neglects to build these, the citizens will complain to the player and demand that these have to be built, especially for the elite and executive class as these classes have higher demands than the lower classes.

An important mechanic of the game is the production and consumption of goods and services. Almost every building produces goods or services and consumes resources (Zgud, 2016a). A manufacturing building for example consumes electricity, goods produced in the heavy industry and services from offices to produce manufacturing goods. Every building, except residential ones, are part of a network of commodity dependencies. With a surplus of a certain goods they are easily accessed and the city can grow, but with a shortage of certain goods it is hard to get them and the city will stagnate in its development. But as the majority of goods is produces by other buildings in the city, placing the correct buildings will dissolve the shortage. The only goods (potential) production which are restricted by the map are fuel, water, food and tourism. If a map does not have sufficient fertile ground or is even non-existent, the player has to import food from outside the city. On the other hand, if the map has large reserves of oil, surpluses can be exported outside the city.

Trade is closely related to the production and consumption of goods. Omnicorp is the trade company in Cities XXL that sells and buys every good available (Zgud, 2016a). If a deficiency occurs of some good occurs this will be represented with a negative number of tokens of that good. The player can buy tokens from Omnicorp of that good in order to dissolve the deficiency. With a surplus of tokens of goods, these goods can be sold to Omnicorp for money. It is also possible to trade with other cities, though the player first has to create them and make sure these cities have a surplus of tokens of goods to allow trade for these goods. The amount of tokens shortage or surplus differs: there is no predetermined amount of buildings needed to produce enough goods representable for one token, as factors as the availability of raw resources, distance from roads and quality of life play a part in this mechanism.

As though time passes in the game, it is not shown with dates or clocks. Rather with the construction of buildings and updates of the amount of money and inhabitants in the city it is shown that time passes in the game, though it is possible for the player to change to different day moments (early night, midday and late morning for example). However, as the player reaches certain population levels, new buildings are made available to construct. In addition, the player can also decide which architectural types of buildings are being constructed in the city: modern, Victorian, colonialism, baroque or Art Deco, to name a few. Type of buildings can also be selected on period (for example, between 1950 and 2000 AD or before 800 AD) and geographical origin (like Western Europe, Asia or Australia). Last, it is possible to add user made content to the game. With the Steam Workshop, it is possible for players to design buildings of their own and make them available for others to add to their game, or even alter the game itself using modifications in the game mechanics called mods.

4.7. Cities: Skylines

Cities: Skylines is city-building simulation. It was developed by Colossal Order and published by Paradox Interactive in march 2015 (Paradox Interactive, 2015a). Players are to construct and manage a city of their own design.

4.7.1. Game characteristics

Cities: Skylines is game that takes place in a full 3D environment. Player start their construction of their city by selecting a map and building a highway-connection to the existing highway infrastructure (Paradox Interactive, 2015b). Each map has its own characteristics regarding climate, terrain features, outside connections and natural resources but also architecture. On European maps European buildings will appear, and on tropical maps buildings found in most hot climate countries. As with Cities XXL, roads are one of the most fundamental features of the game as they allow the construction of buildings directly next to them. Roads can be constructed using the following tools: straight roads, curved roads and freeform roads. Existing roads can also be upgraded if there is enough space to allow an upgrade. In the game, there are many different type of roads: small roads, medium roads, large

roads and highways. However, constructing buildings in *Cities: Skylines* is a mixture between *Cities XXL* and the *SimCity* series. When roads are constructed, a square grid system outline appears directly next to the road which the player can designate to a certain zone, which can be either residential low or high density, commercial low or high density, industrial or an office zone. Like *SimCity*, *Cities: Skylines* features demand bars for residential, commercial and industrial/office zones. Next to assigning land to a zone, land can also be assigned to a district using the district tool. Players can create districts to allow specialisation of buildings within a district, like a farming, tourism or oil extraction specialisation.

In addition to zoning where, once assigned, buildings start to appear automatically (if the conditions are right), the player has to construct utility and service buildings which have to be placed directly on to the map. These can be divided into the following categories: power, water, waste treatment, health, fire, police, education, transport, decoration, unique and monumental buildings (Paradox Interactive, 2015b). Power plants provide power to the city, though usually produce ground and/or noise pollution. In addition, plants to run on fossil fuels need to be supplied regularly to ensure power production. Water buildings provide water to city, tapping from open water sources like rivers and lakes, while other water buildings dispose sewage created by the city, which is dumped into water areas. It is therefore vital for the player to construct water pumping buildings upstream to ensure clean water is pumped to the city. Waste can either be dumped on landfills or burned in incinerators. Health buildings provide health services to the inhabitants of the city, while death care buildings, a sub category of health buildings, take care of the deceased. Fire and police departments provide safety against fire (hazards) and crime, while educational buildings educate the inhabitants. Elementary schools serve children, high schools teenagers and universities young adults and adults. In addition, the player has the ability to construct public transport buildings to begin construction and designing the city's public transport system, consisting of buses, trains, metros and ships. Because *Colossal Order* is also the developer of *Cities In Motion*, many features from *Cities In Motion* have been incorporated into *Cities: Skylines*. As in *Cities In Motion*, the player can design his own lines and stops in the game. Monumental and unique buildings attract tourists and raises land values.

The citizens of the city need to be taken care of at four different levels: age, education, health and happiness (Paradox Interactive, 2015b). Age influences the amount of healthcare and education needed: children need more of these services than adults, while seniors are in need of more health, fire and police services. Education affects the usage of power and water by the citizens: higher educated citizens use less power and water and also generate less garbage. In addition, higher-educated citizens allow for more sophisticated industries to appear. Health affects the life expectancy and work efficiency of the citizens. If not take care properly, citizens will remain sick and will not go to work. Happiness determines how much money is spend by the citizens, but also affects employment and crime rates.

The info view provides the player with data about the city (Paradox Interactive, 2015b). For example, if a player wishes to construct a water pump, the screen displays the available water resources and in which way and with what kind of intensity the water is flowing. That way, the player the can find a suitable location for extracting water from water sources. Every time the player constructs a certain building, the screen will change to an info window that provides the necessary data for the player to make a decision. But info views can also be selected using the info views windows panel, assessing for example which buildings suffer from crime or pollution. The screen always turns to a white, blurred vision, depicting the data selected through a certain colour scheme.

Cities: Skyline allows the creation and sharing of user-made content. Through the Steam workshop, players can edit everything like buildings, vehicles, parks, props, roads and intersections and make them available for other players to download and use in their own game. In addition, modifications in the game mechanics, called mods, allow for other behaviour of the AI, constructing of

buildings, rules of placement of buildings and assets and completely new features ranging from (working) multiple rail road stations to alteration of the speed of individual vehicles.

4.7.2. Game mechanics

In order to grow the city, the player has to provide the basic necessities to allow the construction of buildings: power plants and water buildings (Zgud, 2016b). Power plants provide power at the cost of ground and/or air pollution. However, maintenance costs also are an important factor when constructed. Water buildings do even have more side notes: as water is pumped out of a river, the water volume decreased in that river. Water thus needs to widely available or the river is literally pumped dry. Once the zones have power and water, buildings start to appear. Garbage disposal is also crucial: without garbage disposal, the city turns into a landfill and the citizens will leave. However, buildings can also be upgraded. For residential buildings, the level education is crucial. Once enough residents have gained a certain education level, the building will be upgraded. This process will be repeated until the final upgrade has taken place. Once upgraded, it holds more residents and generates higher revenues. Also, less power and water is needed and less garbage is produced. Commercial and industrial/office buildings need a certain amount of services in their area to be upgraded. These range from public transport services to recreational buildings and public safety facilities. However, facility buildings as educational buildings, public safety services and parks have a certain radius of effect. This is determined by the type of roads around the building: if a police department is next to an avenue, it has a greater action radius than when it is next to a street.

As the game progresses in time and the city grows, the player reaches certain milestones (Zgud, 2016b). With each milestone, the player unlocks new buildings and roads to construct. In addition, he is allowed to buy new squares of land to further expand the city, since in the beginning of each game the player has only one square of land to build on.

Traffic is a result of the journeys being made by the citizens (Lehto et al., 2015). Once a citizen leaves a certain location, the citizen will choose the fastest route to get to the destination, taking into account if they own a vehicle, congested roads and the availability of public transport. When a route is planned citizens will hold on to it: no alternative routes will be calculated in the middle of the journey. To prevent the road system turning into one great traffic jam, a safety mechanic was designed: teleportation. Vehicles are teleported back to their origin location if a gridlock is encountered on their route. This way, the traffic jam is still present in the game but does not grow uncontrollably and the actual location of the problem can still be identified and dealt with by the player.

Like the previous games, *Cities: Skylines* also has a budget panel. While time progresses, money is earned and spent. Most incomes are generated through taxes from the zones, but tourism and tickets sold in the public transport system also contribute, while the expenses are divided into the building categories (Zgud, 2016b). Taxes and expenses can be changed but will result in different demands of zones and effectiveness of buildings. Next to budget changes, the player can issue policies to influence the city. Policies can decrease production of garbage, stimulate education or reduce fire hazards, but can come at a (heavy) cost to implement them.

Districts can have their own specialisation and policies (Zgud, 2016b). Once a district is created, the player can assign a specialisation: the old buildings will be demolished and new buildings, in correspondence with the specialisation, will appear. If a district is assigned a specialisation of oil, oil pumps and refineries will be constructed to extract the oil from the soil (if there is any). However, just like ore, oil is a finite resource. Once extracted, it will not be regenerated as with wood and food production.

Table 4 provides a short overview of the last games handled in the first category. Of the two games, *Cities: Skylines* is the most suitable game to be integrated in decision-making processes. It not

only provides more and more complex planning related mechanics than Cities: XXL, but the ability to easily change the content of the game by adding or adapting items provides the opportunity to adjust the game to specific spatial environments and its problems. Cities XXL on the other hand lacks such finesse and detail and provides only some basic planning themes as need and demands for certain zones and public transport, where Cities: Skylines covers more themes, such as (noise) pollution and planning edicts. In the next paragraphs the analysis will continue to the second category of games, the infrastructure planning games.

	Game Engine	Game World	Complexity	Realism	Easy to play	Co-operative gameplay	Player made content	Mobile version available	Suitable for decision-making
Cities XXL	3D	Open	+	+	+/-	n/a	+/-	No	-
Cities: Skylines	3D	Open	++	++	+	n/a	++	No	+

Table 4: Summary Cities XXL and Cities: skylines.

4.8. Transport Tycoon

Transport Tycoon is a business simulation game, developed by Chris Sawyer and published by MicroProse (Origin8 & Fink Creative, 2013) and released in 1994. The players’ goal is to create a transport empire and to use road, rail, sea and air transport to expand the players’ businesses and to compete against rival companies to generate as much profit as possible. A Deluxe version of the game was released in 1995, adding more options and diversity to the game.

4.8.1. Game characteristics

Transport Tycoon is a 2D isometric grid simulation business game. This means that every grid can only be occupied with one function, e.g. a road, rail track, building or part of a larger building consisting of multiple grids. Due to the isometric display of the game, buildings and infrastructure can only be oriented ‘diagonally’ across the screen, though rail infrastructure can also be oriented ‘horizontally and vertically’. Every object in the game is placed on the ground-level, except for bridges and tunnels: bridges extend themselves above the ground-level while tunnels go underneath of course.

As the main goal of the game is to maximise profit, the player has to build a network of efficient transport routes. In order to realize this, stations have to be placed near centres of towns or industries and for train and road transport modes, along physical infrastructure. There are four modes of transportation within the game: by road, rail, water and air transport. Each vehicle within these modes can transport one or more of the following goods in the game: passengers, post, coals, oil, livestock, goods, grain, wood, iron ore, valuables or steel. Each of these goods are produced on certain points of the map (coal for example in a coal mine, post in a city, grain on farm fields) and can be transported to other locations (coal to a coal power plant, post to another city, grain to factories). Most of the vehicles are designed to only transport one good: post wagons only transport post on a train, steel trucks only transport steel. However, trains can be modified to have multiple different sort of wagons to allow them to transport a range of goods at the same time, while some ships and planes need to be assigned

a type of good to transport, which later can be changed to a different good again. As the game progresses, the player is made available to buy different vehicles with different characteristics. For example, in the beginning of the game the player can only buy steam-based locomotives, with certain top speeds, amount of horse powers and running costs, but as the game progresses, diesel and electric locomotives become available to buy with different characteristics.

Every mode of transport has its own build menu, where all the necessary buildings and infrastructure is listed. In addition, there is also a landscaping toolbar which covers tools to change the landscape in the game. Furthermore, lists of stations, vehicles per transport mode, industries, towns and subsidies can be displayed in the game to provide the player with information about the status and possible options on how to further expand the players' transport empire. Most of all there is a display which covers the finances of the company: in it, expenditures as construction costs, new vehicle costs, vehicle running costs per transport (road, rail, sea or air) type and property maintenance costs, loan interest and other expenditures are shown as well as the income generated per transport type, concluding with a final amount of either profit or loss for the year the player is in.

4.8.2. Game mechanics

To successfully construct transport routes, the player has to construct the desired infrastructure if needed (roads or rail tracks), build a corresponding vehicle depot where the desired type of vehicles can be bought and maintained and build stations where the vehicle(s) pick up and drop off the goods. When the player is constructing the infrastructure, the player gets presented a couple of decisions how to construct it: for example, with bridges, the player gets to choose between all sorts of bridges (wood, steel, concrete, etc.). In addition, the player can place one-way road signs on road infrastructure and railway signs as semaphores and colour lights along rail tracks. In order to complete the process, the player has to create the route the vehicle will drive by selecting the stations where the vehicle is ordered to stop. From then on, the game sends out the vehicle along the ordered stations, picking up and dropping off goods at these locations.

Revenue is earned by dropping off the right goods at the right location. Loading and unloading costs time, depending on how much ton of goods has to be loaded or unloaded. In correspondence with this, the heavier the vehicles are and loaded, the slower they gain speed and the more energy or fuel it costs to climb to higher terrain. The demand of certain goods at stations is determined by the surrounding of the station. Each station has a certain area coverage, and depending on which buildings are covered within the coverage it is determined which goods can be dropped off or picked up at said station. The revenue earned depends on the delivery time, the distance across which the goods are transported and the quantity of the goods. Coals is an example of a good which can be transported across vast distances in large quantities as it does not lose much of its value over time, in contrast to for example mail, which loses value very rapidly.

In addition, the player can earn subsidies. To get offered subsidies, the player has to be the first to construct a transport route of a certain good from one place to another, thereby expanding his transportation network.

Every city in the game has a system of local authority, consisting of a rating for every transport company linked to the city or town. If this rating of approval drops too low, the city no longer allows the player to demolish buildings or construct new stations in the city or town. Every city also develops and expands in the game, according to the economic factors that affect the city. New industries or resource sites may appear over time, but natural resources may also deplete eventually and industries may have to shut down their business if there is no adequate transport service available for the industry.

4.9. Cities in Motion

Cities in Motion is a public transport business simulation game. It was developed by Colossal Order and published by Paradox Interactive and released on the 23rd of February 2011 (Paradox Interactive, 2015c). The main goal of the game is to design and/or improve a public transport system in a major European city, notably Vienna, Helsinki, Berlin and Amsterdam. The player has to complete goals and objectives set out by the game and has to meet the expectations and desires of the commuters, while at the same time making sure that the company does not go bankrupt (ergo, maintaining a healthy profit to cover the expenses and invest in new transport modes and infrastructure).

