Bauhaus-Universität Weimar

Project Report

„Social Game Environmental Management"

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1. Problem outline/scope

For several years games on social networking sites, such as Facebook, become more and more popular. Recent research results show that - although these games often have the appearance of simple game mechanics ("Click and Reward") - the players develop skills for the real life, such as cognitive modelling and reasoning. In addition technical things can be taught - in more simple cases it can be English terms for the play area, and in more demanding cases, the links between systems. The project is aimed at gaming enthusiast students, which develop game mechanics based on an analysis of existing modes of operation of popular social games and game mechanics of existing literature to teach environmental engineering science content and representing them graphically.

Possible approach:

- Play and analysis of popular social games (CityVille, Farmville, Backyard Monsters ...)
- Identification of one or more areas of environmental engineering sciences as the content of the game
- Draft of game scenarios
- Determine possible learning content
- Design of game mechanics
- Playtest (with paper prototypes)
- Graphic documentation of the game

Required Project Results:

- Structured documentation of the designed game
- Presentation

2. Theory of Social games

2.1. The meaning of social games

Social games are mostly computer games, which include online social networking. This means the player is able to involve his friends or other people into his gaming experience. There are many different ways to do this, for example by solving a problem together. The participation in the game play of friends and social network related people are main characteristics of social games.

In this case, social networks like Facebook or StudiVZ are essential for playing these games.

Table 1: Most popular social games of Facebook on 2nd august 2011 [1]

No.	Game	MAU (Monthly Active Users)
1.	CityVille	78,413,520
2.	Empires & Allies	44,526,082
3.	60photos	42,244,358
4.	Static HTML: iframe tabs	39,926,072
5.	FarmVille	34,342,312
6.	Texas HoldEm Poker	34,138,108
7.	BandPage by RootMusic	29,227,960
8.	Bing	28,776,184
9.	Windows Live Messenger	21,082,582
10.	21 questions	19,091,380

As you can see, people from all over the world are able to play together on social games and connect each other. The high number of monthly active users (MAU) evidences the high popularity of social games. Virtual World games are dominating this list.

Therefore a huge gaming industry is developing. A good example in this case is the game developer Zynga, which was founded in 2007. Its revenue was approximately $850 million in 2010 [2]. Zynga publishes the most popular social games like CityVille and Empires & Allies got a totally net present value of seven to nine billion US-dollars by totally 275mio. MAUs [3].

The revenue of these social games bases mostly on the high amount of active users, which were reached by Facebook. In fact, nowadays social games have a bigger weekly audience than conventional primetime TV. Consequently, many advertisers are willingly to make profit out of this case.

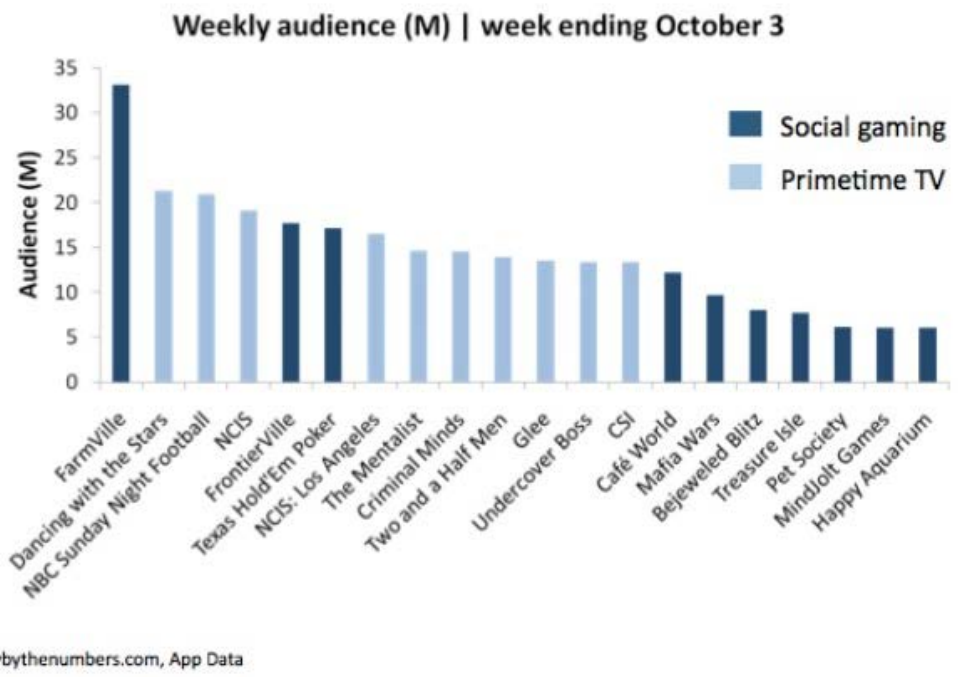


Figure 1: Weekly audience of social gaming and primetime TV [4]

Nevertheless, advertising is only a small part of the revenue. The publishers make most of the money out of directly paying users and indirectly paying users. “The 2011 Entertainment, Media & Advertising Market Research Handbook” [5] reported the market assessment of the USA by ThinkEquity LLC as following:

Table 2: Revenues of social gaming [5]

	2009	2012
Directly paying users:	$340 million	$1.91 billion
Indirectly paying users*:	$324 million	$868 million
Advertising:	$62 million	$124 million
Total:	**$726 million**	**$2.18 billion**

* Users paying for virtual currency by opting for advertising offers or taking online surveys

As you can see, advertising is only a small part of the revenue. Most of the users are willingly to pay directly. These are remarkable numbers, because most of the social games are free to play. The payment bases on different concepts and is in majority by choice, for example buying virtual currency or special features.

2.2. General principles and motivation

So the Question is why is social gaming so popular? The answer could lay in the different (social) game mechanics and the motivations of the users.

An important cause is, users are able to express themselves and motives easily to others, especially their friends. In this case, social networks are very helpful.

Yochai Benkler [6] describes the motivations for social media use in four points:

- Social connectedness
- Psychological well-being
- Gratification
- Material gain

Peter Kollock [7] gives another four motivations of contributing in online communities:

- Reciprocity
- Reputation
- Increased sense of efficacy
- Attachment to and need of a group

In fact, social games support these motivations and create a playful way of expression. But there are also other important causes of playing social games. For example the achievements in the game, like competing others and advancing to a higher level. Immersing themselves into the game's world by discovering, customizing and enjoying the story aspects is also an important cause of the popularity of social games. In this process, social aspects like working in a team, player relationships and socializing in general come together and form a positive gaming mood. Huge social platforms like Facebook are characterized by using following qualities of playfulness:

- Physicality
- Spontaneity
- Inherent Sociability

Successful social games have accordingly a common ground in some main features:

- lots of small rewards
- no negative consequences
- building on the work of others
- frivolous interaction in general

On the technical side, most of the social games are **easily** accessible. There is no need of downloading or installing a gaming client. Almost all games are browser-based and require the Adobe Flash Player plugin. The game developers make a big effort to create an easy introduction into the game by offering tutorials.
Furthermore, social media experts are claiming that social media games are threatening the market of so-called casual games by their virality, accessibility, and scalability. [8]

2.3. Education and gaming

Social gaming opens the chance to combine to ways of education: Learning in groups and learning by playing. The success of the first mentioned point is shown in several studies. The second point can improve the skills like motivation, concentration and attention while learning. [9]

When children play they must follow rules and find out more about their own skills and limitations, skills which will then be used by the child in real situations at a later stage. The game process also allows abstract reasoning to develop in a stress-free environment unlike other more formal social or curricular situations [10].

