LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
SCHOOL OF BUSINESS AND MANAGEMENT
Industrial Engineering and Management
Master's thesis

BUSINESS ECOSYSTEM GAME FRAMEWORK

Erno Pirinen

Examiners: Professor Timo Kärri
University Lecturer Tiina Sinkkonen

Supervisors: Professor Timo Kärri
University Lecturer Tiina Sinkkonen

ABSTRACT

Author: Erno Pirinen

Subject: Business Ecosystem Game Framework

Year: 2017 **Place:** Helsinki, Finland

Master's thesis. Lappeenranta University of Technology, Industrial Engineering and Management.

76 pages, 7 figures, 15 tables and 5 appendices.

Examiner(s): Professor Timo Kärri, University Lecturer Tiina Sinkkonen

Keywords: business network, business ecosystem, collaborative network, serious game, collaborative learning

This thesis studies creation of business ecosystems -themed serious game framework. The framework can be used to create a serious game application for educational purposes or to support decision-making in real life business ecosystems. The study uses literature review of relevant books and scientific journal articles to create a theory base for the framework. Found business ecosystem theory and models are combined with theory of creating successful serious game to create the framework and implementation guidelines.

By use of literature review and applying the found theory using design science methods, serious game framework, models and implementation guidelines that enable collaborative learning are created. For serious game to be successful meeting its goals and collaborative learning to happen, certain design guidelines should be kept in mind. Business ecosystems are complex structures with many different aspects, with some being more suitable for modeling in serious game context than others.

Framework has models for most of business ecosystem aspects, including structure, value creation, risk and decision-making. Applications based on the framework can implement various aspects from the framework. The framework should mostly be used as a guideline and it can be tailored to fit the requirements of the situation final application is created for.

TIIVISTELMÄ

Tekijä: Erno Pirinen

Työn nimi: Liiketoimintaekosysteemipelin viitekehys

Vuosi: 2017 **Paikka:** Helsinki

Diplomityö. Lappeenrannan teknillinen yliopisto, Tuotantotalouden tiedekunta.

76 sivua, 7 kuvaa, 15 taulukkoa ja 5 liitettä.

Tarkastajat: Professori Timo Kärri, Yliopisto-Opettaja Tiina Sinkkonen

Avainsanat: liiketoimintaverkosto, liiketoiminnan ekosysteemit, verkosto, ekosysteemi, hyötypeli, yhteisöllinen oppiminen

Tehdyssä diplomityössä luodaan liiketoimintaekosysteemiteemaisen hyötypelin viitekehys. Viitekehyksen avulla on mahdollista luoda hyötypelisovelluksia opetuskäyttöön tai liiketoiminnan ekosysteemien päätöksenteon tueksi. Tutkimuksessa käytetään kirjallisuuskatsausta aihealueen kirjallisuudesta ja tieteellisistä artikkeleista, joiden pohjalta luodaan teoriapohja viitekehykselle. Teoriaa liiketoimintaekosysteemeistä yhdistetään teoriaan onnistuneiden hyötypelien kehittämisestä, jonka perusteella viitekehys ja sen hyödyntämisen ohjessäännöt luodaan.

Hyödyntämällä kirjallisuuskatsauksesta saatua teoriaa ja suunnittelutieen metodeja, luodaan yhteisöllisen oppimisen mahdollistavan hyötypelin viitekehys, malleja sekä hyödyntämisen ohjessäännöt. Jotta hyötypeli onnistuisi saavuittamaan tavoitteensa ja yhteisöllistä oppimista tapahtuisi, tiettyjä suunnittelun ohjesääntöjä tulisi noudattaa. Liiketoiminnan ekosysteemit ovat myös monimutkaisia rakenteita eri osa-alueineen, joista osa sopii paremmin mallinnettaviksi hyötypelikontektissa kuin toiset.

Viitekehys sisältää malleja useimpiin liiketoiminnan ekosysteemien osa-alueisiin liittyen. Näitä ovat esimerkiksi ekosysteemien rakenne, arvon tuottaminen, riskit ja päätöksenteko. Ohjelmat, jotka kehitetään viitekehystä hyödyntäen, voivat käyttää kehyksen eri osia. Viitekehystä tulisi hyödyntää enemmänkin ohjesääntönä ja sitä voidaan muokata saavuttamaan lopullisen hyötykäyttöön tulevan sovelluksen tarpeita.

FOREWORD

Firstly, I would thank Professor Timo Kärri for the opportunity to make my Master's thesis from this interesting topic. He, in addition to my other supervisor and examiner, Tiina Sinkkonen, have been the most helpful and supportive along the journey of this research.

I'd also like to thank my family, friends and all the other people who have supported me in different ways during my studies in Lappeenranta. When I first started my studies in 2009, I couldn't possibly think what the following years would bring with them. Now many years later and wiser, I feel that I could have done some things in a different way and progress a bit faster with my studies, but I still don't regret a day spent here. Overall, the time went quicker than I thought, but it gave me many different experiences and brought a lot of amazing people to my life.

Erno Pirinen

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Background

Business networks have been under lot of research lately. In the modern world of information technology, means of communication, sharing information and analyzing data are constantly improving. This leads to improved capability for individual entities to work together, forming business networks. The old-fashioned thinking of everyone-for-himself is phasing out and firms are seeking mutual benefit through networking. (Rong and Shi, 2014, 4) These networks can be seen as ecosystems, where entities produce goods and services of value to customers, who also belong to the ecosystem (Moore 1993).

Through personal computers, game systems and mobile devices, games have become part of daily life for a lot of people. For example, 32% of the total UK population consider themselves to be gamers. (Freitas & Liarokapis 2011, 10) Games are usually played for entertainment, but their educational properties are often neglected. Even games which are designed just to be fun can teach lot of skills like logical thinking, planning, teamwork, reflexes and social interaction. Then there are the games designed with additional non-entertainment goals in mind, the so called serious games. (Dörner et al. 2016a, 3) Benefits of using video games in multiple non-entertainment contexts have been identified by many recent studies (Ma et al. 2011, 3). Using games as a mean to teach different skills isn't a new idea, but the results gained from them vary a lot. A game that is un-fun is a poor teacher, since it hinders concentration and will to improve (Mitgutsch 2011, 46). With proper design, a game can be made that is both educational and entertaining, and thus providing a unique method to the educational toolbox (Freitas & Liarokapis 2011, 9).

As both business networks and multiplayer games consist of many actors interacting with each other, these two concepts can be combined to create a multiplayer business ecosystem serious game. Depending on the objectives, this

type of serious game could be used for many different applications, like teaching network dynamics, using it as a tool for possible decision-making in existing business ecosystems or just for entertainment purposes with side benefits.

1.2 Objectives and limitations

In this master's thesis two relatively new areas of research, business ecosystems which are manifestations of business networks, and serious games, which are games designed for non-entertainment purposes, are studied and combined. The challenge in modelling ecosystems for the game is that there aren't currently many established models available, so the models have to be created based on highly theoretical research. Based on these models and theory of successful serious games, framework for serious game usable for educational or case-research purposes about business ecosystems is created. For each of its aspects, guidelines or example models based on theory are given to give base for successful implementation. The development of the actual game application based of this concept and modifying it to fit the needs of the situation is left for the end user or future researchers.

To model business ecosystems for the framework on deep enough level, understanding of how business ecosystems work and what is their structure is needed. There are multiple aspects in how actors gain value and act in business ecosystem, so they need to be studied. Other important aspects in business ecosystems are communication, interaction, decision-making and risks, which need to be modeled for the framework as well. For the serious game to be successful in its purpose, theory about serious games and collaborative learning needs to be included. The business ecosystem models also need to be succesfully implemented to the serious game framework.

From these points, the following two research questions are formed with the following sub questions:

1. How can business ecosystems be modeled?
- What kind of benefits participants gain and what kind risks they have to consider?
- What is the structure of business ecosystem and how additional value is created?
- How can decision-making in business network be modeled?

2. How can business ecosystem models be applied to serious game concept to create usable serious game?
- How to design a game that can be used for non-entertainment purposes?
- How to apply business ecosystem theory and models to the game framework in a way that allows the game to fulfill its purpose?

The actual game application development process and its phases are only presented and few possible methods are introduced. Some suggestions for technologies to be used in development process are presented. The framework created is also very open for modification and different applications, so the many possibilities for its use are not explored deeply and are left for possible future game organizers and application developers. The development of the actual game application is also a complex process with many different phases and methods, and is so left out from this thesis.

1.3 Research methods

The method used in this research is literature review and design science. With the literature review, theory and models about serious games and business ecosystems are analyzed to create a solid base for advancing knowledge. (Webster and Watson 2002) The literature used in research consists mostly of academic books and peer-

reviewed scientific journal articles, with emphasis on more recent items due to rapid development of the fields in question.

In the empirical part, theory about making a successful serious game and business ecosystem models are combined usign design science methods to provide a framework for business ecosystem serious game. After gaining awerness of the problem, theory gained from literature review is applied and framework is developed. The game framework is also applied to business ecosystem game application development process for Lappeenranta University of technology, which is presented in another Master's Thesis by Matti Rissanen. These two Master's theses were written timewise side-by-side, with this thesis focusing more on the actual business ecosystem modelling and features of the game and the other focusing more on applying the game framework and developing playable business ecosystem game application for practical use. For comperhensive feedback and framework evaluation, a full-scale serious game application with all the features presented would be needed.

1.4 The structure of the report

In the introduction chapter, backround and motivation for the research are stated. This leads to research questions and limitations. Since the framework will be based on theory and does not include a development of a full finished serious game, research method used is literature review.

In the serious games chapter, theory about how to create a successful serious game and how to enable collaborative learning is studied. This leads to design guidelines to enable the game to reach its goals. Evaluation-based design framework is also studied.

Collaborative business networks of today -chapter focuses on research of collaborative networks and manifestation of them, business ecosystems. In this chapter structure, categories, life-cycle, value creation, performance measurement,

collaboration, decision-making, goals, risks and management of business ecosystems is researched to create believable models for the game framework. These models give base for applying the framework to create a successful serious game.

In the fourth chapter, business ecosystem game framework, theory is applied to create a framework for serious game and supply it with models and implementation guidelines and example models. Business ecosystem game framework includes three aspescts, serious game design, business ecosystem modeling and evaluation. First, serious game design process is explained, which includes setting goals, implementing business ecosystem aspects, gameplay process, design aspects for the game to meet its goals and enable collaborative learning, avoiding common pitfalls and evaluating player performance and the game process. Next, business ecosystem aspect is applied. This includes business ecosystem structure, collaboration models, performance measurement models, decision-making modeling, risk modeling, ecosystem life-cycle modeling and resource usage modeling. Finally, full business ecosystem game framework is presented with short summary of aspects and implementation guidelines.

In the fifth chapter, discussion, results of the research are discussed. Main research results are stated, commented and compared to previous research. Future research suggestions are stated for both business ecosystem game and related areas.

Last chapter of this thesis is summary, where the contents of the thesis and answers to the research questions are presented in a compact form. Input-Output chart of the whole report structure is presented in table 1.

Table 1. Input-Output chart of the report structure

Input	**Chapter**	**Output**
Background of the research Overview on the thesis	Introduction	Motivation Research questions Methodology Scope and objectives
Previous literature about serious games Previous literature about collaborative learning	Serious games	How to create serious game usable for the current application How to enable collaborative learning
Previous literature and models of collaborative networks and business ecosystems	Collaborative business networks of today	Business ecosystem models and guidelines to use in serious game framework
Serious game design guidelines Business ecosystem models and theory	Business ecosystem game framework	Business ecosystem game framework Impentation guidelines, models and examples
Business ecosystem game framework Previous research	Discussion	Comments on the business ecosystem game framework Suggestions for future research
Research results	Summary	Summary of the research

2 SERIOUS GAMES

2.1 Using serious games for non-entertainment purposes

Games can be used for purposes that aren't just purely entertainment. This idea has been around for a while and has realized as a great number of research projects, published serious games and relatable applications during the last decades. Literature reviews seem to show benefit of them in general for purposes like learning proess support or health-related behavior changes. (Emmerich & Bockholt 2016, 266) Dörner et al. (2016a, 3) define the term serious game as follows: "A *serious game* is a digital game created with the intention to entertain and to achieve at least one additional goal (e.g., learning or health). These additional goals are named *characterizing goals*." The characterizing goals of serious games can be used for categorization. Characterizing goals found in serious games made recently include personal health-related goals like lifestyle change or physical fitness, medical goals like medical diagnosis, business related goals like enterprise management, decision support and other goals like development of social skills, campaigning in politics and military applications. (Ma et al. 2011, 3; Dörner et al. 2016a, 3)

The definition of serious game can be blurry, for example categorizing a game like shooting game, which primary objective is to entertain, but is used by some players for reaction time improvement, would not be a serious game by the definition mentioned above. Another example could be bad educational mathematics game that actually fails to teach anything, which would still be a serious game by above definition. The goal of serious games is to achieve their characterizing goals in a pleasant and enjoyable manner, and can also be called applied games, educational games or games with a purpose. (Dörner et al. 2016b, 4-5)

Using serious games for education has potential benefits and interesting research challenges (Dörner et al. 2016b, 6). Recent research has illustrated that games can promote learning, in addition of further potential benefits like improved capacity

for monitoring self, increased problem recognition and solving capabilities, more comprehensive decision-making and social skills related to collaboration, negotiation and cooperative decision-making. (Freitas & Liarokapis 2011, 11-12) Educators might have high hopes for using computer games for educational goals, but it must be kept in mind that serious games are just another learning medium that has its own strengths and shortcomings. Using digital games in for serious purposes is a very complex topic and to apply the right serious game programs in the right situations, lots of different features and characteristics must be addressed. (Dörner et al. 2016b, 6)

There is some contradiction relating to the cost of serious games. Dörner et al. (2016b, 6) note serious games having high design and development costs compared to conventional educational media, while Ma et al. (2011, 3) refer games technology being inexpensive. The ratio between the serious and entertainment parts in the game is also a complex topic, which make the combination of high development costs, fragile balance of game and uncertain market very risky for video game and educational market industries. Educational organizations are also cautious to give up conventional educational methods to purchase technologies which effectiveness has not yet been proved. (Dörner et al. 2016b, 6)

Industry has been giving more and more support for entertainment- and serious games because of their economic relevance. Research related to the field is higly beneficial for many entities, including society in general in addition for direct benefits. New game ideas are being born all the time, and creative technologies are being developed. Nearly all research related to different fields of computer science are beneficial contributors for serious game development. (Dörner et al. 2016b, 8-9)

There are many ways that games in general create motivation from. Motivation can come for example from beating high scores or objectives, receiving awards in-game awards or performing well in multiplayer environment. The focus of serious games differs from other games which are purely entertaining, but to succeed, they should

be fun too. Target group is selected when serious game design process is started, so the game can be made effective and matching the needs and preferences of that group. (Mildner & Mueller 2016, 57-63) Literature, theories, intuition and personal experience are the building blocks for design and development of serious games. Serious games also need to be evaluated with the respect to its intended purpose. (Emmerich & Bockholt, 2016, 266)

Gamification which is used to create gamified applications, needs to be distinguished from serious games. In gamification, game methodologies or elements are repurposed and used in applications and processes that aren't games. (Deterding et al. 2011) The boundary between gamified application and a serious game can be blurry, but gamified application typically has less aspects and depth than an application designed to be a serious game. Gamification can be used to using playful concepts in non-playing contexts, for example to make monotone tasks at work more bearable. (Dörner et al. 2016a, 5)

There are two kinds of motivation for playing games, extrinsic and intrinsic. If the motivation comes from the game itself, it is called *intrinsic motivation*. If the game is used as a motivational tool and to accomplish a certain goal, for example passing an exam, game is creating *extrinsic motivation*. Serious games can be used to provide extrinsic motivation to players to engage a topic they don't have intrinsic motivation with otherwise. (Mildner & Mueller 2016, 61; Stieglitz et al. 2017, 12) Deep learning requires intrinsic motivation, where learner considers activities taken to be interesting (Apiola & Tedre 2013). Players can be motivated by things like action, which has destruction and excitement aspects, social, which has competition and community aspects, mastery which has challenge and strategy aspects, achievements, which has completion and power aspects, immersion, which has fantasy and story aspects and creativity which has design and discovery aspects. (Yee 2016) Different groups of people find different things motivating, for example in evaluation of Odyssey serious game, secondary school students reported low intrinsic motivation with a mean of 1.6 on a scale from 1 to 4, while students of international school showed a score of 3.7 (Cai et al. 2017, 108).