4.9.1. Game characteristics

Cities in Motion is a 3D simulation game using an isometric grid as base whereupon every item within the game is situated or placed. Though not a static isometric grid game, the camera view and orientation of infrastructure and buildings while constructing is limited: new tracks and roads can only be built 'horizontally, vertically or diagonally'. As buildings vary in size they take up different amounts of space. However, roads and rail tracks take up one grid (single lanes both ways) and main streets two grids (double lanes both ways). There are four layers of the grid whereupon items can be placed. The top layer is the ground layer, where the city itself stands on, along with all its roads, tramrail tracks, buildings and citizens. Beneath the ground layer are three underground layers where only metro infrastructure can be placed. Underground layer three is the lowest layer whereupon can be build and is the only layer in the game where metros can always pass underneath waterways, which can vary in depth between one or two underground layers.

The main goal of the game is to maximise profit or, if the player plays a scenario or the campaign, complete objectives. However, money is not the only 'resource' of importance in the game. Reputation is also a significant resource to manage (Paradox Interactive, 2011). Reputation depicts the company's reputation among the citizens and how likely they will use the players' services.

Within the game there are five different modes of transport: busses, trams, water busses, metros and helicopters. Each mode of transport requires its own infrastructure: busses need bus stops and roads, trams need tramrail tracks and tram stops, water busses require open water and piers, metros require metro tracks and metro stations and helicopters need heliports to function. As is to be expected, bus stops need to be placed alongside roads. However, the player is cannot build roads himself, but only use existing roads. Tram tracks are built on top or alongside roads. Tram stops are placed alongside the tram tracks. Metros have their own metro tracks which can, as mentioned before, be placed on every layer in the game. Piers require a combination of a land and water grid, but heliports can be built anywhere on land.

Through a budget panel the player gets an estimate of the current monthly incomes and expenses. Income is generated through the sale of tickets and (old) vehicles and fines. Expenses consist of possible loans taken from a bank, energy consumption (electricity or fuel), the purchase and maintenance of vehicles and infrastructure, employers' salary and possible advertising to raise the company's reputation.

Every vehicle has its own characteristics. These consist of variations on the following variables: passenger capacity (the number of passenger a vehicle can carry), attractiveness (the level of attractiveness of the vehicle to passengers), energy consumption (the amount of fuel or electricity consumed during one month), likelihood of breakdown (the chance that a vehicle will stop working and needs to be repaired) and speed (the maximum speed at which a vehicle can travel).

The city is inhabited by different social groups of citizens. They will travel from home to work and back again, and occasionally go shopping or travel to some leisure activity. The groups differ from each other in the form of money usage and potential destinations. The groups can be divided as follows:

- Blue collar workers: blue collar workers are the factory workers of the city and work in physically demanding jobs. They have a low budget for transportation and, as many do not

own a car, prefer to use public transportation if it provides them (easy) access to their routine destinations, which is mostly from their home to work and back.

- White collar workers: white collar workers occupy offices, shops and government buildings. As they have a somewhat better salary than the blue collar workers, white collar workers are less interested in ticket prices. Speed and reliability are more important factors for them. As is the same with blue collar workers, white collar workers are primarily work-oriented and are not very interested in going shopping or doing some leisure activity.
- Business people: the business people represent the upper class of society: doctors, lawyers, bankers and directors for example. As business people have a lot of money and own cars, ticket prices of the public transport system are not relevant for them, only the quickest and most enjoyable mode of transport to get them where they are going to.
- Students: around colleges students can be found. Students do not own a car and are characterised by preferring to walk to get from one place to another. Only when a public transport link between the place of study, dormitories and their favoured leisure spot is cost-effectively established, will students travel by public transport.
- Tourists: tourists are in the city to see the city. The main interest of tourists is to enjoy themselves and are therefore not picky to prices. As visitors of the city they always reside in hotels when visiting the city.
- Pensioners: pensioners generally do not own cars, preferring to use the public transport system instead. Pensioners are characterised in being slow walkers, and prime interests lie in shopping for groceries, meeting peers in churches and take strolls through parks.
- Dropouts: dropouts are the social outcasts of the city. With no work, dropouts own no car and have very little money to spend to get from one place to another with public transport.

The game has the ability to generate different graphs in order for the player to monitor the company's performance and economy of the city. The different graphs regarding the performance of the company that can be depicted are coverage, popularity, monthly profit, company reputation, total debt and company value, which are drawn over time as the game is being played. Under the economy section, the following graphs can be shown which are an indicator of how well the economy within the game is doing: economic growth, electricity price, fuel price, city population, unemployment rate and private motoring. These graphs are a good tool to gather information before deciding to make a move in the development of the game. In addition to these graphs there are two rosters panel available to check: the vehicle roster and the stop roster. The vehicle roster panel provides a list of all vehicles of a certain type and their statistics, providing insights in how well each vehicle is performing. The stop roster panel shows a list of all stops and stations sorted by type, also with all their statistics.

In addition to the data regarding the company that can be showed within the game, there is also a map featured in the game which can show map data about the city itself. On the map can be displayed the type of building in the city (homes, workplaces, shops, leisure activities and government buildings) sorted by social group (all, blue collar workers, white collar workers, business people, students, tourists, pensioners and dropouts) and how well-used those buildings are by the selected social groups through a colour scheme. Red means that no citizens of the selected group use, live or work in a building, yellow means some and green indicate that the building is intensely used by the selected social group. Furthermore, the map can display the traffic density on the streets and how well buildings are covered by public transport lines.

4.9.2. Game mechanics

In order to create public transport lines, the player has to build the required infrastructure and vehicles. Whenever the player wants to build a stop for a line, a circle appears around the stop. This is

the area coverage the stop will cover once the stop has been built on a certain location. Citizens living in and just outside the area coverage of that stop can now make use of that stop and the attached line(s) to it. However, citizens will only make use of the public transport system if the citizens think that the public transport system will get them faster to their destination faster than their own car (Paradox Interactive, 2015d). Next, the player has to create the line using the line panel. Within the line panel, the player chooses the desired type of line the player wants to create, selects the first stop where to start the line and then selects every other stop he wishes to include in the line accordingly. To complete the line, the player selects the first stop again to create the loop the vehicles will run and selects in the vehicle managers tab the type and amount of vehicles used for that line. Once the line is completed and opened, the game will automatically run the line following the selected stops and using the selected vehicles.

Buildings are the most important features on the map within a game in *Cities in Motion*. The city can be represented by a complex open system. An open system is a system that consists of complex sets of connected parts that is in a state of constant flux (Allmendinger, 2009). The buildings in the game represent the nodes of the system, the movement of citizens from one building to another the interaction between the nodes. Each citizen can choose out of three options to get from A to B: walk, take the car or use the public transport network. When the player builds his public transport network, the player actually creates another system where the stops are the nodes and the vehicles running the lines the interaction between the nodes. How many citizens will use the line depends on the 'gravity' the different nodes (stops) have, which is determined by which and how many buildings that stop has covered, as each building has a certain function and amount of homes and/or workplaces. Long lines which cover factories, homes, parks, churches and large department stores will be more used than short lines that run only through residential building areas or just connect two factories with one another.

This system of nodes and interactions, however, is not the main reason why the game is complex. The complexity is created through changes within the game itself. Time is an important factor of this, as it does not allow the game to become static. Within the game, players play through simulated time. However, as time passes, the city changes (Paradox Interactive, 2015d). Citizens change jobs, more citizens enter the city and the city grows, private motoring booms around certain dates and at specified dates new vehicle become available. As time passes, vehicles get older. They become less reliable, break down more often and are getting less attractive for citizens to use. Also does the economy change throughout the simulated years. Unemployment rates can vary from year to year, as well as how much citizens are willing to spend on public transport and the costs for fuel and electricity. The player has to adapt to all these changes on time and accordingly in order to successfully expand and maintain his public transport network.

Citizens within the game are keen that the network has to be reliable, cheap and fast. Though each social group will react slightly different than the other to some extent, each group will get angry if the ticket prices are too high, if the vehicles condition is bad that they break down regularly and are unattractive and if they have to wait too long for vehicles to carry them to their destination.

Through the news ticker the player gets information about current events going on in the city. This can either be the introduction of a new advertisement method, general mood about the company or announcements about certain stops where a lot of citizens are unhappy about or where fires are taking place. When a building is on fire, the fire department closes down the road next to the building which causes delays in the schedules of the transport lines (Paradox Interactive, 2015d).

The game is furthermore complex as every action results in a reaction, either directly and/or indirectly. If the player for example changes the wages of its personnel, say that of the drivers, the direct consequence would be that the players' expenses are reduced. However, indirectly, drivers will

perform their job worse by leaving stops before everybody has entered the vehicle, resulting in angry citizens, full stops, lower reputation and less income. If a player wants to build a tram stop alongside a road instead of building it on the grass in the middle of a wide avenue, the player can trigger traffic jams by blocking cars on the roads. This effect can be extensive, especially when cross-sections or complex road constructions are in the vicinity. The player has to think ahead of his actions and come up with possible consequence if he wants to change something in the system. But even if the player could create the perfect public transit system, not everybody would use it. Citizens who work 'outside' the city (map) still take the car to get to their work, while other citizens prefer the car over public transportation in general (Paradox Interactive, 2015d), just as is the case in the real world.

4.10. *Cities in Motion 2*

Cities in Motion 2 is a mass transit simulation game (Paradox Interactive, 2013). It is the sequel to *Cities in Motion* and was also developed by Colossal Order and published by Paradox Interactive on the 2nd of April 2013. As in the first *Cities in Motion* game, the goal of *Cities in Motion 2* is to create a public transport system in a city, all the while completing (optional) goals and objectives, satisfying the citizens inhabiting the city and maintaining a healthy profit.

4.10.1. Game characteristics

As *Cities in Motion 2* is the sequel to *Cities in Motion* both games are relatively similar to one another. However, while *Cities in Motion*, although being a 3D game, is restricted by an isometric grid, *Cities in Motion 2* is a full 3D environment game. This means that the player is no longer restricted as to where he wants to place items. Infrastructure can be built however the player wants it to build. Another important difference between the first *Cities in Motion* and the second is that the ground layer system of *Cities in Motion* is gone. The player can place infrastructure and buildings at any height or depth, as long as there is a long enough ramp to support it.

The main goal of the game is the same as with *Cities in Motion*. The player has design and maintain a public transport network and not go bankrupt. Additionally, the player has to complete tasks to fulfil goals set out by the game to win the game, along with optional tasks that, when done, earns the player with a reward, if the player plays the campaign or a scenario.

Most of the transport modes have remained the same when compared with *Cities in Motion*. Busses, trams, metros and water busses/ferries are still present in the game. However, the helicopters from *Cities in Motion* have been taken out of the game and replaced by trolley busses. Each transport mode still requires its own form of infrastructure, but the game allows for more variation than its predecessor. As the player is allowed the construction of roads, normal roads, avenues, bus lanes and highway roads can be used as infrastructure for busses. Roads with (only) bus lanes and parking lots are desirable for busses as they allow for more space for the busses to operate. Trams and metros still require their own rail tracks to pick up passengers at stops and stations, but do not necessarily need their own tracks to ride on. Trams can make use of metro rail tracks and metros those of trams. However, tram tracks can only be constructed atop roads (in contrast to *Cities in Motion* where tram tracks could be built anywhere) while metro track can be constructed anywhere at any height. The player can decide where exactly on which lane of the road the tram tracks need to come (outer lane, centre lane, inner lane or in between the two directions of the avenue). Water busses/ferries have not changed: open water and piers are still the requirements for this transport mode to operate. Trolley busses need, alongside roads and stops, overhead electric cables (Paradox Interactive, 2013). The cables are built in the same way as tram tracks, on top of existing roads and can be built on any lane.

The budget panel has little changed in *Cities in Motion 2*. It still gives the player an overview on the financial status of the company, but does so now per week instead per month. The sources of income and expenditures remain the same. And while the vehicles have changed in texture and

amount of detail, the characteristic variables have also mostly remained the same, only now maintenance and energy costs are measured per 100km driven and instead of the maximum speed there are differences in the maximum acceleration of the vehicles.

Furthermore, the social groups from *Cities in Motion* are still present in its sequel, except for the social dropouts. The characteristics of each group and the behaviour of citizens have not changed in *Cities in Motion 2*. In addition, the ability to generate graphs and map have also remained. Performance of the company is displayed through graphs like graphs representing company reputation, weekly profit, network coverage and customer satisfaction, while the city's economy can be checked through graphs like city population, unemployment rate, energy prices and traffic density. The display of building types and usages on the map is also available again, with the same legend as in *Cities in Motion*: red for buildings with low usage of a selected (or all) social group(s), yellow for some and green for intense use. Traffic density and company coverage can also be shown on the map.

Where *Cities in Motion* was only a single-player game, *Cities in Motion 2* has a multiplayer option. Up to four players in total can participate in either a competitive or collaborative game mode, and up to six players can participate in a team competitive game mode with two teams of each three players.

4.10.2. Game mechanics

In order to create public transport lines the player has to build the required infrastructure and purchase vehicles to put the line in motion, just like in *Cities in Motion*. The method in building a line is in *Cities in Motion 2* the same as in its predecessor, with the exception that the line has to begin and end in a vehicle depot suitable for the kind of line the player wants to create, instead of beginning and ending with a stop or station.

However, a big difference appears in how the line is run by the game from the moment the line is opened for business. While in *Cities in Motion* the game would automatically run the line, players can in this game adjust the timetable to their liking, changing the interval of the vehicles for different parts of the day (weekdays, morning rush, evening rush, weekends and nights) and which preferred size of vehicle is selected (Paradox Interactive, 2013). This has to do with how the game simulates time. Instead of simulating time by counting a whole day at once as in *Cities in Motion*, *Cities in Motion 2* simulates time by using minutes and hours as counters. The game runs, at least where time simulating is concerned, at a slower pace, using a full day and night cycle within the game.

A game within *Cities in Motion 2* is representable as a complex open system, as buildings still remain the most important features on the map in being the nodes of that system, and the movement of citizens as the interaction between the nodes. How well the system works depends on the players' choice where to build stops and stations to create enough "gravity" that enough citizens use the public transit system to make its existence economically affordable. In addition, the more lines that cover an area, the more attractive that area becomes, resulting in a more densely build area inhabiting more citizens. However, new roads have to be constructed in order to make the city really grow, as new buildings will spawn alongside the empty spaces of the new road.

Much of the game mechanics in *Cities in Motion 2* are the same as described previously in *Cities in Motion*. The social groups have to be satisfied or citizens will get angry at the company, decreasing its reputation. Vehicles have to be properly maintained as they get older and worn through (intensive) use. The economy of the city will change for the good or the bad through time. Ticket prices and personnel wages have to be changed accordingly. Through the message panel the player gets informed whether a vehicle as broken down or a depot has not enough vehicles to maintain the time schedule set out for said line. Traffic jams can occur when the player has not anticipated or monitored a sudden rise in private motoring or an extra flow of traffic during rush hour, and not taken proper action on this by, for example, widening certain roads, changing the lanes on where trams, busses and trolley busses drive or separate the public transit infrastructure all together from the regular infrastructure by building bus lanes, ensuring that the vehicles do not get stuck in traffic jams.

