

Gamification in a real order picking environment of an online grocer

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Abstract

The online grocery retail industry is rapidly growing and has to improve order picking activities which is one of the most costly and labor-intensive activities of their supply chain. Gamification has been promised to increase the motivation and productivity of order pickers, but empirical findings in real world work environments are still missing. In this case study, a gamified design was tested during an intervention with professional order pickers. The design contained the following game elements: points, badges, leaderboards, performance graphs and avatars. The results show that the motivation of the order pickers are positively influenced by the intervention and that this led to a higher productivity. Besides, it was found that different game elements were differently appreciated depending on the level of experience of the order picker.

Keywords: Grocery retail – Game elements – Motivation – Gamification – Order picking

1. Introduction

The grocery retail market is highly mature in terms of growth and market saturation (Kumar, 2008). This means that grocery retailers, mostly supermarket companies, have to be very competitive to grow their businesses. Companies start price wars to gain market share and compete on service level, product quality and freshness. One example of distinctive services is the offering of home deliveries of groceries.

Traditional supermarkets in the UK already started to offer e-grocery at the beginning of 2000, as pioneers of Europe (Linder & Rennhak, 2012). Supermarkets in other European countries followed, but failed mostly in that time due to high logistics costs and slow internet connections (Saskia, Mareï, & Blanquart, 2016).

So far, the online sales of groceries lags far behind on other product categories (Syndy, 2015). Recently though, there is a considerable growth in online grocery sales and an explosive growth is expected for the next decades: In the third quarter of 2016, 2.2% of the groceries in the Netherlands were sold online, against 1.2% in 2015. In 2017, the online grocery sales will exceed 1 billion euros, almost 3% of the market share (Rensen, 2017). For 2030, it is estimated that 15-20% of the groceries sales will be done online (Rabobank, 2016). Next to the traditional supermarkets that offer e-grocery shopping, an online only supermarket has entered the market in 2015 (NOS, 2015).

For grocery retailers, logistics is one of the core activities (Sternbeck & Kuhn, 2014) and come with relatively high costs in comparison to other industries (van der Vlist, 2007). The supply chain for e-retailers consists mainly of warehouse logistics and distribution, which leads to the main challenge of getting the order at the customers in the most efficient way (Saskia et al., 2016). Online supermarkets do not have to pay for physical shops and salesman (Bos, 2016), making the costs of logistics are even more relevant because of the larger share of the total costs in comparison to traditional grocers. In warehouse logistics, the main operational processes are: receiving, put away, storage, order picking, accumulation and shipping (Gong & de Koster, 2011). From these processes, the order picking process has been identified as the “most labor-intensive and costly activity” (de Koster et al., 2007). It is therefore key for e-retailers to improve the productivity in order picking.

A lot of research has already been done on the topic of order picking. Recently, gamification was showed to be a feasible approach to improve work competencies in an experimental order picking environment (Sailer, Hense, Mandl, & Klevers, 2017). This leaves the question whether these results can be translated to an order picking environment in the real world, with actual employees. The objective of this research is to fill this research gap by implementing a gamified design in a real order picking environment at the fulfilment center (FC) of the Dutch online supermarket Picnic.

This article is structured as follows. The next section provides in a theoretical background in the fields of order picking and gamification. The third section discusses the research approach and methodology. The fourth section introduces the case study environment and the fifth section will describe the gameful design which is implemented. Subsequently, the results are discussed in section 6. In section 7 the conclusions of this study are drawn and recommendations are given for future research.

2. Theoretical background

In this section a theoretical background will be provided in the research fields of manual order picking and behavioral change by gamification.

2.1 Order picking

Order picking can be defined as the “process of retrieving products from storage (..) in response to a specific customer request” (René de Koster, Le-Duc, & Roodbergen, 2007, p. 481) and is the often the most costly and labor-intensive process in warehouse logistics (René de Koster et al., 2007b). The human employing *picker-to-parts* system is used like in a majority of warehouses worldwide (Baker & Perotti, 2008; Napolitano, 2012), often the *pick by order* variant for e-grocers. In this system, the order picker travels, according to the *pick by order* variant, along storing aisles to pick different items for the same order in sequence (René de Koster, Le-Duc, & Roodbergen, 2007b). Less than 30% of the academic papers on order picking considers the *picker-to-parts* system though, the main focus areas are: layout design, storage assignment, zoning, batching, routing methods and order accumulation and sorting (Chackelson et al., 2013; De Koster et al., 2007). Most research focusses on a single decision problem within the listed focus area and do not consider a more holistic view on the order picking system to optimize the overall order picking process. Klein (2016) did combine different focus areas assessing different design alternatives for an online grocer fulfilment center with manual order picking as recommendation for the near future. Although picking could be automated (R. De Koster, 2004), for grocery retailers order pickings happens manually since it is not economically feasible to imitate cognitive and motor skill of humans yet (Klein, 2016; Roodbergen & Vis, 2009). With a large range of products with a wide variety of size, weight and fragility, item handling is demanding a very high level of these cognitive and motor skills (Klein, 2016). These skills are human characteristics, which