2.2 Designing a serious game

Some aspects should be considered about the way that the game is going to be played. According to Mildner and Mueller (2016, 64), they are:

- Supervision: Does the game need to be accompanied by an instructor?
- Environment: Does the environment need to be controlled or does leisure time suffice?
- Re-playability: Is the game repeatable and could be used as a training application?
- Timeframe: How much time does playing the game take?

These aspects should be considered thoroughly in the design process to achieve the best possible outcome with the usability of the final product (Mildner & Mueller 2016, 64). To keep the design process and the properly focused, clear problem statement should be made. Characterizing goals can give constraints to the problem statement. (Dörner et al. 2016b).

Budget can be a limiting aspect when making a serious game. Usually, developers working with games designed for non-entertainment purposes don't have the resources needed to hire good game designers or artists. Less-than-optimal balance of the serious parts and the fun parts of the game may result from this. Involved parties in serious games and entertainment games are pretty much the same, with exemption of serious games having domain experts in the design process. Domain experts are people, who know the domain that the serious game is developed to well and contribute their knowledge to the design process. (Mehm et al. 2016, 84; Mildner and Mueller 2016, 57) To provide suitable data like vital parameters or pools of tasks for the game, domain experts are needed. Game and the authoring tool needs to be compatible with this data. (Mehm et al. 2016, 84)

For the serious game to reach it's characterizing goal in the best possible way, it also needs to be adaptive to the choices of players. This makes specialized authoring

tool as a requirement, since adaptivity can lead to non-linear and highly interactive games, which can lead to complex interactions and different results for different players which are hard which are hard to predict. (Mehm et al. 2016, 84)

Game is a structured activity, which is based on rules that players follow. Game also has a beginning and an end. In a game, players must follow rules defined before the game starts to work towards an objective, which differs from a play that is more free and players don't have to follow rules. There are no statements to define what rules and objective should look like, and they are up for game-makers imagination. In literature different elements of how fun is created are identified. These elements include role play, learning, fiction, narrative, challenge, exploration, facing danger, discovery, risks and rewards, immersion, socialization and many more. (Mildner & Mueller 2016, 59-60)

Rules limit the players actions, but acting according to these limits might promise satisfaction at the end of the game. Challenge level of the game can be adjusted by adjusting the strictness of the rules. Challenge level has to be in balance – too high challenge level can frustrate players while too low challenge level can be boring. Optimal situation is when the players enter the so-called *Flow*. This happens when the challenge level is just right. (Mildner & Mueller 2016, 59-61) Solving tasks with appropriate challenge levels leave players feeling rewarded and waiting for the next challenge, and one pointer of a good game design is entering this "flow" -state (Mildner & Mueller 2016, 59-61; Freitas and Liarokapis 2011, 11). In the flow state, the player becomes intrinsically motivated and immersed in the activity (Stieglitz et al. 2017, 25).

In some games, social factors contribute to creating a fun experience. Players build team spirit when cooperating and solving tasks together. Working as a team might provide players with ability to to do things that they aren't able to perform alone. In some games, computer-made social interaction is made by using artificial intelligence controlled interactable players. In the end, it has to be kept in mind that games, serious or just entertaining, are played because they are fun. To explain this,

different models can be used that share common elements such as play, rules, storytelling, social factors and learning. (Mildner & Mueller 2016, 59-61)

2.3 Cooperative and collaborative games

Games can be arranged to two basic categories, *competitive games* or *cooperative games*, according to traditional game theory. The strategy involved in competitive games is individual, players are meant to oppose other players to succeed as the goals are diametrically opposed. In cooperative games, players work according to interests of their own, but at the same time have motivation to work together to achieve mutually benefical conditions. (Zagal et al. 2006) In teams, players either win together or lose together (Wendel & Konert 2016, 222). Also, in cooperative games, rules exist for negotiating or bargaining desirable outcomes (Zagal et al. 2006).

According to a more recent theory, third category exists called *collaborative games* (Zagal et al. 2006). Collaborative games are based on the idea that players complement each other's weaknesses while working towards a mutual goal. (Wendel & Konert 2016, 222). In collaborative games, interaction between the players is in a key role, and the focus is in social aspects like teamwork, coordination, and supplementing each other. This leads to collaborative games being well suited to teach those social skills, and making them great for serious game -based *collaborative learning*. (Wendel & Konert 2016, 223)

2.4 Multiplayer serious games and collaborative learning

In a multiplayer game, multiple players play together, solo or in teams, against other players or computer players controlled by artificial intelligence. Being multiplayer brings many different aspects to the game, mainly social interaction and competitive element. Role of the social interaction is highlighted by many learning theories (behaviorism, cognitivism, constructivism), and all agree that it has a supportive effect for learning. (Wendel & Konert 2016, 211-214) In a serious game

environment, it would be best to try to find optimal mix of players with prior knowledge and personality traits for giving the best possible learning environment ant maximum progress for involved players. Different players have different preferences and affectations for games, genres and ways of playing, so finding the right mix of players can be difficult. Also, it is almost impossible to design a game that appeals to all players. Differences like learning style and state of knowledge between players needs to be considered. (Wendel & Konert 2016, 211-214)

Number of players in a game and the access method can be used to define the type of multiplayer game. To play the game, the players can use their own devices or a shared device with multiple players sharing the same screen or taking turns. Network issues like latency, or packet loss have to be considered when playing over internet. Effect of these for the playing experience is highly dependent on the game genre. (Wendel & Konert 2016, 211) One of the core elements of multiplayer games is communication, which has high impact on almost all types of multiplayer games. There are multiple ways to handle in-game communication, including chat, in-game signs and voice communication. (Wendel & Konert 2016, 211-214)

Zagal et al. (2006) have identified the following lessons and pitfalls for designing a collaborative multiplayer game, which should be noted for successful implementation:

- Lesson 1: In a collaborative game, tension should be introduced between individual and team utilities. This highlights the problems of competitiviness.
- Lesson 2: Individual players should be allowed to make decisions by themselves and take actions on their own without permission gained from the team.
- Lesson 3: Players need to be able to trace outcomes of their actions back to their decisions.

- Lesson 4: In a collaborative game, players should have different abilites or responsibilities to encourage selfless decisions.
- Pitfall 1: Collaborative games must give reasons for players to collaborate, so the game process won't drive into situation where one player makes all the decisions for the team.
- Pitfall 2: Players need reasons to care about the results of their actions. This makes the game engaging, especially if those results are satisfying.
- Pitfall 3: Collaborative game should have re-playability value. To accomplish this, playing experience needs vary and challenge level needs to evolve.

Situation, where multiple people learn, or attempt to learn something together with various specific learning mechanisms is called collaborative learning. (Wendel & Konert 2016, 224-225). Collaborative learning enables players to learn to respect others, and also faciliates their learning performance (Sung & Hwang 2013). To enable cooperation in collaborative learning scenarios, specified circumstances mest be met. According to Wendel and Konert (2016, 224-225), those are:

- Positive interdependence: reaching mutual goals results in positive interdependence, for example, if group members are linked in such a way that it is impossible to succeed alone. Interdependance in resources, roles and tasks is included in this context.
- Individual accountability and personal responsibility: each individual and the whole group should be aware of every single player's assessed performance.
- Promotive interaction: promotive interaction is enabled by encouraging, praising, promoting and faciliating each group members success towards the group goal.
- Appropriate use of social skill: social skills are needed to enable cooperative effort. If group member can't communicate, they can't resolve conflicts or support each other.

- Group processing: group members can evaluate their effort by relfecting their actions as individuals or as a group.

Instructor plays a vital role in many collaborative learning scenarios. The tasks performed by the instructor in preparation of the learning scenario might include setting goals, motivation strategies, planning, activating attention or reactivating prior knowledge. During the collaborative learning scenario there might be tasks related to coaching, moderating, observing the learners, helping and redirecting. The role of the instructor is not trivial, and poses many challengers. The use of digital environment includes instructor with many different tools. (Wendel & Konert 2016, 225) Combining collaborative learning paradigm and serious game principles with computer technology creates a completely new way to introduce collaborative learning. Computer technology can offer benefits like motivation, fun environment and different tools for assessment and evolution which makes especially well suited for providing base to learning-focused collaborative entertainment gaming. Technology also makes new tools available for the instructor, and so improves the instructor's work. (Wendel & Konert 2016, 226)

2.5 Performance in games

In digital games, interaction and action happens between players and the game. Multitude of mechanics, called game mechanics, are used to achieve in-game goals. These goals usually have reward and can be related to solving in-game problems or increasing scores. To measure performance in these actions, quality and results of the actions can be used. For evaluation purposes, assessment of player performance is required. (Wiemeyer et al. 2016, 273-281) Score points can be used to reward players through the different dimensions of the systems (Stieglitz et al. 2017, 8). To maintain player experience and keeping the players within the game flow, game must adapt to the players current performance. This makes assessment of performance in serious games important. Also, to deliver feedback in form of instructions, hints or score the player performance requires assessment. To improve

the game and prove its effectiveness, summative evaluation is required. (Wiemeyer et al. 2016, 273-281)

Specific characteristics are included for every characterizing goal for how the performance is modeled in the serious game. For example, if the objective of the serious game is to improve fitness level, for example through promoting everyday exercise, appropriate behavioral models should be applied to derive game interventions. (Wiemeyer et al. 2016, 273-281) Performance metrics are unlikely to transfer well between different domains (Loh et al. 2015, 3). Wiemeyer et al. (2016, 273-281) have identified few examples of domain-specific performance measures presented in table 2, which serve as good examples of what should be measured in different domains.

Table 2. Examples of domain-specific performance measures (Wiemeyer et al. 2016, 281)

Domain	**Measures (examples)**
Educational games	Skill levels, attitude and knowledge of the subject
Games for Health	Health-related and health-enhanching knowledge, physical activity, behavior, attitude and fitness level
Reha(b)games	Daily living activities, clinical scales and scores
Sport games	Skill and ability levels, performance and knowledge
Advergames	Attitude towards the product and knowledge, realized purchases
Simulation and training games	Transfer of behavior and knowledge to real world

2.6 Evaluation-based design framework for serious games

To prove the effectiveness and suitability of the game to the purpose it has been made to, the game needs to be evaluated. Reliable results are needed to convince

stakeholders and plan for the future design approaches. Successful games and failed games both give valuable experience and may help in design of more effective serious games. (Emmerich & Bockholt 2016, 267) To measure if the collaborative learning scenario was succesful, questionnaires taken pre-game and post-game measuring learning attitudes, motivation and self-effiacy of the participating group can be compared (Sung & Hwang 2013). Another model called "EGameFlow" can be used to measure users' experience of educational games. It contains two dimensions, social interaction that ranges between cooperating with other classmates to supporting communties outside the game and knowledge improvement dimension, which ranges from increased knowledge to wanting to know more about the knowledge taught. (Bachen & Raphael 2011, 67)

According to Emmerich and Bockholt (2016, 267-268), structured evaluations benefit four different main groups of stakeholders: game developers, intermediaries, game researchers and users. For developers, evaluation gives benefits in form of dissemination, improvement of future designs and more efficient game development. Game researchers gain insights about the impact of games on players and guidelines for development. Intermediaries gain trust and justification to use games as efficient tools and users gain convincement and positive impact in terms of the game's purpose. According to Loh et al. (2015, 21), metrics are gained from evaluation that help to understand the game design and its effects on player enjoyment in addition to in-game content they want to play and possibly invest money to in the future.

Emmerich and Bockholt (2016, 271) propose a model for *evaluation-driven design* of serious games. In the framework, well-known phases of game development and evaluation process are contextualized. The framework consists of preparation phase, where the game problem is defined and reason for investing effort and resources is given. After the preparation phase, theory of the problem is identified to tackle it. After identification of theories and mechanisms, purpose of the serious game is defined, which gives the criteria for evaluation. (Emmerich & Bockholt 2016, 273) After these phases, the game design process enters iterative loop of

design and evaluation presented in figure 2, where game is designed in incremental steps based on evaluation feedback (Emmerich & Bockholt 2016, 272).

