Learners' Perception of IoT in the Mauritian Higher Education

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Abstract. The Internet of Things (IoT) connects multiple devices that collect and transmit data without human intervention into one and provides a digital network connection that can change everything, anytime, from any tool. Hence, IoT continues to strengthen its imperative place in the progress and growth of society. The use of IoT in the higher education in Mauritius will bring new opportunities and possibilities for the improvement of both teaching and learning process and HEIs' infrastructure. This research, therefore, evaluates the learner's perceptions on the adoption of IoT in the field of higher education in Mauritius which will bring new opportunities and possibilities for the improvement of both teaching and learning process and HEIs' infrastructure. The sample selection in this study used a convenience random sampling technique and the target population was reduced to public HEIs' in Mauritius. The research yielded 280 usable responses and analysis of descriptive statistics, frequencies, and chi-square test were conducted to address the research objective. The findings showed how the adoption of IoT can help academics and learners influence technologies' benefits to improve learning and academic performance. The results revealed that the learners have a positive attitude towards IoT. Learners have a digital mindset and hence the adoption intention behavior on IoT was positively accepted. The study contributes to the future adoption of IoT by universities from both a theoretical and practical standpoint.

Keywords: Internet of Things, Learners' perception, higher education institution.

1 Introduction

Nowadays, information technology is touching various industries (Financial Services, Entertainment, Telecommunication, Healthcare and Manufacturing) and the Higher Education Institutions (HEIs) should not be left behind. By connecting devices (like personal computers, tablets, laptops, smartphones, etc.) to the inter-net, the Internet of Things (IoT) is in the attempt of changing several routines of our lives and the use of intelligent association between individuals and things to share information and experience (Mahbub, 2020). In 1999, Kevin Ashton was the first to use the term IoT. An international network connects things and offers information to the internet to share with the surroundings (Gowrishankar et al.,2015). IoT can transmit the resources over the system automatically without individual or computer devices interaction.

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According to Aldowah et al. (2017; 2015), the education sector is also one of the industries that is to be impacted by the quick expansion and application of IoT. It upholds intelligence and autonomy and is ubiquitous (Kahlert, 2016). At present, several HEIs have understood the significance of adopting IoT into daily teaching and learning activities (Madakam et al., 2015). The impacts of the COVID- 19 pandemic are clearly visible on the education sector and hence, e-learning, or remote virtual learning has turned out to be popular practice in several universities. An upswing in the regular application of IoT enables HEIs to enhance the efficacy of teaching and learning, stimulating comfortable and speedy access to information. Learners can connect with their lecturers, friends, and professionals from the entire world in their classrooms with such network devices (Ralhan, 2017).

Thus, a regular traditional classroom can change to a smart class that can be coordinated with e-learning. Adopting IoT to higher education encourages an excellent association and cooperation among learners, with their lecturers, or lecturers with lecturers through the devices that are connected. IoT offers learners enhanced access to the whole world (teaching facilities, learning materials, educational performance results and communication networks). For academics, it also offers an innovative way of relating to learners and enhances the skill to gauge learners' learning performance immediately, providing a more personalized educational experience.

This study supports the importance of the IoT and recognizes that such technology has turned out to be an important part of daily teaching and learning. Besides, it also attempts to describe the usefulness and applications of IoT in the future higher education of Mauritius. This research evaluates the learner's perceptions in adopting IoT in the field of higher education in Mauritius.

1.1 Aim of the Study

The COVID-19 pandemic was a unique global health disaster that has had far-reaching economic and social implications. The rapid changes in education due to the COVID-19 pandemic have necessitated the integration of ICT in higher education. However, the education system is just getting started with IoT and its full impact is not yet fully comprehended. Therefore, it has become more important to provide an affluent learning experience, improve operational efficiency, and to gain real-time, actionable insight into student performance. Hence, the adoption of IoT in the higher education in Mauritius will bring new opportunities and possibilities for the improvement of both teaching and learning process and HEIs' infrastructure. The adoption of IoT will strive to radically transform the way HEIs function and improve learner education. This research attempts to evaluate the learner's perceptions to adopt IoT in the field of higher education in Mauritius. Besides, it also strives to describe the usefulness and applications of IoT in the future higher education of Mauritius.

