Implementation model for the gamification of business processes

A study from the field of material handling

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Abstract Gamification, as opposed to serious gaming, focuses on the integration of certain elements and mechanics from the field of gaming and game design into an existing (non-gaming) environment. Typical game design models do not meet the requirements of implementing a gamification application in total because they focus on the development of a holistic game. An implementation model for the gamification of business processes should focus on the integration of game elements and mechanics into an existing work context instead. An implementation model was designed to fulfill these demands and will be presented in this paper. The so called GameLog Model can be divided into three major phases: The *Analysis and Exploration* phase, the *Design and Realization* phase and the *Evaluation and Reflection* phase. Within the *Analysis and Exploration* phase, the context that should be gamified is described on a granular level to find integration points for the game elements that do not change the process. In the *Design and Realization* phase, the gamification application is developed and implemented in the non-gaming context. During the *Evaluation and Reflection* phase, the success of the application, as well as the acceptance of the employees, is measured. Results lead to a possible re-design. The model was evaluated by designing and testing a gamification application for the field of material handling. The gamification prototype was created for the process of manual order picking. Significant results could be achieved in fostering motivation and improving performance among workers in this process. Hence, the introduced model does work to successfully implement a gamification application into a business process. Gamification can also be seen as a useful approach to foster motivation and increase the performance of employees.

1 Gamification

Gamification is an approach to foster motivation, engagement, learning, or problem-solving activities in non-gaming, real world contexts (Kapp, 2012). The concept originally derives from marketing and has been applied in context areas to motivate employees, engage customers, or change specific behaviors (Werbach & Hunter, 2012). The basic idea of gamification is to apply game design elements in the above-mentioned non-game contexts (Deterding et al., 2011). Exemplary game elements are points, badges, leaderboards or levels (cf. Kapp, 2012; Werbach & Hunter, 2012). It is expected that these elements from games, which are normally meant to entertain players, can help to use the appeal of games for the immersion of people in working or learning experiences.
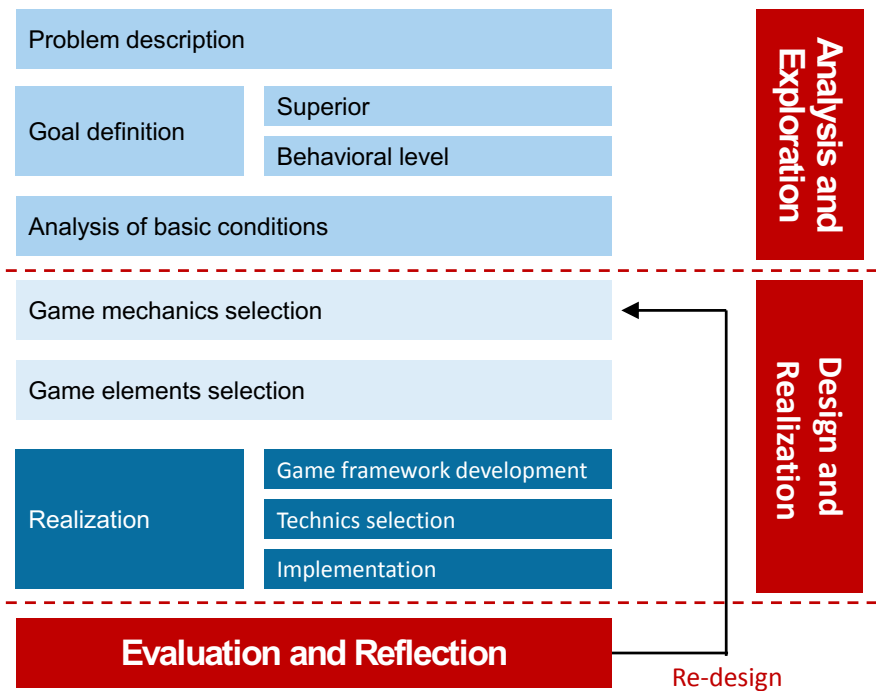
As gamification does not require the development of a holistic game, existing game-design models can not be used one-to-one. They focus on the creation of a complete game in an open context. So for the integration of gamification in business processes an implementation model is needed that on the one hand helps do develop game mechanics and game dynamics, but on the other hand focusses on the analysis of the possibilities to include the specific game elements into existing business processes and environments.

