The M-SG framework: A framework for Multiplayer Cooperative Serious Game development

by

Supara Grudpan

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Gutachter: Prof. Dr. Rainer Malaka Universität Bremen

Prof. Dr.-Ing. Jannicke Baalsrud Hauge KTH Royal Institute of Technology

This dissertation is dedicated to my family, who is my motivation and inspiration for my life...

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Supara Grudpan

Abstract

Designers and developers have to consider many factors when creating Serious Games (SGs), including entertainment and education. After playing games, SGs aim to improve players' or learners' skills (s). In a pedagogical sense, SGs should teach players/participants. SGs should entertain players throughout the game. Thus, SGs must motivate players. Developers must analyze functional demands to select game elements for learning objectives. Developers should also consider non-functional factors like delight and entertainment to promote long-term user engagement. Another issue is that SGs are tailored to learning objectives, which makes recreating and reusing their output difficult and costly. Multiplayer cooperative SG development needs additional work. First, the gameplay must meet conventional multiplayer game needs like player participation and interaction and SG design restrictions like learning content, flexibility, and personalization. Second, players collaborate to achieve a goal in cooperative games. Design must consider both. The developers must consider embedded instructional content, mechanics that engage many players, and mechanics that encourage cooperation throughout the game. Existing research and methods are suggested to solve the challenges of building serious games. However, due to the necessity to address the remaining gaps in usability and utility, only a few of these methods were implemented in actual projects.

The main goal of this research is to investigate systematic ways to develop multiplayer cooperative SGs. This thesis aims to develop a systematic method for decreasing the effort required to develop SGs while retaining the game's entertaining and educational purposes. It presents the findings of an investigation on the effects of game elements on player experience in multiplayer cooperative entertainment and serious games. The lessons learned from producing cooperative serious games, as well as the results of user research conducted for developing "The M-SG framework," a framework to support multiplayer cooperative serious games. To fulfill the primary purpose of this thesis, a user evaluation of the framework was conducted.

The results indicate that the M-SG framework can benefit the research of multiplayer cooperative serious games and improve the reuse of games from previous projects by modifying the games' premises. These findings show the value of the M-SG framework as a tool for supporting the development of cooperative serious games.

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Chapter 1

Introduction

Serious Games (SGs) are games for non-entertainment purposes (Alvarez, Djaouti, et al., 2011; Cheng, Chen, Chu, & Chen, 2015; Hauge, 2007). It is the game that education is the primary goal over entertainment. Adding game elements to instruction is likely to have different effects on both short-term and long-term learning based on the game elements used and the situations in which they are used (Landers, 2014). Even SGs are used in various applications such as industrial production and logistics (Quandt et al., 2020), medicine (Malaka, 2014), military (Yildirim, 2010), etc. However, the games still have challenges motivating players, especially the educational games or the games for learning (Arnab et al., 2015; Carvalho et al., 2015; De Gloria, Bellotti, & Berta, 2014). One of the well-known problems of learning games is the "Chocolate-Covered Broccoli" phenomenon, in which games engage people with uninteresting content by adding motivating elements (Galarneau, 2005). The crucial aspect of Chocolate-Covered Broccoli is that "fun and quality" take a back position to the product's educational value. The major problem with Chocolate-Covered Broccoli is that players or learners can scent it from a great distance. They will still recognize broccoli regardless of how much chocolate (fun) you attempt to disguise it with. The Chocolate-Covered Broccoli problem can be resolved if serious game designers consider pedagogical and learning theories alongside game design aspects (Supriana, Agustin, Bakar, & Zin, 2017). More specifically, SGs developers have to create engaging environments and encourage users (learners or players) to continue playing while they remain motivated by the game's elements and enjoy spending time with the embedded educational content.

From a software engineering point of view, implementing SGs is challenging because developers have to consider pedagogical and entertainment requirements (Carvalho et al., 2015). To fulfill the pedagogical requirements, SGs should be developed in the instructors' views to achieve pedagogical goals such as conveying knowledge, improving

skills, etc., which are considered the functional requirements of the game. SGs developers need to explore ways to add pedagogical content to the game. In this process, linking the suitable game elements to the learning goals has to be taken into account (Amory, 2007; Arnab et al., 2015; Carvalho et al., 2015). An example of applying game elements with the learning goal is applying puzzles for learning algebra in Dragon box games (Siew, Geofrey, & Lee, 2016). In a similar way, player engagement in the long term is also a major challenge in developing SGs (Malaka, 2014); developers should also consider adding game elements that have an effect on player experience to organize player engagement in order to fulfill the non-functional requirements of the games.

In SGs development projects, developers need to manage the aforementioned challenges. The development of multiplayer cooperative SGs is more complex with unique requirements (Zagal, Rick, & Hsi, 2006). First, the gameplay has to fulfill the needs of traditional multiplayer games, i.e., players' engagement and interaction, and overcome challenges in SGs design, including learning content, adaptation, and personalization (Wendel, Gutjahr, Göbel, & Steinmetz, 2013). Second, cooperative games are characterized by communication and cooperation among players to achieve a goal. Both characteristics must be taken into consideration in the design. The developers need to consider the embedded learning content, the mechanics to engage multiple players, and the mechanics actuating players to cooperate through the games. This led to the motivation of this thesis to investigate tools or guidelines that support developers in implementing multiplayer cooperative SGs that fulfill both pedagogical and entertainment goals.

Several existing research and approaches (Aleven, Myers, Easterday, & Ogan, 2010; Amory, 2007; Callaghan, Savin-Baden, McShane, & Eguiluz, 2015; Carvalho et al., 2015; Toups et al., 2014) are proposed to overcome the abovementioned problems. However, only a few of those approaches were applied in real-world projects because the remaining gaps in usability and usefulness needed to be addressed. This leads to my first exploration into using systematic approaches for SGs developments. I developed an online survey to observe opinions from games and SGs developers and researchers about their usages of systematic approaches for SGs developments. More than half of my participants (57.1 "%, 16 of 28) responded that they were experienced in using a systematic approach in development projects. I asked further questions about how the participants applied the systematic approach to their projects. I found a dramatical decrease in the number that only 10.7% (3 of 28) of the participants used a systematic approach as a "common" approach for their development projects. The top three reasons for the denial of applying the systematic approach as a common practice are difficulty in learning new models or frameworks (50 %, 8 of 16), unable to find models or frameworks that are useful for their projects (37.5 %, 6 of 16), and the complexity of using model/ framework (25 %, 4 of 16). The survey results are in line with Carvalho's work which takes

the usability of the framework into account in order to create standard tools for multi-disciplinary team communication (Carvalho et al., 2015). Therefore, it is vital to define a systematic approach for minimizing the effort for SGs development while maintaining the entertainment and pedagogical goals of the game (Callaghan et al., 2015; Carvalho et al., 2015) with the consideration of the framework usability.

This thesis investigates the systematic approach for supporting the development of multiplayer cooperative SGs. The complexity of developing multiplayer cooperative SGs, especially the game for decision-making and the gaps in the current systematic approach, which are the lack of SGs analysis frameworks or models that can identify the relation of learning, game mechanics, and players' interactions in the component levels, as well as the lack of framework and model that considers organizing player experience and the low implementation in the real-world project, impede the development of multiplayer cooperative SGs (see details in Section 2.3). The subsequent section describes the formulation of this thesis's research question and hypotheses.

1.1 Thesis Statement

This thesis investigates the systematic approach, such as methods, methodologies, and frameworks for supporting games and SGs developments for analyzing and implementing cooperative multiplayer SGs.

From the technical point of view, implementing SGs is challenging because the developers must balance the players' enjoyment with the learning contents that need to be embedded into the game to transfer knowledge to the players or learners (Browning, 2016; Chavez, 2019; Slimani, Yedri, Elouaai, & Bouhorma, 2016). Developing multiplayer cooperative SGs is even more complex than the single-player SGs due to the developers having to handle the needs of the traditional multiplayer games and challenges of the cooperative fashion, such as engaging multiplayer to cooperate through the games (Wendel et al., 2010, 2013; Zagal et al., 2006). Therefore, it is essential to understand the game structure to support SGs developers in developing SGs (Arnab et al., 2015; Carvalho et al., 2015). This led to the first focus of this thesis on exploring the approach for analysis of multiplayer cooperative games to fill the gap of the existing systematic approach in presenting relations of games, learning elements, and players' interactions in the component level(Carvalho et al., 2015). Moreover, the complexity of providing an environment for creating players' cooperation and engaging in multiplayer in cooperative SGs (Wendel et al., 2010, 2013; Zagal et al., 2006) is my motivation for the second focus of this thesis which is to explore the effect of game elements on the player experience to create the

guideline to organize the player experience of the games. Based on these motivations, I formulated the primary research objective and question below.

The research objective is to investigate the current systematic approach that can be extended to assist developers in the analysis structure of multiplayer cooperative games, which have the complexity of presenting relations of games, learning elements, and player interaction while considering players' engagement. This thesis intends to bridge the gap of the existing framework mentioned above, which leads to the following research question (RQ):

RQ: How can a systematic approach support developers in implementing multiplayer cooperative SGs that can motivate players to experience cooperative SGs in the desired way while still fulfilling the games' education goals?

Based on the main research question, the hypotheses of this thesis are formulated according to the investigations related to the ***players*** and the ***developers***. The explorations of this thesis are conducted around these two pillars. For the players-related, I first explored specifying game elements that keep players motivated in learning through the multiplayer cooperative SGs. For the developers-related, I aimed to propose a systematic approach supporting developers to systematically design and develop multiplayer cooperative games that fulfill learning requirements. Moreover, I assessed the usefulness and usability of the systematic approach by specifying the possibility of applying the systematic approach to a real-world project.

The first pillar of this research is the investigation of *player-related*. Because it is vital to know which part of the multiplayer cooperative SGs can be modified to manage player experience, the finding can support developers in finding a systematic way to implement the game with the consideration of player motivation.

My preliminary user study was conducted to confirm the statement of Fullerton (2018), which reports that the game elements are essential in organizing the player experience. This statement also follows Deterding's statement (Deterding, Sicart, Nacke, O'Hara, & Dixon, 2011) that using game design elements in a non-gaming context can improve user experience (UX) and engagement. With a similar concept, I applied an approach to convert existing entertainment games into SGs. The conversion utilized the potential of motivating and engaging users in the entertainment games into the SGs to increase the educational value. This concept follows Ulrich's work (Ulrich & Helms, 2017), which mentioned that the mechanics in COTS (Commercial-Off-The-Shelf) games could provide educational value to players. To prove the concepts, I explored literature to identify game elements of entertainment games that potentially are candidates for organizing the player experience of the multiplayer cooperative SGs.

I employed the concepts proposed by Fullerton (2018) that classified game elements into three groups: formal, system dynamic, and dramatic elements. I then further identified the game elements that have the potential to influence the player experience. I defined additional criteria for the elements to be fundamental elements usually found in most game genres. Analyzing the elements should be able to be modified without changing core game mechanics. The selected element minimizes "developers" tasks in the game implementation, which is the main challenge of serious game development. Finally, based on the criteria, I found that *"Game Premise"* is the prominent candidate.

After that, I employed the player-centered approach to explore further how the *"Game Premise"* has an influence *"players"* in multiplayer cooperative entertainment games and SGs. I found further literature stating that the modification of morality in the game affects player behaviors (Grizzard, Tamborini, Lewis, Wang, & Prabhu, 2014; Tamborini, 2011) and player experience (Elson, Breuer, Ivory, & Quandt, 2014; Pearce, 2004). However, there is still a lack of research explicitly mentioning the customization of game premises using different morality versions of games and their effects. I first started by exploring the impact of game premises in cooperative games, then SGs. The cooperative entertainment game was selected as a preliminary study to reduce the bias of the players, which may be caused by the embedded learning content. As mentioned in the introduction, the developing SGs have challenges with player engagement. Therefore, the user study was designed to first explore the effect of the game premise on player experience without considering adding learning content. After that, based on the results of the first user study on the impact of the game premise on players in cooperative SGs, the user study was conducted. The main hypothesis is formulated as follows.

- H1: The customization of game premises using different morality versions influences players' experience and players' cooperation in cooperative entertainment games and cooperative SGs.

Since I was interested in developing cooperative SGs, the influence of game elements on the *educational value* of the cooperative SGs is also the main focus of this thesis. Therefore, I researched how different premise morality versions of the games influenced the learning outcome of players. Based on this, the hypothesis is formulated as follows.

- H2: Customizing game premises using different morality versions influences players' learning outcomes in cooperative SGs.

Another limitation to modifying the game premise in the SGs is that the learning contents should be embedded in elements that do not change the gameplay. This limitation is

added as a condition for implementing game prototypes to avoid bias in observing the effect of game elements on players, which the gameplay can cause, and to minimize developers' effort in modifying game prototypes. Therefore, to emphasize the differences between the game versions, the *Juiciness elements* were added to the game prototypes of the previous user study. Thus, we postulated the following hypothesis.

- H3: Adding juiciness elements to emphasize differences between the Moral and the Immoral versions of game premises influences players' experience and memory retention in cooperative SGs.

The second explorations pillar of this thesis is *developer-related*. This thesis's main objective is to create a systematic approach to support developing multiplayer cooperative SGs.The proposed systematic approach is later called the "Multiplayer Cooperative Serious Games Framework (the M-SG framework)." As mentioned in the introduction, the motivation to develop a systematic approach is to fill the gaps of the current systematic approach, which is to identify the relation between game and learning elements and the players' interactions at the component level (see details in sections 2.3). This thesis also aims to overcome the challenges in fully fulfilling the games' education goals and player motivation of the multiplayer cooperative SGs.

The investigations were conducted to develop a systematic approach for supporting multiplayer cooperative SGs, including a survey of SGs implementation trends, literature searches on the systematic approach, and practices from the lesson learned of multiplayer cooperative SGs development.

I started the investigations on the developers-related by conducting a literature search to identify the possible systematic approach that can be candidates to extend for analysis of multiplayer SGs, identifying games, learning elements, and player interactions. After that, the selected systematic approach was utilized to be part of the process of implementing the game prototypes for the user studies. At the same time, lessons learned for implementing multiplayer cooperative SGs by customizing game premises were iteratively collected. The elaboration of my proposed systematic approach, the M-SG framework, was created by interweaving the results of user studies of the effect of the game premise on player experience and lessons learned in multiplayer cooperative SGs development and applying the possible systematic approach with the implementation process. The prominent systematic approach with the selection criteria was selected and used to support the developer's team in each iteration of game prototype development. Based on the review results, I found that the Activity Theory-based Model (ATM) SG (Carvalho et al., 2015) is the prominent candidate. The reason is that the ATMSG model allows developers to analyze SGs at the component level. It also provides standard tools

for illustrating game flow and procedures to identify relations of games, learning, and instructional components of SGs. However, the model supports only single-player games, not multiplayer games. Thus, based on the ATMSG model, I researched the possibility of extending the ATMSG framework and applied the extension of the ATMSG model as part of our proposed M-SG framework. I formed the hypothesis as follows.

- H4: The extension of the ATMSG model supports developers in identifying the game, learning components, and players' interaction of the multiplayer cooperative SGs.

I further explored the developers-related. Based on the lesson learned and the user studies results, the guidelines for implementing cooperative games and SGs by modifying the game premise were proposed. The guidelines for modifying the premise consist of the *Transforming Game Premise phase* and the *Seasoning Game Premise phase*. The Transforming Game Premise phase is the procedure to convert cooperative entertainment games to cooperative SGs. The Seasoning Game Premise phase is the procedure to organize the player experience of cooperative SGs by modifying the premise of the games to the Moral and Immoral version.

Since this thesis aims to create a guideline to aid developers in implementing cooperative SGs, I also considered applying the proposed framework to real-world projects. To validate the usefulness and applicability of the M-SG framework, I led a two-day workshop with industry developers and university researchers. Participants were instructed to follow the protocols. The purpose of the study was to test the hypotheses listed below.

- H5: Transforming (converting) the premise of cooperative entertainment games can be an option to develop the cooperative SGs systematically.
- H6: Seasoning (modifying) the premise of cooperative SGs with Moral and Immoral versions can be an option to systematically develop games that can fulfill both entertainment and learning goals.

Research Methodology

This thesis classifies the explorations into two pillars: *players* and *developers*, to ensure that the proposed systematic approach can practically support developers in implementing multiplayer cooperative SGs while still concerned with player experience. Therefore, it is vital to understand the components of the games which affect player experience to create practical tools that support developers in systematically implementing and

organizing player experiences. Thus, the investigations of this thesis are interweaving between developers' and players' points of view.

The investigation started with literature research and a preliminary user study to identify possible game elements that affect players' experience in games and SGs. After that, the investigations of game elements' impact on players' experience in multiplayer cooperative games and SGs were conducted while the lessons learned from implementing game prototypes for the experiment were gathered. The systematic approach for supporting the development of the multiplayer cooperative SGs, later called the *M-SG framework*, was developed iteratively from the results of user studies, the lessons learned from implementing the game prototypes, and the prominent systematic approach that is the candidate to be extended. The methodological approach for this thesis can be summarised as follows (see Figure1.1):

1. Identification of the systematic approach that has the possibility to extend for supporting analysis and implementation of multiplayer cooperative SGs. This stage focuses on developers-related issues; a literature review was conducted to explore the systematic approach and identify the gaps in the existing model, framework, methods, and approaches for analyzing and developing games and SGs. The survey was also sent to SGs developers and researchers to identify the current systematic approach's usefulness and usability trend.

2. Identification of the game elements that have an effect on the player experience of the multiplayer cooperative SGs. This stage is players-related; I conducted the literature review on the impact of game elements on player experience, and the *"Game Premise"* is selected as a possible candidate. Then, the preliminary study of the effect of game premise in multiplayer cooperative SGs was conducted.

3. Development of the systematic approach to support multiplayer cooperative SGs. The systematic approach called the *M-SG framework* was iteratively developed based on the literature review to select a prominent systematic approach and user studies' findings to explore the game premise's effect on player experience in multiplayer cooperative SGs as well as the practices collected during cooperative SGs development. I conducted investigations of the interweaving between developers and players aspects with the consideration of usability in the proposed systematic approach: The lesson learned was repeatedly gathered while developing the game prototypes for user studies. The chosen prominent systematic approach, the results of the user studies, and the gathered lessons learned were used as guidelines for implementing game prototypes in each iteration.

4. The M-SG framework validation: the proposed framework was evaluated by experts in both the game industry (developers) and academics (researchers) to verify the usefulness and usability of the framework.

1.2 Outline of the Thesis

The overall structure of this thesis is presented in Figure 1.1. This thesis contributes to SGs development, Human-Computer Interaction (HCI), and Software Engineering. We proposed the M-SG Framework, a guideline for analyzing the cooperative SGs and a comprehensive way to develop the games with the concern of players' motivation. The outline of the thesis is as follows.

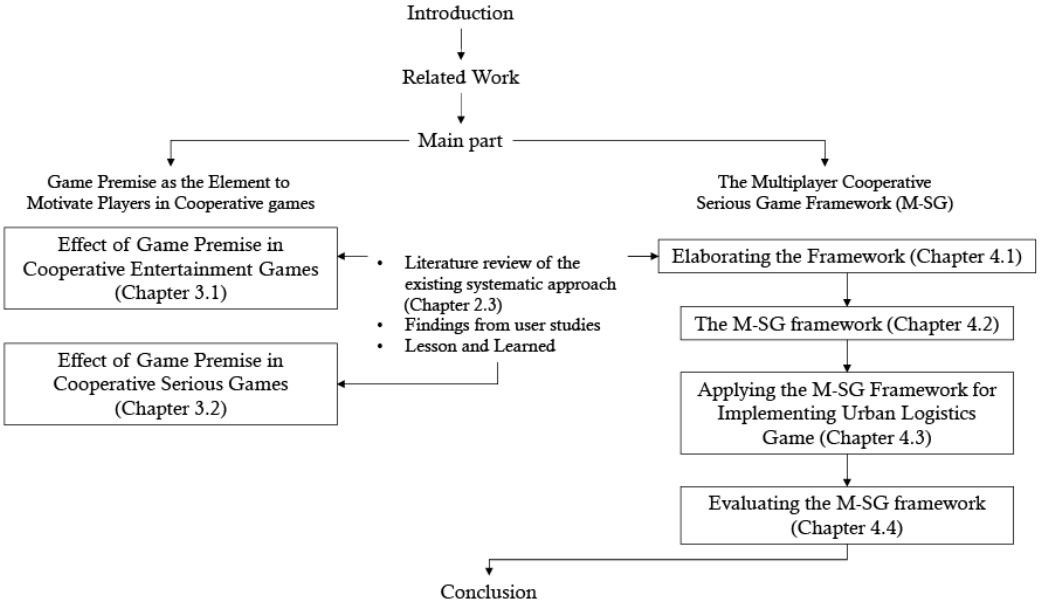


FIGURE 1.1: Research methodology and structure of this thesis

I described the issues that affect cooperative SGs' development: the complexity of identifying the connection between gaming and learning at the component level. Then, I explained the reason to support the use of dramatic elements to organize player motivation in the games. Given these scenarios, I outlined research objectives through research questions I answered throughout the thesis.

In Chapter 2, I began by suggesting that game components be structured from the perspective of the lens to look at the game from the aspect of SGs developers. The elements of games, SGs, and cooperative games are described. Then, the process of SGs development is presented. After that, I compared the advantages and limitations

of existing frameworks and models that support the development of games and SGs. Finally, the discussion of the current state-of-the-art of SG frameworks is presented.

Chapter 3 presents details of the user studies to explore the effect of the game premise on motivating players in both cooperative entertainment and SGs. The details include the procedure of conducting user studies, developing a game prototype in a different version of the premise, and the results of the studies. Additionally, each study presents the contributions to game development in subsections. Finally, the game premise effects on players and the contributions related to game development are summarised.

Chapter 4 presents a framework for analyzing multiplayer cooperative games and the guideline to simplify the development of the games called Multiplayer Cooperative Serious Games Framework (M-SG). This chapter includes the method of elaborating the framework. The framework details, which consist of the guideline for analyzing multiplayer cooperative SGs and the methods to organize player experience by transforming and seasoning the premise of cooperative games, are presented. After that, the application of the framework is shown. Finally, the evaluation of framework usefulness is presented.

Chapter 5 delineates the conclusions and direction of future research. I summarised the works and suggestions of the research concerning problem statements and research questions. Finally, I discussed the limitations of the work and indicated topics for future research.

1.3 Publications

This thesis is based on the following publications:

- Supara Grudpan, Jannicke Baalsrud Hauge, and Thoben Klaus-Dieter. A systematic literature review of challenges in urban logistics. In *Data Driven Supply Chains*, pages 227–231, 2017
- Supara Grudpan, Jannicke Baalsrud Hauge, and Rainer Malaka. Playful training for understanding activities, roles, and stakeholder in urban logistics. In *Supply Chain Networks vs Platforms: Innovations, Challenges and Opportunities*, pages 306–315. Centre for Concurrent Enterprise, Nottingham University Business School, Jubilee Campus, Wollaton Road Nottingham, NG8 1BB, U, 2019
- Supara Grudpan, Dmitry Alexandrovky, Jannicke Baalsrud Hauge, and Rainer Malaka. Exploring the effect of game premise in cooperative digital board games.

In *Joint International Conference on Entertainment Computing and Serious Games*, pages 214–227. Springer, 2019.

- Supara Grudpan, Jakob Hauge, Jannicke Baalsrud Hauge, and Rainer Malaka. Transforming game premise: An approach for developing cooperative serious games.In *International Conference on Games and Learning Alliance*, pages 208–219. Springer, 2021.

- Supara Grudpan, Keattikorn Samarngoon, Jakob Hauge, Jannicke Baalsrud Hauge, and Rainer Malaka. Towards transforming game premise: Validating an approach for developing cooperative serious games: An approach for developing cooperative serious games. *International Journal of Serious Games*, 9(3):43–61, 2022

Chapter 2

Related Work

The main contributions of this thesis focus on exploring game elements that have the potential to organize players' experiences and applying the findings and development practices to create a systematic approach for supporting multiplayer cooperative SGs implementation. This chapter presents the relevant background and associated work based on the main contributions of this thesis. The main concept centers around the lens of serious game developers, which describes the components and structure of cooperative games and SGs, and the challenges in developing SGs, especially cooperative ones. The literature on the game elements' effects and the player experience (pX) is also presented with a particular focus on the impact of dramatic game elements and morality in games on the players. Further, the systematic approach literature review includes models, frameworks, and procedures that enable the creation of games and SGs and discusses the limits of current systematic approaches.

2.1 The Lens for Serious Games Developers

Games are interactive applications that primarily consider player behaviors and nonfunctional requirements, such as player engagement, intuitive control, and graphics, from the perspectives of software engineering and application development. Consequently, as with any software development, the developer's team must identify requirements and effective team communication tools. In addition, the development of SGs necessitates player engagement and the achievement of educational objectives. Thus, it is essential to have specific tools for illustrating game architecture (Amory, 2007; Arnab et al., 2015; Carvalho et al., 2015) in both architecture design (high-level) and details design (low-level) to demonstrate how game elements support players in achieving learning goals and to reduce development costs and time (Carvalho et al., 2015) which identify the quality of

SGs. Thus, to create SGs that serve educational and entertainment requirements, game developers must now view games through a different lens than players (Hodent, 2017). In the subsequent session, we will discuss the topics that guide the readers to stand on the developers' view, including the definition of game mechanics in SGs research, the meaning of cooperative games and their components, and the literature on the impact of game elements on pX.

2.1.1 Game Mechanics in Serious Games Research

Game mechanics have been mentioned in many types of research. The research related to systematic approaches for supporting game developments proposes identifying the game structure and game mechanics to assist developers in understanding games and SGs architecture systematically (Amory, 2007; Arnab et al., 2015; Carvalho et al., 2015; Hunicke, LeBlanc, & Zubek, 2004). The Mechanic, Dynamic, Aesthetic framework (MDA framework) (Hunicke et al., 2004) exemplifies the systematic approach that is the framework for compelling games and supports creating an engaging pX. The mechanics mentioned in the MDA framework refer to the parts of games that make player behaviors (dynamics) that influence the emotional response of the players (aesthetics). Moreover, the game mechanics have been defined from the SGs developer's point of view. Arnab et al. (2015) described the game mechanics of SGs as " the design decision that realizes the transformation of a learning practice/goal into mechanical aspects of gameplay for the sole purpose of pleasure and enjoyment." Carvahol's work (Carvalho et al., 2015) referred that SGs mechanics consist of the game feature or facet that connects pedagogical practice (learning mechanics) to tangible game aspects associated with player actions. Consequently, learning game mechanics is a pedagogical approach that refers to the action or operation of learning dynamics. Typically, these mechanisms depend on games and educational theories.

In multidisciplinary research, game ontology has been investigated. The ontology issue frequently requires explanations of the components of games, how players interact with these components, and the context of the act of play. The game system research involved formally analyzing game components and their interdependencies. Sicart (2008) described game mechanics as the components of the game system, game hardware, and pX mapping mechanics into procedures and player emotions, utilizing the concept from object-oriented programming as methods invoked agents built for interaction with the game state. These works defined game mechanics as "the essential play activity players repeatedly perform in a game; in many games, the core mechanics are a compound activity composed of a suite of actions."

Björk and Holopainen (2006) defined the game mechanics in a more pragmatic way from the designer's point of view: "The game mechanics are what the players can do with the game world, how they do it, and how that leads to a compelling game experience." The core mechanics are generally used for identifying the characteristics of the game. Additionally, according to Jarvinen (Järvinen, 2009), game mechanics is available, preferred, or encouraged means by which players can interact with game elements while attempting to impact the game state at hand to achieve a goal. Therefore, core mechanics are the techniques players employ to reach an end-game state that is systematically rewarded.

For this thesis, I defined game mechanics from the SGs developer's and software engineers' points of view. This thesis describes the SG's mechanics based on the above literature related to game development and the requirements of SGs. The game mechanics of this thesis are defined as the components of the games that transform the learning practice or goal into gameplay, engaging players to participate in the SGs for the purpose of learning and enjoyment.

2.1.2 Cooperative Serious Games

Definition of cooperative serious games

Cooperation and collaboration are two distinct concepts but are often used as synonyms (Sedano, Carvalho, Secco, & Longstreet, 2013). Cooperation is when members develop their plans, share the resources, and discuss with the team. Cooperation is when individual actions or accomplishments take precedence over a collective strategy (Toups et al., 2014), whereas collaboration is when individual objectives are subordinated for collective success.

The words "Cooperation" and "Collaboration" have been employed in various contexts. Regarding game theory, Zagal et al. (2006) defined collaborative games as a game in which all participants work together as a team, sharing the payoffs and outcomes. Therefore, whether the team succeeds or fails, everyone benefits or suffers. Although each team member may have a different type of information, they all must work toward the same purpose. Collaboration as a team differs from cooperation among individuals in that cooperative players may have individual goals and payoffs. In contrast, collaborative players have one goal and share the rewards or penalties of their decisions. Making the most of the team's resources is one of the challenges participants face in cooperative games. The purpose of the games is to assist participants (players) in sharing their knowledge and expertise on a particular subject, identifying unstated presuppositions, and exploring that knowledge in ways that might not naturally emerge during normal interactions. People with various viewpoints on a subject are encouraged to work together

through the shared experience of collaborative games to understand a problem better and create a shared model of the issue or potential solutions. Some cooperative games can be utilized to comprehend different roles' points of view (Seif El-Nasr et al., 2010). Collaborative games often benefit from the involvement of a neutral facilitator who helps the participants under the rules of the game and enforces those rules. The facilitator's job is to keep the game moving forward and help ensure all participants play a role. The activities are created to foster creative thinking.

One of the primary purposes of this thesis study is to explore the effect of game elements of multiplayer games, which require players to make decisions together. Thus, cooperation and collaboration can be used interchangeably. Cooperation and collaboration in this thesis are activities in which team members come together to produce a single outcome. The term "activity" in this work refers to the game activities, which are how players or agents interact cooperatively through social activity in gaming to achieve the game goals (Ducheneaut & Moore, 2004; Wuertz et al., 2018). Therefore, the characteristics of cooperative or collaborative games are those in which players engage in independent activity while working toward a shared objective. Based on the definition, cooperative SGs are games in which player(s) share goals for solving problems; through group activities (in-game scenarios). Each team member's complex concepts and skills are developed by sharing perspectives, experiences, and knowledge.

Components of cooperative serious games

The mechanics of multiplayer games typically design with the primary concern of how players interact with one another to achieve their objective (Wuertz et al., 2018). When looking into more specific interaction patterns, the mechanics have been designed depending on the ways of player activity interactions (Ducheneaut & Moore, 2004). The design pattern can include game mechanics that provide competitive or cooperative environments for players (Ducheneaut & Moore, 2004; Zagal et al., 2006).

For competitive games, the player(s) must find a plan to oppose other player (s) or gaming systems to complete the task (Siu, Zook, & Riedl, 2014). Thus, game mechanics are mainly concerned with motivating players to want to win the game without focusing on teamwork. In contrast, the cooperative game's rules emphasize discussion and bargaining, allowing players to specify their needs (Maurer, Lankes, & Tscheligi, 2018).

In cooperative games, players must come together to solve problems or complete missions. The activities of team members determine the outcome of the game. Each player may have different or the same information regarding the game's setting, depending on their roles (Wendel et al., 2013). The players of the cooperative serious games share their expertise and experiences as they work together to solve the game's difficulties. It can

also be the fresh information/concepts players study while playing the game (Sedano et al., 2013; Zagal et al., 2006).

The cooperative game mechanics are analyzed according to those mentioned in (Linderoth, 2011; Rocha, Mascarenhas, & Prada, 2008; Sedano et al., 2013; Toups et al., 2014; Wendel et al., 2010, 2013). Player activities can be grouped into at least three steps: the opening step, the exploration step, and the closing step. Each step in the game typically has a time limit, such as the game turns of counting down timing. In the first step, the opening step, participants or players become involved in learning the game's rules and begin to produce ideas. Later in step two is the exploration step, during which individuals interact, investigate links among players' perspectives, test those ideas, and experiment with new ideas. Lastly, the closing step is assessing the thoughts and determining the most valuable and productive.