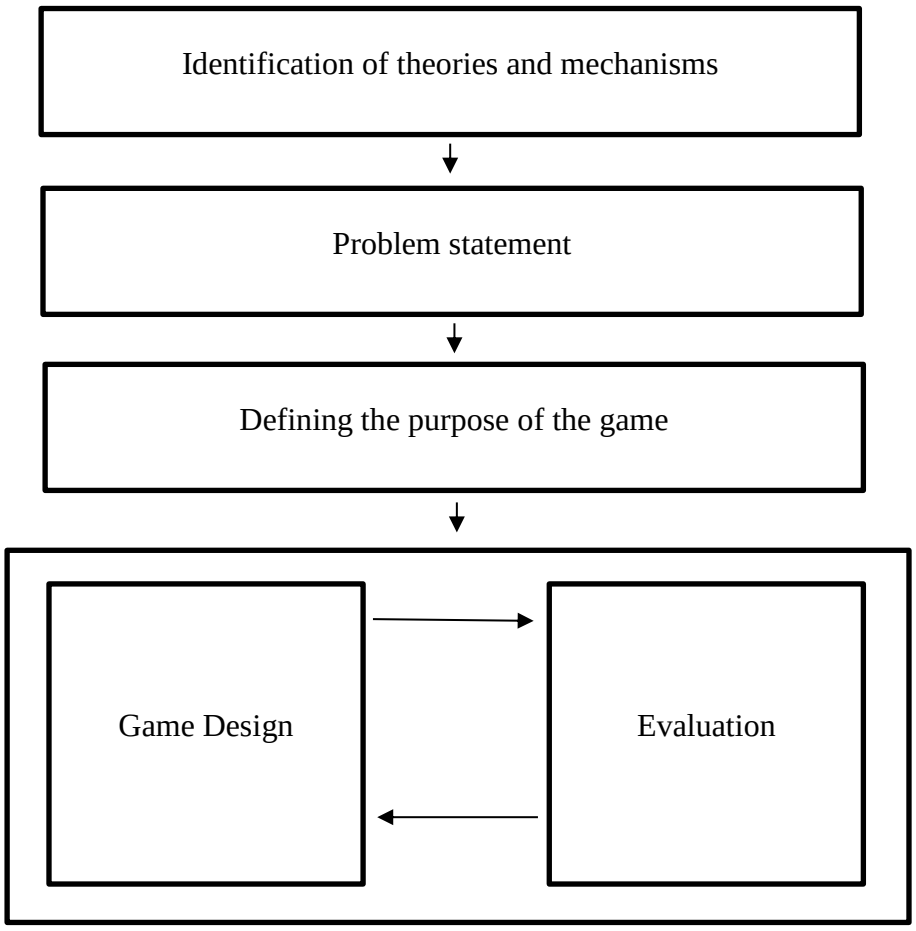

Figure 1. Evaluation framework for evaluation-driven design (Emmerich & Bockholt 2016, 272)

3 COLLABORATIVE BUSINESS NETWORKS OF TODAY

3.1 Collaborative networks and business ecosystems

In the last decades, collaborative networks have been under lots or research and practical implementations around the world. Different forms of collaborative networks have been found along large amounts of empirical knowledge that can be used for future research. This information is highly fragmented and reveals one key weakness in the research – the lack of applicable theories and modeling tools. It can be noted that common definitions for concepts such as virtual organizations, collaborative networks and virtual enterprises has not yet been established. (Camarinha-Matos & Afsarmanesh 2008, 6)

If formal theories and models for collaborative networks are developed, it would allow better understanding of the area and make base for new methods and ways of operation. For ICT-based support systems, for example to support decision-making, models like this would also be needed. Those systems could be used for business and organizational development and operation, as well as effective management and operation of collaborative networks. (Camarinha-Matos & Afsarmanesh 2008, 6)

According to Camarinha-Matos and Afsarmanesh (2008, 6), in order to model collaborative networking, the very notion of collaboration has to be addressed. The following definitions are made to clarify various concepts:

- Networking – mutual benefit is gained from exchange of information
- Coordinated Networking – in addition to networking, aligning and altering activities that more efficient results are achieved
- Cooperation – in addition to coordinated networking, resources are shared to achieve compatible goals
- Collaboration – a process where information, resources and responsibilities are shared to follow a common plan to achieve a common goal

Following the steps along the road from networking to collaboration, firms start to improve their activities. Risk-taking becomes more goal-oriented, partners become more committed and improve their resource-sharing capabilities. We can think these steps as a metric for collaboration maturity level. This provides basis for defining the maturity level of an organization collaboration process. (Camarinha-Matos & Afsarmanesh 2008, 52)

Challenges and uncertainty in the business environments, emergence and transformations of new technologies in addition to new market demands has caused the focus of thinking to shift from individual firms or supply chain level to a more complex *business ecosystem* level. (Rong & Shi 2014, 4) Boundaries of what systems can be categorized to are becoming increasingly blurry. This results from increased turbulence in the business environment, ongoing changes in the society, and the possibilities that new constantly evolving technologies are giving. (El Sawy & Pereira 2013, 1)

Moore (1996, 26) defined business ecosystem according to his article written at 1993 as “an economic community supported by a foundation of interacting organizations and individuals - the organisms of the business world. This economic community produces goods and services of value to customers, who themselves are members of the ecosystem”. Business ecosystems are collaborative network organizations, which have long-term strategic goals. It can be kept as a breeding environment for virtual organizations, providing possibilities for formation of networks which are focusend on set goals and target specific business opportunities. In a business ecosystem, common business processes are typically promoted, providing interoperable collaboration infrastructures, and facilitating trust building among its members. In a business ecosystem, organizations stimulate co-evolution between partners and their business environment. It has both static and dynamic characteristics. (Graça & Camarinha-Matos 2016; Camarinha-Matos & Afsarmanesh 2008; Rong & Shi 2014, 225)

All business ecosystems have main goal of value creation. This is the main distinguisher of business ecosystems from other ecosystems, like natural, political or innovation ones. This is called the general business level. Another level is called specific business, which is related to delivering products and services by coordinating with different partners and utilizing resources. There can be many kinds of specific business ecosystems, for example electric vehicle ecosystems, 3D-printing ecosystems or robotics ecosystems. Any business must have its own unique ecosystem. Inside business ecosystem, business opportunities emerge to trigger interactions, organizations symbiose with others of the same mindset and co-evolve together to shape the future industry. (Rong & Shi 2014, 225)

The structure of business ecosystems has been discussed in literature since 1993. In some literature, four types of organizations were identified in business ecosystems, *keystone players*, *niche players*, *dominators* and *hub landlords*. Keystone players are the ones who set up a platform for others to contribute. Niche players develop specialization which adds value to business ecosystem. Dominators integrate multidimensionally to manage a large section of its network, and without directly controlling the network, hub landlord tries to extract as much value from it as it able to. These roles were integrated in three types in later literature: *shaper*, *adapter* and *reserving the right to play*. Shaper would offer the core resource, while playing the roles of dominator or landlord. Adapters would use the core resource provided by the shaper, and the third type were the ones who were acting as opportunists. (Rong & Shi 2014, 59-64; Iansiti & Levien 2004a)

Three dimensions for testing the health aspect of business ecosystems can be found: *productivity*, *robustness* and *niche creation*. The ability of business ecosystem to transform technology and other resources into cost reductions and new products can be measured by productivity. Robustness indicates the capability of business ecosystem to survive disruptions, like unforeseen technological changes. Maintaining the growth of firm, variety of products and technologies are demonstrated by the niche creation ability. From these three dimensions, health of

the ecosystem could be theoretically measured. (Rong & Shi 2014, 60; Iansiti & Levien 2004b)

3.2 Different categories of business ecosystems

"What exactly can be called a business ecosystem?" and "what kind of different business ecosystem types exist?" are interesting questions. From original definition by Moore (1993), he later extended his statements and definition in 2006 as the term "business ecosystem" and its plural, "business ecosystems", to refer to intentional communities of economic actors whose individual business activities share in some large measure the fate of the whole community. (Koenig 2012; Moore 1993; Moore 2006)

According to Koenig (2012), there are multiple contradictions in Moore's definitions. For example, Moore makes place for different kinds of stakeholders in the composition of the business ecosystem, but on the other hand on definition of the business ecosystem by its properties Moore's focus is centered uniquely on firms that are working on a common project. The literature is split between definitions of business ecosystems that mention peripheral actors and those that exclude them. Koenig (2012) notes that this is also found in literature of other authors.

Another contradiction is the question of governance. According to Moore's one view, business ecosystem is democratically governed, but on the other view he selected business ecosystems in which one entity has main influence over the business ecosystem's key resources for some of his cases. Moore also refuses to consider open source communities as true business ecosystems, even though they are democrating in governance and fits his definition. (Koenig 2012)

The third contradiction Koenig (2012) notes, is the statement that business ecosystem structure is modular, and it is at the same time a community of destiny. This means that values that relate to being community of destiny is in conflict with

values that coopetition base at. For example, one key character of coopetition, existence of mutual intrests, aren't characteristics of communities of destiny. Modularity implies the possibility for actors to leave and join business ecosystems at will. Individual ecosystem members, can be part of several ecosystems, even of competing ones. (Kajüter & Kulmala, 2005; Koenig 2012)

Based on control of key resources and type of interdependence, Koenig (2012) categorizes business ecosystems in four different types of design:

- *Supply systems* and *platforms* for centralized control of key resources
- *Communities of destiny* and *expending communities* for decentralized control of key resources

In supply systems, the business ecosystem is controlled by central entity which is the strategic center, delegates complementary contributions to its constituents to achieve strategic activity. Strategic center and the parthers that unite around it form this type of centralized network. (Koenig 2012)

In platforms, the design is controlled by a central entity who makes keystone available to other members of the business ecosystem to enable developing of their own activities. The key difference between a platform and a supply system is that the entity controlling the business ecosystem won't define the contributions of the exterior actors, but only specifies the rules for usage of the platform. (Koenig 2012) Examples of platforms are IBM 360, video game consoles, Amazon Web Services and the emerging Internet of Things-ecosystems, which consist of Internet-enabled devices, applications, connectivity solutions and the platforms for usage. (Koenig 2012; Toivanen et al. 2015, 30)

In communities of destiny, system has decentralized leadership structure over multiple actors which contribute different amounts to decision-making. Communities of destiny stay true to their name in a way that actors are drifted to

that configuration around existental solidarity principles. This differs from supply systems or platforms, which are built on keystone resources. (Koenig 2012)

In expanding communities, resource that is a common good attracts a large number of members to group around it. Knowledge intensive communities, like free-software communities, correspond to this type of design. In this type of community, each member provides its distinct and isolable contribution, and development for this design is expansion. (Koenig 2012)

3.3 Nurturing business ecosystem through its life-cycle

According to Camarinha-Matos and Afsarmanesh (2008, 70), life-cycle of collaborative networks can be divided into few stages. While setting up and dissolution stages only take a fraction of the lifetime, organizations spend most of their lifetime in operation stage. The stages for collaborative networked organization life-cycle identified by them are:

1. Creation – phase which deals with incubation, system parameterization, database creation, generation and definition of ontology etc.
2. Operation – phase where collaborative networked organization starts to work toward its goals
3. Evolution – phase where organization makes structural changes, might be simultaneous to operation phase
4. Dissolution – some networks dissolve after accomplishing its goals
5. Metamorphosis – organizations who won't dissolve, might enter a stage, where its general form and purpose can evolve

In another approach, according to Rong & Shi (2014, 159), firms' activities include five phases: *Emerging, Diversifying, Converging, Consolidating* and *Renewing*. They researched cases of three firms, ARM, Inter and MTK to find activities they used to nurture the business ecosystem in each of those phases. From those

activities, they made summary of what kind of actions in general firms take in each phase (see table 3).

In the first phase of *Emerging*, vision is shared, new solutions introduced, and new collaboration partners searched. In second phase, *Diversifying*, industry vision is co-designed with collaboration partners, product platform is introduced, and solution diversity is enabled. This results in introduction of diversified solutions and cooperation amongst partners. In the third phase, *Converging*, finalizing industry vision is began and product platform is improved further. Solutions that match the requirements for end-users are selected. This leads to specialization of the market. In the fourth phase, *Consolidation*, to lock in the partners and maintain the competitive advantage, the hub firm continuously consolidates the product platform. Integration will happen, which will lead to improved efficiency and enables mass production. In the fifth phase, *Renewing*, niche ideas are introduced by firms to persuade partners to enter another relevant emerging industry. After that, the business ecosystem enters phase one again, where the leveraging of partners and the commercialization of the new ideas happens. If this fails, original industry will start to decline. (Rong & Shi 2014, 213)

Table 3. Business ecosystem nurturing steps identification (Rong & Shi 2014, 214)

Phase and Step	**Description**
1.1. Sharing of future visions	Future visions of the emerging industry are shared with partners
1.2. Introduction of the solution	Solutions developed self or with partners for emerging market are introduced
2.1. Encouraging of partners	Design of the solution platform is started, and partners are involved
2.2. Enabling of the solution diversity	Products are being designed collaboratively and solution variety based on the platform is enabled
2.3. Co-designing of the future vision	Visions of future are co-designed with participants
2.4. Introduction of the platform	Development of the end-user solution based on the platform is started
3.1. Selecting of the solution	Design of the product is selected according to industry requirements
3.2. Selecting of the partners	Partner network is re-organized to suit the solution in the best possible way
3.3. Finalizing of the future vision	Efficiency is improved by the best solution and re-organization of the network
3.4. Co-desinging of the platform	Work with key members of the network is continued to improve the solution platform
4.1. Improving and finalizing of solution	Improvement of the solution is continued with aim of strengthening the market position
4.2. Integration of key partners	Network members are integrated based on the dominant design to improve efficiency
4.3. Consolidation of the platform	Solution platform is improved to strengthen competitive advantage further, partners are locked in
5.1. Initiation and capturing of niche ideas	Identification of niche markets or new requirements is conducted
5.2. Re-organization of partners	If nice market is found, network is changed to fit the identified market

Rong and Shi (2014, 228) have divided business ecosystem in seven configurations based on solution platform openness and solution diversity (see figure 3): simple solution ecosystem, platform enabling ecosystem, platform integrated ecosystem,

platform coordinating ecosystem, platform co-evolving ecosystem, coordinated open community ecosystem and open community ecosystem. Ecosystem can evolve in a way switching around these configurations, for example being first simple solution ecosystem, then becoming platform enabling ecosystem and later platform integrated ecosystem. (Rong & Shi 2014, 229)

