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# Content validity study: a gamification model to drive behavior change in defeating coronavirus disease 2019 pandemic

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**ABSTRACT**

Gamification refers to transforming the environment to become more game-like to produce a positive experience. In this study, the researchers developed a gamification model, namely the GAMEBC model, to drive behavior change through a health awareness campaign in defeating the coronavirus disease 2019 (COVID-19) pandemic. The GAMEBC model was developed based on the self-determination theory (SDT) and gamification design literature. The GAMEBC model in this study involves four elements: competence, relatedness, autonomy, and engagement. Each element includes criteria that drive behavior change in health awareness campaigns. However, studies that validated the gamification model elements are limited, specifically to drive behavior change. Therefore, the content validity of the GAMEBC model instrument was carried out, and the analysis was based on thirteen expert reviews. The mean value and inter-rater agreement approach were implemented to examine the content validity ratio (CVR), item content validity index (I-CVI), and scale content validity index (S-CVI). The expert evaluation approach was implemented to review the GAMEBC model in terms of relevance and clarity. The data were analyzed using descriptive analysis. As a result of this work, we formulated an instrument that can be used to model and measure behavior change through the gamification approach in health awareness campaigns.



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## 1. INTRODUCTION

Validity and verification involve a critical process to produce reliable and valid instruments. Validity means the instrument's capability to measure what is supposed to measure [1]–[3] whereby at the end of process validity, researchers can answer the research question such as "How well does the instrument measure what it purposes to do". Researchers must also measure the instruments through the reliability process, whether consistent or stable. There are three common validation categories: criterion-related validity, content validity, and construct validity [4]. As content validity is a requirement for other validities, it is commonly reported during the instrument development process and receives the highest attention [3], [5], [6].

In addition, content validity is defined as the items' ability to reflect the measurement elements. It also refers to how the instrument's items are sampled appropriately from the specified content [7], [8]. Content validity is a crucial process [9] that can support abstract concepts to be observable and quantifiable

indices [10], and the process is studied superficially. Reliability measurement is impossible if the instrument lacks content validity [11], [12]. Hence, the current study is intended to establish the GAMEBC model instruments' content validity as guidelines to develop and evaluate behavior change through health awareness campaigns to defeat the coronavirus disease 2019 (COVID-19) pandemic. The content validity of the GAMEBC model is continued work after the proposed model in a previous study [13].

## 2. BACKGROUND STUDY

### 2.1. Proposed model

Self-determination theory (SDT) [14], [15] defines how people can be motivated in any task that they want to explore. The concept of SDT has been implemented in various domains, including health [16], education [17], [18], and business [19], [20]. It is an important concept that supports people's ability to accomplish their life. Based on SDT, humans need an element of competence, relatedness, and autonomy to have optimal motivation. This study proposed a new model, namely the GAMEBC model, adapted from the SDT model of health behavior change [21]. In this model, we also proposed a new element, engagement, that describes how humans need engagement to drive behavior change as a value of user experience.

### 2.2. Measurement instrument validation

A new instrument must be recognized to certify its acceptance [22]. The acceptance of instruments can be achieved by ensuring the reliability and validity of instruments. An instrument should be free from biasness to avoid inaccurate findings [23]. An instrument's reliability is determined based on similarity with findings attained each repeated process [24]. The validity of instruments refers to how well the instrument measures what it is supposed to measure [24], [25]. Table 1 shows the proposed elements and criteria of the GAMEBC model.

Table 1. Proposed elements and criteria of GAMEBC model

| Element | Code | Criteria |
|---|---|---|
| Autonomy | AU1 | I can create a customization profile |
| | AU2 | I can choose the activity in the game |
| | AU3 | I can control interactions in the game |
| | AU4 | I can control interface game |
| | AU5 | I have a sense of control over the game |
| | AU6 | I freely play the game the way I want |
| Competence | CO1 | I have a different level of challenge |
| | CO2 | I have received feedback on the progress |
| | CO3 | I can refer to the performance bar |
| | CO4 | I have a badge as a reward for achievements |
| | CO5 | I can get the point as a reward system |
| | CO6 | I can refer to the leader board |
| Relatedness | RE1 | I can involve in social interactions |
| | RE2 | I can share the information through a social interaction |
| | RE3 | I can join the game community |
| | RE4 | I have experienced various types of social interactions |
| | RE5 | I feel cooperative toward other users |
| | RE6 | I can collaborate with other users |
| Engagement | EN1 | I feel a state of curiosity |
| | EN2 | I feel a state of flow in gameplay |
| | EN3 | I feel intense sensations of success |
| | EN4 | I understand the game content |
| | EN5 | I feel a positive emotion in a learning experience |
| | EN6 | The game is compliant with treatments |

