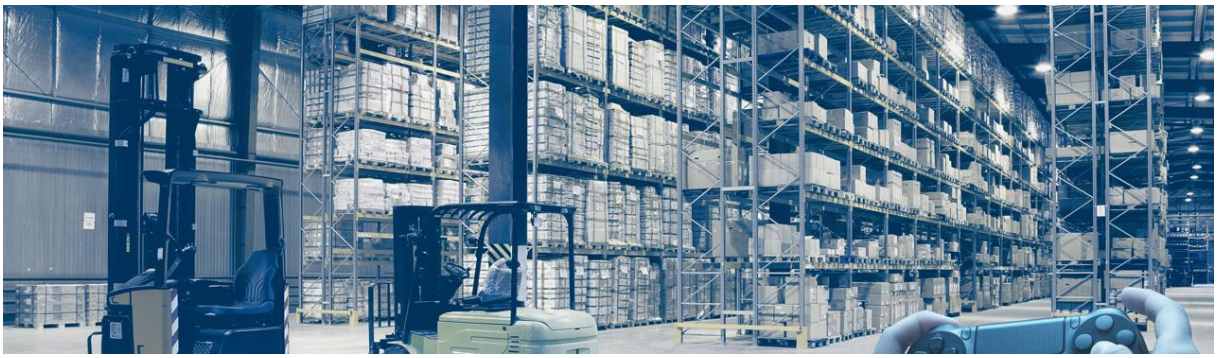
Serious Logistic gaming for supply chain execution in warehousing

Project SLG



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Preface

The origin of the Serious Gaming project

The project had a precursor, a project we had with a large worldwide service provider; Kuehne & Nagel. This company approached BUas some five years ago if we could develop for them a 'serious game' for their operations in warehousing.
The first discussions related to the phenomenon 'work and gaming' led to the link with Tilburg University where researchers from the department of Human Resource Studies are interested in the effects of workplace gamification on performance and well-being of workers. The project had a prosperous start but hardware problems in the facilities caused delays. Besides that staff changes caused a change of urgency in the execution of the project.
In the meantime, 'rumour has it', "….there is a game available for warehousing operations!". So different companies approached BUas if they could buy the product. Regrettably the developed game for K&N was strictly for their use only. That whole project was financed by K&N themselves. So it was clear to all of them that new games need to be developed from scratch.

Developing games is a rather expensive process. Our industry – mainly logistic service providers - within small and medium enterprises, can't afford these kind of investments. So an alternative had to be found if 'gaming' was still interesting for the companies concerned. In the meantime perception management about 'gaming in warehousing' was needed to prevent a miss match between the customer expectation and the final product (the game)

The project has known, as a lot of projects do, quite a bit of difficulties during the process. This report will, in chronological order, follow the process from beginning to the end with the aim of providing a better understanding of what happened.

Thanks to all involved in this project, the companies and their employees and the universities and their staff and students.
In particular we would like to thank the NWO, Netherlands Organization for Scientific Research and TKI Dinalog, for the upfront confidence and the support provided to make the 'serious gaming' project work.

Thanks to you all.
Maarten van Rijn (Project leader)

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Chapter 1: SLG, the project idea

The original application for the project:

On the May 15th 2015 the application form for the project was handed in at Dinalog / NWO.

From the application:

The goal of this project *is the development of a game platform (or extension of existing Dinalog initiatives in this area) that can be used within a vast part of warehousing operations in the logistic industry.*

Over the last few years logistic enterprises on one hand are strongly focussing on systems and automation, on the other on standardisation and process optimisation to reach for the highest possible level of efficiency and effectivity in their warehouse operations. Providers of large Warehouse
Management Systems (WMS) are mostly focusing on basic/generic functionalities of logistic processes.
What is not covered is a major area for further improvement for the entrepreneur; the empowerment of the human factor in the execution of processes in the supply chain. Recently the insight arose that with the aid of serious gaming (the application of a game as an experience designed to achieve a learning or training objective; Mayer et al.,) or gamification (the application of game design principles and technology in a common, daily context typically *not* perceived or *not* designed as a game to achieve psychological and behavioural objectives; Warmelink et al., 2018) it is possible to achieve behavioural changes which can lead to improvement of processes.

The main research question of this project: *"in what way can human behaviour be positively influenced by applying game principles in warehouse operations and what are the effects on the critical performance indicators?"*

The ultimate goal is that this project will lead to a collection of games that could be applied in the logistic industry in a broad spectrum of warehouse operations.
The following insights will be developed with these games:

- An approach for a quick start application of serious gaming;
- Effect studies of the approach with the matching methodologies;
- An overview of the processes in warehousing where serious gaming shows a positive effect.

And the connection with the Human capital road map:

The project proposed to support each of the three subjects of the HC roadmap. On Social Innovation the involvement of the employees / users would be improved through the use of gamification principles (applying typical gameplay elements like scoring, competition with others, game rules etc.) the power of serious gaming lies in the immersive character of this type of new media. It is due to this characteristic that game development explicitly is added to this agenda.

Translation to the curricula in higher education is secured by the two institutions of higher education within the "KennisDC logistiek" organisation. The proposal will contribute to the outflow of highly qualified professionals with knowledge of innovation themes.

Chapter 2: Project execution

On October 14th 2016 the project had been launched. The first step taken was communication with the companies and a rough communication plan for the project was presented:

- Visit of the companies by the project team by the end of November
- Explain rough project idea
- Kick-off meeting at BUas (December 14th)

During the visit it was clear that the companies were glad that finally the project got started (they already paid there share, some months ago!). The rough explanation of the project and the possible project outcome was the main item on the agenda for those meetings.