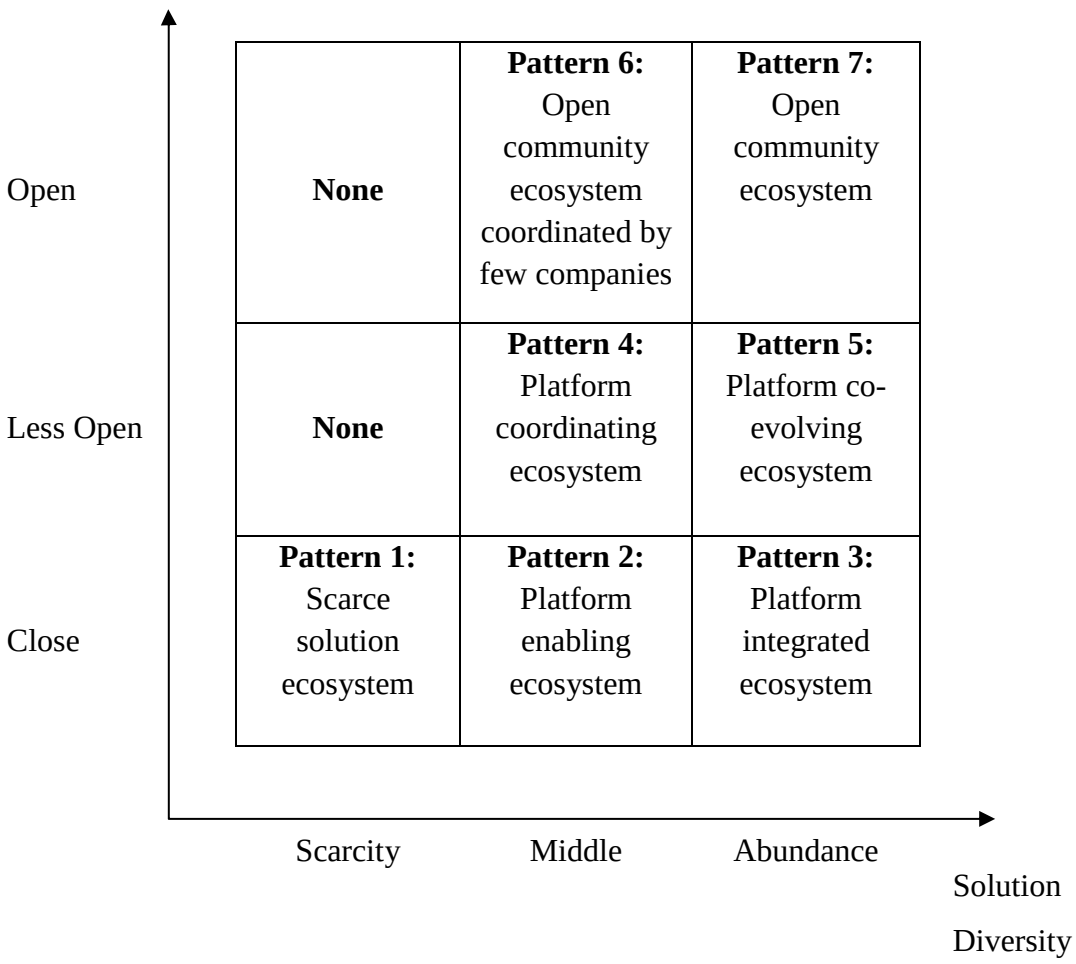

Figure 2. Conclusion about the configuration pattern (Rong & Shi 2014, 228)

3.4 Creating value by networking

Companies must collaborate with each other to survive in a competitive environment, focusing on meeting customers need more efficiently. The key driver in business networking is creating situations where everyone gains, the so-called win-win situations. These situations can be created through different elements, like trust, strong commitment and improved performance. (Ferreira et al. 2013; Saunila et al. 2017)

Marketing literature has been increasingly abandoning traditional perspective of value creation. Value is instead being thought as a phenomenenon that is jointly created. In this view, actors in ecosystem who control resources, perform activities inside the ecosystem. Interaction that occurs when resources are integrated between actors, generates the value. In a network approach, there are necessarily no traditional roles, and all business network participants simultaneously perform activites that are related to being both the customer and the supplier. Resources are being traded through relationships, which breaks the traditional supplier-customer relationships. (Jaakkola & Hakanen 2013) Ecosystem actors including the community, customers and competitors, perform different activities that co-create, co-convert and co-capture value. (El Sawy & Pereira 2013, 4).

Resources that are under control need to be intergrated for them to become valuable. In figure 4 is shown how value co-creation happens at actor- and relationship levels. There are four categories of resources: in the first category resides knowledge, experience and skills of idividuals and groups, in the second oraganizational relationships and in the third and fourth, products, production facilites and other tangible resources. Activity occurs when actors manipulate resources by combining, developing or creating new resources using other resources. With relationships developing between companies, activity links form and activity patterns emerge. (Jaakkola & Hakanen 2013)

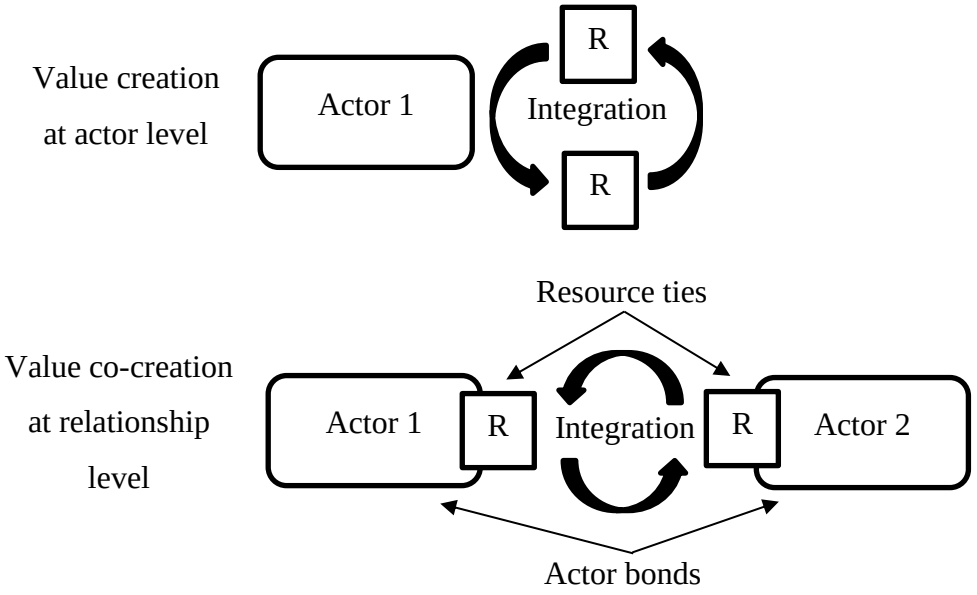

Figure 3. Value co-creation at actor and relationship levels ('R' denotes resources).

Camarinha-Matos and Abreu (2005) have made a basis for analysis of benefits in collaborative networks suggesting some indicators and discussing their measurability. The model is based on theory of social actor networks, transaction cost theory and game theory. In this model, benefits can be divided into partial benefits, which are combined to form the total benefits value as shown in figure 5.

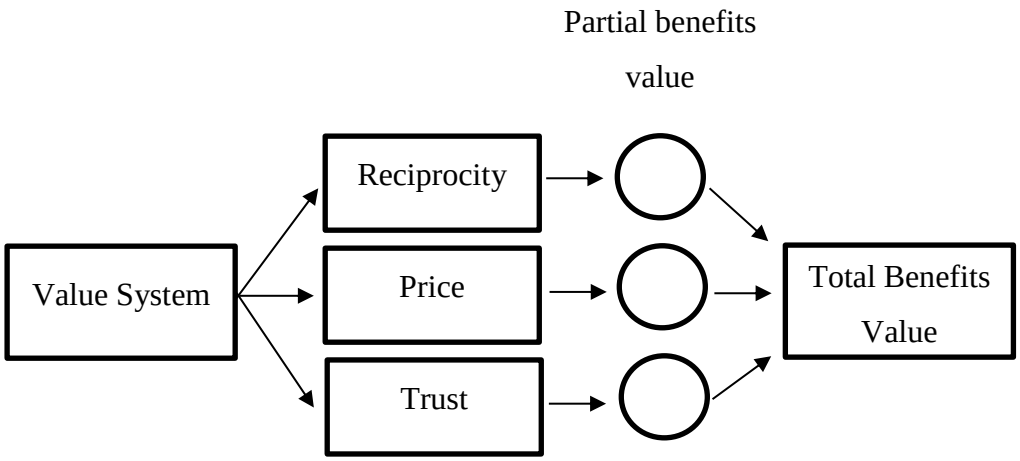

Figure 4. Example of benefit as combined abstract value (Camarinha-Matos and Abreu 2005)

According to Abreu and Camarinha-Matos (2008, 258), benefits might be different for different kinds of organizations, but the concept of benefit remains the same. Benefits can consist of multiple different aspects, that form the total benefit. Whatever the total benefit might be, the type of benefit can be divided in three categories in collaborative networked organization. Considering tasks performed by single actor of the network, these categories are:

1. Self-benefit, when the actor performs a task giving himself benefit
2. Received benefit, when other actor performs a task giving benefit to initial actor
3. Contributed benefit, when actor performs a task giving benefit to other actor

This logic can be applied graphically through a graph to model benefit links between network actors. This gives a total view how benefits apply between network members. For example, according to this approach, it can be determined if the network is centralized or decentralized. If these two types of networks are compared, identical total number of received and contributed benefits might might make entities to find decentralized networks more attractive. (Abreu & Camarinha-

Matos 2008, 268) Example visualizations of centralized and decentralized networks are given in figure 6.

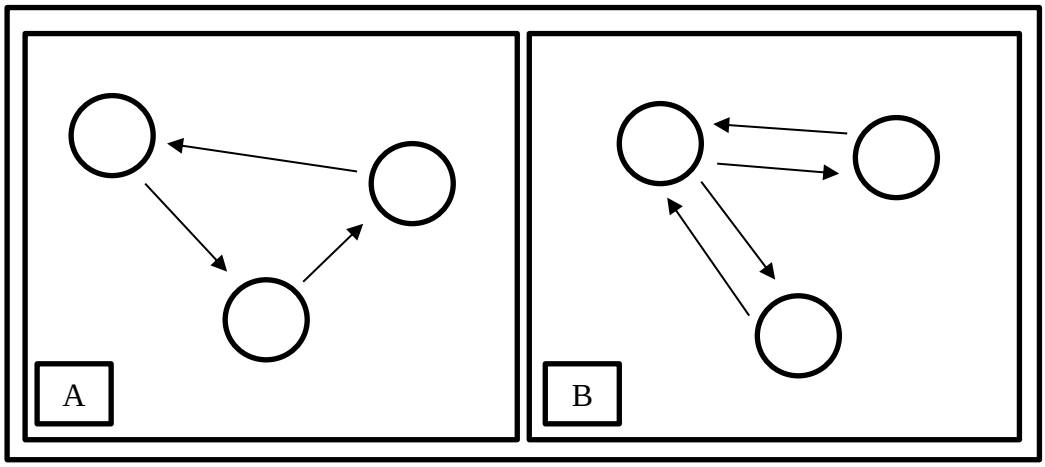

Figure 5. Examples of decentralized (A) and centralized benefits network (B) (Abreu and Camarinha-Matos 2008, 268)

Cost-benefit analysis or cost-effectiveness analysis can be used to identify the cost-benefit ratio of the actions made in collaborative network. In cost-effectiveness analysis, costs of the actions are related to the to the key outcomes or benefits, and in cost-benefit analysis actions are compared to the monetary value of combined benefits. To measure value-adding quantifiable outcomes like dropouts prevented in a school dropout prevention program, units of effectiveness can be used. If the units of effectiveness are assigned a monetary value and it is compared to monetary costs, it is possible to obtain net benefits. (Cellini and Kee 2010, 493-494)

$$\textit{Cost-Effectiveness Ratio} = \frac{Total\ Cost}{Units\ of\ Effectiveness} \quad (1)$$

$$\textit{Net Benefits} = \textit{Total Benefits} - \textit{Total Costs} \quad (2)$$

While these concepts and equations are seemingly simple, difficulties may arise when trying to get reliable estimates of costs and benefits. Lots of assumptions need to be made when performing cost-benefit analysis, which requires lots of complex

data handling and decisions from the analyst. Costs and benefits can be of many categories (see table 4), for example real or transfers, direct or indirect, tangible or intangible, financial or social. Small or neglible costs and benefits can be ignored to simplify thinking and calculations. (Cellini & Kee 2010, 493-499)

Table 4. Different categories of costs and benefits (Cellini & Kee 2010, 500-501)

Real benefits / costs: • Net gains or losses • Examples: Money saved and earned, lives saved, increased earnings, time saved	Transfers: • Actions that redistribute welfare • Example: Taxes
Direct benefits / costs • Closely related to the primary objective • Examples: Personnel, facilities, material, administration, equipment	Indirect benefits / costs • By-products • Examples: Spillovers, investment effects, multipliers
Tangible benefits / costs • Identifiable in unit terms or convertible to monetary value	Intangible benefits / costs • Not-identifiable in unit terms or convertible to monetary value
Financial benefits / costs • Real benefits / costs identified as financial	Social benefits / costs • Real benefits / costs to the society

3.5 Performance measurement and collaboration in networks

In networks, value is created through relationships, not only by delivering products and services. If there is lack of information in the network, it may cause unnecessary workloads and complicated the managing of the resources. These difficulties might be addressed and overcome by utilizing performance measurement systems. If the network-level performance is not measured, it can lead to sub-optimization or weakening of the entire network. Performance measurement is important for both maintenance and industrial networks. (Saunila et al. 2017) Enterprise performance indicators such as BSC are a widely accepted measurement for individual

organizations and some efforts to apply BSC to collaborative networks have been made, but they cannot be considered as well-established approaches yet. (Kaplan & Norton 1996)

Success of the network can be measured with tree collaboration metrics, input, health and the outcome. Measuring the resource contribution of participants to the network is called input measurement, measuring the dimensions of commitment, coordination, trust, quality of communication and joint problem solving is called health measurement, and measuring benefits gained from collaboration in the network is called output measurement. (Saunila et al. 2017)

(Saunila et al. 2017) have defined five value dimensions for the measurement of the network value (see table 5): financial, end customer, network, sustainability and relationships. All dimensions defined except the financial dimension are non-financial and intangible. Majority of the management consists of the management of the non-financial issues, so measurement should focus on non-financial value too. While financial capital is usually accountable in monetary terms, other dimensions are non-accountable. (Saunila et al. 2017)

Table 5. Performance measurement of network value. (Saunila et al. 2017)

Dimension	**Explanation**	**Measures relate to**
Financial capital	How do we look as a network in terms of financial performance?	Growth/profitability; the competitiveness of the network; savings
End customer capital	How do the end customers see the network?	End customer satisfaction; reclamations; recommending customers; relationships with end customers
Network capital	What must we do to improve the operations of the network?	Job satisfaction and well-being; know-how; renewal and learning perseverance
Sustainable capital	What must we do to improve the sustainability of the network?	HSE (health, safety, and environment); business continuity; new network partners
Relationship capital	How can we continue to improve and create new relationships?	Reputation; brand; contracts

There are many metrics and measures to measure the financial performance of a firm, but all of them should be taken in aggregation. Different stakeholders in companies are interested in tracking different things in financial performance. Balance sheet can be used to give overview of how well companies are managing their assets and liabilities, income statement provides a summary of operations and comparsion of performance against previous year and cash flow statement is a combination of both. Different financial indicators like EBITDA (Earnings Before Intersts, Taxes, Depreciation and Amortization) and ROE (Return On Equity) can be used to measure different aspects of firm's performance. ("Investopedia - Financial Performance" 2017)

3.6 Identifying network goals and benefits

There are many benefits commonly associated with participation in a collaborative network. These benefits include an increase in survival capacity in a market

turbulence context in addition to the possibility of achieving common goals. Collaboration also introduces some high overheads in the form of coordination costs, diversity of working methods, transaction costs and more chaotic control structures. (Camarinha-Matos & Abreu 2005) According to Abreu and Camarinha-Matos (2008, 255), literature suggests that the balance between increased overheads and potential benefits when collaborating in a network is positive. The difficulty in proving that the benefits total is positive, lies in the difficulty of finding the right indicators. This especially concerns small and medium enterprises. Determining the contribution of each partner in value generation is also difficult, since for instance in innovation projects, the value generation will not always be proportionally related to the invested resources.