### 2.3. Expert review validation and inclusion criteria

The study aimed to develop an instrument that was valid and reliable. A descriptive analysis was implemented based on expert review validity to evaluate the GAMEBC model. Expert review validity is a content validity procedure determined by evaluating the instrument's contents [26]. Experts' choice depends on the conceptual model produced [27] and their expertise [28]. In this study, the criteria for selecting the expert review were based on the experts' publications, presentations, and research experience in the areas of interest. For example, the current study's main objective was to evaluate a gamification model to drive behavior change in defeating the COVID-19 pandemic. Therefore, the panel of experts should be familiar with gamification, game design, user experience, and usability. The panel of experts will evaluate each item and the whole proposed model.

The experts' panel consisted of nine specialized academic game researchers and four game-industry-related professionals in this present study. Ten female and three male experts were involved. The experts were recruited based on their expertise in game design in terms of experience, knowledge, and publication. All involved experts had at least ten years of experience related to computer science. This study's expert review consisted of associate professors, senior lecturers, and game industry panel members (project managers, assistant producers, and game developers). The experts among academicians were also required to fulfill four criteria, they must: i) be a full-time lecturer, ii) have at least a minimum of five-year teaching experience, iii) have at least a minimum of one year of experience in designing and developing games, and iv) have a qualification that the Ministry of Higher Education recognizes.

## 3. METHOD

### 3.1. Instrument development

The GAMEBC model was developed in four primary phases. The first phase focused on formulating each element's conceptual model and operational definitions to ensure its content validity. The next phase was where the item pool was formulated. An appropriate scale was developed in the third phase. Finally, in the last phase, the expert review of the instrument was conducted.

#### 3.1.1. Content validity

Content validity is a process to measure whether the items are relevant, precise, and correctly worded. The experts were asked to respond autonomously to a questionnaire to evaluate the instrument in this current study. They had to rate on a four-point rating scale of each item, which is for *Relevant* element ($1 =$ not relevant, $2 =$ item needs some revision, $3 =$ relevant but needs some minor revision, $4 =$ very relevant) and for *Clarity* ($1 =$ not clear, $2 =$ item needs some revision, $3 =$ clear but needs some minor revision, and 4= very clear) [27]–[30].

Besides, the content validity evaluates the items to ensure the instruments represent the contents or behavior of the addressed domain. Based on the experts' feedback, the instrument was revised and modified accordingly for the next phase. Thirteen experts were invited to choose the most relevant and clear item in the instrument, which was quantified by the content validity ratio (CVR) as in (1) and content validity index (CVI) as in (2). The CVI score was obtained from the total sum of the agreement scores of all items on the experts' scale of '3' or '4'. CVI approach is commonly reported for content validity in instrument development and can be calculated using the Item-CVI (I-CVI) and the Scale-level-CVI (S-CVI) [30]. The values range I-CVI is from 0 to 1 where I-CVI > 0.79, the item is relevant, between 0.70 and 0.79, the item needs revisions, and if the value is below 0.70, the item is eliminated [30].

$$CVR = (Ne - \frac{N}{2}) / (\frac{N}{2}) \quad (1)$$

$$CVI = (\frac{Ne}{N}) \quad (2)$$

Where, *Ne* is the number of experts giving a rating of '3' or '4', N is the total number of experts.

Moreover, S-CVI refers to the total content-validated content [30], [31], formulated through two methods. The first method is the general agreement among the experts (S-CVI/UA) [30], [31], and the second method is the average of the item-level CVIs (S-CVI/AV). The instrument would be qualified as content valid for the study if S-CVI/UA reaches 80% or a better agreement among experts [27], [32], [33], and if S-CVI/AV is greater than 0.90 [29], [34]. The S-CVI/AV is reported to be a less conservative method [30]. The S-CVI/UA score was generated by totaling up all items with I-CVI equal to 1 divided by the total number of items. Meanwhile, S-CVI/AV is generated by summing the I-CVIs and dividing them by the total number of items. S-CVI/UA $\geq 0.8$ and S-CVI/AV $\geq 0.9$ have excellent content validity [35].

Another category of empirical analysis was CVR, which measures the essentiality of an item [36]. CVR diverges between 1 and −1, and a higher score indicates more significant agreement among the panel members [30]. The minimum value of CVR to indicate the acceptable item is based on the total number of experts in the Lawshe table [37], [38] as shown in Table 2. In this study, the minimum value of CVR is 0.54.