have a high impact on the order picking performance (Grosse & Glock, 2015).

The human characteristics of order picking are often neglected and performance indicators of order pickers are wrongly assumed to be constant (Chackelson et al., 2013; Grosse & Glock, 2015; Grosse, Glock, Jaber, & Neumann, 2015). Human factors, physical and psychological aspects for instance, are as important as the design characteristics layout, storage management, routing/batching and work organization (Grosse & Glock, 2015). These aspects directly influence the outcomes of order picking (Neumann & Dul, 2010), just like individual differences of people (de Vries, de Koster, & Stam, 2015). Motivation is one of the psychological aspects and can play an important role in the performance of order pickers, since motivation might be low due to the monotonous and repetitive character of the work.

2.2 Motivation in order picking

Since motivation is found to be an important factor in the performance of order picking, improving the motivation of order pickers could lead to improved performance. According to the *Fogg Behavior Model* (FBM) (Fogg, 2009), motivation is one of the three components of behavior, together with ability and triggers. Target behavior, good performing during order picking for instance, will only be performed when a person is sufficiently motivated, has the right abilities and is triggered. Because of the simplicity of order picking, it can be assumed that ability is not the limiting component and a trigger can easily be provided with commands and designated tasks. That motivation is the limiting factor, can be explained with the use of the Self-Determination Theory (Deci & Ryan, 2012). According to this theory, every person has fundamental psychological needs to be *competent*, *autonomous* and *related to others*. If these needs are fulfilled by certain behavior, this makes people intrinsically motivated to perform this behavior. Hense et al. (2014) stated that order picking is intensive and manual labor performed by low-paid workers. It is therefore not surprising that order picking could cause low staff motivation and fatigue in the long-term (ten Hompel, Sadowsky, & Beck, 2011) and high turnover rates. The psychological needs of competence and autonomy are not completely fulfilled during the performance of pick tasks (Hense et al., 2014; ten Hompel et al., 2011), with low intrinsic motivation as a consequence, which could lead to lower performance.

2.3 Game elements in order picking

The psychological needs of competence, autonomy and relatedness can be addressed by the use of game elements (Groh, 2012). Game elements are defined as “elements that are found in most (but not necessarily all) games, readily associated with games, and found to play a significant role in gameplay” (Deterding, Dixon, Khaled, & Nacke, 2011, p. 4).

The increasing interest in gamification since 2010 was preceded by the use of game elements in all kind of (smartphone) applications to increase user activity, and thereby changing the behavior of this user (Lindhölm & Monsen, 2016). Furthermore, the application of these elements in an business environment is used to motivate people, influence behavior and thereby increase the performance and productivity (Deterding et al., 2011; Hamari, Koivisto, & Sarsa, 2014; Landers & Landers, 2014).

In literature, there is a large variety of game elements described that could be used for a gameful design. Hamari et al. (2014) present in a literature review an overview of the game elements that were tested in empirical studies. It is notable that most of the reviewed literature is written in context other than work, only four studies were done in a work environment. From these studies, two proved the effectiveness of the following game elements by quantitative results: points, leaderboards, challenges, stories, rewards and the visualization of progress (Eickhoff, Harris, de Vries, & Srinivasan, 2012; Flatla, Gutwin, Nacke, Bateman, & Mandryk, 2011). Recently, Sailer et al. (2017) did an empirical research in an experimental order picking environment. By the use of gamification, both qualitative and quantitative performances of

order picking were significantly higher. The used game elements were: points, badges, leaderboards, performance graphs, meaningful story, profile development and avatars. Although the single impact per game element was not measured in this study, other sources confirm the positive effect on motivation of these elements (Antin & Churchill, 2011; Eickhoff et al., 2012; Flatla et al., 2011; Hamari et al., 2014; Hense et al., 2014; McGonigal, 2011). Besides, the psychological needs of the Self Determination Theory were addressed by some of these elements: points, badges and leaderboards for competence; meaningful story and avatars for autonomy and the avatar for relatedness (Deci & Ryan, 2012). A limitation of the study by Sailer et al. (2017), is that the participants of the study were students (85%) and none had prior experience in order picking. Therefore, it is not to say that the effects of the game design are similar in a real working context. This article will provide in more insights regarding this research gap.