In a collaborative network model based on various literature, Abreu and Camarinha-Matos (2008, 255) have identified benefits concept, cooperation variables and associated target goals linked to them. Target goals lead to advantages associated to collaboration. Cooperation variables, target goals and example of advantages are presented in table 6.

Table 6. Cooperation variables, target goals associated with them and examples of advantages. (Abreu & Camarinha-Matos 2008, 255)

Cooperation variable / Target goal	**Example of Advantages**
Costs / Share costs	Opens up new markets and business opportunities without need of high investments. Research & Development costs can be shared. Financial stability. Allows SME:s to compete with larger entities.
Risks / Share risks	Uncertanity level in operating in changing environments with imperfect knowledge knowledge may affect decision-making processes. This can be reduced by sharing knowledge. If projects include collaboration from multiple parthers, responsibilities are shared. Solidarity mechanisms might emerge among partners. Also, allows SME:s to compete with larger entities.
Dependence / Reduce level of dependence concerning third parties	Companies are dependant on each other to some extent for products, services, materials, resources and competencies. This dependency can be reduced by cooperation with other firms to reduce transaction costs resulting from uncertanity. Also, allows SME:s to compete with larger entities.
Innovation / Increase innovation capacity	New ideas can be generated through utilizing actual capabilities and diversity of cultures and experiences. Emergence of new sources where value can be gained. Product and technology life-cycle improvements. Increase of quality and development of products to fill customer needs more closely.
Market position / Defend a position in the market	To utilize economies of scale, resources are shared. Forming of defensive coalitions to protect against disruptions in form of newcomers or dominant firms. Forming of offensive coalitions to strenghten competitive advantages and market position. Increase in negotiation power in relation to entities outside of the network. Also, allows SME:s to compete with larger entities.
Flexibility / Increase flexibility	Skills, resources and core competencies are shared with partners to increace adaptation capacity. Broader range of products and services can be offered. Stability is enhanced through growth to new segments.
Agility / Increase agility	Increase in process agility enables quicker reactions to business opportunities. Interoperability between processes and products is increased.
Specialization / Increase spcialization	Resource usage is focused on critical activities.
Regulation / Establish proper regulations	Common culture is increased, opportunistic beahivor and conflicts are reduced by definition of rules.
Social causes / Share social responsibilities	Recognition from others is obtained, which can be considered as intangible value. Social responsibility and reinforcing of common values. Altruism.

Two different categories of benefits can be found at a macro-level, survival capacity which reflects the capacity of an single entity or a group of entities to not break when they are faced with harmful forces that might disrupt their existence, and performance capacity, which reflects in a better capability of an single entity or a group of entities to perform their activities. (Abreu and Camarinha-Matos 2008, 256) In table 7, results of a survey conducted by Abreu and Camarinha-Matos (2008, 255) are presented where 45 experts from industry and academia all around the world answered questions about target goals and their benefits relation to survival or performance. Based on this survey, every target goal is scaled considering their given benefits on survival and performance. As can be seen from table, it can be concluded that collaboration benefits are related to increase in performance or survival, which are two key strategic goals.

Table 7. Benefit impact survey results (Abreu & Camarinha-Matos 2008, 256)

Target goal	**Level of benefits impact on**	
	Survival	**Performance**
Sharing and reduction of costs	Medium	Medium
Sharing of risks	High	Medium
Decreasing the dependence level in relation to third parties	Medium	Medium
Increasing innovation capacity	Medium	High
Defending a market position	Medium	Medium
Increasing flexibility	High	High
Increasing agility	High	High
Increasing specialization	High	High
Establishing proper regulations	Medium	Medium
Sharing social responsibility	High	Medium

For example, if the company has a primary goal of staying alive, it would be motivated in sharing risks, which it needs cooperating partners for. Companies with strategic goal in improving performance will rather seek partners to increase innovation capacity with. Some target goals like reducing costs, increasing

flexibility or establishing proper regulations are equally important in both cases. (Abreu and Camarinha-Matos 2008, 257)

It is important to note that the actual meaning of benefits depend on the underlying value system. For example, business-oriented collaborative network has different set of values than non-profit organizations, like some public-sector networks. A value system is needed to order and prioritize set of values that an actor or a society of actors hold. In a business context key value might be profit, while in other context it might be social recognition. The concept of benefit is highly dependent on the context. (Abreu & Camarinha-Matos 2008, 257)

Tian et al. (2008) have constructed a model for analyzing business ecosystems which is based on use of game theory. One of the fundamental mechanisms in their method for analyzing business ecosystems is the links that exist between resources, decisions and activities. When activities are performed by a business entity, those activities need resources and the process has defined metrics of performance. With such linkages, it is possible to calculate costs of executing activities and the impact of consequences of decisions on business metrics. The elements of their model are explained in table 8.

Table 8. Service ecosystem model elements. (Tian et al. 2008)

Class	Concept	Properties
Resource	Monetary elements, human capabilities, machines, softwares, power that is consumed when exectution of business activities is realized	Owner Unit Cost
Activity	A resource-using task	Resource consumption
Decision	Course that is selected when different choises are available, for example pricing	Objective Set of decision variables Constrain set Related decision variable
Metric	Indicator, whichs indicates the performance of a business object	Business object Value
Role	A set of connected activities and decisions	List of activities List of decisions List of metrics
Business entity	Term that can be used for enterprises, business units, and regulators	Goals Demographic properties
Business model	Which are the roles and relationships of a company, its stakeholders and customers, as well as their business processes and resource flows. Goal is to generate benefit for involved parties.	Partnerships Structure of decision-making Mechanism of decision-making

3.7 Risks when entering and participating in a business ecosystem

Entering a business ecosystem might be a way for new companies with limited resources to address issues. Business ecosystem provide entrepreneurs with access to many different value- , resource- and benefit aspects. To succeed in entering and participating in a business ecosystem, risks need to be analyzed and navigated. Firms need to identify and understand what kind of ecosystem they are participating in. Things to consider are category of business ecosystem, the stage of evolution ecosystem is in, identification of the main actor and the associated participation

risks. (Smith 2013) Smith (2013) has categorized risks associated with participating in a business ecosystem into four key areas, presented in table 9.

Table 9. Risks associated with participating in a business ecosystem (Smith 2013)

Risk type	**Examples of risks**
General risks	• Risks related to co-existence, cooperation, competition, and coopetition • Risks related to the nature of relationships • Can the best possible alliances be established? • Does the relationship between core and niche players work? Can changes in core actors' ways of operation force niche player exit? • Introduction of disruptive superstar products or services • Delays related to internal operation of the ecosystem • Key players disrupting the balance of the ecosystem with their actions
Risks related to the core resource	• Operation at the beginning and the end of the supply chain • New actors attracted by the core resource posing a threat
Value chain location risks	• Upstream and downstream relationships with component suppliers and complementors
Standards risks	• Rapid change and possible convergence • Can the best coalitions be established with actors? • Wars

The shift toward cooperation in networked environments has also raised the question about sharing sensitive information, like cost information, which is can be really sensitive and is such kept highly confidential. If cost management and cost structures are kept more transparent, new ways to reduce costs might emerge. Open-book accounting can play key roles, especially when implemented in inter-organizational cost management. Open-book accounting can be difficult to implement in practice, and lack of empirical information reflects that. It is sometimes taken as granted that it just somehow provides benefit for all network participants. (Kajüter & Kulmala 2005)

In a research conducted by Kajüter and Kulmala (2005), they made a summary of open-book implementation failures based on case studies. Six major reasons were found:

1. No extra benefits were found from open-book accounting compared to traditional approaches, or no mutually benefical solutions were found
2. Suppliers were thinking that accounting information should not be shared
3. Accurate cost data could not be produced in the network
4. Fears of exploitation were arisen for suppliers related to revealed cost data
5. Insufficient resources for accounting systems development from the supplier side
6. No agreement could be made about implementation of open-book practices

From these reasons few connecting points could be found. For example, weak state of cost accounting and no resources to improve it can hinder the benefits of the whole network. Also, the issue of trust and opening up weak spots in fear of exploitation seems to be common problems. Since the issues might be in so many dimensions, very complex managerial problems could emerge. (Kajüter & Kulmala 2005)

Open-book accounting is currently not universally common habit in networked environments. It might be used in closer, cooperative relationships, but is usually still limited to less critical information like sales forecasts, operating data and technical expertise. Disclosing data that is internal might include risks of data being used against the discloser, making open-book accounting in networks successful in only particular circumstances. (Kajüter & Kulmala 2005)

Competition and pressure to reduce costs can emerge when cost data is disclosed. If critical need to realize short-term savings emerges, networks participants might not want to adopt open-book accounting in fear of possible benchmarking and business relationship terminations if the data shows hints of bad competitiveness.

In times of economic growth where business environment seems more secure, implementation of open-book accounting might be easier and provide additional cooperative business opportunities. (Kajüter & Kulmala 2005)

The resources firm is able to allocate is also a major factor. Larger companies usually have more advanced conventional cost accounting systems and adopt new accounting methods with less resistance than smaller ones, since they usually have more resources to spend. In open-book practice cost data shared in network should be reliable and not cause misunderstandings. (Kajüter & Kulmala 2005)

3.8 Negotiation power and management in networked organizations

Increase of heterogenity in business ecosystem usually results in inrease in need of agreements, which results in management problem. There are few ways to model this problem, for example resource-based theory or game theory. (Koenig 2012) To this day, there are no theory to fully model management and decision problems related to networked environment.

Possibility of management and nature of networks have been under discussion for a long time. One point of view is that network called ”strategic network” is controlled by ”hub firms”, while others have been arguing that firms are not in total control of their resources as other actors are influencing or restricting actions taken and members of the network are seen as adaptive systems that are not centrally directed. According to this point of view, all firms in the network simultaneously manage the network in a way, making resulting structure and performance produced by their actions. In this sense, network is considered unmanageable by single entity. (Ritter et al. 2004)

Types of relationships in network situations can be defined from dependence of each other of firms. If firm A is dependent on firm B, firm B has power over firm A. Firms can also be mutually dependent over each other, or not dependent at all. Dependence can come from many aspects, for example delivery of systems or long-

term purchase agreements. According Ritter et al. (2004), this leads to four types of possible relationships, presented in Table 10.

Table 10. Types of relationship situations (Ritter et al. 2004)

		B's percieved power over A (A's percieved dependance on B)	
		Low	**High**
A's percieved power over B B's percieved dependance on A	**Low**	No relationship	Followship relationship
	High	Leadership relationship	Mutual relationship

- Leadership relationship, where a firm has power over other firm and might use it to influence less powerful firm to adapt to its wishes
- Followership relationship, where a firm is highly dependent on the other firm and its interactions need to be managed with the more powerful entity
- Mutual relationship, which involves mutual dependence without any party being clearly more powerful than other
- No relationship, where firms aren't dependent on each other

Relationships won't always fit to these archetypes and can evolve over time. If the interdepencence is positive, another actor's actions help the other to achieve its objectives, as in negative dependence, the function is to hinder the other firm. Negative dependence can be seen for example when two firms are competitors. Relationship management in a network is just as much being manageable than its managing. (Ritter et al. 2004)

4 BUSINESS ECOSYSTEM GAME FRAMEWORK

4.1 Goals of the game and role of the game organizer

A serious game needs to have a characterizing goal that distinguishes it from games designed for pure entertainment. Characterizing goals for business ecosystem game could be enterprise management, decision support, development of inter-network communication, teaching network dynamics, improving business ecosystem strategy, increasing awareness of different options and methods or any others game organizer wants the game to accomplish. The game concept can be used for different applications. Possible uses would be a game for university students or a game for experienced business decision-makers. The characterizing goals would differ, since the needs of the two groups are highly different.

The secondary goal of business ecosystem game is entertainment, the game should be fun to play to give social and learning benefits of captivating gameplay. The game can provide both intrinsic and extrinsic motivation for players, and by being entertaining, it can be used for players to engage topics they wouldn’t otherwise be interested in or have limited interest. This can be beneficial to motivate students or to get corporate decision-makers to consider new options.

Characterizing goals for the business ecosystem game application should be chosen to match the demands of the educational or practical situation it is being designed for. Since they direct so much of the following development process, it would be recommended to choose them right at the beginning. For example, for educational game the characterizing goals could be teaching business network dynamics, improving teamwork skills, undestanding strategy and consequences of actions and teaching financial performance indicators.

The most important entity for the successful implementation of the business ecosystem game is the game organizer. This business ecosystem game thesis provides guidelines and framework to build a serious game on, but it needs to be

developed as an application and tailored to meet the needs of the situation at hand. This is a responsibility of the game organizer. The game organizer sets characterizing goals based on expectations about what it wants to achieve with the serious game playing process and directs the design of the game application based on that. The game organizer also modifies the in-game ecosystem, collaboration project lists and everything else in game to best match the characterizing goals of the game.

After the business ecosystem game application has been created, the game organizer is also responsible for running the whole playing process and evaluating the results. It works as an instructor and provides players with means to participate in playing the business ecosystem game.

4.2 Design of the business ecosystem serious game

There are many aspects in the business ecosystem game that need to be linked together. Models for these aspects need to be logical, scalable, dynamic and adjustable to fit as many different scenarios as possible. They also need to be quantitative to allow measurement and computer processing. One of the main challenges in the business ecosystem game design is to make these aspects work in a proper way to produce credible interaction.

The business ecosystem game is a collaborative multiplayer game, where players play together as actors in business ecosystem environment. There are three things that are needed to model decision making and actions: communication, decisions and results. Communication and decisions can be implemented in a single phase, so suitable model for the multiplayer gameplay could be round based model with two phases. In phase one, players communicate and make decisions based on that simultaneously. After the decisions are made and locked in, calculation phase would occur where the results of player's actions are realized. Each round is considered a set amount of time, defined by the game organizer to suit the game scenario in the best possible way. This can be repeated for any number of rounds to

model passing of time and the consequences of players actions. Basic structure of game rounds is modeled in figure 7.

