

Towards Gamification Analytics - Requirements for Monitoring and Adapting Gamification Designs

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Abstract: Application and gamification data contain valuable information about users and their behavior. This data can be used to measure the success of gamification projects, to analyze user behavior, and to continuously improve gamification designs. However, to support the process of gamification analyses, appropriate tool support is missing. Moreover, the specific requirements for methods and tools have not been studied yet and remain unclear. Therefore, this paper presents a theoretical model of 22 requirements that can be used to assess existing solutions or construct novel methods and tools for gamification analytics. The presented model is validated based on comprehensive expert interviews.

1 Introduction

Gamification is a novel topic which receives increasing attention from researchers as well as practitioners. Inspired by the user experience of computer games, gamification describes the idea of using game design elements in non-gaming contexts [DSN⁺11]. Recent studies show that gamification has the potential to considerably improve user experience and user engagement in a variety of software application domains [HKS, HSA12].

In literature [HAWS14], experts structure the methodology of gamification projects into four high-level phases: (1) *Business Modeling and Requirements*, where the application context is analyzed and business goals are documented. (2) *Design*, where the gamification design is developed and playtested. (3) *Implementation* and related activities, where the design is implemented as software artifacts and functionally tested. And finally (4) *Monitoring and Adaptation*, where the business goal achievement is measured and subsequent design adaptations are conducted. To support the rapid implementation and integration of gamification designs in phase three, researchers and industry have come up with generic gamification platforms, e.g., [HAS12, Bun14, Bad14]. However, as we will show in this paper, there is still an unsatisfied demand for tools that support phase four, i.e., the monitoring and adaptation of gamification designs. Experts request such gamification analytics tools to measure the success of gamification design changes, to better understand the user behavior, and to learn when a gamification design requires adjustment [KH13].

In this paper we present 22 user requirements for gamification analytics which were validated by semi-structured interviews with 10 gamification experts. The rest of the paper is structured as follows: Section 2 introduces the used research methodology. Section 3 presents our hypothetical user requirements model. Section 4 describes the expert sample and the model assessment results. Finally, Section 5 summarizes our work and provides an outlook to future research.

2 Methodology

In the following, we introduce our research methodology which is used for developing and validating the user requirements model.

Initially, we created a hypothetical user requirements model based on existing gamification literature, game literature, and our own experience in gamifying various business applications. Besides a textual description of these requirements, we also developed conceptual mock-ups to showcase the functionality in accordance with [May99].

To validate and extend our hypothetical user requirements model, we invited gamification experts from a variety of functions and domains to semi-structured interviews. The interviews were conducted with web conferencing tools and recorded for later analysis. The interview structure comprised four parts: (1) *Introduction* – The interviewer briefly introduced himself, the direction of his work, the interview procedure, and the intended exploitation of results. (2) *Professional background* – To get to know the experts, they were asked to introduce themselves and their professional career. (3) *Experience and expertise in gamification* – Experts were asked to elaborate on their activities in the field of gamification. Questions addressed the state of the art in gamification projects, as well as the identification of problems with today's project methodologies and technologies. (4) *Discussion of mock-ups* – The last step of the interview comprised the presentation and discussion of the conceptual mock-ups. The experts were first introduced to the demo scenario, then guided through the mock-ups. For each presented feature they were asked to provide their opinion and to share feedback.

3 Hypotheses Model

This section presents our initial model of user requirements hypotheses which comprises five categories of requirements: *Application KPI Monitoring* helps gamification experts to observe the development of application-related KPIs. *Gamification Element Analytics* supports them to understand the development of the game state and how users interact with game elements. *Gamification Design Adaptation* enables gamification experts to test the impact of changes to the gamification design. *User Groups of Interest* allows experts to focus analyses on subsets of the users. Finally, *Simulation* empowers experts to simulate arbitrary gamification designs with existing behavior data.