3. Research approach and methodology

For this research, a research framework (Figure A) has been used based on the *metamodel of design* (Herder & Stikkelman, 2004). A literature review and analysis of the case study provided in the (theoretical) background knowledge to determine objectives, constraints and the design space (game elements) for the gamified design. For the design process, the *generic roadmap for gamification of business processes* (van der Kleij, 2014) was used. The design was tested in a real world work environment for two weeks, measuring the pick productivity and quality of the order pickers.

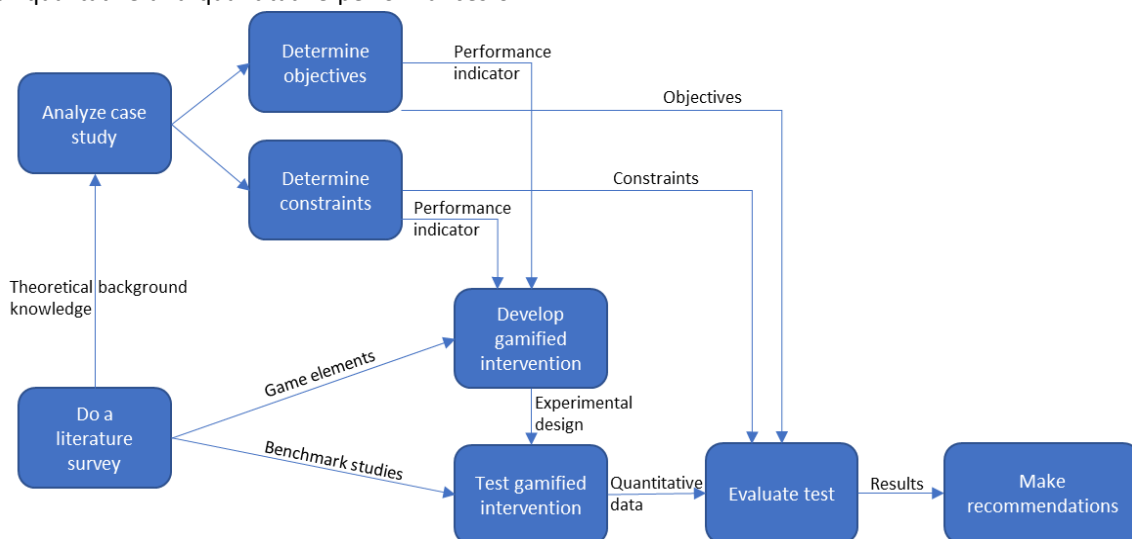


Figure A: Research framework, based on the metamodel of design (Herder & Stikkelman, 2004)

5.2 Gameful design

In section 0 a set of game elements is discussed of which empirical studies have shown the effectiveness: points, leaderboards, challenges, rewards, the visualization of progress or performance graphs, badges, meaningful stories, profile development and avatars. For this study, a selection of five of those elements was used for the gameful design. Other game elements were excluded because of the lack of empirical evidence for the effectiveness in an work processes like order picking.

Points: A simple game element that could be linked to almost every activity. Accomplishing (desired) activities gain points, whereby the number of points displays the success of the participant. The feedback by points addresses the need for competence (Eickhoff et al., 2012; Flatla et al., 2011; Hamari et al., 2014).

Badges: Virtual status symbols (McGonigal, 2011) linked to specific achievements which provide feedback and can be used to show to others (Antin & Churchill, 2011), satisfying the need of relatedness.

Leaderboards: Displays the rank of participants by score, often used to encourage competition (Eickhoff et al., 2012; Flatla et al., 2011).

Performance graphs: Provides feedback by displaying the performance of participants over time as a visualization of their progress. These graphs can satisfy the need of competence (Eickhoff et al., 2012; Flatla et al., 2011).