Table 5 concludes this category of games, depicting an overview of the games analysed that focus on infrastructure planning. Cities In Motion 2 is ranked highest of the three for suitability in decision-making processes. This is due to the ability to construct a wide variation of roads and tracks in the game, a feature that is missing in the first Cities in Motion, but without the aim to make a profit as large as possible, as is the case in Transport Tycoon. In addition, Cities In Motion 2 integrates more aspects of public transport into the game as overcrowding of vehicles and time schedules. Furthermore, the game can be more easily adapted to specific desires of the players. However, as the main focus of the game is on transportation of people rather than infrastructure, as is the case in the other two games as well, it is only ranked highest in this category due to the before mentioned extra abilities when compared with Cities In Motion and Transport Tycoon. In the next paragraph the last category, the grand strategy planning games, will be discussed.

	Game Engine	Game World	Complexity	Realism	Easy to play	Co-operative gameplay	Player made content	Mobile version available	Suitable for decision-making
Transport Tycoon	2D	Square grid	+/-	+/-	+/-	+/-	+	Yes	-
Cities in Motion	3D	Square grid	+	+	++	n/a	n/a	No	-
Cities in Motion 2	3D	Open	++	++	+	++	+	No	+/-

Table 5: Summary Transport Tycoon and Cities in Motion series.

4.11. Civilization V

Sid Meier’s Civilization V is a grand strategy game released in September 2010 (Take-Two Interactive Software, 2010a). It was developed by Firaxis Games (IGN, 2010) and published by Take-Two Interactive. It is the fifth title in the Civilization series. The goal of the player is to create an empire to become ruler of the world.

4.11.1. Game characteristics

Civilization V is a turn based strategy game. This means that the players take turns in rounds: a player can only take action during his turn. This in contrast to real time strategy games, or RTS-games, where every player can simultaneously take action(s) against other players. Civilization V is played on a field of hexagonal tiles, though it is run on a 3D game engine (Take-Two Interactive Software, 2010b). Each represents real world landscapes as deserts, hills, plains, seas, lakes, tundra, snow and mountains and has certain characteristics. These characteristics are valuable to the development of cities founded by the player, as they provide the resources needed to develop an empire. The resources are: food, production and gold (Take-Two Interactive Software, 2010). Some tiles only bring out one of these resources, others a combination. Next to these ‘normal’ resources, some tiles produce luxury, strategic or bonus resources. Luxury resources provide more happiness to the empire, for example cotton, dyes, gold and silk. Strategic resources allow the construction of certain units and buildings: horses, aluminium and coals are examples. Bonus resources boost the food and gold output of a tile: examples are bananas, cattle and wheat.

Using Settlers, a player can found a city. Once a desirable location has been found on the map and a city has been found, the player has the ability to build units, buildings and wonders (Take-Two Interactive Software, 2010). Units can be moved across the map. There are two types of units: combat and non-combat units. Combat units make up the army of the player, consisting of melee units like swordsman, ranged units as cannons, naval units such as battleships, air units as bombers and missile units as atomic missiles. There are however only four types of non-combat units: settlers, used to found new cities; workers used to develop the tiles around a city to enhance or alter its characteristics; work boats, used to fish and extract sea resources and great people, which can contribute significantly to the players' empire in various ways. The buildings in a city help to improve and upgrade a city the player has founded. Buildings as granaries improve food production in the city, while libraries improve in the research of new technologies and barracks improve the units trained in the city. Wonders are the most expensive buildings to construct: however, once constructed, they provide the civilization with great advantages. Every wonder is unique and can only be built once per game.

Before the start of every game, the player can choose from a wide range of civilizations to play with. Every civilization has its own unique characteristics: some have unique units, as the British longbow men or the German panzer, others have unique buildings as the French castle while others have other advantages as longer sight ranges or faster training rates (Take-Two Interactive Software, 2010). The player has five ways to win a game. Victory can be achieved through either: domination victory, where the player is the last one to possess his own capital city: science victory, being the first player to construct a space ship; cultural victory, by completing several social policies trees; diplomatic victory, when the player is chosen as being the world leader through voting and score victory, when the player has the highest score at the end of the game but has not accomplished any victory as described.

4.11.2. Game mechanics

One of the most important goals in the game is to grow cities. However, city growth depends on a couple of factors. Obviously, a city needs enough food to grow (Take-Two Interactive Software, 2010). Every citizen in a city consumes 2 food. Food is produced in the lands around the city that are being cultivated. At the end of every turn, the food surplus (if there is any) is collected in the city growth bucket. Once a specific amount is reached, the gathered food is converted into a citizen and the process starts over again. If not enough food is gathered that even the citizens have not sufficient food to eat first, the population will diminish as the result of starvation. In order to improve food production, buildings can be constructed and technologies researched. Buildings are constructed over time. How much time depends on how productive the city is. Productivity is generated through the land surrounding the city (mines/quarries etc. generate a lot of productivity) and certain buildings in the city as factories (Take-Two Interactive Software, 2010). If a building costs for example 100 productivity to construct and a city generates 25 productivity per turn, 4 turns are required to construct the building. In addition to productivity, buildings cost gold to construct. Gold can be acquired through working the land tiles around the city, certain buildings in the city, conquering other cities and through trade with other civilizations (Take-Two Interactive Software, 2010). Next to construction costs, gold can be used to buy units and buildings instantly, with the exception of wonders.

Several other factors do also play a part in the growth of cities and the civilization. Happiness represents the contentment of the citizen's contentment in the players' civilization (Take-Two Interactive Software, 2010). There are three levels of happiness: normal, unhappy and very unhappy. Normal has no side-effects, but when the citizens are unhappy, cities grow significantly less fast and a very unhappy population affects the fighting rates of army units as well. The larger the population and the more cities a player possesses, the more unhappiness is created. Happiness is created by buildings,

luxury resources, wonders, social policies and technologies. When a population has been happy enough for a long enough time, a Golden Age is started. Productivity and research rates are increased during that time. Culture is a measurement of the players' civilization's commitment and appreciation to the arts and humanities (Take-Two Interactive Software, 2010). It allows for the expansion of the cities' territories in the players' civilization and purchases of new social policies. Social policies represent the way the player wants to govern the people. Through authorial means, with increased productivity but little freedom or militaristic, providing bonuses for combat units for example? Each social policy is purchased through culture points, which are accumulated over time. Every social policy has certain characteristics that can boost the players' civilization. Technology allows for new units, buildings and wonders to construct and provides bonuses to the civilization, enabling it to become more powerful, smarter and bigger (Take-Two Interactive Software, 2010). New technologies are researched over time: each turn the player amasses a certain amount of science points. Same as with productivity, a technology research is completed once enough science points have been contributed to that technology. The amount of time to research a technology depends on how much science points the player amasses every turn. The accumulation of science points can be increased by constructing certain buildings, like libraries and laboratories, and through the research of technologies that bring new research methods with them.

Within a game of Civilization, the player can interact with other civilizations. These can be controlled by either other real players or by an artificial intelligence. Trade can occur, as well as wars, defensive pacts and declarations of friendship between civilizations (Take-Two Interactive Software, 2010). Through the diplomacy menu, players can initiate diplomacy with other leaders. Every leader has his own characteristics: he can be honest or be a liar, be fair or cruel. Through negotiations deals can be hammered out, providing advantages to the negotiated civilizations over other civilizations. Next to other major civilizations there are city-states. City-states are small political entities in the game. As the name says, they consist of only one city with a small area of influence. City-states are not able to win a game, but they can assist the player, and other leaders, in their path to victory. City-states may provide tributes, trade benefits and votes when electing a world leader.

4.12. Forge of Empires

Forge of Empires is a strategy game developed and published by Innogames (Seven Games, 2012). It went into the open beta phase on April 17th, 2012, launching the game and making it available to play. Initially, the game was only browser based but as of 2013 and 2014 it was made available for mobile platforms also, being iOS and Android respectively.

4.12.1. Game characteristics

Forge of Empires is a browser game: players play online on one of the servers running Forge of Empires. This means that players have to create an account and have an internet connection in order to play. The game itself is runs on a 2D isometric grid engine. The goal of the game is for the player to create a city and guide it throughout the ages up until the future era. (InnoGames, 2016). At the start of the game, the player has been given limited ground to build upon but which can be expanded later in the game. In order to construct buildings, the player has to collect coins and supplies, which are produced by residential and production buildings. These then can be used to construct new buildings to develop the city. Residential buildings provide citizens, which in turn are necessary to construct production buildings. Next there are decorative buildings which provide happiness for the citizens, while military buildings allow for the construction of soldiers. Last, there are the Great Buildings: these are buildings that, though expensive to construct, provide the player with a passive and an active benefit. These can be for example a boost in population or extra supplies or medals. Only when a player has all nine blueprints he can construct the Great Building. To connect all buildings with one another, roads have

to be laid out on the map.

In addition to coins and supplies, the games' most important resources, there are goods. Goods are used for trade and negotiation in the game, but also to expand into other territories in the single player campaign. Next are medals: medals are used to increase the space of the land whereupon the player can build his city. However, in contrast to the previous resources, medals are not gathered or produced but earned. Medals can be earned by winning Player versus Player tournaments or when the player aids in the construction of a Great Building. Forge points are necessary to research technologies: while they are generated for free, the rate of generation is only one per hour. Last, there are diamonds. Diamonds can only be earned by successfully completing quests or through the purchase of real money. Diamonds can be used for almost everything: construction of buildings, expanding of space, faster training or production times and researching technologies to name a few.

The game has both a single player and a multiplayer aspect. In the single player campaign, the player can conquer a continent, using both combat and trade to acquire new lands. Conquering new lands gives the players rewards to boost construction of his city. The multiplayer aspect lies in attacking or aiding neighbouring cities of other players, through winning tournaments or helping to build Great Buildings respectively. The player receives for both actions medals which in turn are used to expand the build space of the players' city.

4.12.2. Game mechanics

The time perception in Forge of Empires is fundamentally different from the other games previously handled. In Forge of Empires, the game uses the real time as measurement of passing time rather than an artificially constructed one. As a result, the game can be played significantly longer, but progress is also slower. For instance, a forge point is only generated once per hour. The same is for the other resources: players have to wait a certain amount of time before a good is produced or coins can be collected. In addition, everything in the game has to be collected manually by the player. It is required to be online and in the game to collect resources: if the player is not, the resources automatically generated will stop to increase at a certain point until the player has collected them.

Buildings have to be connected with the town hall. If a building is not connected by a road to the town hall, the building will not produce anything, effectively making it useless. In addition, the player has to provide enough happiness for the citizens: if a population is happy enough, the player receives gold and supply bonuses. In production buildings, items can be manufactured. These cost time and certain resources, but enables new goods and progression. This is representative for the game: every resource can be obtained (with the right actions taken) if the player only waits long enough. A player can always play the game, though some players play more slowly as a result while others manage their city more effectively and advance faster, both in their city's development and overall progress. To boost the gameplay, the player has the option to buy diamonds: with it, the player can quicken processes fast or obtain new items or buildings instantly but at the cost of real money.

As Forge of Empires is a browser based game, with a large number of people sharing a server, the game compares the players' progress through the game with other players using a score. With the score, the ranking of the player is calculated and depicted in the game. Thus, the player can compare himself with other players and try to best them. It is up to the player how: either to aid or attack other players. Both are rewardable: if a player aids another player, he receives a reward. However, if a player attacks another player it depends on the military units used who will the battle, and how the players fight the battle on the battlefield. If the player is victorious, he is able to plunder a building in the losers' city, possibly acquiring a greater reward than if the player would have helped the other player.

4.13. Grepolis

Grepolis is a strategy game developed and published by InnoGames (IGN, 2016c). It was released in 2012. Like Forge of Empires, it is available through the use of a web browser and by the apps available in the App Store and Google Play Store.

4.13.1. Game characteristics

Players need to have an account in order to play the game, either through a web browser or by one of the apps available for smart phones, as the game is played on online servers. The goal of the game is to construct and develop a Polis and to conquer the game-world, starting with gaining dominance of the starting island of the player and eventually other islands as well (InnoGames, 2016b). Grepolis runs on a 2D engine, with some 3D effects in it. The map on which the player plays is fixed: there is no square grid present, the building locations are fixed.

The player starts with one small polis. Only a senate, a farm and a warehouse are constructed at the beginning. The player has to build a silver mine, a lumber camp and a stone quarry in order to enable further growth of the city, as these buildings provide the necessary resources for construction: wood, stone and silver. Not only are these resources used for buildings but for units as well. Every building starts at level 1. However, buildings are upgradable: when the costs for the upgrade are paid and the building has been upgraded after a while, the characteristics of the building have been improved. For instance, the silver mine will produce more silver per hour while a senate with a higher level unlocks new buildings and units to construct. The resources are stored in the warehouse: however, it has only a certain storage capacity per level. If that capacity is exceeded, the generated resources which cannot be stored are lost.

The player has the ability to raid or conquer farm villages on the island. Once these villages are under the influence of the players' polis, he can demand tribute from the villages at certain time intervals or send out military units to plunder the village. In addition, the player can attack other players on the same island. Multiplayer gameplay is an important characteristic of the game: the player can create or join alliances with other players in order to better defend himself against other players. Sometimes players are given certain positions inside the alliance. Alliances can initiate declarations of war, non-aggressive pacts and friendships with other alliances.

Each building has its own function in the polis. The senate allows the construction of other buildings. The silver mine, lumber camp and stone quarry provide the resources needed to develop the polis and maintain an army. The farm can sustain a certain amount of people as a population, while the warehouse stores produced resources. In the barracks new military units can be trained and in the harbour ships can be built. The city wall provides a defensive bonus if the city is attacked. The academy allows the research of new technologies while the market place allows trade between players. The cave is necessary for espionage. With the temple, a god can be worshipped, providing favours of the gods to boost the polis: better training rates, higher production rates or the recruitment of heroes. Gods play a significant role in the game as they can tip the balance in battles between players and boost overall development of the polis. The gods each have their own characteristics, though only can be selected at the same time. The player can choose from: Zeus, Athena, Hera, Poseidon, Hades and Artemis.

4.13.2. Game mechanics

In Grepolis resources are generated over time. However, like Forge of Empires, the game uses real time instead of an artificially constructed simulated time. It extends the amount of time that the game can be played significantly but also means that it takes longer for a player to progress in the game. As a result, resources are generated per hour in the game. The amount of resources depends on the level

of the resource production buildings: the higher the level, the more resources are generated. The same goes for building buildings and training units: the higher the level of the senate and the barracks, the faster buildings are build and units trained. In addition, levelling up buildings unlocks the construction of buildings and training of new units.

To boost the city, the player has the ability to hire experts who aid in the development of the city. There are five available experts: the administrator, the trader, the high priestess, the commander and the captain. Each expert has his own advantages, like constructing buildings faster, generating more resources or providing additional strength to the military troops. However, these experts can only be hired for fourteen days, and are paid with gold coins. Gold coins is the games’ premium resource and can only be purchased using real money. After the fourteen days the player loses the hired expert and has to hire him again if he wishes to continue having the benefits the expert provides.

In the game alliances can be created and joined by the players. If a player joins an alliance and is accepted by it, it is much less likely the player is attacked by other players looking for an easy prey. As the player is now a member of an alliance, he can draw on support of his alliance, by for example asking for military or economic aid in the defence of his city. Within an alliance, players can coordinate their actions to other players better. Within an alliance, each player may have a different role he can play, for instance recruiters and diplomats. A hierarchy can be established, giving more rights to the higher positions in the alliance and less rights to the lower positions. Alliances can exercise diplomacy between on another through the establishment of non-aggressive pacts, declarations of war and covenants.