The first step, the beginning phase of games, is when players understand the game's rules and produce ideas together. The initial information for the player, such as the player's role, the game's rules, and the user interface, should be provided from the beginning state of the game onward. Consequently, game mechanics that help players understand their role and activities in the game, such as Narrative (cut scene, role play, avatar), Shared object (information, space), and Help (Guide characters/ Task lists), should be considered in this step (Toups et al., 2014).

In the second step, exploration, players interact with one another, search for connections between their ideas, and test and experiment with new concepts. This phase focuses on the game mechanics related to the players' actions (in-game). In general, the primary mechanics of many game types vary based on their qualities, rules, and genre. The players are beginning to communicate and share information and ideas to solve problems, generate solutions or new concepts, and make decisions collectively. Important game mechanics include Shared objects (3D space, avatars) (Hämäläinen, Manninen, Järvelä, & Häkkinen, 2006; Toups et al., 2014; Wendel et al., 2013), Segmentation of gameplay (Quest/Problem), and Goal metrics (performance records, success level, and time), which stimulate player participation and facilitate the sharing and exchange of ideas and information. In addition, the Rule (information, game master, multiplayer) and Narrative (cut scene, role play, avatar) can also be used as game mechanics to force players to make decisions, solve problems, and generate new ideas.

In the third and final step, participants evaluate the ideas and determine which are likely to be the most beneficial and productive. The measurement for assessing the group's decision-making can be a Key Performance Indicator (KPI) of the process that can be used to evaluate the group's decision-making. In addition, the players must receive feedback from their activities in the game to help them improve their strategy and urge

them to continue playing. Also incorporated are the cooperative game mechanics Feedback (progress bar, achievement, status level) and Segmentation of gameplay (alternate turns, challenges, levels, quests/problems) (Zagal et al., 2006).

For cooperative SGs, the example of feedback that can determine the effectiveness of the team's decision-making is a progress bar, achievement, status level, and shared rewards. Whereas individual Feedback (progress bar, achievement, status level) can reveal how well each player understands his or her position and how other roles and decisions affect collective decision-making (Wendel et al., 2013). Participants/players in cooperative games should receive the same payoffs and outcomes to avoid selfish players who make biased decisions based on their benefit. Thus, the game mechanics that support individual players are focused on the improvement of their personal skills that help them to engage the group by involving the group, such as individual Score (experience point: received when joining the game), while the group evaluation focuses on the goal of the whole group to measure the performance of group decision making such as Goal metric (group achievement, performance records, score, success level, time).

To sum up, the core game mechanics of cooperative SGs are mainly related to players' interaction and engagement to share knowledge and ideas through the game. Therefore, the core game mechanics important for designing multiplayer cooperative SGs are as follows.

- Narrative (Cute scenes, story, role play)
- Shared object (3D space, avatars)
- Help (Guide characters/ Task lists)
- Mechanics for gameplay segmentation (Quest/Problem, Time)
- Goal metrics (performance records, success level, time)
- Rule (information, game master, multiplayer)
- Feedback (team: progress bar, achievement, status level, joint rewards)
- Score (experience point)

In this thesis, I focused on the difficulty of creating cooperative SGs so that players can interact with them more desirably. To explain the structure of SGs, I drew on the work of several researchers who work on identifying SG components of SGs. I found that some researchers identify that SGs components can be classified into two sets: game mechanics and learning mechanics (Amory, 2007; Arnab et al., 2015; Carvalho et al.,

2015). From this point, I further investigated the systematic approach supporting this concept in section 2.2.

2.1.3 The Effect of Game Elements on Player Experience

This section presents the literature on the effect of game elements on pX, which first presents the theory to give an overview of how the developers look at SGs at the detail design level. Later, the impact of the game elements on the pX is shown in the sub-sections.

According to the systematic literature review shown in the section 2.2, the activity theory described by Carvalho et al. (2015) is selected to explain the concepts of game mechanics at the components level. Based on the activity theory described in the work of Carvalho et al. (2015), the components of single-player SGs can be deduced from the games' activities. The activities that motivate players to interact with objects in a game are called game mechanics. In contrast, learning mechanics refer to the learning elements that assist players in achieving the embedded learning goals of the game. When examining the details or low-level design, these mechanics can be seen as a collection of elements. For instance, the core mechanic of platformer games is to move forward (jump or run) over obstacles, which requires players to press the button at the appropriate time (Zhu, Wang, & Zyda, 2018). Game elements like Jump, Collide, and Move can be identified when examining the core mechanics in greater depth. To incorporate learning content into games, developers must identify game mechanics that simultaneously engage players while delivering learning content. For instance, a puzzle game like DragonBox Algebra 12+ may be appropriate for practicing mathematics (Siew et al., 2016), whereas role-playing games may be suitable for practicing communication skills and second languages (Rankin, McNeal, Shute, & Gooch, 2008).

According to the mentioned example, I classified games' elements to explore their effects on players based on Fullerton (2018). Fullerton (2018) defines games by their formal and dramatic elements and system dynamics. Formal elements are the elements that form the structure of a game. Every game has formal elements: players, objectives, procedures, rule conflicts, and outcomes. Without formal elements, the game would not be a game. For example, the game-play of Detroit becomes human (Dream & Entertainment, 2019) is to make decisions for the event in each scene, such as a player as a freedom fighter has fighter freedom to choose between surviving or saving an android. The formal elements mainly deal with the player's decisions and actions with objects in the scene. Hence, a game is not playable without those elements, which include the player and the game's tactics. Games are systems with a set of formal elements to

create a dynamic experience. The complexity of games depends on the entertainment process created by formal and dramatic elements. On the other hand, system dramatic, the abstract elements surrounded the formal element of objectives games. Examples of dramatic elements are game premise, character, and story. Dramatic elements can create a sense of connection for the players and their overall experiences. The elements can engage players emotionally by creating a dramatic context for the form elements (Fullerton, 2018). Retaking the example player's decision (Dream & Entertainment, 2019), the game uses narrative as the dramatic element to motivate the player. The interactive story-telling and varied ending of the game attract many players to spend money and time to finish it until the end.

In this thesis, the formal, dramatic elements and system dynamics are used for the classification of the game elements due to two reasons. Firstly, the category can help developers prioritize the core game features and formal elements to implement in the initial development project phase. Secondly, the developers look at the games systematically with a specific lens that can focus on customizing the game components and system dynamics that affect players' experience. The following paragraphs describe more details on the effect of the dramatic elements on the pX.

Game Elements and Player Experience

Hicks, Gerling, Dickinson, and Vanden Abeele (2019) explored the impact of visual embellishments on pX. The study found that juiciness design elements positively influence the visual appeal of games and effects, among other elements that contribute to overall pX. Gerling, Birk, Mandryk, and Doucette (2013) study showed that the fidelity of graphics influences pX when graphics are integrated with game mechanics that players attend to play(formal elements). Additionally, the authors found that graphics-fidelity influence affected pX by the game's difficulty in terms of positive effect, intrinsic motivation, competence, autonomy, relatedness, and immersion regardless of game type. Both works of literature focused on designing graphics for casual games. They were not considered the influence of different game contexts or the meaning of graphics in their conditions. Moser and Fang (2015) reported the investigation of narrative structure and many salient decision points that impact gameplay experience in role-playing games (RPGs). Elson et al. (2014) suggested that meaningful experiences of players can be shaped by the interplay of game narrative, mechanics, and context dimension. Squire (2006) supported the idea of transferring content (learning) to the context in video games because games have a dramatic potential to immerse the player in complex systems and allow them to learn the points of view of those systems. Gowler and Iacovides (2019) summarized the factors that create discomfort experience that impacts players' engagement in digital games. The experience of unwanted exposure to disturbing themes is one

factor that makes players feel uncomfortable with games. However, they also concluded that uncomfortable experiences facilitated richer game-play experiences and could lead to reflection on the border issues. Holmes et al. (2019) investigated the impact of aesthetic elements (theme and narrative) with pX in games. The authors designed and playtested two differently themed variants with the same game mechanics, "Horror" and "Sanitized." The preliminary findings suggested that scary content can sustain interest throughout the play and transform players' emotional responses to uncertainty. Petralito, Brühlmann, Iten, Mekler, and Opwis (2017) mentioned that the death of avatars which are negative events in games forms positive and meaningful experiences for players. On the other hand, the results showed the relation between the roles of challenges and failure in games. Birk, Atkins, Bowey, and Mandryk (2016) proposed that identifying with an avatar in a game can increase the player's intrinsic motivation. The authors conducted a user study by asking participants to play an endless runner game with customized avatars with three types of identification: similar, embodied, and wishful. The greater identification can increase pX in autonomy, immersion, invested effort, enjoyment, and positive effect. They also showed that greater identification translates motivation to behavior as operationalized by the time spent in the endless runner games. The results suggested that the more significant investment in a task through an objective measure of behavior has implications for the design of games of serious purposes.

The above-mentioned works of literature show the impact of a game's dramatic elements on the pX. However, these works mainly focused on the impact of dramatic elements on players in games for entertainment but were not primarily considered games with serious or learning purposes. Additionally, from the aspect of game developers, *Game Premise* is the dramatic element that is attractive to examine more details due to the elements' characteristics which are different from the other dramatic elements. A premise stays unchanged by players' actions, while a story and the other dramatic elements build upon the setting or theme and can be changed throughout the game progression (Fullerton, 2018). It is an element that can be modified without changing core mechanics, such as gameplay and rules. However, from the literature review, I found that there is still a lack of empirical study on the effect of the *game premise* on players and the analysis to explore the dramatic elements of multiplayer games, which are social interactions.

Game Elements and Morality in Games

Literature of the discussion about morality pointed out that video games allow a discussion on morality uniquely because unethical content is allowed in video games (Elson et al., 2014; Rauch, 2007). Tamborini (2011) mentioned that moral pondering and contemplation should be considered in media narrative plotting, including games. Harm, care, fairness, loyalty, and purity are five basic moral domains relevant to model intuitive

morality and exemplars (MIME). In the long term, the shapes of the viewers, i.e., the system of norms and values, are affected by narrative structures. However, Elson et al. (2014) argued that the interactions between players and avatars in games could satisfyingly fulfill the need for relatedness more than other media, especially when the game enforces moral decision-making. Players might break down their traditional morality and expose themselves to the less pleasant narrative to experience eudemonic gratification. Grizzard et al. (2014) asked two groups of participants to play guilt condition as a terrorist soldier or control condition as a UN soldier in shooting games to evaluate the impact of virtual behavior in video games. The results showed that the committed immoral behavior in games could elicit a feeling of guilt that leads to an intuition-specific increase in the salience of violated moral foundation and players' moral sensitivity. Likewise, Schrier (2019) proposed a game for moral learning. It is found that games, morality, and learning are interrelated. Video gaming can enhance curiosity and make a learning topic more personally relevant. A game may be effective for learning purposes when the game and the learning mechanics are appropriately tied in, especially when their short-term and long-term objectives are reasonably connected. Pearce (2004) mentioned that narrative can be one of the elements that can classify the reason for players' actions and tell the whole story embedded in games. The story can be said in several ways, including a game's cut scene or dialogue. It depends on the game genre, and for some genres, the game's story can be referred to as social storytelling, which makes the player understand the reason for their actions.

Based on the literature review, I found that modifying dramatic elements with the morality version impact the player experience differently depending on the game genre, which mainly relates to the game's formal elements, including gameplay. This finding motivates this thesis to explore further the effect of the game premise on pX in cooperative games with different settings. As mentioned in the previous section, I explored the impact of the game premise on the player in detail because the premise reduces the developer's effort caused by changing the core game mechanics. In the iterative game prototype development, the prototypes were modified with different morality versions, such as authority (moral) and outlaw (immoral), to investigate the effect of the game premise on players' pX in both cooperative entertainments and SGs.

2.2 Systematic Approaches for Serious Games Development

Several researchers have investigated the relationship between Learning Mechanics and Game Mechanics. The researchers seek to identify common aspects of SGs that can facilitate the design, development, and reuse of SGs (Amory, 2007; Arnab et al., 2015;

Bellotti et al., 2011; Carvalho et al., 2015). Nonetheless, it is necessary to understand how to manage better design across various learning contexts and objectives (Clark, Tanner-Smith, & Killingsworth, 2016) due to the shared qualities of the players or teachers (Annetta, 2010; Ducheneaut & Moore, 2004; Magerkurth, Memisoglu, Engelke, & Streitz, 2004) who are the subject of the games. The design of multiplayer games as cooperative SGs is particularly difficult. This section examines the defining characteristics of existing design and development frameworks to comprehend the game design and development procedure and the reusability of multiplayer games in cooperative serious games.

The emphasis is on the frameworks underlying the standard components and characteristics of multiplayer games, such as the interaction of multiplayers(Amory, 2007; Bellotti et al., 2011) and instructor(s)(Arnab et al., 2015) and social interaction. The goal is to identify a prominent systematic approach that can be extended to create a framework that supports the development of multiplayer cooperative SGs. According to the objective, the properties of existing systematic approaches that help single-player and multiplayer games for entertainment and educational purposes are investigated. Comparing the characteristics of systematic approaches in the following section will aid comprehension of the evolution of existing game design and development approaches and the issues associated with these approaches.

I used a mixed-blended approach to identify a framework/model that can be extended to support multiplayer cooperative serious games. I analyzed the characteristics of existing game design and development frameworks and models by reviewing the literature. To analyze the characteristics of existing frameworks and models, I began by retrieving literature from three of the most prestigious journal indexing services: Scopus, Web of Science, and IEEE. The search's scope includes publications discussing both game design and serious game design. To renew information, the literature was collected for the first time in 2017 and revised at the start of 2020. The literature review analysis focused on frameworks or models that support the design and development of multiplayer games for entertainment and education. This work involves the frameworks and models associated with interaction and engagement in multiplayer settings. The classification of characteristics of existing frameworks/models will lead to an understanding of the current method for designing SGs, and a comparison of these frameworks/models will highlight the prominent frameworks/models that can be extended to support cooperative multiplayer SGs.

Then, to investigate the practical applicability of the existing game and SGs approaches, I sent an online survey to the authors of the collected literature to inquire about the difficulties and their experiences relating to the development approach in SGs development projects and the reusability approach. The systematic literature review and online

survey results are then used to identify a prominent framework or model that can be modified to facilitate the design of multiplayer cooperative SGs. The subsequent section presents the survey and literature review findings.

2.2.1 Classification criteria for the systematic approach

I listed the framework's names and models from the literature we collected from the query as the following query. The review protocol is conducted to select and classify the primary research data. For the selection of the process, the papers related to the game frameworks in three central public databases: Scopus, Web of Science, and IEEE are selected. The scope of the selected literature is restricted to the publication associated with frameworks, models, and methods /practice to support game designing. The query is: "game framework" OR "game model" AND "game design." This research focuses specifically on the study of the implementation of game design framework. The papers that include such keywords as "game design," "game component," or "game architecture" in the abstract, as well as papers related to principle and tools for game implementation frameworks, are selected. Regardless of items returned by the search having all chosen keywords, many do not directly address issues related to the development of the game framework. At this point, the inclusion and exclusion criteria are defined, and the papers contributing to developing the "game framework" are included. The papers presenting only the model or part of the framework without developing a new framework are excluded.

Then, I developed classification criteria. The criteria were developed to respond to the objective: to identify the framework or model suitable to be extended and support multiplayer cooperative serious games. I created the datasheet to classify the characteristics of the frameworks/ models by the following classification criteria.

1. I looked at the frameworks/models and game mechanics/elements/components that support the development process of both entertainment and education games.

2. I looked at the frameworks/models that can support multiplayer. For this criterion, the frameworks/models refer to players' interaction and players' engagement.

3. I looked at the results from an online survey response by serious game researchers. I looked into the development approach that more than 50 % of serious game researchers commonly applied to SG development projects. I found that more than half (53.6 % of overall participants) were involved in projects which reused the existing resources.

Therefore, I added reusable as one of the criteria to classify the characteristics of the approaches. For this criterion, I classified the frameworks/models into two subcategories which are

- The frameworks/models which support the concept of high-level design concepts (principle of game design) and,
- The frameworks/models which support the lower level design (component level, e.g., Unified Modeling Language (UML)) as well as game development tools and technique (e.g.web2.0, web-based).

Based on this, a comparison of the reported frameworks is made. The comparison reflects the different characteristics of the game design frameworks and the components of the game development frameworks. The results will show the characteristics of each framework, such as the game design pattern and its ability to extend to develop frameworks to support multiplayer, as well as a tool and technique for keeping the reusability of game design development of the existing frameworks and models.

2.2.2 The Trend of Systematic Approach in Serious Game Development

The online survey was sent out to 72 researchers who are authors of the literature. I received responses from researchers with experience as designers and developers of their projects. In the end, I received 28 responses from the community. More than half of the respondents (23 of 28) are experienced researchers involved in SGs projects as game designer developers and testers for over a year. The projects include more than 30 members of the team. 57% of the respondents were involved in projects that develop SGs in the application area of logistics and health.

I asked participants about using a systematic approach (e.g., SG frameworks or models) in their projects. There are 16 of 28 participants responding to this set of questions. I found that the main reason for refusing to use a systematic approach is the problem caused by the usefulness and usability of the framework. There are 50% (n=8 of 16) of respondents who preferred to do trial-error more than to spend time studying to use frameworks/models, and 37.5% (n= 6 of 16) could not find a framework suitable to their project. I continued with the questions about the usefulness of the frameworks/models. I discovered that 62% (n=15 of 24) rated the Likert scale more than 5 of 7 to agree that frameworks can be used as the starting point/guideline to design SGs, and 50% (n=12 of 24) give a 5 of 7 scores to agree that frameworks can support the initial design of

selecting game mechanics that are suitable for the learning goal. I filtered respondents by asking whether they have the experience to use the game or SGs frameworks/models. I asked them to name the frameworks/models they used to apply to their projects in order to idendify the frameworks/models that are frequently employed. Mechanic MDA is the most mentioned framework with 41.7% (n=10 of 24), while the ATMSG ranged second on the list with 37.5%.(n=9 of 24). I found that the reusability approach is the most popular approach that serious game researchers use in their project, with 53.6% (n= 15 of 28). Most of them (14 of 15) rated a score above 6, which is to agree that it is worth spending time to understand the design of the previous project to make use of the existing game components. 13 of 15 rated a score above 6 to agree that reusing resource from the current project can reduce the production time in SGs development projects and well-structured documents are necessary for reusability of game products and components.

2.3 Gaps of Existing Serious Games Frameworks

Further analysis was conducted to compare the characteristics among the selected frameworks or models. The comparison has a twofold purpose: first, to determine prominently framework/model that can be used for modifying and/or extending to develop the multiplayer in cooperative SGs framework. Second, to identify the framework/model which concerns reusability and players' assessment in game design and development. The analysis will underline the frameworks that support identifying common game design elements for education and entertainment. Table 2.1 shows the comparison of characteristics of the mentioned framework/model. Based on the table, the prominent frameworks/ models were selected to be described in detail in the following section.

2.3.1 Framework for Entertainment Games

In 2004, Hunicke et al. (2004) proposed the Mechanics Dynamics Aesthetics framework (MDA) to bridge the gap of understanding between game designers, developers, and pX. The framework was developed as a tool to support understanding of the game development cycle, which consists of three main components: Mechanics (rule), Dynamics (system), and Aesthetics (fun). Regarding game development, MDA is the potential game design framework to support pX. It is used to improve the game development process and extended as a framework for game design in education purposes (Robson, Plangger, Kietzmann, McCarthy, & Pitt, 2015). However, the framework provides the concept of game components without descriptions to implement in the low-level components. Song, Lee, and Hwang (2007) defines the fifty-four critical factors of game design

for Massively Multi-player Online Role-playing Games (MMORPGs) through the basis of the empirical data and literature review related to the usability factors, which are categorized into four groups game interface, gameplay, game narrative, and game mechanics. However, the frameworks contribute to the factors that game designers apply to the early stage of the design process and do not define the relationship between the elements.

2.3.2 Frameworks for Serious Games

The Four-Dimensional frameworks (4DF) are developed by (De Freitas & Liarokapis, 2011). 4DF proposes to advise game design by referring to four discrete dimensions: the context of learning (discipline context), learner profiling (demography and game experience), selection of pedagogical used (learning mechanics), and mode of representation (game mechanics). This model considers the relevance between gameplay design and a learning context's objectives. However, 4DF is not a procedure and does not provide a concrete mapping between pedagogical and game mechanics. (Amory, 2007)developed a framework called "Game Object Model (GOM II)" describing the relationships between pedagogical elements and games using Object Oriented Programming concepts. However, the GOM II does not construct the relationship among game elements as it could become complex, which is against this framework's purpose of easy understanding. The Learning Mechanics and Game Mechanics (LM-GM) model (Arnab et al., 2015) represents game flow that shows how to translate pedagogical practice components ("Learning mechanics") into concrete game mechanics by using a graphical framework. This model identifies abstract patterns of game flow and a list of elements in the game to support analysis. Still, it does not present a connection between concrete mechanics and a high level of education objective. Although Carvalho et al. (2015) proposed an Activity Theory-based Model of Serious Games (ATMSG), the ATMSG uses activity theory-based as theoretical background for the structured, serious game. Even though the ATMSG offered a precise model that can represent the high-level requirements of a serious game and the connection between concrete mechanics, the ATMSG also proposed a taxonomy of SGs genres for identifying the SGs component and supporting SGs analysis. However, the ATMSG is only limited to single-player. This framework does not reflect social structures mediating the relationship between the subject, object, and community. Additionally, the limitation does not consider the interaction between players both in-game and on social networks. These aspects reflect the dimension to be considered in understanding the deeper relationship among gameplay components of the games and increasing the traceability among the game design and development to fill the gap of the existing frameworks.

Based on the systematic literature review, I found that the ATMSG model (Carvalho et al., 2015) is the prominent model suitable for the extension used in analyzing multiplayer cooperative SGs. There are two main reasons to choose the ATMSG model for developing the framework for analyzing multiplayer cooperative SGs. The first reason is that the model provides a tool for presenting game flow and identifying the relationship between learning and gaming at the component level. The ATMSG model suggests using a standard annotation "flow chart" to present game flow and provide a taxonomy to guide developers in expressing SG components. Secondly, the ATMSG model was elaborated based on the concept of activity theory. The theory explains that typically activity must include a subject or person who takes action, an object/motive, which is the reason for taking action, and a tool which is an instrument that helps the subject take action. Thus, it is possible to apply the concept to explain the cooperative activity, which is the main activity in cooperative games (see table 2.1).

2.4 Summary

This chapter gives an overview of the current literature about identifying architecture and systematic methods of SGs development. The chapter discusses the component of SGs from the perspective of game designers and their impact on the pX. In addition, it presents the literature, which indicates that the game premise, one of the dramatic components, is the potential factor that can be modified to organize the pX. It also demonstrates that altering dramatic aspects with morality variants affects players.

Moreover, the literature describes the definition and difficulties of developing cooperative SGs showing the unique needs that must satisfy the multiplayer requirements and provide an environment for cooperative activities. The chapter also discusses the trend of applying a systematic approach to serious game development projects and the gaps in existing frameworks/models. The literature review connected to survey results showed the trend of developers avoiding adopting the framework due to usability concerns. Simultaneously, reuse is the most prevalent method that typically applies to their project. In addition, the lack of a systematic approach to establishing the relationship between learning and game mechanics in serious games, particularly for multiplayer, is a gap in the existing systematic approach. There is also a need for other frameworks and models that illustrate the relationship among learning, game components, and social interaction.

In the next chapter, three user studies of the effect of the game premise on players and the systematic approach to applying the premise to support developing serious games are presented in chapter 4.

Table 2.1: Comparison table of the existing systematic approaches for SGs development

Name of systematic approach	**Presentation related**	**Teaching related**	**Player Engagement related**	**Reusable concerned**
Design-Based Research Framework	x	none	x	x
Learning Mechanics-Game Mechanics (LM-GM)	x	x	x	x
Activity Theory-based Model of Serious Games (ATMSG)	x	x	x	x
Relevance Embedding Transfer Adaptation Immersion & Naturalization(RETAIN) model	x	x	x	x
PLAGER-VG: platform for managing educational multiplayer video games	x	x	x	x
Visualization Framework	x	none	none	x
The Pervasive Game Design Framework (PGDF)	x	none	x	none
Three Layered Thinking Model (TLT)	x	x	x	none
Unified Game Design(UGD) framework	x	none	x	none
'I's Framework: Identity	x	x	x	none
A Framework to Gamify Services	x	none	x	none

Table 2.1 continued from previous page

Name of systematic approach	**Presentation related**	**Teaching related**	**Player Engagement related**	**Reusable concerned**
A New Framework of Usability Evaluation for Massively Multi-player Online Game	x	none	x	none
AEINS	x	x	x	none
Avatar-Based Collaboration framework (ABC framework)	x	none	x	none
Game Object Model II (GOM-II)	x	none	x	none
Educational Game Design Framework (EGDF)	x	x	x	none
Four Dimensional Framework (4DF)	x	none	x	none
Framework for cooperative communication game mechanics produced from a grounded theory analysis of game designs	x	x	x	none
IMS-LD	x	x	x	none
Mechanics Dynamics Aesthetics (MDA)	x	none	x	none
mechanics, dynamics, and emotions (MDE)	x	x	x	none
Octalysisgamification framework	x	none	x	none

Table 2.1 continued from previous page

Name of systematic approach	**Presentation related**	**Teaching related**	**Player Engagement related**	**Reusable concerned**
Serious Games for Higher Education: a Framework for Reducing Design Complexity	x	x	x	none
SURM (Stats, Unlockables, Rank and Mini-games),	x	none	x	none
The 6-11 framework: A new methodology for game analysis and design	x	none	x	none
The Gamer Response andDecision Framework (GRAD)	x	none	x	none
NUCLEO system	x	x	none	none
Players, Locations, Actions, Time, and Objects (PLATO)	x	none	none	none

Chapter 3

Game Premise as the Element to Motivate Player in Cooperative games

Understanding game elements and their interrelationships are the basis of game design (Oksanen & Hämäläinen, 2014); the principle and creativity can be used for designing a new type of gameplay. Deterding, Sicart, et al. (2011) mentioned that game design elements in non-game contexts can motivate and increase user activity and retention, known as gamification. However, designing SGs is more complicated because they have full-fledged game characteristics (De Gloria et al., 2014) and specific requirements to fulfill pedagogical goals (Proulx, Romero, & Arnab, 2017; Sedano et al., 2013). Generally, the learning objectives and serious contents are used to determine the elements of SGs. Focusing only on adding learning content to SGs can limit the creativity and flexibility of SGs designers, which affects the player's motivation for the games. Therefore, it is essential to consider ingeniously integrating learning content into the gameplay.

Adding proper dramatic elements to games can be another option that can provide meaningful experiences and enable games to be more emotionally engaging. Therefore, it is interesting to explore how these dramatic elements improve or detract from the experience scientifically (Elson et al., 2014) by studying the effects of game elements on player experience (Clark et al., 2016; De Gloria et al., 2014). The potential of entertainment games is used to improve the player's motivation for SGs (Cameron, Sturt, & Carroll, 2009; Rauch, 2007). This exploration of entertainment games can also help improve players' motivation for SGs.

Moreover, the development of cooperative games has more complexity due to the requirements of traditional multiplayer games, i.e., players' engagement and interactions.

Additionally, cooperative games have specific needs to provide the environment for players to engage in the game to achieve a common goal (Ryan, Rigby, & Przybylski, 2006; Schrier, 2019). There is still a lack of studies to explore the effect of dramatic elements specific to cooperative SGs. Therefore, I am interested in exploring the impact of game elements on cooperative SGs.

From the literature mentioned in section 2.1.3, I determined that the ***Game Premise*** is a candidate for investigating the effect on player experience for two reasons. The game's premise is the dramatic component that lends the game's actions significance. Second, modifying the premise can reduce the effort required to modify the gameplay's essence. Developers can choose to customize only the game elements that give meaning to the game actions to the players. They need not completely alter the gameplay.

Moreover, the literature also shows that modifying game elements with different morality versions affect the players in various aspects. This chapter explores the effect of game premises on players in both cooperative entertainment and SGs. The three user studies' responses to the ***H1-H3*** are introduced to reflect one of this thesis's pillars, ***player-related***. The objective of the studies is to explore the effect of game premises for later utilizing them to support developers in organizing pX.

First, a user study is to explore the game premise's effect on player experience in cooperative entertainment games. This study studies how Moral, Immoral, and Neutral (Abstract) premise versions affect players' experience and cooperation in cooperative entertainment games. Second, I report on user studies to explore the effect of game premises in cooperative SGs. I selected entertainment cooperative games based on the criteria derived from the learning objectives. I then employed digital cooperative board games based on the selected game. After that, I modified its premise (including narrative and players' roles), which have two versions: outlaw (Immoral) and authority (Moral), to investigate the influence of the dramatic elements on the learning effect, pX, and memory retention in cooperative SGs. Third, I explore the impact of juiciness on players' experience in cooperative SGs. I modified game prototypes which were modded in the second study. The juiciness elements, such as feedback and animation, were added to emphasize the differences between the premises. The study is to explore the effect of juiciness on players' experience in cooperative SGs.

3.1 Effect of Game Premise in Cooperative Entertainment Games

Cooperative games are rapidly increasing on the market. Similar trends are observed with board games (Wendel et al., 2010) such as the Pandemic and The Lord of the Rings (Sedano et al., 2013; Zagal et al., 2006). These board games facilitate the players to have fun together while assisting each other in achieving the game goals, which they might not be able to solve individually. This characteristic of cooperative games engages players to work together during the game and trains players' social skills and abilities to work as a team. These reasons make cooperative games widely used in the context of SGs, which can be stated as games that focus on learning and training purposes while also serving as entertainment (Sedano et al., 2013; Zagal et al., 2006). However, the development of cooperative games is challenging as the games require proper mechanics that foster collaboration. One challenge is setting specific outcomes that motivate players to help each other and improve their performance. The unspecified outcomes lead players not to understand the consequences of their actions. Hence, they might not want to play it again.

Literature on game experience often attempts to formalize features of games that engage players. Fullerton defines games by their formal and dramatic elements. While formal elements describe a strong interplay of boundaries and technology, dramatic elements formalize elements that affect the players' emotions providing context to the gameplay and giving a meaningful experience (Fullerton, 2018). The elements make the game more emotionally engaging. The complicated dramatic techniques such as premise, character, and story are used in many games to explain the abstract elements of the formal system, which can create a deeper connection with the player experience (Fullerton, 2018; Wendel et al., 2013).

In this section, I report on a user study that employed a custom "Pandemic"-like video game with three different premises of positive, neutral, and negative player roles to investigate the influence of dramatic elements on pX in cooperative games. My study is motivated by two research questions: (i) *Do the game premises in cooperative entertainment games affect the players' experience?* (ii) *How do three different premises affect player cooperation in cooperative entertainment games?*This user study responded to H1 of this thesis, which stated as follows.

H1: The customizing game premise with different morality versions influences the player experience in cooperative entertainment and serious games.

3.1.1 Game Prototype

To investigate the effect of the premise on pX, I designed a simplified version of the Pandemic game with three different premises and an additional setting to dynamically enable and disable special abilities mechanics. The designed prototype implements 3x2 versions of the game. Firstly, in this section, I explained the original Pandemic game and its features, followed by my game design for the modified version of the experiment. Then, I presented the measurements and the procedure of the comparative study.