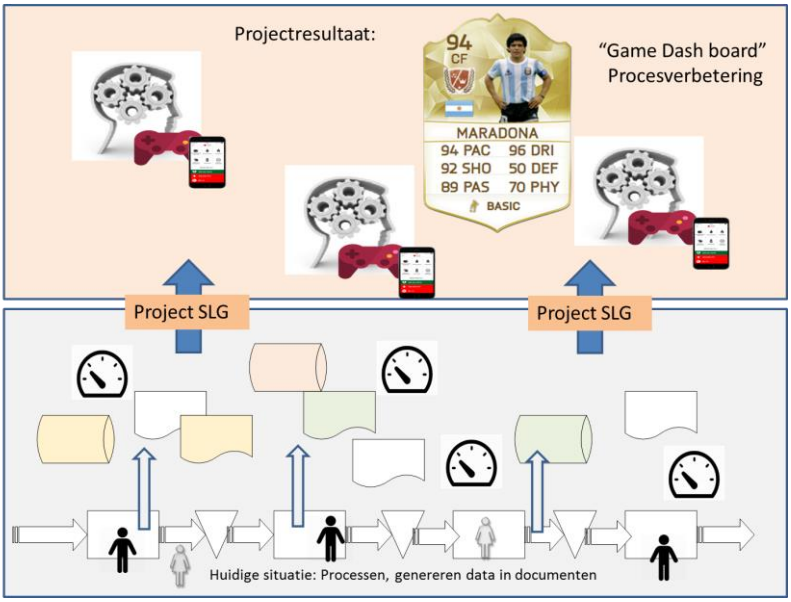


Figure 1: Project result – A game dashboard for process improvement

In Figure 1 the concept is visualised. Companies processes (blue/ grey area) measured, documented and executed by people, generate data. Companies must decide what the key elements are in the process execution and were people have influence. These processes should be monitored and data should be collected.
These data sources will be linked to the 'Dashboard' (light orange area)
The dashboard will be a gamified visualisation of performance.

An intervention study will be designed by Tilburg University with an experimental-control group design that would enable the project to draw inferences as to gamification effects on performance and well-being of workers, as well as provide information as to workers' experiences with the game.

Main outcome from the kick-off:

- Suggested project approach and planning van accepted by all participants. (document 11122016_SLG_presentatie kick-off_Rn V2)

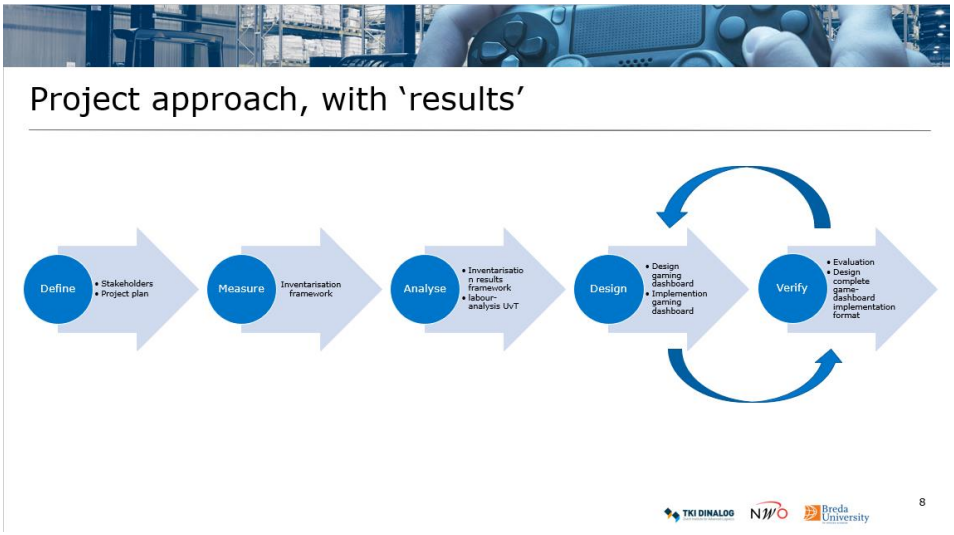


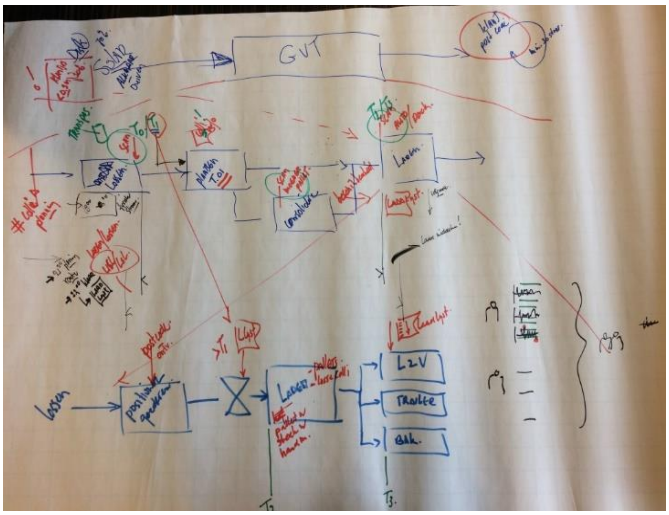
Figure 2: project approach.

- Companies suggest that they want to meet every now and then for project / process evaluation.
- There are 3 different situations, but overall the situations are comparable.

Project phase define: project charter.

During phase 1 of the project the exact limitations and scope were established. This was done with the aid of a 'project charter' as known from six sigma methodology (DMADV).
Within 14 days in January 2017 all companies were visited and the project charters written.

All processes were mapped and systems determined and employees informed.



During this definition phase it became clear that at <company 1> the foreseen business process was not ideal. It was a full hand handled operation with no digitalisation of (performance) data what-so-ever! Besides that effectively only two employees were involved in the process.
The two other companies accepted the project charters as a starting point of the project.

Figure 3: sketch of the process involved at <COMPANY 2>.

Project phase: measure and first design.