In this paper an implementation model will be described that was designed and tested in the development of a gamification application for the material handling process of manual order picking. Following chapters will describe the implementation model (2), the usage of the model to design a gamification application (3) and the results and findings within this process (4).

2 Implementation model for the gamification of business processes (The GameLog Model)

To implement gamification into business processes, a procedure or implementation model is helpfull. That model should not focus on the design of games, but on the enrichment of business processes with game mechanics and game elements. As gamification deals with existing (business) processes, it is necessary to take a closer look at these existing processes and business structures within the designing and implementation of a gamification application.

A model (The GameLog Model) was designed to implement gamification into business processes. It consists of three separate steps which should be passed one by one: *Analysis and Exploration*, *Design and Realization* and *Evaluation and Reflection*. An overview of the implementation model is shown in *Figure 1*. These major phases where created referring to existing design and implementation models like the waterfall model (Mall, 2009) or the Deming Cycle (Deming, 2000).

Problem description

Goal definition | Superior
| Behavioral level

Analysis of basic conditions

Analysis and Exploration

Game mechanics selection

Game elements selection

Realization | Game framework development
| Technics selection
| Implementation

Design and Realization

Evaluation and Reflection

Re-design

Figure 1: GameLog Model: Impementation model for the gamification of business processes

In the following, the GameLog Model will be described by means of the three comprising phases.

2.1 Analysis and Exploration

To start the development of a gamification application, it is necessary to understand the problem that should be solved or the situation that should be changed by using gamification. Within the *problem description* phase, a distinct description of the certain problem or starting situation is issued. Without a clear description, it is not guaranteed that the next model steps will lead to the claimed results.

Based on the *problem description,* the goals of gamification are defined in the *goal definition* phase. Two different aspects have to be taken into account: *superior goals* and *goals on the behavioral level*. *Superior goals* are directly related to the problem(s). It is the translation and rewriting of the addressed problem(s) into the demanded results. Those can be defined from the view of employers and employees. It is important to take the view of the employees (the employees) into account to guarantee the success of the gamification application. Existing key performance indicators can be used to define the superior goals and be used for

performance measurement after the implementation. *Goals on the behavioral level* describe the specific behavioral change that should be achieved within the employees. It cannot be measured by direct quantitative indicators. Qualitative goals fall into this category. *Goals on the behavioral level* directly refer to the addressed employees.

One of the most important steps for the successful implementation of a gamification application into a business process is the *analysis of basic conditions*. The following question needs to be answered here: How can the gamification application be integrated into the existing work context without changing the process execution? The possibilities of integrating game elements into the work context are identified. Therefore, the process is documented on a very granular level. That means, all tasks the employee has to fulfill during the execution of his routine have to be documented. This helps to create a gamification application that can be integrated into the work process without changing it. Hence, the employee can choose for himself whether he wants to participate in the gamification or not. This supports the creation of intrinsic motivation, which in turn helps to reach the demanded goals (Cameron, 2006). Additionally, possibilities to integrate the gamification application into the technical operational system and the organizational structure of the company have to be identified.
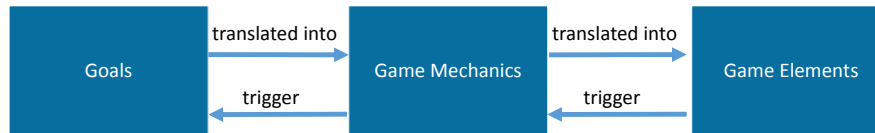
2.2 Design and Realization

After having analyzed the work context and its process execution on a granular level, the gamification application itself is developed and implemented. This is undertaken in the *Design and Realization* phase.

