Research Paper

GYAN MANAGEMENT
AN INTERNATIONAL BI-ANNUAL REFEREED JOURNAL OF MANAGEMENT & TECHNOLOGY
Year 2024, Volume-18, Issue-2 (July - December)
ISSN 0974-7621 (Print)

Development of Technology Adoption Framework on the use of Smart Classrooms

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ARTICLE INFO

Key Words: *Technology Adoption Framework (TAF), Technology Acceptance Model (TAM), SWOT analysis, PESTLE analysis*

ABSTRACT

Smart classrooms have emerged as an innovative solution for educational institutions to deliver quality education during the COVID-19 pandemic. The study focuses on students' perspectives and preferences regarding smart classrooms and recommends effective implementation strategies based on educators' experiences and a well-established Technology Adoption Framework (TAF). The study employed a mixed-methods approach, combining quantitative and qualitative research methods. 188 students who experienced learning in a smart classroom participated in the survey based on the Technology Acceptance Model (TAM), and 16 experienced teachers who taught in smart classrooms participated in qualitative research based on SWOT and PESTLE analyses. Based on the researcher's analysis, it has been found that students are highly interested in having a smart classroom in their educational institution. The study highlights students' receptiveness and sheds light on the valuable insights shared by teachers regarding the optimum utilization of smart technology in the classroom environment. The researcher has developed a Technology Adoption Framework named SMARTCLASS, which includes several crucial components such as communication, training, management support, and user involvement. This framework is expected to enhance the classroom's overall teaching and learning experience, ensuring optimal technology and resource utilization.

Received 07.01.2023; Accepted 21.03.2023
DOI: 10.48165/gmj.2023.conf3
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Introduction

The COVID-19 pandemic disrupted the educational system not just in the Philippines but across the world. This phase in the educational system has brought unprecedented challenges in delivering quality education and providing sustainable and available platforms for education. This instance greatly impacted how the government and other educational institutions provide realistic solutions that can apply to all the school stakeholders, focusing specifically on the learners and teachers.

The Department of Education has developed different ways to help students continue learning despite the decrease in schools that offer quality education. These methods include Distance Learning, Blended Learning, Homeschooling, Modular Distance Learning (MDL) in print and digital formats, TV-Radio Based Instruction, and Online Distance Learning. Modular Distance Learning (Print) is the most popular option, with 75.1% of learners enrolled. Blended Learning and Online Distance Learning have also become popular during the pandemic. Many elementary, junior, and senior high school students opt for printed modular learning due to limited internet connection. This method is convenient as it requires no gadgets and solely relies on written instructions.

Technology has improved education after the pandemic. EdTech and Smart Classrooms are two types of technology used to help teachers and students. EdTech includes hardware and software used in classrooms to help students learn better. Smart classrooms use technology like audio, video, and multimedia to improve the teaching and learning experience for everyone.

Body of paper

Methods

Research Methodology Workflow

The Research Methodology Workflow shown in Figure 2.1.1 presents the systematic process implemented in this research. This involves the specific steps for ensuring the validity and reliability of the data. The research process

Fig. 2.1.1: *Research Methodology Workflow*

entails several systematic steps that the researcher must take to provide knowledge that will be valued by the project and concentrate on the pertinent topic.

First, the problem shall be identified to understand the purpose of the research. With this research problem, the survey will be created to gather insights and information to identify answers to the problem. After creating the survey, data will be gathered for the target respondents of the study. Once the data is gathered, data analysis will proceed based on the quantitative and qualitative analysis. Then, the analyzed data will be interpreted to help develop the technology adoption framework. Lastly, a conclusion and actual recommendation will be provided to guide and assist in improving the whole research study.

Quantitative Analysis based on Technology Acceptance Model

The Quantitative Analysis is based on the framework of the Technology Acceptance Model. This model will refer to the student's experience using the smart classroom. The Technology Acceptance Model (TAM) is the foundation of the quantitative analysis of this research study. This model presents the student's feedback on accepting the new technology, specifically in a smart classroom. The variables that will be considered are perceived usefulness, perceived ease of use, attitude towards use, behavioral intention to use, and actual use, as presented in Figure 2.1.2.