3.1 Application KPI Monitoring

Definition of Application KPIs Gamification literature emphasizes the importance of defining clear business goals and measuring the success of gamification designs towards their achievement [Kap13, KH13, WH12, HAWS14, Rim14]. Key Performance Indicators (KPIs) based on user behavior can be used to operationalize business goals. Accordingly, we argue that the collection of relevant data is one of the essential prerequisites for realizing gamification analytics. A gamification analytics tool should be able to calculate application-related KPIs such as *New Blog Posts Per User and Month* in a community. In the context of KPI definition, we define the following three concrete requirements:

R1) Custom KPIs – Gamified applications typically have domain-specific KPIs. Gamification experts should be able to define these KPIs based on the available application log data which is typically available in form of event streams, databases, or log files. The definition of KPIs should be possible at any point of time, allowing experts to adjust and refine KPIs according to their informational needs and available event data.

R2) Pattern Based KPIs – Experts should be able to formulate KPIs that count the number of particular pattern occurrences in the behavior data of users. This supports experts in measuring the success of game elements which aim at influencing behavior patterns. Experts might, for instance, be interested in a KPI that determines the proportion of community users who actively read the community rules before posting their first question.

R3) KPI Goal Values – The experts should be able to define and adjust KPI goal values whose fulfillment will be monitored automatically by the gamification analytics system (see R6). For instance, that *New Blog Posts Per User and Month* should be at least 0.7.

Presentation of Application KPIs In the following, we describe our user requirement hypotheses regarding the presentation of application KPIs. Figure 1 shows the corresponding conceptual mock-up of the application KPI monitoring screen which was used for discussion during the interviews.

R4) Dashboard – Gamification experts should be able to get a comprehensible overview of the state and over time development of application KPIs. This can be achieved by a visual dashboard that combines charts with descriptive statistics.

R5) Change Markers – Experts should be able to understand the impact of historical changes in the gamification design on the development of application KPIs. This can be achieved by annotating KPI curves with markers that indicate past design changes.

R6) Goal Markers – Experts should be aware of how individual KPIs perform in relation to their goal value. The defined KPI goal value should be shown together with the actual KPI value and deviations should be indicated. This might help experts to immediately notice undesired changes and gives them the chance to take appropriate action such as exploring the data for better insights or adapting the gamification design to increase engagement.

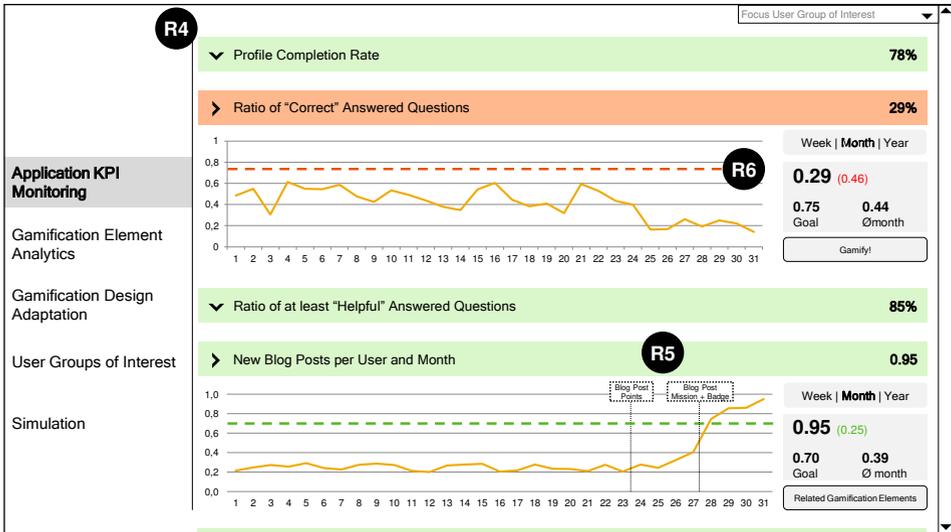


Figure 1: Conceptual Mock-up of Application KPI Monitoring Dashboard

3.2 Game Element Analytics

Game State Overview Gamification experts should have an overview of the game state and its development over time. Exploring the relation between game states and the corresponding users might help experts to detect design flaws or other needs for design adjustment. A design flaw could be, for instance, that users spend significantly more time in a level than expected. A need for adjustment might arise from the fact that most users already reached the final level. In particular, we define the following requirements:

R7) Gamification Feedback Rate – Feedback is an important element of games [SZ04, ZC11, WH12]. We define *Gamification Feedback* as any state change in the game that is perceived by the user as success, e.g., gaining points, or receiving a badge. Correspondingly, the *Feedback Rate* describes the amount of feedback per time. Experts should be able to inspect the feedback rate over time, corresponding descriptive statistics, and annotations representing past design changes. This insight might help them to qualify all other observations, and can be a starting point for investigating unexpected user behavior. For example, a game with an average of 0.1 feedbacks per user hour and a maximum of 20 feedbacks per user hour might have significant flaws in the design of its mechanics.