2 IoT in the Higher Education Sector

IoT is evolving rapidly and progressively turning into an emergent area that produces enthusiasm and apprehension in the world (Ning and Hu, 2012). Many suggestions indicate that IoT will transform many industries, including the education sector, especially HEIs. The possibility of interacting with everything that is connected to the Internet provides learners with a vast pool of information anytime and anywhere. According to Demski (2012) IoT improves and expands the critical skills of learners. It develops, intensifies, and speeds up the learning process of the learners since it also links the learners with the physical world. In the traditional learning process, pen and pencil were imperative tools to acquire knowledge. However, today IoT has initiated opportunities for education (Demski, 2012). Smartphone is also a latest progress in the mobile technologies field, which offers an easy access to learning (Kim *et al.,* 2017). According to Enrique (2010), IoT comprises of various tools that are comfortable to use with internet, which provides an easy way to connect with their peers and lecturers. Therefore, IoT will bring adequate changes and improvements to the HEIs. According to Tianbo (2012), IoT will be responsible for the adjustments in educational technology, restructuring of education, revolutions in teaching, transformations in learning, modernizations of campus, resources for teaching and learning developments, etc.

Zhiqiang and Junming (2011) pointed out that the progress in IoT lies on these three features: learners' progressive appraisal, incorporation of existing teaching and learning platforms and the introduction of an educational middleware. These changes will offer improved accessibility for learners and present a more effective teaching process for the academics. The flow in connected devices and technology means that instructors and professors can focus on the actual learning that is more useful to the students rather than perform the routine task.

2.1 Digital Campus

The setting of the HEIs can completely transform by applying IoT based smart amenities in the establishments. It can enhance the whole services by employing IoT technologies. Digital campus is corroborating, along with smart learning, smart classrooms, and smart laboratories. A smart digital campus may involve the following IoT supported:

- Smart E-learning
- Smart Classroom
- Smart Labs
- Sensors for Notes Sharing
- Sensors used for Mobiles Devices
- Hotspot for Campus
- Smart Parking and lighting
- Smart Inventory
- Smart Students Tracking
- Resource centers

Smart Learning. The traditional learning environment involves two main groups in the learning process, the academics who teach and the learners who study. The typical teaching and learning processes involved both groups to remain in same place and at the same time, which necessitates both groups to make themselves accessible is a challenge (Abuarqoub et al., 2017). A smart learning environment causes a complete continuous learning procedure. The three main dimensions of learning resources to contribute and exchange information are learning groups, learning subjects, and lastly the learning facilities.

Smart Classroom. On the other hand, a Smart Classroom is an intellectual class that incorporates innovative teaching and learning approaches with up-to-date pedagogy along with growing technologies. This concept's system requisite is necessary to guarantee committed communications among learners and academics to virtually cooperate by taking care of the course objectives (Bargaoui and Bdiwi, 2015). Smart classroom concepts have confirmed to encourage internet-based learning, like e-learning, m-learning, and various distance education methods. A smart classroom is a place for learners to learn and perform simultaneously. To accomplish collaborative tasks, academics assemble learners to work in small clusters. In this manner, learners are assisted to help each other to manage with hard challenges. In the traditional classroom design, all the learners in front of their desk follow their lecturer's presentation.

Smart Laboratories. In the Smart Laboratory, to retain energy, IoT is used to assign suitable time and selects complete advantage of the available resources. For example, all the lights spontaneously switch on as arriving in the lab, and each learner will be allocated a precise apparatus. The procedure traces the use of the labs and initiates more labs when it is needed. It is also able to close any unused computers. In addition, air conditioners are switched on automatically when the temperatures are out of range.

2.2 Perceived benefits of the Internet of Things

According to Alhogail (2018), the adoption of new technology, including IoT, is based on the perceived benefits. The latter refers to the extent to which a person considers that with the IoT technology their study/work/life performance would be enhanced (Hsu and Lin, 2016). Therefore, perceived advantages of IoT services advocates that people will consider that the facilities will allow them to improve all their daily tasks either professionally or personally connected. Consequently, it develops the quality of living, allows more relaxation time etc., largely, a better study life balance. In a study conducted by Lee *et al.* (2011), it was found that comparative benefit turns meaningful and positive when adopting technology. Therefore, perceived advantages of the IoT technology must be supported to attain positive implementation of the IoT.