Avatars: A visual presentation of the participant, often free to choose, addressing the feel of autonomy. The avatar can be used as status symbol, for instance if it allows for updates after certain achievements (McGonigal, 2011).

From the listed game elements with empirical evidence, challenges, rewards, meaningful stories and profile development were not chosen to use in this study. Challenges and rewards have a similar effect on the motivation as badges (Hense et al., 2014), and are therefore left out to limit the complexity of the intervention. The implementation of meaningful stories and profile development would have required an interactive user interface for the design that was accessible for the participants. Due to the available resources set by the company, these game elements were not used in the gameful design.

The Pick game

The selected game elements were combined in a coherent gameful design which was presented as

the *Pick game* to the order pickers. The *Pick game* existed of three main components: a personal daily feedback report, a personal weekly performance overview report and a team competition. Communication about the *Pick game* goes through Slack, a messenger application that is used by all employees of the company for internal communication. Reports were shared through Slack in direct messages (DM) and team scores and the leaderboards are shared in a public channel.

Daily feedback report: This report contained the chosen avatar, personal statistics, points, badges and the rank on the leaderboard. Points could be earned for completing pick tasks and pick rounds and bonus points for achieving certain productivity goals on a specific day. Attached to the avatars are special attributes that multiply the bonus points in the categories *speed*, *time* and *endurance*.

Badges could be achieved by cumulative achievements as walking a certain distance during order picking or picking a specific product more than the threshold value. The rank on the leaderboard depended on the points of an individual picker.

Weekly performance overview report: This report showed the performance of the participant in three types of graphs. The first one visualized the progress in pick speed over time, the second the number of completed pick tasks and the third the number of hours spent picking. The average performances of all order pickers was showed as reference.

Team competition: Every day the order pickers were divided over three teams that compete to complete the most pick tasks of the day. The members of the winning team earn bonus points for their personal score. Team members are recognizable on the shop floor by colored bracelets.

5.3 The intervention

The gameful design was tested for two weeks in the FC of Picnic in Nijkerk. The test included 12 consecutive working days on which all order pickers in ambient zone of the FC participated in the intervention. Every day an employee worked on the order picking process, he/she received a personal daily feedback report and participated in the team competition. At the end of the week, all order pickers received their weekly performance overview report.

During the intervention, pick productivity and pick quality was measured. Because of the real world working environment, there was no control group during the intervention. Firstly, the sample size of

the test group would have been too small if half of the order pickers would be part of a control group. Secondly, it was given the operations in the FC not possible to create equal circumstances for a test and a control group since it was not possible to take this research into account making the operational planning and schedules. Besides, it would not have been possible to completely isolate the control group from the different game elements. Instead, the two weeks in advance of the intervention were used to compare the quantitative experimental results with. Only these two weeks were used as benchmark since the order volumes were much lower in the previous weeks due to the summer holidays, making them less suitable for comparison.

For the IMI-test, a group of order pickers in the Picnic FC in Utrecht were asked to fill in the questionnaire as a control group. The FC in Utrecht has the exact same set-up of operations as the one in Nijkerk, except that the capacity of this FC is 1.5 times larger. The order picking process, both in terms of material and procedure, is exactly the same in both FC's.

6. Results and discussion

In this section the effect of the gamified intervention will be explored by both quantitative and qualitative results.

6.1 Pick productivity and quality

During the intervention of two weeks, 97 unique order pickers worked on the order picking process and participated in the *Pick game*. Since the feedback reports only followed after a day of work, only at the second day an employee was fully aware of the game elements: 62 order pickers worked for at least two days during the intervention. However, to compare the results of the intervention with the control weeks, only 22 order pickers were selected as test group to base this analysis on. These employees were order picking for at least 3 days in both the control as the intervention weeks. Furthermore, trainees were excluded since they show a learning curve in productivity anyway, no matter the intervention.

For the test group, the productivity increased with 8,6% during the intervention in comparison with the two previous weeks. An analysis of covariance (ANCOVA) indicated that this was a significant increase in productivity after controlling for the effect of the size of pick rounds: $F(1,21) = 4,83$, $p = 0,039$; partial $\eta^2 = 0,19$. The least productive day during the intervention was 11% more productive than the least productive day in the control weeks.

These results show that the productivity of the order pickers increased during the gamified intervention.