To achieve the project goals, after the acceptance of the project charters the first 'mock-up' drafts were made. This was done to make up for the delays and for better understanding what the final result would look like. But not only that, it was also needed to define exactly what kind of data were needed to fill the game. In figure 4 a first draft of a Mock-up for the game screen. The idea was a large screen above the docking ports in the warehouse were the trucks for distribution are loaded. The fill rate (scan data of the goods compared with the planned goods) is to be seen on the screen. Individuals are working on a truck, but the team takes care of the ones lagging behind.

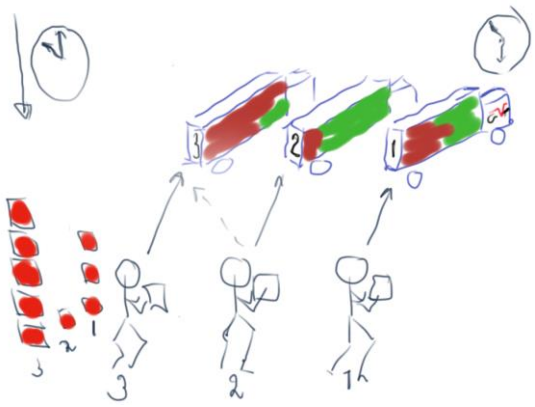


Figure 4: first mock up for the 'game screen'

Given the original idea – "Serious Logistic gaming for supply chain execution in warehousing" -there needed to be business processes that were similar for all parties involved. But during this phase it became apparent that the three chosen business processes were very different. So much different that the design of one overall tool was not within reach.

Scan data are crucial in this design. Data should be available real time, to be able to play. Feedback on decisions should be an immediate response. Data from the operations should be transformed into JSON format (a technical issue) to fit with the appropriate, chosen game technology. These specifications lead to the following conclusion:

- At <company 2> it was not possible to deliver the data for the game. If this was done the operations were severely delayed because the system could not handle the real-time transfer of data for the game,
- At <company 1> the issue was more or less similar to <company 2>,
- At <company 3> it was only possible to deliver the data asked for in their production environment. Due to the advanced automated production systems. However there was a complication in the design, the game dashboard had to be integrated in the process dashboard already in use.

The consequence of this all was that <COMPANY 2> withdrew from the project. They didn't want to search for other possibilities. Their participation in the project stopped September 2017 after months of discussion and delays.

At <company 1> there was a good sense of cooperation and they found another process that might solve the problem. The new process was at the ICT department measuring the amount of 'tickets' open after 12 hours. Four employees are involved in the specific process.

Lessons learned from 'measure phase':
As mentioned on the previous page the 'measure phase' was combined with the 'design phase''. Due to the discussions about "what to measure?" it became obvious that a rough visualisation of the intended dashboard would help to make the right decisions and to find out what kind of data were needed.

Looking back on the process the sequence of phases in the project changed. This change is visualised in figure 5.

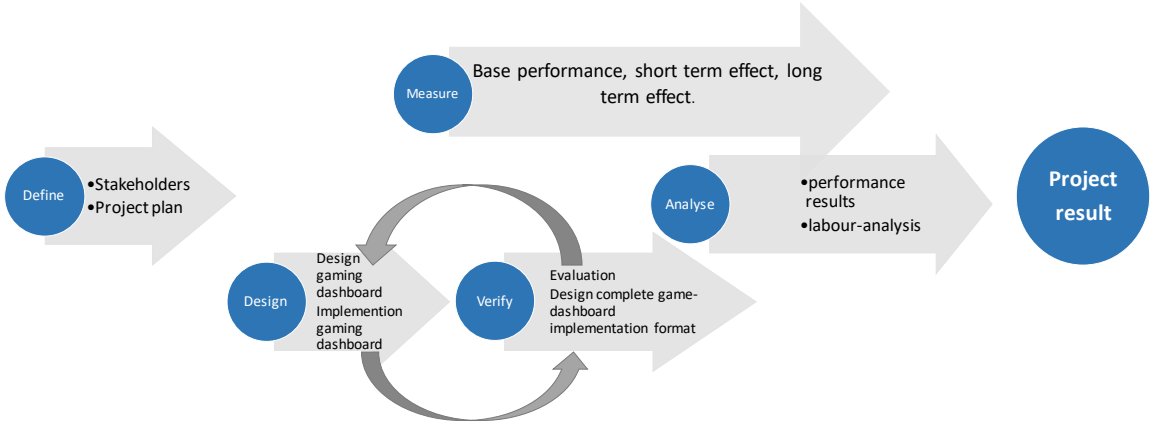


Figure 5: New project approach for "Gamification"

Define still is the starting activity for the project. But to make the whole idea about the final 'product' more clear to the stakeholders a design concept should be made right after the definition phase. Measure base performance should be done only a (relatively) short period before the implementation of the first concept. After possible adaptions / redesign further measurements on short term and long term effects could be done. Finally analysis of the results.

Research on gamification in work situations:

Around the time of the project change request (January 2017) Harald Warmelink had just joined BUas' Academy for Digital Entertainment and became involved in the project on behalf of the professorship in serious/applied gaming led by Igor Mayer. Approaching this project as a full-on *research* project, he was interested in connecting the project objectives to the wider gamification research community. What lessons could already be learned from like-minded or like-spirited gamification design research projects elsewhere in the world oriented towards production and logistics industry, assuming there were any?

He initiated a literature review process, which eventually led to a paper co-authored with veteran gamification researchers from Finland Juho Hamari, Jonna Koivisto and Mikko Vesa, as well as professor Igor Mayer. The paper entitled 'Gamification of the work floor : A literature review of gamifying production and logistics operations' was first presented by Harald Warmelink at the EGOS 2017 conference in Copenhagen, Denmark on 7 July 2017. An improved version of the paper was subsequently presented on 4 January 2018 at HICCS 2018 conference in Hawaii, USA by co-author Jonna Koivisto. Following that conference, a new journal version was developed and finally published in the *Journal of Business Research* in September 2018 under the title 'Gamification of production and logistics operations: Status quo and future directions'.