Table 6 summarises the games discussed in this last category. None of the games analysed in this category are truly suitable for decision-making processes, due to a lack of relevant planning mechanics as a result of a focus on other aspects within the game. Even though Forge of Empires and Grepolis are designed and played by thousands of players, certainly bringing potential to decision-making processes concerning public participation approaches, these games revolve primarily about conquest and competition (with only a certain degree of co-operation in the forms of alliances) rather than constructing and designing cities. This is more the case in Civilization V, where the design of cities plays a more important role in the progression of the game. A complete overview of all the games analysed in this chapter will be provided in the next paragraph.

	Game Engine	Game World	Complexity	Realism	Easy to play	Co-operative gameplay	Player made content	Mobile version available	Suitable for decision-making
Civilization V	3D	Hexagonal grid	++	+/-	--	++	+	No	-
Forge of Empires	2D	Square grid	+	-	-	+	n/a	Yes	--
Grepolis	2D	Fixed	-	--	+	+	n/a	Yes	--

Table 6: Summary Civilization V, Forge of Empires and Grepolis.

4.14. Overview

Table 7 provides a total overview of all the games mentioned in this chapter, presenting the characteristics and the strong(er) and weak(er) aspects of each game analysed in this research.

Game	Game Engine	Game World	Complexity	Realism	Easy to play	Co-operative gameplay	Player made content	Mobile version available	Suitable for decision-making
SimCity Classic	2D	Square grid	+/-	+/-	++	n/a	n/a	No	--
SimCity 2000	2D	Square grid	+	+/-	+	n/a	n/a	No	-
SimCity 3000	2D	Square grid	+	+	+	n/a	+/-	No	-
SimCity 4	3D	Square grid	+	+	+	n/a	++	No	-
SimCity	3D	Open	++	+	+	-	+	Yes	+/-
Cities XXL	3D	Open	+	+	+/-	n/a	+/-	No	-
Cities: Skylines	3D	Open	++	++	+	n/a	++	No	+
Transport Tycoon	2D	Square grid	+/-	+/-	+/-	+/-	+	Yes	-
Cities in Motion	3D	Square grid	+	+	++	n/a	n/a	No	-
Cities in Motion 2	3D	Open	++	++	+	++	+	No	+/-
Civilization V	3D	Hexagonal grid	++	+/-	--	++	+	No	-
Forge of Empires	2D	Square grid	+	-	-	+	n/a	Yes	--
Grepolis	2D	Fixed	-	--	+	+	n/a	Yes	--

Table 7: Summary city building simulation and strategy games.

Chapter 5 – Results

5.1. Game analysis

Based on the games selected and described in the previous chapter, a game analysis has been conducted, identifying the most prominent changes city building simulation and strategy games have gone through the past two decades. The changes found will be described in this section of the thesis.

5.1.1. Increased complexity

City building simulation and strategy games have become more complex. Wenzler (2008), as mentioned before, has identified four elements of complexity in game simulations, being context, players, process and environment. Each of these dimensions has changed in some way since the beginning of city building simulation and strategy games, increasing complexity. Context wise, the nature of the game models has shifted from primarily 2D isometric engine to full 3D engines (see figures 3-6). Where SimCity Classic started with a top down 2D view in 1989, its successors SimCity 2000 and SimCity 4 introduced the 2D isometric view and 3D isometric view in 1994 and 2003 respectively. In the past decade full 3D engines have emerged in games as Cities XL, SimCity and Cities: Skylines. With this development players now have much more freedom to design their cities as the isometric grid (of tiles) no longer restricts building orientation or size. In doing so, playing the game simulation has become more difficult since players have to place buildings, roads and items themselves instead of just designating (filling up) pre-generated squares.

In addition, players have gained more options to construct buildings, infrastructure and items. Where players had no choice of different streets and RCI-zones in SimCity Classic, players can now choose from a plethora of different streets, roads and avenues, as well as new zones as offices and agriculture but also adding different densities to the classic RCI-zones (figures 7 & 8). The same applies to Cities in Motion: where in the first edition no roads could be built, in the second instalment players have a wide range of different roads and variations to choose from. The amount of buildings a player can construct has also increased: not only by adding new buildings as a series progresses but also introducing different sizes and variations of a type of building. For example, from only one type of police department to small, large and special variations of the building between SimCity Classic and SimCity (figures 9 & 10), as well as introducing clinics and hospitals as the series progressed.

As a result of the before mentioned trends, the amount of game mechanics has increased as well. Due to new elements in the games, new mechanics had to be designed in order for the games to operate successfully. Players have to take into account more factors of the game now than twenty years ago. Money and space are no longer the only factors: happiness, safety, pollution and location and treatment of raw materials, to name a few, have become more and more standard in city building simulation and strategy games throughout the years. This is in part due to the trend of realism: the games are becoming more and more realistic. Citizens and goods have to be transported across the map (figures 11 & 12). For example, power plants no longer receive their resources out of thin air but have to be supplied with resources in order to produce power. Without the necessary amount of resources, the power plants will not produce power, leading to a power shortage which results in citizens moving away as one of their basic needs cannot be met. Water has to come from a fresh water source without contamination: otherwise, contaminated water will be pumped around and the citizens' get sick. Vehicles require maintenance and consume energy, while the driver's wage needs to be paid. However, the trend of realism only goes so far: at all times, the game has to be playable and fun to be played in the first place, as the game is a game simulation, and not only a simulation on itself.

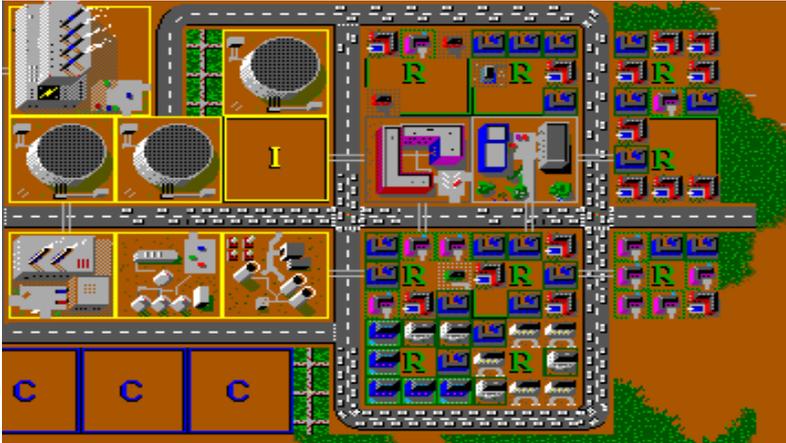


Figure 3: SimCity Classic engine.



Figure 4: SimCity 2000 engine.



Figure 5: SimCity 4 engine.



Figure 6: Cities: Skylines engine.



Figure 7: RCI-zones in SimCity Classic.

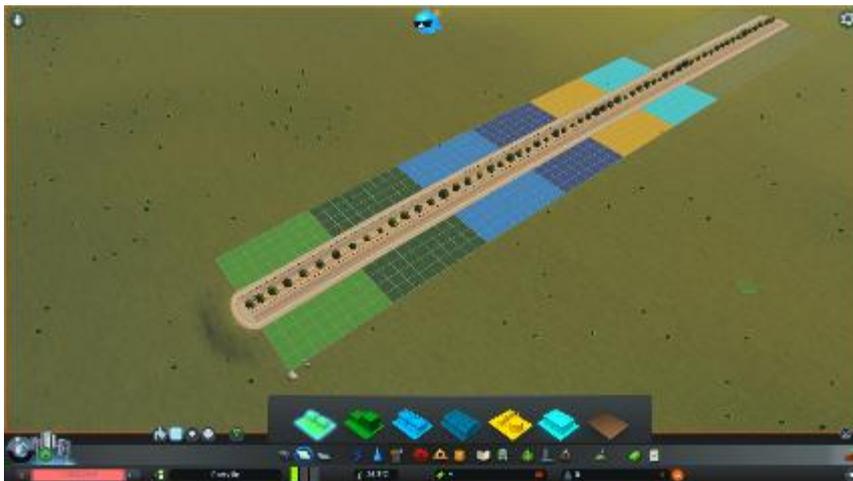


Figure 8: RCI-zones in Cities: Skylines.



Figure 9: Police department in SimCity Classic.



Figure 10: Police departments in SimCity 4.

OpenTTD Industry/Commodity Flow Chart - Temperate

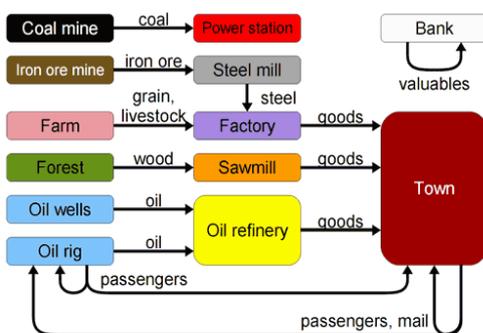


Figure 11: Open TTD industry flow chart (OpenTTD, 2011)

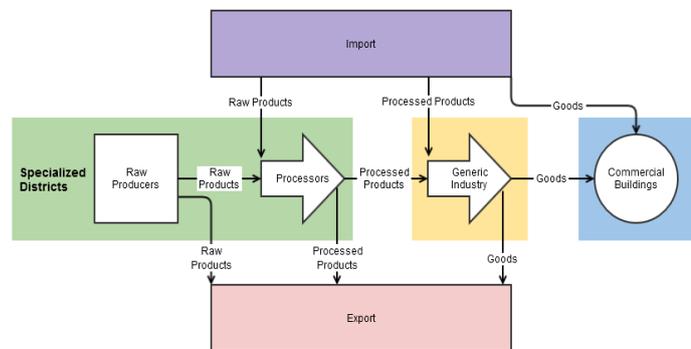


Figure 12: Cities: Skylines Production Chain (Drushki, 2015)

5.1.2. Increased co-operative functions

Co-operative functions are not new to games. Most games have some form where players can team up or contest with one another. However, co-operative functions in city building simulation and strategy games are relatively new, as the orientation has predominantly been on the single player function. Only some city building simulation and strategy games released in the past five years have a co-operative function as a result of the rise of the internet the past decade, though even then it is more often than not a limited form of multiplayer. For instance, SimCity allows to share a region on a server with other players, but players still claim individual city maps where only the player can build on. While other players can visit the city, it is impossible for anybody other than the claimer to change anything on that map. The only collaboration within the game is the shared effort in the construction of great works, where players can pool their resources to gain mutual advantages. Civilization V also has a multiplayer function and allows players to play on the same map, but players can only control the cities they own. However, it is possible to conquer or trade cities with other players. The same applies to Forge of Empires and Grepolis, but as these games are primarily focused on the multiplayer aspect (there is no single player function) they have far more players that can interact with one another than Civilization V can. Yet the primary goal of Forge of Empires and Grepolis is building a great city in order to support an army to conquer other players, while Civilization V does not necessarily forces the player to do so: the cities stand on itself and do not exist only to provide an army. The best co-operative functions can be found in Cities in Motion 2 and Open Transport Tycoon Deluxe. These games allow players to play on the same map, both individually and as a team. In addition, these maps can be changed to the players liking with the construction or removal of infrastructure and the sequential change of the city.

5.1.3. Changed monitoring tools

The monitoring tools, necessary for every player to successfully design, build and maintain a city in a city building simulation and strategy game, have undergone some changes throughout the years as well. Not only has the amount of data that can be showed in the game increased greatly, it is no longer predominantly presented in charts and graphs. Though still a much occurring feature in the games, for instance in the early SimCity games, Cities XXL and Civilization V (figures 13, 14, 15), the newer games as SimCity, Cities in Motion 2 and Cities: Skylines present their data to the player as a lay-over on top of the game map (figure 16), presenting the intensity and location of issues simultaneously. Players thus are better informed where problems originate from and can better deal with them as a result of this shift in displaying data and information as a consequence of these change in monitoring tools.

5.1.4. User made content and game customisation

When players are really enthusiastic about a game, there cannot be enough content in a game to play with. Already for SimCity 3000 user made content was created by players who wanted to add more functions, buildings and items to the game. For SimCity 4, some extensive user made modifications were made, such as the Network Addon Mod which has been downloaded almost 300,000 times (Simtropolis, 2016). However, additional content took flight with the Steam Workshop, a community utility of the digital distribution platform Steam (Valve, 2015). The Steam Workshop was first used to distribute updates and patches of games more easily to all users owning a certain game, but was later extended to share user made content of games as well. The first game using this feature was the game The Elder Scrolls V: Skyrim in 2012, but since then the amount of games using the workshop has risen to 383 (Steam, 2016a). Cities: Skylines has 81,122 items in the workshop (Steam, 2016b), Cities in Motion 2 has 1,027 items (Steam, 2016c), Cities XXL 99 items (Steam, 2016d) and Civilization V has 5,929 items (Steam, 2016e). Items range from maps, units, buildings and terrains to new artificial players, factions, resources and rulesets. With the Steam Workshop, players are able to add self-made

content to the game and share it with other players, as well as subscribing to content of others, gaining the ability to (easily) change and customise the game to one's own liking. It is even possible to replicate real world environments and buildings and use these in a game itself, like the environment of Oakland, California (figure 17), the Rijksmuseum in Amsterdam (figure 18) and trains used in the Netherlands (figure 19).



Figure 13: SimCity Classic monitoring tools.

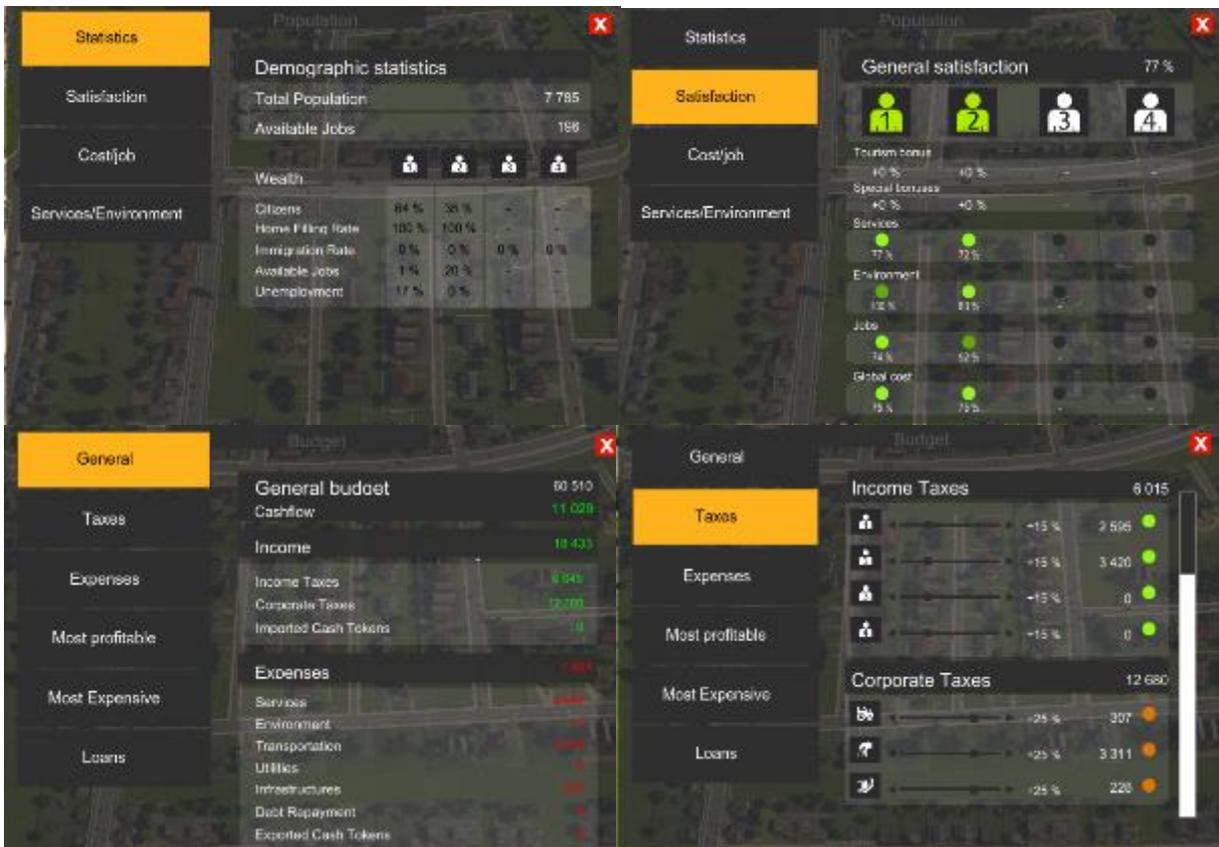


Figure 14: Cities XXL monitoring tools.



