D3.3 Serious Gaming Approach to support Usability of IOT oriented User CoCreation

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SEVENTH FRAMEWORK PROGRAMME

Experiential Living Lab for the Internet Of Things

D3.3 *(light) - ELLIOT Platform*

Serious Gaming approach to support usability of IOT oriented user co-creation

Table of Contents

TABLE OF FIGURES **3**
INDEX OF TABLES **4**
1 SERIOUS GAMES AND THE ELLIOT PLATFORM [POLY] **5**
2 SERIOUS GAMING APPROACHES [BIBA] **6**
2.1 THE CONCEPT OF SERIOUS GAMES 6
2.1.1 Creativity and Learning *6*
2.1.2 Current Use of Games for Innovation in Organizations *9*
2.1.3 The impact of gaming results on the ELLIOT Living Lab and vice versa *10*
3 REQUIREMENTS ENGINEERING THROUGH SERIOUS GAMES [UNOTT] **12**
3.1 USING SERIOUS GAMES TO ACQUIRE REQUIREMENTS 13
3.1.1 Game writing *13*
3.1.2 Game coding *14*
3.1.3 Limits for requirements engineering *15*
4 SELECTED SERIOUS GAME ENGINE [BIBA] **17**
4.1 THE BE.MOG ENGINE 17
4.2 CURRENT BE.MOG FEATURES 18
4.3 IMPLEMENTATION OF A NEW GAMING SCENARIO 20
5 APPLIED SERIOUS GAMING APPROACH IN THE LOGISTICS USE CASE [BIBA] **24**
5.1 OVERVIEW 24
5.2 ROLE OF SERIOUS GAMING 25
5.3 DESCRIPTION OF USED SERIOUS GAME 27
5.3.1 The gaming process *27*
5.3.2 Getting started *28*
5.3.3 Roles in the game (characters) *30*
5.3.4 Process steps *31*
5.3.5 Events *32*
5.4 ACCEPTANCE, UNDERSTANDING AND USABILITY OF SERIOUS GAMING SCENARIO 34
5.5 FURTHER DEVELOPMENT OF THE LOGISTICS GAMING SCENARIO 36
6 GENERIC SERIOUS GAME DRAFT BASED ON BE.MOG [HSR] **37**
6.1 THE DRAFT GAME CONCEPT 37
6.2 INTEGRATION WITH BE.MOG ENGINE 39
6.3 SG MODERATOR ACTIONS 40
6.4 PLAYER ACTIONS 43
6.5 BE.MOG ENGINE UPGRADE REQUIREMENTS 43
6.6 USERS/PLAYERS – HOW TO ORGANIZE SERIOUS GAMING 43
7 APPLICABILITY OF THE SERIOUS GAMING APPROACH FOR IOT ORIENTED CO-CREATION **44**
7.1 FINDINGS FROM LITERATURE [INRIA] 44
7.2 FINDINGS FROM THE SERIOUS GAME IN THE LOGISTICS USE CASE [BIBA] 47
7.3 OUTLOOK ON GENERIC APPLICABILITY OF THE SERIOUS GAMING APPROACH DERIVED FROM GAME DRAFT 49
8 CONCLUSION **51**
REFERENCES **53**

Table of Figures

Figure 1: Serious gaming positioning in the ELLIOT Platform logical Architecture 5

Figure 2: Kolb's learning styles (cycle) 7

Figure 3: Integration of the Serious Game and the Tool Kit from the Logistics Use Case into the overall Living Lab Cycle 11

Figure 4: Requirements elicitation activities 12

Figure 5: Key elements of serious gaming 15

Figure 6: Levels of gamers for eliciting requirements.....16

Figure 7: Relation between User Interface, Game Engine and underlying Game Model 18

Figure 8: be.mog WAMP/LAMP/MAMP - infrastructure 18

Figure 9: An exemplary game process with action (step one) and document (other steps) process steps.....20

Figure 10: Game and Scenario Object Tables 22

Figure 11: Object, Class and Map Tables, examples from the be.mog engine.....23

Figure 12: The ELLIOT Living Lab Phases in the Logistics Use Case 26

Figure 13: The process steps of the logistics use case gaming scenario.....27

Figure 14: Draft of the intra-logistics scenario from the game.....29

Figure 15: Swimlane Diagram of Well Being Game Draft 39

Figure 16: Serious Games projects using IoT elements and relationships between them.....47

Index of Tables

Table 1: A comparison of book, play and game writing.....14

Table 2: Attributes of Process Step P02 – Risk Situations.....32

Table 3: Event 6 - Forklift Drivers License.....33

Table 4: The well being serious game draft corresponding objectives of co-creation 39

Table 5: Examples of parameters which can be detected through sensors.....40

Table 6: Selectable actions which the SG Moderator can select to structure question 6.....41

Table 7: A sample of KPIs (derived from the KSB Model) selectable by the SG Moderator to structure question 7.....42

1 Serious Games and the ELLIOT platform [POLY]

SGs are tools to support mainly the co-creation phase, but can as well support the other phases of the **L**iving **L**ab (**LL**) cycle.

The role of SG is mostly related during the *co-creation* and *exploration* phases of the cycle [ELLIOT D1.1]. In the scope of the first version of the Elliot platform, shown in Figure 1, the SG is linked by the GUI from the *IoT Application Designer Module*. From the deployment point of view, the SG is also deployed in a different machine from the one where the ELLIOT Platform core resides.

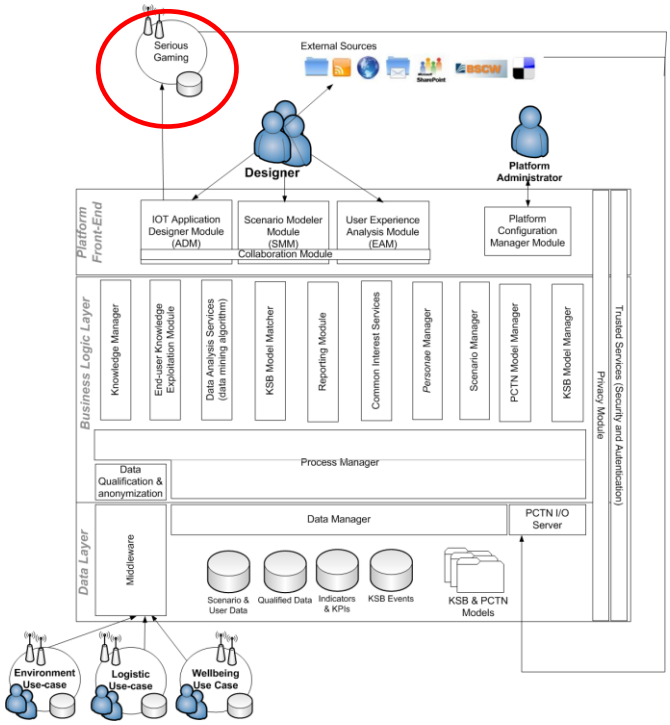

Figure 1: Serious gaming positioning in the ELLIOT Platform logical Architecture

Link from SG to ELLIOT Platform

During the activities done in the context of SG, participants have the opportunity to learn about the IoT world and to co-create the technological artefacts to be implemented and used in the scope of the experimentation. Additionally, serious gaming is seen by the platform as a support of observation during co-creation and the evaluation phase. The game contents created by LL participants like knowledge artefacts produced can be monitored by the PCTN component of the ELLIOT platform and can be reused in order to profile and cluster the users creating the people network.

2 Serious Gaming approaches [BIBA]

Due to its intended use in ELLIOT, 'serious gaming' and according approaches will be considered in relation to co-creation. This is why for further insights and a deeper analysis of the provided topical references should be consulted.

2.1 The concept of Serious Games

A comparison of methods used for ideation and how this process is carried out with paradigms used for education, it can be observed that there are several similarities between the ideation process and constructivism (learning through experiencing). A method used for education based upon this paradigm is SGs. SGs[1] or social impact games[2] are games used for education and work. Ideation is oriented towards the discovery of ideas. Games can be considered to do the same. They are designed to engage and motivate. SGs let the participants experience and learn in a safe environment, but in such a way that the gained skills and knowledge can be transferred to the real world.

In a game, players are presented with information that they then have to interpret and interact with. Games can contain multiple and contradictory knowledge structures. They can be used to promote discussion and re-framing of the knowledge gathered in the ideation process. Often games are hard work but offer engagement by providing challenge and struggle. At the same time, games provide incentives to change existing culture, praxis and routines. This is also what is needed for supporting ideation. SGs that can be integrated in the daily work process are often called *productive games*. In ELLIOT, we will use such games also in an LL context. Consequently, in ELLIOT, the intention of using SGs is to support the co-creation, i.e. supporting actual productive work. This section will give a brief introduction to the use of SGs in the co-creative process (compare D3.1).

Due to the parallels between the ideation process and the learning cycle based on experiential learning, this concept is explained in more detail in the next section.

2.1.1 *Creativity and Learning*

Due to the separation of theory and practice (Whitehead, 1992) in education, it is necessary to overcome the gap between **knowledge and action.** This leads to an underperformance in industry and in organisations (Pfeffer and Sutton, 2000). Crookall and Thorngate's (2009) review on the causes and effects of the 'artificial' dichotomy between knowledge and action makes it difficult to identify causes of inefficient transmission of knowledge and of

[1] "Serious Games"; Clark C. Abt (1970)
[2] Marc Prensky's serious games website: http://www.socialimpactgames.com/index.php

ineffective competence development: The artificial juxtaposition between knowledge and action that once generated the belief that only **knowledge may drive action** and not the opposite way round, that **action generates knowledge**. Crookall and Thorngate acknowledge that there are praiseworthy policies such as internships, on-the-job training and work placement having been put in place to overcome this gap. A well designed apprenticeship-like stage will not only help the learner to transfer their theoretical knowledge to practical skills, but also to transform gained experience into knowledge so that they can **assess previously acquired knowledge and generate new understanding**.

It is basically the spiralling nature of Kolb's **experiential learning** (ELT) that regulates this **virtuous learning cycle** (Kolb, 1984).

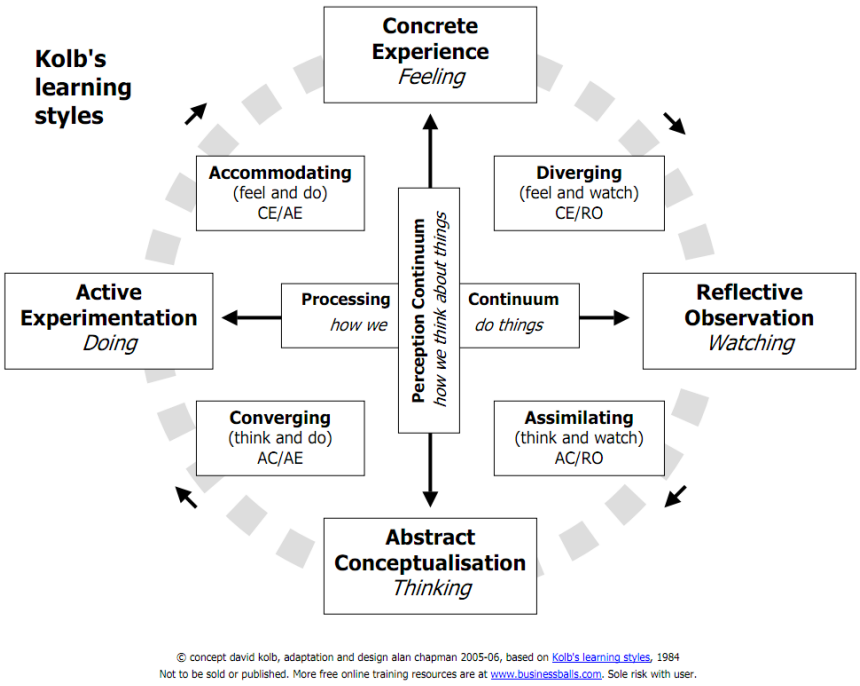

Figure 2: Kolb's learning styles (cycle)

According to Kolb, creativity has been usually associated with the "divergent (concrete and reflective) factors in [human] adaptation [to the environment] such as tolerance for the ambiguity, metaphorical thinking and flexibility". However more generally, ELT states that "Learning is the process whereby knowledge is created through the transformation of the experience. Knowledge results from grasping and transforming experience" (Kolb, 1984). The picture here reported (Figure 2) shows **the experiential learning cycle and the four**

dominant learning styles[3] (Diverging—Concrete Experience and Reflective Observation; Assimilating—Reflective Observation and Abstract Conceptualisation; Converging—Abstract Conceptualisation and Active Experimentation; Accommodating—Active Experimentation and Concrete Experience) which **can be directly mapped onto the four-stage model of creativity**—incorporation, incubation, insight and verification—developed by Wallas (1926).

As Crookall and Thorngate (2009) observe again, "at heart of the knowledge-action equation is experience" and **gaming represents another facet for creatively sustaining learning** (Mainemelis and Ronson, 2006).