R8) Point Distributions – Experts should have insight into the distribution of points over users. This might help them to detect flaws in the balance of point amounts for gamified actions, e.g., when 1% of the users own 90% of the points.

R9) Achievable Game Elements – Gamification experts should have insight into the overall statistics of badges, levels, missions, and other achievable game elements. Moreover, they should see the users' progress in the game. Drill-down functionality should be available to allow a deeper investigation of particular game elements (see R10-R12). This can be

achieved with a dashboard that shows completion rates and temporal statistics of game elements. As an example, a gamification design might require adaptation, when already 60% of the users reached the highest level.

Detailed Statistics of Game Elements From the game state overview, gamification experts should be able to drill down to more detailed information on the relation between users and achievable game elements such as badges, levels, or missions. In particular, we define the following requirements:

R10) User Distribution on Game Element State – Gamification experts should be able to gain insight about the distribution of users on the states of particular game elements. For missions typical states would, for instance, be *Mission Completed*, *Mission Active* and *Not Assigned to Mission* [Dor12]. This should help them to understand how the users progress in context of the game element. Experts could, for instance, notice that only a few users completed a particular mission, while most others are stuck in one particular sub-goal of that mission. This might be an indicator that the design of the mission needs adjustment.

R11) Temporal Statistics – Experts should be able to see how long users need for the completion of particular game elements. Therefore, they should be able to browse the following distributions: *Time to Completion* – Time period between the start of user existence and game element completion. *Time to Assignment* – Time period between the start of user existence and the assignment to the game element. *Time Active* – Time period between assignment and completion of the game element. For example, noticing that users typically complete a mission faster than expected, might be an indicator for necessary adjustments.

R12) User Characteristics – Gamification experts should be able to explore which statistically significant properties users have in common, who share the same state on a game element of interest. We distinguish game properties and user properties. Game properties originate from the user's state in the game, e.g., *owns badge A*, while user properties originate from the information the application has about the user, e.g., *from geographical region Europe*. By revealing significant factors of user engagement in context of a particular game element, experts could optimize the game design for their individual audience. When experts notice that a mission is significantly more often completed by European users, they could, for example, start investigating the reasons and adapt it to raise its attractiveness in all relevant geographical regions.

3.3 Gamification Design Adaptation

A/B Testing Tests with experimental and control groups (A/B tests) are a widely used method for evaluating the effects of changes in a particular context. They have also been proposed for validating gamification design ideas [Kap13, KH13]. With A/B testing, the effects of game design changes can be verified before activating them for the whole user base. Thus, we formulate the hypothesis that an integrated way of conducting experiments and analyzing their results could be one of the key features of gamification analytics. A/B testing comprises the following two requirements:

R13) Experiment Creation – Experts should be able to create an experiment by defining its name, description, the size of the experimental group, target KPIs, desired KPI impact (increase or decrease), and the actual design changes which are subject of the experiment. After specifying the mentioned parameters and starting the experiment, a user group with the selected experiment size should start interacting with the new design. From this point on the analytics tool should analyze the difference between their behavior and the behavior of the rest of the users. This allows experts to analyze the generated impact (see R14).

R14) Experiment Result Analysis – As an intermediate and final result of A/B tests, a gamification analytics tool should show the experts a summary of observed effects in user behavior. Moreover, it should indicate, whether the effects are statistically significant in comparison to the control group. This supports objective decision making in the design adaptation process. As a result of keeping a new design idea, a new annotation should be created in all relevant graphical charts, indicating that a design change was conducted (see R5). Experiment results should be archived for durable access to the result data which led to a design decision. Figure 2 shows the conceptual mock-up of the A/B test result view.