The descriptions of the variables are as follows:

- Perceived Usefulness (PU) is one of the student's perceptions of using the smart classroom. This variable equates to the degree to which an individual or the student believes using technologies in a smart classroom would benefit.
- Perceived Ease of Use (PE) is the second variable of the student's perception of using the smart classroom. This variable equates to the degree to which an individual or the student believes that using any tools, devices, or technologies in a smart classroom would be convenient for their learning activities.
- Attitude Towards Use (AT) is the variable related to students' preferences. This variable equates to the student's positive or negative assessment of studying in a smart classroom.
- Behavioral Intention to Use (BU) is the variable that describes the student's attitude toward using a smart classroom and their intention to use it in the future.
- Actual Use (AU) is the variable related to the student's acceptance of the technology. It describes the degree to which a person employs a specific technology or system.

The respondents of the quantitative analysis are Grade 12 students enrolled in a private institution under the Science, Technology, Engineering, and Mathematics strand with experience studying in a standard smart classroom (at the very least) for more than three months.

The sampling method applied to this study is the Purposive or Judgmental Sampling method, as the target respondents have specific criteria to consider. This sampling method focuses on understanding students' experiences, attitudes, and perceptions.

The data for quantitative analysis was collected based on the following steps: (1) The researcher looks for target students who are fit to the criteria for this survey, (2) The researcher sends a request letter to the Principal to survey selected students in a higher educational institution, (3) Once approved by the Principal, the researcher reached out to the class advisers and

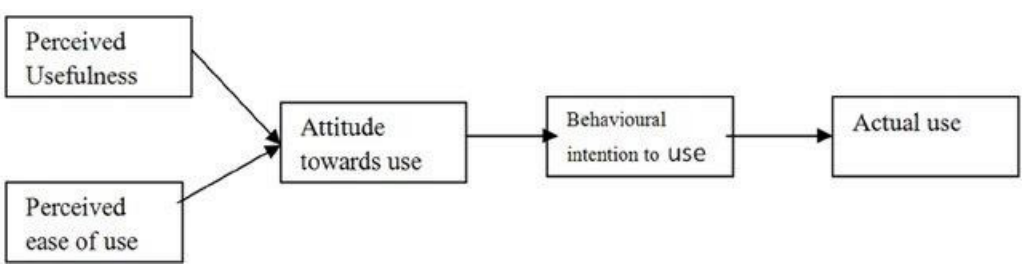

Fig. 2.1.2: *Original Technology Acceptance Model by Davis*

research teachers of the selected students to promote and share the survey link via Microsoft Forms. The students have five days to answer the survey.

Qualitative Analysis based on Technology Acceptance Model

The Qualitative Analysis is based on the SWOT and PESTLE Analysis models. These two models will be the basis of the responses of the teachers answering the survey for this kind of analysis. Specifically, the internal and external environment concerning the use of smart classrooms is assigned to evaluate in this section.

The respondents of the qualitative analysis are Grade 12 teachers in a private institution teaching under the strand of Science, Technology, Engineering, and Mathematics; Experienced teaching in a standard smart classroom (at the very least) for more than three months.

The sampling method applied to this study is the Purposive or Judgmental Sampling method, as the target respondents have specific criteria to consider. This sampling method focuses on understanding teachers' experiences, attitudes, and perceptions.

The data for qualitative analysis was collected based on the following steps: (1) The researcher looks for target teachers who fit the criteria for this survey, (2) The researcher sends an email to the teachers and informs them to answer the survey form via Microsoft Forms. The target respondents have five days to answer the open-ended questions in the survey.

Basis of Technology Adoption Framework

The Technology Adoption Framework (TAF) helps the stakeholders to decide on and implement new or existing technologies in a new environment. In this study, the processes involved in the TAF will be based on the quantitative and qualitative analysis answers, which will be realigned to the components of TAF such as communication, training, management support, and user involvement, which is reflected in Figure 2.1.4 (Hammam, 2023).

To successfully adopt new technology, effective communication is crucial. It ensures that everyone understands the purpose and benefits of the technology and is on the same page. Equipping end-users with the necessary skills through training is also essential. This includes teaching them how to use the software or hardware, troubleshooting, and best practices. The support of management is critical for success. Senior executives need to understand the importance of the new technology and provide the necessary resources and support for its implementation. Additionally, user involvement is vital to a successful technology adoption plan. End-users are the ultimate users of the new technology, and their input and feedback are crucial in ensuring that it meets their needs and expectations.