The *game mechanics selection* is the first step to developing the application. The results of the *goal definition* are depicted in the game mechanics. There are different definitions to be found for game mechanics. Hunicke., LeBlanc and Zubek (2004) describe the mechanic of a game as the "various actions, behaviors and control mechanisms afforded to the player within a game context" (Hunicke et al., 2004, p. 3). Another definition is given by Salen and Zimmermann (2004). They describe game mechanics as the "essential play activities players perform again and again and again" (Salem & Zimmermann, 2004). To break it down for gamification, it is necessary to understand game mechanics within the context of gamification. Mechanics do not refer to explicit activities in that context, but to the mechanisms that trigger the defined goals and make the user change his behavior in that direction. Mechanics in that context could be collaboration, competition, character development, feedback or concrete objectives.

Once game mechanics are defined, game elements are selected to trigger these mechanics. *Game element selection* defines the basis of the gameplay of the gamification application. Game elements trigger the chosen game mechanics. Thus, goals, game mechanics and game elements build a direct causal link with each

other, which can be found in *Figure 2*. Game elements can be, for example, points, badges, high score lists, performance graphs or avatars.

Figure 2: *Causal link between goals, game mechanics and game elements*

The next step in the *design and realization* phase is the *realization* itself. It starts with *game framework development*. The framework consist of the rules and the theme of the game. The rules consolidate the game elements into an overall concept. The dynamic of the application is created. The theme of the gamification application should be in the interest of the employees. Therefore, it is important to study the interests and demands of the designated users. *The technics selection* deals with the selection of suitable soft- and hardware to create the physical components of the gamification application. This includes the system architecture comprising all required interfaces to the existing operative system. Interfaces are needed if information has to be committed between the operative system and the gamification system to create game events. In most applications, this is the case because events in the gamification environment are triggered by specific actions in the business process. The last step is *implementation*. All theoretically acquired components are implemented, tested and finalized. This step could result in a reconsideration of the *technics selection*.

2.3 Evaluation and Reflection

Most development projects in the field of gamification conclude with the delivering of a functioning application. Following the idea of continuous improvement (Imai, 1968) and the Deming Cycle (Deming, 2000), the GameLog Model contains a third phase after the successful implementation: The *evaluation and reflection* phase. This phase can and should result in a re-design loop to improve the application for a longer lifecycle. The target of the *evaluation and reflection* phase is to continuously measure the achieved results and acceptance among the employees. Therefore, the once defined key performance indicators can be used. The acceptance of the employees cannot be measured by those indicators determined in *goal definition* but has to be analyzed with separate surveys among the users. The participant or dropout rate could be an indicator that points towards the acceptance of the gamification application. Even elaborately designed games have a set durability and have to be redesigned, updated or enriched with new features to keep them alive.

3 Model application in the field of material handling

The GameLog Model was tested to create a gamification application for the field of material handling that is concerned with the internal handling of materials and supplies within specific production sites or intermediate storage facilities (Arnold, 2006). Within material handling, the process of order picking was gamified. Order picking means fulfilling a customer's order, which includes receiving a list of items to be picked from storage and combining them into a shipment (cf. Coffey, 1999). Order picking is the typical core process that is fulfilled in trading companies like Amazon to create a box with the customer's order to deliver.

This chapter will explain how the process steps were undertaken and what result was achieved by means of the certain steps.

3.1 Problem description

During the process of order picking, orders have to be fulfilled in shifts and under time constraints with as few errors as possible, and can easily involve dozens of orders. Due to these challenges and context conditions in this monotonous work process, and taking into account that order picking is typically performed by low-paid unskilled workers, staff motivation and high turnover rates are recurrent problems for efficiency in material handling. Along with that, a loss of performance and increasing error rates among staff members are the result.

3.2 Goal definition

From the employer's point of view, the superior goal is *increased performance* of the order pickers. This means a reduction of the error rate, an increase in the pick rate and a *better and shorter learning and training process* for new staff members. From the order pickers' point of view, the superior goal is an *increase in work motivation* and *better preparation for the daily working routine*. Two goals determine each other, as higher work motivation can result in higher work performance. Existing key performance indicators that can be taken into account to measure the performance of the gamification application are the number of picks per worker per shift, the error rate and the average time per order. All of these indicators are normally gathered within the operative system.