Pandemic games (Z-Man Games & Matt Leacock, 2008) is originally a multiplayer cooperative game to stop the spreading of diseases on a map by discovering the cure for the disease before the pandemic occurs. The players have to work cooperatively to win the game. The game begins with the spreading of the infection. In turn, the player takes actions, which consist of the following three phases: Action phase: The player needs to execute movement actions and actions for treating/discovering. Draw phase: The player draws cards that allow movement and cure actions from the player's deck. Infection phase: The player draws two cards from the infection deck, and the infection progresses on the map. The game has a non-zero-sum outcome and ends if the following loss conditions occur: (i) The players run out of cards from the player deck. (ii) all infection markers are set on the map. (iii) an outbreak (a city has more than three infection items and hence, leads to a cascade spreading to adjacent cities) occurs more than eight times. The players must discover a cure for all diseases to win the game. The game is designed so that the more turns the players use, the higher the chances of losing the game by running out of cards or the outbreak. The game design forces players to work cooperatively to discover cures for diseases within limited game turns. A typical play session takes at least 45 minutes. The original version is available as a board game and mobile application.

For the game design, I developed three variants of a simplified version of the original Pandemic game for my experiment and reduced it to only the core mechanics. Consequently, I removed some game elements, downsized the map from 48 to 24 cities, and decreased the number of diseases from 4 to 2. The game was developed as a multi-touch game in Unity3D. During my development process, I did an iterative play-tested paper prototype of the downsized modified game to estimate the playtime and identify the game strategies. The development of tutorial strategies will be discussed later in this section. Figure 3.1 shows screenshots of the final prototype. I intentionally kept the visual design simplistic as I was concerned that advanced graphics would interfere with the three variants.

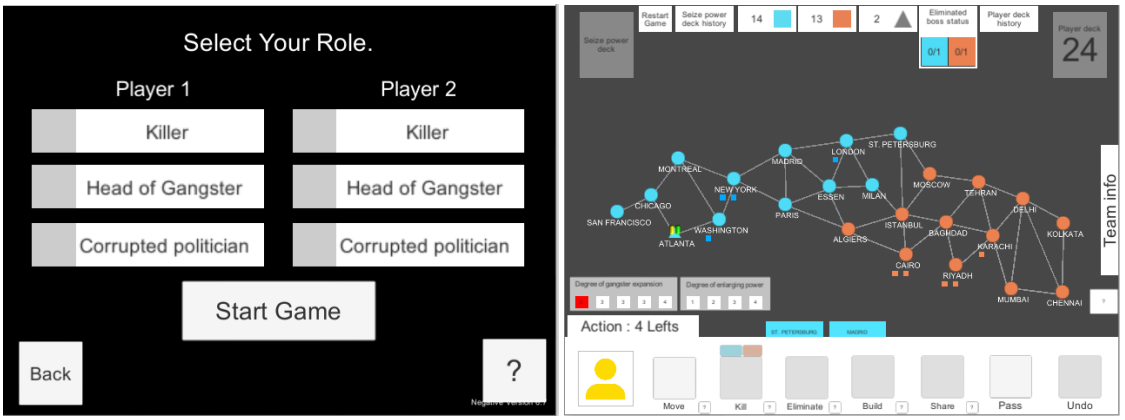


FIGURE 3.1: Screenshots of the game prototype

For additional game elements due to the game's complexity and to establish a stronger connection between the premise with players' actions, I added an option to introduce a subset of the additional game mechanics from the original. These mechanics are not required to make the game playable but to add dramatic elements that improve the dynamics of the gameplay (cards that affect infection rate, reshuffle the infection deck, and resort infection markers on the map) and mechanics that give players roles with special abilities. Namely, I used the: operations expert, dispatcher, and medic roles. The researcher and scientist roles were discarded as they were loosely coupled with the game mechanics for the downsized game.

Game Versions with Different Premises

I developed three premises that put players into specific roles for this study.

Positive premise: Two diseases are spreading around the world. The plot involves a group of two heroes who cooperate in traveling around the world to discover the cures for the two diseases (red and blue cubes) and save the world.

Negative premise: Two groups of gangsters intend to expand their criminal enterprises worldwide. Bosses of both teams try to send their gangsters to seize power over the other networks in the cities of the world. The players from the team of the greatest head of gangsters have to stop the other gangsters from increasing their power by killing their members (red and blue cubes). Then, the players must bring down the other gangsters by taking over their criminal businesses and evacuating their bosses.

Neutral premise: Two colors of cubes are spreading on the map. The players must remove the cubes (red and blue) and stop the spreading of the cubes.

Noted that I ensure that all three game versions have the same game mechanics in my development process. Still, the naming of the game elements, such as the names of actions, players' roles, and the tutorials, are phrased differently depending on the game

TABLE 3.1: Game elements in three different game versions.

Game elements	Naming of game element in different versions of games		
	Positive premise	Negative premise	Neutral premise
Game actions	Treat Cure disease Build research station Shared knowledge	Kill Eliminate bosses Build enterprise Shared license for gambling enterprise	Remove Stop spreading Build triangle Shared card
Other elements	Outbreaks rate Infection rate Epidemic card	Degree of enlarging the gang's power Degree of gangster expansion Expanding power card	Spreading rate Explosion rate Spreading cube card
Roles	Medic Dispatcher Operations expert	Killer Head of gangster Corrupted politician	Remover Transporter Builder

premise. Table 4.1 lists the different naming of game elements and the players' roles in the three-game versions.

3.1.2 User study

30 Participants (18 females) volunteered to participate in my study. Most subjects were between 23 and 34 years old. Most participants (n=20) had experience playing board games, and 6 participants stated they knew the Pandemic board game. 11 participants said they played video/mobile games daily.

In each session, two participants were randomly paired as a team and randomly assigned to one of the three premise versions of the game. First, the participants were informed about the study and asked to complete a consent form followed by a demographics questionnaire that assesses their experience with board games, digital games, and their current gaming habits. Subsequently, they performed a two-part tutorial that taught them the basic game rules. After they completed the tutorial, the participants played the game in normal mode, then with unique abilities. After playing two game modes, the subjects filled out the Player Experience of Needs Satisfaction (PENS). Finally, the examiner conducted a semi-structured interview and debriefed subjects.

To measure pX, I employed Player Experience of Needs Satisfaction (PENS) (Rigby & Ryan, 2007) on a 7-point Likert scale of 1 (strongly disagree) to 7 (strongly agree).

PENS assesses intrinsic motivation based on the Self-Determination Theory (Ryan et al., 2006). The assessment measures the dimensions of competence (how players produce their wanted outcomes), autonomy (willingness for players to do a task), and relatedness (need to connect to other players). The assessment also measures two game-related subscales presence/immersion (how are players "in the game" (Rigby & Ryan, 2007)) and intuitive control (usability of the game controls).

I used observation metrics that Bernard M. Bass & Bruce J. Avolio. Thousand Oaks (1994) established to assess player cooperation. During the play session, I logged the players' actions and recorded their conversations. To explore the effect of the premise, I conducted a semi-structured interview with eight questions regarding the participants' attitudes toward the premise and player roles.

3.1.3 Results

My measure consists of subjective self-reports on the PENS, audio recordings during gameplay, and game logs. There were 54 game sessions in total. Twenty-four pairs finished the game successfully, 20 pairs lost, and ten groups restarted the game because it was impossible to complete. A Kruskal-Wallis Test did not show any differences in the number of wins between the conditions.

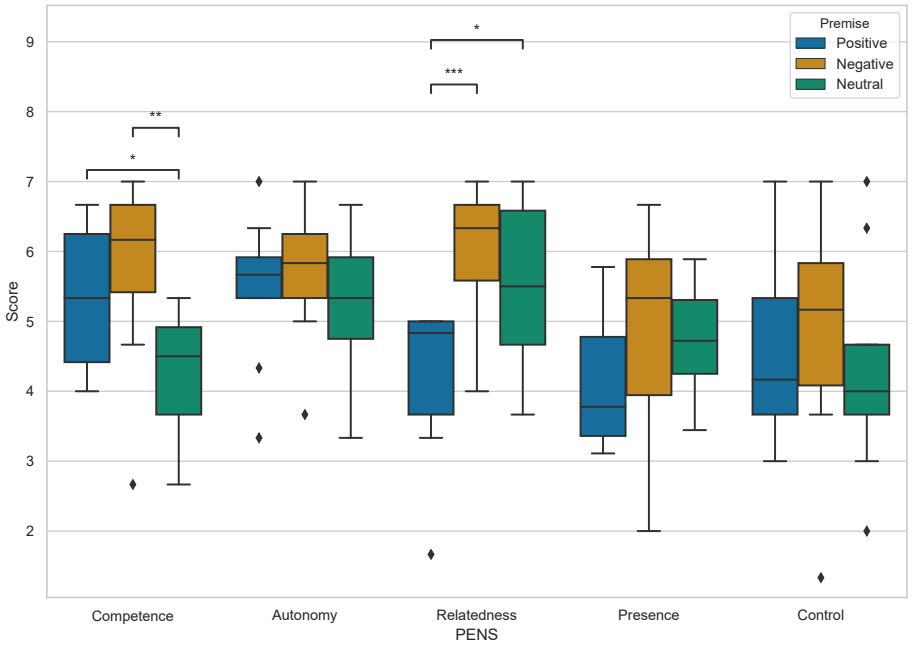


FIGURE 3.2: Boxplots of the PENS results.

Game Premise and Player Experience

I conducted a one-way analysis of variance (ANOVA) on the subscales competence, autonomy, relatedness, presence/immersion, and intuitive controls of PENS with the premise as a factor. The analysis revealed significant differences in the sub-scales relatedness ($F_{2,27}$=7.667, p=.002) and the competence ($F_{2,27}$=5.34, p=.011). A plot of the sub-scales and a detailed view of subsequent post-hoc tests with Bonferroni correction are presented in Figure 3.2. A multivariate analysis of variance (MANOVA) of PENS with the premise and gender as factors did not show any significant differences for gender ($F_{5,20}$=1.767, p=.166) nor an interaction effect of premise*gender on player experience ($F_{10,40}$=0.985, p=.471). A Pearson correlation between gender and the PENS subscales revealed a significant correlation between relatedness ($r = -0.386$, p<.05) and presence ($r = -0.378$, p<.05), with females showing higher ratings on both subscales. However, there was no significant correlation between prior experience with the Pandemic and PENS.

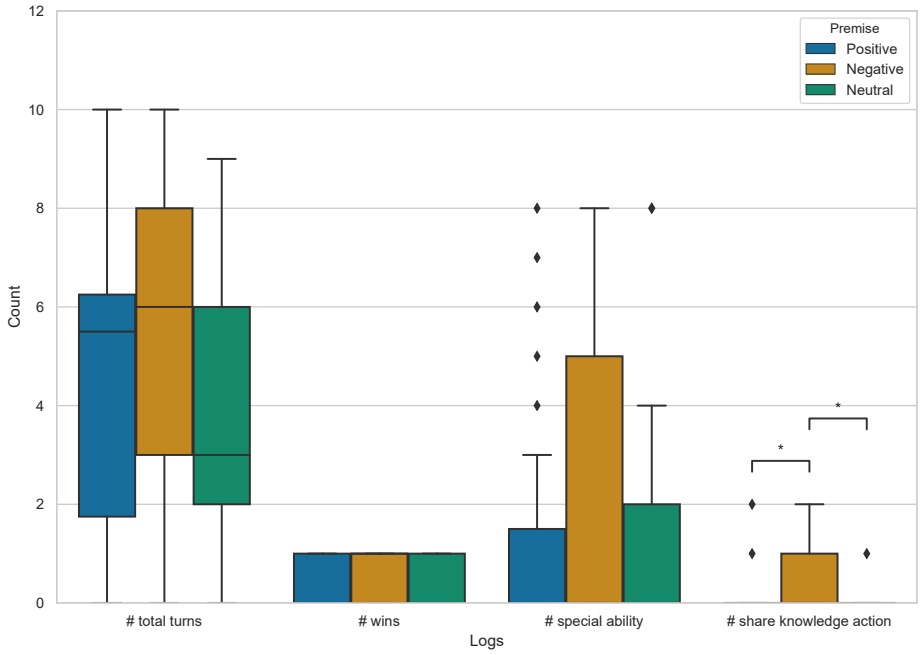


FIGURE 3.3: Boxplots of the game logs per condition

Player Actions

I extracted the number of turns, game-ending, usage of special abilities, and sharing knowledge actions from the game logs. A one-way ANOVA revealed a significant effect of condition on a number of sharing knowledge actions ($F_{2,51}$=3.91, p<0.05). Figure 3.3 shows a chart of the accessed game logs.

Cooperation

I applied Mayring's content analysis method Mayring (2000) to cluster the conversations and summarized them into two categories: cooperation approaches and cooperation tasks.

Cooperation approaches for decision-making : Most players were trying to cooperate and plan their actions together. However, half the players decided to act without asking their partners. I identified five pairs in the positive condition (G1p, G2n, G6p, G10p, G14o) that always asked their partner's opinion to find a consensus before taking action. In contrast, in the negative and neutral conditions, decisions were dominated by the players who had more leadership skills (G2n, G7n, G8n, G9n, G12o, G15o). G2n, G5p, and G7n) started cooperating for treating/killing/removing actions in different continents. In addition, I observed that all groups that lost the game in the first round adapted their strategies and cooperated closer in the subsequent rounds.

Cooperation tasks: Based on Bernard M. Bass & Bruce J. Avolio. Thousand Oaks (1994) model I identified *divisible*, *disjunctive* and *conjunctive* cooperation tasks.

1. *Divisible tasks:* The tasks can be divided between players in one team and then integrated. For example, in my games' scenarios, I found one player from (G2n, G9n, G10o, G11o, and G12o) who moved to different continents to kill gangsters/remove cubes in their responsible continents to avoid the cubes in the storage from running out.

2. *Disjunctive tasks:* The players completed tasks by assigning more responsibility to one person with more potential than the other. For my game, I found that in the game with special ability mode, 11 of 15 groups implemented this strategy by using the concept of disjunctive tasks.

3. *Conjunctive tasks:* The tasks require everyone to contribute unique pieces to a puzzle. The conjunctive tasks only succeed when all members succeed. One such scenario involves sharing card action. I found that the players (G1p, G7n, G12o, G14o, G15o) tried to share their cards but failed, while (G2n, G9n) were able to use this action.

Note: n= negative version, p= positive version and o= Neutral version

Premise and Cooperation

To analyze the effect of the game premise on players' cooperation, I asked specific questions related to the dramatic elements in the interviews. I observed the cooperative

behaviors of players during the gameplay. The game's three versions differ in premise, roles, and special abilities.

Positive premise: 7 of 10 participants liked a positive game premise, while 3 of 10 participants (P5, P6, P11) mentioned that the premise did not affect their feelings. P7, P8, and P12 highlighted that they enjoyed playing hero, especially when using special abilities. P11 did not feel related to the game as there was no personal relationship with the cities. G6 referred to keywords related to the game premise when cooperating and mentioned that they felt proud to be a team of heroes. Additionally, G1, G3, and G6 showed more engaged discussions in urgent situations (e.g., when the Epidemic card has been drawn) than groups from other conditions.

Negative premise: 8 of 10 like a negative role. 4 subjects (P4, P13, P16, P17) mentioned a higher sense of achievement. P4, P16, and P17 stated they could take a role they cannot take in real life, but they do not need to handle the consequences of their moral decisions. Also, P16 mentioned that the negative actions were more exciting. Although P3, P17, P18, and P25 liked the negative premise, they preferred to play a positive role. P15, P25, and P26 relate to the map's cities. P16 and P14 were excited to cooperate as gangsters. G2 and G7 like special cooperative abilities. Especially "Corrupted politician" and "Killer" were stated as powerful and helpful.

Neutral premise: 7 of 10 participants liked a neutral game premise. Due to this version having an abstract premise, I asked more specific questions to ensure that the players gave opinions based on the game premise and not the gameplay. I asked the players to choose among roles: hero, gangster, or neutral. Only P20 preferred to play with a positive premise, while (P23, P24, P27, P28, P29, and P30) liked to play an abstract role since it allows for imagination (P23, P30). P30 also stated that players focus on completing the game mission. In contrast to other conditions, G10, G11, and G15 used abstract terms to describe their cooperation actions. Further, they mentioned focusing on finding cooperation strategies without concern about the name of actions or the background story.

3.1.4 Discussion

All participants perceived the game as enjoyable. This statement is fully supported by the moderate PENS ratings, as well as by many positive comments. Further, the comparable number of turns and winnings indicate that the conditions were comparable and that premise did not affect performance. I identified different cooperative tasks based on the literature (Bernard M. Bass & Bruce J. Avolio. Thousand Oaks, 1994) for planning and decision-making during gameplay. Players performed the divisible, disjunctive, and

conjunctive cooperative tasks in all conditions; this performance indicates the success of my game design. Also, the interview results show that all three game versions received positive feedback regarding the game premise. All subjects agree that the premises fit well with the gameplay. Even though the results from PENS show that the negative premise has the highest ratings for relatedness and competence, most subjects stated that they preferred to play a positive role. The reasons mentioned were related to guilt and responsibility for actions. However, subjects from the neutral condition responded that they preferred an abstract role (neutral premise) as it frees space up for imagination and allows them to focus on the gameplay and explore different cooperation strategies.

The results from PENS show that the game premise impacts the pX on relatedness and competence. The Pearson correlation between gender and PENS shows that females felt more competent and related than males. The negative game version makes players feel most connected with the game and the team members. This situation is also underpinned by the statements from the interviews where the participants mentioned being more excited by the negative premise. The logs show higher shared actions in the negative condition, indicating that the negative premise was most effective at fostering cooperative activities. However, there were only 11 shared actions in total. Thus these results need to be interpreted with caution. With special abilities, I observed a similar trend; however, the data failed to reach significance.

The negative premise showed the highest ratings on competence. This result is in line with the qualitative results. The participants in the negative version mentioned that the goal (eliminating bosses) and actions (killing) provided a high sense of achievement. At the same time, in the positive condition, they felt more responsible for the consequence of their mistakes (i.e., failing to save the world). Similarly, participants who played the neutral version mentioned that winning the game had no meaning since it had no context. In contrast, in the positive version, the participants perceived more competence than the neutral groups. In the interviews, some participants said they felt proud of being heroes.

3.1.5 Limitations

Although my study shows the main effects of the premise on player experience and cooperation, I could not identify any specific patterns between the game premise and cooperation strategies. In the future, I aim to link how different types of premises can foster specific cooperation patterns and actions considering demographic factors. Further, I asked the participants how they liked their respective premises. The exposure to the game itself biases these statements. Future work should investigate unbiased

opinions on-premise design in cooperative games. Due to the small sample size and different distribution of gender in the conditions, my findings are inconclusive.

3.1.6 Conclusion

The findings of this study show the premise significantly impacts player experience and cooperation in cooperative games. This can be operationalized in game design to achieve specific needs of satisfaction or particular cooperative activities. This finding confirmed the part of the *H1: The customizing game premise with different morality versions influences the player experience in cooperative entertainment and SGs.* The confirmation of this study is limited to the cooperative entertainment game. Thus, I continue further investigation to explore the effect of the game premise on players in the cooperative games with the *educational* setting in section 3.2 to continue to confirm **H1**.

3.2 Effect of Game Premise in Cooperative Serious Games

Literature on designing SGs often attempts to formalize features of games that can engage players to train or learn through the games in the desired way. One way to design engaging SGs is to study how the game elements work to integrate serious content into the games(Carvalho et al., 2015; Proulx et al., 2017). The challenges of designing SGs for multiplayer become complicated because the designers have to design a game that provides a learning environment for two or more players. Therefore, the mechanism for engaging players' interactions should be considered (Wendel et al., 2013). Especially designing multi-player cooperative SGs is very challenging. The game requires considering all concepts of traditional multiplayer game design, cooperative games, and SGs (Wendel et al., 2013). Specifically, the multiplayer cooperative SGs design needs to model the situation where two or more individuals must achieve a goal together. The model should also include enforceable rules for players' negotiation and allowance to specify the desired outcome for the involved parties. Last, the model should integrate the learning objective into the games (Wendel et al., 2010, 2013; Zagal et al., 2006). These challenges lead to difficulties in designing efficient cooperative SGs even though the cooperative SGs are being requested in various applications (De Gloria et al., 2014; Ke & Grabowski, 2007).

Understanding how to use game elements and their potential interrelationships is the foundation of game design principles (Fullerton, 2018; Schell, 2019). I can use this principle and creativity to design a new type of gameplay. Deterding (Deterding, Dixon, Khaled, & Nacke, 2011)] mentioned that using game elements in non-game contexts can be one of the options to motivate and increase user activity and retention in gamification.

However, designing SGs is more complicated because of their full-fledged characteristics(Deterding, Dixon, et al., 2011), and the specific requirements to fulfill pedagogical goals (Carvalho et al., 2015; Proulx et al., 2017). Generally, the learning objectives or serious contents are used to determine the elements of SGs. This focus can limit serious game design creativity and flexibility, affecting players' motivation. These challenges are even more significant in a cooperative fashion (Wendel et al., 2013; Zagal et al., 2006). Therefore, it is crucial to consider ingeniously integrating learning content into the SGs gameplay. Adding proper dramatic elements into SGs can be another option that can provide meaningful experiences and can increase emotional engagement in the game (Abt, 1987; Cameron et al., 2009; Lieberman, 2009).

According to the study results shown in the section 3.1, the game premise significantly impacts pX, and cooperation (Grudpan, Alexandrovky, Hauge, & Malaka, 2019). In this chapter, I continue exploring the effect of game premises in cooperative SGs. I conducted a user study to explore the effect of game premises in cooperative SGs, which responded to hypotheses of ***H1-H3*** as follows.

- H1: The customizing game premise with different morality versions influences the player experience in cooperative entertainment and SGs
- H2: The customizing game premise with different morality versions influences cooperative SGs' learning outcomes.
- H3: Adding a juiciness element to emphasize the difference between the Moral and Immoral versions of the game premise influencing player experience and memory retention in cooperative SGs.

The objective of the studies is to explore the effect of the game premise in cooperative SGs in education settings on pX. I phased the premise of the cooperative entertainment games shown in the previous section (Section3.1) to include the additional learning contents. After that, I modified its premise (including narrative and players' roles), which has two versions: outlaw and authority, to investigate the influence of the dramatic elements on the learning effect, pX, and memory retention in cooperative SGs. My study is motivated by the following research questions:

- **RQ1:** How do game premises influence players' understanding of new concepts through cooperative SGs?
- **RQ2:** Do game premises influence players' learning experiences through cooperative games?

3.2.1 Research Approach

I conducted a user study to explore the effect of the game premise on pX in a cooperative learning game. I define game scenarios based on the learning objectives. Then, I selected the existing cooperative entertainment games with common cooperative activities and environments that can serve my learning requirements. After that, I divided the premise of the selected game into two versions, i.e., the authority (moral) and the outlaw (immoral). The participants in the outlaw condition played the gangster who aimed to distribute drugs around the city locations under sustainable urban logistics constraints. On the other hand, in the authority condition, the participants played as a team to deliver goods around the city under similar constraints. Finally, I measured pX, and players' score improvements and then interviewed the participants to explore the effect of game premise in the game.

The Definition of Learning Objectives and Game Scenarios

I defined the game scenarios based on the common situations of urban logistics due to the findings in my previous work (Grudpan, Hauge, & Klaus-Dieter, 2017), where I conducted a systematic literature review to identify the challenges in urban logistics research. I found that one of the challenges in urban logistics is raising awareness of cooperation and understanding the different needs of various stakeholders in the planning phase. Specifically, the main concept of urban logistics is to maintain the delivery needs of the three main factors, i.e., the environment, the residents' well-being, and the city's economics. Furthermore, they also consider the impact of technology development on preferred delivery schemes, including electric vehicles, bikes, drones, and autonomous vehicles. These factors are responsible for different types of stakeholders developing the solutions during the policy planning phase. Urban mobility solutions are often provided by authorities but are used and need to be accepted by stakeholders like citizens, logistics service providers, local companies, etc. (Lindholm & Behrends, 2012). To develop solutions to meet all requirements, it is important to increase the stakeholder's awareness of involvement in the decision-making process in the policy planning phase. According to Grudpan, Hauge, and Malaka (2019); Marcucci, Gatta, and Le Pira (2018), cooperative SGs are one of the effective methods to improve students' understanding of the situations and concepts of urban logistics because of their characteristics that allow players to experience different perspectives from the game.

Therefore, I defined the learning objectives as follows: i) To understand the concept of urban logistics, and ii) To remember the specific requirements of the stakeholders' roles.

Game Reference Selection

I must ensure that the selected game has formal elements that can fulfill the learning requirements. Based on my defined learning objectives and game scenarios, A reference game must meet the following selection criteria.

i). A game where players have to deal with a map containing a network of routes because it can simulate the real-world environment required by the logistics game. ii). It has to be a multiplayer game that requires players' cooperation to complete the game goal. iii). A game that forces players to play and take action only on the decision level., iv). A game where players need to make decisions based on their different roles, which possess different abilities.

After carefully considering a number of cooperative entertainment games, I found that the Pandemic board game by Z-Man Games and Matt Leacock (2008) is one of the most promising games that could be used as a reference game for my prototype because it meets all of the requirements in my criteria (Grudpan, Hauge, & Malaka, 2019).

After that, I changed the scenario of the original Pandemic game to urban logistics. The formal elements, such as the gameplay and the player's actions, are identical to the original game. In contrast, the dramatic elements, such as the game premise, the narrative, and the role of players, are modified and implemented into two versions, i.e., outlaw (immoral) and authority (moral). I describe the details of Mapping of learning objective with formal elements of the Pandemic game, Game design, and the details of the Game versions in the following sections.

The Mapping Between the Learning Objectives and the Formal Elements of the Pandemic Game

The Pandemic game (Z-Man Games & Matt Leacock, 2008) is a turn-based multiplayer cooperative game. The objective of the Pandemic game is to stop spreading diseases on the map before the pandemic occurs. The players need to work cooperatively to make decisions to win the game.

Game-play: The game starts with the spreading of infections. Then, the game is switched to a player turn. The player has to perform his/her decisive actions, which consist of three phases, i.e., action, draw, and infection. The action phase allows the player to execute a movement or make a treat/discovery. The draw phase allows the player to draw cards from the deck, which may reveal a movement or a cure card. The infection phase forces the player to draw cards from the infection deck, which causes the progress of the infection on the map.

Winning/Losing conditions: The game is ended when one of the following conditions occurs. i) the player runs out of cards from the player deck. ii) all of the infection markers are settled down on the map. iii) an outbreak occurs more than eight times (a city has more than three infection items, leading to a cascade spreading to the adjacent cities). Players need to discover a cure for all diseases to win the game. The game is designed in such a way that either the more turns the player uses, the higher the chances of running out of cards or by the outbreak, which is the losing condition. The game is designed to force the players to work in cooperation to achieve the goal of discovering cures for diseases within limited turns. A typical play session takes at least 45 minutes. The game's original version is available as a board game and a mobile phone application.

The Blueprint Mapping: I created a game blueprint to show the relationship between the formal and learning elements. I used the ATMSG model, Activity Theory-based Model of Serious Games (Carvalho et al., 2015) to develop the game's structure. The ATMSG allows us to show the game flow and elements that show how the game elements contribute to achieving the desired pedagogical goals (Carvalho et al., 2015). I show the modifications from the Pandemic game scenario to an urban logistics scenario in Figure 3.5. I identified the subjects and the activities from the urban logistics scenarios in Figure 3.5. Then, I proposed the game blueprint that shows the relations of game elements with the learning objective in Figure 3.4 and Table 3.2

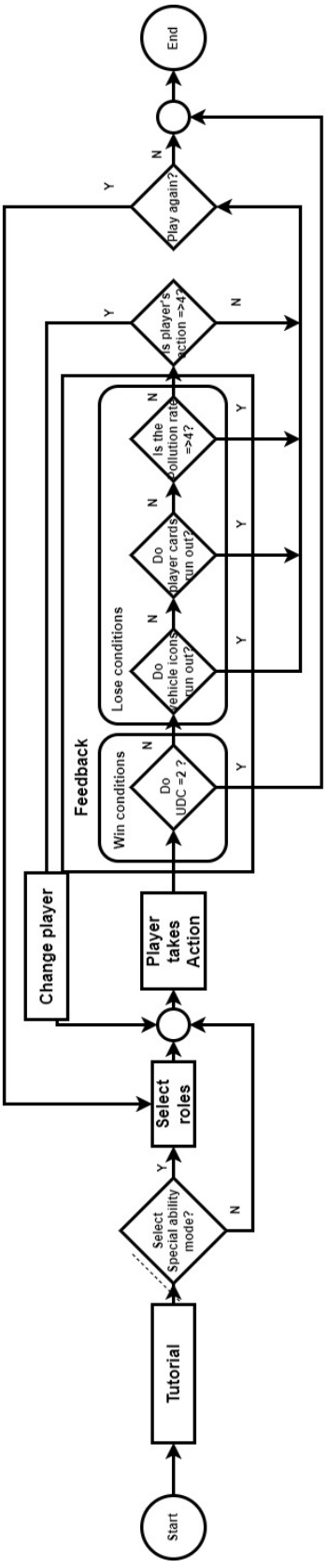


FIGURE 3.4: ATMSG shows the game flow of Pandemic game (The game blueprint part 1).

Table 3.2: ATMSG shows the relation of game mechanics and learning mechanics (The game blueprint part 2)

		Story mode	Tutorial	Select role	Using special abilities	Players take action	Feedback	Change player
Gaming	Action	Watch and Read Story	Obtain help	Select role	Plan/ Strategy: Players plan for their actions	Plan/ Strategy: Players cooperate to take action	Information: See the performance evaluation	Change player
	Tool	Animation, Text	Tutorial	Roles	Roles: Various abilities	Rules: Limited turns/ Randoms scenarios	Feedback: Achievements	Rules: Limited player turn
	Goal	Give information	Discover games goal	Configure game	Tasks: Players cooperate to solve puzzles	Tasks: Players cooperate to solve puzzles	Discover games goal	Encourage the player to cooperate for the next turn
Learning	Action	Describe stakeholder roles	Remember: Read, Click	Understand: Players discuss selecting roles	Understand: Players discuss their abilities	Applying /Performing tasks	Verify	Repetition / Experimenting
	Tool	Animation, Text	Game instruction	Text	Interaction: Group discussion	Interaction: Group discussion	Text information: Report	Interaction: Group discussion

Table 3.2 continued from previous page

		Story mode	Tutorial	Select role	Using special abilities	Players take action	Feedback	Change player
	Goal	Remembering stakeholder relationships	Remembering new keywords	Understanding: Players know the role of various stakeholders	Perception	Understanding: Urban logistics concepts	Perception	Perception
Intrinsic Instruction	Action		Demonstrating	Presenting choice	Repetition	Repetition	Assess performance	
	Tool		Tips	Discussion	Challenges: Multiple choice Limited of turns	Challenges: Multiple choice Limited of turns	Performance measuring	
	Goal		Provide learning guidelines	Gain attention	Inform learners of objectives	Inform learners of objectives	Provide feedback	

Activity	Subject / Actor	Description
Gaming	Students in Production Engineering and Economic Faculty	The objective of the game is to understandconcept and the roles of different stakeholder in urban logistics
Learning	Students in Production Engineering and Economic Faculty	The students are able to understand concept of urban logistics and the role of stakholders in order to mak awareness of cooperation in planning and policy phase.
Instrinsic Instruction	Lecturers	The students realise the importance of factors in urban logistics and the role of stakeholders in urban logistics.

FIGURE 3.5: The description of the gaming activity, identification of subjects/ players/ users, and the game's objective.

Adapted Game Scenario

My development approach is to transform the entertainment cooperative game into a cooperative SGs by changing the game premise. Then, I seasoned the premise by phasing the dramatic elements into moral and immoral versions. I have to ensure that the two-game versions have identical mechanics but different premises. Moreover, the naming of the formal elements, such as roles, names of actions, and tutorials, are phrased differently.

I used only the core mechanics of the Pandemic game. To reduce the game's complexity, I removed some formal elements, i.e., the map size from 48 to 24 nodes. Then, I modified the dramatic elements to add the learning content related to urban logistics. I named the nodes as the street names of <Chiang Mai, Thailand>, where I conducted the user study. I changed the goal to be based on the urban logistics scenario. Thus, instead of discovering the cure, the goal is to solve traffic congestion and pollution by building the Urban Distribution Center(UDC). The number of achievements is reduced from 4 to 2. The game was developed as a digital game using the Unity game engine.