2.3 Benefits of utilizing IoT

There are numerous advantages of applying IoT. They include a rise in efficiency, growth in productivity and increase in flexibility. A study conducted by Kranz (2017)

revealed that IoT produces better efficiency and productivity. On the other hand, the study done by Schimek (2016) established that IoT increases in flexibility.

3.0 Methodology

This study assesses how students in Mauritius view IoT in higher education. Moreover, it also aims to outline the benefits and potential uses of IoT in the future higher education sector of Mauritius. It employs a quantitative approach based on a survey carried out among learners in the public HEIs in Mauritius. The survey included students from University of Mauritius (UoM), University of Technology (UTM), Open University of Mauritius (OUM), and Université des Mascareignes (UdM), with 386 respondents selected through random sampling.

The data collection tool was created according to the research aim and relevant literature. The questionnaire comprised of two parts where the first part included the five questions to examine the demographic profiles of the learners. On the other hand, the second part of the questionnaire expanded on the dependent variable and the independent variables, which were to be measured in the survey. The 5 demographic questions examined the information such as gender, age, education qualification, and years of experience in using IoT products and services and frequency of use. A combination of 5-point Likert scale and dichotomous items were aimed to provide quantitative data in the second part.

The Google form survey was distributed using a convenience random sampling technique to first-year students in various fields of study. Care was taken to make the sample as representative as possible and the ethical and confidentiality considerations were strictly respected during data collection and respondents have been enlightened about their anonymity concerning confidential data. After conducting a meticulous data screening process, only 280 out of the completed questionnaires were deemed suitable for analysis due to the exclusion of unengaged responses and multivariate outliers.

The information gathered is subsequently examined with the Statistical Packages for Social Sciences (SPSS) software for descriptive analysis, incorporating frequency, standard deviation, and mean calculations. Next, a Pearson Chi-square test was carried out to evaluate the link between students' views on IoT and their opinion on whether IoT should be integrated into higher education. Inferential statistics were employed to draw conclusions about a certain unknown factor of the population based on the sample taken from it.

4.0 Results and Discussion

To assess the internal consistency of the factors the reliability test was conducted. The factors were reasonably reliable as they met the threshold of 0.70 as suggested by Hair *et al.* (2016). The Cronbach's alpha values were 0.739 (IoT and Education), 0.783 (IoT and Learning), 0.891 (Application of IoT in Classroom) and 0.887 (Perception of IoT).

4.1 Descriptive analysis

According to Quintana *et al. (*2017), a descriptive analysis is the critical transformation of information applied to illustrate the fundamental characteristics of data gathered. In this study, the analytical method that is performed to evaluate and understand the basic characteristics of the data is covered by the demographic profile of respondents; and (2) descriptive analysis of data collected. From the demographic data analysis, the results show some distinctive characteristics of the HEIs where 94.12% of the respondents are between 18 to 25 years old. According to Hauk, Huffmeier and Krumm (2018), as age increases technology acceptance decreases, and this is largely due to perceived ease of use therefore this was considered an advantage, as young learners tend to interact with technology significantly more than people who are older.