In particular, the ability to cover all the phases through the learning cycle, allows learners to **"increase their learning power"** (Kolb, 2009) and, as well detailed into the report on the introduction of learning teams in a French higher education establishment (Borredon et al., 2010), to **overcome resistance to change** from cultural constraints and habits that prevent mutual exchange and sharing. Critical points have been: (1) the time factor (it cannot be too short to make learning emerge from experience and reflection), (2) learning pace (it is not simultaneous, each team member got own pace in learning), and (3) facilitation is key (experienced facilitation is required in novel teams). It has also been observed that Agryis's double loop process (1999) plays a key role in the **acquisition of new ideas** in the learning process. Since **creativity** is also associated with places where inequalities are reduced (Florida et al., 2011), it is also evident that this brings with it trust and psychological safety as well as **collaborative working environment**. These are conditions which also enable efficient team learning, as confirmed by experiences on-the-field (Wyss-Flamm, 2002) preventing inhibiting behaviours and malfunctions in teams as like as groupthink, diffusion of responsibilities, social loafing, over-committing to goals and so on (Kayes et al., 2005a,b). Moreover, relevance of **mutual exchanges and knowledge sharing** among organisation members has been recently observed as contributing to "dyadic creativity" (Fliaster, 2011; Fliaster & Schloderer, 2010). The social aspects that characterise the participatory quality introduced by **WEB2.0 technologies** are also very important for making tacit knowledge emergence (Polany, 1966) (Brown & Adler, 2008). Moreover, this has **a decisive impact on the whole society**, reversing some consolidated and often stuffy cultural habits (O'Reilly, 2005; McAfee, 2006). In short, **being creative in the teaching-learning process it will foster new business models and patterns** such as Open Innovation that tap into the creative talent of the communities of practices regardless the traditional boundaries set by

[3] The four dominant learning styles diadically composed are often referred to as basic learning modes. The other five learning styles are given by the four single elements of the learning cycle (Concrete Experience, Reflective Observation, Abstract Conceptualisation, Active Experimentation) and by the full integration of all of them.

organisations and institutions (Chesbrough, 2003; Lytras et al., 2007; Hagel & Brown, 2008).

As Moran and John-Steiner (2008) point out, "The current approach to creativity most in line with Vygotsky's general methodology is the idiographic case-study approach, which tries to recreate the process of creation over time through the close examination of highly creative people's lives, works, works-in-progress and journals (Gardner, 1993; Gruber, 1989; John-Steiner, 1997)". However, we want to demonstrate how the creation of a **suitable learning space** by means of the **IT-platforms for teachers and learners** complemented and integrated by a **collaborative sharing and exchange** community environment can **foster the generation of creative dynamics**. This will **sustain the learning efficacy** by lowering down the factors that hinder the **transformation of experience into knowledge** as well as the **transmission of knowledge**.

2.1.2 *Current Use of Games for Innovation in Organizations*

Games are used in a variety of ways in organisations today, e.g. games for strategy building like WarRoom or simulation games for change-management processes like EIS simulation. However, games are rarely used for ideation, but tools and games exist. The INSEAD Centre of Advanced Learning technologies (CALT), one of the world-wide centres of excellence in learning innovation designed and developed some of the most successful business and management simulations that are used extensively worldwide in top ranked business schools and academic institutes as well as in corporate universities for training top and medium level executives and managers, Among them "The Eagle Racing" simulation, developed in the framework of the EC-funded "L2C- Learning to Collaborate" project (which building on interdisciplinary scientific/academic models and best/worst practices and experiences aims to identify the factors inhibiting effective collaboration, and the interventions required to reduce this risk) (L2C) and the "The EIS" simulation (which inspired the EC-funded ChangeMasters projects platform that addressed change and innovation management competencies of European corporate learners and decision-makers, and the change and innovation readiness of organisations, both in the private and public sector, Europe-wide) (Angehrn, 2004/5). The so-called SmallWorld simulations are simulation-based experiential learning approaches, which implement learning-by-doing or learning-by-playing techniques. After an introductory briefing session for setting the problem terms within a context, the actual simulation runtime follows and a debriefing session, based on a conceptual model of the learning objectives and the underlying knowledge domain, closes the user's learning experience. All these phases are guided or supported by experienced facilitators whose role is to assist and customise the simulation learning experience according to users' age, situations, culture and learning

abilities and in order to maximise the learning value and the capability of the learners to effectively transfer the knowledge acquired into their individual practices, such as transformation of learning outcomes into permanent and valuable knowledge assets.

Conclusively, existing games supporting innovation can be divided into the following categories:

- Games for providing input from external stakeholders
- Games as explorative tools
- Games for supporting the diffusion of innovations
- Games for structuring the ideation process
- Games as creativity stimulating processes

These categories are not definitive, they are sometimes overlapping. Within the early stage of innovation, games will be used for shorter, specific work routines. In ELLIOT, the games will be used to develop ideas on services for IoT in four different industrial sectors and will be applied in an LL context. Thus, in the ELLIOT project, we will look at games for supporting the diffusion, structuring the ideation process as well as supporting the creativity stimulating process. The game generates initial ideas, but could also be broader and imply "options", e.g. ideas for solutions for specific problems, that could be taken for the next step of the LLs.

2.1.3 *The impact of gaming results on the ELLIOT Living Lab and vice versa*

In the ELLIOT project the gaming approach is mainly used in the co-creative phase in order to develop suitable IoT services. Nevertheless the games are not limited to this phase. Furthermore the games will interact with the "govern and support" phase of the ELLIOT LL. The ideas developed in the game will be passed on to the LL members for further discussion, development and for feedback collection.

From the exploration and / or experimentation phase results, feedback and sensor data could be fed into the game again and such improve the co-creation phase in further LL iterations.

Figure 3 illustrates the explained approach on how to integrate and connect the SG and the LL; this is especially focussing on the logistics use case. The learning cycle of Kolb (in the middle, compare with Figure 2) illustrates that its learning styles are partly included in this approach. The individual purpose of a game determines which styles are used within the game. This means that not the whole cycle is used. Nevertheless, due to the LL's iterative structure the potential to cover all phases rises.

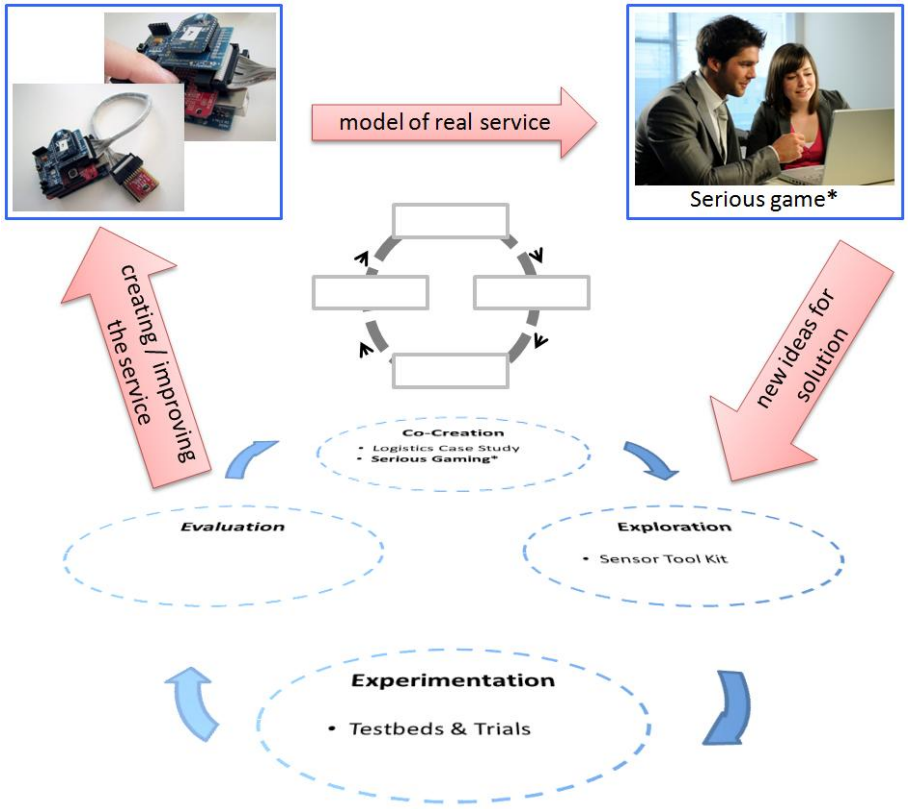

Figure 3: Integration of the Serious Game and the Tool Kit from the Logistics Use Case into the overall Living Lab Cycle

3 Requirements Engineering through Serious Games [UNOTT]

The engineering of requirements is a process that consists of activities to elicit, analyse, validate and document a formal, complete and agreed requirements specification, as shown in Figure 4. This process aids in addressing gaps between the actual needs and the perceived needs of user as understood by analysts (Goldin and Berry 1997). However, the elicitation phase represents a critical phase in the entire process that generates an initial set of requirements. In other to accomplish elicitation, several tools, methods and techniques (TMTs) proposed have been provided as summarised in D3.2 deliverable (Report on Requirements Engineering). These TMTs support two main steps: **acquisition**, in which user needs are captured, determined, uncovered, surfaced, sought, extracted or discovered, and **representation**, in which acquired data is combined, written and disseminated for analysis. Game playing and role playing offer two important avenues to acquire requirements with particular focus interaction during group work and in simulated environments. In game playing the experiences of users is replicated in environments that mimic real life. For role playing, the focus is on experiences of interactions among users based on defined roles as surrogates (non-stakeholder experiencing the role of a stakeholder or a stakeholder playing the role of a user), protagonists (users whose interactions are the focus of the group work) and auxiliaries (other group work participants).

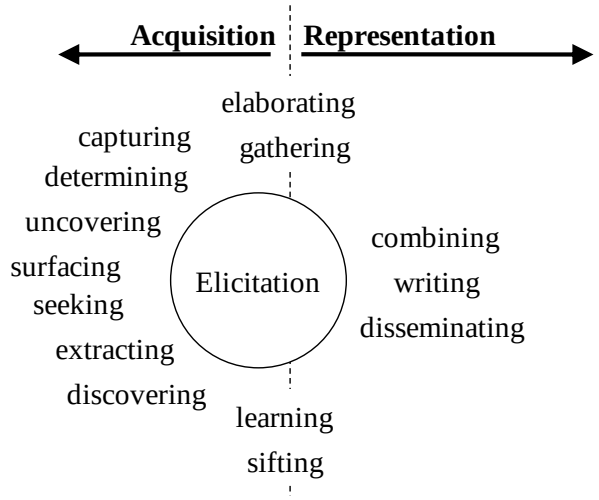

Figure 4: Requirements elicitation activities

SGs can represent a synergy between game and role playing. It is a computer-based simulation designed for entertaining games but with non-entertainment goals (Raybourn 2007). Also, the SGs approach reflects a shift from the "learning by listening" to a "learning by doing" attitude (Garris et al. 2002). However, most sources focus on how the method can

be used for learning (or training) purposes (Michael and Chen 2006, Susi et al. 2007, Riedel and Hauge 2011).

On the ELLIOT platform itself, not every detail of SG is presented nor the detailed transition from SG for learning to SG for acquisition. Instead, this part is focused on how SG can be used for acquisition. More details about SG for learning and the transition to SG for acquisition can be found in the ELLIOT Deliverable D3.3.

3.1 Using serious games to acquire requirements

In the use of SGs, it is highly recommended that an existing game be used as a reference (Ambring et al. 2010). This saves game development time because factors relating to authenticity, education and entertainment needs to be considered. This section highlights key considerations for game development in terms of game writing and coding and concludes with a discussion of some limitations of serious gaming for requirements engineering.

3.1.1 *Game writing*

To use SGs within the context of the ELLIOT project, concurrent support needs to be provided for authenticity/entertainment of game play and the acquisition of system/user requirements. This necessitates key knowledge on game writing and coding. Game writing centres on the development of a narrative that serves as the basis for gaming. As shown in Table 1, game writing differs from writing a book or a screenplay because it tells a story based on active roles for users. To do this, three approaches to formulating game narratives have been suggested (Ambring et al. 2010, Chandler 2007):

1. Brick-and-mortar design in which the emphasis is on game play and the storyline is used as an avenue for connecting ‘moments’ in the game play.
2. Story-driven design in which a storyline is formulated and the game play is driven by the storyline. This approach is similar to *mythocentric* philosophy in which game creators control the experience, stories and potential memorable events of gamers. This could potentially destroy immersion and frustrate games if careful and extensive testing is not undertaken to circumnavigate the problem.
3. Open world design in which storylines evolve as the game is played by users. This approach is closely related to *logocentric* philosophy that allows gamers to make choices and carry out actions to influence game’s story.

	Writing books	**Writing plays**	**Writing games**
Purpose	Various uses	Tells a story	Tells a story
User roles	Passive role for users	Passive roles for users and	Active roles for users

		active roles for performers	
User involvement	Reading	Watching	Interacting

Table 1: A comparison of book, play and game writing

3.1.2 *Game coding*

To develop a game, the coder must make use of the interpreted and adapted narrative of the games to decide on game genres (e.g. simulation, strategy, role playing, action and adventure). This information aids in deciding on game characters and the tools to be used for game coding.

Game characters are of two kinds: playable characters and non-playable characters. Playable characters are controlled by human gamers and non-playable characters are by means of artificial intelligence embedded in the game (Santorum 2011). Coding tools depend on the operating system used and supported for the game. It also depends on the programming paradigm adopted (such as object-orientation, agent-orientation, and aspect-orientation) by the developer.

Using game characters and tools, the developer must then create the game engine and provide mechanisms to evaluate game play in line with at least five functions (Liu and Ding 2009):

1. **Record & Playback functions** to judge game play based on specific criteria according to actions and behaviour of gamers,
2. **Data Processing** to provide insights to emerging patterns on game used through an analysis of logged data (using techniques such as data mining) on gamers' actions and decisions,
3. **Feedback** to automatically or manually correct mistakes and reinforce positive steps towards task completion or learning outcomes, and
4. **Database interface** to aid in assessing the behavioural use and effectiveness of the game for accomplishing its goals,
5. **Script language support** to aid in modifying the criteria used in providing feedback.