Figure 15: Civilization V monitoring tools.



Figure 16: Cities: Skylines monitoring tools.



Figure 17: User made map of Oakland, California for Cities in Motion 2 (rawocd, 2014).



Figure 18: User made building of the Amsterdam Rijksmuseum (Epic Lurker, 2016).



Figure 19: User made vehicle NS ICM "Koploper" (Acc3ss violation, 2015).

5.1.5. Emergence of mobile gaming

Games become increasingly more mobile through the use of apps on smartphones and tablets. The genre of city building simulation and strategy games are no exception. Mobile versions of the web-based games –Forge of Empires and Grepolis- were launched relatively fast after their initial launch on the internet. With these apps, players are now capable to play the game almost everywhere at any time. Managing the city becomes easier as a result: the player can immediately give new orders once the previous issued orders are executed. Mobile versions have also been created for Transport Tycoon

and the latest version of SimCity. These versions are however no exact copies of the original games but are adaptations. SimCity, for instance, has been simplified to allow for better gameplay on mobile screens which are devoid of cursors and the external hardware needed to operate them. The tile grid pattern has returned as well as the square building construction sites. In addition, the game tends characteristically to Forge of Empires, as players now have to collect taxes (in the form of coins) themselves and need to produce and collect building materials themselves before a new building can be constructed. A premium resource, Sim money, has been added as well, to boost production, construction and unlocking new items. Transport Tycoon has chiefly only graphically changed. Roads and rail tracks are for example curved in the bends and buildings, roads, rail tracks, trees and the landscape are more detailed.

5.1.6. Final remarks

Though these described trends are appearing, not all games follow all of them. For instance, Forge of Empires and Grepolis still use a 2D-engine, being a web-browser game with the focus to attract as much people as possible willing to play the game. Making certain standards of equipment, such as processors and video graphics cards, a required necessity to play the game raises the threshold for people to play a game. It is therefore logical for the developers of Forge of Empires and Grepolis to use 2D engines as it will not contradict the goal of attracting as much people as possible. In the end, it is up to the developers whether or not certain trends will be followed, being subjective to their judgement if the game will benefit from such a feature in realising their vision for the game.

5.2. Experiment

The results of the experiment and the questionnaire will be described in this section of the thesis. Firstly, there will be some general aspects discussed about the questionnaire, followed by a comparison of the results of before and after the experiment and lastly found connections between different aspects researched in the questionnaire.

5.2.1. General aspects

Table 3 depicts the descriptive general results of the questionnaire. The first series of tests were done to see whether general aspects of the participants have a significant relationship with the frequency and duration of playing games. In addition, it was tested whether frequency and duration of playing games would influence the likelihood that the participants had played Transport Tycoon or a similar game before.

The average age of the participants was 20,9 (N=45). A Fisher-Freeman-Halton test (IBM, 2014) was conducted to determine whether men play

Statistics

Statistics are used to examine, summarize and draw conclusions from data. Different types of data can be distinguished: nominal data, data consisting of unique values; ordinal data, data which can be meaningfully ranked and ratio data, data where the distance between the values is meaningful. There are a lot of different statistical tests which can be used, but each tests only works with a certain type or combination of types of data. All the data gathered from the questionnaire is of the ordinal type, with the exception of gender, whether the participant has played Transport Tycoon or a similar game before, which are nominal data, and age, which is ratio data. As a result, the tests used in this research were the Fisher-Freeman-Halton test and the Wilcoxon matched-pairs signed rank test, as both tests allow ordinal variables to be used. When the p-value is lower than 0.005, a test is statistical significant, meaning that the variables have a statistical relationship. The open evaluation questions at the end of the questionnaire were left of the statistical analyses.

Box 2: Statistics (Norušis, 2011).

more often strategy games than women. The test had a non-significant outcome, $p=0.130$, meaning that there is no difference in frequency of playing a game between men and women. The same test was conducted to determine if males, when they play, also play longer per session than females. Again, the test was not significant, $p=0.187$. Men do not play longer than women in a play session.

However, when the frequency of playing strategy games was compared with whether similar games like transport tycoon were played, the outcome of the Fisher-Freeman-Halton test was significant: $p=0.022$. Players who play strategy games more often are more likely to have played a game similar to Transport Tycoon Deluxe. This is not very surprising, as Transport Tycoon is a strategy game. People who play more frequently strategy games have a higher chance of encountering a strategy game similar to Transport Tycoon. Lastly, the same test was executed to investigate if people who play longer during a play session were also more likely to have played a game similar to Transport Tycoon. The result of the test was not significant, $p=0.066$. People who play longer during a session are not more likely to have played a similar game to Transport Tycoon than people who play for a shorter amount of time. Striking in table 3, especially for students of the course planning and infrastructure, is the amount of people who have played Transport Tycoon before: only two have. This could be due to the age of the game, as the game originates from 1994, possibly explaining the lack of familiarity of the game among the students.

		N	Percentages
Gender	Male	34	75,6
	Female	11	24,4
Age	19	11	24,4
	20	14	31,1
	21	8	17,8
	22	7	15,6
	23	1	2,2
	24	3	6,7
	33	1	2,2
Frequency of playing strategy games	Seldom/never	27	60,0
	Once a month	8	17,8
	1x-3x a week	7	15,6
	4x-7x a week	3	6,7
Duration of one play session	<30m	10	22,7
	30m	4	9,1
	1h	10	22,7
	2h	12	27,3
	3h	5	11,4
	4h	1	2,3
	>4h	2	4,5
Played Transport Tycoon before	No	43	95,6
	Yes	2	4,4
Similar games played	No	27	60,0
	SimCity	8	17,8
	Cities: Skylines	4	8,8
	Cities in Motion 2	2	4,4

	Cities XL	1	2,2
	Metropolis	1	2,2
	Railroad pioneers	1	2,2
	Transport Giant	1	2,2

Table 8: Descriptive results of the general aspects of the questionnaire.

5.2.2. Before and after experiment results

Figures 19 to 33 show the results of the questionnaire taken before and after the experiment. Each of the graphs represent the amount of answers given to a particular question asked in the questionnaire. The respondents had to answer whether to which extend they agreed with the statement or not. The graphs represent the answers given. In Appendix D the descriptive statistics belonging to these questions can be found. The figures show that most participants in the experiment answered either agree or neutral towards most questions presented to them, both before and after the experiment. The exceptions are depicted in figures 23, 26, 28 and 32 where at least 20% of the participants either before or after the experiment responded disagree towards the question. Figure 31 is a reversed question where the outcome is also negative as more than 20% of the participants agreed with the proposition.

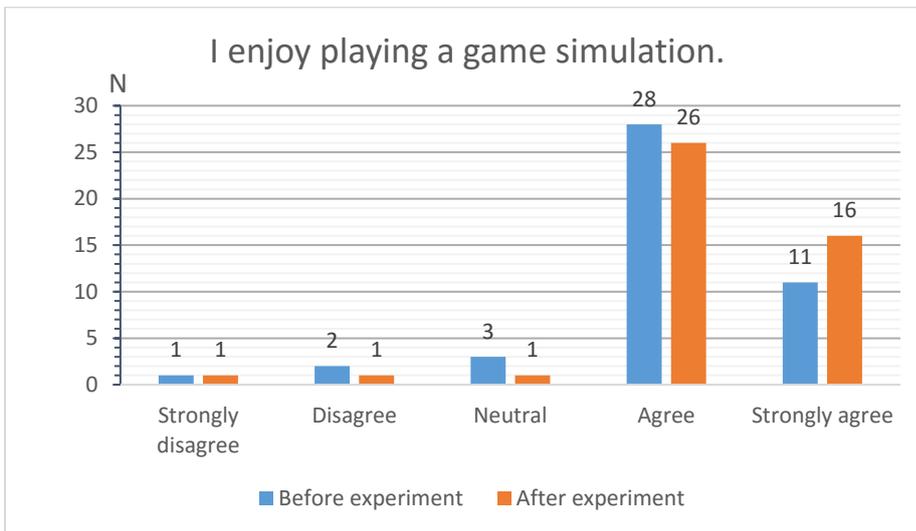


Figure 20: Result graph "I enjoy playing a game simulation".

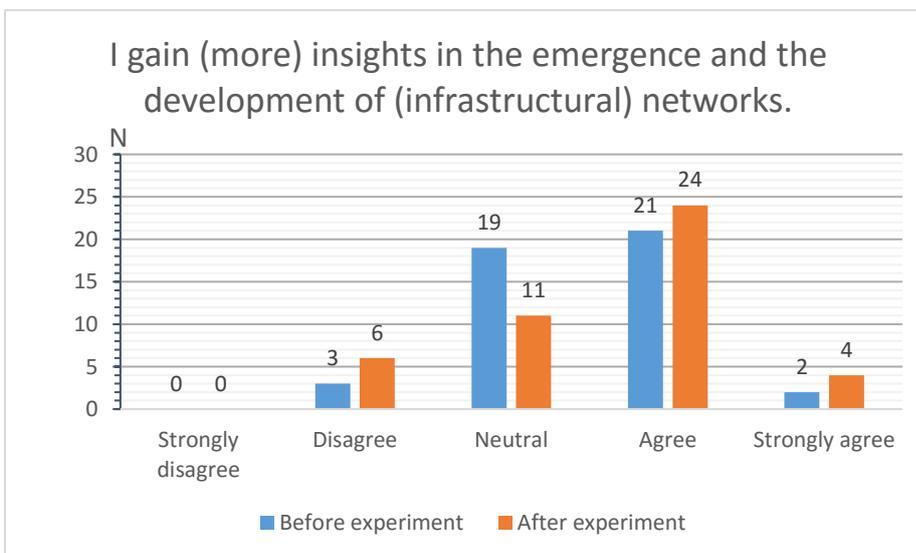


Figure 21: Result graph "I gain (more) insights in the emergence and the development of (infrastructural) networks".

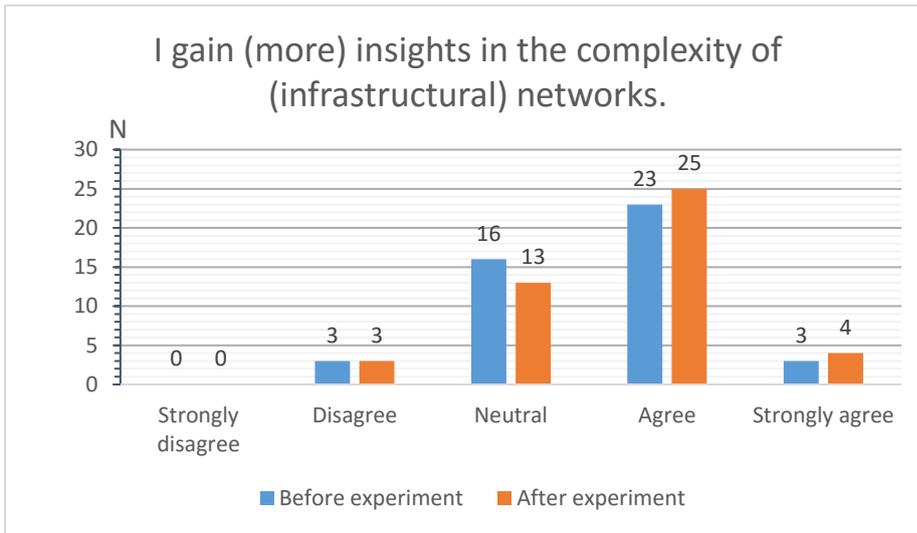


Figure 22: Result graph "I gain more insights in the complexity of (infrastructural) networks".

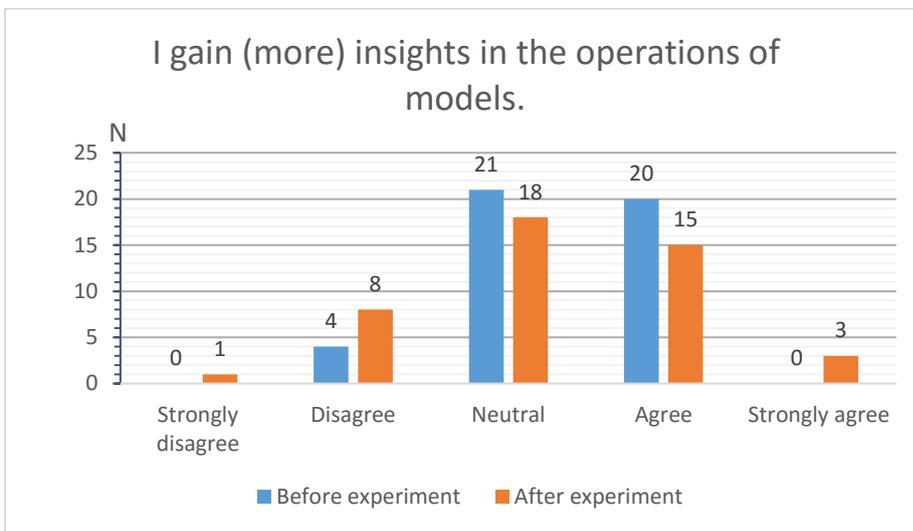


Figure 23: Result graph "I gain (more) insights in the operations of models".

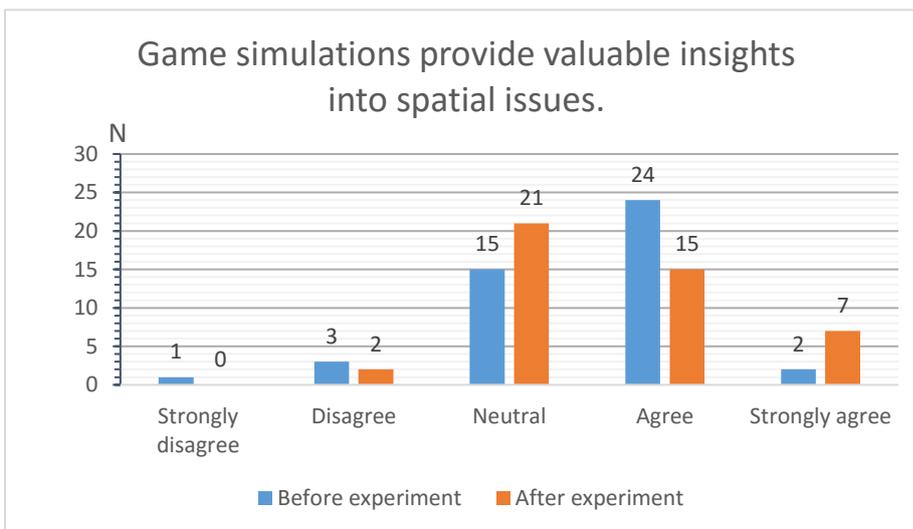


Figure 24: Result graph "Game simulations provide valuable insights into spatial issues".