This final journal paper presents a review of the current body of academic literature concerning gamification of production and logistics to understand the status quo and provide suggestions for future research. The findings indicate that the execution and control of production and logistic processes has been addressed most often in the current body of literature, which mostly consists of design research. Objectives and goals, points, achievements, multimedial feedback, metaphorical or fictional representations, and levels and progress are currently the most often employed affordances within this field. Research has focused in the given context on examining or considering motivation, enjoyment and flow, as the main psychological outcomes of gamification, while individual

performance and efficiency are the most commonly examined or suggested behavioural and organisational impacts. Future studies should employ more rigorous designs within new subdomains of production and logistics and should firmly ground research designs and discussions in management theory and critical studies.

Applied to this project, the article reveals many more intricacies and much more complexity of this project. This realisation, combined with the fact that hardly any published studies involve the application of gamification in a real logistical work process, rendered this project still very ambitious and really required a full-on research perspective in which we as a consortium cannot, as yet, promise concrete, practical, industry benefits from this project upfront.

Planning of mixed 'measure and design' phase.

This phase already started at the beginning of February 2017. A very important role in this phase was assigned to Atlantis, a start-up related to BUas.
Atlantis Games has been responsible for the game design, software development and -implementation in the project. From the beginning of March Atlantis was – bilaterally - communicating with the three companies.
For several reasons delays became inevitable, (for Atlantis leading to budget exceedances)

- Companies were not able to define exactly what they wanted. A vast amount of time was spent on creating a clear understanding of the gaming concept for them and the consequences for the data collection.
- Companies, as mentioned before, were not able to provide real time data. Data warehousing is for two out of three companies a problem. To illustrate the consequences; despite delivering the full described game design at <COMPANY 2> the company decided to with draw from the project on September 27th 2017.

Despite the delays the researchers from Tilburg University started preparing the research regarding the impact of gaming on work performance and work experience. Surveys were designed, appointments for the measurements of the base performance were made. In the total project three surveys were planned for the two remaining cases, <company 1> and <company 3>. Data were to be collected as to survey variables and departmental performance indicators before implementation (T0), three weeks (T1) and three months (T3) after the start of game implementation.
Because of the delays in the game design, the surveys were postponed over and over. Not before January 6th a base performance measurement was conducted at <company 1>. (for the outcome of the research see page 17)

By the beginning of September 2017 the game design was ready for full implementation at <company 1> and by the end of October for <company 3>.

Lessons learned:
Considering the vast delay of the project some important lessons learned:

- Management always prioritise day to day work and issues in the involved companies. In times of high workload this lead to a full stop of the project. This was not really new to the project members, but startled them never the less! Companies involved should be more aware of this and be prepared to invest in the project despite of running issues.
  Planning of Game design and implementation are leading in the planning for research on effects. The timing for research on the effects – three weeks before the start of the 'gamification' the base performance measurement should be executed. First measurement of the results after three weeks, second after three months. The planned research design does not match well with both game design and operational issues still needing attention. The research part can only work if game design and operational issues are under control. If

not, research tends to be “the end of the line”, e.g. the place in the project that is served last and where any earlier bottlenecks surface.

- Business developers ‘selling’ these kind of projects and project managers executing the projects should be more aware of these kind of problems from the beginning. Defining the project goals and means should be based on explicit requirements. (see paragraph “project result” page 20-21)

Measure phase.

The research design and execution for this evaluation study of a dashboard gamification intervention was performed by the department of Human Resource Studies from Tilburg University (the team of researchers consisted of Prof. Dr Marc van Veldhoven and three research assistants (all MSc’s): Tina Peeters, Teun van Stratum and Rosanne Bollen.

Based on an earlier study into gamification this research group came up with 6 optional areas for gamification interventions based on the existing HRM literature, see figure 6 below.

The intervention studied in this project does not capture all possibilities for workplace gamification but has a clear focus in one specific area. Based on discussion with the SLG-project team and the three prospective case participants it became clear that the intended gamification intervention can be characterized as a “performance management” intervention. This means that the main goal of the intervention is to provide an innovative way of giving feedback about performance to employees and thus influencing their work behaviours based on knowledge, social comparison and reward components that are related to performance.