Experiment		Focus User Group		
Incentivize correct answers with mission + points				
Goal	Increase ratio of „Correct“ answered questions			
Experiment Size	250			
Start Date	12.03.2013			
End Date	26.03.2013			
Effects Summary				
Metric	Experimental Group	Control Group	Δ	
Ratio of „Correct“ Answered Questions	+6.7%	-0.3%	+7.0%	
Ratio of at least „Helpful“ Answered Questions	+0.3%	+0.1%	+0.2%	
Profile Completion Rate	+0.1%	+0.0%	+0.1%	
New Blog Posts per User and Month	+0.0%	+0.0%	+0.0%	
...			..	

Figure 2: Conceptual Mock-Up of A/B-Test Result View

Direct Design Adaptation R15) In addition to design decisions based on A/B-tests, gamification experts should also be able to conduct direct changes to the gamification design resulting in the creation of change markers in the KPI visualizations (see R5). Direct changes might be necessary in cases when A/B tests are not suitable, e.g., with small user groups or when time constraints apply.

3.4 User Groups of Interest

Experts should be able to focus their analyses on user groups which are of special interest. In the following, we describe our hypothesis regarding their definition and use.

Definition of User Groups of Interest We assume the following three techniques to be relevant for the definition of user groups:

R16) Criteria Based – The experts should be able to define groups based on criteria which are evaluated against the users’ properties. This approach is applicable when the exact criteria are well known before creating the user group. Such a group could, for instance, contain all users who are located in the geographical region *Europe* and who at the same time reached game level 9.

R17) Cluster Analysis – Cluster Analysis aims at finding similar groups in a set of objects [ELLS11]. The experts should be able to conduct a cluster analysis on relevant properties of users to discover groups which are of interest for them. This approach is applicable when the exact criteria of the user group are not known a priori.

R18) Manual Selection – Experts should be able to manually compose a user group. This can be useful in the analysis of user groups, whose members’ behavior is of special interest and whose members are known a priori. Gamification experts might, for instance, want to compose a user group out of community members with a high reputation.

Filtering of Overviews by User Groups of Interest R19) The experts should be able to filter overviews by selecting a user group of interest. This should be possible at all places, where statistical overviews are shown. Affected are the application KPIs, as well as the game element statistics and the result presentation of A/B tests.

3.5 Simulation

R20) Simulation is a common tool in game design [Dor12]. In gamification design it is also considered as useful to support early design decisions [Rim14]. Gamification experts should be able to simulate their design ideas with existing user and behavior data. Given that an appropriate dataset of historical user behavior exists, a simulation can help to identify major flaws in the mechanics of a new gamification design. The simulation results should be explorable in the same way as real data by viewing application KPIs, game element analytics, and the opportunity of defining user groups of interest.

4 Evaluation

In the following, we present the results of our semi-structured expert interviews with regards to the proposed requirements. First, we document the characteristics of our expert sample. Second, we describe the results of the model assessment. Finally, we list additional requirements which were raised during the conduction of the interviews.

4.1 Sample

In this section we characterize the interviewed experts by presenting their professional background and gamification experience. The interviews were conducted with 10 experts, took place in February and March 2014, and had a typical duration of 2-3 hours.

Professional Background To the date of the interview, the experts were involved in 36 ($\mu = 3.6, \sigma = 3.9$) currently running or already finished gamification projects. The average experience in the field of gamification projects was $\mu = 2.0$ years ($n = 9, \sigma = 1.2$). A breakdown of the experts' functions and domains of projects which were closer discussed, is given in Table 1. In addition, Figure 3 shows the audience size of projects that are already operative.

Expert Function	N	Project Domain	N
Development	3	Training and Education	4
Gamification Consultancy	2	Social Media	3
Community Management	2	Software Development Tool	2
Project Leadership	1	Customer Relationship Management	1
Research	1	Marketing	1
Software Architect	1	IT-Support	1
		Serious Games	1

Table 1: Expert Functions and Project Domains

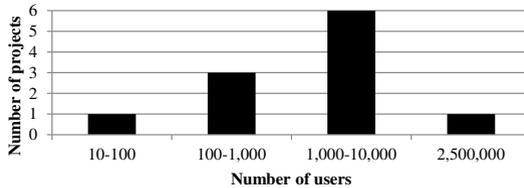


Figure 3: Audience size of experts' finished projects

Experience and Expertise In consistence with gamification literature [Kap13, KH13, WH12, HAWS14, Rim14], we based our requirements model on the assumption that gamification projects have a clear problem definition and measurable business goals. Eight experts reported that their gamification projects started with a clear problem definition. Furthermore, they agreed that they had clear quantitative goals or were still working on their definition. Only the two gamification consultants stated that they often get involved, when the target problems are not well-defined yet. Thus, analyzing the business problem and defining KPIs for success measurement is one of their first activities in a project. We conclude that clear business goals and measurable business goals typically exist.