Results and Discussion
Quantitative Findings: Analysis based on TAM Components

The quantitative findings are based on the survey deployed to the students who are the target respondents

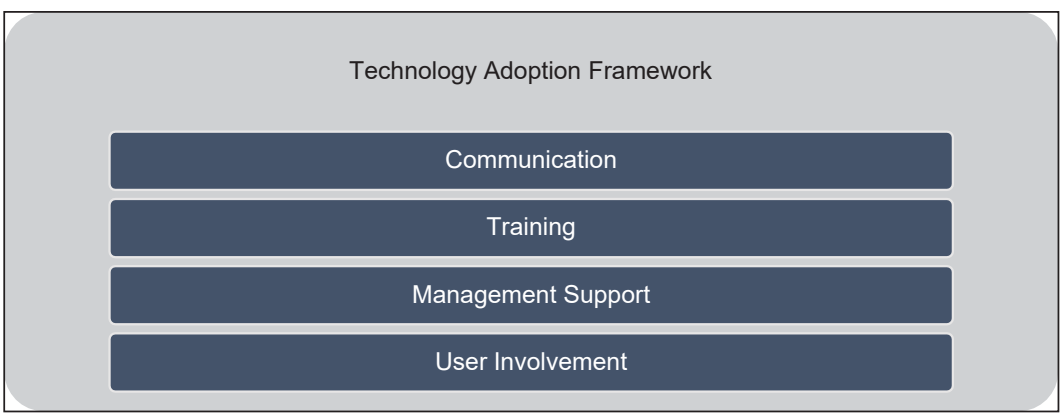

Fig. 2.1.4: Technology Adoption Framework Components

for this section. In addition to that, the feedback for each TAM component is discussed in this section.

In summary, Table 2.2.1 presents the demographic profile of the learners/students identified for the survey under quantitative analysis.

Table 2.2.1: *Summary of Respondent's Demographic Profile (Students)*

Demographic Group	Information	Total	Percentage
Gender	Male	115	61%
	Female	73	39%
Age Bracket	Below 18 years old (<18)	44	23%
	18 years old and above (>=18)	144	77%
Number of Respondents per Section	Section A	31	16%
	Section B	18	10%
	Section C	34	18%
	Section D	14	7%
	Section E	24	13%
	Section F	5	3%
	Section G	20	11%
	Section H	11	6%
	Section I	31	16%
Familiarity with Smart Classroom Devices / Technologies	Camera	178	95%
	Microphone	141	75%
	Speaker	122	65%
	Computer / Laptop / Tablet	154	82%
	Smart TV / Board	166	88%
	Projector	31	16%
Video Conferencing Platform (Zoom, Google Meet, etc.)		169	90%

Source: Table generated based on gathered data

In this study, reliability analysis was applied to identify the consistency of the questionnaires. With the help of SPSS, the value of Cronbach's Alpha was obtained easily. Each TAM Variable has four items or questions which the learners answered. Based on Table 2.2.2, TAM Variable PE got an excellent interpretation as it got a Cronbach's Alpha of more than 0.90. TAM Variables PU and AC got a good interpretation of Cronbach's Alpha with values more than 0.80. Lastly, TAM Variables AT and BE got adequate interpretation as their Cronbach's Alpha is more than 0.70. Having said this, all answers from the questionnaire are valid and will be interpreted based on descriptive statistics.

After identifying Cronbach's Alpha of the variables, the next analysis is Descriptive Statistics. Before identifying the specific statistic for each question, the adjectival rating of the range of means was identified and presented in Table 2.2.3 to have a quick reference for each mean value of the answers.

Table 2.2.3: *Adjectival Rating based on Computed Range*

Range of Means	Numerical Value	Adjectival Rating
1.00 – 1.80	1	Strongly Disagree
1.81 – 2.60	2	Disagree
2.61 – 3.40	3	Neutral
3.41 – 4.20	4	Agree
4.21 – 5.00	5	Strongly Agree

Source: Table generated based on gathered data

Table 2.2.4 presents the descriptive statistics of each survey question deployed to the target respondents. This summary has five columns: TAM Code Question, N, Mean, Standard Deviation, and Level of Agreement.