There are mainly three ways in which students can interact during the teaching/learning process:

- competitive
- individualistic
- cooperative

Studies are shown that students with cooperative experiences are more able to take the perspective of others, more positive about taking part in controversy and having better developed interaction skills and more positive expectation about working with others.

Following the learning model proposed by Vygostky [11], the game acts as a ‘‘mediator” in the learning process, since educational content is hidden in the game itself. It has to pay attention on developing entertaining game elements, which are not obviously educational.

Essential elements of cooperative learning by Johnson & Johnson [12] are described in five points as following:

1. **Positive interdependence**
   The group targets must be achieved by members working together. You cannot succeed unless the group do. A common goal and a common “group life” system are required. The evaluation happens as a group. Individual score leads into a group score. The players should have similar features, but distinguish elements. Individual rewards are sharable to the whole group. In some cases, the group competes against other groups.
2. **Individual accountability**
   The player has to contribute knowledge to other group members. They have to learn from their partners’ contributions. A multiplicative factor could be assigned to each player to increase their scores. For example, the best player gets the lowest factor and the worst player gets the highest factor. The group has to establish a group leader for some cases. Further assigning surprise challenges for players with fewer score can balance the group too.
3. **Face-to-face promotive interaction**
   This interaction happens by sharing knowledge, discussing different points of view and helping others. Establishing social relations between group members are necessary. All members respond or interact in the same way and have consequently a need of consensus. A possible competition against other groups could encourage the union and communication in the group.
4. **Social skills**

These skills consist mostly of organizing, making decisions, showing leadership and conciliation abilities. Further skills are trust-building, communication and conflict-management skills. Skills such as planning, debate and consensus should be encouraged.

5. **Group processing (Self-analysis of the group)**
   At last, discussing how well and effectively the group has achieved their goals is recommended. This includes graphs and analysing tools to the group, so that they can review their abilities, members and rewards.

2.4. Gaming and engineering content

The definition of engineering is the practical application of natural science. Since the first time, mathematics and physicists were very important in this discipline. Digital gaming bases also on mathematics, so it seems to be easy to bridge the gap from gaming to environmental engineering content. Nowadays, complex computer games simulate nearly fully realistic environments. The players are able to dive into these virtual worlds, to explore strange new worlds, to seek out new life and new civilizations. Experimentation is possible without real negative consequences. A good example for an engineering game is “bridgebuilder” [13]. The player has to construct a bridge for a train with limited materials and money. The clue of this game is the deployment simulation when the train crosses over the bridge. Another good example for a game with environmental content is “energitika” [14], where the player has to manage an ecological power supply system. But there are also more specific games for school lessons like “experiMINTe” [15], in which pupils can comprehend physics. All these games are mostly single player games without mentionable interaction, which is limited to a competitive high score list.

2.5. Conclusion

The literature shows that there are already criteria for successful social games. Educational games are well researched too. The implementation of environmental content happened not very often. Consequently there are a lot of possibilities and chances for a mixture of social games and engineering. The approach will be the use established techniques/mechanics and fill them up with new, environmental content. Additional to this, new innovative mechanics based on engineering content have to be created.

3. Fieldnotes

3.1. Overview

In preparation of creating our own game it seemed to be very useful to play some social games by ourselves. The reason for this was to make some field notes, which allows to gathering impressions of the games. While playing a game you regard spontaneous to your mood and attitude. What do you like in the game? Why do you want to play the game furthermore? Which aspects are necessary in the game for you? Which details are there? How the social component is working and how important is it for the success in the game?

Next there is a field note overview about the social Facebook games which we have played for over 2 months.

3.2. CityVille

Figure 2: Logo CityVille

This game is a kind of build-up strategy game with a big social component. It is developed by ZYNGA INC. CityVille seems to be adjusted to everybody. The whole family is appealing. The game appears in a comic style with cute and realistic looking building design. People are presented in a similar way. Besides the game has a lot of sound effects to any actions you make. This underlines the game experience. In a menu it is possible to switch off the sound and the game music. Further you can toggle to full screen view. CityVille starts with a tutorial where a person shows all necessary elements step by step while these things are spotlighted. So the first 10 minutes of playing didn’t feel overstrained. The appearance of the game invited to play.

The aim of the game is to create and design a little town with all modern and real existing matters under child friendly circumstances. The complexity increases while gaming continuously, thereby you have to interact with other people. So it’s very important to have a lot of friends (Facebook friends which also playing CityVille). Of course you have the possibility to invite your Facebook friends to play CityVille, too. Otherwise you can pay real money for getting CityVille Dollars to buy stuff for your projects and tasks. So sometimes I felt disadvantaged, because it’s not my fault that other friends are less or not playing that game.

As mentioned the social component is very significant. So the following aspects you’ll find in the game:

- Receiving and sending gifts to your friends
- Go to your friend and sending tourists to their game areas

- Collecting you friends rental of their houses, finishing their construction or gathering their plants
- Ask for several things which you need for completion of constructions, level up housing or different collections of house classes
- Ask for team membership (very often you need team members for community buildings e.g hospital→ doctor, assistant, caretaker and so on)
- Ask for train station places so that you get more goods
- Ask and offer construction fields so that you can build a firm on your friends field or your friend builds a firm at your game field→ business connection
- Send or ask for donuts (necessary to arrest criminals by your police)
- Comparing with your friends development

Main resources of the game are the coins which you receive in cause of rentals or other benefit options. With coins you can buy most of the available buildings and decorations for your town development. Cash is a way of real money exchange or level up benefit. Cash allows ~~you~~ to buy special features or complete tasks faster. With the cash feature the developing firm Zynga Inc. makes their real money. Goods and later luxury goods are needed to deliver shops and firms so that they can automatically sell their products to your inhabitants. Energy limits the action you can make in the game. Every collection, harvest or build process costs one energy point. This point is very useful to achieve that the player wants to play constantly. Thus you receive one energy point every 5minutes till a maximum level which depends to your game level. The number of energy rises while playing CityVille level by level.