During the development process, I pretested a paper-made prototype of the downsized game for many iterations to estimate the playtime and identify the game strategies. The strategies were added to the tutorials and embedded in the learning contents derived from the urban logistics scenarios. In addition to reducing the complexity of the game, a new subset of the original game mechanics can be introduced. .There may be no effect on the gameplay, but these elements might add dramatic elements like a story mode, which was needed to strengthen the game's connection with its premise. I used 3 out of 5 roles from the original game related to the stakeholders' tasks and requirements in urban logistics, i.e., operational expert, dispatcher, and medic roles. The researcher and the scientist's roles in the original game were discarded because they are loosely coupled with my intended game mechanics. Figure 3.6 shows screenshots of the final prototype.

The Two Different Game Premises

To determine the effect of the game premise on the cooperative game in the education setting, I implemented two versions of the game as the conditions of a user study. The two versions are authority and outlaw. I modified the game premise, which is the setting behind the game. The names of the player actions and the roles of the player are modified because they are different from the original Pandemic game.

For the ***authority version***, the game's goal has been amended according to the urban logistics scenarios. A player has to choose to be one of the roles of the city stakeholders, i.e., mayor, logistic service provider (LSP), and shop owner. The goal is to cooperate to solve the traffic congestion and the pollution problems caused by good delivery from the manufacturers located outside the city.

Likewise, the ***outlaw version***, the urban logistics scenarios are similar. However, the player roles are changed based on the game premise, which is to distribute narcotics into the city; i.e., I changed the roles of my players to outlaw roles. The player acted as the urban logistics stakeholders behind the drug trafficking business (Corrupted Mayor, Drug distributor, and Drug seller).

In my development process, I particularly paid attention to altering only the naming of the game elements, such as actions, players' roles, and word phrasing in the tutorial, while keeping the game mechanics consistent across both game versions. The story mode is added before tutorial mode to show all stakeholders' roles, requirements, and relationships. Figure 3.7 lists the game elements' different names and the players' roles in the two versions of the game.

Addition of Juiciness to the Game

In addition to the Juiciness of the Game after the first study, I modified my game prototype according to the feedback on game design from the qualitative results of the first study and the game researchers. The comments were to increase the differences between the two versions of the games to emphasize the meaning of the players' actions. Additionally, the gameplay should be more simple to understand.

I emphasize the feeling of moral and immoral to increase the differences between the two game versions. To make the two versions of the game comparable, I only added the dramatic elements of the game while keeping the gameplay identical. I looked for theoretical ways to modify the virtual embellishment of the game without changing gameplay. I found that Hicks et al. (2019) mentioned juiciness elements, i.e., animation and particle effect, through the integration of virtual embellishment. The addition of

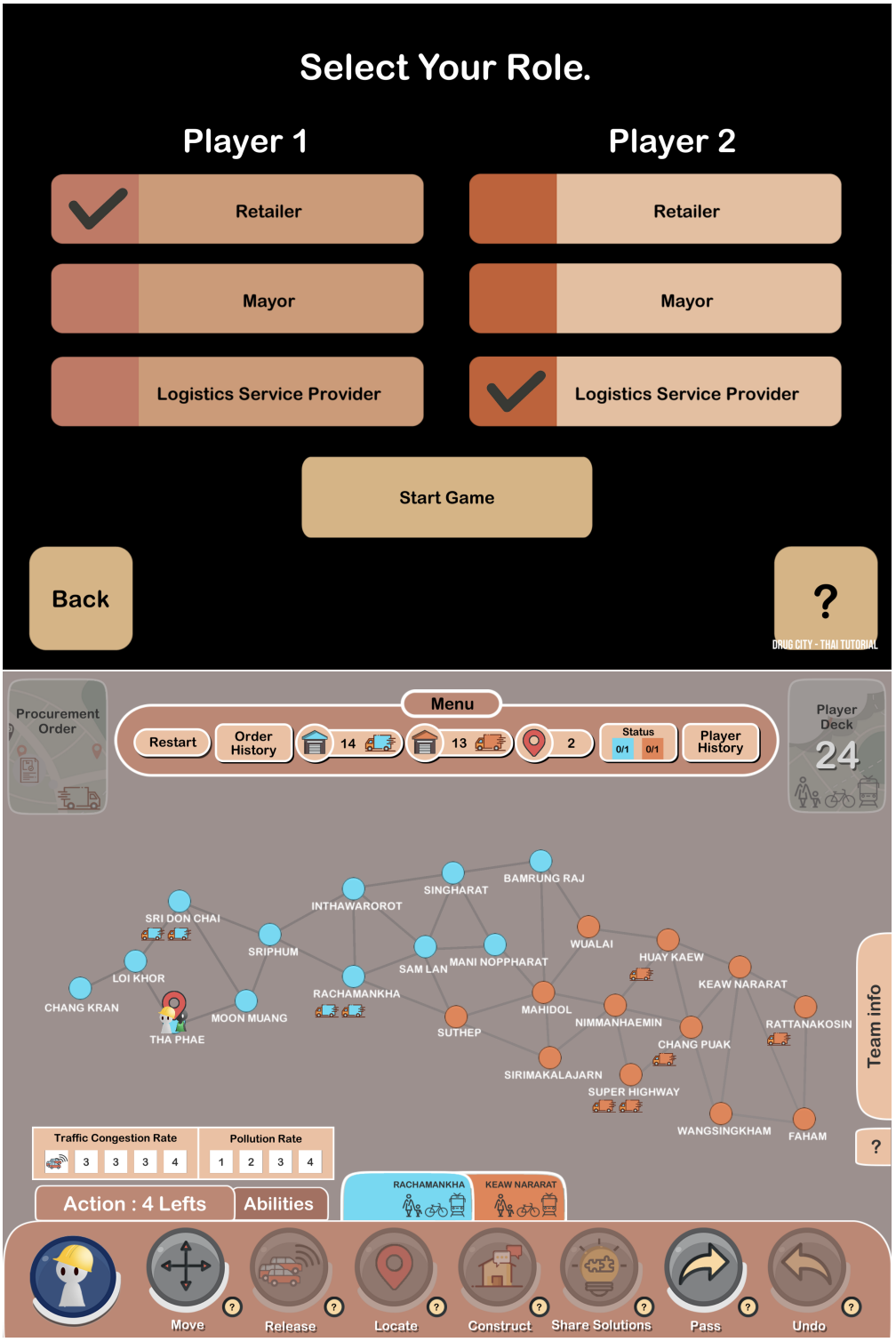


FIGURE 3.6: Screenshots of the game prototype

Game elements	Naming of game element in different versions of games		
	Pendamic premise	Antogonised premise	Urban logistics premise
Game actions	Treat	Release traffic jam	Release traffic jam
	Cure disease	Construct a UDC	Construct a UDC
	Build research station	Locate a UDC landmark	Locate a UDC landmark
	Share knowledge	Share solutions	Share solutions
Other elemnts	Outbreak rate	Pollution rate	Pollution rate
	Infection rate	Procurement rate	Procurement rate
	Epidemic card	Market Expansion.	Market Expansion.
Roles	Medic	Shops owner	Drug saler
	Dispatcher	Logistics Service Provider (LSP)	Drug distributer
	Operations expert	Mayor	Corrupted Mayor

FIGURE 3.7: Game elements in three different game versions

juiciness can improve player competence and immersion in games. Therefore, I added the juiciness element to the game and made the tutorial simpler to understand.

Three parts of the game are modified as follows. First, I added the short animation effect. I changed the background color when players achieved any sub-goals, i.e., win or lose, to emphasize the difference between moral and immoral versions. Second, I added the animation effect, the sound effect, and the post-text effect to show the meaning of players' actions. Finally, I separated the tutorial into three short sections to give players a short break during the tutorial session.

3.2.2 User studies

I conducted my first study to determine how the game premises affect pX, short-term learning improvement, and memory retention. After that, I modified my game prototype according to the qualitative results and then conducted a second study to explore the effect of game premises and the additional juiciness elements on learning improvement in more detail. The two studies are structured as follows.

3.2.2.1 The First Study: Game Premise Versions

I recruited 76 students, of which 52 enrolled in the Supply Chain Economics and Logistics course while 24 enrolled in the Management course. Forty-six of them are female. Most of them are aged between 18 and 34 years old.

The participants were asked to join my experiment twice in the same setting. The experiment's second phase is conducted ten days after the first phase to measure memory retention. The procedure of the experiments is described as follows.

Two participants were randomly paired as a team and assigned to one of the two-game versions, i.e., the different premises. The participants were informed about the study and asked to complete a consent form. Afterward, they were asked to complete a demographics questionnaire to assess their learning style, experience with board games and digital games, and current gaming habits. Then, the participants were asked to fill out personality tests and pre-tests, using 15 multiple questionnaires.

After that, each of the participants performed a game session. The session consists of sequentially three sub-sessions, including story, tutorial, and gameplay sessions.

After finishing a game session, the participant is asked to answer the post-test and the PENS questionnaires. Finally, I conducted a semi-structured interview. The questions are related to the satisfaction of the game, the game premises, and the learning contents.

Ten days after the first participation, the participants are asked to join the second phase of my experiment. According to the restricted conditions of the lecturers, I can only recruit a total of 52 participants enrolled in Logistics and Management class to join the second phase. The same procedure is repeated for this phase, but I changed only the questions into the semi-structured interview. In this second participation, the questions are changed to measure the memory retention of the participants.

3.2.2.2 The Second Study: Juiciness Elements

The second study was conducted with n = 32 participants. They are the Digital Game department students enrolled in the Digital business course (age: 18-22 years old, seven females). I used the Player Traits questionnaire (Tondello, Arrambide, Ribeiro, Cen, & Nacke, 2019) instead of Ten-Item Personality Inventory- (TIPI) to classify player traits. The participants are teamed up in a pair and randomly assigned into two conditions with different premises, i.e., the outlaw and the authority versions. All participants followed the same procedure in the first study; I used the same data recording for demographic, measuring pX, and score improvement in remembering. I added questions related to players' understanding of the learning contents and the players' cooperation in the semi-interview. To measure memory retention and understanding of players, the participants were repeatedly asked questions related to learning content after each play session of the first round and before/after the play session of the second round.

Measures

To explore the effect of personality traits, I used the ten items of the Ten-Item Personality Inventory-(TIPI) (Romero, Villar, Gómez-Fraguela, & López-Romero, 2012) in the first study. To investigate the effect of player traits, I used 25 items of Player Traits (Tondello et al., 2019) in the second study.

To measure pX, I employed the Player Experience of Needs Satisfaction (PENS) (Rigby & Ryan, 2007). PENS assesses players' intrinsic motivation from five dimensions. Three are competence, autonomy, and relatedness, derived from the Self-Determination Theory (Ryan et al., 2006). Competence is a measure of the player's ability to produce an outcome. Autonomy is a measurement of the player's willingness to do a task. The relatedness measures the player's need to be connected to others. The fourth dimension is obtained from the game-related sub-scales, i.e., presence and immersion. The presence measures how a player is "in the game." The intuitive authority measures the immersion, in other words, the usability of game authority. Finally, the fifth dimension is intuitive control, i.e., the usability of the game control. I used a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree) for all questionnaires.

To assess the effect of learning through my game, a set of 15 multiple-choice questions is used to measure the participants' knowledge. The participants are asked to answer the questionnaire both before and after the game session. The questions are derived from the learning objectives embedded in the game: 1) the understanding of the concept of urban logistics, 2) the understanding of stakeholders' requirements in urban logistics, and 3) the understanding of the roles of stakeholders in urban logistics. There are five related questions for measuring each of the learning objectives. The identical set of questions is reevaluated after ten days of participation to investigate memory retention.

Additionally, I conducted semi-structured interviews to explore the effects of the game premise on player experience, player cooperation and learning improvement through the game, memory retention, and understanding as follows.

In the first study, I conducted a semi-structured interview about participants' attitudes toward the game premises, player roles, and learning contents. The same questions were asked for the play session's first and second rounds (after ten days).

In the second study, I added ten open questions in the semi-interview to measure memory retention and understanding. The questions are linked to learning objectives. To investigate the effect of the game premise on learning, I asked 11 questions in a semi-interview. The questions respond to players' attitudes with the elements derived from the game premise and its effect on their learning. To study the game premise to players'

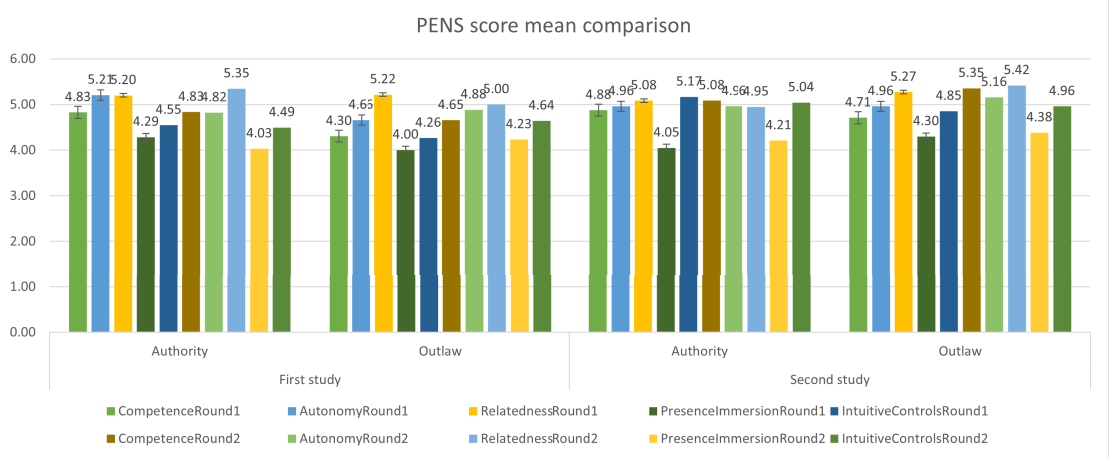


FIGURE 3.8: PENS questionnaire scores' mean comparison

cooperation, I asked 11 questions to rate their attitude toward how the game elements related to the premise (7-point Likert scale).

3.2.3 Results

My measurements consist of subjective self-reports on the questionnaires, participants' pre-test and post-test scores, and post-experiment interviews of both studies.

Game Premise and Player Experience

I conducted a one-way analysis of variance (ANOVA) on the subscale's competence, autonomy, relatedness, presence/immersion, and intuitive controls of PENS with the premise as the factor. From the first study, my analysis of the mean scores between two groups, i.e., authority (moral) and outlaw (immoral) revealed significant differences in the sub-scales autonomy ($F1,74=4.459, p=.038$) and competence ($F1,74=4.826, p=.031$). The autonomy and competence sub-scale of the Authority premise version was significantly greater than the Outlaw group. However, in the second experiment, when I added short animation and the juiciness element to the game, no significant difference in the player experience was found between the two groups of Authority (moral) and Outlaw (immoral) premises. The plot of the sub-scales on both user studies is presented in Figure 3.8.

Effect on Short-Term Memorization and Memory Retention

I conducted a paired t-test between pre-test and post-test scores (full score of 15 points) in both studies to indicate that my game resulted in an improvement in short-term memorization. In the first study, the results show significant differences in the pre-test ($M=6.329$, $SD= 3.117$) and post-test ($M=7.474$, $SD= 2.754$) in Round1, $t(76)= 2.745$, $p=.039$, as well as a pre-test ($M= 7.65$, $SD= 2.90$) and post-test($M=8.54$, $SD=2.75$) in

Round2, t(52)=2.756. p=.008. The same improvement in the second study (N=32), the analysis revealed a significant difference between pre-test (M=5.78, SD=2.99) and post-test (M=7.59, SD= 3.10) scores Round1, t(32)=2.48,p=0.18 as well as a pre-test (M=,8.00, SD= 3.16) and post-test score (M=,9.09, SD= 2.59) Round2, t(32)=, p=.042.

To determine the short-term memorization effect by looking at the score improvement between pre-test and post-test scores of participants in each group. I conducted paired sample T-test on the score of participants within the group in both Round 1 and Round 2.

In the first study, the results revealed a significant difference between the pre-test score and post-test score of participants who played the Outlaw version in both Round 1 and Round2 (pre-test(M=2.62, SD=2.83) and post-test(M=5.91, SD=3.03) Round1, t(34)=2.568, p=.015 and pre-test(M=6.73, SD=3.09) and post-test(M=8.00, SD=2.6) Round2, t(26)=2.33, p=.028).

While the pre-test (M=5.69, SD=3.34) and post-test(M=7.77, SD=3.02) scores of the Authority version revealed significant differences only Round 1, t(26)=-3.46,p=.002.

However, in the second study, the participants of the Authority condition were only the group who has significant differences in the pre-test(M=7.29, SD=3.17) and post-test(M=8.57, SD=3.31), t(26)=-2.223,p=.045 scores when they played second Round. The mean comparison of pre and post-test scores is shown in Figure 3.9.

I looked at the improvement score (Post-test scores minus Pre-test scores) to compare between groups. I conducted a paired t-test between the improvement score Round1 (M=2.33, SD=3.411) and improvement score Round2 (M=0.88, SD=2.315). It was found that in the first study, there was a significant difference between the 2 rounds, t(51)=-2.489,p=.016 while there was no significant difference between the 2 rounds in the second study. The mean comparison of the improvement score is shown in Figure 3.9.

One-way ANOVA was conducted on the scores of two conditions. The results have shown no significant differences in both studies. Even there were no significant differences in improvement scores between the groups. I found the mean of improvement scores in Round 2 lower than in Round 1 in both study and all conditions.

To indicate the memory retention of the participants after 10 days, I conducted an independent simple t-test on (pre-test Round2 minus post-test) R1 with the premise as a factor. The analysis revealed a no-significant difference no significant difference in both studies. In the first study, I conducted a paired t-test to indicate the retained memory of pre-test Round 2 (M=7.65, SD=2.896)and pre-test Round 1 (M=5.40, SD=3.11). The analysis revealed a significant difference, t(52)=-4.062,p=.00. The same pattern as the

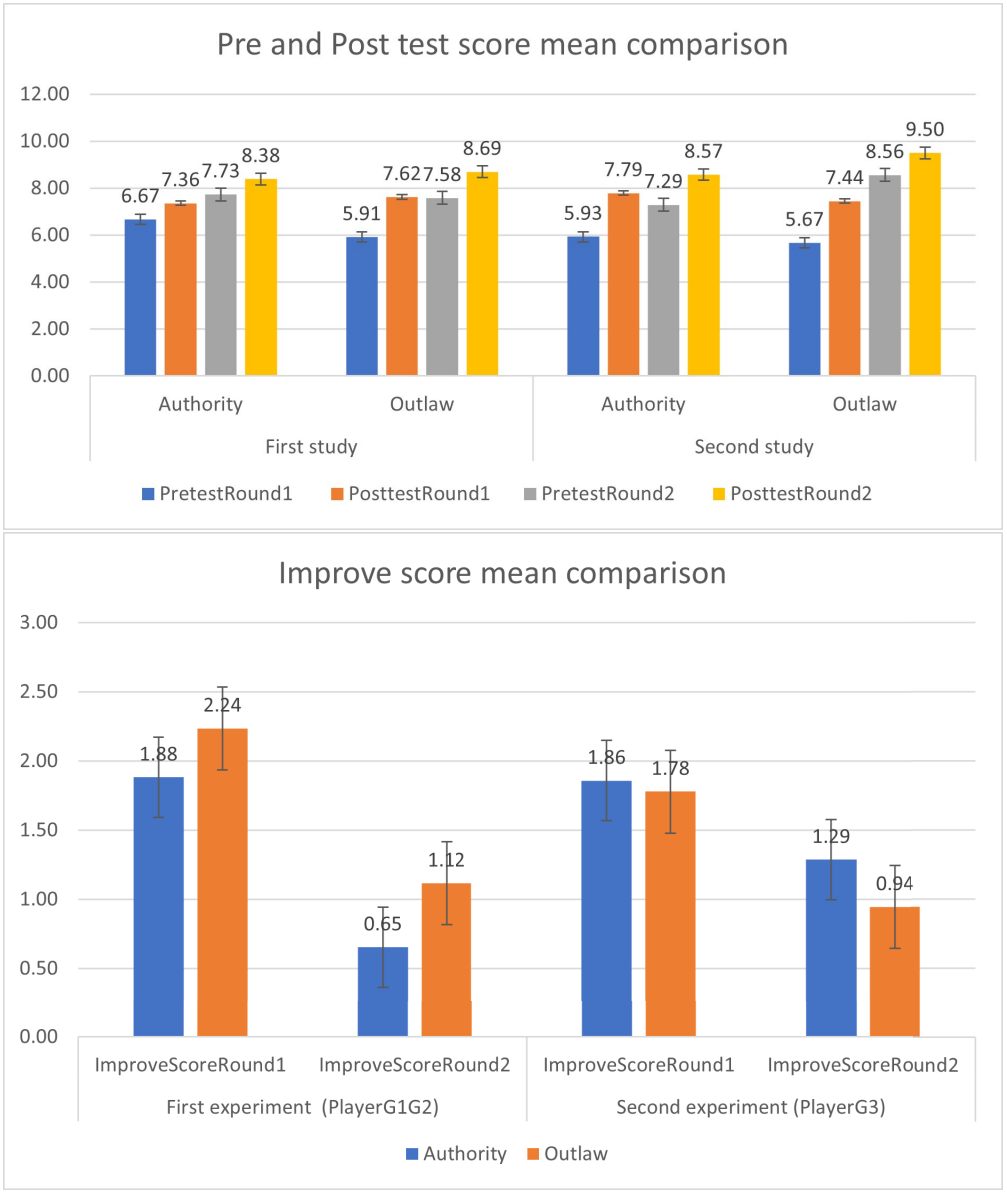


FIGURE 3.9: Mean comparison of pre-, post-, test and improvement score

second study, I conducted a paired t-test of pre-test Round2 (M=8.00, SD=3.16) and pretest Round1 (M=5.78, SD=2.99). Significant differences were found, t(32)=4.338, p=.000.

Semi-structure interview

Overall, I asked participants to answer four sets of questions. First, the questions related to learning content. Second, the questions related to the memorization of participants. Third, the questions relate to the understanding of participants, and fourth, the questions related to players' cooperation.

In the first study, I asked the opinions of the participants mentioned above and focus on analyzing the game mechanics that remind the participants of the learning contents. In Round 1, I set the interview session after the play session while in Round 2, I add a small session to ask participants questions related to the learning contents.

In Round 1, I asked participants to identify components/objects/phases in the game which remind them of the contents. I found that 32 of 52 participants mentioned that Ability, Goal, and Story are the game components that recalled their memory. There are components which modified to make different of two premises. Moreover, P34, P62, and P78 mentioned that the contents of drugs and gangsters help them to remember the urban logistics planning conditions.

In Round 2 (after 10 days), I asked participants *if they still remember the learning contents of the game. if yes, what reminds you of the learning contents?*. I conduct a Chi-square test to examine the relation of the frequency of participants who answer *"Yes"* in the questions related to learning and memorization. The relation between these variables was significant, X^2 (4, N = 52) = 10.658, p = .031.

In the second study, Round 1, I asked participants about the oral examination and the content related to urban logistics content. I then asked their opinion on mechanics which relate to the game premise. In Round 2, I do again oral examination with the same set of questions. Then, I asked them to rate the game elements that help them to recall their memory.

In Round 1, I found participants mentioned that Story mode (N=15), Tutorial(N=15), Gameplay (N=6), and Special ability (N=6) are the game elements that recall their memory. Participants rated Gameplay (N=10), Tutorial (N=9), and Special ability (N=5) as the top game elements to help them understand the content. The matching of game mechanics and the learning objective connect with the game blueprint. I asked participants to rate how the game elements modified based on the game premise were influenced (Likert scale of 1 to 7). I conducted one-way ANOVA on two conditions (Authority and Outlaw). The results show no significant differences.

In Round 2, I compared oral examination scores before (M=5.59, SD=3.004)and after (M=9.00, SD=3.233) playing games. The analysis revealed a significantly different, t(32)=8.140.

3.2.4 Discussion

The findings of the first study (section 3.2.2.1), exploring the effect of the game premise on pX in cooperative SGs, show that the game premise impacts players' competence

which is in line with my previous study examining the impact of the game premise on pX in entertainment games show in section 3.1. However, there is a contradiction in the prediction I draw from Hicks's consideration (Hicks et al., 2019) in the second user study (section 3.2.2.2). The second user-study of this chapter was conducted to explore the effect of impact on adding juiciness to emphasize differences between the Moral and the Immoral versions of game premises in cooperative SGs. The second study's findings show no significant difference in pX among the Moral and Immoral versions, which is the contraction with Hicks's work that the juiciness elements as the visual embellishments can be utilized to enhance pX significantly. Thus, I looked at the demographics of the participants in both studies. I found that 49 of 72 participants in the first study, exploring the impact of the game premises in cooperative SGs, lacked experience playing board games. In comparison, 26 of 32 participants in the second study, exploring the effects of the game premises with the juiciness element added in cooperative SGs, had experience playing board games. Moreover, the qualitative results show that the participants of the second study focused on recreating or winning the game instead of paying attention to the added dramatic elements. Additionally, the participants of the first study are students with a logistics background. Therefore, they could find a relation with the game contents more than the students with no logistics background. Thus, it is noted that experience in gaming and background knowledge can influence the pX of the players.

The findings of both studies show no significant differences in the players' improvement scores of the two premise conditions. Even the results from the interview explain that the premise does not have an effect directly on memory and understanding in SGs. However, the participants in the first study also mentioned in the interview session that the premise of selling drugs gave them an overview of pictures and concepts of the logistics process.

3.2.5 Limitation and future work

Although my study shows the main effect of the premise on player experience on competence and autonomy, it could not identify the specific patterns of game premises in other types of cooperative games. This study only focuses on cooperative games, which require cooperation at the decision level. The results suggest that framing premise can be one method to design and develop SGs. The results can be helpful for game designers in improving engagement in cooperative SGs.

3.2.6 Conclusion

Designing SGs, especially cooperative games, is challenging due to the requirements to engage players to cooperate and achieve learning objectives. Framing the game premise

could be one option in developing cooperative games to emphasize players' roles and relationships with the game content (Grudpan, Alexandrovky, et al., 2019). The studies in this section show that the game premise affects pX on competence and autonomy in cooperative games for learning and also suggest that the seasoned premises have advantageous effects on pX in the cooperative game for learning purposes. The authority-seasoned premise encourages players to perceive experience on competence and the autonomous. Also, the authority premise lets the players quickly get into the learning content. On the other hand, the seasoned outlaw premise shows higher memory retention performance after a short session break. Furthermore, the studies are divided into two rounds to measure the effectiveness of the SGs for learning and pX with engagement as the indicators. I found that the overall players' score from the second round is higher than the first round, which indicates improved players' learning and engagement from the seasoned game premises.

To sum up, the findings of this study show the premise type significantly impacts pX in cooperative games in an educational setting. These findings confirmed the ***H1*** of this thesis. The results of the exploring effect of game premise in cooperative SGs confirm the ***H2*** with the qualitative results that seasoning game premise with different morality versions helps players for memory retention, and the quantitative results of the studies show players achieved learning goals demonstrated in the improvement score of the pre- and post-test. However, no quantitative evidence exists to confirm that the different morality versions of the game premise affect the learning outcome. Additionally, the results of exploring the effect of the game premise on pX show the interesting points that the game premise involves pX only when seasoning the games with the different morality versions with no juiciness elements included. The last findings respond to the ***H3*** of this thesis. The results and lessons learned from the game prototypes created from user studies exploring the effects of cooperative games and SGs will be used to develop the framework for supporting multiplayer cooperative SGS called "The M-SG framework." Details of elaborating and validation of the M-SG framework presents in chapter 4.

Chapter 4

Multiplayer Cooperative Serious Games Framework (M-SG)

This chapter presents the systematic approach to support the Multiplayer Cooperative Serious Games development called "The M-SG framework." The contributions are mainly to help ***"developers"*** in the analysis and development of the multiplayer cooperative SGs. This thesis addresses the issue in SGs analysis that the current systematic approach has limitations in analyzing multiplayer games. Even the current systematic approach can identify single-player games and learning components. However, the existing systematic approach cannot identify games, learning elements, and players' interactions which is vital for developing multiplayer games (Carvalho et al., 2015). For the issue of game development, the framework aims to propose a systematic way to organize pX while still overcoming the problems of lacking reusable in game development projects. The gaps in the current systematic approaches are mentioned in section 2.3. The results of user studies and lessons learned from game prototypes development in chapter 3 are used for elaborating the M-SG framework (details in 4.1).

The M-SG framework is a main contribution of this thesis that is related to the SGs analyzing responding ***H4*** and the contribution of the SGs development responding to ***H5-H6***, which are presented as follows.

- H4: The extension of the ATMSG model supports developers in identifying the game, learning components, and players' interaction of the multiplayer cooperative SGs.
- H5: Transforming(converting) the premise of cooperative entertainment games can be an option to develop the cooperative SGs systematically.

- H6: Seasoning(modifying) the premise of cooperative SGs with Moral and Immoral versions can be an option to systematically develop games that can fulfill both entertainment and learning goals.

Details of elaborating the M-SG framework are presented in section 4.1. The set of the four-phase guideline of the M-SG framework for analyzing, including the taxonomy of multiplayer cooperative SGs, and developing cooperative SGs, are presented in section 4.2. Then, the M-SG framework is then applied to implement the urban logistics games presented in section 4.3. A user study is conducted to evaluate the usability and functionality of the framework. Details of the study are given in section 4.4. The identification of weak and strong points of the M-SG framework is presented in section 4.4.5.

4.1 Elaborating the Framework

To elaborate M-SG framework, the framework was iteratively developed from the literature review and practical testing of the concepts to identify the refinement points.

The M-SG framework was developed by investigating two different perspectives, which are the developers' and players' aspects. The investigations ensure that the M-SG framework can support developers in systematically analyzing, developing, and fulfilling players' requirements in both educational and gaming goals of multiplayer cooperative SG. The investigation from the developers' point of view starts with exploring the methods, methodologies, and frameworks developer teams use to fill the gaps in the existing systematic approaches.

The survey and literature were conducted to define gaps and missing links that should be addressed in the existing methods, methodologies, and frameworks, as mentioned in section 1.1. From the literature, I identified the prominent models and frameworks that can extend to support game developers in analyzing the connections of gaming, learning, elements, and players' interaction of the multiplayer cooperative games at the components level. I used standard notation and taxonomy to help developers illustrate essential components required for SGs development. This idea is mentioned in the "Activity Theory-based Model for SGs model" (ATMSG) from Carvahol's work (Carvalho et al., 2015). The ATMSG model is employed to look at the structure of existing games or COTS games that contains possible reused elements and identify the relationship between gaming and learning at the component level. From these steps, I derived Phase 1–Selecting Reference Games(details in section 4.2.2) and Phase 2– Developing a Game Blueprint of our framework, which response to ***H4*** of this thesis.

A literature search is conducted to understand the effects of game elements on the player experience when playing SGs. Possible game elements that influence players in entertainment games are then identified. The results of the literature showed that dramatic elements such as story and narrative Moser and Fang (2015), could be used as a set of tools for engaging players emotionally by creating a dramatic context for the formal elements (Fullerton, 2018). The dramatic elements give context to gameplay and integrate the formal elements of the games into a meaningful experiencep Fullerton (2018).

Subsequently, I looked at the dramatic elements that could be modified without changing the gameplay. Minimizing cost and time is the main challenge in SG development. I conducted another literature search and found that the game premise is a possible candidate, as discussed in Chapter 2.

By the concepts of deconstructing SG elements for the design analysis at the component level mentioned in the ATMSG model (Carvalho et al., 2015), I integrated the idea with the utilization of the game elements for non-gaming context from Deterding, Dixon, et al. (2011); Deterding, Sicart, et al. (2011) utilizations COTS games to provide educational value to SGs (Ulrich & Helms, 2017). Game prototypes were developed based on these concepts.