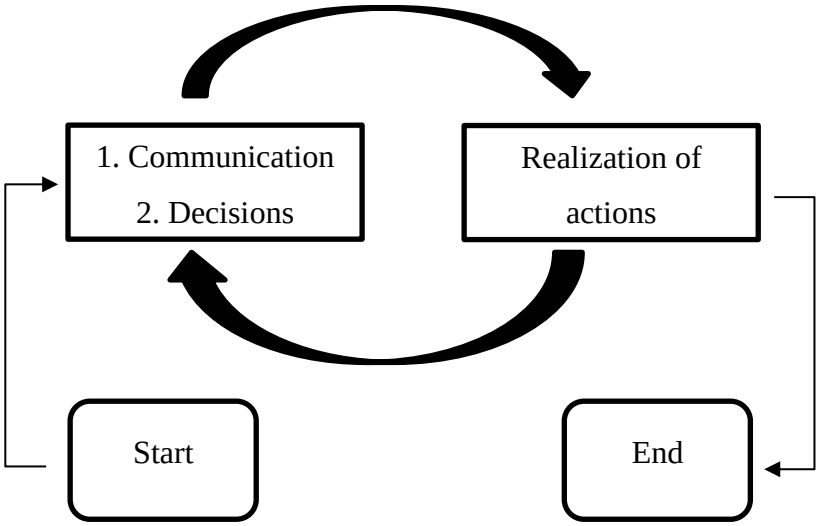

Figure 6. Basic structure of game rounds

The timeframe of each round could be for example six months, so a game of 24 turns would simulate timespan of 12 years. The timespan of the game should be chosen according to the goals: longer timespan gives more time to players actions have consequences and see the effect of good or bad decisions. In a game where playing time is limited leading to fewer possible amount of turns, for example a game played in a workshop-style situation, the timeframe of rounds and the ”power” of actions of the game have to be adjusted accordingly to provide room for players in-game growth.

Game rounds are played between a start phase and an end phase. The start phase consists of making preparations for successful game rounds. Preparation consists of actions like tutorial to get players familiar with the game, creating or selecting actors for the ecosystem and negotiations about goals that players want to accomplish with their business ecosystem. The end phase consists of player performance evaluation and recap of the game rounds. Range of aspects identified by Mildner and Mueller (2016, 64) and presented in table 11 with suggested

implementation need to be thought to make the structure of the business ecosystem serious game will work.

Table 11. Serious game design aspects and their implementation

Aspect	Implementation
Supervision	Game usually needs to be accompanied by game organizer or instructor, who oversees and guides players through the gaming process, takes notes and possibly interferes with gameplay with events.
Environment	If played with software over internet, game can be played in decentralized way. Playing from single location makes communication between players and the game instructor easier, but sets limits for the timeframe available for playing.
Re-playability	There are many aspects in the gameplay which make the game extremely re-playable. The lack of set paths, large number of random elements and player decisions make for interesting gameplay where two playthroughs should never be the same.
Timeframe	There are no set timeframe for the total length of the game and it is highly dependent of the rounds played.

The game for university students could be more focused to teaching network dynamics and other aspects while being fun to keep players interested. It could be based on real case-scenario or a purely fictional network of different actors. Clear progression of things spiced up with random events to keep the players interested and on their toes. For the decision makers, the concept could be less game-like. It could be based on a real scenario with real actors, with the focus of game simulating the consequences of the actions as closely as possible while not being too complicated. The emphasis on random events would be small.

One important part of serious games is the collaborative learning. In order for cooperation and collaborative learning to happen, the following aspects identified by Wendel and Konert (2016, 224-225) and their implementation presented in table 12 should be thought about.

Table 12. Collaboration aspects and their implementation.

Aspect	**Implementation**
Positive interdependence	Business ecosystem members in-game are able to provide each other benefits by cooperating and working towards common goals. This gives motivation for collaboration instead of being lone wolves.
Individual accountability and personal responsibility	Each player has his own resources and is scored individually. It is possible to share information in-game, but it is not forced.
Promotive interaction	Players can help each other and collaborate towards common goal, providing promotive interaction.
Appropriate use of social skill	Group and communication skills are vital for players to perform well in the game. Without proper communication and working towards common goals, players are less likely to succeed.
Group processing	Players reflect their actions as individuals and as business ecosystem members to evaluate their effort.

The business ecosystem game can be played in different styles regarding how the players act in game. For example, more role-play focused way of playing can be used for some scenarios, where players role-play their actors and base their decisions on how they think the actor would act in that situation instead of how they would act themselves. This way of approach could be useful for real-life case style scenarios, where the goal could be for example increasing the view for enterprise decision-makers of how different strategies could play out in the business ecosystem.

The business ecosystem game can be designed to include most of the motivational and entertainment aspects presented earlier of the theory. When the game is entertaining and players are intrinsicly motivated, learning process is intensified. While action aspect with sub-aspects of destruction and excitement might be more difficult to apply, rest of them can be more easily implemented. Motivational

aspects identified by Yee (2016) earlier in thory part and their implementation is presented in table 13.

Table 13. Motivational aspects and their implementation.

Aspect	**Possible implementation**
Competition	While actors in the business ecosystem collaborate, they still want to maximize their own success. Aspect of competitiveness can come from allocation of resources, or in ecosystems with multiple actors of same kind, from competition with each other.
Community	Actors in the same ecosystems are acting as a community, socialization and communication are possible by game mechanics
Challenge	Challenge in the game comes from the optimal use of resources and making the right decisions. There might also be challenge in the social aspect and making the communication and collaboration between actor's work. Challenge level can be adjusted for example by adjusting values in in-game projects or adjusting severity of bad decisions and mistakes.
Strategy	Actors can execute different strategies alone and together. With different strategies, different results are achieved. Strategy is important in business ecosystem game and acting randomly most likely gives worse results than goal-oriented planning.
Completion	Players can improve their in-game attributes and indicators, giving a base for progression
Power	Performing well in-game rewards players with more power in form of improved capability to do things and achieve a better end-game score
Fantasy	If business ecosystem game is played in fictional setting, players can design their own actors and possibly role-play them in-game.
Story	Business ecosystem game is tied to a backstory in both real case-scenarios and fictional settings. Players can role-play and act according to the backstory or make their own-minded decisions.
Design	Players collaborate and design how they want their business ecosystem to look like and what they want to achieve with it. Ecosystem is shaped by actor decisions.
Discovery	Players can try different strategies and feel sensations of discovery for example when they try new strategies and see their effects.

4.3 Taking advice from lessons and avoiding pitfalls in game design

To maximize the chance of making a successful game, advice should be taken from past mistakes and lessons in the gaming industry. In the following table 14 guggested properties of the game are compared to the past lessons identified by Zagal et al. (2006) earlier in the theory part:

Table 14. Game design lessons and implementation

Lessons to take advice from	**Answer**
Lesson 1: In a collaborative game, tension should be introduced between individual and team utilities. This highlights the problems of competitiviness.	In this game concept, tension is created by resource investment decisions between direct individual gain and possible long-term gain by investing in working in a collaborative network.
Lesson 2: Individual players should be allowed to make decisions by themselves and take actions on their own without permission gained from the team.	Each player makes his own decisions for his own actor in-game, but it is possible to negotiate with other players too.
Lesson 3: Players need to be able to trace outcomes of their actions back to their decisions.	Payoffs can be seen by analyzing the financial data. Informative graphs are generated during and at the end of the game.
Lesson 4: In a collaborative game, players should have different abilites or responsibilities to encourage selfless decisions.	Selfless decisions and helping others in need might or might not help directly or indirectly. Some goals are achievable only by working together.

Game should also be designed to avoid pitfalls. In the following table 15 game features are listed that avoid the pitfalls presented by Zagal et al. (2006) earlier in the theory:

Table 15. Game design pitfalls and dodging them

Pitfalls to avoid	**Answer**
Pitfall 1: Collaborative games must give reasons for players to collaborate, so the game process won't drive into situation where one player makes all the decisions for the team.	Every player is trying to maximize own profit, and collaborating with right decisions might be a way to that. There are no forced decisions in the game.
Pitfall 2: Players need reasons to care about the results of their actions. This makes the game engaging, especially if those results are satisfying.	Every player will try to maximize profit they are making. The scenario and scoring system engages and rewards players for making beneficial decisions.
Pitfall 3: Collaborative game should have re-playability value. To accomplish this, playing experience needs vary and challenge level needs to evolve.	Random elements make the experience different each time and players can try different strategies to end up with different kind of results.

4.4 Requirements for the game application platform

Since the game has lots of calculations, communication and possible random elements, the best way to run it would be as a computer program. Ideal solution would be a single program with all the needed features integrated, but using different solutions for communication won't hinder running of the game. There are many possible technologies to use for communication:

- Integrated voice, video or chat built-in to the game program. This type of solution would be available for every player, it would be simple and work for both workshop-style and longer timeframe games, but needs additional work to implement.
- External voice, video or message communication software, for example skype, irc, e-mail, and various video conference softwares. This would

probably be the most flexible option and works for both workshop-style and longer timeframe games.

- Face to face communication. This option would only work for workshop-style scenarios.

Each player can use their own interface to play or use shared interface. Application can be hosted on cloud or ran from each player's own device. Platform should be chosen according to needs of the application. For some cases, cloud hosted solution which players access through internet browser could be better implementation than application executable ran from their own devices.

4.5 Evaluating player performance

When the game ends, performance of the players is evaluated. If players managed to make good decisions and collaborate towards common goals, it should show as increased end score. Player performance should be assessed during the game process and feedback given according to it, since they are important parts of serious games.

There are two scores which are calculated at the end of the game; a network score, which measures the evolution of the collaborative network and a player score, which measures the evolution of each player's actor. Measuring both aspects is important, since the system should reward both individual success and network collaboration. Working towards common goals usually improves players individual scores too, but two metrics are needed to prevent situations where players neglect their own actor in favor of the business ecosystem and vice versa. The domain-specific performance measures in this serious game could be individual and networked strategic knowledge.

4.6 Modeling business ecosystem structure

The challenge in applying existing business ecosystem models for game-style concept is the amount of qualitative and complex information. There are many kinds of theories and models, but for a concept like serious game things must be simplified enough to allow fluid and easy-to-follow gameplay. Also, qualitative things have to be given numerical values, so that calculations can be made. This might cause some things to be rough on the edges, but allows more aspects to be taken into the game. Relatively simple modelling gives also possibility for easy modification of the concept, allowing the game to be used for many kinds of scenarios. Features can be made more complex or simplified, added or reduced, to make the game fit the current need. For example, game directed for university students has different features and approachability than a game directed for corporate executives with years of experience using the game for a real-life scenario.

In this game concept, general business level of the business network is distinguished with the objective of general value creation. Politics, innovation or other aspects aren't directly the objective, but can be parts of the value creation process. Actors of the game ecosystem cooperate with each other to generate value, fulfilling the specific business aspect. The in-game ecosystem can be any kind of business ecosystem, like service or production ecosystem.

The business network in the game consists of number of actors collaborating as a business ecosystem. Actors can consist of any number of firms or other entities, that are linked through benefit links. Network can be centralized or decentralized or have any kind of other properties. The in-game ecosystem can be stable or have actors to join and leave at will. It is also possible to model multiple ecosystems with sufficient number of actors and have actors to swap between ecosystems. This is all dependent from the game organizer and what kind of scenario is to be played.

The in-game business ecosystem can be classified to one of the following designs based on the type of interdependence and control of key resource: supply system, platform, community of destiny or expanding community. Based on this classification, actor specific in-game attributes, available player events, role-played actor and network behavior, in-game ecosystem structure or benefit links between actors can be adjusted by the game organizer to best suit the played scenario.

In-game ecosystem actors can be roled for four roles: keystone players, niche players, dominators and hub landlords. These roles can be either set in stone when the game begins or adaptable. Actors can roleplay their own role, or their attributes and in-game actions available might be adjusted to chosen role to support it. For example, actors roled as keystone players can provide in-game actions that are related to the control of some kind of key resource like application platform, while players roled as niche players can provide in-game actions that support specialization improvement.

4.7 Modeling collaboration benefits and value creation

Collaboration in a business ecosystem can give actors many different kinds of benefits, but may also increase costs. Costs can come directly or indirectly for example in form of coordination costs, diversity of working methods, transaction costs and chaotic control structures. This is reflected in-game by making collaboration actions to have costs too, not just benefits. Some actions that increase attributes might decrease others, while having resource cost too. The net benefit of most actions should end up positive.

Actors in in-game business ecosystem can have different goals and reasons for participating. Some of them can focus on staying alive, thus increasing survivability, while others might seek performance benefits from the business ecosystem. Individual and network-perspective strategic goals can be set on the beginning of the game and changed later while the firms and the in-game ecosystem evolve. In-game actions to reach target goals can have two aspects, ones which give

more survival-related benefits and ones that give more performance related benefits. Example of these could be risk-analysis network action giving benefits more on the survival side and innovation capability improvement network action giving benefits more on the performance side.

For the collaboration part, actors of the network have to have common goals in addition to individual goals. Common goals can be ones that give benefit to everyone.

The network benefits model that is suitable for game-style application has some requirements.

- Needs to be adjustable for needs of different scenarios
- Needs to be scalable for different number of turns
- Needs to model benefits of networked environment as closely as possible

Attribute system with cooperation variables linked to target goals can be used in-game to model the collaboration benefits and abilities of the actors. These attributes give base for in-game actions, events and work as a metric to measure individual actor and ecosystem evolution and capabilities. When attributes of all actors are compared, the system can also be used as a business ecosystem maturity-level metric. Examples of cooperation variables based on model by Abreu and Camarinha-Matos (2008, 255) and their possible in-game effects are presented in appendix 1.

To measure in-game business ecosystem performance from input, health and output, five-dimensional measurement system for network value can be used. Each of the dimensions can be assigned in-game value that is informative metric during the gameplay and can be used to give base for end-game scoring. Examples of in-game performance measurements based on theory by Saunila et al. (2017) are given in appendix 2.

There are few possible approaches to model how in-game business ecosystem members generate profit or value. In first one, in-game business ecosystem members interact with each other and possible customer entities by selling and buying products and services. This is very complex to implement, since it has many aspects, but could be more suitable for supply chain -like larger in-game ecosystems. In a more simplified approach, business ecosystem members have background processes that generate value which can be made more efficient by increasing in-game cooperative variables like *costs*. This aspect removes intra-ecosystem value chain, but is simpler to implement while still preserving collaboration benefits, and would be more suitable for non-profit organization modeling.

4.8 Modeling collaboration actions and decision-making

To model management and decision making, players communicate with each other take actions in-game. Every in-game business ecosystem actor is responsible for management, since everyone can initiate actions affecting the whole network. The relationships between in-game actors can be categorized in four categories: leadership relationships, followership relationships, mutual relationships or situation where there are no relationships at all. The differences in negotiation power come from available resources, available in-game network actions and the status of the whole in-game ecosystem. Interdependence can be positive or negative. If the game organizer runs a game situation that is more focused on role-playing, negotiation power can have other aspects like old business relationships or technology dependence.

There are two kinds of in-game actions players can take. Actions that affect their actor only and collaborative projects that can be done with other actors. Collaborative projects are decisions that actors seek to gain win-win situations with and to gain benefits they couldn’t get by acting alone. Players need to make decisions where they need to think about consequences of being selfish and just

focusing on direct individual benefit versus focusing on improving the functionality of the network and gain direct or indirect benefits from that later.