Scalability and synchronicity are also important aspects of game coding that needs to be considered. Managing scalability entails the use a balanced approach to ensure large numbers of gamers are not concurrently requesting access to a central control. The management of synchronicity on the other hand involves updating the game (and game play) to harmonise interactions and outcomes for multiple scenes to improve believability. The aspects contribute to game component composition, gamer action encouragement and gaming 'immersiveness' that enhances game play quality.

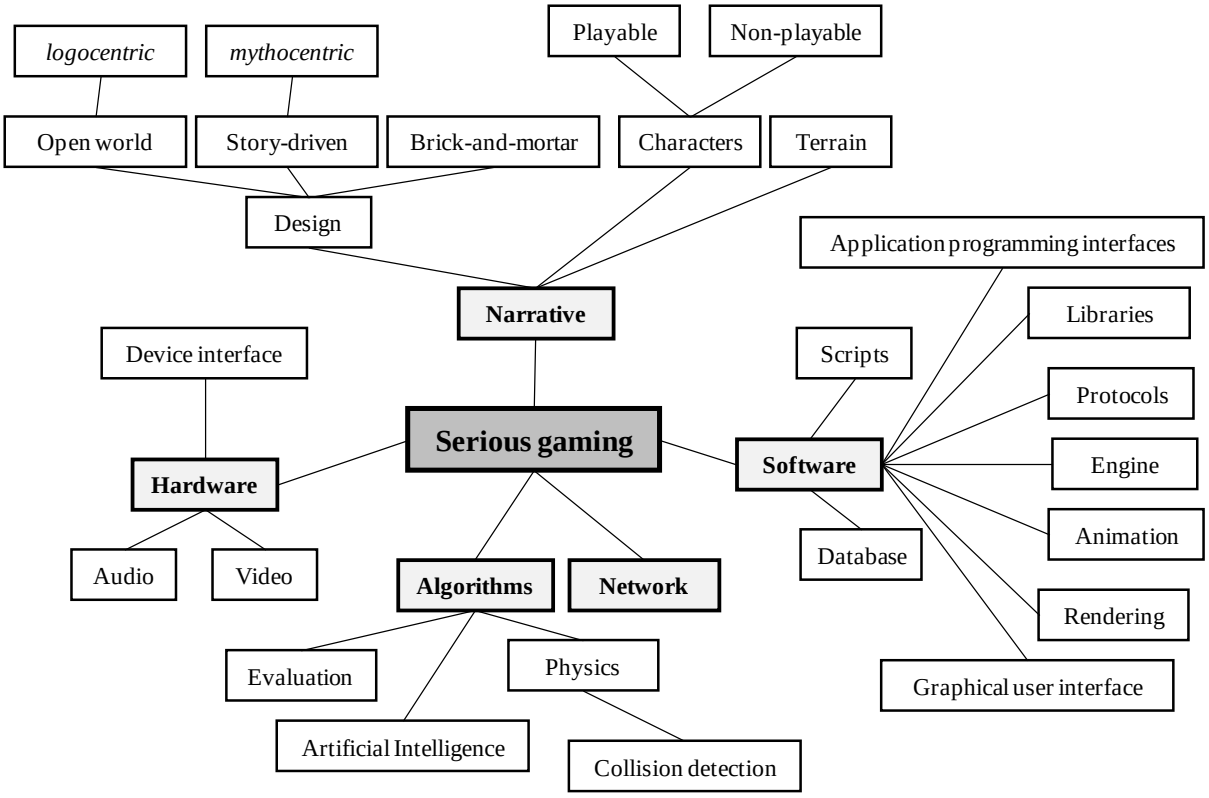

Figure 5: Key elements of serious gaming

3.1.3 *Limits for requirements engineering*

It is however important to note that SGs are particularly useful during steps to acquire requirements. These steps represent a subset of activities to elicit requirements. Added to this, is the point that requirements elicitation is an activity during requirements engineering. **SGs therefore aids requirements acquisition and should not be viewed as a method for accomplishing the overall requirements engineering process.**

Specifically, attention must be paid to the human involvement during the use of SGs for acquiring requirements.

First, the co-opting of users and TMTs for deriving game narratives must be carefully considered. In terms of co-opting users, the game developer may be aided or un-aided by users to accomplish the input stage. These factors should also be considered during the outcome stage during which gamers, game environments and game use are analysed.

It also important to stress that unlike games used for entertainment purposes, SGs are characterised by: time specificity with fixed starting and finishing points, as well as structured, sequential routines targeted towards achieving specific goals (to avoid overwhelming the gamer or complicating the task) and modifying the behaviour of gamers. It

is however important to note that learning styles are different and impact on how outcomes are accomplished using SGs. In the use of SGs to acquire requirements, special attention must be paid to levels of system users from which requirements are sought. In particular, the game developer will need to consider two important levels of users that can be involved with the game, as shown in Figure 6. First, is an expert user of the system, who could be valuable in identifying 'perspective gaps' i.e. the needs for the user in relation to interaction with other users of the system and proficiency of systems. Second, is a non-expert user of the system, who would be valuable in identifying 'missing experiences' i.e. the logically steps that novice users need for interaction with other users (and systems) and for simplifying or clarifying scenarios and cases.

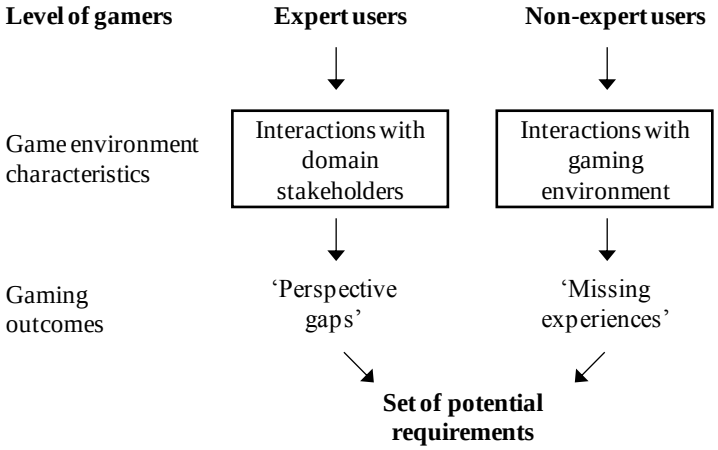

Figure 6: Levels of gamers for eliciting requirements

Finally, during the game and observation cycles, it is recommended that moderators and facilitators be used to encourage participation and manage negotiation (Gambhir 2001, Decker et al. 2007, Riedel and Hauge 2011). Depending on the context and domain, the role of the moderators can include encouraging user participation during game play, bridging the gaps among numerous and diverse stakeholders, or acting as a devil's advocate during the acquisition activities.

4 Selected Serious Game engine [BIBA]

Within the ELLIOT project the be.mog engine from BIBA has been selected to develop a serious game scenario for IoT oriented user co-creation. The engine has been selected, because of its purpose to elicit user needs. As the be.mog engine has been used before, some publications already exist and provide more details about the engine and on its application (see amongst others: Duin et al 2009a; Duin et al 2008; Baalsrud et al 2008; Baalsrud et al. 2008a; Zarvić et al 2009; from the EU project Laboranova: D3.3.1 and D3.3.4). *Given information here is partially based on the mentioned publications*.

4.1 The be.mog engine

The engine has been used before in different projects as a basis for new SGs. Be.mog is composed as a gaming engine executing a game model consisting of objects of different gaming classes. The content of the game can be considered as a set of objects instantiated from the gaming classes. This approach ensures the separation of algorithmic processing and game content which allows the change of the content without changing the game itself.

A three-layer-architecture is the basis of the simulation game: the game model provides the basis, the gaming engine as the control unit of the game and a user interface which displays the relevant information to the players. This architecture allows to examine the model elements and to apply game specific actions. These parts are described below and illustrated in Figure 7:

- **Game Model**: The underlying game model provides all modelled entities as a formal basis for the implementation of the simulation game.
- **Game Engine**: The engine works on the underlying model and simulates the main variables influenced by the players' actions. The game engine can be seen as the central control unit of the game. Usual variables are time, costs and quality, which are the main variables influenced by the players in taking specific actions.
- **User Interface**: The user interface allows to browse the overall and personal information in the game and to apply game specific actions.

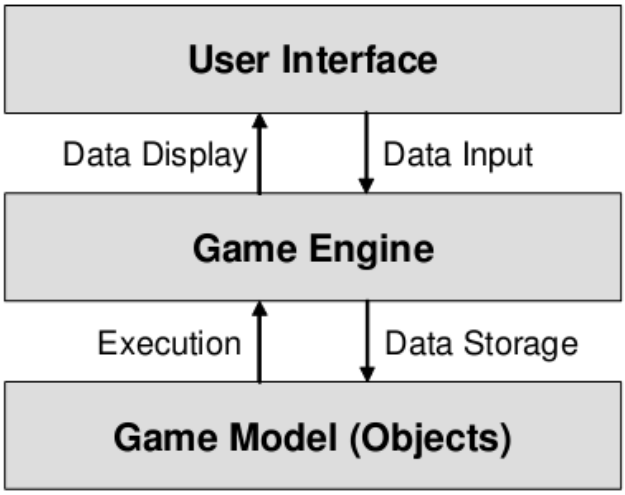

Figure 7: Relation between User Interface, Game Engine and underlying Game Model

be.mog setup

The be.mog Version 2.0 is based on a XAMP infrastructure. Therefore it can easily be run under Windows, Linux and Mac OS X systems. Further versions of involved software distributions are (according the acronym): Apache HTTP Server 2.x, a MySQL Database 5.x and the PHP Module 5.x.

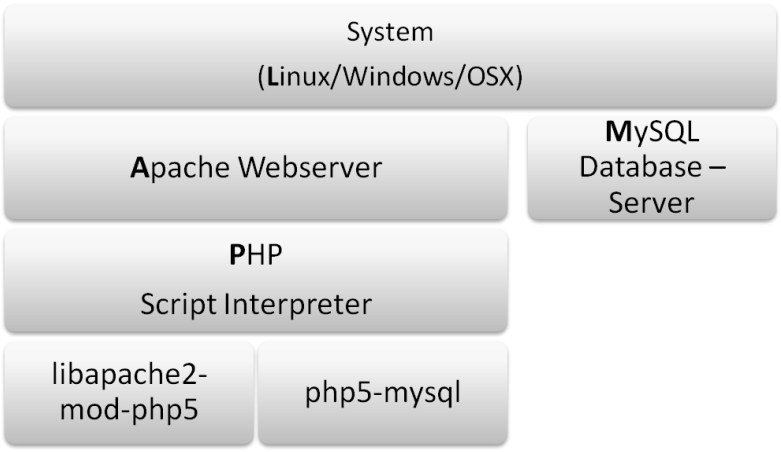

Figure 8: be.mog WAMP/LAMP/MAMP - infrastructure

4.2 Current Be.mog Features

Players and Roles: In each scenario the players can be grouped into groups and sub-groups, each with individual descriptions. Players can have different roles in each sub-group, e.g. manager or forklift driver (as in the Logistics Use Case). For each role a description is stored, additionally to *name, user identifier, password* etc.

Process Steps: Each group of players follows a given game process. This process is further divided into process steps which *all* need to be completed in order to complete the whole process. The process steps are processed in sequential order. The completion of a process step means either that some action is executed (e.g. a decision is made out of a range of given possibilities) or by editing and finalizing some document.

Actions: Some process steps may be completed by applying an action of a set of actions. Actions are always under control of a specific player. The setting of an action reveals further information for the player. Actions can only be set by players. This is different to events which are set by the facilitator. The facilitator cannot set actions.

Events: Events can only be set by the facilitator. A list of events is given to the facilitator in advance. Usually every event can be applied to any of the process steps. Nevertheless some events are more applicable to certain process steps than others. The players are informed about the occurrence of the event and get further information about it.

Documents: Documents are a simple collection of document entries following the structure "attribute" and "Type" (number, text, or selector).

Documents are owned by a player and can initially only be edited by this user. Via an access rights management the document owner can provide viewing and editing rights to other players. The facilitator can view all documents but cannot change them.

Documents might be visible from the beginning or they are created when specific process steps are completed. Players can work on documents when they are visible until they are completed. The associated process step is completed when all documents associated to this process step are completed.

Performance Indicators: The engine provides the possibility to use performance indicators in order to measure the game success. These indicators are usually time, costs and quality.

Message Board: Sort messages can be exchanged between the players. The facilitator can follow the message log and can as well place messages into it.

The Game Play Concept

The generic gameplay concept is rather simple. A game consists of an ordered list of scenarios which are played subsequently; the minimum of one scenario is needed for a game. The game is over when all scenarios are complete.

Groups are assigned to each scenario and to each group certain process steps are assigned as well. Such the game process for each group is defined. This process is played by completing

successively all of the involved process steps (see above). Once all the groups completed their process steps the concerning scenario is complete. The above mentioned types define the manner how a process step is completed. Such, a document based process step requires completed documents while action based steps require the selection of (at least) on action out of a given action range.

Further Features

Inclusion of multimedia data has been reached by consequently using HTML for any kind of descriptions of game objects. Therefore, anything which could be done using HTML (e.g. including Flash animations) can be done in be.mog.