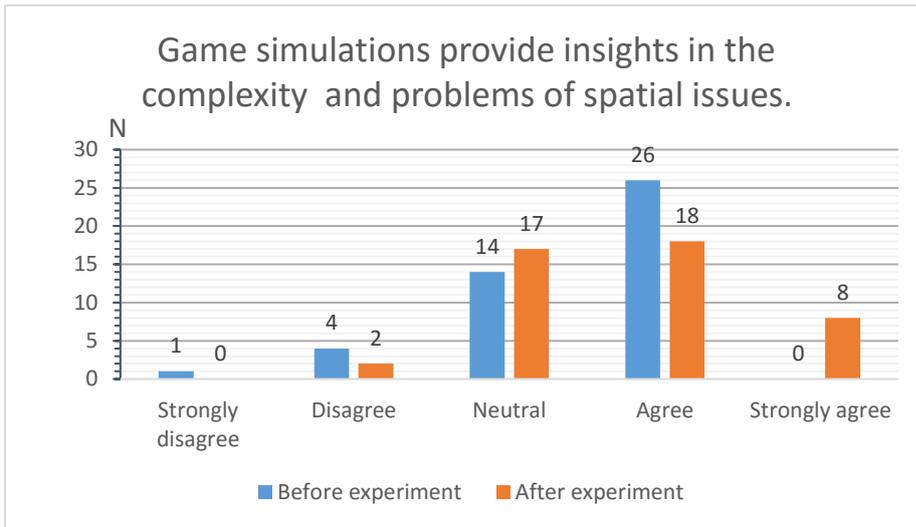


Figure 25: Result graph "Game simulations provide insights in the complexity and problems of spatial"

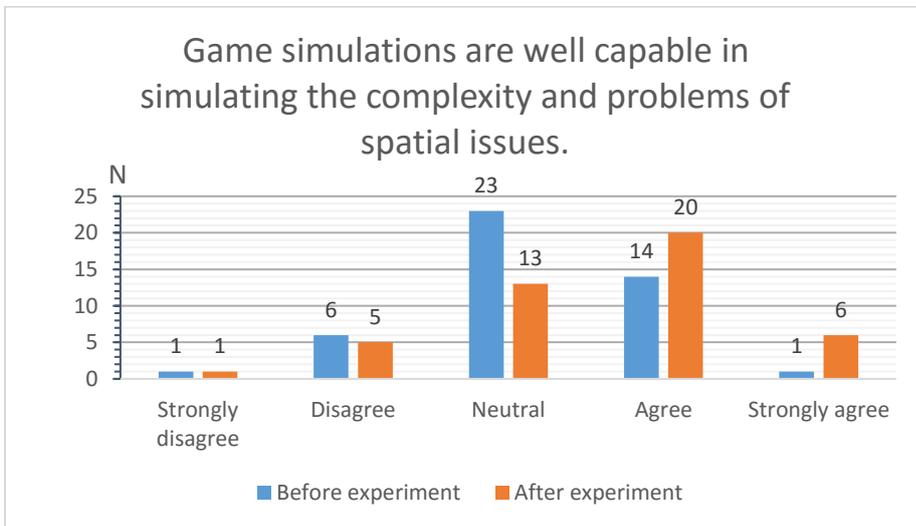


Figure 26: Result graph "Game simulations are well capable in simulating the complexity and problems of spatial issues".

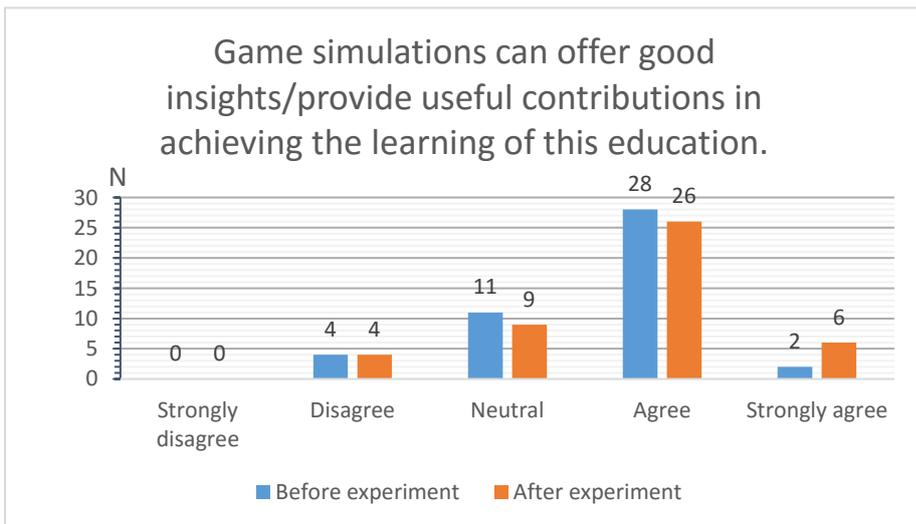


Figure 27: Result graph: "Game simulations can offer good insights/provide useful contributions in achieving the learning of this education."

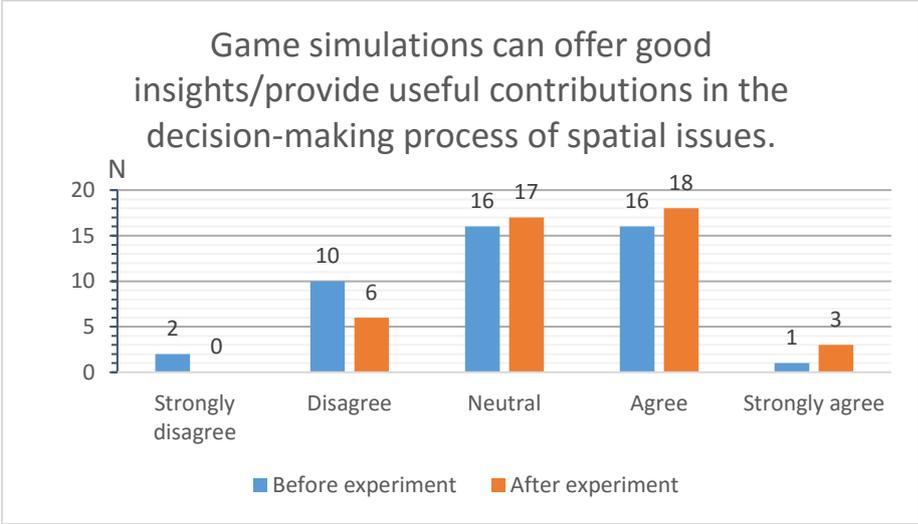


Figure 28: Result graph: "Game simulations can offer good insights/provide useful contributions in the decision-making process of spatial issues."

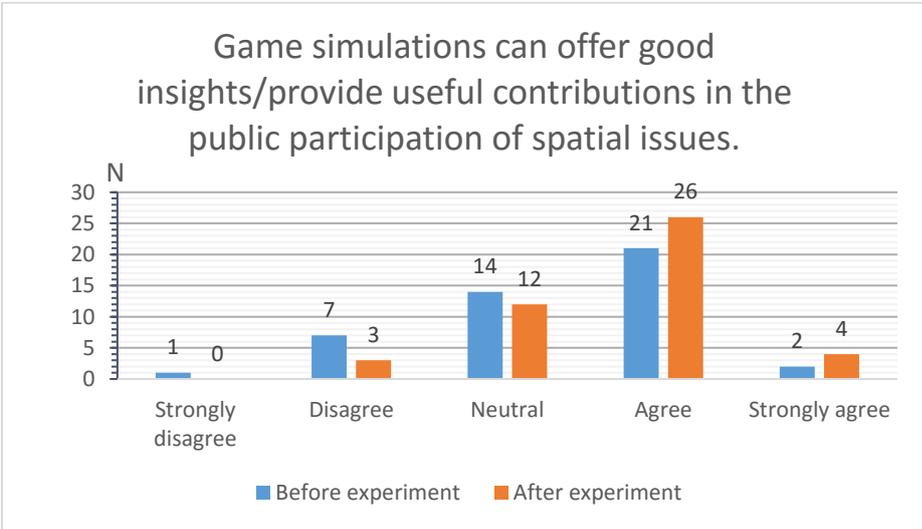


Figure 29: Result graph: "Game simulations can offer good insights/provide useful contributions in the public participation of spatial issues".

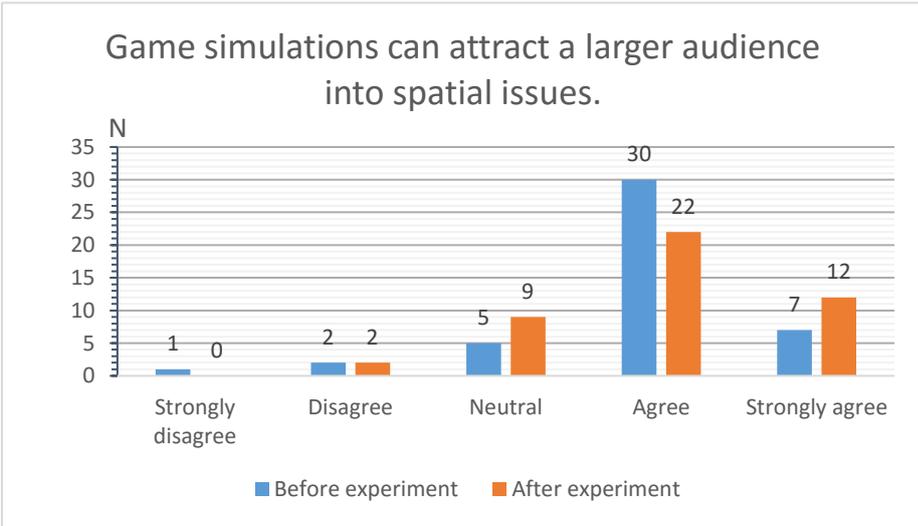


Figure 30: Result graph "Game simulations can attract a larger audience into spatial issues."

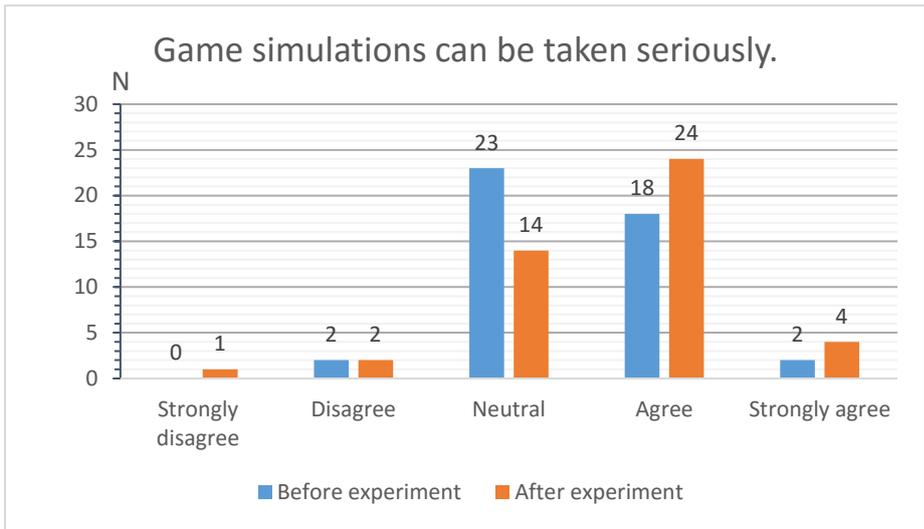


Figure 31: Result graph: "Game simulations can be taken seriously."

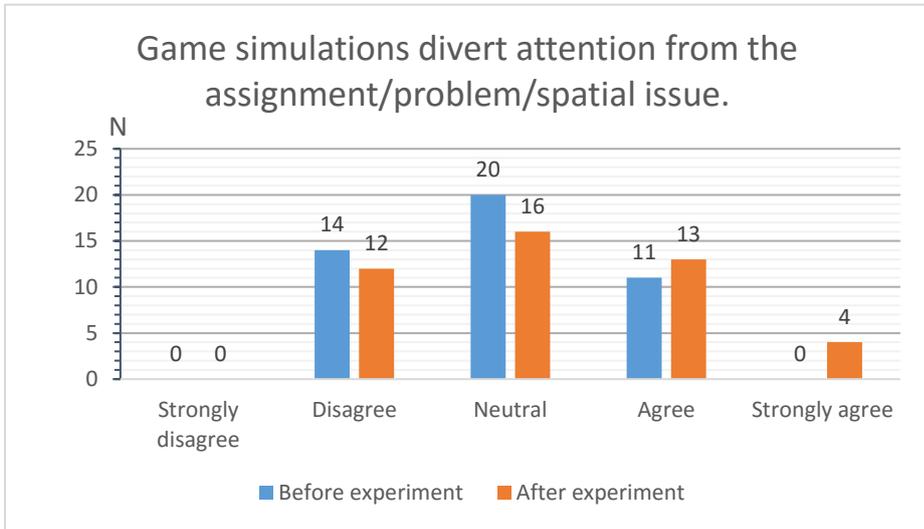


Figure 32: Result graph: "Game simulations divert attention from the assignment/problem/spatial issue".

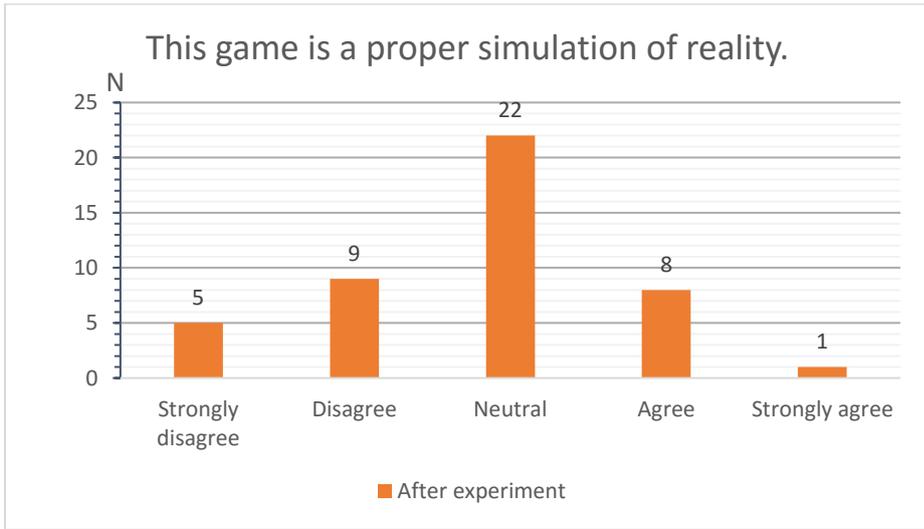


Figure 33: Result graph "This game is a proper simulation of reality".

