

# USING GAMIFICATION FOR IMPROVING NURSES' PRODUCTIVITY IN A HOSPITAL WARD

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**Abstract.** *Healthcare acquired infections are one of the biggest problems healthcare field is facing, which can end up in an increasing quantity of deaths, extra-days of hospital stay and costs for both the hospital and the patient. Performing hand hygiene is a simple and inexpensive prevention measure, but healthcare workers compliance with it is still far from desired. Recognized hurdles are lack of time, forgetfulness, wrong technique and motivation. Besides, nurses' perception about their compliance is disturb by a busy schedule. This study aims at exploring the use of gamification to promote nurses' HH compliance self-awareness and action. Real-time collected from an indoor location system will provide feedback information to a group of nurses working in an ICU ward. In this paper we present our research's motivation and methods, along with the collected results and its discussion.*

**Keywords:** Healthcare-Acquired Infections, Hand hygiene compliance, Healthcare workers, Gamification, Behavior changing

## 1. INTRODUCTION

Healthcare acquired infections (HAI) are infections that are neither present nor incubating when a patient is admitted to hospital (Garner, Jarvis, Emori, Horan, & Hughes, 1996). HAI are a risk that hospitals must control to manage healthcare economically and safely for patients, whom can become disabled at long-term or even die. Although preventable, by means of hand hygiene (HH) compliance, these infections are the most adverse event a patient can experience during care delivery, and cause more deaths than AIDS, breast cancer and auto accidents together (Carboneau, Bengé, Jaco, & Robinson, 2010).

Nonetheless, leading busy healthcare workers (HCW) to comply with HH remains puzzling. Recognized hurdles are lack of time, forgetfulness, wrong technique and motivation. Besides, nurses' perception about their compliance is disturb by a busy schedule.

Having this, it becomes crucial to monitor nurses' compliance with existing guidelines and provide them with feedback regarding their performance. Direct observation, the observation of HCW's HH practice by professional observers, is the standard approach to fulfil this task, but it is costly and time-consuming.

Automated monitoring systems have emerged during the last few years, and can electronically identify when an HCW uses a sink or a handrub dispenser. It provides exact quantitative results, which can be used to examine trends regarding the value of HH compliance over time.

Gamification is a recent but popular approach which can be defined as “the use of game elements and game-design in non-game contexts” (Werbach & Hunter, 2012) to “engage and motivate people to achieve their goals” (Burke, 2014), providing a whole different user experience. It aims at stimulating people’s intrinsic motivation in doing an activity by trying to make it rewarding for itself.

Game elements are the “toolkit” for building a game (Werbach & Hunter, 2012) and they must be chosen in the end of the process of designing a game, after some variables are analyzed and defined (goals, behaviors we want to stimulate, our target players, etc.). Werbach and Hunter (2012) provide a list of game elements divided into three categories with different levels of abstraction.

This study aims at exploring the use of gamification to promote nurses’ HH compliance self-awareness and action. An automated monitoring system will be used to collect data in real time and provide feedback information to a group of nurses working in an ICU ward, in a fun and engaging way.

We start this paper by defining the methods we used to conduct our research. The already collected results will be presented, followed by their discussion. We end with future work statements and a conclusion.

## **2. METHODS**

In this section we present the methods used in our study. A design science research approach is being used to iteratively design, test and evaluate our solution (Peffer, Tuunanen, Rothenberger, & Chatterjee, 2007), which consists on an automated monitoring system, composed by an indoor location system and a gamified system. The solution was already presented to its target users (the nurses) and its usage was simulated in both non-real environment (by non-real users) and real environment (by a real user).

### **2.1. Design and implementation of the solution**

The first component of our solution is an innovative indoor system built with smart beacons and smart tags, which use both Bluetooth and a proprietary protocol (also operating on the 2.4GHz frequency band) to communicate, and a proximity-based technique.

More specifically, the smart tags (which are carried by the nurses) receive information from smart beacons and send a message to the server (communicating the smart tag ID, the detected beacon ID, the current time and the type of message – approaching or leaving) whenever they are approaching a beacon or walking away from it. Analyzing the messages stored in the server, we are able to detect nurses’ position over time.

The next step is for the system to detect and validate HH moments. To achieve this, we use the World Health Organization (WHO)’s “My five moments for hand hygiene” framework (World Health Organization, 2009), which links specific moments to HH opportunities (Table 1). With this framework, we are able to create and implement business rules in our system (for example, if a nurse is approaching a bed, it must have approached an alcohol handrub dispenser or a sink previously).