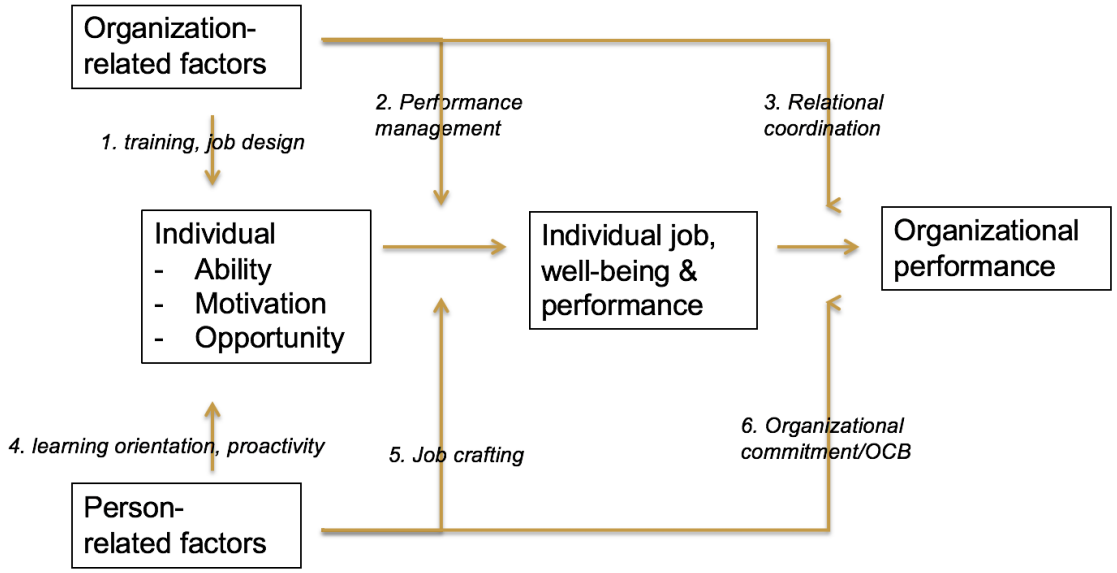


Figure 6: six optional areas for gamification based on HRM literature

The Master theses by Peeters (2017) and van Stratum (2018) include descriptions of the literature to date on HRM/work in relation to gamification. Based on their literature reviews it was expected that a performance management-oriented gamification intervention would mainly impact on how individual workers experience their job, their well-being and performance on the job, and hence - indirectly- the performance of the department that these employees are working in.

The literature suggests that on the one hand positive effects might be expected from such a gamification intervention, most notable one would expect that the game could:

- Improve task feedback
- Improve clarity of the tasks to be performed and their status
- Improve variety on the job
- Improve autonomy on the job
- Improve work pleasure (fun factor) and improve energy levels on the job
- Improve performance on the job, including better customer orientation

The literature is not expecting only positive effects from performance/feedback-oriented games, however. Researchers warn that such positive gamification might also come at a cost, most notably:

- Higher experienced workload and hence more work-related fatigue (need for recovery) because employees work harder to achieve (symbolic) targets
- Higher competition among workers and hence lower levels of experienced social support from colleagues
- Risk of lower compliance because employees cut corners to achieve fast/high performance

Hence a study design was adopted that would be able to monitor changes in the three prospective cases both at the level of departments and individual workers. The study uses the design of a quasi-experimental field study. For each of the three cases it was proposed to have an experimental group that uses the game, and a control group that does not use the game. The experimental and control groups would need to be matched in terms of types of work/workers/performance indicators.

In order to be able to track any gamification effects over time the research design uses three measurement moments for the survey and weekly follow-up measures for the departmental level performance data:
T0, a couple of weeks before gamification onset
T1, a couple of weeks after gamification onset
T2, a couple of months after gamification onset.
The research design is represented in figure 7 below.

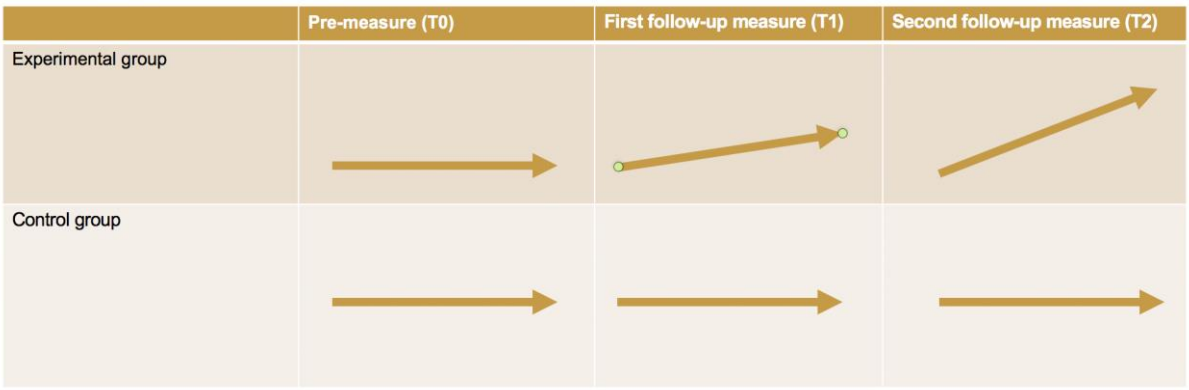


Figure 7: Research design (for the survey)

The research design was presented and approved among all parties involved in the project.
As mentioned elsewhere one of the cases (<company 2>) ultimately did not participate in the study.

In another of the cases (<company 3>), only T0 was completed. A separate report (Stratum & Veldhoven 2017) on what was found at T0 for this case was written by the researchers. The performance data for the two departments at <company 3> were collected for several weeks starting after T0, but as survey information failed to be produced at T1 and T2, the idea to further analyse these data was dropped. For this report the T0 data in case 2 are not relevant, so we pay no further attention to these here.

In the third case (<company 1>), full participation was achieved for the surveys in both the experimental and control groups. However, performance data were only available for the experimental group, and both groups do not hold similar jobs/workers/performance indicators. Hence, here also the idea to further analyse performance at the departmental level was dropped.

The survey responses at <company 1> only pertain to very small number of respondents (2 or 3, depending on the group and the measurement moment, out of 3-4 total employees employed in the department at the time). Nevertheless, a separate report for these survey data was written by the researchers.

The survey used was based on survey material that has been developed and tested extensively elsewhere. Out of the 13 survey scales used, 10 derive from the QEEW2 (Van Veldhoven et al., 2015).

The scale about safety compliance was derived from Neal & Griffin (2006). The scales about performance are based on Goodman & Syvantek (1999).

Verify phase.

Implementation at <company 1>

At <company 1> the intended process in warehousing changed twice due to the lack of data availability.

Since <company 1> wouldn't quit it was decided that the ticket process of the ICT department became subject of study.

Process: ICT, the reduction of open tickets.