At the beginning of gaming you got a few tasks (the current ones you'll see at the left side of the screen). While playing more and more, tasks accrue till a maximum. I never felt really satisfied, because there are more and more tasks which should be finished except after finishing a task or completing a task for several minutes. You shall build housing, streets and some shops. With increasing number of inhabitants you need public buildings so that you have the possibility to build more houses and generate more people to your town. But you have a mood meter of your population (left bottom bar) so you see how much inhabitants are maximum possible and how much you have current. Till today there is no change of gaming if the population is in a bad mood. So there is no real punishment for this circumstance. Furthermore you need to increase your game area, so you need to buy expansions and need also permissions of your friends and specific number of people to do this.

At next you see some CityVille screenshots to have a better imagination of the game and to understand the following descriptions better.

Figure 3: Typical CityVille task to receive experience points and a gift

Figure 4: Typical CityVille procedure to complete a building

Figure 5: Screenshot CityVille game field with the special information bars

You can see living buildings for the inhabitants, streets, community buildings (e.g. wedding hall) and the big number of shops like grocery-, T-shirt-, ice-, sports shop and so on. You can also see that there is very often a sign of a box over some shops. That means you need to deliver these shops with goods from your warehouse or store. Otherwise these shops are not selling. I like that the people go automatically to shops which are selling something (no controlling to people). Goods you receive from a farmer (here in the North with some acre), train station (North West) or the harbours (in the South).

The amount of collectable money depends on the size of the shop/building and how much the construction is decorated with flowers, trees and community able features like bicycle racks. In my

opinion this is a great idea because it’s like in real life. Rather you go to a more friendly looking shop or move into a better looking flat.

At the bottom you can see your friends and menu bar. From there you can invite more friends, visit friends and you can control and construct your buildings. The Police station is a mixture of own and community building. You need donuts that feed your police men (funny prejudice) catch some criminals (they randomly appear after collecting money). After catching you can share this success with your friends and they can also earn a donut for their own achievement so that they are able to arrest their criminals and they can also share donuts in case of it. I think that’s not important for the game. It’s a further community aspect and assists the connection of the players.

For building housing, collecting money, helping friends and finishing tasks you earn experience (right top field). With higher experience level you unlock more constructions and features. But for some features you have to pay cash for it or you need a big number of friends.

In general CityVille generates a lot of game fun because of the big number of possibilities to design the town individually. It is up to you which tasks you do clear. Solving tasks result in personal gratification.

To put into a nutshell I’m going to give a pro and contra list about the Game CityVille:

PRO

- Nice looking graphic/ animation and nice sounds
- A lot of details
- A huge amount of several buildings and decoration features
- Simplified economic system
- Community system to help each other
- If a friend donates you the wished stuff, he got as well
- Continuous new task (little addiction function)
- Continuous new constructions (e.g. zoo area) (little addiction function too)
- Alternative to grow the shop level (higher gain)
- Gratification for completing aims
- Possibility to rename stores and shops (humanise the game)
- Bonus points in reason of mouse over to appearing boxes, stars and specific objects

CONTRA

- At my computer partly very long loading time for the game itself and sending requests (recognize to day time that the Facebook servers stays in the USA; when mostly the US people play the game)

- In cause of every small achievement CityVille give you suggestion to share this info with your friends in use with your pin board (that’s really annoying; some of friends do not like it because you are “spamming” Facebook, but you can put a filter toward it)
- If you have a small number of friends frequently playing friends, CityVille took a lot of time to achieve new matters

3.3. Backyard Monsters

This game was developed by the firm KIXEYE and is a kind of tower defensive game. That means you built a base and have to increase your tactical skills into an offensive or defensive way. Thereby you have to attack or defend opponents.

The game world appears in a 3D view. Buildings and monsters also have shadows. It reminds me to games like The Settlers or Anno and so it generated a confidant mood. The game starts with a plan game field with a couple of starter buildings. The action begins with a tutorial. At the same time at the left bottom appears little pop up notes and shows you advices what to do next. Besides the quite easy plot of the game is told you. I didn’t feel overstrained to the game. In addition to the tutorial there is a finger which shows you the necessary game buttons and fields to end the tutorial. At the beginning you have one cute looking monster worker which builds the construction. But you should buy a second or third worker from the starter 500 Shiny (currency in Backyard Monsters). So a faster game will be possible, that means in the same time more monsters can work at different tasks. With Shiny it is also possible to buy materials or to reduce construction time. Of course you can buy shiny for real money for example with a Mastercard. Following a screenshot of Backyard Monsters is shown. In this graphic you’ll see the typical view to the Backyard Monsters field with the menu and the most common buildings.

Figure 6: Screenshot of a Backyard Monsters game field with factories, defensive and research buildings and monsters

In the early stages you recognized that there are 4 important resources: twigs; pebbles; putty; goo (4 left top bars). The different resources are needed for constructions and monsters or their level development. So factories which are mining the materials are very necessary in the game. In the screenshot you see the four different factories and storage silos around the town hall centre. Besides you need a hatchery, a monster locker and housing for the creation of the monsters and some other defensive houses (also presented in the screenshot). In the hatchery you see your disposable different monsters and can create amounts of them (depends on your goo resources, number and level of monster housing). Later you can unlock a monster lab and monster academy to increase your monsters special skills if you think it is necessary. All constructions and upgrades cost specific resources and time. Every building has a own mouse over menu where you can find all information about weapon range, damage, needed upgrade resources and circumstances and what time a level up takes. In higher levels it is normal that an upgrade takes 2days and 14hours for example.

Figure 7: View to the monster locker menu

Altogether 15 monsters with different skills (damage, health, speed, goo costs, capacity and production time) and possibilities are existing, 13 buildings are available, 11 defensive systems you

can use and a huge number of expensive decorations you can buy. Times by time new features are released by the game developer to increase the range of tactics. Also very important is the map room there you can see where your enemies are (human and computer controlled). You can attack and spy them out. It is also possible to sign a peace treaty. But you only see enemies which has quite the same level like you. So the game is fairer and allows a direct power comparison. Of course there is a difference between paying and not paying players.

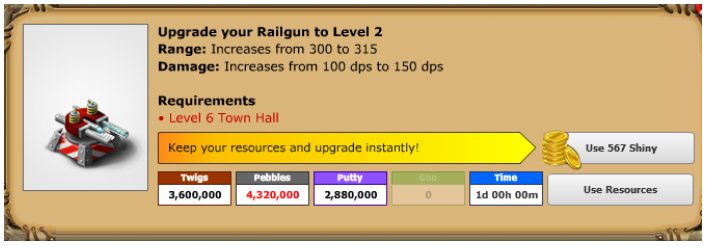


Figure 8: Typical upgrade menu for a building

At the first 6 days you can't be attacked by somebody. This "newbie protection" I like very much but it is possible to attack one of the three computer opponents.