The concepts utilizing elements of games (Deterding, Sicart, et al., 2011) or COTS games (Ulrich & Helms, 2017) for non-gaming purposes motivate us to investigate the effects of game premises in both entertainment and SGs. I employed a player-centric approach to investigate the effects of the game premise on player experiences. The purpose of the investigation was not only to explore the effect of the game premise on player experience but also to collect lessons learned to modify the premise of the existing game for reusing game component purposes. The reason to collect lessons learned for modifying the game premise is that customizing the game premise affects only the dramatic elements of the game. It can be done without changing formal elements or the dynamic system of the games. I conducted three user studies to investigate the influence of game premises on players in multiplayer cooperative entertainment games (Grudpan, Alexandrovky, et al., 2019), and cooperative SGs (Grudpan, Hauge, Baalsrud Hauge, & Malaka, 2021) and the effect of adding juiciness elements to the cooperative SGs. Learning objectives related to urban logistics are defined and limit the scope of my research—details of the user studies mentioned in Chapter 3.

For conducting user studies presented in (Grudpan, Alexandrovky, et al., 2019; Grudpan et al., 2021; Grudpan, Hauge, & Malaka, 2019), prototypes of multiplayer cooperative entertainment games and SGs are developed. Practices and the lessons learned from the game prototype development are collected to produce a guideline for systematic development and organizing player experience of multiplayer cooperative SGs.

Phase3–Transforming Premise (details in section 4.2.3) and Phase4–Seasoning Premise (details in section 4.2.4) of Multiplayer Cooperative Games are iteratively developed during the process of game prototype development. The contributions of phases 3 and 4 respond to ***H5-H6*** of this thesis.

4.2 The M-SG Framework

The M-SG framework is suggested to apply with the iterative rapid prototyping process and player-centric approach, the process to help developers have more understanding of players' aspects (Fullerton, 2018; Hunicke et al., 2004). The framework includes workflow and documents supporting communication among the developer team, including game designers, game programmers, and educational experts (the persons who developed learning content). The contribution of this framework focuses on helping developer teams have a more understanding component of the multiplayer cooperative SGs, which is to fill the gaps of the current systematic approach in lacking systematic approach for analysis of multiplayer games (Carvalho et al., 2015). The M-SG framework also provides guidelines for reusing and organizing pX.

The M-SG framework consists of a four-phase approach which is 1)—selecting a reference game, 2)—identifying connections between the game and learning components and players' interaction, 3)—transforming the game premise, and 4)—Seasoning the game premise. The initial concept of the M-SG framework is to utilize the potential of COTS (Ulrich & Helms, 2017) or to use the game elements to engage players for learning purposes (Deterding, Dixon, et al., 2011). The framework suggests guidelines to select and analyze the existing entertainment cooperative games' mechanics to utilize the games for learning purposes (Amory, 2007; Arnab et al., 2015; Carvalho et al., 2015). However, SGs requirements are unique; the games are tailored to the learning requirements (Carvalho et al., 2015). Therefore, to employ the concepts of reusing game components of the existing projects or COTS games, the developers must understand the game at the component level to select suitable components that can fulfill specific learning requirements; however, there is still a lack of systematic approach to identifying the game, learning and players interactions in the component level (details in section 2.1).

The above-mentioned challenges focused on identifying the functional requirements of cooperative SGs in the first two phases of the M-SG framework. The first phase proposes a systematic guideline to select cooperative entertainment games suitable for transforming the chosen games into SGs. The considerations developers should consider in developing selection criteria are suggested in this phase. The second phase provides a tool for analyzing the structure of multiplayer cooperative games. The analysis tool is suggested

for analyzing cooperative entertainment games selected in the first phase. This step is proposed to confirm that the mechanics of the selected game is suitable to serve learning contents that will be added in the next step. The analysis tool is a "game blueprint" consisting of two parts: first, the diagram illustrating game flow and player interactions of multiplayer cooperative game, and second, the table identifying connections of games, learning, and player interaction of multiplayer cooperative SGs. The developing blueprint in this phase allows a multidisciplinary team, including game designers and knowledge experts, to have a common view of the game prototype in the initial phase of development projects. In the next step, the framework suggests using the blueprint for brainstorming and adding learning content to the game.

The third and fourth phases of the M-SG framework are developed based on the studies of the effects of the game premise and the lessons learned from developing the game prototype of our previous works (Grudpan, Alexandrovky, et al., 2019; Grudpan et al., 2021; Grudpan, Hauge, & Malaka, 2019). The concept is to add learning content and to organize player experience by modifying the game premise of the existing multiplayer cooperative games. In the third phase, the transforming game premise phase, the learning contents are added to the existing games to organize the functional requirements of the SGs. This phase provides workflow and documents for transforming the premise of chosen entertainment games to cooperative SGs. With a similar workflow, the fourth phase of the M-SG framework provides the guideline for the seasoning premise of the cooperative games to moral and immoral versions. The seasoning phase is suggested to be applied in the later iterative to organize player experience, which is considered a non-functional requirement of the SGs. The following figure illustrates using four-phase of the M-SG framework for each iteration of the rapid prototyping process in developing SGs (Figure 4.1).

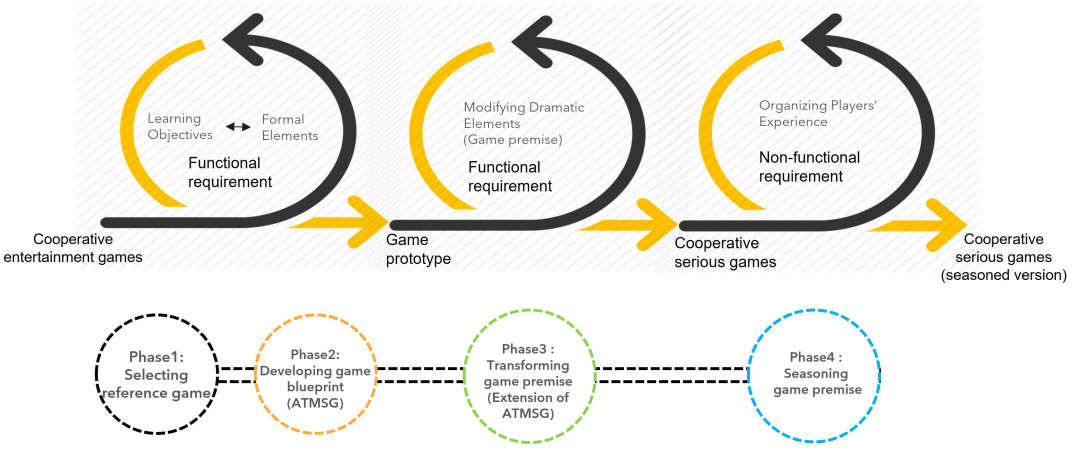


FIGURE 4.1: Applying the M-SG framework with rapid prototyping process.

The four phases of the M-SG framework were proposed to apply in other iterative development. Each iteration has a different objective. The lesson learned from implementing game prototypes and the results of the user studies in chapter 3 is used to develop these phases. The objective of using Phase 1– Selecting reference games, and Phase 2– Developing a games blueprint ensures that the functional requirements, including learning objectives, are fulfilled through players' interactions, which are the essential mechanics of multiplayer cooperative SGs. The objective of implementing Phase 3– Transforming Game premise is to provide the option to implement cooperative SGs by reusing existing entertainment games. The reusing approach minimizes the cost, time, and game developers' effort. The last phase, the Seasoning game premise, aims to fulfill the non-functional requirements, which is the requirement related to players' engagement. This phase is suggested to apply after concluding functional requirements in the previous phase to reduce developers' effort in modifying core game mechanics. Details of each phase are presented in the following sections.

4.2.1 Phase1–Selecting a Reference Game

The first phase of the M-SG framework is to select a reference game. Concepts of using the potential COTS games (Ulrich & Helms, 2017) and game elements to engage play (De Freitas & Liarokapis, 2011) for learning purposes were employed.

The M-SG framework suggests considerations that designers should consider to select the game reference. The framework suggests developers conduct Selection Criteria for selecting full-fledged entertainment games to be utilized for developing SGs were provided. The criteria help developers explore suitable games to serve specific learning proposes. The selection criteria have to contain information describing learning activities that instruction intends to add to the SG. Thus, the M-SG framework suggests developing selection criteria by considering three topics as follows:

- The similarity of games and learning activities: Generally, the formal elements (rule, gameplay, and character) of SGs are built based on the learning objectives. Therefore, selecting the COTS game as a candidate for transforming to SGs, the M-SG framework suggests looking into the formal elements of the game by considering the games that have game activities (actions, tools, goals) similar to the learning activity. For example, the cooperative board game can be one of the possible candidates to train players to collaborate among stakeholders involved in urban logistics planning (Grudpan, Hauge, & Malaka, 2019).

- The similarity of real-world and game scenarios: The M-SG framework suggests considering the games with a similar environment as the learning contents. With this criterion, the developers' team can minimize the design process. For example, a game with networking or map graphics and traveling activities can be a prominent candidate for developing a logistics game.

- Characteristics of cooperative activities: The M-SG framework suggests looking for the interaction between players to ensure that the activities support learning objectives which are the main requirements of developing cooperative SGs. For example, to develop multiplayer rehabilitation games, developers should look for existing cooperative games that require players to cooperate in the gameplay. Additionally, developers need to consider the game, which includes cooperative activities such as the cooperative mode of the Guitar Hero game (Ubisoft Leamington, 2015).

It is important to note that copyright issues must be considered as one of the selection criteria to avoid conflict, which may be a sensitive issue for creative work. To sum up, the outcome of this phase is the selected game reference that meets the selection criteria mentioned above. I suggest analyzing the mechanics of the selected game. They should be analyzed at the component level to ensure that the game has the potential to serve the required learning requirements. The tool for analyzing multiplayer cooperative games/SG is presented in the next section.

4.2.2 Phase2–Developing a Game Blueprint

Even though several researchers have studied the SGs analysis approach, the current SGs approaches still have limitations. Some approaches support the identification relation between gaming and learning mechanics at the conceptual level (Amory, 2007). They do not support the analysis of SGs at the component level. Although some researchers implemented models or frameworks to analyze SGs at the component level, the model focuses on analyzing single-player games (Arnab et al., 2015; Carvalho et al., 2015). However, there is still a lack of systematic approaches for analyzing multiplayer, especially multiplayer cooperative games. The literature review also identified the prominent framework possible to extend for supporting the analysis and development of cooperative SGs. Based on the literature review, I found that the *ATMSG model* (Carvalho et al., 2015) is the prominent approach suitable to extend for supporting analysis of the multiplayer cooperative SGs (see details in section 2.3.2).

The ATMSG model utilizes the activity theory to describe the SGs structure. The model stated that the structure of SGs consists of three main activities: Gaming, Learning, and

Instruction. The ATMSG represents the three activities of SGs with the three triangles (Figure 4.2) to show how the learner or player interacts with the teacher or instructor throughout the games. With the learner or player aspect, SGs can be seen as a tool for motivating players to learn (learning activity) while playing (gaming activity). On the other hand, from the teacher's perspective, SGs are a tool for supporting teaching activities. For example, an instructor, a lecturer, or a game designer uses the SGs to raise the learner's interest in the topic. In contrast, the player or learner focuses on playing the game for fun and completing the learning lesson. The ATMSG model also distinguishes instructional activity, which depicts the instructor or lecturer side, into intrinsic and extrinsic instructional activity. The intrinsic instructional activity refers to the activities that support learning inside the game. In contrast, extrinsic activity represents actions performed before or after the playing session.

To sum up, the ATMSG model uses activity theory and three triangles in Figure 4.2 to represent the interactions of a player and a teacher in SGs. Both users have different objectives and motivations to use games to interact through the games. Thus, the three triangles are activities (Gaming, Learning, and Teaching activity) that players and instructors have to be done during the play session. The Gaming, Learning, and Teaching taxonomy are used for identified elements of SGs. Even the ATMSG model is the prominent systematic approach for identifying SGs at the component level; however, one of the limitations of the ATMSG model is that the model focuses on representing activities of single-player games only. To fill the mentioned gaps, the M-SG framework extends the concept of the ATMSG model in describing the structure of multiplayer cooperative SGs. The detail of the extension is described in the next section.

The second phase of the M-SG framework is the extension of the ATMSG model. The extension includes two parts: (1) extending analysis procedures and standard annotation to present game sequences; and (2) extending activity theory with multiplayer games.

In the first part of extension, the M-SG framework extends the concepts to use standard annotation from the ATMSG models. The M-SG framework proposed to use *Swimlane* instead of the *Flow Chart* suggested by the ATMSG model. This extension mainly emphasizes the players' interactions in multiplayer games (see Swinlanes details in 4.2.2.1).

The second part is the extension by appling the activity theory to explain player cooperation in multiplayer SGs. The M-SG framework utilizes the same concept as the ATMSG framework to decompose the structure of SGs into three layers of activities: Gaming, Learning, and Instructional activity. The M-SG framework utilizes the activity theory to explain the relation of the player's interactions with the essential components of SGs, including gaming, learning, and instruction activities provided in the ATMSG model. With the activity theory, the M-SG framework implies that all the subjects/players, who

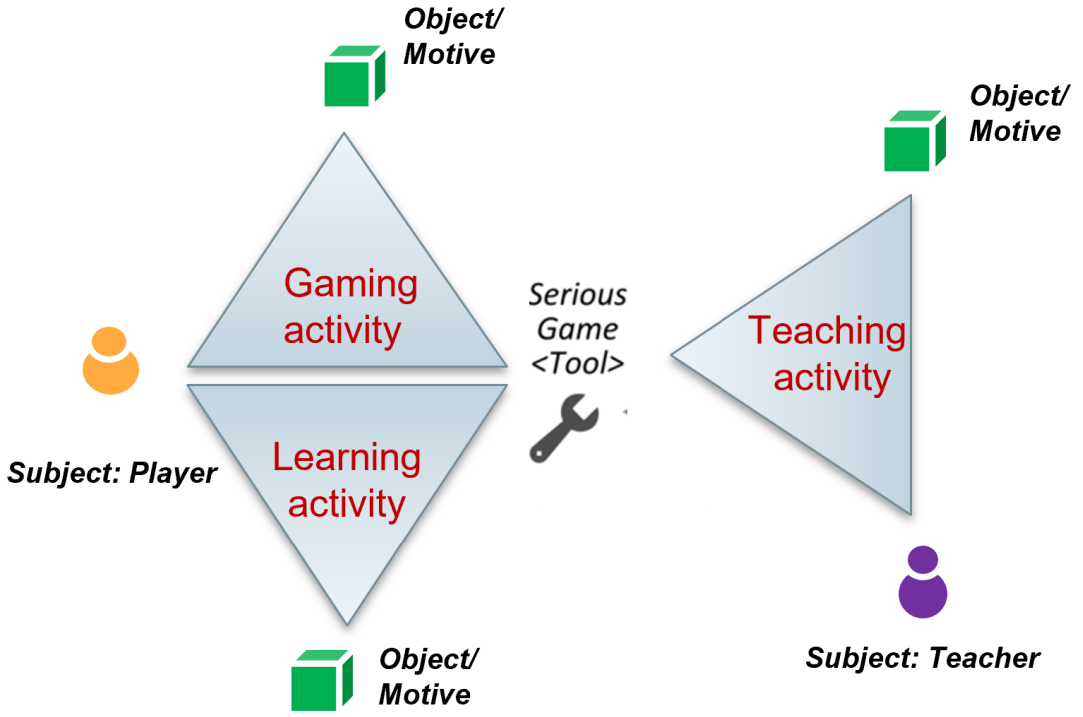


FIGURE 4.2: The ATMSG model Carvalho et al. (2015)

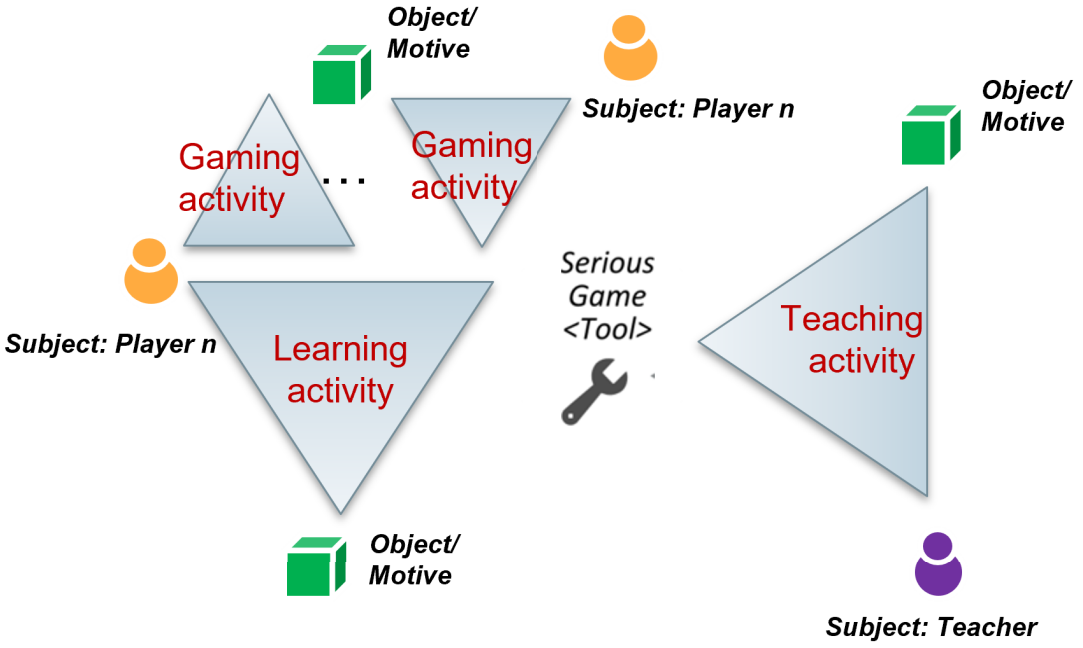


FIGURE 4.3: Phase 2 of the M-SG framework–the extension of the ATMSG model

play the game, share the same gaming activity with the same object/ motive. Multiplayer interact through the same games with the same learning and teaching activity. In other words, the small triangles present multiplayer gaming activities, and one triangle presents one activity. The reason to define that the player should have individual activity is that in the multiplayer cooperative SGs, players have different roles or actions. Still,

they share learning and teaching goals. Therefore, the M-SG extends the concept of the ATMSG model by adding gaming activities to show how players interact to each other and to the games. The explanation of the M-SG framework with the activity theory is presented in Figure 4.3

The cooperative taxonomy is proposed to explain cooperative actions. The cooperative taxonomy is part of the extension proposed in the M-SG framework. The taxonomy of the actions, tools, and goals of the learning, instruction, games, and SGs provided in the ATMSG model is utilized to identify the basic components of the SGs. In contrast, the cooperative taxonomy is added to identify cooperative activities, which are the main activities of the cooperative games. The details of the cooperative taxonomy are described in section 4.2.2.2. The objective of this step is to support developers in creating game blueprints. The blueprint presents the game structure, including game flow and relation of the game and learning components, and players' interaction. The blueprint allows game developers to specify connections among elements extracted from the chosen game and elements added for learning.

4.2.2.1 Analysing Multiplayer Cooperative Serious Games

The M-SG framework provides analysis tools for multiplayer cooperative SGs. This step is the extension of the ATMSG model (Carvalho et al., 2015). The two-step approach for the analysis of multiplayer cooperative games is proposed. The first step is to represent the game flow and players' interactions. The second step is to specify actions, tools, and goals for the multiplayer cooperative games.

Step 1: Represent the game flow and players' interactions

The ATMSG model suggests using the *Flowchart*, a standard notation that is common in the software engineering field, to present the flow of activities of the SGs. The flowchart is a part of the game blueprint. The diagram is utilized to show the game sequence, which will be used in the second step to identify the relationship between gaming, learning, and teaching in each state of the games.

The M-SG framework applies the concept of the ATMSG model that uses the de facto standard in the software engineering field to present the flow of activities of the SGs.The M-SG framework suggests the development team follow the guideline of the ATMSG model to draw a flowchart diagram to give an overview of the game flow. After that, the M-SG suggests using, Swimlane, another standard diagram representing players' interactions with the multiplayer cooperative SGs.

The Swimlane is suggested to overcome the limitation of the ATMSG model in that the model does not support analysis of the multiplayer game. The M-SG framework suggests using the Swimlane diagram. It is one of the Business Process Modeling and Notation (BPMN) that has become the de-facto standard for business process diagrams *BPMN specification business process model and notation* (n.d.). We apply it to represent cooperative activities of multiplayer cooperative SGs due to the fact that that diagram provides notations for illustrating the process of stakeholders involved in the process. The Swimlane also has an easy-to-use flowchart-like notation independent of any particular implementation environment.

The Swimlane diagram consists of pools and lanes. The pools represent participants in a business process for specific entities such as departments or roles. Flow elements inside a pool represent the process that needs to be performed within the lanes. Another part of Swimlane is the lanes. It is the sub-partition of the pools. The lanes can be used for representing specific entities or roles that are involved in the process. For example, the Head of the Department can be the pool, and the lecturers and officers can be the lanes. The course registration process requires both stakeholders to be involved and can be represented within the lanes.

In the M-SG framework, the Swimlane diagram is suggested to represent the cooperative activity of multiplayer cooperative SGs. The pool can illustrate game flow while the lanes represent players. The flow elements of Swimlane can be used to represent cooperative activities. The interaction of the players can be presented using notation, which are the arrows that point out from the process (e.g., boxes) across the lanes.

Step2: Identifying actions, tools, and goals of the multiplayer cooperative games

In this step, the vocabularies in the taxonomy related to teaching, learning, games, SGs and cooperation (details in section 4.2.2.2) are used to identify game components. The developers are suggested to identify the components by adding related components in each game state using the provided taxonomy. The reason for doing the activities in each state of the game is described in these steps to identify the relation of teaching, learning, games, and SGs components. The question that users need to answer for this step is "What is the subject doing, how, and why"(Carvalho et al., 2015). For the M-SG framework, further questions to guide developers to have an additional focus on cooperative activities were added. The question is, "What are the interactions among the subjects and the objects, how and why?" Thus, the cooperative taxonomy is suggested to guide developers in identifying relations of the cooperative activity with the other game components. The details of the cooperative taxonomy are presented in the next section.

4.2.2.2 Cooperative Taxonomy

The M-SG framework utilizes the taxonomy proposed in the ATMSG model (Carvalho et al., 2015) to identify the basic components of the SGs. The ATMSG model provides a taxonomy for the identification of SGs components, including taxonomies of learning, instruction, and gaming (games and SGs). The taxonomies were reorganized into three classifications based on the activity theory. The game elements are classified into three categories within an activity: actions, tools, and goals. The lists of Gaming, Learning, and Instructional elements are mentioned in Carvalho's work (Carvalho et al., 2015).

The M-SG framework is the extension of the ATMSG model, which provides an additional taxonomy, the cooperative taxonomy, to guide developers in identifying connections between cooperative activities with basic SG components proposed in the ATMSG model. The cooperative taxonomy is organized with the same classification (actions, tools, goals) as provided in the ATMSG model. The taxonomy was organized in which the items are classified according to the cooperative activity to which they belong. Details of the categories of cooperative actions, tools, and goals are given below.

The components classified as Cooperative actions (*Cooperative actions* in Table 4.1) describe, in general terms, the possible type of cooperative tasks in which players typically take actions to do cooperative work. The taxonomy on computer support cooperative work from Grudin and Poltrock (2012) is selected for this category because the proposed cooperative tasks are used in various contexts in the computer science field. It is also used for guidance in choosing cooperative tools which support the network of the gaming activity triangle (see Figure 4.3). The cooperative actions of multiplayer cooperative SGs are performed using at least two gaming activities from two subjects (players) to achieve at least one gaming goal.

The cooperative actions describe what kind of cooperative tasks players do, while the (*Cooperative tools*) are the components that force players to do the cooperative actions. For example, players may have common goals while having different abilities to perform to achieve one single game goal. The cooperative tools are a common goal and contain different abilities. The list of cooperative tools incorporating the gaming tools from the ATMSG model (Carvalho et al., 2015) and the cooperative mechanics are mentioned in Wendel et al. (2013).

Cooperative goals list (Table 4.1) is an outcome of the cooperative actions/tasks. The list describes the components of the outcomes players generated together in the games. These components are the outcomes of the gaming activity network. The outcomes of the gaming activity network respond to at least one of the learning goals (see Figure 4.3).

TABLE 4.1: Categories of the cooperative actions, tools and goals.

Cooperative actions	Cooperative goals
Planning tasks	Generating Plans
Creatives tasks	Generating Ideas
Interactive tasks	Solving Problems
Decision making tasks	Deciding Issues
Cognitive conflict tasks	Resolving Conflicts of Viewpoint
Mixed-motive tasks	Resolving Conflicts of Interest
Contest/ Battles/ Competitive tasks	Resolving Conflicts of Power

Cooperative tools
Common goal
Heterogeneous resources
Refillable personal resources
Collectable and tradeable resources
Collaborative tasks
Communication
In game help system
Scoreboard
Trading system

The typology of the cooperative tasks of McGrath mentioned in Grudin and Poltrock (2012) is directly used in this category.

To sum up, the second phase of the M-SG framework provides tools and taxonomy for analyzing multiplayer cooperative SGs. The tool helps developers gain a better understanding of how the cooperative activities relate to basic components of the SGs, which are gaming, learning, and instructional components in multiplayer cooperative SGs. The outcome of this phase is the *game blueprint*, which presents the game sequence and players' interaction (present in section 4.2.2.1), and the component (present in section 4.2.2.1) of the multiplayer cooperative SGs. The blueprint helps the developer team communicate in the initial phase of the prototyping process. Additionally, the game blueprint will be used to support developers in converting COTS games to SGs. Transforming Game Premise is the third phase of the M-SG framework. The details of Transforming the Game Premise will be described in the next section.

4.2.3 Phase3–Transforming Premise of Cooperative Serious Games

The M-SG framework suggests a development approach for Transforming Game Premise of the existing cooperative entertainment games to cooperative SGs. The existing games can be the game from the current projects, the cooperative entertainment games, or the COTS games, which pass the selection criteria provided in section 4.2.1. The game will be transformed into cooperative SGs in this phase.

This phase focuses on the implementation of cooperative SGs. The M-SG framework supports the game prototyping process. For the first iteration of prototyping, the M-SG framework suggests developers create a game prototype based on the game blueprint, which is the outcome of the second phase (section 4.2.2). With the game blueprint, developers can focus on implementing the formal elements, i.e., the gameplay rule. The developers do not need to worry about balancing the game mechanics because of the selection criteria. The criteria help the team choose qualified games containing mechanics to serve learning requirements.

The M-SG framework suggests that developers should first focus on modifying the game premise and game elements (role skill and abilities) that must be changed due to learning content while avoiding changing core gameplay to minimize developers' effort. The developer team and learning content experts have to brainstorm in initializing the game's narrative to avoid misleading the learning content. The M-SG framework suggests that programmers arrange flexible source code to rephrase the objects to minimize the cost and time of modifying the original game prototype. All texts embedded in the game should be easily accessible and editable by educational experts who can change the learning contents of the game.

The third phase of the M-SG framework provides the steps for documenting and keeping track of transforming the original game's premise to SGs. To ensure that the game is documented systematically, the three-step of game documentation as described. It not only guides developers to transform the game premise of the existing cooperative games to cooperative SGs but also supports communication of the developer team, including game designers, educational experts, and programmers.

Step 3.1: Labeling game elements derived from the game premise. This step selects the game elements that will be given meaning in the later step. The game elements related to the premise of the existing game are labeled. In this step, the game blueprint from the second phase is used to support developers in documenting the game elements that will be given meaning related to learning content in the later step. In this step, developers are suggested to work on the gaming aspect, consisting of the game elements and tools,

a row in gaming activity in the activity table of the ATMSG model, and the M-SG framework sequentially.

Step 3.2: Listing game elements of the original game into the Version table. The M-SG framework recommends creating a Version table to keep track of the naming of game elements of the original game version with our modified version document changes. In this step, game designers and programmers must cooperate to extract all the game elements into the table. The storyboard and user interface of the original game are the additional documents required in this step.

Step 3.3: Phasing game elements. The game elements in Step 3.2 are edited and added in the column next to the original game of Version table. The Version table is a checklist for game designers and programmers to modify the naming of game elements to give meaning to the games. An example of this step is to change the names of the roles and player actions and the narrative which describes the goal of the games in order to modify the premise. The premise has to represent the scenario related to the learning context. This step provides the document to help educationists/experts with no technical background change entertainment games to SGs without dealing with technical problems. Programmers have recommended flexibly organizing source code to import the new version of the text file back to the game project.

To sum up, the third phase of the M-SG framework suggests developers focus on adding learning content by modifying the premise of the existing cooperative games, while avoid changing the game's main features, which can increase the cost and time consumption. The game blueprint helps developers extract game elements that should be phrased, while the documents support the team's keeping track of the different premises version. The outcome of this phase is the game prototype embedded in the required learning content. In the fourth phase of the M-SG framework, modifying the premise of the game prototype into moral and immoral versions to organize the player experience in the game was suggested.

4.2.4 Phase4–Seasoning Premise of Cooperative Serious Games

The last phase of the M-SG framework supports developers in organizing the player experience from the cooperative SGs. In this phase, the M-SG recommended developers continue to modify the game premise of the prototype created from the third phase. The results of the literature review in section 2.1.3 and the results of the user studies in section 3.1 and 3.2 show that modifying game elements with *Moral and Immoral* version influence to pX. Thus, the M-SG framework provides a systematic approach which is the document, to support developers in modifying the game premise with Moral and

Immoral versions. The document support communication between teachers who are content providers and developers to change the game premise systematically and minimize time. This process suggests adding another iteration of prototyping development and conducting playtesting to select the suitable versions for the target group. Similar to the Transforming Game premise phase, developer teams were recommended to brainstorm in the initializing building up the moral and/or immoral versions to avoid misleading the learning contents that may cause by the specific vocabulary in the field.

In this phase, the M-SG framework provides the same documents as the Transforming Game Premise phase to season the transformed game to moral and/or immoral versions (the Version table and table of the ATMSG model and the M-SG framework). The steps of the *Phasing game element* are repeated. The Version table helps developers ensure that two game versions have identical mechanics but different premises. In contrast, the table of the ATMSG model and the M-SG framework help developers keep track of the game's original version.

To sum up, the fourth phase applies the steps of modifying the game premise from the Transforming Game Premise phase to organize pX by Seasoning the Premise of the game prototype into moral and/or immoral versions. This phase provides another option for developers to manage the player experience of the target group. I employed the concept by focusing firstly on the dramatic and game elements related to the game premise to decrease the cost and time in implementing the whole new game. The documents in the seasoning phase help developers ensure that the two-game versions have identical mechanics but different premises. At this point, even the suggestion of the M-SG framework employs an approach for *reusing /resking* the existing games or COTS games; however, I would like to emphasize that the copyright should be a significant concern. Creative work is a sensitive issue that has to take into account. Thus, I suggest applying this framework to the in-house games, which can be the existing project of the studio. Additionally, business partners' permission also needs to take into consideration.

4.3 Applying the M-SG Framework for Developing Urban Logistics Games

This section presents the M-SG framework features that support developers in analyzing and developing multiplayer cooperative SGs. Regarding the challenges of urban logistics planning mentioned in my previous works (Grudpan et al., 2017; Grudpan, Hauge, & Malaka, 2019), an urban logistics scenario is selected to present the framework's application.

The following section presents an example of using the M-SG framework to analyze and develop multiplayer cooperative SGs for learning concepts of urban logistics. Details for utilization of the four-phase M-SG framework are described as follows.

The example of Selecting Reference Game (Phase 1): Pandemic Game

I began by analyzing the urban logistics scenarios from the literature and identified the learning objectives. Then, I created the selection criteria to choose the reference games. I investigated the popular cooperative commercial games and then developed the following criteria to filter the number of games. The main criteria for selecting the reference games are i). A game that needs the players to deal with a map of networked locations, which is the type of environment required for a logistics game. ii). A multiplayer game requires the players to help each other complete the game goal. iii). A game that mandates the players to cooperate on the decision level., iv). A game where the players need to make decisions based on their roles. I found that the Pandemic board game (Z-Man Games & Matt Leacock, 2008) was one of the most promising games that could be used as a reference game for our prototype implementation because it satisfied all the requirements in our criteria.