Additionally it is possible to branch process steps. This allows the parallel execution of process steps.

4.3 Implementation of a new gaming scenario

As described the general idea of be.mog is to provide an engine capable of performing process-oriented scenarios. Features are the explicit execution of process steps with different participants, different roles / characters, performance indicators (time, costs, and quality) and an integrated chat. The roles are able to execute actions or to manage documents. Additionally the facilitator exists as kind of a special role. While the usual roles are actively involved in the execution of the game process, the facilitator can be described as a passive observer who supports the gaming process. This support is mainly based on the possibility to interact via the chat (messaging) module and on events which are triggered manually (see Figure 9).

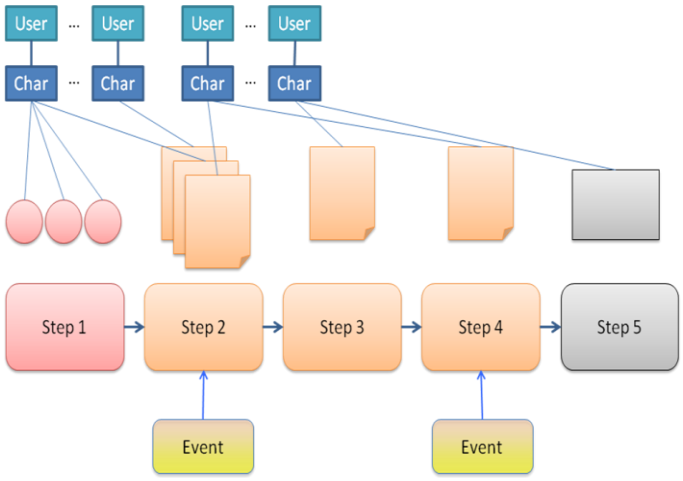

Figure 9: An exemplary game process with action (step one) and document (other steps) process steps.

The gaming scenario

Before a new scenario can be implemented into the engine the scenario needs to be developed taking into account the described features. These features are the available tools to represent the scenario and they have to be adjusted properly in order to reach the objective of the individual gaming scenario. In ELLIOT the objective is to co-create an IoT enabled service; in the logistics use case, this service should monitor risk situations in intra-logistics and therefore the serious gaming scenario treats exactly this task.

First a process needs to be defined and the associated process stakeholders have to be allocated. It is helpful to describe the stakeholders and their roles at this stage, beforehand going deeper into the process. The description of the roles helps not only to provide a useful description to the user/player (if this is needed) but also to understand how the roles might or should act throughout the process.

When refining the process into process steps, or even before, the question arises if every stakeholder has to participate in every process step. This might not be so. Thus the stakeholders should be allocated to the process steps as well. Maybe even parallel processes exist (which is possible to be modelled in the engine). The allocation of stakeholders is covered in task and process step (documents/actions) descriptions.

Afterwards the according features for each process step are defined, e.g. documents and actions. Documents in the logistics game scenario are e.g. the risk situations and the risk ranking as well as the defined statuses of involved objects.

Once the process steps, documents and actions are set, events should be defined. Events might support the gaming experience, which is necessary as such ideation oriented gaming processes might lack this experience more than other game approaches. Events are, for example, used to challenge the player or to provide additional information. In the logistics game scenario events are used to point out to the player the aspects his/her role should focus on. Other events provide additional information in terms of short questionnaires or videos, always related to the context. For example a questionnaire with selected questions from the forklift driver licence is used as well as training videos for forklift and warehouse safety and security.

If not already defined beforehand (see above), at least short role descriptions should be prepared to ensure that roles are selected well and fit into the developed process.

Implementation into the engine

For the implementation of the scenario into the engine's database the following steps are

suggested:

- Step 1: Define organisational structures and a "swimlane" diagram
- Step 2: Define all relevant game objects (game, scenario, character, process, actions, docs, …)
- Step 3: Enter data into database

It is suggested to use tables which specify the characteristics of the involved objects, in order to ease the implementation of the developed scenario into the engine. Once these tables are completed they can easily be transferred into the engines database. As an example, the following Figure 10 shows the Game and Scenario Object Tables.

Game-Object	
Attribute	*Value*
Identifier	
Name	
Description	

Scenario-Object	
Attribute	*Value*
Identifier	
Game-Identifier	
Name	
Description	
Order	

Figure 10: Game and Scenario Object Tables

Entering Data

For entering game objects the following order should be used:

1. Class Table
2. International Strings
3. Object Table
4. International Stings
5. Text files

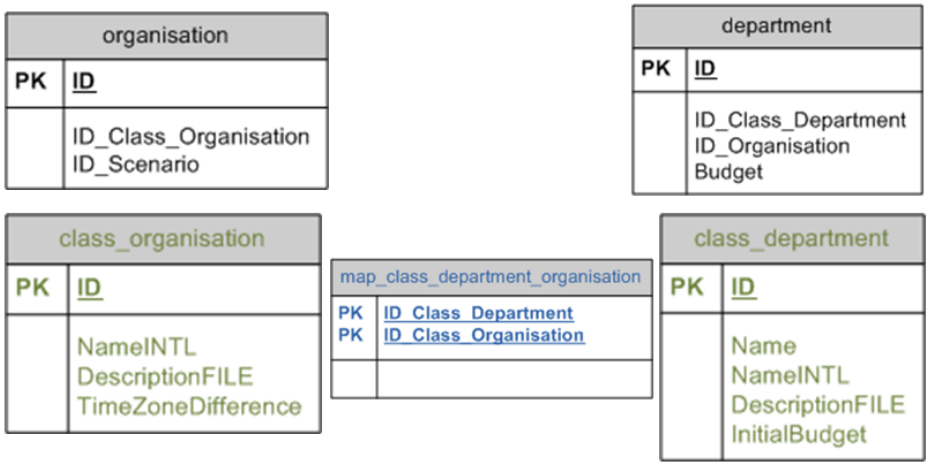

Figure 11: Object, Class and Map Tables, examples from the be.mog engine

When looking at the overall order how to generate the game objects it is proposed to use the following order:

1. Game
2. Scenario(s)
3. Organisation(s)
4. Departments
5. Characters & Roles
6. Process
7. Process Steps
8. Actions
9. Documents
10. Document Entries

5 Applied serious gaming approach in the logistics use case [BIBA]

In chapter 4.3 the development process of a gaming scenario and its implementation into the be.mog engine has been explained. In this chapter the SG which is developed in the ELLIOT Logistics Use Case will be described in more detail. This could be useful to gain a better and more practical understanding of the description given in chapter 4.3.

Furthermore, based on the development plan as well as on findings and experiences from first applications of the game, an outlook will be given on which aspects the future development will focus and which probable additional features are discussed at this stage of development.

5.1 Overview

The game scenario in the logistics use case scenario treats the ideation and aims to elicit requirements for the service which is to be developed throughout the LL cycle. It has been shown that serious gaming could be a supporting and helpful tool to reach this objective. As well it has been explained to what extend this objective seems to be reasonable (see chapter 3.1).

The utilization of an SG in the co-creation phase is expected to lead to first service layouts which then can be used in the exploration phase for further analysis. Once the whole LL process will have been performed for the first time, by using the game, events can be triggered to change the way the players (and LL participants)[4] think about a service they developed beforehand.

In addition, the reference to the utilization of events in the SG points out the fact that the LL process is an iteration of pre-defined steps (Co-Creation, Exploration, Experimentation and Evaluation). Having such iterative approach, it is probable that iterations of an ideation process lack the proper ability to get disruptive ideas, as the perspective of the process participants experiences a predefinition due to earlier iterations. This way the participants got used to think about a problem in a certain way and start to rather incrementally improve than re-think the idea in a radical way (Duin et al. 2009a). This challenge of disruptive vs. incremental ideation can especially be seen in innovation processes of organizations (Lam 2004). To a small extent, this process might be decelerated by the mentioned utilization of events.

Nevertheless, this last mentioned aspect doesn't have to be a limitation. As long as working with a fixed group of individuals in the LL, it can be expected to have an incremental

[4] Participants of the Living Lab became players during the game is performed.

development of the service. But the LL provides the opportunity to have different groups working (in parallel) and co-creating in it and therefore creating – probably – different service solutions.

The way the SG is used within the logistics use case, in spite of the expected advantages, still leaves some limitations. When using SGs for ideation and requirements engineering the entertainment aspect is less minded than in usual games. Thus in the logistics use case game the individual game development based on player's decisions is limited, due to the process based game sequence. This is different to some game developments where opportunities to influence the game and its outcome are more diverse.

During the ongoing observation and development of the game, the mentioned limitation will be observed and taken into account. Furthermore additional features are discussed to improve the IoT implementation in terms of an improved connection of the SG with the toolkit and the developed service (see chapter 5.5).

5.2 Role of serious gaming

The SG in the logistics use case has a main focus on the co-creation phase. The *goal* of using serious gaming is to elicit requirements by developing a theoretical (virtual) service solution which will then be further examined during the LL process steps following on the co-creation phase; and of course in LL iterations. Thus the SG can be seen as a starting point to organise and gather ideas from which a first service solution is derived. During the mentioned iterations of the LL Cycle the SG will again be able to support these iteration cycles.

Affected processes

Figure 12 shows the SG of the ELLIOT Logistics Use Case in the LL (LL) located in the Co-Creation phase. The SG is used in terms of ideation. Once the case study is explained to the LL participants the SG is used to develop first ideas which will be transferred into the next phase of the LL. After the SG and before the next phase (exploration) starts, the developed ideas will be finally discussed and ranked and/or filtered. This ranking or filtering is done in a workshop and is no more part of the game. The exploration phase following next in the process is based on this ranking (or filtering).

The whole Co-Creation phase is framed by a workshop which will end with a questionnaire for the participants about their workshop and gaming experience. Also more detailed and qualitative interviews will be used to gain more knowledge about the LL participant's experience.

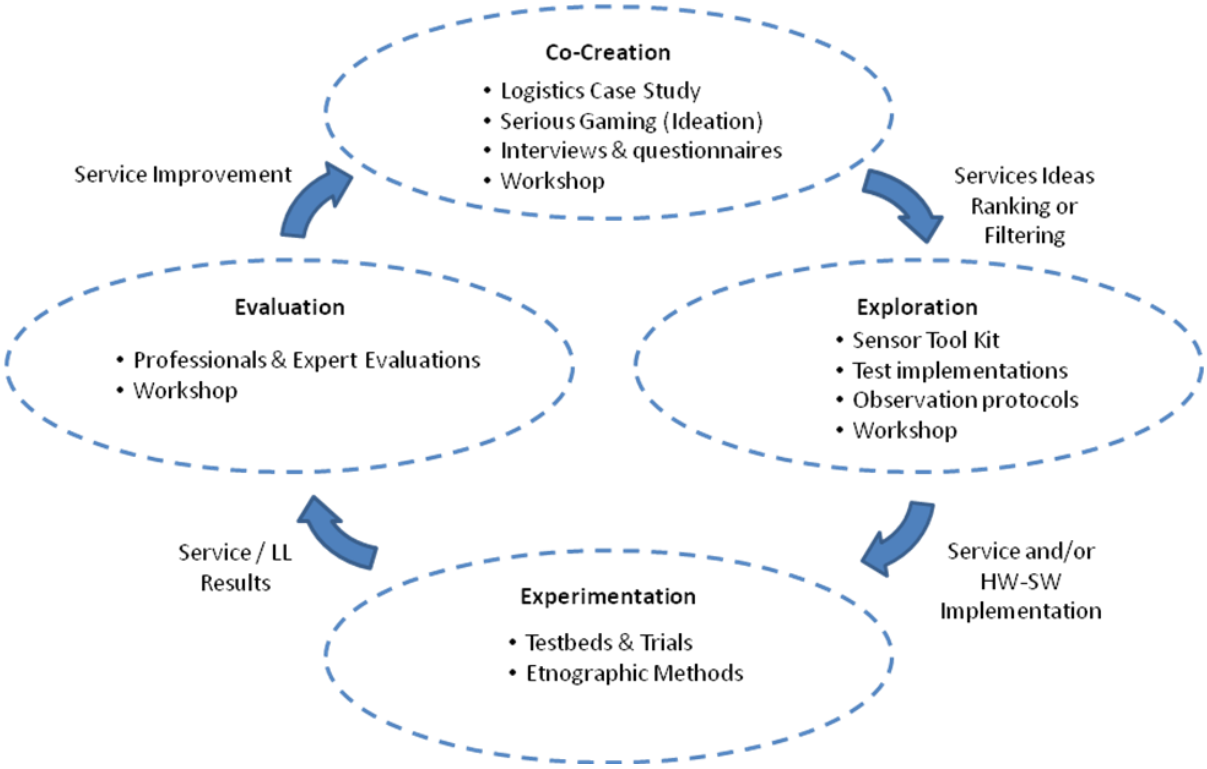

Figure 12: The ELLIOT Living Lab Phases in the Logistics Use Case

Relevance of IoT in the game

The SGs in the logistics use case focuses on the development of an IoT enabled risk monitoring service in intra-logistics. This is the task, which is presented to the game players in the SG and explicitly names the objective of the logistics use case itself. Thus the utilization of IoT enabled technologies is stressed and it is inevitable for the players to use such technologies throughout the idea generation.

Regardless this view, the connection between the SG and the "to be developed" service itself in reality (outside the game) is a major desire. The possibility to develop such a solution within the projects scope is still under discussion and the feasibility is not finally evaluated yet (see chapter 5.5).