In reason to the good graphics, available quests and interesting game mechanic (mixture of assembly and war) I want to continue this game. Furthermore it's very interesting to figure it out which strategy might be the best. Build more monsters to attack, level up the skills of available monsters or upgrade your housing and defensive construction?

But where is the social component of this game? Indeed there is a social component of the game but it is not useful. You can invite friends and can send some random gifts. Further you can visit friends and can help them to fix upgrades, but it only reduces the upgrade or construction time to a few minutes or hours. It is not possible to attack or defend some opponents together. Most when I visited a friend I could do nothing there ("no help is necessary") because they didn't need any construction help. So I played the Backyard Monsters like a single player game.

In spite of the missing social component I found out the game generates a lot of daily fun in reason of small achievements. The design and avatars of the monsters and constructions underlines this impression. In reason to the limited monsters, area and resources and in addition to the time parameter it is very interesting which tactic maintains to victory. So Backyard Monsters invites to play it for a longer time and to clear the different tactical possibilities.

At next you see some CityVille screenshots to have a better imagine of the game and to understand better the following descriptions.

3.4. Criteria and analysis

CityVille and Backyard Monsters are quite two complete different games with different game task and solutions. Both games have partly the same and different game mechanics, e.g. a punishment

mechanic, posting mechanic or a joint task termination. In the following table there is a subjective classification towards different game aspects.

Table 3: Criteria

Criteria	CityVille	Backyard Monsters
Social game qualities		
1. Physicality	***	**
2. Spontaneity	***	***
3. Inherent sociability	****	*
4. Lots of small rewards	****	***
5. No negative consequences	****	**
6. Building on the work of others	***	*
7. Frivolous interaction in general	**	**
8. Pin board advice	****	**
Education qualities		
9. Positive interdependence	****	*
10. Individual accountability	***	***
11. Face-to-face promotive interaction	**	****
12. Social skills	***	*
13. Group processing (Self-analysis of the group)	***	**

Behind every game there are numbers of game mechanics. They are the reasons if a game is a good or bad game and why a player plays one game longer than another one. Most these mechanics appears subtle to the player. So it’s interesting to name these mechanics and how they are working. If you know about this theory it is easier to develop an own successful game because you’ll know about the important issues. In following part the game mechanics of CityVille and Backyard Monsters are listed with some descriptions.

3.5. Game mechanics of CityVille and Backyard Monsters

Table 4: Refer to Mr. Heinrich Soebke "Possible Mechanics for Social Games"

Game mechanic	*CityVille*	*Backyard Monsters*
Customization	Whole city development deals with customization, but there are no custom buildings or people	Custom adjustment of common buildings and monsters
Dual Monetary System mechanic	There are coins and cash. Cash is derived from real world money. Special housing and features are only available with cash	There is only Shiny. Shiny can be harvesting by mushrooms or you pay real money for it.
Multiple income sources mechanic	Income through rental, benefit and selling goods	Only mushrooms
Gifting mechanic	Every day you earn energy while visiting the game	No daily gifts
Collections mechanic	For specific harvesting you earn random special goods. Finished collection you are able to trade.	No collection mechanic
Achievement mechanic	A big amount of achievements are able	There are few special achievements able
Good samaritan mechanism	You can help your neighbours directly specific what they need.	Less function
Questing mechanic	There are a lot of tasks which you can take or not. No penalty for not taking the quest. The completion helps to increase experience and special goods	Some quest which deals with earning resources
Multiple Goals/Story lines mechanic	It’s on you which goals you make, but no completely different story lines	There is no actual story line
Exploration mechanic	It’s possible to buy new field areas step by step. You see the fields before.	It’s possible to expand the square field maximum 4 times.
Coop mechanic	There are a lot of task where you need the help of friends (e.g. team membership, special goods)	No coop mechanic
Team mechanic	No function there	It’s only possible to sign a treaty of piece with somebody
Display mechanic	While visiting your friend you see its game area	While visiting your friend you see its game area
Scalability mechanic	Buildings and decorations becomes more expensive. You need more points for receiving new level. To complete task takes more	Necessary resources and time increases with higher level. More experience is required for next level

	resources and money	
Level Advancement mechanic	Each level has a own town name reward	There is only a pop up that you are one level more mightier
Skill Mastery mechanic	Not really	Monster or construction skills depend to the players chosen tactic
Hiring mechanic	Possible to ask for help	Not possible
Posting mechanic	It is not possibly to post directly into the neighbours world	It is not possibly to post directly into the neighbours world
Advertising mechanic	There is the a way to advert for something, e.g. KungFuPanda 2 by animated car cinema	No advertising
Localization mechanic	There is only sometimes some special weeks where you are able to by some national items, e.g. a Scottish coast house or a German flag	No specific localization
Contest mechanic	Some rewards are only achievable if you make special tasks or through random processes	No special rewards or items
Battle mechanic	There are no directly confrontations or fights. There is no bad playing existing because of no punishment	You can be attacked or you attack someone. Should your main quarter be destroyed there is no punishment. You only have to wait 1h for repair all broken down things. After fight it is not possible to fight against within after 3 days
Mobile capability mechanism	Actually available for Android and mobile Mac products	No mobile support
Leaderboard or ranking mechanic	There is no comparison with other players. You only see your friends worlds and there town development	You'll see your friends and your neigbours statics in the map room. But you see only the enemies with your quite same ranking stars.

4. Developing a Game Mechanic for Environmental Content

4.1. Target definition

The main target of the game is to give an insight of the complexity of waste management. The player will be facing problem during the treatment and collection of waste. He has to identify the link between a good working circular economy and the prosperity of a healthy city. The sharpening of the mind for ecological and economic issues is also targeted. The player has to get to know the various techniques of waste treatment and sewage plant. He has to check the right aggregates and the right order of the process engineering. It shell be shown how important a waste management system is. On the other hand, the players themselves have to scrutinize their own habits regarding to their handling of waste. The challenge is how to become the players curious about waste and wastewater treatment. The answer is a playful and rewarding game mechanic. The game should use a house designer, which motivates the players to express their self-individual. During the designing process, the players should also learn the various components of a building, especially of the ecological aspects.

4.2. Target group

Because of our definition of the project the potential game is directed to the social game audience in the Facebook community. That mean our target group is orientated to the Facebook membership. Our game has a constructive, simulative and technical nature, that’s why it can be expected mostly people who like these facets to games will play the game for a longer period. May be more men will play the game in proportion to women.

But there are some other target groups which are thinkable for us. Once our game could be a good introduction for incipient technical students or universities can make some advertisement and increasing interest for their process orientated study courses at an educational tradeshow.

Further firms can use our game in an adjusted style to advertise for their products and show how these components would work in a connectedly view. So an imagination of a process is quite better.