The first column is the TAM Code Question that covers the code for each assigned question under a

Table 2.2.2: *Summary of Cronbach's Alpha of each group of TAM Variable*

TAM Variable	Cronbach's Alpha	Interpretation
Student's Perception: Perceived Ease of Use (PE)	0.906229	Excellent
Student's Perception: Perceived Usefulness (PU)	0.845633	Good
Student's Preference: Attitude Towards Use (AT)	0.767652	Adequate
Student's Perspective: Behavioral Intention to Use (BE)	0.792848	Adequate
Student's Acceptance: Actual Use (AC)	0.839293	Good

Source: Table generated based on gathered data

TAM variable: Perceived Ease of Use (PE), Perceived Usefulness (PU), Attitude Towards Use (AT), Behavioral Intention to Use (BE), and Actual Use (AC). The second column, N, presents the respondents answering each question which is 188. The third column is the mean or the average of the answers, wherein 1 is the minimum possible answer and 5 is the maximum possible answer. The answers are represented by the numerical value based on Table 2.2.3, wherein Strongly Disagree is equivalent to 1, Disagree is equivalent to 2, Neutral is equivalent to 3, Agree is equivalent to 4, and Strongly Agree is equivalent to 5. The fourth column shows the standard deviation, which tells us how close the data is to the mean. A low deviation means the data is clustered around the mean, while a high deviation means the data is widely distributed. Six questions got a "Strongly Agree" rating, and fourteen got an "Agree" rating, as per Table 2.2.3. Table 2.2.4 shows the agreement level.

Table 2.2.4. *Descriptive Statistics of Each Survey Question*

TAM Code Question	Mean	Standard Deviation	Level of Agreement
PE1	4.27	.844	Strongly Agree
PE2	4.26	.815	Strongly Agree
PE3	4.00	.925	Agree
PE4	4.21	.845	Strongly Agree
PU1	4.07	.830	Agree
PU2	4.14	.831	Agree
PU3	4.03	.933	Agree
PU4	4.11	.846	Agree
AT1	3.77	.975	Agree
AT2	4.34	.787	Strongly Agree
AT3	4.29	.873	Strongly Agree
AT4	3.88	1.070	Agree
BE1	4.11	.877	Agree
BE2	3.86	1.000	Agree
BE3	4.01	.859	Agree
BE4	4.17	.915	Agree
AC1	3.96	.921	Agree
AC2	4.27	.856	Strongly Agree
AC3	3.88	.937	Agree
AC4	3.98	.997	Agree

Source: Table generated based on gathered data

Qualitative Findings: Analysis based on SWOT and PESTLE Analysis

The qualitative findings are based on the survey deployed to the teachers who are the target respondents for this section. In addition to that, the feedback for each SWOT and PESTLE component is discussed in this section.

In summary, Table 2.2.5 presents the demographic profile of the teachers identified for the survey under qualitative analysis.

Table 2.2.5: *Summary of Respondent's Demographic Profile (Teachers)*

Demographic Group	Information	Total
Gender	Male	9
	Female	7
Number of Years of Teaching Experience	3 years	1
	4 years	5
	4.5 years	1
	6 years	3
	7 years	1
	8 years	1
	12 years	1
	15 years	1
	20 years	1
	23 years	1
Familiarity with Smart Classroom Devices / Technologies	Camera	7
	Microphone	7
	Speaker	8
	Computer/ Laptop/ Tablet	14
	Smart TV/ Board	11
	Projector	4
Video Conferencing Platform (Zoom, Google Meet, etc.)		15

Source: Table generated based on gathered data

The analysis reflected in Table 2.2.6 is based on the feedback from the teachers.

Table 2.2.6: *Summary of SWOT Analysis Based on Teacher's Feedback*

SWOT Components	Analysis
Strengths	Accessibility to Class Discussions Convenience in Learning and Teaching Flexibility in Attending to Different Learning Modalities Management in Classroom Practices
Weaknesses	Academic Dishonesty Adaptability to TechnologyClassroom Maintenance Student's Retention
Opportunities	Gamification of ActivitiesLearn Best Practices Maximizing of Tools Teacher's Creativity in Teaching
Threats	Insufficient Training Knowledge about Syllabus Adjustment Limited Access to Equipment Unexpected Technical Issues

Source: Table generated based on gathered data

The analysis reflected in Table 2.2.7 is based on the feedback from the teachers.