The power of analytics depends on the richness of the available data-sources. For gamification analytics it is essential to have the necessary data from application side, i.e., user properties and user behavior, and from game side, i.e., the game state. All experts reported that the required application data for measuring the success of game elements is typically available. Seven experts reported, that they already used own tools in order to generate

focused reports on relevant KPIs, mainly for management reporting purposes. However, the fact that application and gamification data typically reside in separate systems, makes a joint analysis very expensive. The upfront investment to build a system for explorative data analysis is too high for typical gamification projects which have a reported size of typically 3-5 project members. Accordingly, all experts expressed a strong demand for appropriate tools and methods which help them to better understand how game elements affect the behavior of the users in an application.

4.2 Model Assessment

All experts agreed to the overall structure of our requirements model as it was directly reflected in the corresponding mock-ups and none of them was missing another high level group of requirements. Table 2 shows a detailed overview of the assessment results for each of the presented requirements. We categorized expert feedback into the following categories: [✓] *Agree* – The expert expressed agreement and stated that the requirement is relevant for gamification analytics, [-] *neutral* – The expert did not express a strong opinion towards the discussed requirement, and [✗] *disagree* – The expert expressed that the discussed requirement is not relevant for gamification analytics. In the following paragraphs we will discuss aspects with noteworthy input from the interviews.

Requirement			✓	-	✗
Application KPI Monitoring	R1	Definition of Custom KPIs	10	0	0
	R2	Definition of Pattern Based KPIs	10	0	0
	R3	Defintion of KPI Goal Values	10	0	0
	R4	Dashboard	10	0	0
	R5	Change Markers	10	0	0
	R6	Goal Markers	10	0	0
Game Element Analytics	R7	Feedback Rate	10	0	0
	R8	Point Distributions	9	1	0
	R9	Achievable Game Elements Statistical Overview	10	0	0
	R10	User Distribution on Game Element State	10	0	0
	R11	Temporal Statistics	10	0	0
	R12	User Characteristics	10	0	0
Gamification Design Adaptation	R13	Experiment Creation	10	0	0
	R14	Experiment Result Analysis	10	0	0
	R15	Direct Design Adaptation	10	0	0
User Groups of Interest	R16	Definition Based on Criteria	6	5	0
	R17	Definition Based on Cluster Analysis	4	6	0
	R18	Definition Based on Manual Selection	1	3	6
	R19	Filtering of Overviews by User Groups	10	0	0
Simulation	R20	Simulation and Result Analysis	7	3	0

Table 2: Model Assessment Results

Application KPI Monitoring All experts agreed to the key concept of monitoring relevant KPIs of the target application. The interviewees participated very actively in its discussion and provided many examples of relevant KPIs from their project contexts. In addition to the definition of KPIs (R1), three experts expressed the wish to be able to define KPIs even

with historical event data. This can be helpful to gain new insights in the process of data exploration and interpreting effects that took place in the past.

Game Element Analytics All experts confirmed that the feedback rate (R7) is useful to qualify other observations. Since, neither too much, nor too less feedback is desirable, they confirmed its value for balancing the amount of feedback of gamification designs. Six experts explicitly emphasized the importance of this high level metric. Moreover, two experts expressed that they would like to have access to more detailed statistical figures and the ability to drill down on the graphical chart in order to start investigating the users that are in the range of interest. All experts agreed on the concept of visualizing point distributions via visual charts combined with descriptive statistics (R8). However, one expert was not sure, whether such an information would really help to understand if the design has flaws, or not.

Gamification Design Adaptation Only two of the interviewed experts reported that they already conducted tests with experimental and control groups. However, all of them agreed that a tool supported workflow would be a strong benefit in the process of adapting gamification designs. Additionally, most of the interviewees explicitly emphasized their desire to conduct A/B tests. They perceived it as a reliable and objective information source that shows the effects of game design changes while also revealing negative side effects.