Moreover, Wynd *et al.* [10] recommended a Kappa formula (3) in addition to CVI be computed [10], although CVI is widely utilized to measure content validity. Kappa offers the degree of agreement beyond chance, computed using the formula (3). Kappa values above 0.74 are regarded as excellent. Between 0.60 to 0.74 is considered good, and 0.40 to 0.59 is fair.

$$K = (I - CVI - Pc) / (I - Pc) \quad (3)$$

$$Where, Pc = [\frac{N!}{Ne!\,(N-A)!}] * 0.5^N$$

Where, Pc is the probability of chance agreement, N is number of experts, and Ne is number of experts agreeing on a rating of 3 or 4.

Table 2. The lawshe table for minimum values of CVR [38]

| No. of Expert | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 20 | 25 | 30 | 35 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min Value | 0.99 | 0.99 | 0.99 | 0.75 | 0.78 | 0.62 | 0.59 | 0.56 | 0.54 | 0.51 | 0.49 | 0.42 | 0.37 | 0.33 | 0.31 | 0.29 |

## 4. RESULTS AND ANALYSIS

### 4.1. Content validity of the autonomy element

Table 3 depicts the finding of the content validity of the autonomy element. The expert review panel regarded the items AU1, AU2, AU3, and AU5 as having excellent validity (very relevance and very clear), with I-CVI values ranging from 0.92 to 1.00. The S-CVI/AV for the autonomy element in terms of relevancy and clarity was 0.91 and 0.88. Four out of six items in this element showed excellent validity, which I-CVI and Kappa were above 0.90, and two items were in good validity, which is I-CVI, and Kappa scored less than 0. 78 regarding relevance and clarity. The average CVR value in the autonomy element regarding relevancy and clarity was 0.82 and 0.77, respectively, which means they were above the CVR's minimum value. Items AU4 and AU6 had good validity but needed revision in relevance and clarity with an I-CVI value lower than 0.80. All experts agreed that AU1, AU2, and AU3 items were excellent validity and very relevant (I-CVI=1.00), and all experts also agreed that the AU2 item was very clear with an I-CVI value was 1.00. Based on Table 3, AU4 and AU6 items needed some revision, such as rephrasing and restructuring, based on the panel of experts' feedback.

Table 3. Content validity of the autonomy element

| Relevance of the item | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Code* | *N* | *Ne* | *CVR*[a] | *I-CVI*[b] | *Pc*[c] | *Kappa*[d] | *Evaluation*[e] |
| AU1 | 13 | 13 | 1.00 | 1.00 | 0.000 | 1.00 | **** |
| AU2 | 13 | 13 | 1.00 | 1.00 | 0.000 | 1.00 | **** |
| AU3 | 13 | 13 | 1.00 | 1.00 | 0.000 | 1.00 | **** |
| AU4 | 13 | 10 | 0.54 | 0.77 | 0.035 | 0.76 | *** |
| AU5 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| AU6 | 13 | 10 | 0.54 | 0.77 | 0.035 | 0.76 | *** |
| | | | | | | S-CVI/AV | 0.91 |
| Clarity of the item | | | | | | | |
| *Code* | *N* | *Ne* | *CVR*[a] | *I-CVI*[b] | *Pc*[c] | *Kappa*[d] | *Evaluation*[e] |
| AU1 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| AU2 | 13 | 13 | 1.00 | 1.00 | 0.000 | 1.00 | **** |
| AU3 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| AU4 | 13 | 10 | 0.54 | 0.77 | 0.035 | 0.76 | *** |
| AU5 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| AU6 | 13 | 10 | 0.54 | 0.77 | 0.035 | 0.76 | *** |
| | | | | | | S-CVI/AV | 0.88 |

[a] *Content validity ratio* $(CVR) = (Ne - \frac{N}{2})/(\frac{N}{2})$

[b] *Content validity of individual item (I-CVI)=number of experts providing a rating of 3 or 4/number of experts*

[c] *Probability of chance occurrence* $(Pc) = [\frac{N!}{Ne!\,(N-A)!}] * 0.5^N$

[d] *Kappa* $(K) = (I - CVI - Pc)/(I - Pc)$

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI≥0.78 and Kappa>0.74 (****); good validity=I-CVI<0.78 and≥0.60 and Kappa≤0.74 (***); fair validity=I-CVI<0.6 and ≥0.40 and Kappa≤0.59 (**); and poor validity=I-CVI<0.4 and Kappa<0.40 (*)*

### 4.2. Content validity of the competence element

All items in the competence element in Table 4, CO1, CO2, CO3, CO4, CO5, and CO6, were considered very relevant and very clear (excellent validity) I-CVI and Kappa values were more than 0.80. All thirteen experts agreed with CO4 and CO5 items with CVR, I-CVI, and Kappa value obtained a full score of 1.00 in terms of relevancy. Meanwhile, all experts agreed that CO3 and CO6 were very clear items with excellent Kappa value by scoring 1.00. The S-CVI/AV for competence element was 0.92, which had excellent content validity. Overall, all the items in the competence element were remained based on the score values rated by the experts.