Development of Technology Adoption Framework

This section presents the developed technology adoption framework that any organization or school can utilize in implementing smart classrooms. This framework will assist educational leaders in meeting the expectations of the educational stakeholders effectively and also identify emerging technology trends that suit the educational environment of a specific institution.

Figure 2.2.3 presents the workflow for the developed technology adoption framework, which is named SMARTCLASS: Set Goals, Map Stakeholders, Assess Technology Needs, Research and Select, Train and Professional Development, Create Implementation Plan, Leverage Content and Resources, Assess Progress and Adjust, Scale and Expand, and Support Sustainability. This framework is a cyclical approach to maintain and provide feedback for every implementation of the same framework.

The steps in the workflow play a huge role in achieving the fit smart classroom setup for your organization. Here are the descriptions of each process:

- Set Goals: To implement a smart classroom successfully, define clear goals and objectives. Specify what you want to achieve, like increasing student engagement, fostering innovation, or using technology in teaching methods.
- Map Stakeholders: Involving all key stakeholders in a smart classroom is crucial for success. This includes teachers, students, administrators, parents, IT staff, etc. Understanding their needs and expectations is essential.

Table 2.2.7: *Summary of PESTLE Analysis Based on Teacher's Feedback*

PESTLE Components	Analysis
Political	Budget Allocation for Schools, Teachers, and Students Mandate Policies and Rules in Support of Smart Classroom Professional Training
Economic	Affordability of the Devices Bidding Process in Building Infrastructure Salary Increase for Teachers
Social	Student Engagement and Participation Student-Teacher Classroom Rapport Unequal Opportunity
Technological	Concerns with Devices and Technologies Knowledge of Technical Products Maintenance in Smart Classrooms
Legal	Data Privacy and Security of the Students and Teachers Intellectual Property of the Institution Software Licenses
Environmental	Contribution to Carbon Footprint Emission Green Initiatives Paperless Transactions or Activities

Source: Table generated based on gathered data

- Assess Technology Needs: To prepare for a smart classroom, evaluate current technology, identify gaps, and choose tools that align with goals.
- Research and Select: To find the right classroom technology, research your options thoroughly. Look for solutions that fit your goals and needs, and consider factors like compatibility, ease of use, expandability, and cost.
- Train and Professional Development: Training and support for teachers are crucial in using smart classroom tech effectively. Ongoing professional development can improve instruction and maximize its benefits.
- Create Implementation Plan: To create a smart classroom, plan carefully with a timeline, budget, and specific tasks. Assign responsibilities, consider hardware and software, network infrastructure, content creation, and support. Set measurable goals.
- Leverage Content and Resources: Select appropriate digital resources and tools that fit the curriculum and support learning goals. Work with content providers or make internal materials that can easily be added to the smart classroom.
- Assess Progress and Adjust: Regular assessments of smart classroom implementation help identify strengths, weaknesses, and areas for improvement. Feedback from teachers, students, and stakeholders can inform necessary adjustments to optimize technology usage.
- Scale and Expand: Expanding smart classrooms to other areas can inspire adoption. Continuously