Goals on behavioral level refer to the employees, the order pickers. In the observed context *faster and more precise work execution*, *promotion of the group orientation* and *support within the employees* are goals from this perspective. As well, staff members *should be motivated to reveal problems* within their work execution and come up with solutions and improvement proposals.

3.3 Analysis of basic conditions

For the analysis of basic conditions, the examined work process was documented on a granular basis. In the specific process, an order is sent to the order picker onto a handheld scanner. After receiving the order, the order picker goes through the warehouse to pick out the items that are shown within the order list. After picking an item, the pick is confirmed by scanning a barcode on the shelf within the warehouse. All items are collected in a transport container, which is then delivered to a drop-off point. Afterwards, the order picker requests a new order to repeat the specific tasks for the next order. All order pickers working together in one shift perform these tasks simultaneously in the same area of the warehouse. There are multiple staff members working together in the same process.

As for the concept, integration points have to be found in this process. To integrate the gamification application without changing the work, the order picker can only actively interact with the game in between two orders. Otherwise the work process is interfered. During the fulfillment of an order, only passive interaction is possible. That means audio-visual feedback; for example, via displays that should be installed in the warehouse. The display of the handheld scanner itself can also be enriched with certain game elements.

Within the work process there are some interfaces between the order picker and the operative system. The order picker actively requests a new order, scans a barcode after each pick and confirms the completion of each order by delivering the transport container to the drop-off point. Thus, the chosen key performance indicators can be measured and the existing interfaces can be used to create game events.

3.4 Game mechanics selection

To select game mechanics for the gamification application, the goals have to be translated into specific mechanics. The major goals in the examined context can be described as an increase in work performance and motivation. As well as an improvement in the training of new staff members.

As for motivation, the self-determination theory by Decy and Ryan (1985) was chosen as the basic framework. It implies that human beings are motivated to work if they encounter feelings of being competent in dealing with a situation or task (competence), if they are free to make their own choices (autonomy), and if they are part of a community with relevant others (social relatedness) (Decy & Ryan, 1985). Most of these needs are not fulfilled in the process of order picking as the work is heteronomous, simple and monotonous. Also, all staff members work by themselves. Hence, game mechanics where chosen that could affect these basic needs.

To support the feeling of competence, the game mechanics of *feedback*, *result transparency*, *concrete objectives* and *competition* where chosen. As for *competition,* it is important not to generate an environment in which employees try to manipulate each other to get better results. Therefore, a *team competition* in which all members of one shift function as a team was chosen as the mechanic of choice.

To fulfill the need of autonomy, the staff member must be given a chance for *individualization*. This strongly contrasts with the actual work task, as all order pickers work the same routine over and over again and are easily interchangeable. The game mechanics, *profile- and character development* and *freedom of choice,* were chosen to encounter that.

Social relatedness should be triggered through the game mechanic, *collaboration*. Goals should be set that can only be solved if the team members work together.

Besides the goal of fostering motivation, performance should be improved by the gamification application. The chosen game mechanics work towards that goal and can achieve it by fostering the staff's motivation. The training process is not improved by a game mechanic, but by a direct game element. This will be explained in the next chapter.

3.5 Game elements selection

Game elements were chosen to trigger the mentioned game mechanics.

Points can be earned by the order picker for good results in the process. *Points* give feedback about the rendered performance. Therefore, it is important that the user understands how points are measured. Besides feedback, *points* target the mechanics competition and result transparency.

Badges are given to the staff member for outstanding performance and the fulfillment of certain goals. They trigger the game mechanics concrete objectives, competition and result transparency. *Badges* can also foster collaboration as order pickers with the same badges could feel a connection between each other.

To support the game mechanics competition, it was chosen to use a *highscore list*. As mentioned before, however, the *high score list* does not display the ranked results of each individual order picker, but the team's outcome. Hence, the game element can trigger collaboration as well.

The game element, *performance graph,* was chosen to target the mechanics, concrete objectives and result transparency. The graph displays the result of the order picker in the categories of executed picks, required time per order and errors per order. Thus, the staff member gets feedback about his performance and his improvement in the particular categories. The *performance graph* is only visible to the user himself so that it cannot result in pressure from other team members.