Table 4. Content validity of the competence element

| Relevance of the item | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Code* | *N* | *Ne* | *CVR*[a] | *I-CVI*[b] | *Pc*[c] | *Kappa*[d] | *Evaluation*[e] |
| CO1 | 13 | 11 | 0.69 | 0.85 | 0.010 | 0.84 | **** |
| CO2 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| CO3 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| CO4 | 13 | 13 | 1.00 | 1.00 | 0.000 | 1.00 | **** |
| CO5 | 13 | 13 | 1.00 | 1.00 | 0.000 | 1.00 | **** |
| CO6 | 13 | 11 | 0.69 | 0.85 | 0.010 | 0.84 | **** |
| | | | | | | S-CVIAV | 0.92 |
| Clarity of the item | | | | | | | |
| *Code* | *N* | *Ne* | *CVR*[a] | *I-CVI*[b] | *Pc*[c] | *Kappa*[d] | *Evaluation*[e] |
| CO1 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| CO2 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| CO3 | 13 | 13 | 1.00 | 1.00 | 0.000 | 1.00 | **** |
| CO4 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| CO5 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| CO6 | 13 | 13 | 1.00 | 1.00 | 0.000 | 1.00 | **** |
| | | | | | | S-CVI/AV | 0.95 |

[a]*Content validity ratio* $(CVR) = (Ne - \frac{N}{2})/(\frac{N}{2})$

[b]*Content validity of individual item (I-CVI)=number of experts providing a rating of 3 or 4/number of experts*

[c]*Probability of chance occurrence* $(Pc) = [\frac{N!}{Ne!\,(N-A)!}] * 0.5^N$

[d]*Kappa* $(K) = (I - CVI - Pc)/(I - Pc)$

[e]*Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI≥0.78 and Kappa>0.74 (****); good validity=I-CVI<0.78 and ≥0.60 and Kappa≤0.74 (***); fair validity=I-CVI<0.6 and≥0.40 and Kappa≤0.59 (**); and poor validity=I-CVI<0.4 and Kappa<0.40 (*)*

### 4.3. Content validity of the relatedness element

Based on Table 5, all items in relatedness elements were measured relevant and clear (excellent validity) with Kappa value scores ranging from 0.84 to 1.00. Besides, all feedback depicted excellent values about relevance and clarity. All experts agreed the RE1 item was very relevant and very clear with CVR, I-CVI, and Kappa value had a score of 1.00. All six items needed no modification and revision.

Table 5. Content validity of the element relatedness

| Relevance of the item | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Code* | *N* | *Ne* | *CVR*[a] | *I-CVI*[b] | *Pc*[c] | *Kappa*[d] | *Evaluation*[e] |
| RE1 | 13 | 13 | 1.00 | 1.00 | 0.000 | 1.00 | **** |
| RE2 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| RE3 | 13 | 11 | 0.69 | 0.85 | 0.010 | 0.84 | **** |
| RE4 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| RE5 | 13 | 11 | 0.69 | 0.85 | 0.010 | 0.84 | **** |
| RE6 | 13 | 11 | 0.69 | 0.85 | 0.010 | 0.84 | **** |
| | | | | | | S-CVI/AV | 0.90 |
| Clarity of the item | | | | | | | |
| *Code* | *N* | *Ne* | *CVR*[a] | *I-CVI*[b] | *Pc*[c] | *Kappa*[d] | *Evaluation*[e] |
| RE1 | 13 | 13 | 1.00 | 1.00 | 0.000 | 1.00 | **** |
| RE2 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| RE3 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| RE4 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| RE5 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| RE6 | 13 | 11 | 0.69 | 0.85 | 0.010 | 0.84 | **** |
| | | | | | | S-CVI/AV | 0.92 |

[a]*Content validity ratio* $CVR = (Ne - \frac{N}{2}) / (\frac{N}{2})$

[b]*Content validity of individual item (I-CVI)=number of experts providing a rating of 3 or 4/number of experts*