But consider it is still a game and no professional simulator for real problems. So the use for firms is limited to a presenting character.

4.3. Developing “Eco-Circularis”

4.3.1. Fundamental principles of “Eco-Circularis”

The player has to manage a recycling yard with a sewage treatment plant. He starts at a predefined area on a map. The task of the player is to treat waste and wastewater and to develop a good looking and working city. Through accepting and treating waste and wastewater, he gains money and

experience. Step by step he improves his recycling yard and treatment plant. One fundamental game mechanic is that waste and wastewater will be produced by his or her Facebook friends. The more active friends he or she got, the more waste can be treated and more money can be earned. The player gives his friends the possibility to build waste and wastewater producing building on his map and he can also construct buildings on the map of his friends. The recycling yard is a separated area on the map. The player gives his friends options to buy freeholds, which are also on a separated area with streets and infrastructure.

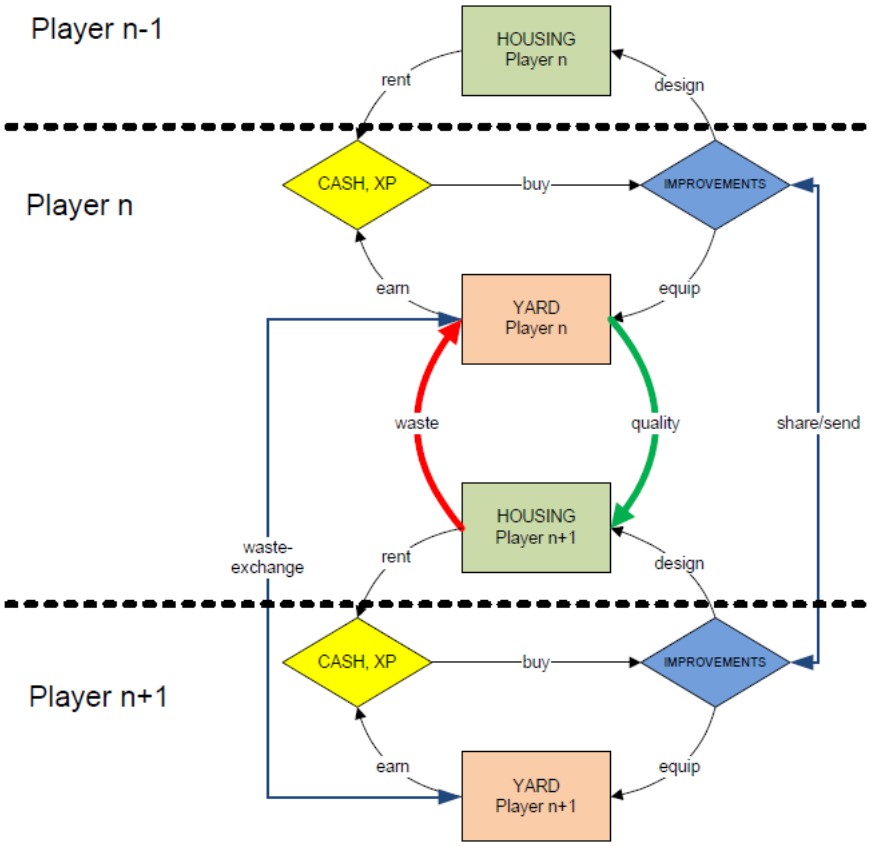


Figure 9: Fundamental game principles: Improvement cycle

As you can see on the figure, there are two sections, where the player is able realizing himself. It's the yard with the waste treatment and the housing with the individual expression. To improve the quality of the housing and to create more unique buildings, the player has to earn more cash to buy these improvements. Also it should be possible to trade or share these improvements with his friends, similar to other social games. If the housings reach higher standard trough additional equipment, the rent rises and the players earn more cash. Simultaneously the amount of waste and wastewater rises too. Now, the player has to ensure the waste management. Otherwise it will not be possible to develop higher standards. Consequently we have a closed loop of improving the waste treatment and improving the housings. That's why we call the game "Eco-Circularis". The motivation for the player should be a good working waste treatment, which leads to a more unique and

impressive buildings at the maps of his friends. The player should be also motivated to develop a nice and unique looking city on his own map. That should be the reason, why he needs the help of his friends, and so the social aspect gets started.

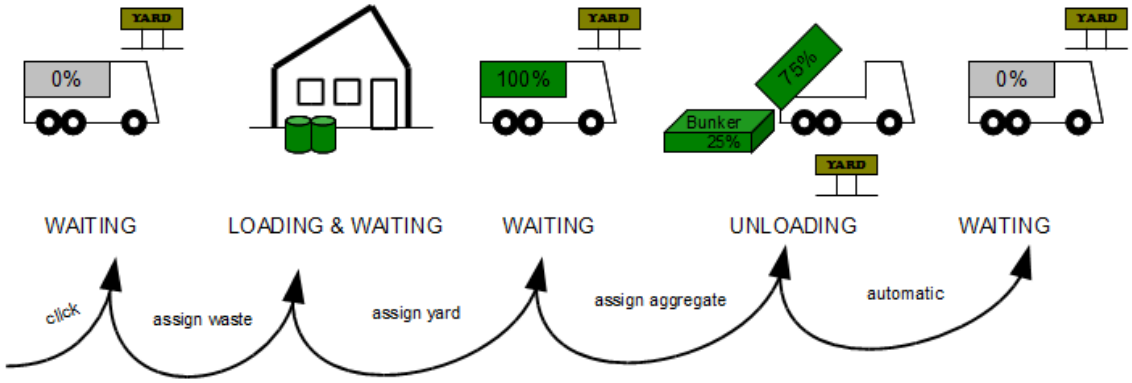
4.3.2. Further game mechanics

4.3.2.1. How to treat waste?

4.3.2.1.1. Collecting waste by garbage trucks

As seen in other popular social games, the actions should be not automatic. The player has to click every waste and garbage truck to collect waste. The purpose is that every click enables the player to get a small reward. That could be a special sound or a graphic effect. In the game, the waste containers should stand at front of the buildings, and in later level at collecting points. In any case, the containers with the waste have to be visible. The aim of the player is to assign a garbage truck for the waste. In later progress, there should be simplified collecting with bigger, faster and more intelligent trucks. After collecting, the truck arrives at the yard and waits, after clicking these waiting trucks, the treatment starts. The first reward receives the player after collecting waste by garbage truck in front of the housings. The second reward will be received after the complete treatment of the waste. It has to be possible that experience points can compiled by clicking every step of this process. The following figure shows the estimated five steps of waste collecting in the game.

