Facilitating Learner Centric Decision Making for Massive Open Online Courses

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Abstract : Learners opt for MOOCs as it provides multiple benefits and the most important being that these courses can be accessed anytime and from anywhere with internet access. Learners can study their desired course at their convenience of time and desired pace. But as there are multiple options for them, they may get confused about selecting a course. This study highlights the findings of implementing the Analytical Hierarchical Process (AHP), a Multiple Criteria Decision Making (MCDM) technique used to choose the best option in case of multiple alternatives. Attributes were selected from literature and a survey was administered to learners. Responses were analyzed and courses were ranked based on their scores. From the analysis, we interpret that usefulness of the course in the University Curriculum is the most preferred criteria while selecting the course.

Keywords : MOOC, Multiple Criteria Decision Making, Analytical Hierarchical Process

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1. Introduction

In our evolving world, technology has taken over multiple domains where it wasn't used back in time. This helps in creating a better working environment which also serves multiple benefits. Education was initially limited to classrooms but now its boundaries have expanded to a whole new level. Everyone cannot travel to a different place to study but the study material can travel to them.

To overcome such issues, Massive Open Online Courses (MOOCs) are introduced. MOOCs are mostly free of charge, which help learners to study different courses and attain certifications that they can use in their professional life(Sachdeva et al., 2016).

This helps learners to remotely access the courses and learn from top educators which otherwise is physically impossible. Some of the key benefits of MOOCs are that courses from different domains are available, timings are completely flexible, and they know how much time will be required for a course to complete (Lucy Bodenham, 2019). Some of the leading MOOC providers are Coursera, edX, and Udacity.

The government is also helping the education sector by setting up various schemes, NPTEL being one of them which was founded by the Ministry of Human Research and Development (Government of India) in

2003. The aim of establishing this was to expand the offering of MOOCs. These courses are run by top institutions like the Indian Institute of Technology which ensures that the learners are getting quality education from trustworthy sources. Certification of these courses is widely accepted by different companies so learners also have an advantage while applying for jobs(Singh et al., 2014).

The objective of this study to determine the criteria which are preferred by learners while opting for a lab-based MOOC and design an AHP to rank the courses so that they can choose the best course from options that are available to them.

This paper consists of VIII sections, Section I is the introduction. Further, Section II describes the AHP technique which we have implemented in this research paper. Section III and IV talks about the benefits and challenges of MOOCs respectively. In section V, we have reviewed the literature which was available on various repositories. Section VI consists of the methodology of how our research instrument was created. Different criteria are also explained in this section. All the calculations and analysis are shown in section VII which is followed by the conclusion in section VIII.

2. Ahp Technique

When we are choosing something, we look for all its alternatives and it is also considered good if have multiple options. But having multiple options is also a problem as it creates confusion in deciding which the best option is. These problems are called Multiple Criteria Decision Making (MCDM) and to solve these Analytical Hierarchical Process (AHP) is one of the popular techniques.

Thomas L. Saaty proposed this decision-making approach termed AHP through one of his works(Saaty, 1984). It divides a problem into many criteria and then calculates priority in each to make a decision. In the paper, he also gave two examples showing the use of AHP as a measure to make the decision. The technique helps in scenarios where we have to make a decision involving multiple alternatives. In AHP decisions are made by creating a hierarchical structure with all the available options(Gandhi et al., 2016). In the hierarchical structure, level 1 is the goal that has to be achieved. Below it, level 2 consists of the criteria which are

being considered in the decision making. Level 3 has the alternatives, which are available to us.

AHP works by dividing any problem into multiple subproblems based on the criteria involved and then priority is calculated in each criterion for the alternatives. This helps in ranking alternatives using a logical approach and make a decision.

The AHP matrix is calculated based on preferences of the individual between two criteria which is in turn used to calculate the criteria weights which give us the rankings for alternatives in each criterion as well as the most prioritized criteria. These Criteria weights from each category and criteria weights for all the criteria are used to rank the alternatives and make a decision.