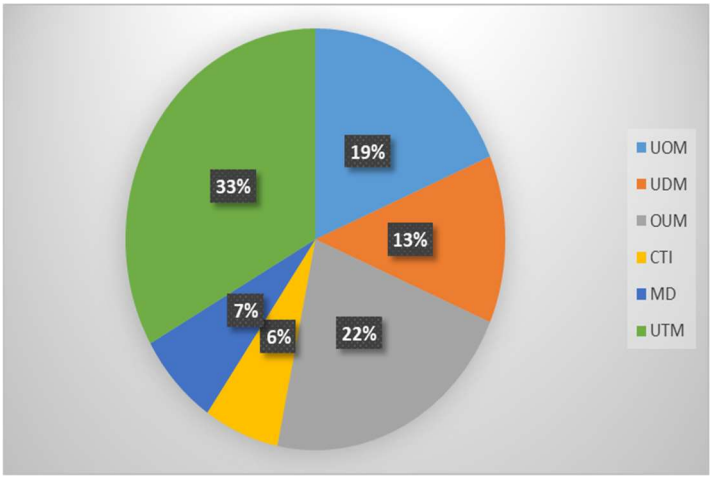

Fig. 1. HEIs in Mauritius

This showed that most students were of the millennial group and therefore they had a more open behavior in grasping and appreciating new technologies such as the IoT products and services. Therefore, they were familiar with IoT products and services, which directed them to provide enhanced insight into their perception of IoT. Additionally, most of the learners of the HEIs were not exposed to the IoT products and services regardless of the area of expertise they had; most of the learners were studying in Management courses. The study was dominated by Undergraduate learners representing 89% whereas the Post Graduate learners were represented by 11%. This indicated that knowledge about how IoT influences the daily living style of the learners in general, which was a good sign in terms of enablement and promoting cutting edge technologies to the younger generations. 100% of the respondents had internet access and they all get access to the internet through mobile data and Wi-Fi as compared to the internet café.

72% of the learners very often go online whereas only 28% often go online. It is worth noting that all the respondents had a Smartphone, 63% a laptop, 27% a computer, 1% PDA, 6% iPad, 11% iPhone and 36% had a tablet as shown on Fig 2. Today high-

tech products as well as services are no longer seen as a privilege to or limited to only the computer literate user group with a strong technology background but more like a common trend and activity in anyone's daily life. This finding will help policy makers in their vision to become a highly digitalize and innovative nation soon.

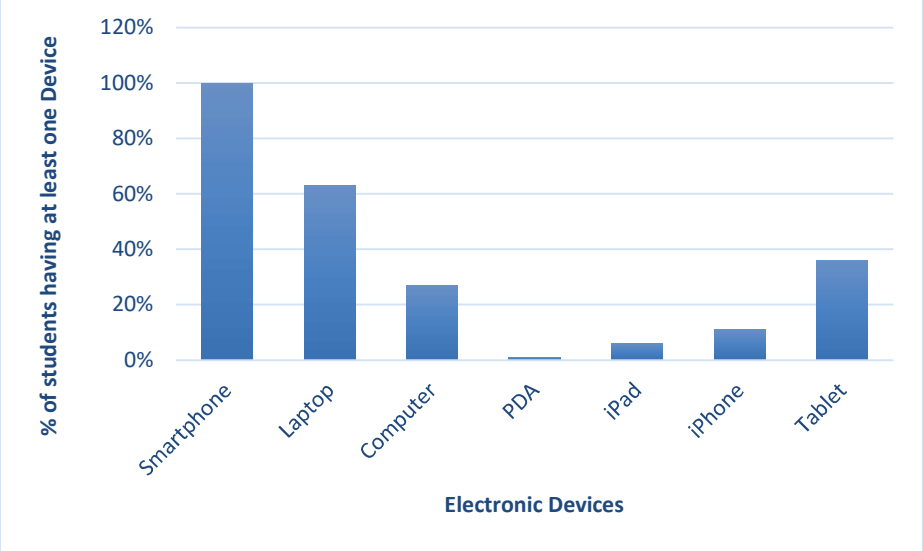

Fig 2. Electronic devices possessed and mostly used to access the internet.

4.2 Learners' Perspectives

Students were questioned with respect to their perception towards the use of IoT in their learning and on Campus. They were also asked about their opinions on various aspects of IoT, the difficulties they faced and what they appreciated about the adoption of IoT. Four scales namely IoT and Education, IoT and Learning, Application of IoT on campus, and Perception of IoT to measure the opinions of the learners.

IoT and Education. An interesting point is the use of IoT as an educational tool as shown in Table 1 below. The mean score for these prioritized themes that a university should attend when adopting an IoT environment; with a mean score of 3.97 students have a very strong perception about the adoption of IoT that their lecturers would have better opportunities for course planning. The students perceived that With IoT, teaching should be more creative (mean = 4.03, SD = 0.861); IoT will make teaching more interesting for them (mean = 3.86, SD = 0.966); and they would prefer the use IoT technology in the classroom (mean = 3.93, SD = 1.057). As Enrique (2010) had pointed out IoT provides an easy way for the learners to connect with their peers and lecturers for learning. The greater the learners' perception of engagement, the greater their

perception of learning. Similarly, Galina and Yankova (2020) asserted that IoT enabled lecturers to boost their operational efficiency in an online learning environment.