Table 5: Five steps of collecting waste in game

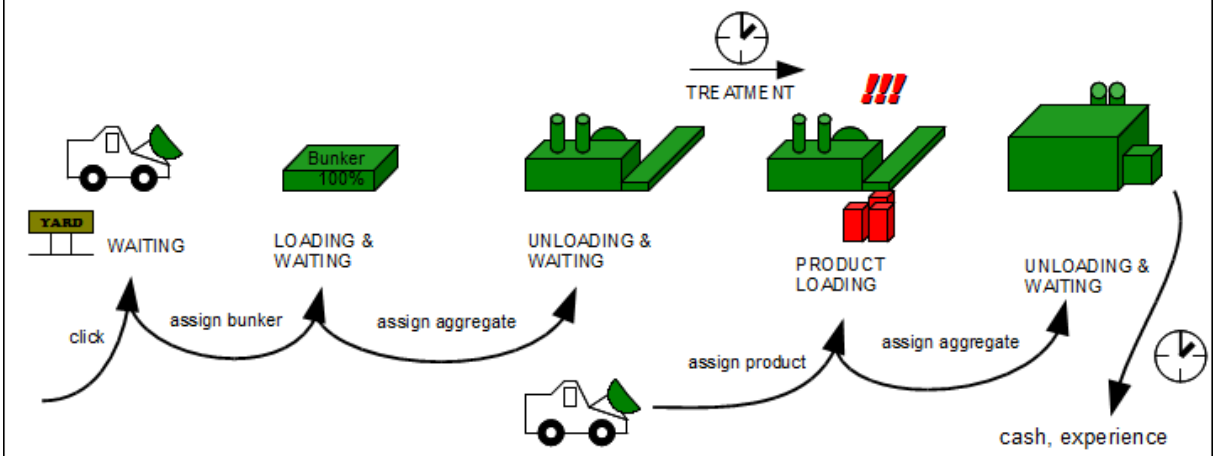
Step 1	Step 2	Step 3	Step 4	Step 5
				
(1) Garbage truck waits in front of yard (2) click truck to start collecting	(1) Assign truck to waste in front of a house (2) Maybe assign waste in front of next house (3) Truck moves off, arrives and starts to load waste (with lots of sounds) (4) After loading, the truck waits	(1) Truck drives in front of the yard (with sounds) (2) Truck waits in front of yard til player clicks it and assigns a aggregate on the yard	(1) Truck unloads waste (specific sounds) (2) Truck drives on the yard after assigning aggregate (sounds) (3) After unloading, truck drives automaticly in front of the yard	(1) Garbage truck waits in front of yard (2) click truck to start collecting
	REWARDs • Cash • Experience		REWARDs • Cash • Experience	

4.3.2.1.2. Treatment of the waste

There should be different kinds of waste treatment machines on the yard, which are all buyable. Some of them could be mobile with less efficiencies and costs. On the other hand there could be immobile machines which are very efficient and expansive. The player has to choose which correct aggregate to treat a specific waste type. There have to be different procedural stages like bunker, shredder, sieve, etc. Every single process has to be started by the player. He has to become aware how to treat waste in a correct way and supervise the whole process in each single step. In this case, lots of rewards by starting the machines by clicking can be placed into the game play mechanics.

To explain the whole treatment mechanic, here is an easy example: The player wants to compost green waste. At first, he clicks the right garbage truck, which is indicated by a green colour for green waste. After that, the truck drives on the yard. In the second step, the player clicks the trucks, which status is now “on the yard”, and sends it to the green waste bunker. The bunker gets filled by the truck and the player can watch the unloading process and check the fill level. To assign a wheel loader to transport the green waste to the shredder should step three. After loading the shredder, the process starts to working for a certain time. The player can watch and has to wait till the shredder has finished. After that, there pops a product out of the machine. In the fourth step, the player has to assign a wheel loader to bring the product to the next treatment facility. This production chain should be at first very simple and less profitable/ecological. At higher levels, they have to be more complex and profitable/ecological. However that be, there should be process parameters for this single machines like performance, costs, buying/sale price, environmental sustainability, storage, size, mobility and so on. At the end of every process, the waste should “disappear” and transformed to income and experience points. Intermediate products can be stored, traded to friends or sold to the “system” for less money. Every transport should be managed by the player by assigning a vehicle to do this. In higher levels, there are maybe conveyors. For every complete action, the player should gain small rewards like experience, prestige, special items or money.

Table 6: Five steps of waste treatment in game

Step 1	Step 2	Step 3	Step 4	Step 5
				
(1) Wheelloader (WL) waits on the yard (2) Click on the WL to start treatment	(1) Assign WL to loading waste at the bunker (2) WL drives to bunker and loads waste (3) After loading, WL waits in front of bunker	(1) Assign WL to aggregate (2) WL transports waste to aggregate (sounds) (3) WL unloads waste (4) After unloading, WL waits (5) Aggregate starts treatment	(1) Treatment ends after certain time, indicated by exclamation marks (2) Product pops out of the aggregate (3) Assign WL to load product	(1) WL unloads product at assigned aggregate (2) After unloading, WL waits for next assignment (3) Aggregate starts treatment (4) If final aggregate, product completly transformend into cash and experience
			REWARDs • Cash • Experience	REWARDs • Cash • Experience

4.3.2.1.3. Wastewater delivery

The player has to build a sewage treatment plant on his yard. Every estate will be connected automatically to the sewage system, which ends at the treatment plant inside the yard. This sewage system is recommended to let construct buildings on estates. The player has to build several aggregates for treating wastewater. The aggregates may have different parameters like size, efficiency, costs and maintenance. Checking the aggregates will be the task of the player. After a certain time, there should be maintenance. If he doesn’t maintain, the efficiency gets low and the tenants get unsatisfied, which results in decreasing rents. The plant may starts to smell and gets looking dirty, which will be a negative graphical consequence, visible for the player’s friends. The whole process should work every time, but if the player wants to have high efficiency he has to do more maintenance, which costs more money. All aggregates can be “tuned” by special items in a limited form (slots). Better aggregates should have more slots to improve the process and the items could be shared or traded with friends. The player earns money after clicking a process, which has finished. Every aggregate needs special storage parameters, so that after the storage is full, attention sign appears. The player is able to start the new process by clicking. The next aggregate will get filled

by the product of the former aggregate. To improve the efficiency, the player can install special items, like chemicals or bacteria. At the end, the wastewater “disappears” from the map and is transformed into cash and experience points.

4.3.2.2. How will the waste be produced?

4.3.2.2.1. Construction of waste/wastewater producing buildings

The housings are the origins of all waste and wastewater. The clue in this game is that your Facebook friends can built this “producers” on your map, and the player himself is of course able to build on the map of his friends. But there should be also limitations. We suggest a level system based on experience points. Every higher level, the player should be able to build one new housing his own map and one on the map of his friend. For every own house build in the own map, one friend is able to build a house on your map. In higher level, it would be conceivable that one own house plus two or more house form friends can be build. Players with a lot of friends should have an advantage at his stages of levels. Nevertheless, the game has to be playable with no or only a few Facebook friends, but not as quick as with more friends. At this point, the virality becomes import, which is typical for social games.