Moment	Period where HH must take place	
	After...	Before...
1 – Before touching a patient	...the last contact with a surface in the health-care area	...the first contact with a surface in the patient zone
2 – Before clean/aseptic procedure	...the last exposure with a surface	...access to a critical site with infectious risk for the patient or critical site with combined infection for patient care.
3 – After body fluid exposure risk	...a care task associated with a critical site with body fluid exposure risk for the patient or critical site with combined infection	...the first contact with any other surface
4 – After touching a patient	... the last contact with a surface in the patient zone, <u>with</u> touching the patient	...the first contact to any surface in the health-care area
5 - After touching patient surroundings	...the last contact with a surface in the patient zone, <u>without</u> touching the patient	...the first contact to any surface in the health-care area

Table 1- WHO's "My five moments for hand hygiene" framework, adapted from (World Health Organization, 2009)

After this processing, we have information regarding each nurse's compliance, which is displayed, in an anonymous way, in a screen in real-time (Figure 1).

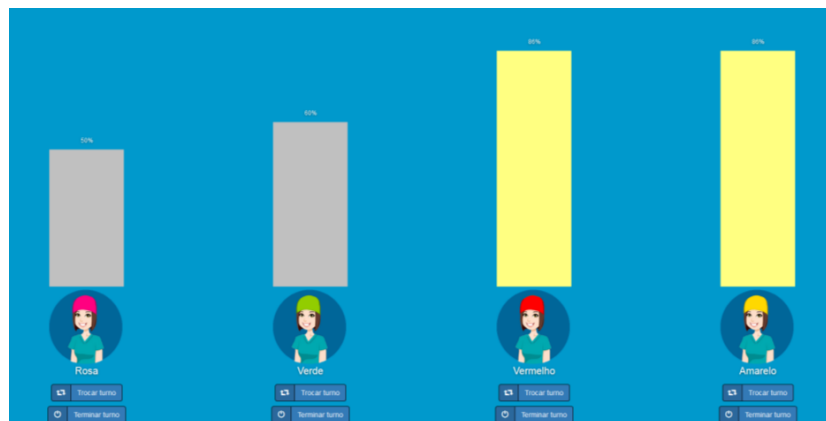


Figure 1 – Part of the gamification solution presented in a screen in the nurses' room

This, along with other components, including the player's profile (Figure 2),composes the gamification solution, which aims at solving the compliance problem by engaging and motivating people to achieve specific goals (King, Greaves, Exeter, & Darzi, 2013), using several and distinct game elements (feedback, competition, points, levels, badges, etc.). The technological architecture of this solution is presented in Figure 3.

## 2.2. Meeting with the nurses

There have been some meetings with the nurses from the ICU where the system is to be implemented. We presented the Information System (IS) aiming at gathering feedback regarding their feelings about it.

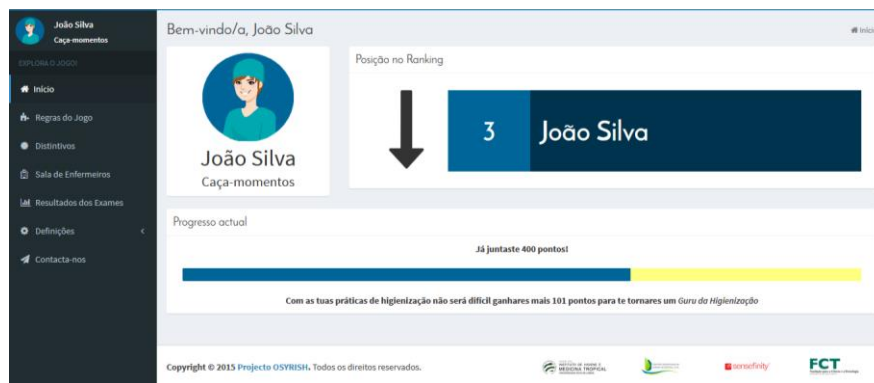


Figure 1 – Page of one player's profile

### 2.3. Simulation

A simulation was performed, in a non-real environment by non-real users (the research members), in order to validate if the solution was technologically working correctly. A protocol was written and executed, and after that we looked at the HH compliance rate computed, which was compared with the expected rate.

To analyze the impact of the IS's usage by a real user, we asked one nurse from the ICU ward to carry a smart tag during a workday. This data was compared to a previously established baseline (built with respect to an observational study) to measure the changes in behavior.

## 3. RESULTS

From the already done work, we extracted some results, which are presented in this section.

### 3.1. Installation of the solution

After being designed and implemented, the IS was installed in the ward. We placed one screen in the nurses' room and 26 beacons in specific positions: in the rooms' doors, in each alcohol-based hand rub container, in each sink and in each bed. This way, the system would be able to trace a nurse's position along time based on the proximity to each beacon.