The average pick quality during the weeks of the intervention was 0,1% higher for the order pickers of the test group than it was during the control weeks. It can therefore be concluded that the constraint to maintain the pick quality is met.

6.2 Motivation

The IMI-test was used to measure the intrinsic motivation of order pickers during the intervention and for the control group in the FC in Utrecht. Only the 22 order pickers that worked for at least 3 days during the intervention were asked to fill in the questionnaire. From Utrecht, 35 experienced order pickers filled in the questionnaire. The outcome of the test gives a score for 4 different subscales: interest/enjoyment, perceived competence, effort/importance and pressure/tension. The first subscale is considered as a self-report measure for intrinsic motivation, while perceived competence is a positive and pressure/tension a negative predictor of intrinsic motivation. Effort/importance is related to motivation (Intrinsic Motivation Inventory, 1994).

Order pickers that participated in the gamified intervention in the FC in Nijkerk scored 5,5 on the experience of interest/enjoyment, the control group in the FC in Utrecht scored 4,5. An independent samples t test indicates that the participants of the intervention scored significantly higher on the experience of interest/enjoyment: $t(65) = 3,55$; $p = 0,001$.

Order pickers that participated in the gamified intervention in the FC in Nijkerk scored 2,1 on the experience of pressure/tension, the control group in the FC in Utrecht scored 3,5. An independent samples t test indicates that the participants in the intervention scored significantly lower on the experience of pressure/tension: $t(53) = -4,7$; $p < 0,001$.

There was no significant difference found between the test group and the control group for the other two subscales.

These results show that the order pickers in Nijkerk had a higher intrinsic motivation than the order pickers in Utrecht during the time of the intervention. Since the intervention is the only observed difference in the order pick processes in

both FC's, it can be concluded that the intervention has a positive influence on the intrinsic motivation.

6.3 Observed experiences

To get a better understanding about the experiences of the order pickers with the gameful design, two focus group sessions and an interview were held with the order pickers and the leadership of the FC in Nijkerk. Furthermore, order pickers had the possibility to reach out to the researcher through Slack.

It was found that the general opinion about the gameful design was very positive, both from the order pickers as the leadership. Both groups thought that the motivation and productivity was higher during the intervention and order pickers liked to participate. Not all game elements were appreciated equally by different order pickers. The unexperienced order pickers liked the performance overview reports the most, which clearly showed their progress over time. The most experienced and top performing order pickers especially liked the badges and team competition. The statistics and point in the daily reports were appreciated equally by order pickers of different experience levels.

The team competition was the only component of the design that got some negative feedback as well. Some order pickers found their colleagues too competitive, while the competitive ones thought that others were piggy backing in the competition. Besides, there were a lot of comments to make the team composition more fair.

An unexpected finding came from the leadership of the FC; they indicated that the *Pick game* was a nice subject to interact more with the order pickers.

7. Conclusion and recommendations

A lot of research has been done on order picking activities in logistics, one of the most labor-intensive and costly processes of warehousing. However, the human factors were often ignored in this field of research. Recently, multiple studies addressed the importance of human characteristics of order picking. The motivation of employees is one of these characteristics, and the use of gamification has been shown a very promising method to increase the intrinsic motivation of order pickers in both theoretical as empirical research. Empirical results from a study in a real working environment were not yet published though. This study addresses this gap in literature by the implementation of a gameful design in an real order picking environment. A set of five game elements

were combined in a coherent design: points, badges, leaderboards, avatars and performance graphs.

It was shown that a gamified intervention had a positive effect on the intrinsic motivation and productivity of professionals in this case study. This conclusions can be drawn based on both the qualitative and quantitative results of this study. These results suit the results from previous theoretical studies and empirical studies in an experimental context.

A limitation of this study is the small sample size. Although 97 order pickers participated in the intervention, to create similar conditions the data of only 22 order pickers could be used to quantitatively analyze the productivity and the quality. Furthermore, due to the real world environment the experimental conditions could not be completely controlled during the intervention.

Since the sample size of this study was small, further research should focus on an empirical study in the real world with more participants over a longer period of time to validate the results of this research. Besides that, in this study the effect of the different game elements was not measured. In further research, these game elements could be isolated to determine the impact of every single element. Finally, the long term impact of gamification was not particularly researched in this study. However, it was found that different game elements were liked differently, depending on the level of experience of the order picker. Further research should address the long-term effects of gamification and could focus on how a combination of different game elements could affect these effects.

8. Literature

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