[c]*Probability of chance occurrence* $(Pc) = [\frac{N!}{Ne!\,(N-A)!}] * 0.5^N$

[d]*Kappa* $(K) = (I - CVI - Pc) / (I - Pc)$

[e]*Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI≥0.78 and Kappa>0.74 (****); good validity=I-CVI<0.78 and ≥0.60 and Kappa≤0.74 (***); fair validity=I-CVI<0.6 and ≥0.40 and Kappa≤0.59 (**); and poor validity=I-CVI<0.4 and Kappa<0.40 (*)*

### 4.4. Content validity of the engagement element

Table 6 shows the engagement element considered excellent in relevancy with all items EN1, EN2, EN3, EN4, EN5, and EN6 scored above 0.80 for the I-CVI value. However, EN2 showed good validity in terms of clarity with I-CVI and Kappa value less than 0.8. None of the engagement items was rated below

0.50 for the I-CVI value, indicating the item's elimination. EN2 item in terms of clarity had rated a good validity with a score of less than 0.80. The item needed revision and modification.

Table 6. Content validity of the engagement element

| Relevance of the item | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Code* | *N* | *Ne* | *CVR*[a] | *I-CVI*[b] | *Pc*[c] | *Kappa*[d] | *Evaluation*[e] |
| EN1 | 13 | 13 | 1.00 | 1.00 | 0.000 | 1.00 | **** |
| EN2 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| EN3 | 13 | 11 | 0.69 | 0.85 | 0.010 | 0.84 | **** |
| EN4 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| EN5 | 13 | 11 | 0.69 | 0.85 | 0.010 | 0.84 | **** |
| EN6 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| | | | | | | S-CVI/AV | 0.91 |
| Clarity of the item | | | | | | | |
| *Code* | *N* | *Ne* | *CVR*[a] | *I-CVI*[b] | *Pc*[c] | *Kappa*[d] | *Evaluation*[e] |
| EN1 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| EN2 | 13 | 10 | 0.54 | 0.77 | 0.035 | 0.77 | *** |
| EN3 | 13 | 13 | 1.00 | 1.00 | 0.000 | 1.00 | **** |
| EN4 | 13 | 11 | 0.69 | 0.85 | 0.010 | 0.85 | **** |
| EN5 | 13 | 12 | 0.85 | 0.92 | 0.002 | 0.92 | **** |
| EN6 | 13 | 11 | 0.69 | 0.85 | 0.010 | 0.85 | **** |
| | | | | | | S-CVI/AV | 0.88 |

[a]*Content validity ratio* $CVR = (Ne - \frac{N}{2}) / (\frac{N}{2})$

[b]*Content validity of individual item (I-CVI)=number of experts providing a rating of 3 or 4/number of experts*

[c]*Probability of chance occurrence* $(Pc) = [\frac{N!}{Ne!\,(N-A)!}] * 0.5^N$

[d]*Kappa* $(K) = (I - CVI - Pc) / (I - Pc)$

[e]*Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI≥0.78 and Kappa>0.74 (****); good validity=I-CVI<0.78 and ≥0.60 and Kappa≤0.74 (***); fair validity=I-CVI<0.6 and ≥0.40 and Kappa≤0.59 (**); and poor validity=I-CVI<0.4 and Kappa<0.40(*)*

## 5. DISCUSSION

The present paper evaluated the content validity of the GAMEBC Model instruments as guidelines to develop and evaluate behavior change through health awareness campaigns to defeat the COVID-19 pandemic. Thirteen experts returned their responses out of the 16 experts who initially agreed to participate, resulting in a return rate of 81.25%. The average S-CVI/AV in relevancy and clarity generated four elements resulting in 24 content validity indices, 0.91. All S-CVI/AV values in each item ranged from 0.88 to 1.00. The results showed that the instruments reviewed by these experts fit the purpose of the study. Three items, which were AU4, AU6, and EN2, needed some revision in terms of relevancy and clarity of the instrument. Subsequently, the GAMEBC instruments were considered to contain excellent content validity.

## 6. CONCLUSION

The purpose of this study was to ascertain the content validity of the GAMEBC model instruments that were specially developed as guidelines to develop and evaluate behavior change through health awareness campaigns to defeat the COVID-19 pandemic. The content validity process implemented on the GAMEBC model was essential to produce a reliable and valid instrument. The instrument had excellent content validity with an average S-CVI/AV=0.91 about relevancy and clarity. The findings indicated that the GAMEBC model instruments developed in this study were valid, relevant, and clear.

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