There will be different sizes and types of housing with different amount of waste and wastewater production. The amount of waste depends on realistic parameters like size (number of inhabitants) and type (poor people to rich people). The waste pops out the building if the owner, and not the player, clicks the housing at the map of his friend to collect the rent. At the same time, the rent and waste pops out. It will be recommended that all of the players are able to visit the map of his friends. The waste stands in front of the building and is ready for loading by garbage trucks. Every time the owner collects his rent, there comes new waste out of the building, no matter how much waste already stands in front of the housing. But if there is too much waste in front, the rent decreases, because the waste begins to smell. So the owner has to contact his friend to load the waste by garbage truck. If there is a quick and active loading of waste, there should be a win-win-situation for both players. If there is more waste, the player is able to treat more and if there is more rent for his friend, he can build more or better housings or aggregates. The rent can be collected after a certain time, depending of housing type.

4.3.2.2.2. Designing these buildings individual

All housing has to be designed individually. Consequently the player needs a housing editor or house designer. This editor should be very easy to use and provides a huge amount of combinations of different style and sizes. One building consists of different modules, which can be bought or unlocked per level. There should be different possibilities for each module. The player has to be able to select colours and fancy details to create a very unique building. The editor shows the player how much it

will cost and much he will earn and also how much waste and wastewater will be produced. At the end, the player can save his layouts. He also should manage his existing buildings to improve them in the editor. The amount of rent and waste/wastewater depends on inhabitants and prosperity. The number of inhabitants depends on size, the prosperity of the complete equipment. In this case an ingenious mechanic will be recommended.

4.3.2.2.3. Building industry and commercial buildings (advanced development)

In later game play, there could be advanced buildings possible, like industrial and commercial ones. They could produce more waste and wastewater in a more specific way. The rents will be consequently higher. This idea is too complex for now and could be an option to expand the game.

4.3.2.3. What else could be done?

4.3.2.3.1. Share/trade waste and improvements with friends

It should be possible to send excess waste to friends for treating there. Confirmation will be needed. In the same way, the player should be able to send used or old improvements to players, which are new.

4.3.2.3.2. Use common team-infrastructure with friends

An additional game play element could be the usage of a common team infrastructure. This could be a nice feature in the later levels. Big amounts of waste should be more efficient treated on aggregate, which is owned by more than one player. The aggregate needs access privileges and is only buildable on one players' yard. To use this aggregate, all the other players have to send their waste to this facility. At later levels this could be a must have, because of lack of space and differentiation of the waste treatment.

4.3.2.3.3. Tease your friends

Another funny idea could be mechanic which opens the possibility to tease your friends. That could be a little sabotage on the aggregates on the yard, but without negative consequences to the process. This will be only a graphical or sound effect. This mechanic could be used for remembering the friend to collect the waste from the buildings.

4.3.2.3.4. Help your friends treating the waste

To extend the social aspect of this game, there should be the possibility to help friends. A running process can be accelerated by a friend. He should have limited time units, which he can spend to specific aggregates.

4.4. Game play example

4.4.1. Tutorial mechanic

Complex management games require a tutorial system. The player has to learn the rules of the game and how the different tools work. This chapter gives a list of actions, which the player should learn at first. The game starts with small amount of cash, no experience points, a yard (green field) and some streets with one house, which was automatically built and is owned by the player. The yard also provides some workers and a donkey card for garbage collection.

1. **Buying Aggregates**

   The player gets displayed the purchase menu with only one aggregate for the composting. He has to select this one and place it on the yard. The aggregate could be the green waste bunker. After placing, the player has to select the second aggregate for treatment. The process engineering is for this small part completed. The player gets the first reward and experience points.

2. **Collecting Rent**

   In the next step, the player has to learn how to collect the rent of his estates. The display shows now the players' first house, which is ready to spend the rent. The player has to click the building and money pops out the building directly through his cash bar. At the same time, the first waste pops out too.

3. **Collecting waste**

   Now, the player is able to collect the first time waste. The display switches back to the yard. The donkey cart is getting marked by a graphic effect and a short description. The player has to click the donkey and assign to the waste in front of the house. After that, the cart starts to move with a lot of sound effects. After reaching the building, the waste will get loaded automatically. The tutorial system calls for attention to send the donkey back to the yard. After reaching the yard door, the cart waits for the assignment to the bunker. The unloading of the cart has to be assigned to the bunker. The collection is completed after that and the player gets a reward, cash and some experience points.

4. **Waste treatment**

   The waste is now ready in the bunker. The player is shown a worker on the yard. He has to assign them to bunker, so the worker can load the green waste. After loading, the player has to assign the next process step – the shredder. If it was clicked, the treatment process at this aggregate starts. A short time later, the process is finished. The player gets a reward, cash and experience points. The player gets congratulations that he treated his first waste. Some graphic effects appear. The next level is reached.

5. **House design and construction**

   At this stage, the house designer will be shown to the player. There has to be a short description that you can expand to your own city and to the cities of friends. The introduction of the house designer depends on the user interface. At first, the player should be able to select only a few components for the building. But it seems to be important to show the player all possibilities of the later game so he gets motivated to buy this equipment. After compiling a building, he is able to save this custom draft. In the next step, he can select his city to place the building. After that, the player gets congratulations and experience points.

The main tutorial is completed and the player is able to play undirected. During the first levels, the player should get hints for everything, what comes new into the game.

4.4.2 Later game play

For further examination, this chapter shows the game play and technologies of three different levels. The game itself will have more levels as shown below.

Table 7: Low, medium and high level technologies

Unlocked technologies	Low levels	Medium levels	High levels
Waste types	Biodegradable	Recyclable waste (paper, glass or scrap metal)	Hazardous and radioactive waste
Aggregates	Composting	Sorting plant or Reused glass factory	Waste incineration or Atomic waste reconditioning plant
Transportation	Donkey carts	Garbage truck or wheel loader	Electric or future technologies
Building components	Wooden, brickwork, Simple styles	Glass materials, heat insulation, solar and thermal energy	Sustainable housing technologies, zero emission technologies

For further environmental engineering technologies, you can check the appendix.

5. Conclusion and outlook

To summarize this project, a lot of potential is shown. Educational content teaching through social games is no antagonism. The extension of games with engineering is easily possible, because of the wide spectrum of this science. Increasing complexity will be also no problem, because of the new technologies and the large amount of combination of different aggregates.

This introduced game is only a collection of ideas. All parts have to be checked for scaling, especially the social and economic parts. On-going scaling is recommended for solving future problems.