### 3.2. Feedback from the nurses

The group of nurses to whom the IS was presented to enjoyed the concept and think it is a unique and good opportunity to receive feedback regarding their performance (although they are sometimes subject to audits, they said that this would give them a totally different experience). Although worried with the accuracy of the location system, they found the avatars experience funny. Regarding future improvements suggested, they showed little interest in components like badges, virtual goods and content unlocking because it would require them to use the system outside their labor hours. They, however, liked the concept of leaderboards. To finish, we asked them if they prefer to maintain their privacy (that is, information presented by sensor and not by HCW) or if they wanted their name (or a chosen nickname) to appear on the screen. They said that this was indifferent for them, since they had no problem in having their identity exposed in the screen.

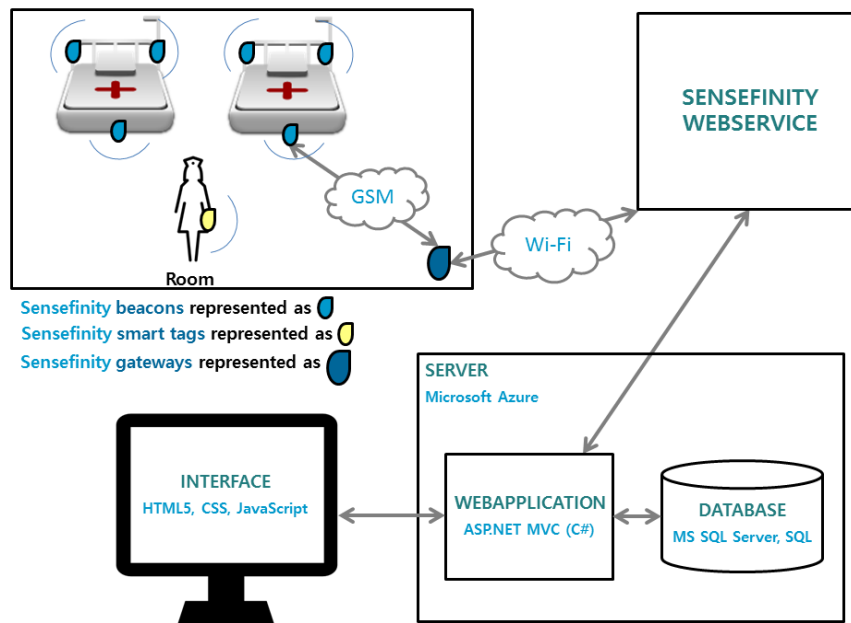


Figure 2 – Technological architecture of the solution

### 3.3. Simulation

The simulation in a non-real environment presented good results. The system worked accordingly to our expectations, returning a HH compliance rate of 100% regarding the moments simulated. However, when testing it at the hospital, we noticed that these results were a false positive and that the system needed some refinements.

Regarding the simulation performed by the nurse from the ICU ward during one 12-hour shift, the feedback received was that she got happier as she progressed in the game, and whenever she noticed that the rate had decreased (even if only a little), she felt the urge for being more aware of the HH moments.

## 4. DISCUSSION

Based on the results presented in the previous section, we can conclude that the IS was conceptually validated, since we were able to detect the nurse's movements using proximity and to quantify the compliance with good precision, which was only possible due to the indoor system's capability of providing nurses' position with great accuracy and in a real-time basis, despite using radio-frequency based technologies.

The participant nurse approved the measure as an opportunity to improve her performance, which corresponds with the results from the initial meeting with the nurses. Since nurses were a little skeptical in using some game elements that required them to access the system outside their work time, we decided to include a functionality in the system to send an e-mail to each nurse in the end of the day. This simple e-mail provides feedback regarding their HH compliance rate and has a link to their profile for further information. This nurse realized that she ended up consulting the webpage, even though she said she wouldn't in a first instance.

## 5. CONCLUSIONS AND FUTURE WORK

The impact of gamification on HH compliance is still under evaluation. Even though we only performed small validation tests to check whether or not the concept would

work, so far the results show that the IS is promising in improving nurses' productivity. A demonstration in the ICU ward is already planned. During a 5-day trial, 24 nurses will be using the gamification solution and will be provided with feedback regarding their HH compliance rate. Simultaneously, we will be observing their behaviors and reactions, trying to understand if they are comfortable with it and if they trust the presented results, and focused on spotting some technical issues that might be leading to undesired side effects of the system. In the end, we will analyze the gathered results and refine our tool, both in terms of improving our gamification solution and fixing some problems that may emerge during the demonstration. After this, our goal is to implement the solution in a unit of another hospital during a larger number of days.

To conclude, we believe that the IS is aligned with nurses' needs and that it will have a positive impact on their daily routine. Although we noted some resistance to some ideas we discussed for future work with the nurses, the nurse who participated in our initial test agreed that she ended up using the system, so we trust that after using the IS on a daily basis nurses can be more interested in different options.

It must be highlighted that nurses participated in IS's design since the beginning, which enabled a higher sense of ownership in the process, recognized as to improve performance.

## **6. ACKNOWLEDGEMENTS**

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