We need to verify if the AHP is consistent by calculating its consistency ratio (CR) which needs to be less than 0.10 for AHP to be consistent, if CR>0.10 we need to revisit our comparison matrix.

3. Benefits

As MOOCs are easily accessible to everyone and learners can study at their own pace, this makes MOOC a very good way to gain new skills. MOOCs also have many other benefits and some of them are discussed below:

A.   Round-the-clock availability- Learners can access their course material whenever they are free and are not bound to log in at the time of the lecture. This permits them to focus on other things as well.

B.   Diverse options- Sometimes learners are pursuing a degree but want to study another subject that is not part of their curriculum. To match their need, MOOCs are available irrespective of the major/specialization of the learner. They have a large pool of courses to choose from which match their interests.

C.   Top-quality content- Learners can choose courses that are curated by professors of top institutions around the world. This provides the opportunity to attain knowledge from teachers whose classes might not be possible to attend by physically going to their universities.

D.   An advantage in professional life- Some courses can be done to get better knowledge about some topics

which may be useful in the current job. This will also help them to get raise in their salary and gain more recognition among their colleagues.

4. Challenges

MOOCs have many benefits but they also come with some challenges which are faced by their learners. Some of them are discussed below.

A. No live questioning- Courses are generally prerecorded for learners so the teacher is not present during the lecture. This forbids learners to get their doubts cleared at that time, they have to wait for a QnA session where their doubts can be cleared.

B. Language barrier- Courses are in the English language. Learners from non-English speaking regions will not be able to understand the course.

C. Internet availability- To stream course videos, high-speed internet is necessary. This could be a problem for learners living in remote areas where they don't have proper internet speed.

D. Online payment- Course/Certification fee has to be paid online. There can be some learners which do not have the facility to do online transactions.

E. Credits transfer- In some cases, credits of a MOOC can be transferred to a current college degree, but most of the time colleges do not transfer these credits.

5. Literature Review

We accessed different repositories such as IEEE, ACM, and Taylor & Francis to review the literature. Few papers were also extracted from Scopus which is the citation database of peer-reviewed literature.

Some of the literature which we reviewed for MOOC is as follows:

Oriol Borrás Gené et al. discussed how MOOCs can be benefited by gamification. Gamification is a technique to create an experience similar to games. By doing this in MOOC, learners may be willing to participate more actively as they will experience something new. Their study material was divided into different "missions" which they had to complete for course completion. "Ranking rating" was calculated by the scores of each module and a leaderboard was

generated which helped them to compete with other learners. "Number of likes" was also used in which learners could share their course progress or leaderboard score on social media, where their friends will see it and more learners will be engaged (Gené et al., 2014).

Di Chen et al. reported the seriousness of learners towards MOOCs. They found that the completion rate for a course is lower than 10% on average. Reasons for abandoning courses are numerous like the learner may not know what the difficulty level of course was, they started as it seemed interesting but it turned out to be a boring course, there were many assignments so they didn't have enough time for completing. Learners are also enrolled in universities and a certificate obtained by a MOOC is less valuable than a regular course from university so the learners focus more on their university studies as compared to the online course. For analysis, a course from Coursera was taken named "Traditional Chinese Medicine and Chinese Culture". It was found that some of the learners submit their assignments 1-2 days before the deadline but many of them submit after the deadline due to which their grades got affected. The study found out that learners did not give priority to assignments that's why they were submitting them after the deadline (Chen et al., 2014).

To check the influence of immediate feedback on a question in an exam, John W. Harrold, Jr, and Jessica Sandland experimented on a MOOC which was offered by MIT. In that course, there were three tests. While attempting them when the learner entered their answer, they were immediately able to see if it is correct or not. They were also allowed to change their answers a total of 20 times during one exam. As an experiment, this immediate feedback method was removed from the 3rd exam to see how learners reacted to it. It was found that most of them were reluctant in giving the exam after it was revamped. Providing immediate feedback encouraged learners to give that exam and the scores were also high when they were shown immediate feedback. It was also believed that if they were told the correct answer when they selected the wrong one, chances are higher that they will remember this in the future(Harrold & Sandland, 2018).