Initially, Pandemic (Z-Man Games & Matt Leacock, 2008) was a turn-based multiplayer cooperative game whose goal was to stop the spreading of diseases on the map before the Pandemic occurred. The players must cooperate to make a series of decisions to win the game. Gameplay: The game starts with the spreading of infections. The player needs to take action during his/her turn, which consists of three phases. Action phase: the player needs to execute movement actions and the actions for treating/discovering. Draw-phase: the player draws the cards that allow movement and cure actions from the deck. Infection phase: The player draws cards from the infection deck, and the infection progresses on the map. Win/Lose conditions: The game ends when one of the following loss conditions occurs: i) the player runs out of cards from the player deck; ii) all infection markers are set on the map; or iii) an outbreak occurs more than eight times (a city has more than three infection items, leading to a cascade spreading to adjacent towns). Players need to discover a cure for all diseases to win the game.

The game is designed so that the more turns players use, the higher chances of losing by running out of cards or being in the outbreak. The game design forces players to work cooperatively to discover cures for the diseases within limited game turns. The gameplay of the Pandemic forces players to cooperate in making a decision similar to the situation required in urban logistics planning. Thus, the game is selected to be a reference game.

The example of Developing a Game Blueprint (Phase 2)

The Pandemic game, the selected game from the first phase, is an example of demonstrating how to develop game blueprints. I utilized the analysis tool provided by the ATMSG model (Carvalho et al., 2015) and the M-SG framework to create a game blueprint (Grudpan et al., 2021) of the multiplayer cooperative SGs. The ATMSG represents the game flow and basic game components, whereas the M-SG framework focuses on illustrating connections between players' interactions and cooperative activities that support learning and teaching activities in multiplayer cooperative SGs.

The ATMSG model (Carvalho et al., 2015) provides an analysis tool to create an initial games blueprint that represents game flow and essential components of SGs. The analysis tool helps developers deconstruct the Pandemic game to ensure that it has possible mechanics that meet learning requirements. The learning objective, in this case, is to be able to explain the concept of urban logistics and the different roles of stakeholders. Applying the ATMSG model to analyze the Pandemic game is presented below. The analysis tool provided in the ATMSG model includes a Flowchart (Figure 4.4)and an ATMSG's table to present taxonomies and connections of gaming, learning, and teaching in SGs (Figure 4.6). The Flowchart is used to illustrate Game flow, while the ATMSG's table and taxonomies explain the relation of the game's gaming, learning, and teaching components in each state of the game flow. While the ATMSG's table, which consists of three layers: gaming, learning, and teaching layers, is prepared for filling out the gaming, learning, and teaching components can be done in this phase. However, I recommend focusing on the game flow and adding gaming components to have first a common understanding in gameplay in this phase. With the game flow and the ATMSG's table, the developer team can have the initial idea for brainstorming, adding learning and teaching components later. Identifying the learning and teaching components can be completed in the third phase–Transforming Game Premise.

The M-SG framework provides an analysis tool to present the interaction of multiplayer and the relation of cooperative activities with the basic components in multiplayer cooperative SGs.The analysis tool is called the *game blueprint*, which is the combination of the Swimlane diagram shown in Figure 4.5 and the table to identify game components show in Table 4.2. The blueprint of multiplayer cooperative SGs includes Swimlane and the table to identify connections between cooperative activities and basic components of SGs, which is the extension of the ATMSG model.

The Swimlane is a diagram for representing players' interaction. The M-SG framework suggests drawing Swimlane Diagram after the team members have a standard overview of the game flow, which is the flowchart provided in the ATMSG model, because the Swimlane allows users to present the activities of individual users, in this case, the cooperative activities of the players in multiplayer games. The Swinlane also enables

users to draw data flow which is the data that stakeholders in the lane exchange during the game activities. Thus, using the Swimlane diagram presents the cooperative activities and player interactions in multiplayer games in more detail. This contribution can fill the gaps in the ATMSG model, which is lacking concerning multiplayer games and social interaction.

The M-SG framework suggests using the Swinlane with the *cooperative taxonomy* to identify the relation of players' interactions with gaming and learning components. A *cooperative layer* is added to the ATMSG's table with the provided cooperative taxonomy to guide developers in describing how the cooperative activities related to gaming, learning, and teaching components of the cooperative SGs see Table 4.2.

Figure 4.5 shows an example of players' interactions in the Pandemic game as turn-based. An example is the modified Pandemic game for learning urban logistics concepts. The pool represents the game sequence, while the lanes show the activities of each player. The diagram shows the game sequence and players' cooperation in each turn. The combination of Swimlane and the cooperative layer, the additional layer of the ATMSG table, is the game blueprint showing connections in each gameplay state. More specifically, the example of Swimlane shows the state of the games that require players to cooperate in decision-making and the timing to take turns players. The diagram shows the state of players' interactions in detail. Moreover, Table 4.2 shows the example of using cooperative taxonomy to identify cooperative activities of the Pandemics game. It shows the Cooperative tool, goal, and action employed in the Pandemic game, which was modified to learn urban logistic concepts. Taking *Action phase* as an example for identifying the relations of the game state, players' interactions and gaming, learning components, and cooperative activities of the urban logistics games. Focusing on the *Action phase* in the Swinlane Figure 4.5, then looking into the word *Action phase* in table 4.2. The Swimlane describes how and in what state of the game the first and second players cooperate in the action phase of the games. At the same game state (Action Phase), the Gaming, Learning components, and Cooperative layers explain that the players have to discuss planning for cooperating and taking actions (Cooperative activity) due to the limitation of players' actions in each turn (Gaming components). The mentioned situation responds to the learning objective (Learning components) of the games: understanding urban logistics stakeholders' different roles and responsibilities.

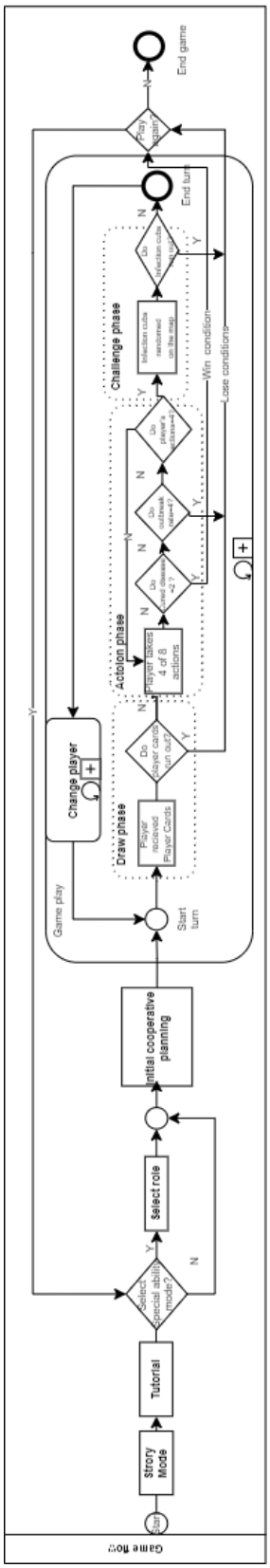


FIGURE 4.4: The ATMSG model: Using flowchart to represent Game flow of Pandemic game

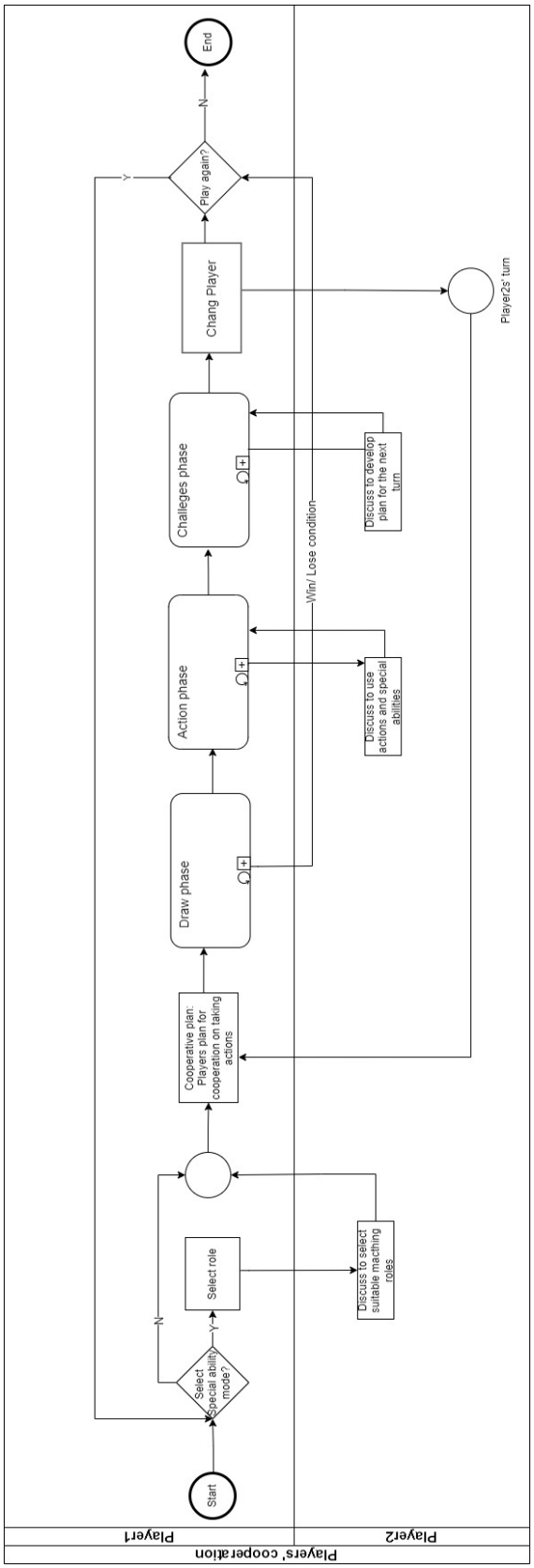


FIGURE 4.5: The M-SG framework: Using Swimlane to represent players' interaction of Pandemic game

		Story mode	Tutorail	Select role	Initial cooperative planning	Draw phase	Action phase	Challenge phase	Change player
Gaming	Action	Watch/ Read story	Read information	Select		Manage resources: Player recived cards.	Take actions with an allotted number of	Watch/ Read information	Plan / Strategy
	Tool	Animation, Story (Text)	Tutorial	Information		Randomed cards: Each player received two randomed Player Cards.	Challenges: Random scenarios. Roles: Special abilities of eah role. Segmentation of game play: Alternating turns.	Randomed cards: Vehicle icons randomed on the map Animation, Story (Text)	Segmentation of game play: Alternating turns Time: Alotted number of actions
	Goal	Get acquainted with story	Learn UI/ Discover goal	Configure game		Players cooperate to manage resources	Player takes 4 actions	Players cooperate to plan for the next turn.	Players cooperate to develop their plan for the next turn.
Learning	Action	Remembering: Read. Player go throgh the story that relate to the learning content.	Remembering: Read, Click	Understanding: Discuss. Choosing special ability	Understanding: Discuss.	Understanding: Discuss.	Applying: Experimenting.	Analyzing: Identify.	Understanding: Discuss. .
	Tool	Dramas, Animation	Animation	Textual information: Texts Group discussion	Problem solving: Challenges Group discussion	Problem solving: Challenges Group discussion	Problem solving: Challenges, Animation, Text	Displays, Graphics, Animation Group discussion	Problem solving: Challenges
	Goal	Remembering	Remembering	Remembering: Responsibilities and tasks of stakeholder	Remembering: Important factors / Stakeholders' roles in Urban logistics	Remembering: Urban logistics activities	Remembering: Urban logistics activities Remembering: Stakeholder roles.	Perception (awareness): Important factors / Stakeholders roles	Perception (awareness): Stakeholders cooperations
Intrinsic	Action		Demonstrating	Presenting the choices		Repetition	Repetition	Repetition	Repetition
	Tool		Tips	Discussion		Problem solving: Challenges	Animation, Story(Text)	Challenge, Multiple chance, Limited set of choices	Problem solving: Challenges
	Goal		Providing learning guidance	Gain attention		Inform learner of objective	Inform learner of objective	Inform learner of objective	Perception (awareness)
Extrinsic	Action			Suggest improvements	Plan / Strategy: Cooperation of difference roles				
	Tool			Problem solving: Challenges	Challenges: Random scenarios. Roles: Special abilities of eah role. Segmentation of game play: Alternating turns.				
	Goal			Inform learner of objective	Players to share their action plan.				

FIGURE 4.6: Using the ATMSGs'tables to represent relation of gaming, learning and teaching of the Pandemic game

TABLE 4.2: The M-SG framework table to represent relation cooperative activities and basic game components of the Pandemic game

		Draw phase	Action phase	Challenge phase	Change player
Gaming	Action	Manage resources:Player recived cards.	Take actions with in alotted number of action.	Watch/ Read information	Plan / Strategy: Players replan their strategy .
	Tool	Random cards	Challenges: Random scenarios.Roles: Special abilities of eah role.Segmentation of gameplay: Alternating turns.	Randomed cards: Vehicle icons randomed on the mapAnimation, Story (Text)	Segmentation of game play: Alternating turnsTime: Alotted number of actions
	Goal	Players cooperate to manage resources	The player takes actions based on their plan in the previous state.	Players cooperate to develop their plan for the next turn.	Players cooperate to develop their plan for the next turn.
Learning	Action	Understanding: Discuss. Uban logistics concepts	Applying: Experimenting. Perform actions	Analyzing: Identify. Consequence of their actions	Understanding: Discuss.Urban logistics stakeholders roles
	Tool	Problem solving: ChallengesGroup discussion	Problem solving: Challenges, Animation, Text	Displays, Graphics, AnimationGroup discussion	Problem solving: Challenges

Table 4.2 (continued)

		Draw phase	Action phase	Challenge phase	Change player
	Goal	Remembering: Responsibilities and tasks of stakeholders in urban logistics and Essential factors for developing urban logistics	Remembering: Responsibilities and tasks of stakeholders in urban logistics and Essential factors for developing urban logistics	Perception (awareness):Aware of the essential factors for developing urban logistics	Perception (awareness):Aware of the critical cooperation of stakeholders who have different abilities and roles.
Intrinsic	Action		Repetition	Repetition	Repetition
	Tool		Animation, Story(Text)	Challenge, Multiple chance, Limited set of choices	Problem solving: Challenges
	Goal		Inform learner of objective	Inform learner of objective	Perception (awareness)
Extrinsic	Action	Suggest improvements	Repetition		
	Tool	Problem solving: Challenges	Problem solving: Challenges		
	Goal	Inform learner of objective	Inform learner of objective		
Cooperation	Action	Plan / Strategy:Using special abilities cooperatively	Players plan on taking action in this turns	Players cooperate to identify the consequnce of the actions in the previous turn.	Players plan on taking action in next turns

Table 4.2 (continued)

		Draw phase	Action phase	Challenge phase	Change player
	Tools	Challenges: Random scenarios. Roles: Special abilities of each role.Segmentation of game play: Alternating turns.	Challenges: Random scenarios (cards).Roles: Special abilities of eah role.Segmentation of game play: Alternating turns.	Randomed cards: Vehicle icons randomed on the mapAnimation, Story (Text)	Challenges: Random scenarios (cards).Roles: Special abilities of each role.Segmentation of gameplay: Alternating turns.
	Goal	Players share their action plan.	Players cooperate in planning on taking action in this turn based on the limited resources.	Players cooperate to analyse the consequence of their plan.	Players cooperate in planning on taking action in the next turn based on the limited resources.

The example of Transforming and Seasoning Game Premise (Phases 3 and 4

In these phases, I focused on the implementation process. The M-SG framework provides procedure and the document to systematically document and keep track of transforming the original game's premise to SGs.

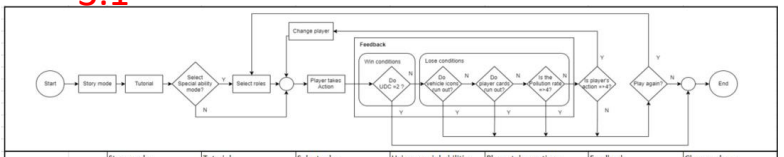
The example is the documents iteratively developed from lessons learned from urban logistics game developments. The table from the ATMSG model (Carvalho et al., 2015) is used for identifying game elements related to the premise. The Version table (Step 3.2 and 3.3 in Figure 4.7) shows the Transforming of the Pandemic game, which is the original game, to an urban logistics game. The table is also used for the Seasoning phase to compare game elements of the Positive (moral version) and Negative (immoral version). To be more specific, I modified the version of the original Pandemic game for my user study by simplifying the game to its core mechanics. The simplified version of the original Pandemic game ensures that the game can be played within 30 minutes. This time restriction requires the lecturers to adapt the game to be applied during a class session. I modified the game premise, which is the setting behind the game. The names of the players' actions and their roles also need to be modified because they are different from the original Pandemic game version. My learning goal is to understand the concept and relation of stakeholders in urban logistics. Thus, I applied the urban logistics scenario to the game. The game has three types of city stakeholders in the game, i.e., the Mayor, the Logistic Service Provider (LSP), and the Shop owner. The players have to cooperate to solve the traffic congestion and pollution problems caused by goods delivery from manufacturers outside the city. My design process focused on modifying the game elements' names, such as actions, roles of the players, and phrases in the tutorial, while keeping the game mechanics identical to the original version. Before the tutorial mode, the added story mode must be played before the tutorial mode to describe all stakeholders' roles, requirements, and relationships.

Step 3.1: Labeling game elements derived from the game premise

Step 3.2: Listing game elements of the original game in the Version table.

Step 3.3: Transforming and Seasoning game elements.

3.1



		Story mode	Tutorial	Select roles	Using special abilities	Player takes actions	Feedback	Change player
Gaming	Action	Watch and Read story	Obtain help	Select roles	Plan/Strategy: Team of 2 players plan to use special abilities.	Plan/Strategy: Team of 2 players plan to take action togethers.	Information: See performance evaluation	Change player turn
	Tool	Animation; Story (Text)	Tutorial	Rules	Rules; Special abilities of each role	Rules; Random scenarios and Events	Feedback; Achievements	Limited turns of players; Events
	Goal	Get acquainted with the story	Discover goal; Learn to use interface	Configure game	Tasks: Players cooperate to use special abilities of each role to solve puzzle.	Tasks: Players cooperate to solve puzzle	Narrative: Discover goal	Encourage players to plan for the next turn
Learning	Action	Remembering: describe the relationship of the stakeholders in urban logistics	Remebering: Read;Click	Understanding: Players discuss to select their roles.	Understanding: Players discuss to use special abilities which related to stakeholders roles in urban logistics.	Applying: Performing action/task	Verify /reviewing	Repetition; Experimenting
	Tool	Animation; Story (Text)	Guideline	Textual information: Text	Interaction: Group discussion	Interaction: Group discussion	Textual information: Report	Interaction; Group discussion
	Goal	Remembering the relationship of the stakeholders in urban logistics	Remembering: Remembering new keywords related to consideration in urban logistics e.g. Urban Distributed Center (UDC).	Understanding: Discussing to choose apporiate tasks of different roles in urban logistic.	Perception: Be aware of the importance for cooperation of different roles in urban logistics.	Understanding: Understanding the considerations for developing plan for urban frieght distribution.	Understanding: Be aware of the consequnce of stakeholders decision to urban freigh distribution flows.	Understanding: Understanding the importance of stakholders cooperation in urban logistics.
Intrisinc Instrcution	Action		Demonstrating	Presenting the choices	Repetition	Repetition	Quatitatively assessing performance.	
	Tool		Tips	Discussion	Challenge; Multiple chance; Limited set of choice	Challenge; Multiple chance; Limited set of choice	Perfomance measure	
	Goal		Providing learning guidance	Gain attention	Inform learner of objective	Inform learner of objective	Providing feedback	

3.2

3.3

Original	Green city Eng ver	Green city Thai ver	Negative Eng ver
Positive	Green city	Green city	Drug city
Infection deck	Procurement deck	Procurement deck	Procurement deck
Infection deck history	Procurement deck history	Procurement deck history	Procurement deck history
Cured disease status	UDC construction status	UDC construction status	UDC construction status
Player deck	Player deck	Player deck	Player deck
Player deck history	Player deck history	Player deck history	Player deck history
Infection rate	Procurement rate	Procurement rate	Procurement rate
Outbreak rate	Pollution rate	Pollution rate	Pollution rate
Epidemic	Market Expansion.	Market Expansion.	Market Expansion.
Move	Move	Move	Move
Direct flight	Tram	Tram	Tram
Charter flight	Bicycle	Bicycle	Bicycle
Shuttle flight	Share e-vehicle	Share e-vehicle	Share e-vehicle
Treat	Release traffic jam	Release traffic jam	Release traffic jam
Cure	Construct a UDC	Construct a UDC	Construct a UDC

FIGURE 4.7: The example of documents and steps for applying the Transforming and Seasoning Game Premise phases

4.4 Evaluating the M-SG Framework

In this chapter, I conducted a qualitative user study to evaluate the users' perception of the usability and usefulness of the M-SG framework. The user study responds to ***H4-H6*** of this thesis. The validation goal was to obtain user feedback to address the issue, particularly usability, from experts in game design and development areas in the academic and game industry who envision profit from utilizing a framework. A two-day workshop was conducted to evaluate four phases of the M-SG framework. The workshop scope excludes the first phase of M-SG, Selecting Reference Games, according to the time restriction. However, I asked the participants to comment on the concept of reusing the core mechanics of the existing games, which is the main idea of the first phase.

The first day of the workshop is to evaluate the second phase of the M-SG framework, which is the analysis tool for multiplayer cooperative SGs. The ATMSG model (Carvalho et al., 2015) was used as a benchmark to compare the functionality and usability of the M-SG framework in identifying the connection of gaming, learning, and players' interaction in multiplayer cooperative games.

Subsequently, on the second day, to verify the third and fourth phases of the M-SG, participants are asked to transform and season the multiplayer cooperative SGs, which is the game that the participants were asked to analyze on the first day. The new scenarios and learning objectives were given. The participants were asked to transform the premise into the given learning objective, and after that, they were asked again to season the premise into the Moral and Immoral versions. At the end of the second day, participants were asked to evaluate all phases of the M-SG framework

4.4.1 Participants

This user study was conducted in Chiang Mai, Thailand. Nine experts in game development in the academic (n=5) and game industry (n=4) were recruited to evaluate the M-SG framework. Participants are between 18 and 39 years of age, with eight males and one female. All participants have experience in various roles in game development projects, such as game designers, game programmers, game artists, and project managers. Some are also researchers in games and SGs research areas (see demographics in Table 4.3). Participants' backgrounds are described in more detail as follows.

- P1 is a 3D game artist and game design researcher who is a doctoral student working on game mechanics and aesthetic elements of SGs.

Table 4.3: Demographic of the participants.

Group ID	Participant ID	Field of work	Exp. in SG projects	Gender
G001	P001	Game designer/2D-3D Artist/	Yes	Male
	P002	Game programmer/Game data analysis researcher	Yes	Male
G002	P003	Game programmer/AI for game researcher	Yes	Males
	P004	Game designer/2D-3D Artist	Yes	Female
G003	P005	Game designer (Industry)	Yes	Male
	P006	Game programmer (Industry)	Yes	Male
	P007	Game tester/Designer (Industry)	Yes	Male
G004	P008	Game designer/Project manage	Yes	Male
	P009	Game programmer(Freelancer)	Yes	Male

- P2 is a game developer and researcher who is a doctoral student working on the game pipeline and data analytics of multiplayer online role-playing games (MMORPG).
- P3 is an AI game researcher with a game developer background. He is a post-doctoral who is working on applying deep learning to create characters' behavior in games.
- P4 is a junior researcher in UX/UI for games. She is a master's student with experience in various game and SGs development projects as a game artist and UX/UI designer.
- P5 works as a game designer at a local game studio. He involves in various game and SG development projects and has experience working with the multidisciplinary team in SG development projects.
- P6 works as a game developer and game designer with a local game studio working on gameplay and the development of game mechanics. He has experience in applying a systematic approach to game development projects.
- P7 works as a game tester with a local game studio working on developing learning games.
- P8 is an employee in the game studio; he has experience in various games and SGs development projects as a coordinator and project manager.
- P9 is a freelance game developer working on gameplay and the development of game mechanics of SGs.

4.4.2 Procedure

Participants were invited to join a two-day workshop. In the workshop, the participants were grouped (2-3 participants/group) according to their familiarity with the field of work. The participants, who are colleagues, were teamed up as a group. Each group must include at least one participant with experience in game design or SGs, while another participant needs to have experience as a programmer in the games or SGs development projects. Each group attended the workshop on different days to ensure that the participants were closely observed during the sessions. However, due to the COVID-19 situation, two groups (Group 1 and Group 2) attended the workshop on site in a closed room, while the other two groups (Group 3 and Group 4) attended the online workshop.

The first-day workshop

The first-day workshop's main activity is verifying the analysis tool mentioned in the second phase of the M-SG framework. The application of the systematic approach in developing games and SGs, including the rationale for using it, was introduced prior to the activity because most of the participants were unfamiliar with applying frameworks or models in game development projects.

The workshop program started with the introduction to the basic concepts of the ATMSG model and the M-SG frameworks, followed by the description and objectives of the user study, including the first- and second-day activities. After the participants completed and signed a consent form, a demographic questionnaire was given to them to evaluate their experiences in the game and SG development.At the end of the first-day workshop, participants' feedback on the usability and usefulness of utilising the ATMSG model and the M-SG framework in analyzing multiplayer cooperative SGs was gathered.

The activities were divided into two sessions: Playing and Analysing. In the Playing session, the groups of participants were asked to play the Urban logistic game, the multiplayer cooperative SG developed for teaching university students. The learning contents relate to the urban logistics concept, the importance of coordination, and the role of stakeholders in urban logistics. In this session, participants were allowed to play the game as many times as they wanted within the time limitation during the morning session.

The Analysing session started in the afternoon. The participants had to analyze the Urban logistics game they played in the morning by utilizing the ATMSG model and the M-SG framework. After the Analysing session, the participants were asked to fill out the System Usability Scale (SUS) questionnaire and were interviewed with questions

related to the usefulness and usability of the tools. Finally, the participants were asked to discuss the advantages and disadvantages of both the ATMSG model and the M-SG framework.

The second-day workshop

The main activities of the second-day workshop were transforming the cooperative entertainment game they played and analyzed on the first-day workshop into the SG, and seasoning the developed cooperative SGs with different premise versions. The participants were assigned to utilize *the M-SG framework's third and fourth phases*, Transforming Game Premise and Seasoning Game Premise, respectively, which provide the guidelines to do so. Prior to the assignment, the background and introduction of the Transforming Game Premise and Seasoning Game Premise, as well as guidelines, were described to the participants. The guideline documents were provided to the participants to help participants in applying the proposed concepts. The activities of the second-day workshop are as follows.

First, the participants were asked to choose one of two different scenarios, Pandemic management or Marine Spatial planning, which later was used for modifying the game premise. These scenarios have similar challenges with urban logistics and require stakeholders' cooperation in solving problems.

Second, the participants were assigned to transform the game premise of the original game (urban logistics game) to the chosen scenario (Pandemic management or Marine Spatial planning).

Third, the participants were asked to season the game premise to moral and immoral versions.

Finally, the participants completed the SUS questionnaire for the evaluation of the Transforming and Seasoning Game Premises phases. They were then interviewed to discuss the usefulness and usability of both phases and their opinions on applying the M-SG framework to their project. After going through all the steps, the participants were asked to give their opinions on following the Transforming and Seasoning Game Premises procedure.

4.4.3 Interviews

The interview questions were to evaluate the usefulness and usability of the M-SG framework. We asked participants specifically about the features of each phase of the M-SG framework. There were three groups of questions: general, usability and usefulness of

the game blueprint phase, and usability and usefulness of the Transforming and Seasoning Game premise phase questions. Details of the interview questions for the two-day workshop are described as follows.

The first set of interview questions was general, asking about the participants' experience in the SGs development project and their experience using a systematic approach. For the participants' experience questions, they were first asked about their experience related to processes, methods, steps and tools that they usually use in their projects. After that, they were asked about their experience in using a systematic approach. The names of well-known systematic approaches, such as MDA (Hunicke et al., 2004) and ATMSG model (Carvalho et al., 2015) were given to them as examples. Moreover, the participants listed the methods and tools that they used for communicating among the developer teams(designers, programmers, and content experts).

The second set of interview questions was to evaluate the usability and usefulness of the analysis tool, which is the second phase of the M-SG framework (Developing game blueprint phase). The questions were used for interviewing participants at the end of the first-day workshop. For this category, we evaluated the usefulness and the usability of our proposed analysis tool, which is the extension of the ATMSG model (Carvalho et al., 2015). The participants were asked to give their opinions on simplifying the M-SG framework to support them in creating a game blueprint. They were asked to discuss in detail about using the tools to represent players' interaction in multiplayer games and identify the relation of gaming and learning components of the cooperative SGs. We asked specific questions related to using the Swimlane notation to illustrate the game flow and players' interaction in multiplayer games and using the cooperative taxonomy to identify cooperative activities in cooperative SGs. We asked the participants to give their opinions, concerns, and limitations on applying the approach in practice. Additionally, we asked participants to discuss reusing game components, leading to the third set of questions that participants were asked in the Transforming and Seasoning Game Premise phase.

The third set of interview questions evaluated the usability and usefulness of the M-SG framework's first, third and fourth phases; Selecting Game Reference, Transforming Premise and Seasoning Game Premise. The discussions mainly focused on the usefulness of applying the framework in a real-world project, the usability of the provided documents, and limitations to implementing the Selecting game reference, the Transforming and Seasoning Game Premise phase

For evaluating the usefulness of the Transforming Game Premise, we emphasised asking participants to give their opinions on modifying the premise and the content of the existing games for developing new games or SGs. For the Seasoning Game Premise

phase, the participants were asked to give their opinions on modifying the premise to the Moral and Immoral version in their projects.

To evaluate the usability of the provided documents, the participants were asked about simplification using the procedures and documents for the Transforming and Seasoning premises during the workshop sessions.

The participants were also asked to discuss the possibility of applying the MSG framework to their projects. The participants were asked to give an example of the existing projects that can apply the Selecting Game Reference, the Transforming premise, and the Seasoning premise phase-in.

In the last set of questions, participants were asked to give an opinion on all phases of the M-SG framework. The general questions related to the usefulness and usability of the M-SG framework were asked again to acquire overall feedback.

4.4.4 Results

To analyze the interview results, the participants' answers were classified into three main categories: *i) General comments, ii) Usefulness and usability of the Developing Game Blueprint phase and iii) Usefulness and usability of the Transforming and Seasoning Game premise.* Then, I summarised similar responses to reduce the number of statements. The selection criteria were set. To minimize bias, two examiners were invited to repeatedly group the information. I then scanned the answers for the emerging topics from those we defined for the interview. In the following, we present the results along with the categories.

General Comments

I asked the participants to give their opinions on their experience using the M-SG framework and to discuss the overall features of the M-SG framework. The average usability score of the M-SG framework obtained from the SUS questionnaires was 60.71 (N=9, SD=15.40), on a scale of 0-100.

The issues that were mentioned included team communication (P8, P9) and the reusing approach (P5, P6, P7, P8, P9). For the team communications, all participants mentioned that the M-SG framework mainly supports communications of multiplayer games. The game blueprint, the extension of the AMTSG model, supports a multidisciplinary team with a common understanding of gameplay and player interactions (P3, P4, P5, P7, P8, P9). Additionally, P8 and P9 mentioned that the framework helped to illustrate the game overview in the developer aspects. Regarding the reusing approach, all participants

agreed with reusing games from the previous project or COTs games to remake as an SG. P2, P4, and P5 stated that reusing the existing games could reduce the development process because they did not have to start from scratch.