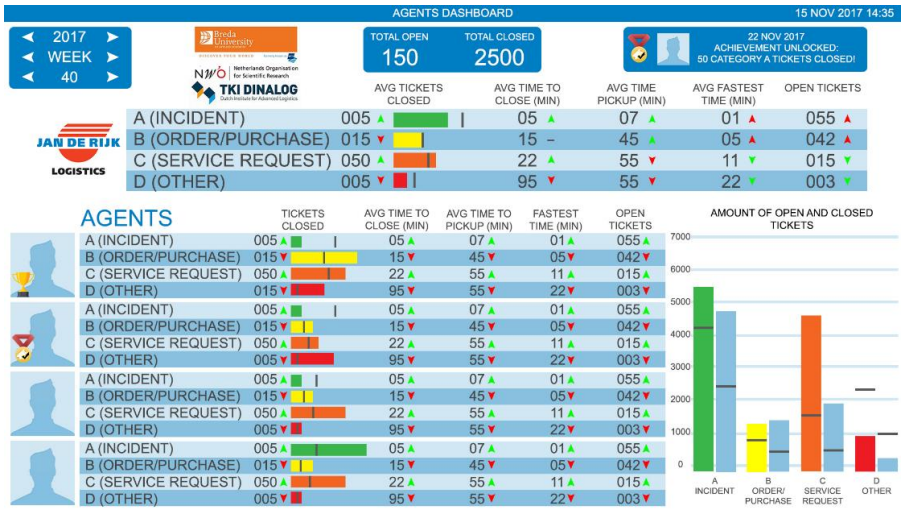


Figure 8: screen shot game dashboard <company 1>

Within the company the ICT department is dealing with the ICT issues of the employees. For every issue a 'Ticket' is made. The goal of the department is to solve the issues and clear the tickets within a certain amount of time.

four ticket types: incident, order/purchase, service request and other were defined. Performance of the ICT employees is scored on the amount of tickets closed, average time for closure, queuing time

(pick up), fastest time and amount of open tickets. All these scores for the team and for their individual score. (for research outcome see paragraph “Analyse” page 17)

Implementation at <company 3>

A vast number of modern production lines (10) produce millions of “cookies” every year at <company 3>. These enormous production volumes can only be handled by fully automated processes and modern techniques. Not all of the processes are automated. Packing of the wrapped trays with cookies has still to be done manually. At the end of the production line the employee picks the right amount of wrapped trays and puts them in a box. This whole process is monitored on a screen next to the employees working position (see figure 9).

Figure 9: Dashboard at working station from <company 3>

The gaming element in the process is based on three elements. The tidiness of the work area, the response time on disruption of the packing process and packing performance.
Standards for three different levels were set. Performance influences the level of play. Performance < 200 demotion to lower level. >500 points means promotion to the next level. The points to be scored to be seen at the right side of the dashboard (see figure 10. For the details)

Figure 10: Detail from Dashboard

The game is played on two lines, with two shifts a day. Two lines were used as control group.

To make the game more a team game the overall performance of the game supposed to be shown on a big screen in the employees canteen. On the screen employees are shown with their scores on: level, skills ("vaardigheden") and Cookie stars!

Sadly this screen has not been installed due to internal problems with, among others, labour unions.

As one can see the route from original idea's, the creative mock-up's (see figure 4), to final implementation was long and winding. This also deviated from the 'gamification' idea which was subject of the research. But it was the outcome of a lot of discussion and was the accepted result for the project.

Interestingly, <company 3>'s CEO was still very much interested in better discussing the broader role that gaming and gamification design and technologies could play in his entire organisation. After a separate meeting on this topic, Harald Warmelink wrote a white paper (Warmelink, H. (2018).) aimed at confronting the different worlds of different kinds of game designers as well as of leaders/managers of businesses highly focused on their product/service delivery. This 9-page white paper was entitled 'What would a game designer do?' and was delivered to <company 3> specifically a few months after this meeting.

Lessons learned

- the Game design changed during the project. The final design (process / dashboard) has strongly deviated from the goal. Management of the companies tend to have a more managerial view on the 'gamification' and are inclined to make the visualisations more abstract than gamified dashboard should be. (the Canteen Dashboard could have been a better example of gamification)
- Game/gamification design and business leadership/management tend to be worlds apart. They speak different languages and have different mindsets. It is important and useful to find different ways to bridge that gap (e.g. schedule meetings, offer a white paper, etc.).
- A broad application of the project result was intended with the project. Due to the implementation problems (mainly lack of data) the project deviated from warehousing processes to 'any applicable' process at least to be able to do the research on the effect of gamification. But that way it resulted in company specific applications of the dashboard.

  If a 'generic' dashboard is the goal, the project should start with a 'generic' concept of a 'warehousing dashboard'.

- The implication of the lack of data availability has been a show stopper for the project. Positive attitude of (at least 2 of) the companies prevented a total stop of the project which should have been a loss of money and effort. The change to other processes made it (in principle) possible to do the research more or less within the goal.

Figure 11: Canteen Dashboard at <company 3>

Analyse

Because of the small number of respondents it is not possible to perform complicated statistical analyses on the data collected at <company 1>. However, indicative results can be obtained for the QEEW scales, because the reliability and validity of these scales has even been established at the individual level (Van Veldhoven et al., 2015). In interpreting the results for <company 1> use is being made of a large group of Dutch workers that have filled in the QEEW in the past. These workers serve as a so-called reference group (data used here were collected between 2006-2009 and pertain to thousands of workers in all kinds of jobs and organizations across the Dutch economy, see Van Veldhoven et al., 2015). Although the small group size at <COMPANY 1> prohibits any firm conclusions, and we need to be careful in interpreting the results, large deviations from the reference group are still indicative of important factors in the experimental and control group and changes from T0, to T1 and T2.

We take differences between the <company 1> groups and the reference group of more than 1 standard deviation as indicative of an important difference. These results are presented in table 1 below.