Table 1. IoT and Education.

	N	Min	Max	Mean	Std. Deviation
With IoT, my lecturers would have better opportunities for course planning.	280	1	5	3.97	0.835
With IoT, teaching should be more creative.	280	1	5	4.03	0.861
With IoT, teaching would be more interesting for me.	280	1	5	3.86	0.966
I would prefer the use IoT technology in the classroom.	280	1	5	3.93	1.057

IoT and Learning. The level of IoT and learning was assessed with a 4-item scale anchored on a 5-point rating system (1 = strongly disagree and 5 = strongly agree). As summarized in Table 2, most participants agreed that IoT would improve their learning. For, 46.1% agreed that with IoT they will feel more motivated and confident while 40% and 43.6% of the learners felt more focus and inspired to learn using IoT devices/ applications. With IoT, 36.8% believed that their teaching can be adapted on an individual level. Participants had a positive opinion about the use of IoT devices/applications would improve their learning. Even Hanan Aldowah, *et al*., (2017) considered that IoT had the ability to increase the learning experience by providing for real-time and actionable insights into student performance.

Table 2. IoT and Learning.

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
	Frequency (Percentage)				
With IoT I will feel more motivated.	2.1	1.4	22.5	46.1	27.9
With IoT my focus would be improved.	1.4	3.6	21.1	40	33.9
With IoT, teaching would be more inspiring me.	3.6	5.0	21.8	43.6	26.1

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	Frequency (Percentage)				
With IoT, teaching can be adapted on an individual level.	4.6	6.4	17.5	36.8	34.6

Applications of IoT on campus. Table 3 further illustrates that the participants agreed that the use of IoT devices in the classroom/lab would help them improve teaching and learning. It was observed that students overall had a positive attitude toward the IoT application in their classroom/lab. According to Aldowah et al., (2015), allow learners to study at their own pace and have same learning experience in classrooms. Galina and Yankova (2020) expressed that IoT can support classroom instruction by improving learning settings, methods, and techniques, enhancing learning resources, raising management efficiency, and saving management costs. Furthermore, some of the HEIs have classes are so big that taking learners' attendance turns out to be a discouraging task. Hence, it is unlikely to expect lecturers to remember every learner's name and this is why they call out each name one by one. According to Credé et al. (2010), keeping track of attendance is useful because learners' participation is essential in some courses and attendance is a predictor for class success. Using IoT technology, academics can monitor students' presence in an efficient manner. Lecturers can monitor their student's attendance at the same time be able to find out their overall engagement with academics also. The lecturers can use this data to track their own teaching performance, with the assumption that learners who regularly attend class are expected to do better. IoT devices can be used to search for students in the classroom and notify parents if they are not present (Bagheri and Movahed, 2016).

Table 3. IoT in the Classroom/Lab.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	Frequency (Percentage)				
My lecturers will be able to monitor attendance.	3.2	3.6	19.3	32.9	41.1
Monitor attention with eye-tracking during tests	7.1	13.9	22.9	25	31.1

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	Frequency (Percentage)				
Monitor air quality in the classroom/lab.	0.4	0.7	10.4	33.2	55.4
Personal feedback from lecturers	0.7	0.4	10	30	58.9

Perception of IoT. On average most of the participants agreed that IoT products improve their ability to perform their daily activities and tasks efficiently, support them to save time, provide access to information quicker, perceived positively the adoption of IoT in their institutions. 40.4% of the participants strongly agreed that IoT products and applications are trustworthy, while 42.9% believed that they provide reliable information that can used for learning and count on their university to protect their information (66.4%). Similarly, 47.1% admitted that IoT products and applications improved their performance of daily activities and tasks and 49.3% like using the IoT products and applications. 48.2% learners' overall attitude towards using IoT products and applications in the higher education was favorable where 44.3% perceived benefits related positively to the adoption of IoT.