Involved stakeholders & actors

As the logistics use case's goal is to develop a service to monitor risk situations in intra-logistics, the expected environment for a potential later application in industry is taken into account in every single step of the LL cycle. Therefore the roles in the SG are geared to corresponding positions in business/industry environments. Derived roles for the players in the SGs are (roles are explained in more detail in chapter 5.3.3):

- the manager
- the quality (management) officer

- the forklift driver
- the technical expert and
- the representative of the Works Council.

Furthermore the facilitator can be named here, but this is not a role in the game like the others. Nevertheless, when utilizing events the facilitator might act e.g. as the general management and thereby becomes temporarily a stakeholder of the developed service.

5.3 Description of used serious game

Within the logistics use case one gaming scenario is developed and utilized in the co-creation phase. The game treats an intra-logistics scenario, located in a warehouse. As long as there are no LL participants who are actually involved in according industry processes, but students and logistics experts (like at the LL at BIBA location), the game provides a proper scenario as well as roles which equal the stakeholders of a real industrial environment.

5.3.1 *The gaming process*

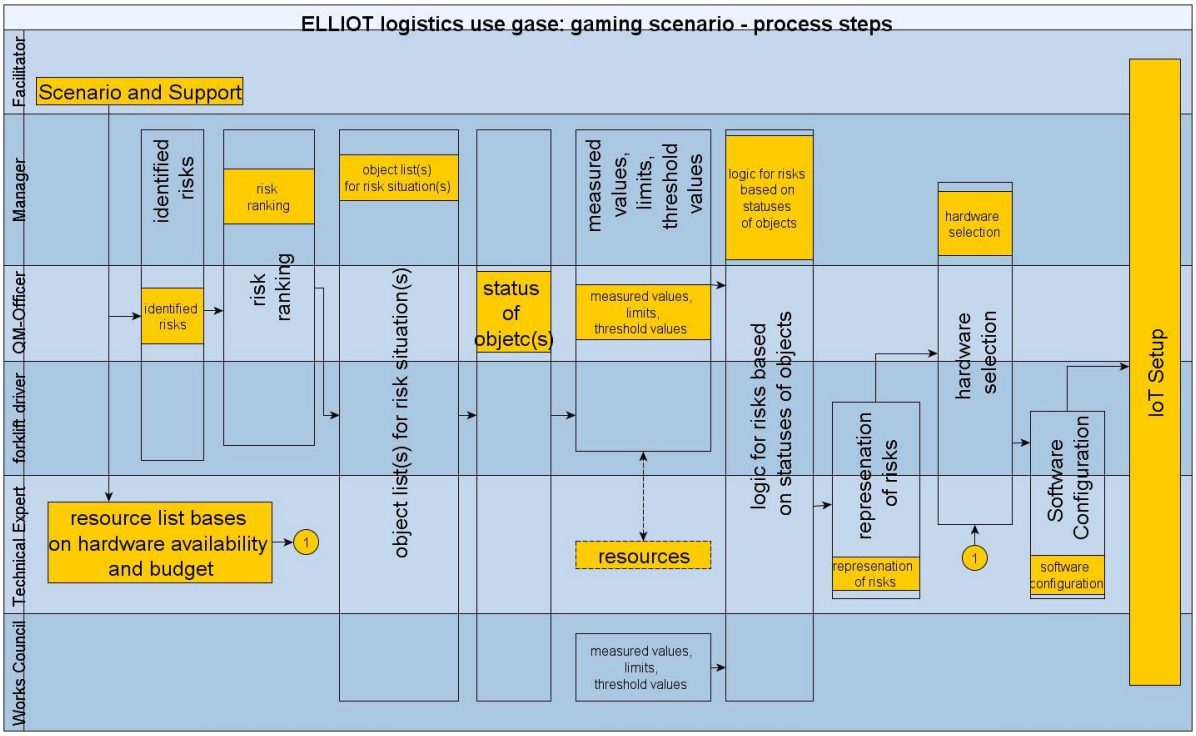

Figure 13: The process steps of the logistics use case gaming scenario

A swim lane diagram is used to illustrate the process steps of the logistics use case gaming scenario (see Figure 13). Each horizontal lane stands for a role in the game. The yellow boxes indicate the "process owner" (e.g. document owner) and transparent boxes, if given, frame those roles which are involved in the according process step. In this diagram only one event

is shown (E01) for reasons of clarity, all mentioned events in chapter 5.3.5 can as well be allocated into this diagram with connections to the process steps (see section 4.3 for more details on the characteristics of the *event* object in the be.mog engine).

5.3.2 *Getting started*

Before the task and the scenario are given, a video is presented to the players. This video contains a risky intra-logistic activity and the players are asked whether or not the shown activity leads to an accident or not. The answer to this questions does not have any influence on the game development but should get the players "into the mood" for the game and the treated topic.

Afterwards the **task** is described to the players:

> Your task is to develop a risk monitoring service for safety (persons) and security (goods) based on sensor technologies (e.g. temperature, position, location, vibration etc.).
>
> This sensor based service has to indicate to workers (e.g. the forklift driver) that a risky situation may arise when performing certain activities (e.g. speeding and curving).

The task description is followed by the **gaming scenario**, for which three main steps are identified in case that a storage rack and a loading area exist. The storage rack is used to store all goods after entering the warehouse while the loading area is used to prepare whole shipments mainly short before loading:

1. Forklift picks up a pallet (e.g. from a trailer at the loading platform) carries it to a storage rack and stores it.
2. Forklift takes out a pallet from a storage rack and carries it to a loading area where shipments are prepared.
3. Forklift picks up a pallet from loading area and loads it onto a trailer.

The (game's) warehouse operator is a logistics service provider with own assets who servers different customers and provides distribution logistics as well as value-added services. The logistics service provider with its value added service is part of the overall product supply chain, due to complexity reasons the focus of the game is reduced to the warehouse activities. Therefore the value-added services are supposed to be provided in a separate warehouse and are therefore not investigated within the gaming scenario.

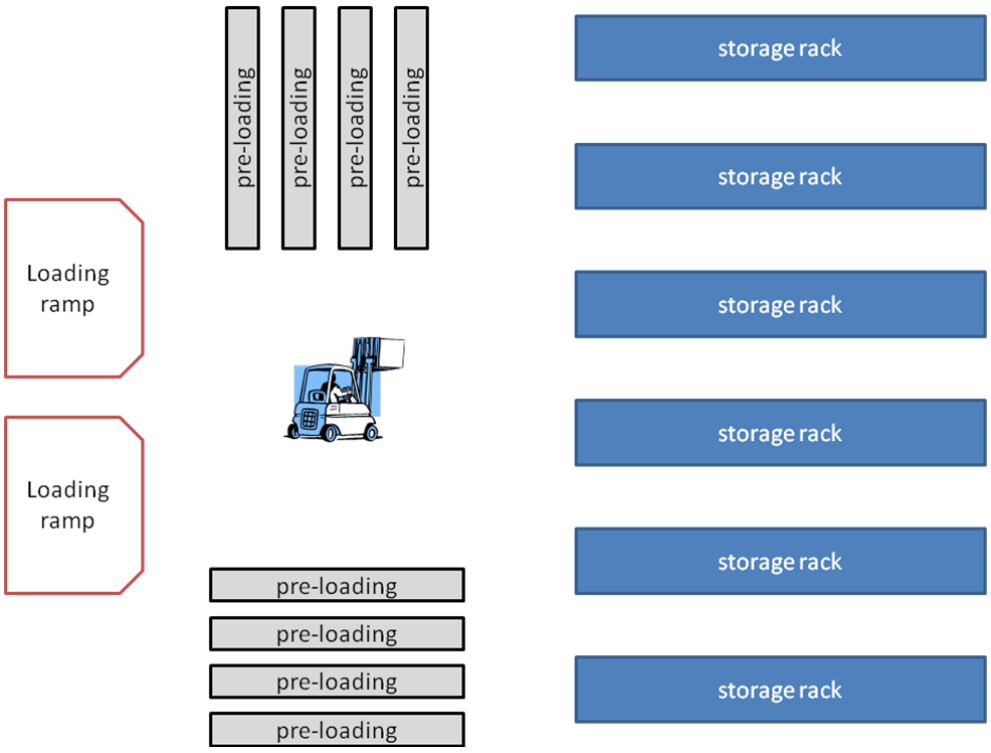

Figure 14: Draft of the intra-logistics scenario from the game

Initially the game starts with two types of transported goods: Palletized DIY-tools from leading power tool OEM and individually packed goods (mainly engines and spare parts). This selection is not fixed, especially not for the overall logistics LL. In order to get the participants started in the game, they are provided a small selection of goods. This selection can be extended later on, based on assumptions of the participants or to challenge the players. Therefore in the initial gaming sessions no dangerous / hazardous goods, no food or perishable goods are transported. This can as well be changed based on the experience gained while the LL cycles are performed and the participants building up more knowledge.

In order to ease the process and to learn about the gaming activity the mentioned steps (step 1 to 3) and the goods can also be used individually. Thus the game becomes less complex. In further LL cycles scenario steps and goods can be added, broadening the perspectives of the participants.

In addition, the given scenario environment can easily be extended if necessary or useful. This might be the case once the LL participants gained the knowledge or are familiar with certain, more complex warehouse environments. It would also be possible to add additional gaming scenarios to the game which cover e.g. different logistics environment or take a different set of stakeholders into account (or both) etc..

After the players got to know the scenario and the task this initial part will be completed by

five insights[5] on forklift caused damages and accidents. If necessary "starting questions" are presented[6] to the players in order to support the initiation of the active part for the players.

5.3.3 *Roles in the game (characters)*

As long as the LL is located at BIBA and is mainly frequented by non-experts the following roles are used. These roles equal the expected stakeholders of a risk monitoring service.

Each role is provided with "additional information" where the player is able to review documents, websites, videos and other artefacts in order to gain more insight and knowledge on certain topics related to his/her role. This "additional information" menu is provided individually to each role and the players will have access to this menu throughout the game. Optionally the facilitator can provide additional information by triggering events (events are explained in chapter 5.3.5). Such events can result in an interruption for all players or in additional information provided through the explained menu. The players are informed by a notification about additional information.

The **facilitator** is accompanying the game, introduces the scenario, he/she helps the players with starting the game and triggers events if possible or necessary. The facilitator should have knowledge about the scenario and the possibilities of the sensor tool kit used later on in the exploration phase of the LL cycle. As well as the facilitator should be familiar with the game's process and the events.

The **Manager** represents the company's overall interests and strategy. Of course he comes from the logistics department and therefore knows about certain aspects of the environment and general relevant facts of the transported goods.

The **quality management officer** is the expert for the existing processes and process relations. Additionally he knows the transported goods and its quality related attributes and therefore knows what influences the quality.

[5] Insights derived from this list: http://www.ccohs.ca/oshanswers/safety_haz/forklift/accident.html
[6] Such questions could be presented by using so called pop-ups or by an event.

The **forklift driver** is the main actor in the investigated scenario and therefore essential for this process. It is not expected that the forklift driver is an expert on technical aspects nor does he focus on strategic questions of his company. But as he will be mainly affected by the service and further knows most about the operational process his knowledge and experience is necessary. Besides, in order to create a service which is accepted afterwards, the forklift driver's participation should also lead to a higher acceptance of the service already before implementation.

The **technical expert** accompanies the process with his knowledge about sensors and actuators which could be used in the service. The expert will provide a list of hardware resources available or accessible based on budget limits. Further the expert will be involved in the whole process to ensure that he can give feedback to certain solutions developed. Due to the fact that that this process should also be able to be attended by non-experts for the specific service, the technical expert as a "normal" participant ensures as well that the knowledge base is enlarged.

The **representative of the Workers Council** is mainly involved to ensure that personal and privacy rights of the involved workers (forklift driver) are not violated. Of course it is expected that the player participates in the process as well with ideas and not only with focusing on the law side.

For every character a more detailed description is provided to the players within the game.

5.3.4 *Process steps*

The process steps have already been shown in Figure 13. In the appendix (see p. **Fehler! Textmarke nicht definiert.** et seq.) all process steps are given. Within this section one step will be explained exemplary.

In the Logistics Use Case Game there are 11 process steps which are mainly documents; nevertheless one process step is of type of action (see below). As an example process step 2 is used. This process step is a document which needs to be filled out by the users. It shows

process step 2 which treats the collection and description of risk situations.

Attribute	**Content**
Number	P2
Name	Risk situations
Scenario	LogRiMon
Group	RiMon-Group
Involved players	Manager, QM-officer and forklift driver (Works Council)
Step Order	1
Kind	**Document**
Dependency	None
Description	The manager, the QM-officer and the forklift driver discuss risk situations related to the (given) scenario and they develop an unsorted and unranked list of risks. [List of risks]
Description (to player)	Your first task is to gather risk situations you think about when imagining the given scenario of a warehouse and forklifts carrying cargo around. The manager is moderating the discussion and of course participates but he is in no position to judge about anyone's suggestions and ideas. You communicate with your team members (if necessary via Skype or a similar tool) to gather the information. If you need further insides on this topic remember the introduction and the given scenario. There is as well further information to be found in your personal menu. There you have as well the opportunity to use other tools (internet) for further research.

Table 2: Attributes of Process Step P02 – Risk Situations

In this process step the manager is the document owner and should involve the other users (his colleagues) into the editing of the document. Thus a discussion about risk should evolve. Furthermore the user should get to know the other roles and their main interest in terms of risk situations.