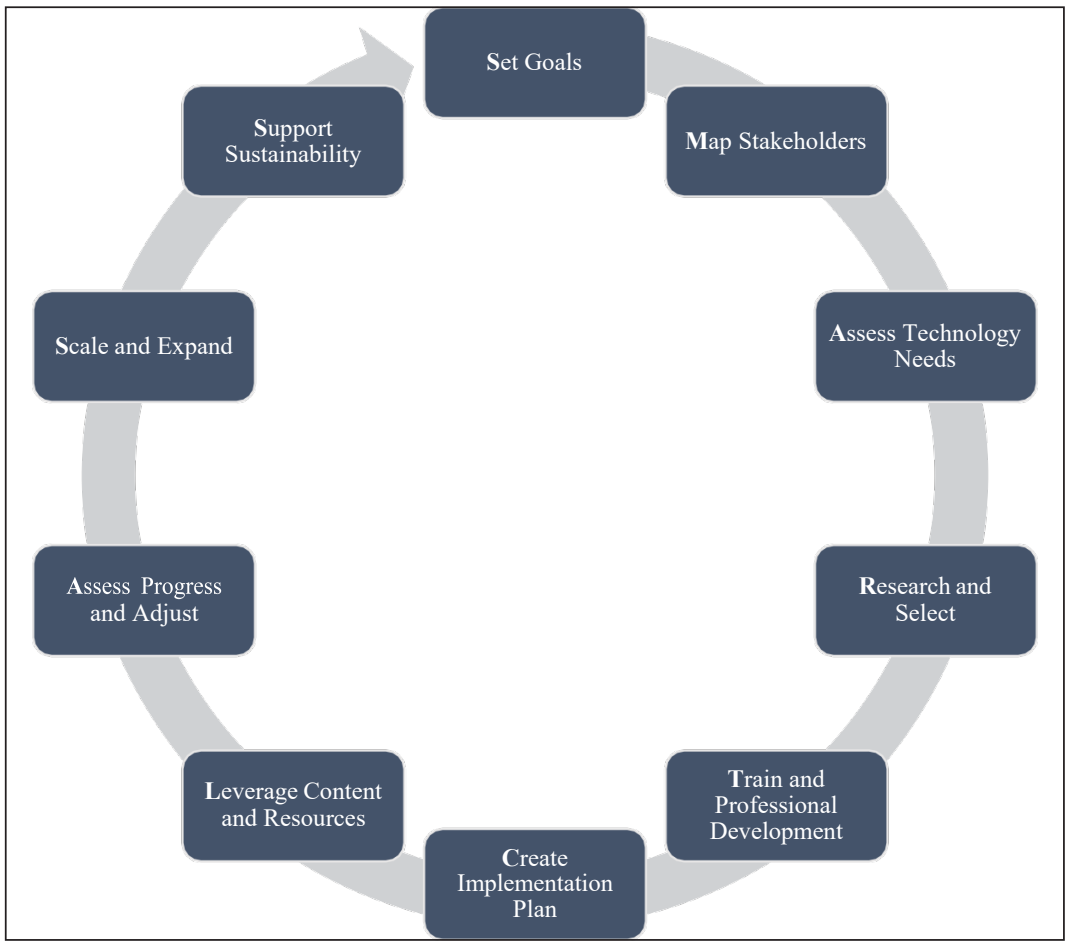

Fig. 2.2.3: *SMARTCLASS Technology Adoption Framework*

assess the impact and guide future expansion and improvement efforts.

- Support Sustainability: To ensure the long-term success of the smart classroom initiative, create a sustainability plan covering maintenance, technology updates, budget allocation, professional development, and ongoing support and collaboration.

The SMARTCLASS framework helps you plan and implement a smart classroom strategy, including technology selection, stakeholder involvement, training, and ongoing support. It ensures successful integration and maximizes the benefits of smart classroom technologies.

Conclusion

The Technology Acceptance Model indicates that students have a positive experience in smart classrooms, with a majority agreeing with the statements related to the model. They find the use of smart classrooms beneficial for their learning experience, value the effectiveness of learning, and are open to interacting with new technology. Students also agree that smart classroom devices are beneficial for their academic learning and engagement during class discussions, and are ready to maximize their use to enhance their learning experience. They hope for standard and upgraded devices in smart classrooms to become accustomed to and accept the technology. The research concludes that students enjoy using smart classrooms and believe that converting conventional classrooms to smart classrooms would benefit the Philippine educational system.

Smart classrooms have been positively received by experienced teachers, who find them accessible and flexible for learning. However, maintenance and technical training for teachers is necessary for effective implementation. Monitoring students' participation and honesty is also crucial, as cheating can occur. Technical advancements and government support can further establish smart classrooms, which have great potential for improving teaching and student engagement with careful attention to use.

Schools can use the developed technology adoption framework to implement and establish smart classrooms. The framework was created through quantitative and qualitative analysis to connect directly to the adoption process of the smart classroom. It is important to assess the teacher's and students' experience in teaching and learning inside the smart classroom to adjust based on the stakeholders' needs. This way, the components of the smart classroom can be adjusted to what is only needed in a particular setup.

Acknowledgment

This paper is an output as part of the partial fulfillment of the requirements for the Master of Technology Management Program of the researcher.

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