Today, there is a growing demand for HEIs to digitize their content and activities and adapt their methods to allow academic and students to work and learn efficiently in a digital environment. Therefore, a well-designed physical campus, completely integrating technology, is fundamental for building the brand of digital university by enhancing the student experience, and providing the appropriate settings and facilities for teaching, learning and research. According to Porter and Sherwin (2013), it encourages, favors, and boosts lifelong learning.

Table 4. Perception of the use of IoT in education.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	Frequency (Percentage)				
IoT products and applications are trustworthy.	2.5	2.5	22.1	32.5	40.4
IoT products and applications provide reliable information.	2.1	3.9	21.8	29.3	42.9
I think that IoT products and applications will improve my	1.4	5.4	8.9	37.1	47.1

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	Frequency (Percentage)				
performance of daily activities and tasks.					
I like using IoT products and applications	1.8	2.5	9.3	37.1	49.3
I can count on my university to protect my information.	0	1.4	7.9	24.3	66.4
Overall, my attitude towards using IoT products and applications in the higher education is favorable.	2.1	3.2	11.1	35.4	48.2
Perceived Benefits relates positively to the adoption of IoT.	2.1	8.2	7.9	37.5	44.3

A chi-square test was performed to determine the association between students' perception of IoT and whether they felt that IoT should be incorporated into their education, learning and classroom. The results of the test were significant, $\chi 2(143, N=280) = 2186.42$, $p<.001$ indicating a significant association between the students' perception of IoT and whether IoT should be incorporated into their education. $\chi 2(91, N=280) = 997.534$, $p<.001$ indicating a significant association between the students' perception of IoT and whether IoT should be incorporated into their learning. $\chi 2(91, N=280) = 980.968$, $p<.001$ indicating a significant association between the students' perception of IoT and whether IoT should be incorporated into their classroom. Similarly, the Likelihood Ratio test was significant, $\chi 2(143, N=280) = 1058.85$, $p<.001$; $\chi 2(91, N=280) = 964.053$, $p<.001$; $\chi 2(91, N=280) = 663.995$, $p<.001$, supporting the presence of a significant relationship.

5.0 Conclusion

According to Gabriela (2013), IoT in education creates a new environment that supports the acquisition of knowledge in a new, and efficient manner consistent with the learners' needs and expectation. Smart campus can attract more students to learn with the integration of the technology in education. The use of computers, laptops, Smart phones, tablets, white boards, and many other tools are becoming an easy way of communications that save our time in doing different things nowadays. Administrative process much easier with the use of IoT, which makes administrative cost cheaper and more efficiently.

This study provides an insight on the perception learners have on the application and use of IoT in the HEIs, not as a substitute for existing on-campus education, but as a

complement to it. According to the existing literature and analysis of data presented above, IoT integration can bring variations to the methods students learn, and therefore adapt the already existing learning models. This means that academics may have to adjust their basic theory to technological improvements and consequently approve new features that can exist in the prevailing learning concepts. The integration of IoT in the higher education sector of Mauritius will enhance self-directed learning, and at the same time, academics will have less administrative tasks hence additional time for their learners. Even, Sari *et al.* (2017) argued about how the IoT integration can eventually create possible smart campus infrastructure in an HEI.

A requirement and essential element for teaching using IoT products is that the teaching materials need to exist online. Students can obtain feedback on their activities, probably automatic and in actual time. Moreover, by giving information regarding their performances, academics can get evidence of knowledge gained and help them prepare enhanced teaching materials in the future. Besides, IoT allows students to have learning material in accordance with their educational needs. As argued above, such materials are designed in line with the learners' learning needs and is available online and is spread through network since this is how IoT works.

Finally, it can be concluded that IoT has great ability to bring important values to the higher education sector in Mauritius by motivating and engaging the learners and academics. The purpose of this study was to find out the perception of IoT in higher education and the students believed that IoT does increase their speed of learning.

Most learners are currently using IoT in some way or the other, but they are not conscious of it. It is therefore important to create an awareness of IoT applications to inform the learners of the benefits from IoT without putting themselves at risk. Hence, academics and management should be considered to take part in this study for achieve the overall respondents. Therefore, the future work will be to focus on IoT adoption in higher education.

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