When observing the process steps (see **Fehler! Verweisquelle konnte nicht gefunden werden.** p. **Fehler! Textmarke nicht definiert.** et seq.) it can be seen that the according involved players to each step are different. For example in Process Step 9 "representation", which is also an *action* the forklift driver and the technical expert are the only involved roles. One reason that process step 9 is developed only by forklift driver and technical expert: the forklift driver is involved and the expert knows about the user interface and software. The steps before have been performed by (almost) all the stakeholders and the risks and their definitions have already been determined. Thus this step influences mainly on the forklift driver and the operational realization. As the forklift driver has to accept the service in order to reach a higher performance of the service, this constellation is selected to have the forklift driver having a high influence on the risk representation design.

5.3.5 *Events*

In this chapter one event for the logistics use case game scenario is explained, representative

for all events. All events are listed in the appendix (see **Fehler! Verweisquelle konnte nicht gefunden werden.**: **Fehler! Verweisquelle konnte nicht gefunden werden.**, p. **Fehler! Textmarke nicht definiert.** et seq.)

The used tables for the event characteristics still contain the three indicators costs, quality and time. As explained in section 4.2 it is not yet finally decided how these indicators could and would be considered for the game, due to the fact that such indicators might be (indirectly) interpreted as limitations. Therefore some of these indicators are still *to be defined* (tbd).

Some events are used to support the game process (e.g. events 1 – 4). Other events are focused on new insights to create new ideas (events 5 – 8). Still others aim at certain roles of players to refocus them to their tasks (events 10 – 12).

As an example event 6 is given. This event has two objectives. The main one is to provide new input about risk situations and a subsidiary objective is to keep users occupied and motivated which might not have too much work to do in a certain process step.

Name and # of event	E6: Forklift Drivers License
Description	This event contains a short 3 to 5 question enclosing questionnaire treating topics from the forklift driver's theoretical training.
Involved players	All (or only Forklift driver and Manager)
Costs	*2*
quality	*+10*
Time (generated)	*tbd (e.g. + 1 day)*
Associated documents	
Associated processes	
Add. information	This event provides two advantages: First the diversion increases and secondly the players learn about dangerous situations and dangerous behaviour and reactions with forklifts. This event's intent is to lead to a better understanding of risky situations.

Table 3: Event 6 - Forklift Drivers License

During the gaming sessions new events can be added by the facilitator. This was done e.g. while playing the game with the project partners at a workshop.

End of game and connection to the exploration phase

Once the game is finished the LL continues with the exploration phase. In this phase the results from the co-creation phase in general and the game in particular are used when the participants get in touch with the sensor tool kit. They use this tool kit first to experience the toolkit itself and afterwards to translate the results from the co-creation phase into the tool kit.

5.4 Acceptance, understanding and usability of serious gaming scenario

The SG has yet been used in LL workshops and was evaluated individually as well as concerning the IoT service which is developed. Parts of this evaluation are described in the ELLIOT deliverable 4.3.1 where data from logs and observation is analyzed and first conclusion for the further development of the LL process and its procedures are drawn.

First experiences with the SG designed for the logistics use case were made and feedback from LL participants is constantly taken into consideration when discussing the further development of either the game itself as well as the evolution of the LL process for the development of the risk monitoring service itself.

Due to its role in the co-creation phase of the Logistics Use Case and the fact that this is the first scenario of an SG developed in the ELLIOT project, the evaluation and improvement of the game is done not only connected to the LL process but as well separately in order to improve knowledge about the games usability in terms of the project.

Following impressions given are based on the first game scenario (with its particular process steps and events etc.) which was developed and played. This scenario can be adjusted during the future game development process in order to improve the game scenario. This means that based on finding and experiences with the game, process steps or events might be adjusted or reconfigured in terms of involved stakeholders, involved technologies etc. Such adjustments have already been made and therefore the presented scenario, process steps (in the upper sections) and findings presented in this section represent not the first initiation but already a higher level of development.

Acceptance

So far the acceptance of the serious gaming approach has been basically positive. Nevertheless some participants acknowledged some lack of motivation through playfully elements. Still all participants agreed that the motivation for this game is different to casual games and therefore they had a lower expectation and less need for such elements. Thus, participants mentioned, that they wouldn't devalue the game too much for this reason.

Further, participants agreed that the given process and used events helped them to proceed in order to achieve a solution rather than getting stuck due to a wrong focus or eternal discussions between the players. Still it was brought up that the gaming session need a different timing, either by reducing the time for each process step and / or by interrupting the process and proceed e.g. on another day / after a longer break.

Some participants added that the open character of this game approach supported them in being more open minded about new ideas. Due to a very low level of restrictions they felt

"freed" and didn't think too much about constraints. Despite, once the budget constraints were neglected by the facilitator still the objection about potential costs of high complex services occurred once in a while during the game.

Understanding

In terms of understanding the overall task of the game as well as the tasks defined by the process steps of occurring events no major issues could be detected. However, the finding and ranking of risk situations, based on the FERMA risk management process[7] appeared too complex to the participants as this undermined the general task, from the participants' point of view. Therefore the proportion of the risk management aspects was adjusted in order to maintain motivation while as well focusing on the main task which is the service development. The results from a later gaming session (without the LL focus) supported this adjustment which results in a lower orientation on the risk management process.

Usability

So far the usability of the game is dealing with some issues, mainly related to the used version 1.0. It is expected that some issues will be solved by the transformation into the new engine, be.mog 2.0 (see chapter 4).

Findings from the gaming sessions reveal some issues with the user interface. This means, for example, when using drop-down menus within a document after making the selection the page is reloaded and the user is presented the top of the page. This can disturb the filling of a form especially when the user has to scroll down again to edit document entries.

Due to usual browser window preferences of the users, pop-ups were blocked. Unfortunately events are demonstrated to the user most prominent by pop-ups, even though a separate list exists. Additionally it was experienced that the list of events isn't organised by time of occurrence. Both aspects, the pop-ups and the occurrence of events in the list, might need some modification. This will probably be treated by an improvement of the occurrence list. This way the event list indicates by enlarging that a new event occurred. Additionally, players will be spotlighted even more than already to the pop-up issue in order to change their browser settings.

Furthermore, a usual "class room challenge" could be experienced. Even though all tasks, down until the process step level, were explained, participants seem not to read carefully and therefore start acting and end up missing the objective of a task. Such "inattention" can either be encountered by selecting properly the users and/or by ensuring that the users have a strong interest in the particular game task. The usability of the game might be improved by giving

[7] For further details see: http://www.ferma.eu/risk-management/

more prominent hints about "what to do" to the users.

Overall it can be summarized that the usability could be improved and the new version of be.mog will support this process. Nevertheless, the game has been used successfully throughout full gaming sessions and the possibility to insert media content (like video clips) was positively acknowledged.

5.5 Further development of the logistics gaming scenario

Based on findings from the game evaluation as well as on the evaluation of the LL some major topics for the further development of the logistics use case gaming scenario were defined. Regarding the SG these topics are under discussion and where promising improvement is expected new features should be implemented.

Reducing Complexity, Example: Risk management process

As mentioned in the above section, a risk management, used to derive risk situations and a ranking of such, based on the FERMA risk management is used in the gaming scenario. However, it became clear, both by observation and by feedback from the participants, that this task takes the participants' minds off the main task of service development. Therefore the risk analysis and risk ranking was simplified. This is reasonable as the use case itself is focused on the service rather than the risk analysis. Still this aspect isn't neglected, because of its relevance. As well this is supported by the feedback of the participants. Even though the participants/users would reduce the complexity of the according process steps they stressed simultaneously the relevance of this task.

Improving Gamification and Motivation

In terms of gamification and motivation the main focus lies on adjusted process steps and new events. Both elements of the game can support the motivation of the players and the gamification of the scenario process itself.

With events motivation via playful actions could be supported. Such actions might provide a competition about a separate – but somehow related – task. While this doesn't focus on the main goal of the game task such events have to be used with consideration.

Due to the focus on creativity and creation, typical performance indicators like time, cost and quality are difficult to measure. Such indicators have been used before within the game engine but cannot be adopted one-to-one to every scenario. Therefore the development of corresponding and fitting indicators is an ongoing task.

6 Generic Serious Game Draft based on be.mog [HSR]

In this chapter a draft concept is presented for an SG that could support the co-creation of services, especially related to the Well Being Use Case of HSR for reasons of illustration. The game has been created in order to be as generic as possible and therefore useful to any case study or scenario that involves an IoT service or system.

6.1 The draft game concept

Given an innovative product, an IoT-embedded service (X) determined and described by the Serious Game Moderator (SG Moderator), and a series of objects/services (Y) which characteristics and qualities could provide an added value if applied to X (e.g. plush toy, iPhone, Lego, home, car, glasses, shoes, Facebook, hide and seek), the player accesses the SG for IoT co-creation in the following manner:

- Level 1: What do you like of X?

  The player moves up to level 2 if 10 other players (or SG Moderator) approve or vote him/her.

  The player also earns 10 points and the title of Attentive User

- Level 2: What do you not like of X?

  The player moves up to level 3 if 10 other players (or SG Moderator) approve or vote him/her.

  The player also earns 10 points and the title of Expert User

- Level 3: What is X missing?

  The player moves up to level 4 if 10 other players (or SG Moderator) approve or vote him/her.

  The player also earns 10 points and the title of Witty User

- Level 4: How would you solve the following problem (indicating the feedback of another player given in level 2)

  The player moves up to level 5 if 10 other players (or SG Moderator) approve or vote him/her.

  The player also earns 10 points and the title of Problem Solver

- Level 5: What could X do more if it were able to detect …. (provide a measurement that can be acquired by a random sensor).

- The player moves up to level 6 if 10 other players (or SG Moderator) approve or vote him/her.

  The player also earns 10 points and the title of Junior IoT Designer

- Level 6: What could X offer more of if it could … (provide an action out of a list of verbs).

  The player moves up to level 7 if 10 other players (or SG Moderator) approve or vote him/her.

  The player also earns 10 points and the title of Senior IoT Designer

- Level 7: How would you improve the … aspect of the service (provide a list of KPI from KSB Model).

  The player wins if 10 other players (or SG Moderator) approve or vote him/her.

  The player also earns 10 points and the title of Innovator

- Level 8: How would you solve the following problem … (indicating the feedback of another player given in level 3)

  The player wins if 10 other players (or SG Moderator) approve or vote him/her.

  The player also earns 10 points and the title of Chief Innovator

Bonus Level: to be randomly inserted between 2 levels for each player

- Bonus Level (phase A): Describe object Y with 5 adjectives.
- Bonus Level (phase B): In what way could object X be "A" (player selects one adjective – A - among the 5 given to define object Y)?

Player earns 50 points if other 10 players (or the SG Moderator) approve or vote him/her.

If a player does not suggest an answer within a week to the question posed by the level he/she is at, he/she loses a title.

Objectives of Co-Creation	SG elements that respond to objectives	Principles of game mechanics embraced
Understand user requirements, likes and dislikes, attitudes and behaviours	Level 1 Level 2 Level 4 Bonus A	- Players take turns - Game is divided in increasingly more challenging levels - Presence of a progress bar/timeline - Game within a game - Unexpected elements - Reward system
Generate the greatest number of ideas	Level 5 Level 6	
Understand the limitations of the service and generate ideas in order to improve User eXperience	Level 7 Bonus B	
Fine-tune solutions that respond to previously identified user requirements	Level 3 Level 8	

Table 4: The well being serious game draft corresponding objectives of co-creation

6.2 Integration with Be.mog engine

The basic process of the game proposed and its most important nodes of interactions are presented in the image below, in order to understand the feasibility and instantiation of the SG previously described using the Be.mog engine.

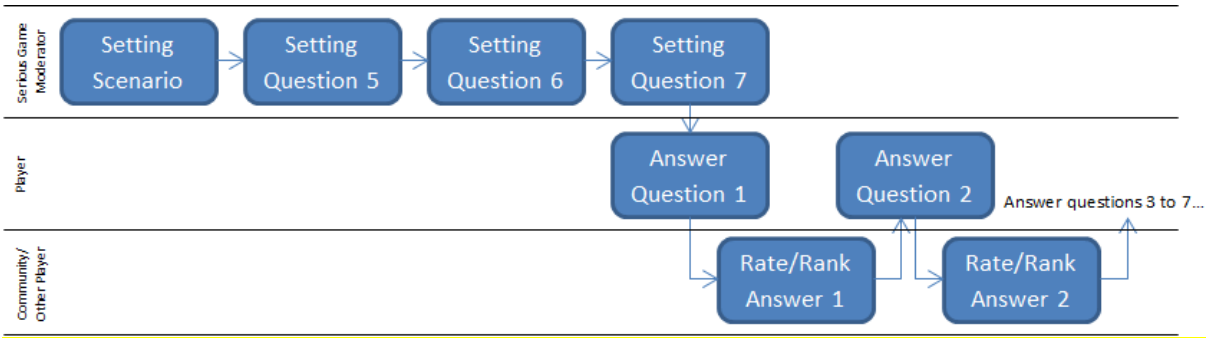

Figure 15: Swimlane Diagram of Well Being Game Draft

As it can be noticed, each player is able to develop his/her game concurrently to other players in the community.