Prashast Kumar Singh reviewed various MOOC platforms such as EdX, Coursera, Udacity. These are international platforms that are quite popular among learners. India has also launched a MOOC platform

which is named National Program on Technology Enhanced Learning (NPTEL). This is developed with the guidance of the Ministry of Education, formerly the Ministry of Human Resource Development. The courses in NPTEL are controlled and run by different IITs. NPTEL is emerging as learners are getting quality content from highly qualified teachers so they also suggest their fellow learners opt for some courses on the NPTEL platform. Due to its higher quality of study material, this platform is also gaining popularity in the rest of the world(Singh et al., 2014).

We also reviewed the literature to find the application areas of the AHP technique.

Melvin Alexander explained in his paper how AHP was used to find the best suitable phone for his family. He used AHP to find the priority of the attributes and alternatives in each criterion and they were then weighted to find the most preferred smartphone (Alexander, 2012).

Hospitals are a part of essential services and it can be a difficult task to choose between multiple hospitals. They may be providing different services in terms of treatment given, room charges, medicine availability, imaging services, financial aid, etc. To show how to decide, Chosy Yuda Sakti et al. implemented AHP with MOORA to rank multiple hospitals. These methods are used for deciding between multiple options which are available to us. Their qualities are compared with their alternates and calculations are done which leads us to rankings between all the alternates and then the person can decide which alternate they should consider (Chosy Yuda Sakti et al., 2019).

Mohammed Said Obeidat researched in Jordan with Tarek Qasim & Aseel Khanfar to implement AHP for buying a residential apartment. Choosing a home for any individual is very important because once they have bought it, they will be residing in it for a long time as it is not possible to change it frequently. They are investing a significant amount of money in buying so they will thoroughly look at all the options available to them. In this, the researchers took the opinions of builders or land developers, and also the customers who will be investing in these projects. To know their answers, a survey was created with attributes that were checked while buying a house like building age, sewage, electricity, method of payment, price. All the answers were then correlated with the available options and the customers were shown which apartments or houses suit their needs. This helped them not to waste time by going to multiple places where they may be not interested (Obeidat et al., 2018).

Emel Kuruoglu et al. conducted a study in Turkey to evaluate the implementation of AHP which is used by people while choosing a family physician. They gave 96 patients an AHP survey and then created an AHP model to determine what criteria are most prioritized while choosing a family Physician (Kuruoglu et al., 2015).

Though it has been widely used from electronics to healthcare, there are limited studies that focus on the use of this well-established technique in selecting appropriate alternatives in the Education domain.

6.. Methodology

A survey was formed on google forms to gather the responses from learners for the attributes which they check while considering a MOOC. We selected 6 attributes as criteria for the survey.

Table 1 : Selected Criteria

S.No.	Criteria
1.	Platform
2.	Course/ Certification Fee
3.	Offering Institution
4.	Course Content
5.	Instructor Profile
6.	Usefulness in University Curriculum

A pilot test was conducted with 25 participants to ensure the appropriateness of the research instrument. We made some modifications that were needed based on the responses of the pilot study and after that research instrument was broadcasted. A total of 112 learners participated in this study, from which 100 responses were taken for analysis and 12 responses were omitted due to duplicity or incomplete responses. It was mandatory that the participant had opted for any MOOC once so that we will only get responses from learners who have gone through the process of selecting a course.

The participants were asked to answer questions about their preference between different categories and that data was used for creating the AHP

comparison matrix. The survey consisted of 15 questions comparing each criterion against each other and asking the participants to provide their response on the original Scale of 1-9 proposed by Saaty(Saaty, 1984).