	JDR experimental group			JDR control group			Reference group NL		
	T0 N=2	T1 N=3	T2 N=2	T0 N=3	T1 N=3	T2 N=3	Mean	-1sd	+1sd
Feedback	55.5556	51.8519	44.4444	66.6667	51.8519	44.4444	46	25	67
Task clarity	50.0000	55.5556	55.5556	18.5185	25.9259	22.2222	30	12	48
Variety	16.6667	7.4074	16.6667	37.0370	40.7407	33.3333	38	18	58
Autonomy	45.8333	44.4444	25.0000	25.0000	33.3333	41.6667	39	19	59
Work pressure	63.8889	66.6667	36.1111	40.7407	44.4444	37.0370	34	17	51
Social support	25.0000	33.3333	37.5000	41.6667	36.1111	33.3333	22	7	37
Need for recovery	66.6667	55.5556	33.3333	18.5185	35.1852	35.1852	26	8	44
Energy at work	40.0000	57.7778	76.6667	26.6667	40.0000	35.5556	36	19	53
Work pleasure	25.0000	35.4167	40.6250	29.1667	27.0833	43.7500	28	10	46
Customer orientation	29.1667	19.4444	16.6667	27.7778	27.7778	30.5556	33	15	41
Safety compliance	29.1667	27.7778	16.6667	41.6667	36.1111	30.5556	x	x	x
In-role performance	26.5625	29.1667	26.5625	26.0417	33.3333	29.1667	x	x	x
Extra-role perf	16.9643	23.2143	28.5714	29.7619	18.4524	20.2381	x	x	x

Table 1. Results for the survey study at <company 1>

For the interpretation of results in table zz it is important to recognize that for all scales higher number indicate more problems with that variable, so for example: worse feedback quality, less autonomy, more work pressure, more need for recovery, less energy at work etc.

The comparison between the experimental and reference group,
Comparing the results of the experimental group (EG) with the Dutch reference group (RF) four specific items strike as exceptional. All four in a negative, unfavourable way.
The degree of "task clarity" knows relatively many problems. The experimental group shows high scores for all three measurements, and the scores are almost the same for those three measurements
The "work pressure" and "need for recovery" are both at T0 and T1 high, at T2 though again within the normal range
Concerning "energy" during work data show at T1 and T2 unfavourable relatively high scores Whilst the scores in T0 were within the normal range.

The comparison between the control group and reference group.
The control group (CG) does not differ at all from the Dutch reference group at measure moment T1 and T2. Only at T0 there are two striking differences: the amount of problems with the task feedback (bad quality of feedback) and problems with colleagues (bad work atmosphere)

Effects of the game?
Because of the small size of the experimental group and the limited comparability of both groups of employees it is very difficult to determine the real effect of the game. Many of the differences between the EG and the CG mentioned above are possibly due to the variation of a single respondent from moment to moment. In group sizes from 10-15 respondents these kind of individual / random fluctuation levels itself, so that the difference between departments is easier to determine. Nevertheless a brief glance at the possible effects of the game.

An indicator for a positive effect of the game would if at T0 there would be no differences between EG and CG but at T1 and T2 there are, and in such way that the EG has lower scores then the CG.
For "work pressure" the scores decline for the EG from T0/T1 to T2, whilst for the CG it stays constant. For "need for recovery" there is a similar decline from T0/T1 to T2, where the CG shows a slight increase of problems.
Less obvious one can recognise a similar patron at autonomy. Also here in favour of the EG (decline from T0/T1 to T2) compared with the CG (more problems with time)

In short: concerning work pressure / need for recovery / autonomy data show a positive trend that is possibly related to the game.

An indication for a negative effect of the game would be that there would be no difference between EG and CG at T0 but at T1 and T2 there are, and in such way that the EG has higher scores then the CG.
Data from "Energy at work" and, but less obvious, "Social Support" and "Extra-role performance show a clear negative patron. The effect of the game could put these categories under pressure!

For further details please see "Further results – research results" page 23: Teun van Stratum, Marc van Veldhoven December 2017 and Veldhoven Marc van, December 2018

Chapter 3; overall evaluation of the project

Despite the delays in starting the project the companies were very cooperative in the beginning. The definition phase of the project went very well. At the kick-off, companies suggested they wanted to meet every now and then for project and process evaluation. From the beginning this was a mission impossible. Companies operations issues made it impossible to get them gathering for these kind of sessions. These operational issues were very much of influence in the execution of the total project.

Project execution:

During the first stage of the project it became clear that there was a wide gap between project application and project execution. The application foresaw a 'game platform' in contrast to the project execution where only a 'gamified' dashboard was offered. This lead to unnecessary discussions and a change of focus on the project that could have been avoided through a proper project application.

Another main change during the project has been the shift of execution phases. It seemed to be obvious to use, from the six sigma method, DMADV (Design, measure, analyse, Define and verify) but during the project it became clear that the chosen phases were not logical. Right after the design phase companies were puzzled and asked for more clarification of the possible final result. So design became apparent. And with that also the other phase changed (see figure 5)

The main problem of all has been the lack of availability of real time data in the operation of the warehouses. All though the involved companies emphasised the availability of all kind off data during the measure / design phase it became apparent that it was not possible to use real time data for the gamification. This was a real show stopper! Also in this case it should have been an discussion item in the application phase. Possibly leading to different companies involved in the project, or no project at all.

As already shown in figure 12 the implementation of the dashboards was delayed several times. The delays had their influence on the intended research of the effects of gamification as performed by the University of Tilburg. The research design was based on an experimental-control group design in each of the targeted companies, hence the execution of the research depended on both availability of measurements and game implementation between T0, T1 and T2. When finally the dashboards were implemented at <company 1> and <company 3>, only at <company 1> some limited research could be executed according to plan. (see paragraph "Analyse" page 16-18)

Project result:

At two out of three companies the 'gamified' dashboards were implemented before the end of the project. But are they transferable to other companies….no! The inevitable changes in the project and the desire to at least execute the research on the effect of gamification in work situations deviated from the original goal.