6.3 SG Moderator actions

The SG Moderator decides when to commence and end a game. In order to create a new game, the following four steps must be followed:

- Description of the Scenario: A title must be given to the game, and the scenario must be communicated via a textual description, images and/or multimedia content.
- Parameters for question 5 must be set: The SG Moderator is given the opportunity of limiting the player's area of investigation of the service in the question concerning the sensing of the IoT System *"What could the service do more if it were able to detect <sensor>?"*. For this reason, the SG Moderator will be provided with a checkbox interface that will allow him/her to select or ignore the sensors to be presented in the <sensor> variable. The table below represents an example of the checkbox that could be presented in the interface:

☐ Sounds	☐ Orientation	☐ Temperature	☐ Smell
☐ Voice	☐ Acceleration	☐ Rain	☐ Sleep
☐ Noise	☐ Motion	☐ Wind	☐ Heartbeat
☐ Colors	☐ Position	☐ Humidity	☐ Oxygen
☐ Light	☐ Inclination	☐ Altimetry	☐ CO2
☐ People	☐ Proximity	☐ Quakes	☐ Ozone
☐ Objects	☐ Touch	☐ Magnetic level	☐ Viscosity
☐ Emotion	☐ Pressure	☐ Flame	☐ Alarm
☐ Presence	☐ Twist	☐ Heat flux	☐ Calories

Table 5: Examples of parameters which can be detected through sensors

- Parameters for question 6 must be set: As in the case of the previous question, the SG Moderator can access an interface through which he/she can select the parameters relative to question 6 "*What could the service offer more of if it could <action>?*":

□ Advertise	□ Analyze	□ Classify	□ Enable	□ Create
□ Authorize	□ Answer	□ Co-operate	□ Compare	□ Critique
□ Award	□ Build	□ Coach	□ Compile	□ Cultivate
□ Balance	□ Bought	□ Capture	□ Coordinate	□ Decide
□ Calculate	□ Check	□ Take Care	□ Copy	□ Defend
□ Calibrate	□ Check in	□ Catalogue	□ Control	□ Delegate
□ Categorize	□ Diagnose	□ Employ	□ Convert	□ Deliver
□ Discharge	□ Distinguish	□ Encourage	□ Evaluate	□ Expedite
□ Display	□ Distribute	□ Enforce	□ Examine	□ Experiment
□ Discover	□ Diversify	□ Engineer	□ Exchange	□ Explain
□ Edit	□ Document	□ Enhance	□ Execute	□ Explore
□ Familiarize	□ Present	□ Prepare	□ Extract	□ Impart
□ Filter	□ Draft	□ Enlarge	□ Exercise	□ Forecast
□ Finalize	□ Draw	□ Identify	□ Exhibit	□ Extend
□ Fine-tune	□ Furnish	□ Write	□ Help	□ Observe
□ Found	□ Move	□ Fabricate	□ Foster	□ Obtain
□ Fund	□ Implement	□ Facilitate	□ Illustrate	□ Walk

Table 6: Selectable actions which the SG Moderator can select to structure question 6

- Parameters for question 7 must be set: The aim of Question 7 is to generate ideas able to improve the user experience of a given service, in relation to the KPIs of the KSB model. *"How can you improve the <KPI> aspect of the service?"*. In the setting of this question, the SG Moderator must select those KPIs that represent the aspect which were perceived as weak points in the evaluation phase throughout the observation of the User eXperience. Theoretically such feedback could be derived automatically from the Elliot Experiential Platform:

Human computer interaction	*How to design human-machine interfaces and cognitive artefacts so that human performance is sustained in work environments where information may be unreliable, events may be difficult to predict, multiple simultaneous goals may be in conflict, and performance may be time constrained.*
Team cognitive process	*Cognitive processes may be distributed across the members of a social group. Collaborative Tagging or Group Blogging are examples of technological support for distributed cognition.*
Cognitive coordination	*Cognitive processes may be distributed in the sense that the operation of the cognitive system involves coordination between internal and external (material or environmental) structure.*
Shared cognition and off-loading	*Shared cognition is that which is shared among people through common activity such as conversation where there is a constant change of cognition based on the other person's responses. Sometime, the cognitive duties are off-loaded to a dedicated technological artefact, such as a calculator for computing numbers.*
Social Networking	*Ability to establish positive social (interpersonal) ties as information carrying connections among people (social networking).*
Communication	*Interact with one another (dyad) or two other persons (triad) or even more individuals (social group such as user communities)*
Collaboration	*Sharing knowledge for the common purpose of collective production.*
Usefulness	*In economics, utility is a measure of relative satisfaction. It refers to the total satisfaction received by a consumer from consuming a good or service. Utility is often modelled to be affected by consumption of various goods and services, possession of wealth and spending of leisure time.*
Emotional connection	*the affinity the user feels for an object that appeals to him, due to the formation of an emotional connection with the object. Norman (2005) in his book "Emotional design" shows that design of most objects are perceived on all three dimensions (visceral, behavioural and reflective level).*
Affordability	*Economic appraisal*
……..	

Table 7: A sample of KPIs (derived from the KSB Model) selectable by the SG Moderator to structure question 7

- Parameters for the 'Bonus' question must be set: with the bonus question (which in a 1.0 version of the SG could be an integrated part and could therefore become a level like any other) the SG Moderator's objective is to covey the experience that characterizes a widely recognized object/service/game/… and apply this to the service in question. The SG Moderator must insert in 5 textboxes 5 well-known objects/services/games/… (e.g. plush toy, iPhone, Lego, home, car, a pair of glasses, a pair of running shoes, Facebook, hide and seek, hopscotch). The player will be asked the question: *"Describe <object> with 5 adjectives"*. One of the answers to this question will be randomly picked and combined to the following question: "*In what*

way could the service be more <adjective>?".

6.4 Player actions

The player can begin to play once all the parameters have been set and the SG Moderator launches the game. The SG proposed does not have a specific target as previously mentioned and in order to start playing the player must simple register himself/herself. Each player's session is independent from other player's, apart from the levelling system for which one's answer must be rated or ranked by the other uses of the community in order to advance level, which means that each player has the right/obligation to vote the idea of other players. Voting could be a separate phase between levels, and mandatory to pass form one level to the other.

6.5 Be.mog engine upgrade requirements

In order to develop and deploy the SG proposed, a series of new functions must be implemented by the Be.mog engine:

- SG Moderator backend pages: to make the scenario and questions settable, it is necessary for the moderator to be able to launch new games, new scenarios and initiate new play sessions. For this reason the moderator must be able to access and manage all pages concerning the setting of the parameters of the various questions.
- Points system: In order to implement the principles of game mechanics, a point system must be introduced which requires the game's ability of assigning points to players which are then able to advance level throughout the game. At the moment a very simple and basic point system has been imagined (which could evolve in the future), and which articulates itself as an escalation of conferment of titles.

6.6 Users/players – how to organize serious gaming

Any sort of user, with any cultural or knowledge background, can participate to the Co-creation phase and therefore can interact with the SGs proposed. Such games could be published on the research centre's main website or be on a specifically-designed SG website. Users can play any time they want. Users can be invited to participate randomly via communication campaigns (in the case of HSR, via fixed ads positioned strategically in the hospital grounds) or can be recruited by research members and SG Administrator personally via face-to-face or e-mail invitations. In the working hypothesis of an unbranded website offering a collection of SGs, publicity could be organized across other channels including relevant sector websites and literature.

7 Applicability of the serious gaming approach for IoT oriented Co-Creation

As stated in chapter 3 SGs are useful to acquire requirements, nevertheless they only form a part of the requirements engineering and shouldn't be seen as "stand-alone" approach. Further the human involvement in such approach needs to be carefully attended. Based on preliminary findings from this deliverable a final insight on literature about serious gaming, IoT and co-creation is given. Further, findings from the implementation of the SG in the logistics Use Case will be outlined. Finally an outlook on the applicability of the serious gaming approach in the Use Cases is given. This outlook uses as well results from an ELLIOT workshop held in February 2012.

7.1 Findings from literature [INRIA]

We performed different search queries to find some literature review about SGs related to Co-Creation and/or IoT. On the IEEE Xplore database, we found 34 articles with the following *query ((("serious game") OR "serious gaming")) AND ("internet of things")* and on the INSPEC database we found nothing with the two following queries *"serious gam*" AND ("internet of thing*" OR RFID OR IOT)* and *"serious gam*" AND (cocreation OR co-creation OR "co creation")*, 8 articles with *"serious gam*" AND "user experience"* and 8 articles with *"serious gam*" AND sensor*.

We tried also to investigate relations between serious gaming and co-creation methods during the ideation phase: we performed on INSPEC the following query "serious gam*" AND (ideation OR "idea generation" OR brainstorming) with only 2 articles, among them a reference to RefQuest (Duin & Hauge, 2008). On ScienceDirect, the same query gives us 123 articles, refined with the keyword "sensor", we found 21 articles which could be related to our present report.

So, among the results of IEEE Xplore and ScienceDirect, we have selected only the following articles that put lights on the use of body sensor data or mobile sensor data into SGs, in order to strengthen the context awareness and the fulfilment of gamers' goals (some interesting sentences in the abstracts are highlighted)

Alenka Poplin,

Playful public participation in urban planning: A case study for online serious games, Computers, Environment and Urban Systems, Available online 16 December 2011,

***Abstract**: The aim of this paper is to study the implementation of online games to encourage public participation in urban planning. Its theoretical foundations are based on previous work in public*

participatory geographical information systems (PP GISs), play and games, with a special focus on serious games. Serious games aim to support learning processes in a new, more playful way. We developed the concept of playful public participation in urban planning, including playful elements such as storytelling, walking and moving, sketching, drawing, and games. A group of students designed an online serious public participatory game entitled NextCampus. The case study used in NextCampus was taken from the real-world question of a possible move of a university campus to a new location in the city of Hamburg, Germany. The development of the serious public participatory game NextCampus resulted in a physical prototype, user interface design, and a computational model of the game. The NextCampus game was tested with the help of two groups of urban planning students and presented to three external experts who provided valuable recommendations for further development. The critical comments questioned the level of complexity involved in such games. The positive comments included recognition of the potential for joy and the playfulness a game like NextCampus could evoke.

***Keywords**: Playful public participation; Urban planning; Serious online games; Game design; Game testing*

Adérito Marcos, Nelson Zagalo,
Instantiating the creation process in digital art for serious games design, Entertainment Computing, Volume 2, Issue 2, 2011, Pages 143-148,
***Abstract**: The creation process in digital art relies often on collaborations between an artist (or group of artists) and a multidisciplinary team. This collaboration implies a multidisciplinary work involving art, science, technology, design, psychology, etc. that come together by sharing a common communicational and informational space.*
In this essay we bring into discussion how the creation process cycle in digital art could be instantiated and applied for the development of serious games through end-user purposes of both creative authors: the digital artists and the serious games developers. We realise a comprehensive analysis of this creation process in digital art, specially the aesthetic musing activity, while devising how it could be helpful to introduce new engaging stimulus in the creative process of serious games.
***Keywords**: Digital art; Serious games; Creation process cycle; Aesthetic musing; Artefact*

Sung Ah Kim, Dongyoun Shin, Yoon Choe, Thomas Seibert, Steffen P. Walz,
Integrated energy monitoring and visualization system for Smart Green City development: Designing a spatial information integrated energy monitoring model in the context of massive data management on a web based platform, Automation in Construction, Volume 22, March 2012, Pages 51-59,
***Abstract**: U-Eco City is a research and development project initiated by the Korean government. The project's objective is the monitoring and visualization of aggregated and real time states of various energy usages represented by location-based sensor data accrued from city to building scale. The platform's middleware will retrieve geospatial data from a GIS database and sensor data from the individual sensory installed over the city and provide the browser-based client with the accommodated information suitable to display geo-location characteristics specific to the respective energy usage. The client will be capable of processing and displaying real time and aggregated data in different dimensions such as time, location, level of detail, mode of visualization, etc. The platform's middleware has been developed into an operative, advanced prototype, providing information to a Web-based client that integrates and interfaces with the Google Earth and Google Maps plug-ins for geospatially referenced energy usage visualization and monitoring.*
***Keywords**: Energy monitoring; Data visualization; Smart Green City; Spatial information model; EnerISS; Social sensing*

Schmitz, M. & Moniri, M. Burgomaster and Pedro
A Pervasive Multi-Player Game for Rural Tourism
Games and Virtual Worlds for Serious Applications, 2009. VS-GAMES '09. Conference in, 2009, 205 -208

***Abstract**: Pervasive games have the potential to add new qualities to otherwise possibly tedious or uninspiring areas and let users interact with their environment in novel and enjoyable ways. The spreading of wireless communication infrastructures and low cost programmable mobile devices equipped with positioning systems and cameras span a large and growing open playground for pervasive gaming applications. In this work we describe the game Burgomaster and Pedro, the result of an interdisciplinary project for the state Ministry of Environment to promote development and tourism of rural areas. It is a multiplayer game that requires its players to explore villages in order to find real and virtual objects, which have to be delivered to given destinations. It also allows to hide from or seek other players, since objects that are being delivered can be stolen by competitors. GPS positioning, wireless communication and visual marker recognition are the key technologies in this game that is designed for playful engagement with rural environments.*
***Keywords:** GPS positioning;Pedro;pervasive multiplayer game;positioning system;programmable mobile devices;rural tourism;visual marker recognition;wireless communication infrastructure;computer games;travel industry;ubiquitous computing*

Budde, A. & Michahelles, F.
Product Empire; Serious play with barcodes
Internet of Things (IOT), 2010, 2010, 1 -7
***Abstract**: Despite the ubiquity of barcodes there exists no common product repository available today linking product master data to the corresponding barcodes. This paper proposes a social network game (Product Empire) that motivates users to scan barcodes and to enter basic product information, such as product name, brand and category and to upload a picture of the product. This user-generated product repository aims at providing a base to link real world objects with virtual information. After a first prototype has been implemented and applied in an informative user study we released an improved version to the public on the android market. Within 17 days 244 users have generated more than 990 product descriptions and cross checked product data 1230 times. These results show the potential of generating an open product repository by motivating users with a game approach related to social network games.*
***Keywords** : android market;barcode scan;basic product information;product empire;product master data;prototype;social network game;ubiquity;user-generated product repository;virtual information;bar codes;computer games;production engineering computing;social networking (online);virtual prototyping*

Hardy, S.; El Saddik, A.; Gobel, S. & Steinmetz, R.
Context aware serious games framework for sport and health.
2011 IEEE International Symposium on Medical Measurements and Applications (MeMeA 2011). Bari, Italy, 2011
***Abstract**: Serious Games for Sport and Health are a promising chance to help people to improve their health. In this paper, we address the challenges of adding context awareness to Serious Games for Sport and Health. We propose a framework for social networks and web services that is specialized in capturing temporal and spatial context as well as vital parameters of a user. Our framework dynamically maps necessary e-Health services such as exergames. In this way, we assist a user to find the most appropriate health services according to his/her needs at anytime and anywhere. We present our initial proof of concept implementation of the framework, which includes new sensor based Serious Games for Sport and Health as well as our test results.*
***Keywords**: sport ; social networks ; Web services ; e-Health services ; context aware serious games framework*

The following picture represents finally the different SGs projects we put emphasis on in the

chapter 3 and 9. According to their abstracts and the understanding of their paper's contents, we related these projects with several keywords to find relationship between them. The green spheres represent SGs Projects related to environmental issues and the red ones represent more general SGs using IoT elements.