As can be seen in figure 20, a vast majority of the participants likes to play a game simulation, both before and after the experiment: 28 filled in agree before and 26 after as answer, while 11 filled in strongly agree before and 16 after. The next proposition, 'I gain (more) insights in the emergence and

the development of (infrastructural networks), is answered more neutral: 19 participants said neutral before and 11 after the experiment, while 21 said agree before and 24 after, as can be seen in figure 21. Figure 22 depicts that most participants agree gain (more) insights in the complexity of (infrastructural) networks (23 before and 25 after the experiment), but that there is a substantial amount of participants who felt neutral to the proposition (16 before and 13 after). On the proposition 'I gain (more) insights in the operations of models', figure 23 shows that the two main response groups -neutral and agree- were fairly equal answered, with 21 before and 18 after and 20 before and 15 after respectively. However, the amount of people disagreeing rose from 4 to 8 after the experiment as well. Figure 24 depicts the attitudes towards the proposition of 'Game simulations provide valuable insights into spatial issues': from 15 to 21 participants answering neutral, 24 to 15 answering agree and 2 to 7 strongly agree after the experiment. The participants also believe game simulations can provide insights in the complexity and problems of spatial issues, 14 answering neutral before and 17 after, 26 agree before and 18 after and 0 strongly agree before and 8 after the experiment, according to figure 25. A same result could be found for the proposition 'Game simulations are well capable in simulating the complexity and problems of spatial issues' in figure 26: from 23 to 13 answering neutral, 14 to 20 answering agree and 1 to 6 answering strongly agree after the experiment. To the proposition 'Game simulations can offer good insights/provide useful contributions in achieving the learning of this education (Technical Planning), a majority responded with agree as depicted in figure 27: 28 before and 26 after the experiment, along with 11 to 9 neutral and from 2 to 6 strongly agree after. However, figure 28 shows a more balanced view whether game simulations can offer good insights or provide useful contributions in the decision-making process of spatial issues. The amount of responds disagree fell from 10 to 6, neutral raised slightly from 16 to 17 and agree as well from 16 to 18 after the experiment. To the proposition 'Game simulations can offer good insights/provide useful contributions in the public participation of spatial issues' most participants responded with agree: 21 before and 26 after, along with 14 neutral before to 12 and 7 disagree to 3, as can be seen in figure 29. Figure 30 however shows a general positive attitude towards the proposition that game simulations can attract a larger audience into spatial issues, with 30 to 22 agree, 7 to 12 strongly agree and 5 to 9 neutral after the experiment. Game simulations can be taken seriously however: figure 31 shows that the amount of responses neutral fell from 23 to 14 after the experiment while the amount of responses agree rose from 18 to 24. The proposition 'Game simulations divert attention from the assignment/problem/spatial issue was met with mostly neutral responses, 20 before and 16 after, as well as with a roughly equal share of disagree and agree responses, being 14 to 12 and 11 to 13 after respectively, as is shown in figure 32. Figure 33 shows a similar picture whether this game was good simulation of reality: 22 neutral responses, 9 disagree and 8 agree responses.

To determine whether the answers given before and after the experiment are significantly different as a result of the experiment, the Wilcoxon matched-pairs signed rank test was conducted on all the previously mentioned questions and given answers from before and after the experiment since all questions consist of two paired ordinal variables. The results of the test are depicted in table 9.

Proposition		N	Mean Rank	Sum of Ranks	P
Before: I enjoy playing a game simulation. - After: I enjoy playing a game simulation.	Positive Ranks	5	9,00	45,00	0,050
	Negative Ranks	13	9,69	126,00	
	Ties	27			

Before: I gain (more) insights in the emergence and the development of (infrastructural) networks. - After: I gain (more) insights in the emergence and the development of (infrastructural) networks.	Positive Ranks	8	13,25	106,00	0,464
	Negative Ranks	14	10,50	147,00	
	Ties	23			
Before: I gain (more) insights in the complexity of (infrastructural) networks. - After: I gain (more) insights in the complexity of (infrastructural) networks.	Positive Ranks	11	12,50	137,50	0,450
	Negative Ranks	14	13,39	187,50	
	Ties	20			
Before: I gain (more) insights in the operations of models. - After: I gain (more) insights in the operations of models.	Positive Ranks	12	13,38	160,50	0,457
	Negative Ranks	11	10,50	115,50	
	Ties	22			
Before: Game simulations provide valuable insights into spatial issues. - After: Game simulations provide valuable insights into spatial issues.	Positive Ranks	12	13,63	163,50	0,502
	Negative Ranks	15	14,30	214,50	
	Ties	18			
Before: Game simulations provide insights in the complexity and issues of spatial issues. - After: Game simulations provide insights in the complexity and issues of spatial issues..	Positive Ranks	8	8,50	68,00	0,081
	Negative Ranks	13	12,54	163,00	
	Ties	24			
Before: Game simulations are well capable in simulating the complexity and problems of spatial issues. - After: Game simulations are well capable in simulating the complexity and problems of spatial issues.	Positive Ranks	7	12,93	90,50	0,012
	Negative Ranks	20	14,38	287,50	
	Ties	18			
Before: Game simulations can offer good insights/provide useful contributions in achieving the learning of this education. - After: Game simulations can offer good insights/provide useful contributions in achieving the learning of this education.	Positive Ranks	8	10,50	84,00	0,221
	Negative Ranks	13	11,31	147,00	
	Ties	24			
Before: Game simulations can offer good insights/provide useful contributions in the decision-making process of spatial issues. - After: Game simulations can offer good insights/provide useful contributions in the decision-making process of spatial issues.	Positive Ranks	4	9,50	38,00	0,011
	Negative Ranks	15	10,13	152,00	
	Ties	25			
Before: Game simulations can offer good insights/provide useful contributions in the public participation of spatial issues. - After: Game simulations can offer good	Positive Ranks	3	8,00	24,00	0,004
	Negative Ranks	15	9,80	147,00	
	Ties	27			

insights/provide useful contributions in the public participation of spatial issues.					
Before: Game simulations can attract a larger audience into spatial issues. - After: Game simulations can attract a larger audience into spatial issues.	Positive Ranks	11	11,50	126,50	0,458
	Negative Ranks	13	13,35	173,50	
	Ties	21			
Before: Game simulations can be taken seriously. - After: Game simulations can be taken seriously.	Positive Ranks	7	11,50	80,50	0,088
	Negative Ranks	15	11,50	172,50	
	Ties	23			
Before: Game simulations divert attention from the assignment/problem/spatial issue. - After: Game simulations divert attention from the assignment/problem/spatial issue.	Positive Ranks	7	10,50	73,50	0,068
	Negative Ranks	15	11,97	179,50	
	Ties	23			

Table 9: Results of the Wilcoxon matched-pairs signed rank test.

A couple of propositions were answered significantly different after the experiment. These are: (1) I enjoy playing a simulation game (mean before: 4,0222; mean after: 4,2222; $p=0,050$), (2) game simulations are well capable in simulating the complexity and problems of spatial issues (mean before: 3,1778; mean after: 3,5556; $p=0,012$), (3) game simulations can offer good insights/provide useful contributions in the decision-making process of spatial issues (mean before: 3,0889; mean after: 3,4091; $p=0,011$) and (4) game simulations can offer good insights/provide useful contributions in the public participation of spatial issues (mean before: 3,3556; mean after: 3,6889; $p=0,004$). These four means have all increased after the experiment. People thus enjoy playing a simulation game more than they anticipate, but also regard that such a game is more capable in simulating the complexity and problems of spatial issues than initially thought. In addition, people also believed that, after playing, game simulations offer more good insights/useful contributions to the decision-making process and public participation of spatial issues than they thought before playing a game simulation.

To determine whether the factors asked at the start of the questionnaire have influence on the answers to the propositions after the experiment, a series of Fisher-Freeman-Halton tests were performed on the factors of gender, frequency of playing strategy games, duration of playing strategy games and having played a similar game in the past before. The results of these series of tests are shown in table 10.

Proposition	Gender (p=)	Frequency (p=)	Duration (p=)	Similar (p=)
I enjoy playing a game simulation.	0,290	0,234	0,380	0,075
I gain (more) insights in the emergence and the development of (infrastructural) networks.	0,264	0,337	0,081	0,189
I gain (more) insights in the complexity of (infrastructural) networks.	0,264	0,129	0,229	0,386
I gain (more) insights in the operations of models.	0,695	0,731	0,942	0,029
Game simulations provide valuable insights into spatial issues.	0,338	0,937	0,895	0,069

Game simulations provide insights in the complexity and issues of spatial issues.	0,603	0,556	0,536	0,658
Game simulations are well capable in simulating the complexity and problems of spatial issues.	0,576	0,562	0,392	1,000
Game simulations can offer good insights/provide useful contributions in achieving the learning of this education.	0,483	0,469	0,318	0,016
Game simulations can offer good insights/provide useful contributions in the decision-making process of spatial issues.	0,52	0,331	0,608	0,203
Game simulations can offer good insights/provide useful contributions in the public participation of spatial issues.	0,384	0,128	0,906	0,218
Game simulations can attract a larger audience into spatial issues.	0,126	0,872	0,371	0,542
Game simulations can be taken seriously.	0,947	0,345	0,453	0,681
Game simulations divert attention from the assignment/problem/spatial issue.	0,664	0,059	0,292	0,313
This game is a good simulation of reality.	0,027	0,035	0,605	1,000

Table 10: Results of the Fisher-Freeman-Halton tests comparing the influence of different factors on the outcomes of the propositions.

Some tests had a significant outcome, meaning that those outcomes on the propositions are significantly different as a result of a factor. The first significantly different outcome is the difference in answers on the proposition ‘This game is a good simulation of reality’ between men and women ($p=0,027$). Gender and believing that the game Transport Tycoon is a good simulation of reality are not independent from one another. Men and women have different beliefs as to how good the game is a simulation of reality. The second significant difference in table 10 is the difference in answers to the same proposition but between different degrees of frequency of playing strategy games ($p=0,035$). Apparently, the amount of times people play a strategy game influences their opinion on how good they think Transport Tycoon is a good simulation of reality.

Two more significant differences were found in the analysis. The factor whether people had played a similar game like Transport Tycoon before influences the answers to the propositions ‘I gain more insights in the operations of models’ ($p=0,029$) and ‘Game simulations can offer good insights/provide useful contributions in achieving the learning of this education’ ($p=0,016$).

However, by far most test had not a significant outcome. This means that there is not enough evidence in the results of the experiment to reject the null hypothesis -there is no relation between a proposition and a factor- as being false for all other tests. Therefore, it must be assumed that the factors do not affect the outcomes of the propositions, except for those described above.

5.2.3. Evaluation questions

At the end of the questionnaire, the participants were asked some evaluation questions. First, participants were asked what they liked and disliked about the experiment. Most named where the complexity (but playability) of the game (8x), the competitive/strategical aspect(s) of the game (4x), the possibility to build a lot in not much time and the visibility of consequences as a result of building actions (8x) and that the game was just something else than ordinary and fun to play (9x).

“It makes it easy to see what the considerations and effects may be of (not) building infrastructure”.

Other aspects mentioned were the interactivity and many options of the game (4x), as well as the reasonably truthfulness depicted in it (2x). However, when asked what the participants did less like about the game, most answered that it was hard to (really) understand the game, especially at the start of the experiment and under the given amount of time to play (16x). In addition, some participants answered that the game was too simplified (7x), consisted of unrealistic elements (4x) and lacked other, different interests besides those of the players themselves (3x).

“It seems easy to learn but even after the tutorial it remains challenging to play for the first time”.

Nonetheless, some participants could not find any dislikeable aspects of the game and answered either nothing or left the space for an answer blank (5x).

Next, participants were asked how game simulations could be used in spatial and urban issues, as well as in which phase it could provide a contribution to the planning process. Most participants believed that game simulations could be well used to test certain scenario's as a response to a spatial issue and see which works best (10x). Furthermore, others thought game simulations could be a tool to be used in participatory planning and to attract more civilians to participate (8x), but also as a tool to provide insight in the complexity of spatial issues (7x) and as way to provide information to the public (5x).

“Residents can participate in finding a solution they think is acceptable. They then know what the issue is about and what the options are”.

In addition, some participants thought that game simulations can be used to visualise the problems (3x) and opportunities of spatial plans (3x). However, some participants did not know any useful way to use game simulations or believed that there was none at all (4x). When asked in which part of the planning process game simulations can add a contribution, a lot of participants answered at the beginning, in the analysis, orientation or conceptual phase (22x). But the participation (4x), design (5x) and presentation phase (4x), midway and at the end of the planning process were also mentioned.

“Preparation/design phase. Especially at the beginning or at the very end in order to make it clear to the public”.

Most participants had no further remarks (39x), though some did mention that they liked the experiment and the game, and that they were entertained by it.

“I will continue at home!”.

5.2.4. Final remarks

Based on the subjects discussed before in this chapter, it can be concluded that the experiment overall was received rather well. Most participants were either positive or neutral about the experiment, with only a few exceptions being negative. As a result, almost every average rating of the propositions increased when compared before and after the experiment, but only four were statistically significant, being ‘I enjoy playing a simulation game’, ‘Game simulations are well capable in simulating the complexity and problems of spatial issues’, ‘Game simulations can offer good insights/provide useful contributions in the decision-making process of spatial issues’ and ‘Game simulations can offer good insights/provide useful contributions in the public participation of spatial issues’.

At the start of the experiment, the participants were asked some general aspects about themselves first: gender, age, frequency and duration of playing strategy games, if the participant has played transport tycoon before and if the participant has played a similar game before. Out of statistical analysis it was determined that people were more likely to have played a similar game as Transport Tycoon if they played more frequently strategy games in general. However, some of these

aspects also have a significant influence on the attitude of the participants to some of the propositions asked after the experiment. Gender influenced the outcome how the participants perceived the quality of realism of the simulation. The same proposition was also influenced by the participant's frequency of playing strategy games. And whether people had played a similar game before or not influenced their answer if games could provide insights in the operations of models and if game simulations can be used in their educational program.

According to the evaluation questions, the participants both liked and disliked the complexity of the game. It made the game challenging to play but could become too much for some resulting in not understanding how the game works. Most participants also made it clear that game simulations can be used in spatial and urban planning in various ways, especially at the start of the planning process.

Was Transport Tycoon however a suitable game for this experiment? When looking at table 7, both Cities In Motion games have a higher rating than Transport Tycoon. Based on the trends discussed in paragraph 5.1., both Cities In motion games are more realistic due to an increasing amount of game mechanics used in more modern games. In addition, the monitoring tools used in the Cities In Motion series would better correspond to the participants. Based on this information, one of the Cities In Motion games would be a better choice for the experiment than Transport Tycoon. However, the quote in paragraph 5.2.3. makes it clear that some participants found Transport Tycoon already difficult to manage. It stands to reason that the increased complexity of the two Cities In Motion games would only heighten the number of participants having trouble understanding and playing one of these games as a result of more and more difficult game mechanics, despite having better monitoring tools. In addition, the experiment would have been a lot harder to conduct if one of the two Cities In Motion games was used, for two pragmatic reasons. First, Transport Tycoon is freely available to everyone, while the Cities In Motion series is not. Secondly, Transport Tycoon can be played on any operating platform without having any prerequisite on hardware, whereas Cities In Motion 1 and especially 2 demand certain levels of hardware (that not every participant possess) in order to run. Furthermore, Transport Tycoon did yield valid and usable results for this research, making the game a good choice to use in the experiment conducted.

Chapter 6 – Conclusion & Discussion

6.1. Conclusion

This research was conducted to research how city-building simulation and strategy games could play a role in new spatial and urban challenges. Three research questions were formulated to help the research conducting, being: what are city building simulation and strategy games and how do these games work, which developments have city building simulation and strategy games go through the past three decades and which insights in decision-making processes can planning students acquire through the usage of city building simulation and strategy games, and what are the chances and risks in doing so?