Usefulness and usability of the Developing a Game Blue Print phase.

The SUS questionnaire and systematic interview questions for the analysis of multiplayer cooperative SGs were used to gather the data regarding UX and usability aspects. Participants agreed that utilizing both the ATMSG model and the M-SG framework improved their understanding of the characteristics of the games. The ATMSG scored 63.48 *(N=9, SD=13.96)*, and the M-SG scored 65.28 *(N=9, SD=16.22)* on the SUS scale. Similarly to the qualitative data, the SUS usability scores reflected the difference in perception between the two models. However, the sample size was insufficient for definitive conclusions to be drawn. Therefore, I investigated the qualitative data further.

All participants mentioned that the game blueprint helped the team to understand the requirements and the game's structure that the team was implementing (P2). The blueprint also allowed the team to improve the game designer's skill to structure the game flow (P8, P9). We then asked the participants to explain their experience creating each part of the game blueprint.

All participants confirmed that the Flow chart, the standard annotation provided in the ATMSG framework, supported the team in having a common view of the gameplay. In contrast, the Swimlane, the annotation suggested by our framework, supported the illustration of player interaction and cooperative activity of cooperative games. P2 mentioned that the Swimlane supported the programmer plan for the coding module. P2 and P3 stated that the Swimlane was suitable for analyzing multiplayer games.

Additionally, P3, P7, and P9, the programmers from three different groups, mentioned that it was essential first to use the Flow chart to display the gameplay to help developers picture the gameplay overview. Then, using the Swimlane in the second step to illustrate the player's interaction helped the developers focus on each player's activities. The sequence helped the developer teams to shape their idea with the gameplay systematically.

Moreover, the participants also give feedback on the table containing the four taxonomies: game, learning, instructional, and cooperative. The cooperative taxonomy is part of our framework. All the participants confirmed that the taxonomy table helped them identify relations between the game, learning, instructional and player cooperatives. P1, P2, P4 and P5 mentioned that the taxonomies help them initiate ideas. They do not need to develop everything from scratch in the project's initial phase.

Usefulness and usability of the Transforming and Seasoning Game premise.

Data regarding the usefulness and usability aspects of procedures and documents for the Transforming Game Premise and Seasoning Game Premise phases were gathered with the SUS questionnaire and interview questions. On the SUS scale, the participants rated the usability of the procedures and documents provided in the Transforming and Seasoning Game Premise phase with 73.02 (N=9, SD=16.50).

After that, for qualitative analysis, we asked participants to give their opinions on utilizing procedures and documents given for the Transforming Game Premise and Seasoning Game Premise phases. Generally, all participants could fill out the provided documents to follow the process of transforming the existing game premise into the new learning content. The participants (P1, P2, P5, P6) mentioned that the document supports cooperation in the development team. Based on the concepts of Transforming premise of entertainment games to SGs, I focused on the questions about reusing the existing games, especially the game for entertainment purposes, to modify the premise and transform them into SGs.The participants (P1, P2, P5, P6, and P7) mentioned that the Transforming Game Premise was an interesting approach to minimizing the time and cost of developing SGs. The participants (P3, P9) noted that the procedure of the phases similar to the practice generally utilized in the game industry was called "reskinning" games. At the same time, the provided documents helped them to phase the game elements more systematically. The participant (P5) mentioned that the Table version, the document provided in the Transforming and Seasoning Premise phase, helped them to modify learning content and assisted the designers and teams to manage and track back to the original design.

Moreover, the participants (P5, P6, and P7) mentioned that keeping the core gameplay of the entertainment games that were already fun and balanced mechanics can reduce the development team's workload in implementing the whole new system. At the same time, it still ensured that players could enjoy the core mechanics that remained from the existing games. The participants (P2 and P3) mentioned that the Seasoning Game Premise phase could help organize player experience. The team can plan for playtesting with the target group with different premise versions. The programmers can plan to edit text and graphics, customarily called the "Skin" of the games, to minimize the time for modifying prototypes with different versions.

4.4.5 Discussion

The M-SG framework aims to support game developers in analyzing and implementing multiplayer cooperative SGs. The framework aims to improve the current SG analysis

tools by adding a process to identify the relationship among the game, learning mechanics, and player interaction of multiplayer games at the component level (game blueprint). Moreover, the M-SG framework provides an option for implementing cooperative SGs by modifying the premise of the existing cooperative entertainment games. The framework offers procedures and documents that support developers in systematically modifying the game premise to add learning content (Transforming Game Premise) and to organize the player experience of games (Seasoning Game Premise).

The result of the analysis phase in the M-SG framework is the game blueprint. The M-SG framework shares the same taxonomies, including game, learning, and instructional, with the ATMSG model. However, the M-SG framework adds up steps by using the Swimlane to represent players' interactions and cooperative taxonomy to identify cooperative activities during the gameplay. At this point, our evaluation indicated that the game blueprint provided in the M-SG framework was helpful for the developer teams to have a common understanding, especially for multiplayer cooperative games. The Swimlane provided in the Developing a Game Blueprint phase supported the developers in understanding the role of each game's components, game sequences, actions, and especially the players' interactions. More specifically, the ATMSG model provided a flow chart to illustrate sequences of game activities. In contrast, the M-SG framework provided Lanes, part of Swimlane, to help the developers present cooperative activities of the multiplayer games. The example of using Swimlane to illustrate Urban Logistics game with the same core mechanics as Pandemic game (Z-Man Games & Matt Leacock, 2008) is presented in section 4.3.

Another main contribution of the M-SG framework is to provide an option to implement multiplayer cooperative SGs, which includes two framework phases: Transforming and Seasoning Game premise. The evaluation confirmed that transforming the premise of cooperative entertainment games into cooperative SGs could be one of the options for developers to minimize cost and time. Moreover, seasoning cooperative SGs with various morality versions can improve players' experience. The various premises versions could be added as a plan for playtesting. To do so, the programmers should plan their code to be able to modify the prototype with various versions. For example, the text embedded in the game should be managed in a way that is easily replaced.

I noted feedback on the consideration and limitations of applying the M-SG framework and listed them as follows.

o Copyright of the selected games: even the "re-skinning game" is a similar approach in the game industry. However, it is a sensitive issue for creative works. Therefore, the participants suggested selecting the in-house game to implement this approach to avoid unexpected problems.

o Project stage: the guideline suggested to apply in the pre-production of a game development project to gather requirements and illustrate the game flow in the project's initial phase.

o Cooperative taxonomy and Swimlane: participants suggested that the cooperative taxonomy needed further study to ensure that the developers who are inexperienced in the games and education fields can apply it to use the annotation and understand the meaning of vocabulary.

o Size of the development team: participants suggested that the Transforming Game Premise guideline is more suitable for application in small and medium-sized studios/labs (5 to 10 persons) to decrease complexity in communication.

In summary, the M-SG framework provides a tool for analyzing multiplayer cooperative SGs and an option to support developers in implementing cooperative SGs. The framework can be used as the analysis tool that helps developers decompose game elements and illustrate the flow of games and players' interaction in multiplayer cooperative SGs. The output of the analysis phase is the game blueprint that can be used for team communication to ensure that the team member has a common view of the games in the initial phase of development projects. With the blueprint, the game developers and expert who provides the learning content can ensure that developing games can fulfil both entertainment and learning goals. Moreover, the analysis tool fills the gap in the existing framework by suggesting using the Swimlane notation to display how players interact in multiplayer games. The M-SG framework provides an option to implement cooperative SGs by modifying the premise of the existing cooperative entertainment games and then seasoning the games with different morality versions to organise the player experience of the games. The suggestion of the implementation phase is to apply the guideline to the prototyping process to improve players' engagement through the iterative design.

Chapter 5

Conclusion

This thesis is set out from a framework to support the analysis and implementation of multiplayer cooperative SGs. I started the investigations of this thesis based on players' and developers' aspects. The first aspect is to explore the game elements that influence players in multiplayer cooperative SGs. Another point of view is to develop a framework for supporting developers in the analysis and the development of multiplayer cooperative SGs from lessons learned which were collected from the iteration of game prototype development.

I started by studying the effect of game elements on players to explore the elements that affect players' experience in multiplayer cooperative games. The objectives of the studies related to the players are to explore game elements that influence players to overcome problems in players' engagement with SGs. I conducted literature on game elements that potentially affect players' experience and require fewer developers' efforts to modify the game, reducing cost and time consumption in developing a game prototype. From the literature, I found that the game premise is a possible candidate. Therefore, I started to investigate the effect of the game premise on players in cooperative entertainment games in section 3.1. Following, in section 3.2, I investigated the effect of game premise in multiplayer cooperative SGs.

Regarding the game developers' aspect, I collected lessons learned from the iteration for developing game prototypes that were used for conducting user studies in section 3.1 and section 3.2. There are the practicing for designing and implementing the game prototypes for my studies (Grudpan, Alexandrovky, et al., 2019; Grudpan et al., 2021; Grudpan, Hauge, & Malaka, 2019).

In parallel, the M-SG framework was iteratively developed from the lesson learned from game prototype development. The framework is an iterative elaborated alternation between literature review and practical concept testing to identify refinement points. The elaboration of the M-SG framework is presented in section 4.1. The four-phase set of the M-SG framework, which is the guidelines that support the analysis and implementation of multiplayer cooperative SGs is presented in section 4.2. The example of using the M-SG framework to implement Urban logistics games is shown in section 4.3. Lastly, in section 4.4, I evaluated the usefulness and usability of the M-SG framework.

The central hypothesis is revised in the following sections, summarising the main insights and results of the research chapters.

5.1 Contributions

My first three hypotheses ***(H1-H3)*** mainly focus on the effects of the game premise on the ***player(s)*** in both cooperative entertainment and SGs.

I started the investigation by conducting literature to identify game elements that can affect the player(s)' experience and require minimizing the developer's effort in reusing game components to reduce the time and cost consumption of the projects. From the literature, I found that the *Game premise* is one of the potential game elements to use in modifying games without changing core gameplay. Thus, I explored further how the game premise should be applied to organize the player experience in cooperative games. I continued with the literature and found that customizing dramatic elements (theme, graphics, etc.) with different versions of morality can influence players' experiences. This finding motivated us to start exploring how to customize game premises in Moral(positive), Immoral(negative), and None-content(neutral) versions. I studied how each premise affected players' experience and cooperation in cooperative games. In addition, I investigated how each game premise affected the players' experience and players' cooperation in cooperative entertainment games.

Effects of game premises on players' experience in cooperative entertainment and SGs.

The first hypothesis is *H1: Customising game premise with a different morality version influences the player experience and cooperation in cooperative entertainment games.* My studies found that the game premise impacts player experience on relatedness, competence, and cooperation. The Immoral version showed the highest ratings on competence, making players feel more connected with the game and team members. Additionally, the qualitative results showed that participants in the Immoral version mentioned that the

goal (eliminating bosses) and actions (killing) provided a high sense of achievement. At the same time, in the Moral version, they felt more responsible for the consequence of their mistakes (i.e., failing to save the world).

Similarly, participants who played the None-content version mentioned that winning the game had no meaning since the game had no context. In contrast, in the Moral version, the participants perceived more competence than the None-content groups. Additionally, some participants felt proud of being heroes for the Moral version.

In this study, I studied the effects of game premises on players' experience. Next, I continued exploring the impact of game premises on players in cooperative SGs in the second study of how the different morality versions of the game premise influence the players' learning improvement and memory retention.

Effects of game premises on learning outcomes.

The second hypothesis is *H2: Game premise affects learning outcomes in cooperative SGs.* In this study, I investigated the effects of game premises on learning outcomes to verify the second hypothesis. I found that the rating of the Moral (Authority) version was higher than the Immoral (Outlaw) version. However, I asked the participants to answer the pre-test and post-test to measure players' knowledge about urban logistics, and the learning content embedded in the game prototype. I found a significant difference in the improved score but no significant difference in the enhanced score between the Moral and Immoral versions.

Then, I emphasized the differences between the two versions of premises by adding the juiciness elements such as feedback from game actions and game events such as win/lose or achieve sub-goals) to another remake of game prototype versions.

Emphasizing the meaning of game premises with juiciness elements

The third hypothesis is *H3: Adding a juiciness element to emphasize the difference between Moral and Immoral versions of the game premise influence the player experience and memory retention in cooperative SGs.*

After I found that the game premise affects player experience on competence and autonomy but has no effect on learning outcomes, I continued a further investigation by modifying my game versions with juiciness elements to the contents related to morality in each version. The reason is to ensure that the morality contents are noticeable to the players. Then, I measured the player experience and learning outcomes again. This study found no significant differences in player experience and learning outcome.

The following sections describe the last three hypotheses (H4-H6) and focus on contributions to support developers in analyzing multiplayer cooperative SGs and implementing the cooperative SGs. The M-SG framework alternates between literature review and practical concept testing to identify refinement points. The contributions related to the validation of the framework are described in the following sections.

M-SG framework for the analysis of multiplayer cooperative SGs

My last three hypotheses ***(H4-H6)*** mainly focus on creating a systematic approach to support developers in the analysis of multiplayer cooperative SGs and finding options to implement cooperative SGs with reusing existing projects and players engagement considerations.

The fourth hypothesis is *H4: The extension of the ATMSG model supports developers in identifying the game components, learning components, and players' interactions within the multiplayer cooperative SGs.* The literature suggested that identifying the relations between game mechanics and learning outcomes for multiplayer SGs at the component level is a challenge of SGs analysis. The ATMSG model was selected for the extension because the it applied the Activity theory-based to support developers in presenting game blueprints. The blueprint consists of standard tools, including a flowchart and a three-layer table. The flowchart supports the analysis of game flow by representing players' activities at each stage of the game. The three-layer table supports the analysis of components by defining the game taxonomy, including the learning, game, and instructional elements. I extended the concepts of the ATMSG model by modifying the analysis tool to support the analysis of multiplayer cooperative SGs. My proposed M-SG framework applied the Swimlane, a standard flowchart diagram, to represent cooperative activities of multiplayer games. In addition, a taxonomy for cooperative games was defined to support developers in identifying relations of game, learning, instructional and cooperative activities in multiplayer cooperative SGs. In using the developed M-SG framework, the game developers confirmed that Swimlane helped analyze multiplayer games. At the same time, the cooperative taxonomy gives them an initial idea to extract cooperative activities, especially at the beginning phase of the development project. However, the definitions of the cooperative taxonomy should be better clarified.

To conclude, there is a clear advantage of using the proposed analysis guideline, which is extending the ATMSG model to analyze multiplayer cooperative SGs. Significantly, the Swimlane notation supports developer teams to have a standard overview of games' concepts in the initial phase of game development projects. However, the cooperative taxonomy needs further study to improve the framework's usability. Therefore, next, I studied the implementation of the proposed M-SG framework.

M-SG framework for the implementation of cooperative SGs

The fifth hypothesis is *H5: Transforming(converting) the premise of cooperative entertainment games is an option for the systematic development of cooperative SGs.* Previously, in my studies of the players' aspect, I implemented the game prototypes with different premise versions. Along with the studies, I collected the lessons learned from iterative game prototype development to elaborate the guideline for cooperative SGs development. After extracting the core mechanics of the cooperative entertainment game during the prototype development, I first built an original prototype. I later added learning content by phasing only dramatic elements of the games to minimize the developer's effort. Then, on each prototype, I investigated the effect of the game premise. I named the approach in converting the cooperative entertainment games to cooperative SGs as "Transforming Game Premise". The Transforming Game Premise guideline is one of the four phases of the M-SG framework. In my studies for this hypothesis, I verified the guideline with both aspects of game developers and players. The implemented game followed my design to support players to achieve the defined learning outcomes.

The developers also confirmed that the Transforming Game Premise could be an option for developing cooperative SGs. However, the critical consideration for the transformation is the copyright of the original games. Based on the proposed framework, the guideline suggests that the phasing of cooperative SGs development focuses only on the part of the premise to give a different meaning to players' actions. By phasing the premise, the learning contents are added to the game without changing core mechanics, including the gameplay and rules of games of the original games. This approach is to ensure that the games are well-balanced. Thus, for a real-world project of cooperative SGs development, I suggested using an in-house game to apply the Transforming Game Premise guideline to avoid copyright issues. However, the developers confirmed that the advantage of reusing the existing games is to minimize the time consumption in adjusting games' functions and balance.

The sixth hypothesis is *H6: Seasoning(modifying) the premise of cooperative SGs with Moral and Immoral versions can be an option for systematic game development that can fulfill both entertainment and learning goals.*

In my studies of the previous hypotheses, the players confirmed that seasoning or modifying the game premise with the Moral and Immoral versions have different effects on players' experience. Therefore, viewing from the developers' aspect, the variety of producing game versions can help the developers' team extend the chance for playtesting with the target group.

In the M-SG framework validation study, the developers confirmed that the given documents, particularly the version table, helped them systematically organize and phrase the game premises in different versions. However, the developers were concerned about the difficulties in phasing the game version to the Immoral version. When phasing the game premise to the Immoral version, the meaning of the objective may conflict with the learning content. A limitation of applying the Seasoning Game Premise guideline depends on the learning objective. Therefore, it is essential to carefully follow the steps of selecting the reference games and analyzing them to ensure that the modified elements are not changing the meaning of the games.

For example, the learning objective of my Urban Logistics game is to teach players to understand Urban Logistics concepts, the role of stakeholders, and the importance of their cooperation in urban logistics planning. The game's premise is to distribute products to the shops in the city center. The UDC (Urban Distributed Center) needs to be built to improve transportation flow, decrease traffic jams and protect the city's environment. The pollution rate will be increased at every turn. This version is considered the Moral version. To season the game to the Immoral version, developers must consider not changing the learning objective while keeping the same gameplay. In this step, the version table helps developers as a checklist to keep the Moral and Immoral versions comparable to maintain the meaning of the game objective. The game elements filled in the version table can be traced back to the analysis table and game flow to ensure that the learning objectives are not changed during the seasoning game premise steps. To modify the Moral version to the Immoral version, I changed the premise from building the UDC to support the distributing goods to the distributing narcotics into the city. A consideration mentioned by developers was the limitation of game studios, which do not have various in-house games to modify. At the same time, this approach is an option for the game resources to be reused from previous game projects.

5.2 Reflection and Future Directions

My studies show that modifying the game premise in cooperative entertainment games and SGs using different morality versions affects players' experience. In both cooperative entertainment games and SGs, players feel more competent when they play a role in the Immoral version. While playing in the Moral version of cooperative entertainment games, players feel more responsible in the role related to the game's premise. This aligns with the study result that the Moral version makes the players easily get into the learning content in the cooperative SGs.

Although my study showed the main effects of the premise on player experience and cooperation, I could not identify a specific pattern between the game premise and cooperative strategies. In the future, I aim to study the different types of premises that foster patterns of specific cooperation and actions. Demographic factors and personality traits might relate to the premises and cooperation linkages. Future work will investigate how the premise can address differences in personalities.

The results suggested that the premise is an easy-to-use and effective design option to enforce cooperation. The premise element is helpful for game developers, especially for improving the engagement of players in SGs. The results of investigating the effect of the game premise and the lessons learned from developing a game prototype with various morality versions are used for elaborating the M-SG framework.

The M-SG framework consists of two main contributions: firstly, it provides tools for the analysis of multiplayer cooperative games. Secondly, it provides the guidelines for implementing cooperative SGs by transforming cooperative entertainment games into SGs and then seasoning the transformed version into various morality versions to produce more rapid prototypes for playtesting.

The evaluation of the M-SG framework shows that the second framework phase's analysis tool supports developers in communicating with the multidisciplinary team, especially in the initial phase of the game development projects. Overall, my analysis tool can fill the gaps in the current SGs analysis, which lacks tools to support the analysis of multiplayer SGs at the component level. Swimlane is the suggested standard notation that helps developers to present multiplayer activities. At the same time, the table version consisting of elements of the game, learning, instructional and cooperative taxonomy can guide the developer team in the overall picture of the game project. However, the table version can be improved regarding the meaning of element vocabulary to support novice members. The study of cooperative taxonomy should be investigated further, especially by educational researchers.

Another contribution of the M-SG framework is that it provides a guideline as an option for implementing cooperative SGs. The guideline consists of steps to transform the premise of cooperative entertainment games into cooperative SGs and to season the premise of the transformed game, converting the game into various morality versions. The evaluation of the framework shows that the Transforming Game Premise phase can be an option to implement cooperative SGs systematically; however, copyright is a primary consideration. I suggested developers apply the transformation using in-house games to avoid copyright issues. At the same time, the Seasoning Game Premise phase supports the developer team to have more options in producing a rapid prototype. To be cautious, varieties of game premise versions may distort the learning objective of the

original version. Thus, the Table version is the document provided to maintain the core mechanics of the original game. The Table version compares game versions during the Transforming Game Premise and Seasoning Game Premise phases. Another limitation of this work is that the M-SG framework was evaluated systematically but still theoretically. Thus, future work should include validation that can provide evidence of the usability and usefulness of real-world projects. The framework should be applied in the game studio to receive feedback from real-world situations.

In conclusion, modifying the game premise with various morality versions influences player experience in both cooperative entertainment and SGs. I elaborated on the M-SG framework with the results of my user studies and lessons learned from iterative implementing game prototypes. The results of my user studies are used as an inspiration for implementing SGs or gamification. At the same time, the MSG framework is used to analyze multiplayer SGs at the component level. Moreover, the framework provides an option to systematically convert entertainment games to SGs and season the games to various rapid prototype versions for organizing the player experience from the games.

Appendices

Appendix A

Online survey

this appendix provides additional information about the online survey for collecting trends of using the systematic approaches for SGs development in section 2.2.2. The survey was distributed to researchers and developers working on SGs development in order to determine SGs development tendencies.

Title: Survey of using serious game design framework

This survey is conducted as a part of a Ph.D. thesis for the University of Bremen, Germany. The main objective of my Ph.D. research is to identify the linkages between learning mechanics and game mechanics in order to improve the serious game design process. The contribution will be a serious game design framework to support the design of the multiplayer collaborative serious game. This survey is conducted in order to study the trend and the usefulness of using serious game design frameworks. The three main objectives of this survey: 1). to gather the opinion of serious game designers, developers, and programmers for using game design framework as a guideline for design and development of serious games, 2). to identify the difficulties in design and development process of serious games, and 3). to identify the complexity of reusable game components from the existing projects.

Your answers will remain anonymous. The responses will be used only for this study and not for any commercial purposes.

Thank you for your time,

Supara Grudpan

Questions

Q1. How long have you been involved in the development of serious games projects as a serious game developer?

Q2. How many serious games projects have you been involved in as a game developer?

Q3. What is the average size of serious games development projects you have been involved in?

Q4. What are your roles/ responsibilities in the serious games' development projects?

Q5. Who are the target groups of the serious games that you have developed?

Q6. What are the application areas of the developed games?

Q8. Which genre(s) of the serious game have you developed?

Q9. Which serious games frameworks do you know?

Q10. Have you used any game design frameworks (theoretical framework, software tools, a software library) that helped you in the process of designing or developing serious games?

If yes, please give me a specific type of framework (theoretical framework, software tools, a software library, etc.)

Q11. What were the top three reasons that made you refuse to use a serious game design framework?

Q12. What is the type of serious games that you used to develop by using framework(s)?

Q13. Please mention three frameworks that you often used for supporting serious game design process.

- Serious game frameworks can be used as a guideline at the starting point to design the serious game.
- Serious game frameworks can support game designers to have concrete ideas for selecting game mechanics which are suitable for learning goals.
- Serious game frameworks can support game designers to have concrete ideas for selecting game mechanics which are suitable for learning goals.
- Serious game frameworks can help estimate and plan for resources (budget, time, man-hours, etc.) in the serious game development project.
- Serious game frameworks help the members of the development team to understand serious game modules.

Q15. What is the most common method that you use to design serious games?

- Requirements specification (functional: define learning goal, game genre, non-functional: game look and feel, etc.)
- Design (transferring learning objective to game mechanics, design game play, etc.)
- Implementing (coding, graphics, etc.)
- Testing (quality assurance, game evaluation: play-ability test with experts/ real-world users, etc.)
- I think a good game design document helps to have a good game design product.
- The game design document can help game developer team for tracking the progress of the project.
- Design tools for rapid game development such as Mario maker, GameMaker, Construct 2, etc. can help the game designer to create a game description in detail.
- Game prototyping in the pre-production phase can help the game developer to clarify the fundamental mechanics of the final game.
- Game prototypes can help to identify missing functionalities, and to support co-operation between developer teams.

Q18. Have you ever been involved in a project which reused existing resources (serious game product or component) from previous projects?

Q19. What were the game components you reused when you redesigned for the latest serious game? Please list at least 3 components (e.g., reward system, feedback system, etc.)

- I think it is worth spending time to understand the design of the previous project to reuse components and the product.
- Well-structured documents are necessary for re-usability of game products and components from the existing serious game projects.
- Reusing resources from existing projects can reduce the production time of serious game development.

D1. Please specify your occupation

D2. Please specify your age.

Appendix B

Questionnaires

This appendix presents details of the data collected during the user studies in chapter 3 and chapter 4.

B.1 Standard Questionnaires

The standard questionnaires for Player Experience of Needs Satisfaction (PENS) in section 3.1 and 3.2 and System Usability Scale (SUS) are used in the user study in section 4.4. The information in the questionnaires was created on the online platform. The details of the questionnaires are presented below (Fig B.1 and Fig B.2).

B.2 Pre-Post test

The pre and post-test questions were developed to measure student improvement in section 3.2. Details of the fifteen questions are presented in this appendix (see Figure B.3).

Title: PENS questionnaire [TH]/แบบสอบถาม Player Experience Need Satisfaction ภาษาไทย

1. ฉันรู้สึกมีความสามารถในการเล่นเกมนี้/ I feel competent at the game

2. ฉันรู้สึกว่าสามารถเล่นเกมได้ดีและมีประสิทธิภาพ/ I feel very capable and effective when playing.

3. ความสามารถของฉันเหมาะสมกับความท้าทายของเกม/ My ability to play the game is well matched with the game's challenges.

4. ภายในเกมมีทางเลือกต่างๆที่น่าสนใจให้ฉัน/ The game provides me with interesting options and choices.

5. เกมให้โอกาสฉันได้ลงมือทำสิ่งที่น่าสนใจ/ The game lets you do interesting things.

6. ประสบการณ์ในเกมทำให้ฉันรู้สึกมีอิสระในการเล่น/ I experienced a lot of freedom in the game.

7. ฉันรู้สึกว่าความสัมพันธ์ที่เกิดขึ้นในเกมนั้นน่าพึงพอใจ/ I find the relationships I form in this game fulfilling.

8. ฉันรู้สึกว่าความสัมพันธ์ที่สร้างขึ้นในเกมมีความสำคัญ/ I find the relationships I form in this game important.

9. ฉันไม่รู้สึกใกล้ชิดกับผู้เล่นคนอื่น/ I don't feel close to other players

10. ขณะเล่นเกม ฉันรู้สึกเหมือนถูกพาไปอยู่ในช่วงเวลาและสถานที่ในเกม/ When playing the game, I feel transported to another time and place.

11. การสำรวจโลกภายในเกมให้ความรู้สึกเหมือนการไปท่องเที่ยวในสถานที่ใหม่ๆจริงๆ/ Exploring the game world feels like taking an actual trip to a newplace.

12. ระหว่างการท่องเที่ยวภายในเกม ฉันรู้สึกเหมือนอยู่ ณ ที่นั้นๆจริงๆ/ When moving through the game world, I feel as if I am actuallythere.

13. เหตุการณ์ภายในเกมไม่มีผลกระทบต่อจิตใจของฉัน/ I am not impacted emotionally by events in the game

14. เกมนี้มีความโน้มน้าวใจ/ The game was emotionally engaging.

15. ฉันรับรู้ความรู้สึกที่ลึกซึ้งเหมือนในชีวิตจริง/ I experience feelings as deeply in the game as I have in real life.

16. ฉันรู้สึกเหมือนเป็นส่วนหนึ่งของเนื้อเรื่องภายในเกม/ When playing the game, I feel as if I was part of the story.

17. เมื่อฉันประสบความสำเร็จในเกม ฉันรู้สึกภาคภูมิใจอย่างแท้จริง/ When I accomplished something in the game, I experienced genuine pride

18. ฉันตอบสนองต่อเหตุการณ์และตัวละครภายในเกมเหมือนในชีวิตจริง/ I had reactions to events and characters in the game as if they were real.

19. การควบคุมในเกมนั้นง่ายต่อการเรียนรู้/ Learning the game controls was easy.

20. ฉันรู้สึกมีความสามารถและมีประสิทธิภาพระหว่างเล่น การควบคุมในเกมนั้นเข้าใจง่าย/ I feel very capable and effective when playing. The game controls are intuitive.

21. เมื่อฉันอยากจะทำอะไรในเกม ฉันสามารถจดจำการควบคุมในเกมเพื่อทำสิ่งนั้นๆได้อย่างง่ายดาย/ When I wanted to do something in the game, it was easy to remember the corresponding control.

FIGURE B.1: Standard Questionnaires: Player Experience of Needs Satisfaction (PENS)

Title: System Usability Scale (SUS)

1. ฉันอยากจะใช้ framework นี้เป็นบ่อยๆ/ I think I would like to use this framework frequently.

"2. ฉันพบว่า frameworkนี้มีความซับซ่อนเกินความจำเป็น/ I found the framework unnecessarily complex."

3. ฉันคิดว่า framework นี้ง่ายต่อการใช้งาน/ I thought the framework was easy to use.

4. ฉันคิดว่าฉันต้องการความช่วยเหลือจากคนที่มีความรู้ด้านเทคนิคในการใช้งาน framework นี้ / I think that I would need the support of a technical person to be able to use this framework.

5. ฉันพบว่าการทำงานของส่วนตางๆใน framework นี้สามารถทำงานร่วมกันได้อย่างดี/ I found the various functions in this framework were well integrated.

6. ฉันคิดว่า Framework นี้มีความไม่สอดคล้องกันมากเกินไป/ I thought there was too much inconsistency in this framework.

7. ฉันสามารถจิตนาการได้ว่าคนอื่นๆสามารถเรียนรู้ในการใช้ framework นี้ได้อยางรวดเร็ว/ I would imagine that most people would learn to use this framework very quickly.

8. ฉันพบว่า framework นี้ยุ่งยากมากที่จะใช้ / I found the framework very cumbersome to use.

9. ฉันรู้สึกมั่นใจที่จะใช้งาน framework นี้/ I felt very confident using the framework.

10. ฉันต้องเรียนรู้หลายสิ่งหลายอย่างก่อนที่จะเริ่มใช้ framework นี้/ I needed to learn a lot of things before I could get going with this framework.

11. คุณจะแนะนำ framework นี้ให้คนอื่นใช้งานหรือไม่ / How likely are you to recommend this framework to others?