While designing the survey we used 6 factors that affect most of the decisions of learners while selecting a MOOC as criteria. The 6 criteria based on which the questionnaire was created are:

A.   Platform- This is one of the main factors which learners look for while choosing a MOOC. The choice of platform is important as it affects the credibility of the course which would be more for a well-established platform and less for a new or less known platform(Shrivastava et al., 2019).

B.   Course/Certification Fee- This is a major criterion while deciding on a MOOC as a lot of learners are on a budget and a higher price could be the reason to not select a course. Some courses have a course fee which is the price of the course and the learner is required to pay this amount for starting the course whereas certification fee applies to courses that are free to study but the learner has to pay to get a certificate after the completion. Course/Certification Fee is important as the learners look for a course that would give them the best benefit at a minimal cost.

C.   Offering Institution- This factor is important while selecting a MOOC as the credibility of the Institution that is offering that course would affect the value of the course, if the course is offered by any reputable organization or university, it would hold more value and be more useful to the learner.

D.   Course Content- This is one of the most important criteria while choosing a MOOC as this is the main reason behind doing any MOOC. Course content is the skills or knowledge that the learner would gain from that MOOC and if a course provides better content that is ideally curated to the learners' need it would be preferred by the learner.

E.   Instructor Profile- It is also a big factor while considering any MOOC because if the instructor of the course has a good reputation that would increase the value of the course and also the teaching style of the instructor is important as if it is good it would be easier for the learner to learn and more beneficial.

F.   Usefulness in University Curriculum- This is a very important criterion while choosing a MOOC as if a course is useful in the university curriculum which means if your current university would provide credit transfer for the course which you choose(Shrivastava et al., 2021). This criterion could affect learners' decisions as if a MOOC can be considered part of the curriculum by their university, it would be helpful for the learners.

AHP hierarchy in fig 1 shows the categories and alternatives for the selection of the best MOOC.
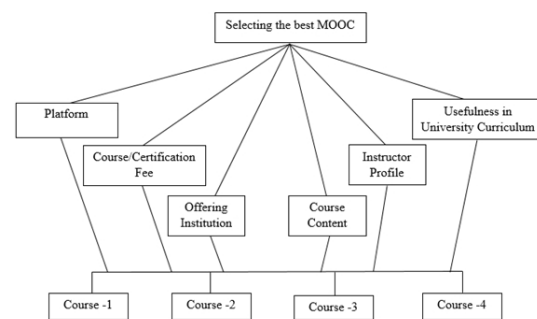

Fig. 1 : AHP Hierarchy

The data collected from the survey is collated and analyzed and then an AHP Comparison Matrix is created. After creating the matrix, the data is normalized using (1):

$$\frac{x}{\sum_{i=1}^{n} x} \qquad (1)$$

Then we use the normalized values in each criterion to calculate the Criteria Weights for all the categories using (2):

$$\frac{\sum_{i=1}^{n} x}{i} \qquad (2)$$

The criteria weight provides us the priorities given to each criterion by learners while choosing a MOOC. After the calculation of criteria weights, we need to verify the AHP using the Consistency Ratio. For Calculation of Consistency Index (CI) we first need to calculate Weighted Sum Value which is calculated using (3):

$$\sum_{i=1}^{n} x \qquad (3)$$

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The CI is calculated by using Lambdas which are in turn calculated from Weighted Sum Value and Criteria weights. The lambda max is used to calculate CI as follows:

$$\lambda = \frac{weighted\ sum\ value}{criteria\ weight} \qquad (4)$$

$$\lambda_{max} = \frac{\sum_{i=1}^{n} \lambda}{i} \qquad (5)$$

$$CI = \frac{\lambda max - n}{n-1} \qquad (6)$$

The CI is then divided by Random Index (RI) to find out the Consistency Ratio (CR). RI is given by Saaty in his paper for each number of categories. We have used RI equal to 0.90 when we have 4 courses as criteria and 1.24 when we have 6 criteria(Saaty, 1984).

$$CR = \frac{CI}{RI} \qquad (7)$$

During the analysis, we observed that CR for all AHP comparison matrices is less than 0.10 which depicts that they are consistent.