City building simulation and strategy games can be divided into three different categories: city and urban planning games as SimCity and Cities: Skylines, infrastructure and mobility games as Transport Tycoon and Cities in Motion and competitive strategic city building strategy games as Civilization V and Forge of Empires. Each of these games is operated by two layers: a characteristics layer and a mechanics layer. The characteristics layer depicts all the in-game items, textures and resources the player can use to achieve his goal or desires, while the mechanics layer computes the actions of the player into reactions (Aarseth, 2003; Konzack, 2002).

From the game analysis based on these two layers, it has been deduced that city building simulation and strategy games have undergone quite some changes throughout the years. Overall, the complexity of the games has increased: from 2D to 3D game engines, more items, buildings and infrastructure that can be constructed and the more complex game mechanics that accompany these changes. As a result, city building simulation and strategy games tend to become more realistic. A cautious emergence of more co-operative options have appeared in the last past years as well. Monitoring and managing functions have changed: problems and issues in the game are better illustrated as a result of new monitoring tools. User made content has also made its entrance in city building simulation and strategy games, especially since the emergence of the game and software platform Steam, where user made content is easily transferred between people. Lastly, more and more games are releasing a mobile game app for smartphones and tablets, allowing players to play the game everywhere at any time.

To answer the third research question an experiment was conducted. From the questionnaires filled in before and after the experiment chances and risks can be identified. The participants liked to play the game in the experiment: most were positively orientated towards it. Fun seems to be an important aspect for game simulations for people to participate, as Duke (2008) believed. But game simulations also seem to be able to provide insights into spatial issues and the complexity and problems that come along with it. The argumentation of Wenzler (2008) that games can be successfully used as a tool to better understand the greater picture, holds up according to the results of the experiment. Games do help with the visualisation of different futures. In addition, Poplin's (2011) point that games can increase the public participation of spatial issues is also supported through the experiment, as the participants of the experiment mostly believed that game simulations can attract a larger audience into spatial issues. These are certain chances for game simulations, as it allows for better participatory planning processes with a larger audience, especially in combination with the increasing realism, mobility and accessibility of city building simulation and strategy games. However, the experiment also supports another point made by Poplin (2013), namely that (the design of) these games should be playable for all kinds of players. In other words, the game must not be too complex to play. Some of the participants experienced difficulties during the experiment as they did not (yet) fully understood the mechanics of the game. Still, most participants learned from the game by playing

it during the experiment.

As a result, city building simulation and strategy games can be used to acquire insights in the decision-making processes of spatial and urban planning. First, a city building simulation and strategy game can be used as an informer: through visualisation of spatial issues, students (and possible citizens) can better understand what spatial problems and the corresponding decision-making processes are about. It is possible for students (and citizens) to learn about the size and complexity of (these) planning problems and decision-making processes. Secondly, city building and simulation games can be used as a lecturer: by learning by doing students acquire insights in the difficulty of decision-making processes and finding suitable solutions to spatial problems, possibly leading to a better understanding of planning process outcomes. Thirdly, city building simulation and strategy games could be used as hosts in public participation planning processes: (new) citizen groups can be persuaded to join in participatory planning practices as these games introduce a new, fresh and more fun way to do planning. An imaginable consequence would be that citizens could also gain insights in planning and planning processes, similar to students of planning.

6.2. Discussion

The experiment was carried out in a particular setting, with young students of planning as participants. It should be taken into account that the results of this experiment are biased as a consequence. This could mean that, if a similar experiment would be executed but with different participation groups, results between the experiments could differ. It is recommended that further research should be done in order to determine if more representative participants of the population would react in a similar way. Furthermore, the results come from only one experiment with only one game. It would have been better if more experiments with different games could have taken place to reach more concrete results instead of the tentative results generated in this research.

In addition, the primary function of the city building simulation and strategy games remains to entertain the players and to provide fun to them. If these games are to be taken seriously in planning processes, which is not impossible, they have to be adapted accordingly. It is important to stress this out: after all, it is simulation *games* rather than only simulations. Again, as this research points out, it is not to say that such games do not have a place in planning processes, on the contrary. The games have a certain potential. However, if city building simulation or strategy games are to be used in spatial and urban planning, its primary function of generating fun for the players has to be changed into generating solutions to spatial and urban issues in a fun way. It would be recommended that lecturers, game developers and planners come together to develop such a planning simulation game and take into account the necessary amount of complexity and reality needed to not only to realistically portray the planning problems and issues, but to remain a playable game as well. Clear and logical lay-outs of menus and monitoring tools are of vital importance to accomplish this, as well as a sharp focus on relevant planning mechanics where visual aesthetics are subordinate. Furthermore, it would be recommended for lecturers to teach students of planning using city building and strategy game simulations. Not only does it concur well with the students but they gain insights in the complexity of planning and decision-forming processes as well, as the students experience and learn by doing next to learning by listening and reading. Additionally, the technologies required to do so become more and more accessibly, notably with the rise of mobile gaming. It would be good if planning students were to become familiar with these developments and their potentially wide-spread use in planning problems and issues in the future early on.

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Appendixes

Appendix A: Questionnaire OpenTTD Experiment

Dank u wel voor uw deelname aan dit experiment. Dit experiment vindt plaats in een onderzoek naar de mogelijkheden en risico's van spelsimulaties voor toekomstige ruimtelijke ontwikkelingen. Deze enquête bestaat uit twee delen. Het eerste gedeelte vindt plaats voor het experiment: hierin wordt, naast een aantal persoonlijke vragen, gevraagd naar uw verwachtingen over het experiment. Het tweede gedeelte vindt plaats na het experiment: uw verwachtingen en het experiment zelf zullen dan worden geëvalueerd.

Deel I

Vul dit gedeelte in vóór het experiment.

1) Wat is uw geslacht?

- Man
- Vrouw

2) Wat is u leeftijd?

3) Hoe vaak speelt u strategiecomputerspellen? (strategiecomputerspellen zijn spellen waarin bekwaam denken en handelen centraal staat voor het winnen van het spel, bijvoorbeeld SimCity, Civilization, Age of Empires etc.).

- 4x-7x in de week
- 1x-3x in de week
- Eens in de maand
- Zelden/nooit

4) Hoe lang speelt u gemiddeld een computerspel in één sessie?

- Minder dan 30 minuten
- 30 minuten
- 1 uur
- 2 uur
- 3 uur
- 4 uur
- Langer dan 4 uur

5) Heeft u al eens eerder Transport Tycoon gespeeld?

- Ja
- Nee

6) Heeft u ooit andere spelsimulaties gespeeld die vergelijkbaar zijn met Transport Tycoon? (Bijvoorbeeld Traffic Giant, Cities in Motion).

- Nee
- Ja, namelijk

Open Transport Tycoon Deluxe (OpenTTD) is een simulatiespel waarin de speler een transportbedrijf moet opzetten. Door (slim) gebruik te maken van bussen, vrachtwagens, treinen, schepen en vliegtuigen om vracht en passagiers te vervoeren wordt geld verdiend om het transportbedrijf te onderhouden, vernieuwen en uit te breiden.

7) Geef bij de volgende vragen aan in hoeverre u vooraf denkt het eens te zijn met de volgende stellingen. U kunt kiezen uit “erg mee eens” (++), “mee eens” (+), “neutraal (+/-)”, “oneens” (-) of “erg mee oneens” (--).

	++	+	+/-	-	--
Ik vind het spelen met een spelsimulatie leuk.	<input type="radio"/>				
Ik krijg meer inzicht in het ontstaan en de ontwikkeling van (infrastructuur)netwerken.	<input type="radio"/>				
Ik krijg meer inzicht in de complexiteit van (infrastructuur)systemen.	<input type="radio"/>				
Ik krijg meer inzicht in de werking van modellen.	<input type="radio"/>				
Spelsimulaties leveren waardevolle inzichten op in ruimtelijke vraagstukken.	<input type="radio"/>				
Spelsimulaties bieden meer inzicht in de complexiteit en problemen van een ruimtelijk vraagstuk.	<input type="radio"/>				
Spelsimulaties kunnen de complexiteit en problemen van een ruimtelijk vraagstuk goed nabootsen.	<input type="radio"/>				
Spelsimulaties kunnen een goede/nuttige bijdrage leveren in het behalen van leerdoelen/educatieve doelstellingen in deze opleiding.	<input type="radio"/>				
Spelsimulaties kunnen een goede/nuttige bijdrage leveren in de besluitvorming bij ruimtelijke vraagstukken.	<input type="radio"/>				
Spelsimulaties kunnen een goede/nuttige bijdrage leveren in de publieke participatie van ruimtelijke vraagstukken.	<input type="radio"/>				
Spelsimulaties kunnen een groter publiek betrekken bij een ruimtelijk vraagstuk.	<input type="radio"/>				
Spelsimulaties zijn serieus te nemen.	<input type="radio"/>				
Spelsimulaties leiden de aandacht af van de opdracht/het probleem/ruimtelijk vraagstuk.	<input type="radio"/>				

Deel II

Vul dit gedeelte in *nà* het experiment.

- 8) Geef bij de volgende vragen aan in hoeverre u het eens bent met de stelling. U kunt kiezen uit “erg mee eens” (++), “mee eens” (+), “neutraal (+/-)”, “oneens” (-) of “erg mee oneens”(--).

	++	+	+/-	-	--
Ik vind het spelen met een spelsimulatie leuk.	<input type="radio"/>				
Ik krijg meer inzicht in het ontstaan en de ontwikkeling van (infrastructuur)netwerken.	<input type="radio"/>				
Ik krijg meer inzicht in de complexiteit van (infrastructuur)systemen.	<input type="radio"/>				
Ik krijg meer inzicht in de werking van modellen.	<input type="radio"/>				
Spelsimulaties leveren waardevolle inzichten op in ruimtelijke vraagstukken.	<input type="radio"/>				
Spelsimulaties bieden meer inzicht in de complexiteit en problemen van een ruimtelijk vraagstuk.	<input type="radio"/>				
Spelsimulaties kunnen de complexiteit en problemen van een ruimtelijk vraagstuk goed nabootsen.	<input type="radio"/>				
Spelsimulaties kunnen een goede/nuttige bijdrage leveren in het behalen van leerdoelen/educatieve doelstellingen in deze opleiding.	<input type="radio"/>				
Spelsimulaties kunnen een goede/nuttige bijdrage leveren in de besluitvorming bij ruimtelijke vraagstukken.	<input type="radio"/>				
Spelsimulaties kunnen een goede/nuttige bijdrage leveren in de publieke participatie van ruimtelijke vraagstukken.	<input type="radio"/>				
Spelsimulaties kunnen een groter publiek betrekken bij een ruimtelijk vraagstuk.	<input type="radio"/>				
Spelsimulaties zijn serieus te nemen.	<input type="radio"/>				
Spelsimulaties leiden de aandacht af van de opdracht/het probleem/ruimtelijk vraagstuk.	<input type="radio"/>				
Dit spel is een goede simulatie van de werkelijkheid.	<input type="radio"/>				

9) Wat vond u goed/leuk aan deze spelsimulatie?

10) Wat vond u minder goed/leuk aan deze spelsimulatie?

11) Hoe zou volgens u spelsimulaties gebruikt kunnen worden bij ruimtelijke vraagstukken?

12) In welk gedeelte van het planningsproces zou een spelsimulatie volgens u een bijdrage kunnen leveren?

13) Heeft u nog overige opmerkingen?

Hartelijk dank voor uw participatie in het experiment en het invullen van deze enquête!

Appendix B: Assignment 1 OpenTTD Experiment

Doel

In Transport Tycoon kunnen steden groeien. Dit gebeurt echter alleen wanneer er uitwisseling van goederen of personen plaats vindt met de stad. Jullie groepje heeft als doel om, met behulp van transportverbindingen, een zo groot mogelijke stad te creëren.

Opdracht

Maak een print screen zodra de eerste transportverbinding is aangelegd. Zo is duidelijk wat de eerste schakel was in jullie infrastructuurnetwerk. Maak vervolgens bij elke decenniumwisseling (1990, 2000, 2010 etc.) ook een print screen van het volledige netwerk om de groei van het netwerk in beeld te brengen.

Appendix C: Assignment 2 OpenTTD Experiment

Doel

In Transport Tycoon heeft ieder transportbedrijf een bepaalde bedrijfswaarde. De bedrijfswaarde van het transportbedrijf wordt bepaald door de gebouwde stops, stations en faciliteiten, de voertuigen en de hoeveelheid geld in het bedrijf. Jullie doel is om, met behulp van transportverbindingen, een zo groot mogelijke bedrijfswaarde te realiseren.

Opdracht

Maak een print screen zodra de eerste transportverbinding is aangelegd. Zo is duidelijk wat de eerste schakel was in jullie infrastructuurnetwerk. Maak vervolgens bij elke decenniumwisseling (1990, 2000, 2010 etc.) ook een print screen van het volledige netwerk om de groei van het netwerk in beeld te brengen.

Appendix D: Descriptive statistics propositions questionnaire

Proposition		N	Mean	Std. Deviation	Minimum	Maximum
I enjoy playing a game simulation.	Before	45	4,0222	0,83907	1,00	5,00
	After	45	4,2222	0,79455	1,00	5,00
I gain (more) insights in the emergence and the development of (infrastructural) networks.	Before	45	3,4889	0,69486	2,00	5,00
	After	45	3,5778	0,83907	2,00	5,00
I gain (more) insights in the complexity of (infrastructural) networks.	Before	45	3,5778	0,72265	2,00	5,00
	After	45	3,6667	0,73855	2,00	5,00
I gain (more) insights in the operations of models.	Before	45	3,3556	0,64511	2,00	4,00
	After	45	3,2444	0,90843	1,00	5,00
Game simulations provide valuable insights into spatial issues.	Before	45	3,5111	0,78689	1,00	5,00
	After	45	3,6	0,80904	2,00	5,00
Game simulations provide insights in the complexity and issues of spatial issues.	Before	45	3,4444	0,75545	1,00	4,00
	After	45	3,7111	0,81526	2,00	5,00
Game simulations are well capable in simulating the complexity and problems of spatial issues.	Before	45	3,1778	0,7772	1,00	5,00
	After	45	3,5556	0,94281	1,00	5,00
Game simulations can offer good insights/provide useful contributions in achieving the learning of this education.	Before	45	3,6222	0,71633	2,00	5,00
	After	45	3,7556	0,80214	2,00	5,00
Game simulations can offer good insights/provide useful contributions in the decision-making process of spatial issues.	Before	45	3,0889	0,92469	1,00	5,00
	After	44	3,4091	0,81606	2,00	5,00
Game simulations can offer good insights/provide useful contributions in the public participation of spatial issues.	Before	45	3,3556	0,88306	1,00	5,00
	After	45	3,6889	0,73306	2,00	5,00
Game simulations can attract a larger audience into spatial issues.	Before	45	3,8889	0,80403	1,00	5,00
	After	45	3,9778	0,81153	2,00	5,00
Game simulations can be taken seriously.	Before	45	3,4444	0,65905	2,00	5,00
	After	45	3,6222	0,80591	1,00	5,00
Game simulations divert attention from the assignment/problem/spatial issue.	Before	45	2,9333	0,75076	2,00	4,00
	After	45	3,2000	0,94388	2,00	5,00
This game is a proper simulation of reality.	After	45	2,8000	,94388	1,00	5,00