The user of the gamification application will have the choice between different *avatars* that represent him in the gamification environment. This should trigger the game mechanics of profile and character development and freedom of choice. This

is because the user can develop his *avatar* in different directions. This in turn can lead to a certain level of individualization.

Another element that was chosen is a *narrative*. The other elements are combined into a story that has been told during the use of the gamification application. As there are decisions to make within that story, it supports the game mechanic, freedom of choice.

The last element to be implemented within the gamification application is a *tutorial*. The *tutorial* helps to learn the game dynamics and rules within the gamification application. That directly supports the training of new staff members and helps the order pickers become better prepared on the job.

3.6 Game framework development

The game framework describes the theme of the application is located in and the gameplay rules.

The theme of the application is a futuristic virtual order picking league. It was decided to not take the theme too far away from the work context, as it should interest the whole employees. Every other theme allows for the possibility that certain staff members feel excluded because they do not feel connected to the theme at all.

The rules combine the game elements and create the game dynamic for the gamification application. At the beginning, staff members create their own character by choosing from six different avatars that differ in their attributes. In total, there are three attributes, namely speed, strength and accuracy. These are linked to the three major key performance indicators: picking time, number of picks and picking errors. The attributes work as multipliers to gain points. The faster the employees finish their order, the more points they get through the attribute speed; the more picks they make, the more points they get through the attribute strength; the less errors the employees make, the more points they can earn through the attribute accuracy.

After creating the character, staff members get access to their own game profiles. Here they can find an overview of their character's attributes, team high-scores, leaderboards, statistics and summaries about their performance in the gamification application (performance graphs), information about running game rounds and a list of all badges. Badges can be earned by reaching certain goals. For example, a badge is given for a series of ten orders without any error. Badges are rewarded with attribute points. These can be used to upgrade the character's three attributes. From the performance graphs in the profile, the users can see how many points they have already got in each of the three sections and develop their avatars in a certain direction.

From their profile, order pickers can join a team to fight for the win of the order picker league. When joining a team for the first time, the game round starts with a tutorial. This takes place directly in the warehouse. The tutorial consists of an in-

teractive movie in which the order picker is introduced to the background story of the order picking league and to the rules of the gamification application. During the tutorial, the users learn how to handle the handheld device and have to fulfil exemplary orders. The rules of the game contain the order picking process steps mentioned before. In summary, the employees are trained in the gamification application and in their daily work routine at the same time.

Afterwards, the game round starts at a certain time. Staff members fulfill their orders and get feedback about earned badges or if the team climbs in the tea, high score list. All points of the team members are summarized to represent the team points which are shown in this high score list. After delivering a complete order the order picker gets feedback about open attribute points. From this information they can chose to upgrade their character before requesting the next order.

When a game round is finished, a short debriefing film is shown. The content of the film varies according to the team's performance and result. Also, the best participants with the most points and most badges are honored. This is the only time where personal statistics will be displayed.

3.7 Technics selection

This paragraph is cut short, as the technics selection is not relevant for the purpose of this paper. During this step, a number of different frameworks, soft and hardware components, protocols and programming languages where chosen to create the described gamification application.

3.8 Implementation

The gamification application was integrated into the order picking process. Computer stations were established on which the employees could log in to their profiles, upgrade their characters and get information about their performance and the running game round. Order pickers could join a team from these computers as well.

Inside the warehouse, big screens were installed. The so called *Ingame Screens* show the current team high score list, the points of the team playing and the remaining game round's time. Every time an order picker wins a badge, an animation is played.

At the drop-off point, a *Feedback Screen* is mounted. This screen contains information about the delivered order. The number of points gathered per picks, time and errors are displayed. Performance graphs also show the progress over the last five orders. The recently earned badges, total gained points and open attribute points are shown on the *Feedback Screen* too.

The application running on the handheld scanners was enriched with the earned points, a picture of the avatar and the time elapsed since the recent order was started.