FIGURE B.2: Standard Questionnaires: System Usability Scale (SUS)

Title: Pre and Posttest

1. ข้อใดคือปัจจัยพื้นฐานที่ควรคำนึงถึงของ Urban logistics
2. ในการพัฒนา Urban logistics เราควรคำนึงถึงข้อใด
3. ข้อความใดกล่าวถึงการขนส่งรูปแบบ last-mile ในเขตเมืองได้ถูกต้อง
4. ข้อใด"ไม่ได้"กล่าวถึงการแก้ปัญหาที่ยั้งยืนสำหรับ Urban logistics
5. ข้อใดเป็นสิ่งที่ผู้มีอำนาจจัดการในท้องถิ่น หรือ Local authorities เช่น นายกเทศมนตรี (Mayor) คำนึงถึงมากที่สุด
6. ข้อใดเป็นสิ่งที่ ผู้ให้บริการลอจิสติกส์ หรือ Logistics Service Providers เช่น transportation companies and Infrastructure Service Providers คำนึงถึงมากที่สุด
7. ข้อใดเป็นสิ่งที่ ผู้ค้าปลีก หรือ "Retailers" คำนึงถึงมากที่สุด
8. ข้อใดเป็นบทบาทหน้าที่ของผู้มีอำนาจจัดการในท้องถิ่น หรือ Local authorities เช่น นายกเทศมนตรี (Mayor)
9. ข้อใดเป็นบทบาทหน้าที่ของผู้ค้าปลีก หรือ "Retailers"
10. ข้อใดเป็นบทบาทหน้าที่ของ ผู้ให้บริการลอจิสติกส์ หรือ Logistics Service Providers
11. ผู้มีส่วนร่วม (stakeholder) ประเภทใดมีหน้าที่และอำนาจในการให้เงินสนับสนุนบริษัทเอกชน ในการให้บริการลอจิสติกส์โดยคำนึงถึงแผนและกิจกรรมแบบ sustainable urban logistics เช่น ให้เงินสนับสนุนการสร้าง UDC
12. ข้อใดคือผลประโยชน์ทางตรงที่ผู้ให้บริการลอจิสติกส์ หรือ Logistics Service Providers จะได้จากการสร้างสิ่งอำนวยความสะดวก (infrastructure) เพื่อสนับสนุนการขนส่งแบบ last-mile
13. ข้อใดคือสิ่งที่ ผู้ค้าปลีก หรือ Retailers สามารถทำได้เพื่อช่วยสิ่งแวดล้อม
14. ผู้มีอำนาจจัดการในท้องถิ่น หรือ Local authorities สามารถมีส่วนร่วมในการช่วยพัฒนาสังคม เศษรฐกิจและสิ่งแวดล้อมของเมืองได้อย่างไร
15. ผู้มีส่วนร่วม (stakeholder) ประเภทใดมีหน้าที่ในการกระจายหรือขนส่งสินค้าไปในเขตเมือง

FIGURE B.3: Questionnaires: Pre and Post-test questions

Appendix C

Interview questions

This appendix details the interview questions collected during the user study in chapter 4.4. Details of the interview questions are shown below.

Title: Interview questions on the Usability and Usefulness of the M-SG framework			
Level 1	Level 2	Level 3	Qualitative
General	Usefulness	Overall	How do the framework change your perception of the game?
General	none	Overall	How does the framework be used as a tool for communication of development team?
none	Usefulness	Identifying learning and gaming in component level	Does identifying learning and gaming in component level useful for development of cooperative SGs
none	Usability	Identifying learning and gaming in component level	How is the framework usable for identifying relation of learning and gaming of multiplayer cooperative SGs in component level?
none	Usefulness	Multiplayer cooperative games	Does the framework usable for identifying relation of learning and gaming of multiplayer cooperative SGs in component level?
none	Usability	Multiplayer cooperative games	How does the framework usable for identifying relation of players' cooperation and learning goals of multiplayers cooperative SGs in component level?
none	Usefulness	Reusability	Does reusing game the existing entertainment or education games can simplify development of multiplayer cooperative SGs?
none	Usability	Reusability	How does the framework usable for simplify reusing game the existing entertainment or education games in order to simplify development of multiplayer cooperative SGs?
General	Usefulness	Overall	How do the framework change your perception of the game?
General	none	Overall	How does the framework be used as a tool for communication of development team?

FIGURE C.1: Interview questions part1

none	Usefulness	Identifying learning and gaming in component level	Does identifying learning and gaming in component level useful for development of cooperative SGs
none	Usability	Identifying learning and gaming in component level	How does the framework usable for identifying relation of learning and gaming of multiplayer cooperative SGs in component level?
none	Usefulness	Multiplayer cooperative games	Does the framework usable for identifying relation of learning and gaming of multiplayer cooperative SGs in component level?
none	Usability	Multiplayer cooperative games	How does the framework usable for identifying relation of players' cooperation and learning goals of multiplayers cooperative SGs in component level?
none	Usefulness	Reusability	Does reusing game the existing entertainment or education games can simplify development of multiplayer cooperative SGs?
none	Usability	Reusability	How does the framework usable for simplify reusing game the existing entertainment or education games in order to simplify development of multiplayer cooperative SGs?

FIGURE C.2: Interview questions part2

Appendix D

Documents of the M-SG framework

This appendix reports in more detail the documents of the M-SG framework in section 4.3 including the instruction (Figure D.1) and template documents provided to participants in section 4.4. The template documents consist of a game blueprint including Swimlane Diagram (Figure D.2, Figure D.3), and Cooperative Taxonomy (Figure D.4). The template of the Swimlane diagram is provided in digital form as the following link:

Game Blueprint template(Swinlane).

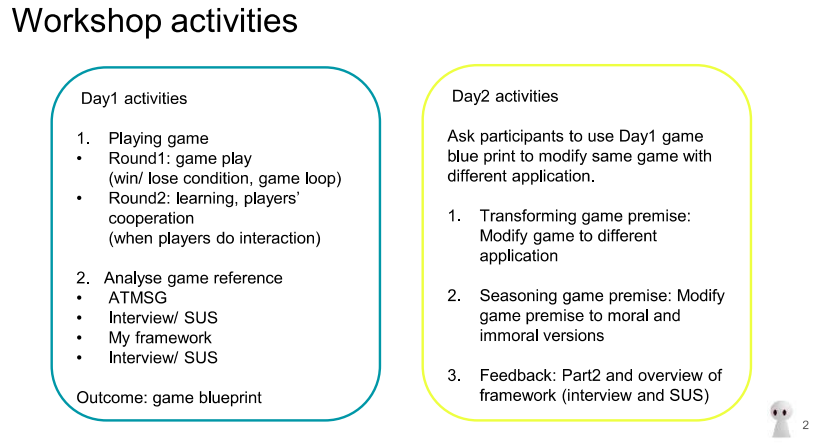
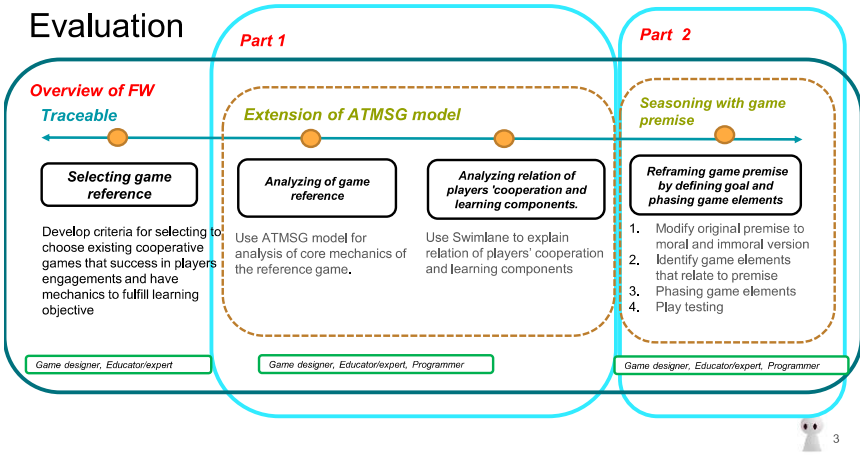
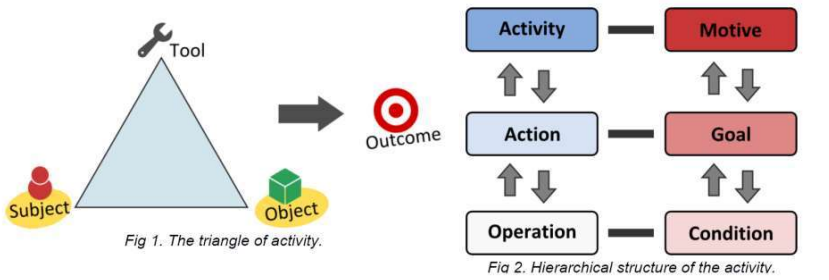


FIGURE D.1: Instruction provided to the participants in the user study to evaluate the M-SG framework


Evaluation
Part 1
Part 2
Overview of FW
Traceable
Extension of ATMSG model
Seasoning with game premise
Selecting game reference
Develop criteria for selecting to choose existing cooperative games that success in players engagements and have mechanics to fulfill learning objective
Analyzing of game reference
Use ATMSG model for analysis of core mechanics of the reference game.
Analyzing relation of players 'cooperation and learning components.
Use Swimlane to explain relation of players' cooperation and learning components
Reframing game premise by defining goal and phasing game elements
1. Modify original premise to moral and immoral version
2. Identify game elements that relate to premise
3. Phasing game elements
4. Play testing
Game designer, Educator/expert
Game designer, Educator/expert, Programmer
Game designer, Educator/expert, Programmer
3


ATMSG model
Tool
Subject
Object
Outcome
Fig 1. The triangle of activity.
Activity
Motive
Action
Goal
Operation
Condition
Fig 2. Hierarchical structure of the activity.
4

ATMSG model

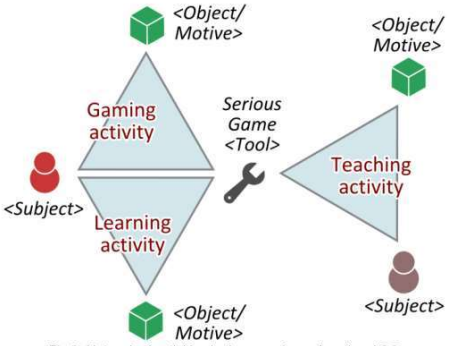
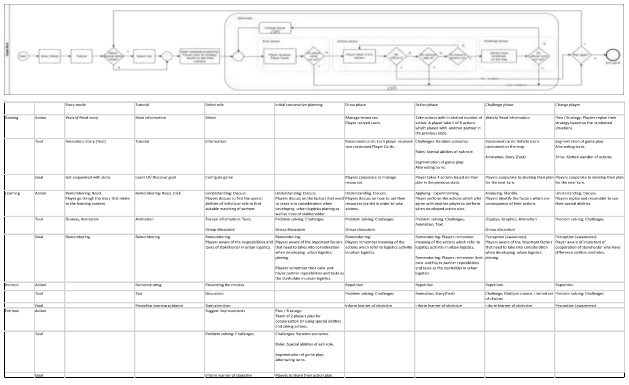


Fig 3. Network of activities in the use of an educational SG.

5

ATMSG model

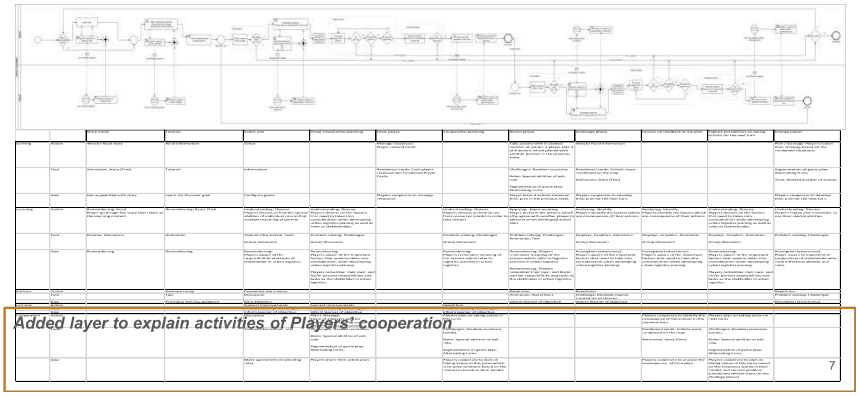
Step1. Game flow: Relation of Game components and Learning components



6

Extension of ATMSG model

Step2. Swimlane: Relation of Players' cooperation and Learning components



Added layer to explain activities of Players' cooperation

7

Day 1: Analyze cooperative serious games

8

Scenario

To do: Analyse relation of learning goals, game components players 'cooperation of the given game.

Roles: Game designer and Game programmer and Expert (conductor)

Project: Developing cooperative game for Urban logistics

Learning objectives
1. To understand concepts of urban logistics
2. To understand the difference roles of stakeholder in urban logistics
3. To understand relation of stakeholder in urban logistics


9

Playing game

Play for two rounds
- Round1: game play
  (win/ lose condition, game loop)
- Round2: learning, players' cooperation
  (when players do interaction)

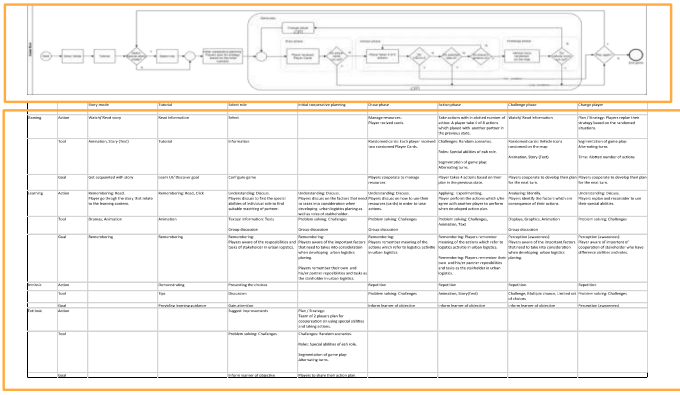
Analyse relation of learning, gaming, and players' cooperation which related to the learning objectives below
1. To understand concepts of urban logistics
2. To understand the difference roles of stakeholder in urban logistics
3. To understand relation of stakeholder in urban logistics


10

ATMSG model

ATMSG model

Step1. Game flow: Relation of Game components and Learning components



1. Flow Chart

2. Fill out Taxonomy of Learning/ Tools/ Goals

12

1.Draw diagram:

https://drive.google.com/file/d/1C9-cC17NCchsk9RthTs_a6U4_Bhd5wqz/view?usp=sharing

2.Fill out taxonomy:

2.1 Document: https://o365cmu-my.sharepoint.com/:x:/g/personal/supara_g_cmu_ac_th/EeyCBOT_m7VJpwWqpiGeRSABLptVzzurpY1NLMXHT1apAw?e=4QzZ4M

2.2 Action/ Tools/ Goals Taxonomy: https://o365cmu-my.sharepoint.com/:b:/g/personal/supara_g_cmu_ac_th/EQoIPNclpQ9MmvHXnWqVPvYBR-haO6fSisI0LYzt5H0DXw?e=4i42iJ

Feedback

1. SUS-ATMSG:

https://forms.gle/q35YUr9cSrJr3Wuh9

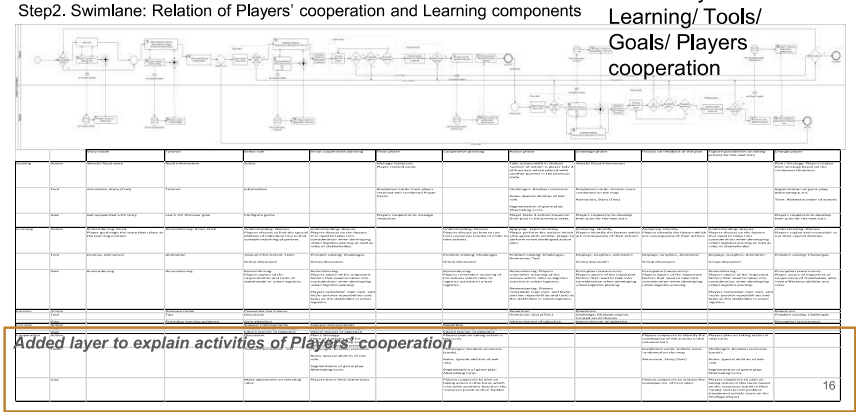
2. Interview: https://o365cmu-my.sharepoint.com/:f:/g/personal/supara_g_cmu_ac_th/EqJt8yKXriRKuzdUdD8pS58BgI7jJxA6lDYgtm-lPZod3g?e=jFSln8

Extension of ATMSG model

15

Extension of ATMSG model 1. Swimlane 2. Fill out Taxonomy of Learning/ Tools/ Goals/ Players cooperation

Step2. Swimlane: Relation of Players' cooperation and Learning components



Added layer to explain activities of Players' cooperation

16

1.Draw diagram:

https://drive.google.com/file/d/1C9-cC17NCchsk9RthTs_a6U4_Bhd5wqz/view?usp=sharing

2.Fill out taxonomy:

2.1 Document:
https://o365cmu-my.sharepoint.com/:x:/g/personal/supara_g_cmu_ac_th/EeyCBOT_m7VJpwWqpiGeRSABLptVzzurpY1NLMXHT1apAw?e=4QzZ4M

2.2 Cooperative activities Taxonomy:
https://o365cmu-my.sharepoint.com/:b:/g/personal/supara_g_cmu_ac_th/ERwaoOto0a9HheXChPw7cKcBNwTqYtkCEIC1I0I46U5xFw?e=3u9XW8

Feedback

1. SUS-Our framework (identifying):

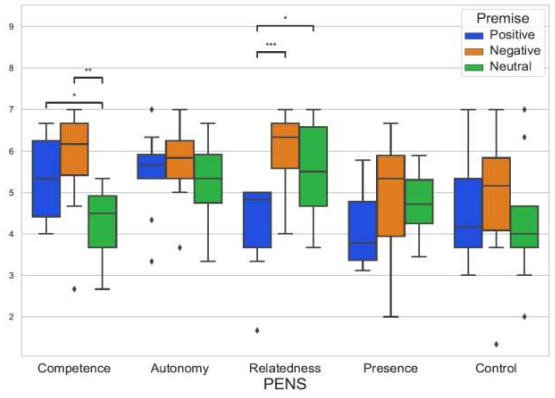
https://forms.gle/NWvaqXuRFgGHh5KN6

2. Interview: https://o365cmu-my.sharepoint.com/:f:/g/personal/supara_g_cmu_ac_th/EqJt8yKXriRKuzdUdD8pS58BgI7jJxA6lDYgtm-lPZod3g?e=jFSln8

Day 2: Transforming and Seasoning Premise

19

Player Experience



20

Scenario for Day 2

To do : Choose game premise and modify the game prototype using Game blue print from Day1

Learning objectives
1. To understand concepts of stopping spreading of disease/ transport across countries
2. To understand the difference roles of stakeholder
3. To understand relation of stakeholder

Transforming game premise

Pandemic: Two diseases have broken out in the world, each threatening to wipe out a region. Stakeholders need to find the way to discover the cure of diseases.

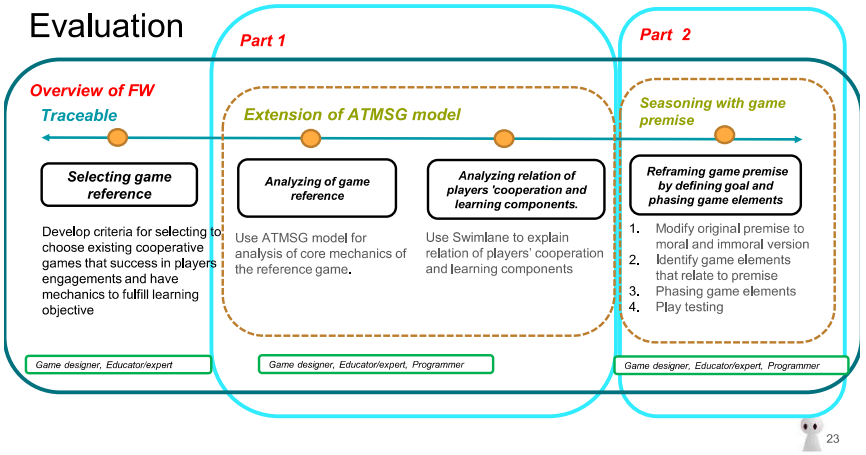
Roles:
- Medic: Doctor (treat patient).
- Dispatcher: Government officer from public health who allocate doctors and researchers to the countries.
- Operations expert: Private company who build research station

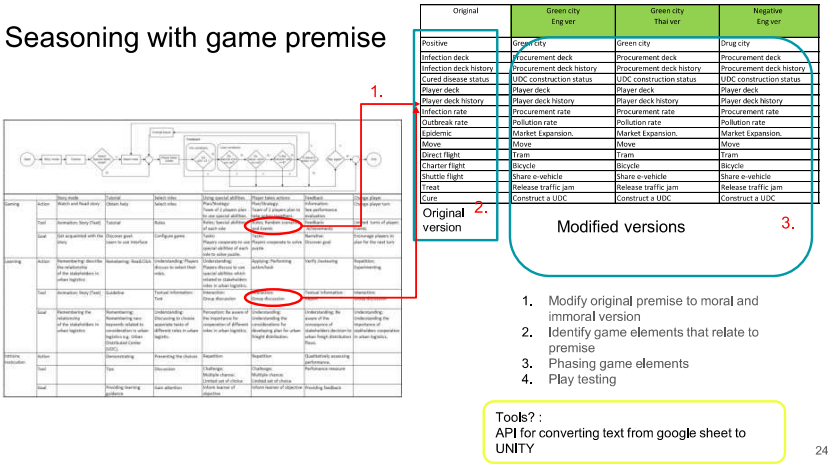
Factors: To controls Outbreak, Infection rate and Spreading of the disease

Marine Spatial Planning: Two shipping companies have to transport their products to countries around the world. Stakeholders need to find the appropriate location to extend the port.

Roles:
- NGOs: Resident represent the resident who live in area
- Minister of Transport: Government officer who establish policy,
- Port company: Private company who invest to build the ports.

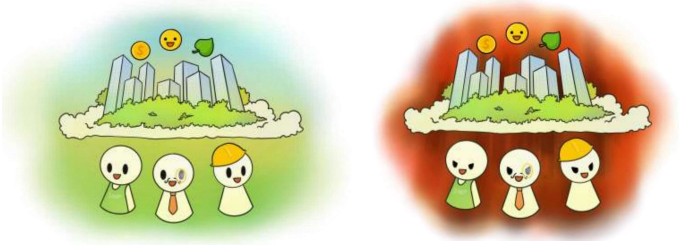
Factors: To controls Economic, Environment and Ecological in order to develop marine spatial planning





Original	Green city Eng ver	Green city Thai ver	Negative Eng ver
Positive	Green city	Green city	Drug city
Infection deck	Procurement deck	Procurement deck	Procurement deck
Infection deck history	Procurement deck history	Procurement deck history	Procurement deck history
Cured disease status	UDC construction status	UDC construction status	UDC construction status
Player deck	Player deck	Player deck	Player deck
Player deck history	Player deck history	Player deck history	Player deck history
Infection rate	Procurement rate	Procurement rate	Procurement rate
Outbreak rate	Pollution rate	Pollution rate	Pollution rate
Epidemic	Market Expansion.	Market Expansion.	Market Expansion.
Move	Move	Move	Move
Direct flight	Tram	Tram	Tram
Charter flight	Bicycle	Bicycle	Bicycle
Shuttle flight	Share e-vehicle	Share e-vehicle	Share e-vehicle
Treat	Release traffic jam	Release traffic jam	Release traffic jam
Cure	Construct a UDC	Construct a UDC	Construct a UDC

Seasoning game premise



Moral Immoral

25

Feedback (Overview)

1. SUS:

Transforming and Seasoning: https://forms.gle/vVLFPr1qq3fyndSRA

Overall: https://forms.gle/Q2w2WQ8JSb22PqJb9

2. Interview:

https://o365cmu-my.sharepoint.com/:x:/g/personal/supara_g_cmu_ac_th/EY0K53dhxm5FsxoC-5jFsz8BgEHIYI5zwKIYfvVdwwhQSA?e=JLFEvn

26

Title: Instruction for participants

Step 1. Game analysis: use the ATMSG model to explain the relation of the game components and learning goals at the components level.
There are two subsequences,

1.1) Draw a flow chart to explain Game Flow. The diagram should explain details of Gameplay and Player interaction at a high level. For example, the diagram has to include win, lose conditions, and game loop as well as to explain in which state of the game that player interaction occurred.
1.2) Fill out the tables to explain the relation of game, learning, and instruction activities.

Step 2. Explain the relation of players' cooperation and learning goals using the modification of the ATMSG model. There are two procedures in this step.

2.1) Draw a BPMN (Business Process Model and Notation) diagram to explain the Player Cooperation. The details of the diagram should answer the following questions. 1) who are the players, 2). in what states of the games that the cooperations occurred, 3).do the players cooperate occurred inside or outside the games? and 4). what level of the cooperations (decision making and operation level)?
2.2) Fill out the players' cooperation layer to the table on Step 1.2. to explain the relation of players cooperation at the states of the game and learning goals.

Step 3. Draw the flow charts to explain subprocesses if the processes relate to the learning objectives state in the tables on the Step 1.2 or Step 2.2

For example, the procedure which players use for making decisions while they are playing the game. The activities will be explained in more detail using ATMSG models.

FIGURE D.2: Instruction for Swimlane diagram provided in the M-SG framework

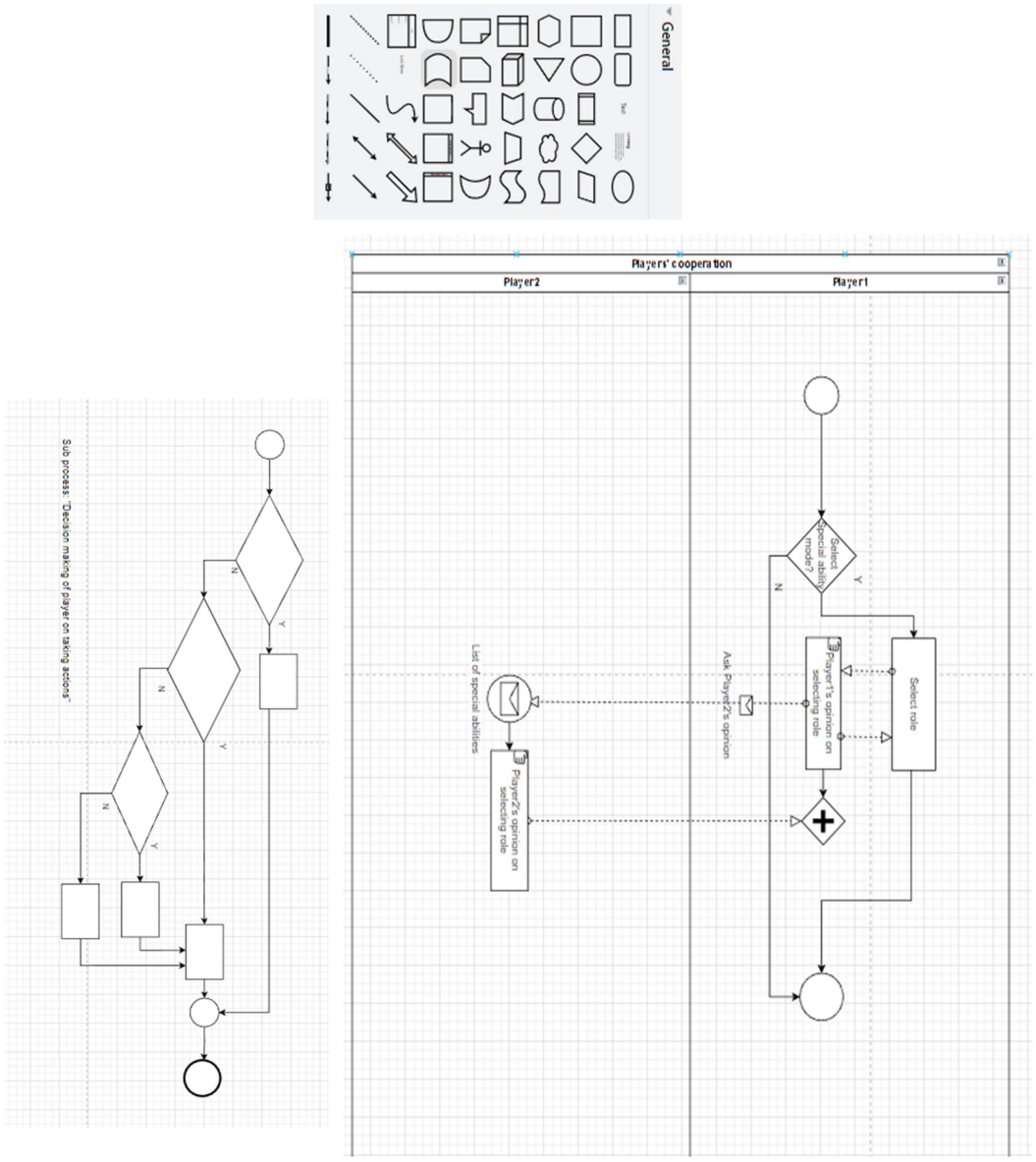


FIGURE D.3: The example of Swimlane template provided in the M-SG framework

Cooperative Actions	Cooperative Goal
Planning tasks	Generating Plans
Creativities tasks	Generating Ideas
Intellective tasks	Solving Problems
Decision making tasks	Deciding Issues
Cognitive conflic tasks	Resolving Conflicts of Viewpoint
Mixed-motive tasks	Resolving Conflicts of Interest
Contest/Battles / Competitive tasks	Resolving Conflicts of Power

Cooperative Tools (Additional game element)
Common goal/Success
Heterogeneous resources / Each player should have one or more unique tools or abilities
Refillable personal resources
Collectable and tradeable resources
Collaborative tasks
Communication
Ingame help system
Scoreboard
Trading system

FIGURE D.4: Cooperative taxonomy provide to participants the M-SG framework

Appendix E

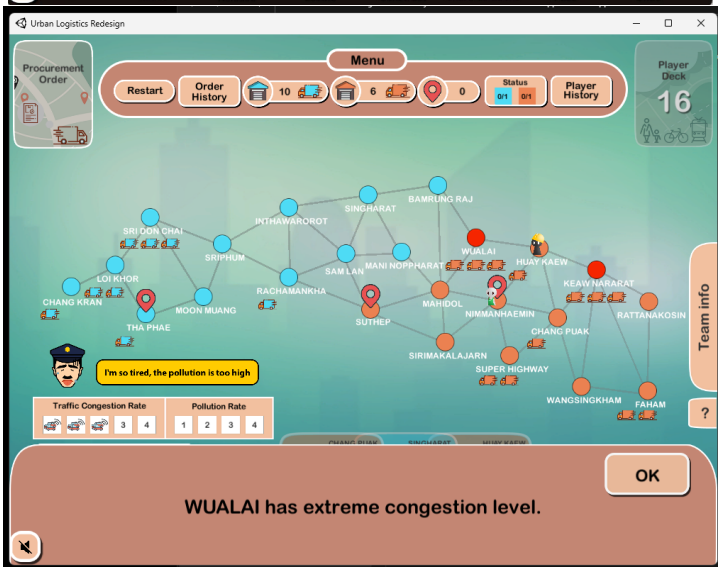
Urban Logistics Games

This appendix details the urban logistics games developed for the user studies in section 3.2.


Urban Logistics Redesign
Menu
Restart
Order History
Status
Player History
Player Deck
16
Procurement Order
WIN
Team info
Traffic Congestion Rate
Action : 2 Lefts
Abilities
Restart
Move
Release
Locate
Construct
Share Solutions
Pass
Undo


Urban Logistics Redesign
Menu
Restart
Order History
Status
Player History
Player Deck
20
Procurement Order
LOSE
Team info
Traffic Congestion Rate
I'm so tired.
Restart
OK


Urban Logistics Redesign
Menu
RED UDC HAVE BEEN CONSTRUCTED
ตอนนี้เราสร้าง UDC สำเร็จแล้ว !!
Team info


Urban Logistics Redesign
Menu
Procurement Order
Restart
Order History
Player History
Player Deck
16
BAMRUNG RAJ
SINGHARAT
INTHAWAROROT
SRI DOON CHAI
SRIPHUM
WUALAI
HUAY KAEW
SAM LAN
MANI NOPPHARAT
KEAW NARARAT
LOI KHOR
CHANG KRAN
RACHAMANKHA
MAHIDOL
RATTANAKOSIN
MOON MUANG
SUTHEP
NIMMANHAEMIN
THA PHAE
CHANG PUAK
SIRIMAKALAJARN
SUPER HIGHWAY
WANGSINGKHAM
FAHAM
I'm so tired, the pollution is too high
Traffic Congestion Rate
Pollution Rate
Team info
OK
WUALAI has extreme congestion level.


Urban Logistics Redesign
Menu
Restart
Order History
Player History
Player Deck
20
Share solution
NIMMANHAEMIN- is given to Player 1
Close
Action : 0 Lefts
Team info
Move
Release
Locate
Construct
Share Solutions
Pass
Undo

References

Abt, C. C. (1987). *Serious games*. University press of America.

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