User Groups of Interest Most of the experts' examples for user groups in their project contexts were criteria based, e.g. filtering by organization unit. Six experts stated that they would like to define user groups based on criteria (R16). The remaining four experts were interested, but did not express a strong opinion towards this requirement. Four experts reported that they were interested in using cluster analysis to discover interesting groups of users with similar characteristics (R17). The remaining six experts were interested, but did not express a strong opinion towards this requirement. One expert reported that he would like to be able to compose user groups manually (R18). In contrast, three experts stated, that they probably would not use such a feature. The remaining six experts were interested but did not express a strong opinion towards this requirement.

Simulation Seven experts agreed on the idea of being able to execute existing sets of behavior event data against arbitrary gamification designs, while only two of them reported that they already conducted simulations in their practice. The interviewees reported that simulation could be helpful for balancing a game, e.g., point amounts, or determining the progression speed. We consider the absence of appropriate technological tools as the main reason why simulations are not conducted more often.

4.3 Additional Requirements

Our initial requirements model did not cover all relevant requirements. Using a threshold of at least two mentions during the interviews, two additional requirements were included into the model. Both of them fall into the category of *Game Element Analytics*.

User Interaction Tracking for Game Elements in the User Interface R21) Three of the interviewees explicitly requested the ability to see how users interact with game elements

in the user interface of the gamified application. They argued that this would help them to understand how attractive individual game elements are. Moreover, the analytics should determine which effects the interaction with a game element has on user behavior, e.g., how viewing a leader board may influence the engagement of users.

Alerting R22) Half of the interviewed experts raised the requirement that they would like to be alerted, when the statistics of a particular game element fulfill certain conditions. The mentioned conditions comprised: *Violation of a Threshold*, or *Violation of a Value Range* – Gamification experts sometimes have an a priori goal how certain key figures of their game elements should look like. In this case, the tool can help them to define and monitor the fulfillment of those intentions, e.g., that no more than 5% of the users should be in the highest level. Finally, *Anomaly Detection* – Automated notification about uncommonly strong changes in the statistics of a game element, e.g., that 1,000 users received a particular badge during a day, while the typical amount is 10–50.

Figure 4 shows the final user requirements model after incorporating the new requirements.

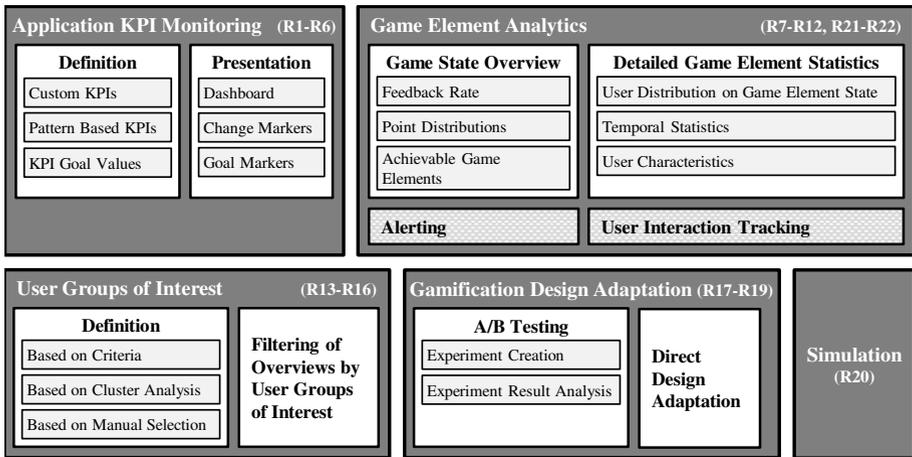


Figure 4: Final User Requirements Model for Gamification Analytics

5 Summary and Outlook

In this paper we presented a model of 22 user requirements for supporting the monitoring and adaptation of gamification designs. The model was validated and extended by 10 semi-structured interviews that were conducted with gamification experts. Our interviews mainly show three aspects: First, gamification projects typically have clear and measurable business goals. Second, the necessary data resources are typically available, however appropriate tools for data analysis and exploration do not exist. Third, the proposed model of an integrated gamification analytics tool was broadly accepted and considered as relevant.

Our future research efforts will focus on quantitative validation and prioritization of the user requirements model, and the design of an appropriate architecture that allows to integrate gamification analytics into today's common system landscapes.

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