3.9 Evaluation and Reflection

The evaluation of the gamification environment was performed through an analysis of two of the mentioned key performance indicators and a survey within the users. Therefore, a study with 103 participants was conducted. To examine the training process of new staff members, test persons that had not worked in order picking before were recruited. 51 participants were trained and worked within the original order picking process (reference group), while 52 participants were put in the gamified work process (experimental group). The training lasted 10 minutes. Afterwards, the test persons worked within the order picking process for 20 minutes.

As for the performance, a significant difference between both groups could be achieved. In 20 minutes, the test persons in the normal order picking process performed 46.82 picks on average, while test persons with gamification executed 62.43 picks. The number of errors could also be significantly reduced through the use of gamification. While the reference group permitted 14.76 errors on average, the gamification group only permitted 9.63.

Motivation was surveyed using a questionnaire with open questions and statements that should be rated on Likert Scales from 1 to 7 (Brace, 2008). As a result, in all of the three mentioned motivational needs, a significant improvement was achieved by the use of gamification. On average, between the test persons and the corresponding questions, the need for competence could be raised from 4.11 to 4.90, the need for autonomy from 3.64 to 4.04 and the need for social relatedness from 1.93 to 3.33. Also, intrinsic motivation was surveyed directly. On average, the reference group rated their intrinsic motivation 3.71, as the experimental group rated it 5.00. This is a significant difference as well.

The training process was surveyed by the questionnaire too. The preparation for the work task was rated by the reference group with 4.27 and by the experimental group with 4.90. This is a significant improvement. No improvement could be achieved in the training quality via gamification. An explanation for that could be that the tutorial was not sensed as training by the test persons.

The acceptance among the employees was surveyed with open questions. Results are that the gamification application was a welcomed alternation in the daily work routine. Test persons liked to play the game, but stated that the complexity of the gamification application could lead to boredom after a while. So a re-design should take place to improve and change the game procedure and dynamics after a while.

4 Conclusion

In this paper an implementation model for the gamification of business processes was presented. It contains three major phases: Analysis and Exploration, Design and Realization, Evaluation and Reflection. The model does not focus on the creation of a holistic game, but on the integration of certain game elements and mechanics into a running business process without changing its execution.

The model was used to create a gamification application in the field of material handling. This application was evaluated. Findings from this evaluation show that, on the one hand, the implementation model does work to successfully gamify a business process; on the other hand, the study displays that gamification is a useful approach to foster motivation and performance among employees in business processes.

References

Arnold, D. (ed.) (2006). Intralogistik. Potentiale, Perspektiven, Prognosen [*Material handling. Potentials, perspectives, prognoses*]. Berlin: Springer.

Brace, I. (2008). Questionnaire Design: How to Plan, Structure and Write Survey Material for Effective Market Research. London: Kogan Page Limited.

Cameron, J, & Pierce, D.W. (2006). Rewards and Intrinsic Motivation: Resolving the Controversy. Westport: Greenwood Publishing.

Coffey, D. (1999). Zero in on Picking. Logistics & Transport Focus, 1(4), 22-25.

Deci, E. L., Ryan, R. M (1985). Intrinsic motivation and self-determination in human behavior. New York: Plenum Press.

Deming, W. E. (2000). Out of the Crisis. Cambridge: MIT Press.

Deterding, S., Khaled, R., Nacke, L., & Dixon, D. (2011). Gamification: Toward a Definition. Paper presented at the CHI 2011, Vancouver.

Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A Formal Approach to Game Design and Game Research. Paper presented at the Game Developers Conference, San Jose.

Imai, M. (1986). Kaizen (Ky'zen): The key to Japan's competitive success. New York: Random House Business Division.

Kapp, K. M. (2012). The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education. San Francisco: Pfeiffer

Mall, R. (2009). Fundamentals of Software Engineering. New Delhi: PHI Learning.

Salen, K., & Zimmerman, E. (2004). Rules of Play: Game Design Fundamentals. Cambridge: MIT Press.

Werbach, K., & Hunter, D. (2012). For the Win: How Game Thinking Can Revolutionize Your Business. Philadelphia: Wharton Digital Press.