The actions affecting players own actor only could be actions that increase actor's own performance by amount tied to invested resource. Example of action like this could be a member of business ecosystem investing in their private innovation team, increasing innovativeness cooperation variable. These actions wouldn't usually be as effective as larger collaboration projects, but would give actors possibilities to fix their weaknesses or increase strengths.

In collaboration projects actor starts a larger project with other actors to gain mutual benefits. In-game collaboration project could look like this: One actor in the in-game business ecosystem gets the chance to start a project of automating business processes network-wide. He can negotiate with other members of the ecosystem if they want to take part in the project and gain mutual benefits by sharing costs of the project. The initiating actor has enough innovativeness and flexibility to start the project, and some of its internal processes are refined enough to implement process automation to. Participating actors need to have their cooperation variables at the same level too, so their companies are on mature enough level to take part. Automating business processes could lead to reduction of operating costs, decrease in errors in process leading to increased process stability and increased performance in core activities. Common values and trust in network are also increased through information sharing needed to work with the processes. This leads requirements and effects presented in appendix 3 for those who wants to take part in the project.

Project would cost resources from participants, this resource being for example monetary value deducted from budget. For example, the project could cost 500 000€ per round for each participant for 4 rounds, after which the project would be ready and benefits would come to effect for the participant actors. If network performance measurement aspect is considered in-game, the project could have impacts on the network performance presented in appendix 4.

There are multiple scenarios this kind of implementation can lead to, including:

- Single actor or group of actors being selfish and not investing in network, but still doing well
- Group of actors investing in network, making more profit long term than without networking
- Single actor or group of actors investing too much in network, hindering their own profitability

4.9 Modeling risk

To model risk, to add uncertainty and to keep players engaged the game has randomness factor. Risks and reward are one element of “fun” factor in games, contributing for intrinsic motivation. Random events can model situations like swings in material price, natural disasters, new innovations. The randomness factor is modeled by random events, and can be adjusted to the needs of the current characterizing goals and scenario. Risk could also be modelled by a chance for collaboration projects and actor-only actions to fail or have setbacks. Goal-oriented collaborative risk taking and risk-sharing is also important aspect of the collaboration in the business ecosystem. In addition to external risks, risk events can also be related to participating in a business ecosystem. These kind of risk events could relate to nature of relationships, intruduction of superstar product or service, new actors attracted by the keystone resource, rapid change or sharing of cost data.

There are many possible ways to implement risk events to the game. One way is to have “triggered” events, where risk event triggers on certain conditions. Other way is to make risk events which are based on random chance. There should be a way to avoid disaster, which could be implemented by using “Risk” cooperation variable. This relates to ecosystems members increased ability to analyze and share

risk. Possible in-game implementation could be decreasing the chance of risk events happening or eliminating them completely if sufficient levels are reached.

4.10 Modeling ecosystem life-cycle

Business ecosystems have a life-cycle, and this can be modelled in-game. There are few different life-cycle models, and suitable one for business ecosystem game can be found. Through the business ecosystem life-cycle, there are five phases that needs to be noted in-game: emerging, diversifying, converging, consolidating and renewing. This reflects mostly as a form of in-game choices available, and if the in-game ecosystem structure is adaptable, as actors joining or leaving in-game ecosystems. To determine the phase business ecosystem is in, solution derived from in-game ecosystem attributes or general in-game ecosystem status can be used. The in-game action and event table can be adjusted for each phase. In appendix 5, few example events that are based on sub-dimensions of each phase can be found. Model used for this is based on five phases by Rong and Shi (2014, 159), presented earlier in theory part.

In-game choice-table or actor behavior can also be modified by using the seven configurations of solution platform openness and solution diversity model as a base for in-game ecosystem evolution. The model can also be used as just a support to provide players with information of what stage of evolution their current in-game ecosystem is and to provide additional attributes for end-game network scoring. Evolution can also be used as a in-game goal, for example actors try to evolve their in-game business ecosystem from simple solution ecosystem to platform coordinating ecosystem by increasing key attributes related to solution diversity and solution platform openness. Game organizer can set these attributes as own attributes in-game modified by in-game actions, or derive them from other attributes, for example in-game network benefit model attributes.

Business ecosystem health can be used as a in-game information metric. The dimensions for business ecosystem health are productivity, robustness and niche

creation. They can for example be derived from combined player actor cooperation variables, and thus giving players information about the health of their in-game business ecosystem. This metric can be also used as a in game scenario goal, for example business ecosystem participants want to improve health of their ecosystem to ensure stable future.

4.11 Modeling ecosystem resource usage and value metrics

Different kind of business ecosystem actors use different kinds of resources for different kinds of actions. Different kinds of business ecosystems and actors in them need different kinds of value metrics depending on their operating goals. Suitable metrics should be chosen for different situations. For example, benefit-cost ratios would be a better metric to measure value in non-profit organizations, while organizations focusing in generating profit would benefit more from using financial indicators like EBITDA. If measuring performance with financial indicators, multiple indicators should be used over long timescale to create a balanced picture. Using single indicator won't usually give comperhensive picture of the actor's situation, and it also makes the choice of right in-game metrics for player performance evaluation important, since performance evaluation may direct player actions.

4.12 Business ecosystem game framework and implementation

From the aspects studied in previous chapters, business ecosystem game framework presented in figure 8 can be formed. Business ecosystem game framework aspects can be categorized in three categories: serious game design, business ecosystem modeling and evaluation. Serious game design aspects are related to creation of successful serious game application that enables collaborative learning. Business ecosystem modeling aspects are related to modeling in-game business ecosystems. Player performance evaluation is needed to give players indicator of how successful they were in playing the game and game session evaluation is needed to improve the game in general.

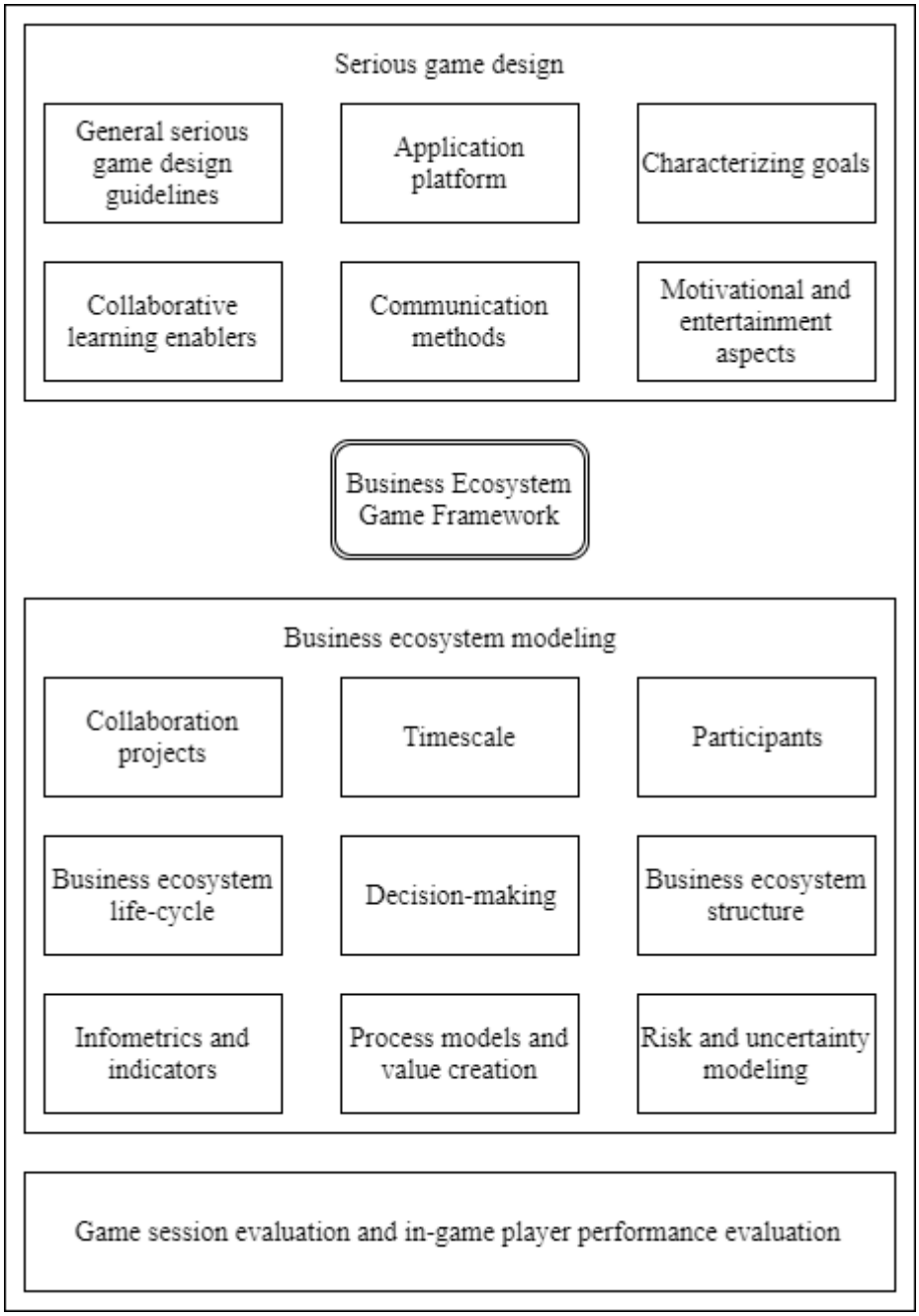

Figure 7. Business ecosystem game framework

There are lots of things game developer needs to note when designing the application. Short summary of aspects and their implementation guidelines described in earlier chapters is given in the next part:

Serious game design -related:

- Characterizing goals: the characterizing goals should be selected according to demands of the situation application is being developed to.
- Application platform: application platform and technologies should be selected to match the needs of the game. Good design would be expandable and modifiable, since it would allow many different kinds of scenarios to be played with the same application.
- Communication methods: the business ecosystem game needs communication between players so they are able to collaborate. Suitable methods for communication should be used, with text-based chat being the bare minimum. External applications like Skype can be used for this.
- General serious game design aspect: These aspects could be implemented according to table 11.
- Collaboration aspects: For collaborative learning to be possible, these aspects could be implemented according to table 12.
- Motivational and entertainment aspects: To game become fun and be intrinsicly motivating, these aspects could be implemented according to table 13.
- Collaborative game design guidelines and pitfalls: These could be implemented according to table 14 and 15.

Business ecosystem modeling -related:

- Collaboration projects: collaboration projects are where the actors co-create value in the business ecosystem. Win-win situations are sought via collaboration projects and participation in them models negotiations and decision-making. Collaboration projects can be used used to improve cooperation variables, examples are presented in appendices 1, 3 and 4.
- Participants: the business ecosystem game framework doesn’t have limits for player count. It is possible for same players to play multiple actors in same in-game business ecosystem if needed.

- Timescale: timescale and number of rounds is dependant on the game scenario. Timescale should be long enough to see effects of decisions and projects. Timescale should be divided to number of rounds so that each round would have meaningful action. If timescale is divided into too many rounds, players might get bored of micromanagement.
- Business ecosystem structure: the business ecosystem game framework doesn't have limitations for structure. In a large-scale game, it might be even possible for actors to join and leave ecosystems.
- Business ecosystem life-cycle: if business ecosystem life-cycle aspect is taken in game, it could be implemented according to example in appendix 5.
- Decision-making: decision-making in game can be implemented by collaborative events and communication related to it in addition of improving actor's own attributes via personal actions.
- Infometrics and indicators: infometrics are needed to support players with information required by the gameplay and assessment of their performance. Good informative metrics could be for example scored performance indicators and status of their actor and network. Examples of them is given in appendix 3.
- Process models and value creation: in-game business ecosystem actors can have background processes that generate value or resources, or more complex modeling where actors sell products or services to each other.
- Risk modeling and random events: condition-triggered or random chance risk events to model risk versus reward, with chance decreasable by cooperation variables.

Evaluation related:

- Performance metrics for in-game evaluation: Right metrics to fit actors and business ecosystem in question should chosen. Multiple metrics should be used if possible for comperhensive performance evaluation. Network and

players can be scored with different metrics. Measuring can have effects on player behavior.

- Game session evaluation: After the game is finished and players are scored, playing session can be evaluated for success in reaching the characterizing goals. If evaluation-driven game design framework is used, this evaluation feedback provides the base for further development of the game.

5 DISCUSSION

In the last decades, emergence of new technologies and transformation of the business environment has caused a lot of turbulence. This has caused a new form of complex collaborative networks to emerge called business ecosystems. These business ecosystems come in many forms and have many different kinds of stakeholders and can be categorized based on the type of control of the key resources. Technology has also made it possible to use serious games as a considerable medium for education. This has created a possibility to use business ecosystem -themed serious game for many purposes.

Creating a successful business ecosystem game implementation using this framework and design guidelines provided as base should be possible. Framework leaves free hands for the application developer in many places, so the solution can be tailored to fit the needs of the situation. The models provided should be used as a guideline – different characterizing goals need different kinds of tools. If business ecosystems aspects of the framework are left out, design and evaluation aspects can be used as base for creating collaborative serious games of other domains.

The framework created complies with many key elements found from previous research on serious game design, learning and collaborative business networks. There weren't many conflicts in theory by different authors, but the rapid development of the fields in question was noticeable when comparing older theory with newer. Also, different approaches to business ecosystem modeling were found with some being more traditional while others using more recent methods like game theory. Impact of digitalization and new technologies was especially noticeable in evolution of digital business ecosystems and new methods of teaching, like augmented reality applications and virtual reality. The business ecosystem game framework was designed keeping this evolution in mind and should be compatible with future applications too.

If the framework is used for educational serious game, the intrinsicly motivational aspects should not be forgotten to create a fun learning experience. A good balance between the “fun” and the “serious” part must be found, otherwise players can easily get bored and the game fails to achieve its “serious” goals. If the goal of the game is to improve players social skills and decision-making, in-game models and events can be tuned more for the “fun” side to keep players engaged, since improvement of those will not be affected by for example inaccurate benefits modeling.

If the serious game framework is used to create a solution to support real-life decision-making and innovation, focus can be shifted from the “fun” part to more precise modeling of different situations. A lot of different kind of approaches can be used – for example live-discussed results for cooperation events. For real-life scenarios business ecosystem models most likely need a lot of tailoring, but some parts of them might be usable. The basic turn-based approach to communication, decision-making and realization of events should support a wide range of possible modifications. It is also important to put thought into in-game collaboration events and random actions, since they play huge part of how the game will play out. Modifying them is a way to balance the game, good or bad event lists can make or break the game.

In any case, lot of focus should be put into evaluation of both player performance and the game application itself. Measuring and evaluation-based development is requirement for further improvements. Same is also true for this business ecosystem game framework. The framework is currently based very heavily on theory and has not yet been used to create any finished, tested and evaluated product. There might be parts in this framework that need polishing, adjustment or complete rework that cannot be seen before it is applied in practice. Future development of the framework is highly dependant on new theory about collaborative learning, business ecosystem models, new technologies and feedback from applications created using the framework.