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7. List of figures

8. List of tables

9. Appendix

Waste types

1.1. Solid waste types

1.1.1. Biodegradable waste

1.1.1.1. Green waste
1.1.1.2. Food and kitchen waste

1.1.2. Recyclable waste

1.1.2.1. Used paper (waste paper)
1.1.2.2. Scrap glass
1.1.2.3. Scrap metals
1.1.2.4. Construction/demolition waste (concrete & masonry)
1.1.2.5. Packaging waste

1.1.3. Special Hazardous/toxic waste

1.1.3.1. Medication
1.1.3.2. Chemicals
1.1.3.3. Batteries
1.1.3.4. Explosives
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1.2. Wastewater types

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1.2.2.2.1. Grey water
1.2.2.2.2. Black water
1.2.2.2.3. Yellow water
1.2.2.2.4. Brown water
1.2.2.3. Three-mass flow system
1.2.2.3.1. Grey water
1.2.2.3.2. Brown water
1.2.2.3.3. Urine
1.2.3.Industrial sewage

Aggregates…

1.1. …for biodegradable waste

1.1.1.Storage place
1.1.1.1. Deep bunker
1.1.1.2. Flat bunker
1.1.2.Raw mechanical conditioning
1.1.2.1. Comminution
1.1.2.2. Magnetic separator
1.1.2.3. Sieving
1.1.3.Treatment facility
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1.1.3.1.1. Static treatment
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1.1.3.1.3.2. Rotting drum with sieving
1.1.3.2. Fermentation
1.1.3.2.1. Dry-fermentation
1.1.3.2.2. Wet-fermentation
1.1.4.Fine mechanical conditioning
1.1.4.1. Sieving
1.1.4.2. Impurity selection
1.1.5.Product storage
1.1.5.1. Warehouse

1.2. …for recyclable waste

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1.2.1.1. Dumpsite
1.2.1.2. Disposal
1.2.1.3. Warehouse
1.2.1.4. Storage site
1.2.1.5. Waste tip
1.2.1.6. Scrap yard
1.2.2.Raw mechanical conditioning
1.2.2.1. Defibration with a pulper (used paper)
1.2.2.2. Separation (magnetic, optic, density, by hand)
1.2.2.3. Grinding (breaker)
1.2.2.4. Sieving (different ranges with different physical methods)
1.2.2.5. Kiln
1.2.3.Treatment facility
1.2.3.1. Reused paper factory
1.2.3.2. Reused glass factory
1.2.3.3. Collection station
1.2.3.4. Scrap metal station
1.2.3.5. Sorting plant
1.2.3.6. Disposal

1.3. … for hazardous/toxic waste

1.3.1.Storage
1.3.1.1. Deep bunker
1.3.1.2. Flat bunker
1.3.2.Treatment facility
1.3.2.1. Special waste department
1.3.2.2. Special waste landfill
1.3.3.Conditioning
1.3.3.1. Sorting
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1.3.3.3. Incineration
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2. Product Types

2.1. Biodegradable waste

2.1.1. Compost
2.1.2. Biogas
2.1.3. Fertiliser

2.2. Recyclable waste

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2.2.2. Glass
2.2.3. Metals
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2.2.4.3. Rocks
2.2.5. Composite waste
2.2.5.1. Clothing
2.2.5.2. Tetra packs
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2.3.

3. Aggregate attributes

3.1. Size (square units)
3.2. Appearance (graphic)
3.3. Building costs ($)
3.4. Selling price ($)
3.5. Construction time (min)
3.6. Storage capacity (units)
3.7. Accepting goods (list)
3.8. Producing goods (list)
3.9. Improvement slots (number)
3.10. Efficiency (treatment time per unit)
3.11. Input/output ratio (products per treated goods)
3.12. Probability of failure (%)
3.13. Maintenance time (min)
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House Designer

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     - 1.1.2.Pools
     - 1.1.3.Garages
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         - 1.2.2.1.5. Mansard roof
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         - 1.2.2.1.8. Flat roof
         - 1.2.2.1.9. Green flat roof
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         - 1.2.2.2.3. Brown
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      - 1.2.5.3.1.5. no plastered lime-sand brick
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    - 1.2.6.1.2. Casement window
    - 1.2.6.1.3. Slide window
  - 1.2.6.2. Glasses
    - 1.2.6.2.1. One glasses
    - 1.2.6.2.2. Two glasses
    - 1.2.6.2.3. Three glasses
  - 1.2.6.3. Accessory

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1.2.6.3.2. Automatic roller shutter
1.2.6.3.3. Folding shutter
1.2.6.4. Colour
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2.1.1.2. Eco-Standard
2.1.1.3. High Eco-Standard
2.1.1.4. Extravagance
2.1.2.Alarm system
2.1.2.1. Standard
2.1.2.2. Good
2.1.2.3. Better
2.1.2.4. Premium
2.1.3.Electric energy production
2.1.3.1. Energy source
2.1.3.1.1. Fossil fuels
2.1.3.1.1.1. Oil
2.1.3.1.1.2. Gas
2.1.3.1.2. Atomic based
2.1.3.1.2.1. High level feature
2.1.3.1.3. Renewable Energy
2.1.3.1.3.1. Photovoltaic panels
2.1.3.1.3.2. Windmill
2.1.3.1.3.3. Geothermal energy
2.1.3.1.3.4. Biogas
2.1.3.1.3.5. Tidal power
2.1.3.1.3.6. Waver power
2.1.3.1.3.7. Fuel cell
2.1.3.2. Size
2.1.3.2.1. Free scalable
2.2. Heating installation
2.2.1.Size
2.2.1.1. Free scalable
2.2.2.Energy source
2.2.2.1. Electric
2.2.2.1.1. Standard
2.2.2.1.2. Eco-Standard
2.2.2.2. Coal
2.2.2.2.1. Tile stove
2.2.2.2.2. Coal-fired central heating
2.2.2.3. Gas
2.2.2.3.1. Gas-fired central heating
2.2.2.4. Renewable
2.2.2.4.1. Pellets
2.2.2.4.2. Wood
2.2.2.4.3. Biogas
2.2.2.4.4. Geothermal
2.2.2.4.5. Heat pump

2.2.2.4.6. Solar thermal energy

2.3. Sanitary installation

2.3.1.Toilette type

2.3.2.Water supply

2.3.2.1. Groundwater well

2.3.2.2. Central water supply

2.3.3.Wastewater type

2.3.3.1. Mono-mass flow system

2.3.3.2. Two-mass flow system

2.3.3.3. Three-mass flow system

2.3.4.Comfort

2.3.4.1. Low

2.3.4.2. Medium

2.3.4.3. High

2.3.4.4. Premium

2.3.4.5. Luxurious

2.4. Communication & media systems

2.4.1.Standard

2.4.2.Accurate

2.4.3.High

2.4.4.Premium

2.4.5.Luxurious