Sadly, despite of all efforts made within the companies, due to several factors e.g. delays in implementation, amount of employees involved in the research, issues with the unions the effect of gamification could not be researched properly.

Conclusion:

The main research question of this project: *"in what way can human behaviour be positively influenced by applying game principles in warehouse operations and what are the effects on the critical performance indicators?"* **could not be answered!**
What is left of the goal is "the insight of an approach for a quick start applying of serious gaming". Did the project succeed in that? With all the knowledge from this project a list of prerequisites can be drawn.

Prerequisites for gamification in work situations.

From the gamification theory and design point of view:

- Gaming or play is often understood as a voluntary experience asking people to make creative choices with limited to no external consequence, all of which is often in contradiction to work. Acknowledge that gamifying work introduces this tension between work and play, becoming the foundation of the entire project.
- Seek work situations that are suitable for gamification. If the work is defined so extensively and tightly that there is no room for cognitive or behavioural choice or discretion, then it is probably unsuitable for gamification. If there is room for that (e.g. through job crafting), then gamification becomes much more suitable and interesting.
- Try to involve the employees targeted in the gamification design process. At least step into the minds, hearts, contexts and work of those you are targeting in your gamification. What do they want from and in their work? What do they (not) find important in their work?
- Consider the proposed gamification within the complete organisational context at hand, a context in which other perspectives and measures that try to reach similar objectives probably already exist, e.g. human resource management and labour unions. How and to what extent will the gamification fit in with or compete against that?
- Prototype and test gamification design ideas and elements early and in multiple iterations with multiple levels of design fidelity. Start with paper prototypes if possible, or otherwise with simple digital solutions that actually fake most the experience, just to see how those affected could react cognitively and behaviourally.

From the practical / project point of view

- Project application and project start should be within ultimately 6 months,
- Real-time performance data should be available, as well as data warehousing to enable data comparison within the game,
- In project application, game design, ICT and project managers should be involved,

- Management should accept creative designs of the dashboards not a 'normal' performance dashboard,
- Operational affairs will be disruptive and delay the implementation. Management support for the execution is that crucial,
- First Design of the final product should be done in a very early stage,
- An analysis of the needed data and data format should be done in an early stage of the project. Perhaps also involve the game designers earlier in the project to prevent any assumptions regarding this topic.
- Anonymity in performance could be demanded,
- There should be a minimum of required players in the blueprint.

From a research point of view

- Research of base performance, short-term effects and long term effects should be done 3 weeks before the gamification, 3 weeks after and 3 months after the start of the gamification,
- Amount of 'players' / employees should be big enough to gather sufficient data for survey measurements,
- The change of employees in the research phase should be minimized. Situations in which a lot of flexible employees are involved deserve special attention. A different approach from a research point of view could be better in situations where flexible employees are involved.
- Aim for experimental or quasi-experimental research design. Ensure you have enough teams & people involved to be able to set up a equivalent control group undergoing a proper alternative simultaneously as the experimental group,
- Language (mother tongue) of the research should fit the employees. Survey measures should be simple enough to be filled in by employee groups with lower levels of education,
- Language for foreign employees should be adapted to mother tongue. Game measures should be simple enough to be filled in by employee groups with lower levels of education.

Further results

Scientific article:
Warmelink, H., Koivisto, J., Mayer, I., Vesa, M., & Hamari, J. (2018). Gamification of production and logistics operations: Status quo and future directions. *Journal of Business Research*. https://doi.org/10.1016/j.jbusres.2018.09.011

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Peeters Tina; Master's thesis Human Resource Studies. December 15th 2016
Gamification and HR: When two seemingly incompatible worlds are joined to create a job design intervention.
Tilburg School of Social and Behavioral Sciences Program. MSc Human Resource Studies
Name supervisor: prof. dr. M. J. P. M. van Veldhoven Name second reader: dr. F. C. van de Voorde

Stratum Teun van; Master's Thesis Human Resource Studies 2018
Healthy competition? The role of trait competitiveness in explaining differences in employee strain, engagement and performance
Supervisor: Prof. Dr. M.J.P.M. van Veldhoven / T. Peeters, MSc.

Second reader: Prof. Dr. R.F. Poell

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Presentations:
Maarten van Rijn: *Serious Logistics Gaming, a project story.* At Meaningful meetings October 11th 2018 Breda University

Maarten van Rijn: *Serious gaming while working…does it work?* At conference Logistics and ICT / KennisDC Logistiek Theater November 7th 2018

Maarten van Rijn*: ICT, Performance Indicators and Logistics Gaming* At 'Logistieke dag Limburg 2018' December 12 2018

Warmelink, HJG., Koivisto, J., Mayer, IS., Vesa, M., & Hamari, J. (2017). *Gamification of the work floor: A literature review of gamifying production and logistics operations*. Paper presented at 33rd EGOS Colloquium - The Good Organization: Aspirations, Interventions, Struggles, Copenhagen, Denmark.

Warmelink, HJG., Koivisto, J., Mayer, IS., Vesa, M., & Hamari, J. (2018). *Gamification of the work floor: A literature review of gamifying production and logistics operations*. Paper presented at 51st Hawaii International Conference on System Sciences, Big Island, United States.

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Teun van Stratum, Marc van Veldhoven December 2017 : Serious Logistics Gaming. *Rapportage nulmeting Banketbakkerij <company 3> B.V.* Tilburg University *Departement Personeelswetenschappen*

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Research articles:

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Neal, A., & Griffin, M. A. (2006). A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents at the individual and group levels. *Journal of applied psychology*, *91*(4), 946

Goodman, S. A., & Svyantek, D. J. (1999). Person–organization fit and contextual performance: Do shared values matter. Journal of Vocational Behavior, 55(2), 254–275.

Please find several deliverables on:
the website "KennisDCLogistiek" http://www.kennisdclogistiek.nl in "kennisbox" Serious Gaming

Breda, December 2018