If the business ecosystem game framework is used successfully to create a playable serious game, the game should be evaluated and improved. Since the framework has been created by using theory only and has not yet been used to create a finished and comperhensively playtested product, there might be faults and shortcomings. The framework might also be more suited for some kind of scenarios than others. Also, to create better models to use with the framework, research on business ecosystems should be made. Literature was lacking especially from the sides of performance measurement and measurement of value in business ecosystems. Focusing on these possible shortcomings of the framework and business ecosystem modeling, future research can be made.

6 SUMMARY

The objective of this thesis is to create framework for business ecosystem serious game. The serious game created using the framework can be used as an educational tool or as a tool to support decision-making in real business ecosystem environment, and creates value through increased knowledge or innovation. Literature review is used to gain insight on the required areas in business ecosystems, serious games and collaborative learning. Through this theory framework for the usable business ecosystem game is created.

First research question is answered through research on business ecosystems, their stucture, life-cycle, value creation, risks and decision-making. Business ecosystems have a life-cycle, where its participants usually act based on steps determined by maturity phase. Value is co-created, co-converted and co-captured together within the ecosystem between customers, competitors, complementors and the community. Target goals can be set, which allow ecosystem members to collaborate together for common goals. These lead to gains in survival and performance capabilities of actors that they cannot achieve alone. Acting within business ecosystem has its risks, which should be analyzed. These risks can be related to many things, including loosening of control structure and disclosure of cost data. Actors in business ecosystems can be on inequal footing due inbalances in power structure. This leads to few possible kinds of relationships, like followership or leadership relationships where some actors are more powerful or more dependant on others than anothers. This can affect decision-making and negotiations inside the business ecosystem.

Second research question is answered through research on serious games, multiplayer games, evaluating games and collaborative learning process. Serious games are games created with intention to entertain and to achieve at least one non-entertainment additional goal. Many serious games have been developed in the last decades and literature reviews show the benefit of them as a tool to support learning process and to improve many different problem-solving and social skills.

Motivation to play the game can be intrinsic, where the motivation comes from the game itself or extrinsic, where the game is used to accomplish a certain goal. Best learning results can be achieved when the game is intrinsicly motivating, which enables deep learning.

In collaborative multiplayer games, collaborative learning can happen. To enable this, various circumstances have to be met; group members have to be linked in a way they cannot succeed alone, have to have responsibilities and interact together as individuals in a group. Role of the game organizer is vital for success in designing and running a collaborative serious game session. Performance of the players in-game and success of the gaming scenario have to be evaluated. Evaluation feedback gives players motivation and indicator of their skills in game. Evaluation of the game session is needed for improvement of the game process.

The business ecosystem game framework created has three aspects; serious game design, business ecosystem modeling and evaluation. When the design process for business ecosystem game framework implementation is begun, chracterizing goals are to be defined to give direction for the following evaluation-based development process. Characterizing goals should be chosen to match the demands of the educational or practical situation it is being designed for. There are many aspects that can be included in the business ecosystem game implementation. There are also many pitfalls and aspects that need to be thought about for the game to be motivating and to allow it to reach the characterizing goals.

REFERENCES

Abreu, A. and Camarinha-Matos, L. M. (2008). 'A benefit analysis model for collaborative networks', in Camarinha-Matos, L. M. and Afsarmanesh, H. (Eds.), *Collaborative Networks: Reference Modeling.* Springer and Business Media, New York, pp. 253–276.

Apiola, M. and Tedre, M. (2013). 'Deepening Learning through Learning-by-Inventing', *Journal of Information Technology Education Innovations in Practice*, Vol. 12, No. 12, pp. 185–202.

Bachen, C. M. and Raphael, C. (2011). 'Social Flow and Learning in Digital Games', in Ma, M., Oikonomou, A. and C. Jain, L. (Eds.), *Serious Games and Edutainment Applications.* Springer, London, pp. 61-84.

Cai, Y., Goei, S., Trooster, W. (2017). S*imulation and Serious Games for Education.* Springer Science and Business Media, Singapore, pp. 145.

Camarinha-Matos, L. M. and Abreu, A. (2005). 'Performance indicators for collaborative networks based on collaboration benefits', IFIP *Advances in Information and Communication Technology*, Vol. 186, pp. 273–282.

Camarinha-Matos, L. M. and Afsarmanesh, H. (2008). *Collaborative Networks: Reference Modeling.* Springer and Business Media, New York, pp. 333.

Cellini, S. R. and Kee, J. E. (2010). 'Cost-effectiveness and cost-benefit analysis', in Newcomer, K., Hatry, H., Wholey, J. (Eds.), *Handbook of practical program evaluation* 3. John Wiley & Sons, New Yersey, pp. 493–530.

Deterding, S., Dixon, D., Khaled, R. and Nacke, L. (2011). 'From game design elements to gamefulness: Defining gamification', *Proceedings of the 15th*

International Academic MindTrek Conference on Envisioning Future Media Environments - MindTrek '11, pp. 9–11.

Dörner, R., Göbel, S., Effelsberg, W. and Wiemeyer, J. (2016a). *Serious Games - Foundations, Concepts and Practice.* Springer, Switzerland, pp. 421.

Dörner, R., Göbel, S., Masuch, M., Kickmeir-Rust, M. and Zweig, K. (2016b). *Entertainment Computing and Serious Games.* Springer, Switzerland, pp. 540.

El Sawy, O.A. and Pereira, F., (2013). *Business Modelling in the Dynamic Digital Space.* Springer, New York, pp. 68.

Emmerich, K. and Bockholt, M. (2016). 'Serious Games Evaluation: Processes, Models, and Concepts', in Dörner, R., Göbel, S., Masuch, M., Kickmeir-Rust, M., Zweig, K. (Eds.), *Entertainment Computing and Serious Games.* Springer, Switzerland, pp. 265-283.

Ferreira, P. S., Shamsuzzoha, A. H. M., Toscano, C. and Cunha, P. (2013). 'Framework for performance measurement and management in a collaborative business environment', *International Journal of Productivity and Performance Management*, Vol. 61, No. 4, pp. 672–690.

Freitas, S. de and Liarokapis, F. (2011). 'Serious Games: A New Paradigm for Education?', in Ma, M., Oikonomou, A. and C. Jain, L. (Eds.), *Serious Games and Edutainment Applications.* Springer, London, pp. 9-23.

Graça, P. and Camarinha-Matos, L. M. (2016). 'Performance indicators for collaborative business ecosystems - Literature review and trends', *Technological Forecasting & Social Change*, Vol. 116, pp. 237–255.

Iansiti, M. and Levien, R. (2004a). 'Strategy as ecology', *Harvard business review*, Vol. 82, pp. 68–81.

Iansiti, M. and Levien, R. (2004b). *The keystone advantage: what the new dynamics of business ecosystems mean for strategy, innovation, and sustainability*, Harvard business school press, Boston, pp. 259.

Investopedia - Financial Performance (2017). Available at: http://www.investopedia.com/terms/f/financialperformance.asp (Accessed: 17 September 2017).

Jaakkola, E. and Hakanen, T. (2013). 'Value co-creation in solution networks', *Industrial Marketing Management,* Vol. 42, pp. 47-58.

Kajüter, P. and Kulmala, H. I. (2005). 'Open-book accounting in networks. Potential achievement and reasons for failures', *Management Accounting Research*, Vol. 16, No. 2, pp. 179–204.

Kaplan, R. and Norton, D. (1996). 'The balanced scorecard: Translating strategy into action', *Harvard Business School Press,* USA, pp. 304.

Koenig, G. (2012). 'Business Ecosystems Revisited', *M@n@gement,* Vol. 15, No. 2, pp. 208–223.

Loh, C. S., Sheng, Y. and Ifenthaler, D. (2015). *Serious Games Analytics - Methodologies for Performance Measurement, Assessment, and Improvement.* Springer, Switzerland, pp. 477.

Ma, M., Oikonomou, A. and C. Jain, L. (2011). *Serious Games and Edutainment Applications.* Springer, London, pp. 504.

Mehm, F., Dörner, R. and Masuch, M. (2016). 'Authoring Processes and Tools', in Dörner, R., Göbel, S., Effelsberg, W. and Wiemeyer, J. (Eds.), *Serious Games - Foundations, Concepts and Practice.* Springer, Switzerland, pp. 83-105.

Mildner, P. and Mueller, F. (2016). 'Design of Serious Games', in Dörner, R., Göbel, S., Effelsberg, W. and Wiemeyer, J. (Eds.), *Serious Games - Foundations, Concepts and Practice.* Springer, Switzerland, pp. 57-80.

Mitgutsch, K. (2011). 'Serious Learning in Serious Games', in Ma, M., Oikonomou, A. and C. Jain, L. (Eds.), *Serious Games and Edutainment Applications.* Springer, London, pp. 45-58.

Moore, J. F. (2006). 'Business ecosystems and the view from the firm', *The Antitrust Bulletin*, 51, pp. 31–75.

Moore, J. F. (1993). 'Predators and prey: a new ecology of competition.', *Harvard Business Review*, Vol. 71, No. 3, pp. 75–86.

Moore, J. F. (1996). 'The death of competition. ' *Fortune,* Vol. 133, No. 7, pp. 142.

Ritter, T., Wilkinson, I. F. and Johnston, W. J. (2004). 'Managing in complex business networks', *Industrial Marketing Management*, Vol. 33, pp. 175–183

Rong, K. and Shi, Y. (2014). *Business ecosystems : constructs, configurations, and the nurturing process.* Palgrave MacMillan, UK, pp. 257.

Saunila, M., Rantala, T., Ukko, J. and Pekkola, S. (2017). 'Gaining insights into the measurement of value in industrial service network', *International Journal of Quality & Reliability Management*, Vol. 34, No. 4, pp. 478–493.

Smith, D. (2013). 'Navigating Risk When Entering and Participating in a Business Ecosystem', *Technology Innovation Management Review*.

Stieglitz, S., Lattemann, C., Robra-Bissantz, S., Zarnekow, R. and Brockmann, T. (2017). *Gamification: Using Game Elements in Serious Contexts*. Springer, Switzerland, pp. 164.

Sung, H.-Y. and Hwang, G.-J. (2013). ‘A collaborative game-based learning approach to improving students’ learning performance in science courses’, *Computers & Education*, Vol. 63, pp. 43–51.

Tian, C. H., Ray, B. K., Lee, J., Cao, R. and Ding, W. (2008). ‘BEAM: A framework for business ecosystem analysis and modeling’, *IBM Systems Journal*, Vol. 47, No. 1, pp. 101–114.

Toivanen, T., Mazhelis, O. and Luoma, E. (2015). ‘Network Analysis of Platform Ecosystems: The Case of Internet of Things Ecosystem’, in Fernandes, J. M., Machado, R. J., and Wnuk, K. (Eds.) *Software Business: 6th International Conference, ICSOB 2015, Braga, Portugal, June 10-12, 2015*, Proceedings. Cham: Springer International Publishing, pp. 30–44.

Webster, J. and Watson, R. T. (2002). ‘Analyzing the Past to Prepare for the Future: Writing a Literature Review’, *MIS Quarterly*, Vol. 26, No. 2, pp. 13-23.

Wendel, V. and Konert, J. (2016). ‘Multiplayer Serious Games’, in Dörner, R., Göbel, S., Effelsberg, W. and Wiemeyer, J. (Eds.), *Serious Games - Foundations, Concepts and Practice.* Springer, Switzerland, pp. 211-238.

Wiemeyer, J., Kickmeier-Rust, M. and Steiner, C. M. (2016). ‘Performance Assessment in Serious Games’, in Dörner, R., Göbel, S., Effelsberg, W. and Wiemeyer, J. (Eds.), *Serious Games - Foundations, Concepts and Practice.* Springer, Switzerland, pp. 243-268.

Yee, N. (2016). *Gamer Motivation Profile Findings - #GamesUR US Conference 2016.* Available at: https://www.youtube.com/watch?v=YZwiQd-0xqQ (Accessed: 19 July 2017).

Zagal, J. P., Jochen, R. and Hsi, I. (2006). ‘Collaborative games: Lessons learned from board games’, *Simulation & Gaming*, Vol. 37, No. 1, pp. 24–40.

Appendix 1. Cooperation variable examples

Cooperation variable:	**Example values, higher = better**	**Example of effect**
Costs	2	Reduces costs
Risks	3	Diminishes the chance of risk event
Dependence factor	4	Reduces costs
Innovation capacity	5	Increases growth potential
Market position	4	Increases market presence
Flexibility	4	Increases flexibility
Agility	6	Increases reactivity
Specialization	3	Increases core competence
Regulation	3	Increases cooperation possibilities
Social causes	7	Increases cooperation possibilities

Appendix 2. In-game business ecosystem performance measurement examples

Dimension	**Measures relate to**	**Examples of measurable values in-game**
Financial capital	Growth/profitability; the competitiveness of the network; savings	ROI Benefit-cost ratio Budget
End customer capital	End customer satisfaction; reclamations; recommending customers; relationships with end customers	Attribute derived from market position, regulation and social causes cooperation variables New attribute modifiable by in-game actions
Network capital	Job satisfaction and well-being; know-how; renewal and learning perseverance	Attribute derived from flexibility, agility and specialization cooperation variables New attribute modifiable by in-game actions
Sustainable capital	HSE (health, safety, and environment); business continuity; new network partners	Business ecosystem health
Relationship capital	Reputation; brand; contracts	Attribute modified by in-game actions

Appendix 3. Example project: Implementing network-wide business process automation

Cooperation variable	Minimum requirement	Example effect
Costs	0	+ 2
Risks	0	+ 1
Dependence factor	3	0
Innovation capacity	5	0
Market position	0	0
Flexibility	4	0
Agility	0	0
Specialization	4	+ 1
Regulation	3	+ 1
Social causes	3	+ 1

Appendix 4. Example project impacts on network performance

Dimension	**Effect**
Financial capital	Improvement of ROI due to reduced operating costs
End customer capital	-
Network capital	Improvement of job satisfaction due to reduced routine work
Sustainable capital	Health of network is increased due stabilization and improvement of operating methods
Relationship capital	Increased reputation due to adaptation of new technologies

Appendix 5. Example in-game business ecosystem life-cycle

Phase	**Sub-dimensions**	**Example of actions in-game**
Emerging	Share vision Introduce solution Leverage partners	Collaborative actions related to social variables or introducing new solutions
Diversifying	Encourage partners Enable solution diversity Co-design vision Introduce platform	Collaborative actions related to risk analysis, strengthening partner ties and co-designing vision
Converging	Select solution Select partners Finalize vision Co-design platform	Collaborative actions related selecting technologies and methods
Consolidating	Improve and finalize solution Integrate partners Consolidate platform	Collaborative actions related to improving selected technologies and methods
Renewing	Initiate and capture niche idea Re-organize partners	Possible reformation of in-game business ecosystem