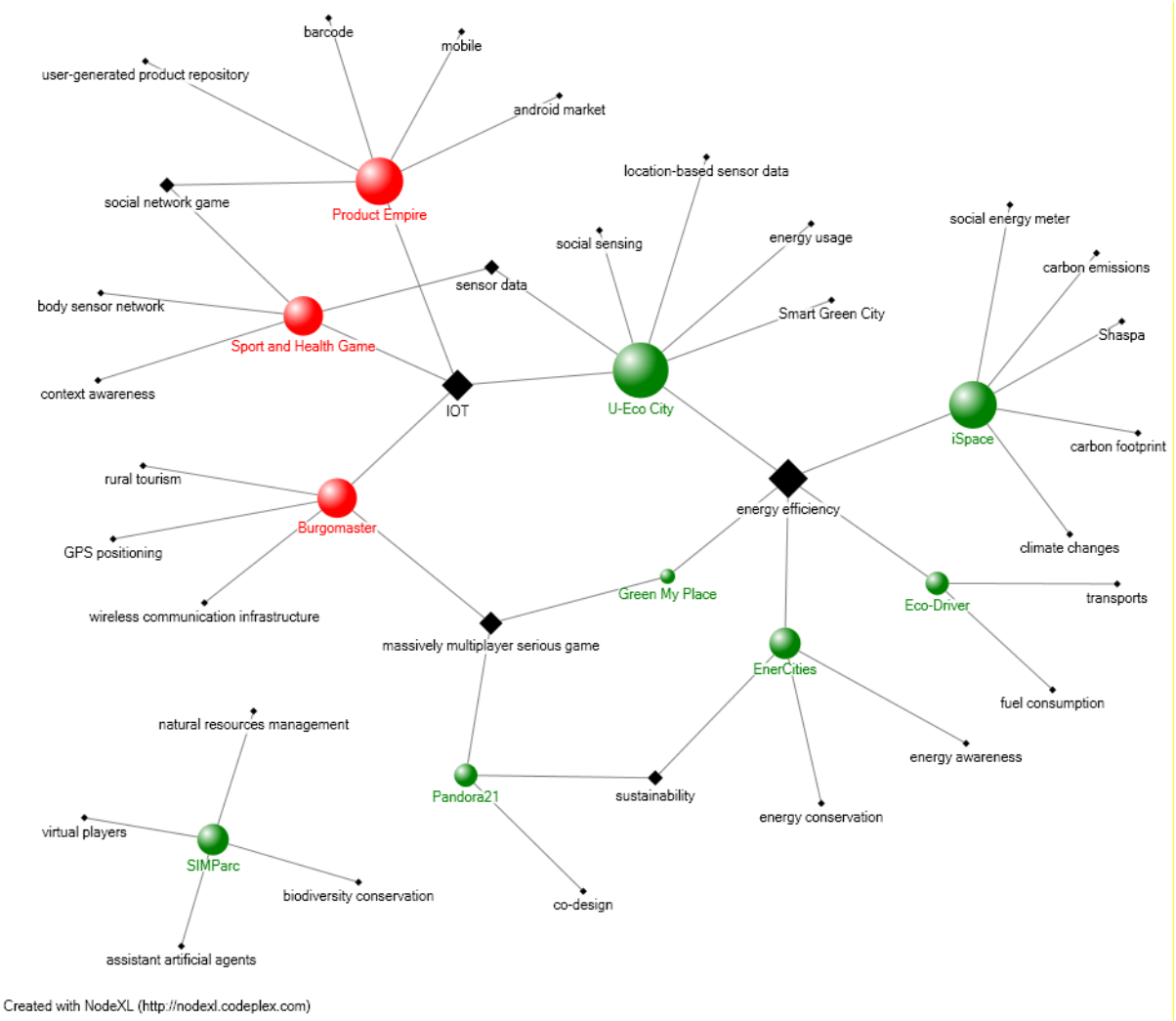

Figure 16: Serious Games projects using IoT elements and relationships between them

All these projects use IoT elements such as sensor data, GPS and mobile sensors to better help contextualization and ease of use for the gamers. In our search, we didn't find specific SGs dedicated to IoT, IoT elements are mostly seen as a mean to perform SGs tasks. One trend to notice is the convergence of geolocalization and social networks in the use of SGs dedicated to green services and eco-citizen.

7.2 Findings from the Serious Game in the Logistics Use Case [BIBA]

The SG has already been used in the LL workshops and game results were transferred into the exploration phase of the LL. Furthermore the developed game was analysed from a

different perspective than in this section. This section focuses on the support of the game for IoT oriented co-creation.

When looking at existing SGs which use IoT, IoT is used as a tool to ease the SG rather than to become part of the game result or its goal (see section 7.1). In such cases it is already stated how the IoT technologies are used (Smartphone's with GPS and cameras to localize and take pictures) and their utilization is known. This is different in terms of the logistics use case, as the sensor toolkit is a totally new 'device' and their utilization and implementation into a new service is the main objective. Thus the role of IoT is totally different in this case.

Within the ELLIOT LLs IoT oriented services are co-created by users. These users are usually not experts in the field of service development or in using special IoT technologies. Difficulties to properly acquire requirements are well known. In such an environment, where users are developing services on their own with technologies which are new to them, the proper collection of requirements is even more important. Such situation is given in the ELLIOT LLs. The potential of SGs as a tool for requirements engineering was examined in chapter 3. Even though SGs cannot be seen as a stand-alone and comprehensive tool to do requirements engineering, they can be used to elicit requirements in the first place.

The potential of using SGs for IoT oriented co-creation lies in its potential to support the elicitation of requirements. When persons without or with a low knowledge about creativity techniques are coming together to develop new products or services, they probably would appreciate support. Within the Logistics Use Case the LL participants stated very clearly that the SG and its underlying process helped them to proceed with the task without knowing exactly how to perform the task at the beginning of the game. Regarding the Logistics Use Case, the serous game provides the opportunity to get non-experts and student – and even experts – working together.

In terms of applying the game into the ELLIOT LL's co-creation phase the results as well as later analysis supported the utilization of the game for the ideation process. The game structures this process and provides the possibility to support the game users (and therefore the LL participants) to develop new ideas. Furthermore the result of the game in terms of a sensor service, even if less complex, can be transferred and be used outside the game itself. Additionally not only the IoT sensor service but as well the knowledge about risk situations supports the overall development process in the LL.

Looking at the IoT orientation of the service which is developed, it needs to be realized that the game isn't directly connected with the service yet. But results and the outlook on future evolution of the service illustrated development potential. If it is possible to develop an interface which connects the game with the Arduino toolkit used in the LL, such approach

would further improve the advantage of having an SG for the co-creation phase.

A side effect of using the SG is its support in terms of observation. The SG can easily be logged. By doing this, process step results and message board (chat) entries can be examined. For example a text mining tool can be used to derive major topics of the user's discussions. Investigating and analyzing this data can give valuable hints for the adjustment of the LL as well as for the IoT service.

7.3 Outlook on generic applicability of the serious gaming approach derived from Game Draft

When looking at literature IoT games with relation to health and green services do exist. Such a SG approach to support IoT oriented user co-creation seems to have potential. In terms of the logistics use case the relation between the IoT service and the game seems different as such in this case the co-creation phase is supported by the game for the ideation process, but the involvement of IoT might be even higher in other scenarios.

When examining the utilization of SGs in Health Care it is obvious that SGs already became an important tool to support especially training and behavioural change; for both, professionals and patients. However, SGs in healthcare for co-creation were not found.

Taking into account the architecture of the City of the Future LL the implementation of an SG to support IoT oriented user co-creation was considered as a supporting tool. With the draft concept of an SG in chapter 8 the idea about how a generic SG could look like was presented. This concept shows that an SG seems applicable in this Use Case and in the LL environment.

The Healthcare / Well Being Use Case illustrates that the usefulness of SGs to support co-creation is more likely dependent on the purpose and case rather than the field of application. For example, using an SG for requirements engineering to create a new medical product (e.g. surgical instruments) would not be appropriate but rather jeopardous. Instead using SGs to co-create a service for patients which is not threatening the patient is a reasonable approach.

Examining the Healthcare / Well Being game concept draft and LL further application potential surface. Once similar surroundings are in place in other use cases, such approach could be easily transferred and adjusted to another LL and therefore another service development. This example shows that a generic approach of a game scenario, like in the HSR LL, can be one solution. The more specific solution used in the Logistics Use Case represents another approach. Both approaches can be used alone in terms of the LL or can as well be combined.

The utilization of more than one SG for solving a task was shown in the EU COIN project with the games SECONDS and refQuest (Zarvić et al. 2009). SECONDS was used to collect an initial set of requirements while refQuest was used to refine this initial set. With the presented game scenarios such constellation could be realized as well; in this particular case more within the Logistics Use Case, as no other ELLIOT Use Case scenario for the be.mog engine exists so far. The Logistics Game would collect an initial set of requirements. By implementing the Healthcare / Well Being draft into a gaming scenario this game could be used to evaluate and improve a service which was built based on the initial set.

8 Conclusion

Serious Games (SGs) are used throughout various disciplines and for different purposes, but mainly for education, learning and behavioural change. Nevertheless, some examples were presented that games can be used for ideation and co-creation processes.

The analysis of the potential of SGs for requirements engineering gave more insight on the potential usage in terms of the ELLIOT project. Requirements of users are needed to improve products and services. It was shown that the usage of SGs can be helpful for the elicitation of requirements. Therefore SGs can be one tool to improve the requirements acquisition.

Within the project the be.mog engine from BIBA was selected for further investigation of the SG approach to support IoT oriented co-creation. The engine has already been used for ideation gaming scenarios and was therefore a reasonable selection for further investigation. By developing a unique gaming scenario according to the needs of the Logistics Use Case, an SG individually adjusted is now used within the logistics Living Lab (LL).

As part of the Co-Creation phase the SG's potential was examined. First results from LL and project workshops were promising and further investigation to improve the gaming scenario will be performed. Even though it needs to be taken into account that adjustments and customizations of the gaming engine depend on their scope and practicability.

The detailed explanation of the engine as well as of the scenario development helps to understand possibilities as well as boundaries of the engine. Additionally, these explanations support others to develop and customize a proper gaming scenario according to their needs. Thus, combined with a held Serious Gaming Workshop, project partners are put in a position to use the be.mog engine for their own purposes.

Within the Logistics Use Case the SG approach was successfully implemented. Nevertheless, some limitations were found; fist, in terms of the engine as described in section 5.4 and second, in terms of the embedding into the LL. This supports the findings from chapter 3, that SGs can be a tool for supporting the requirements engineering process especially for the elicitation of requirements. However, the utilization of an SG needs to fit into the LL environment in the first place and secondly a proper game development and adjustment is needed in order to benefit from an SG.

Based on the findings presented in section **Fehler! Verweisquelle konnte nicht gefunden werden.** and the knowledge about the be.mog engine a more generic concept for an SG scenario was drafted, based on the needs of the City of the Future LL (HSR, chapter 6). This concept and the logistics LL game scenario show that two different game objectives can be

used to support the co-creation of services. The selected approach from the City of the Future LL seems promising; results from a project workshop support this assumption. However, some changes would have to be made to the be.mog engine in order to implement the scenario as described.

Finally, chapter 7 outlined limitations and possibilities how SGs can support IoT oriented co-creation. It is necessary to understand to what extend SGs can potentially support co-creation. It was outlined that main advantages of SGs are the support of the early phase of requirements engineering and the potential to encourage non-experts to participate in co-creative processes like in the LLs. Furthermore the SG approach could be used for case specific purpose or in a generic manner as well. By combining different game concepts the usage can as well be expanded. For each Use Case and purpose an adequate approach for the implementation of SGs needs to be elaborated.

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