Table 2 : Category Comparison Matrix

	Platform	Certification/Course Fee	Offering Institution	Course Content	Instructor Profile	Usefulness in University Curriculum	Weighted Sum Value	Criteria Weight	
Platform	0.042415243	0.023814385	0.027195506	0.042534419	0.061654084	0.069754331	0.267367968	0.042415243	6.303582138
Certification/Course Fee	0.142212127	0.079846161	0.044843342	0.048854159	0.079742418	0.09960827	0.495106476	0.079846161	6.200754932
Offering Institution	0.189955617	0.216861966	0.1217944	0.054056529	0.08527144	0.111889958	0.779829909	0.1217944	6.402838784
Course Content	0.214021826	0.350775391	0.483566028	0.214623175	0.092152518	0.150773431	1.50591237	0.214623175	7.016541286
Instructor Profile	0.147025959	0.213992499	0.305251377	0.497740887	0.213714461	0.120254073	1.497979256	0.213714461	7.009255473
Usefulness in University Curriculum	0.196195372	0.258640552	0.351215916	0.459292946	0.573419019	0.322654686	2.161418491	0.322654686	6.698859751

Lambda Max=	6.605305394
CI=	0.121061079
CR=	0.097629902

For our alternatives, we chose 4 lab-based courses from three different platforms in the field of web development. All the courses were offered by different institutions such as Universities, organizations, or foundations. All 4 courses were priced in the range of ₹3,500 to ₹4,500. The content for all courses was about 90% similar. All the selected courses were self-paced. Two of the courses had multiple instructors while others had only one instructor, the initials of the instructors are mentioned in table 3. We have assumed that courses from one platform are considered to be valuable in the university curriculum.

The following Courses were used as alternatives for the AHP:

Table 3 : Course Alternatives

	Platform	Certification/Course Fee	Offering Institution	Course Content	Instructor Profile	Usefulness in University Curriculam
Course 1	Platform-A	₹ 3,593	Organisation-X	HTML, CSS, JS	RA, UL	No
Course 2	Platform-B	₹ 4,329	University-X	HTML, CSS, JS, CSS Framworks	YC	Yes
Course 3	Platform-C	₹ 3,589	Foundation-X	HTML, CSS, JS	MH	No
Course 4	Platform-B	₹ 3,595	University-Y	HTML, CSS, JS, Bootstrap	CVL, CRS	Yes

Then, an AHP comparison matrix was created for all courses in each criterion and verified using the Consistency ratio.

Table 4 : Platform AHP Matrix

	Course 1	Course 2	Course 3	Course 4	Weighted Sum Value	Criteria Weight	
Course 1	0.133012821	0.083012821	0.258012821	0.083012821	0.557051282	0.133012821	4.187951807
Course 2	0.665064103	0.415064103	0.331730769	0.415064103	1.826923077	0.415064103	4.401544402
Course 3	0.019001832	0.046118234	0.036858974	0.046118234	0.148097273	0.036858974	4.017943409
Course 4	0.665064103	0.415064103	0.331730769	0.415064103	1.826923077	0.415064103	4.401544402
						Lambda Max=	4.252246005
						CI=	0.084082002
						CR=	0.093424446

Table 5 : Course/Certification fee AHP Matrix

	Course 1	Course 2	Course 3	Course 4	Weighted Sum Value	Criteria Weight	
Course 1	0.3	0.3	0.3	0.3	1.2	0.3	4
Course 2	0.1	0.1	0.1	0.1	0.4	0.1	4
Course 3	0.3	0.3	0.3	0.3	1.2	0.3	4
Course 4	0.3	0.3	0.3	0.3	1.2	0.3	4
						Lambda Max=	4
						CI=	0
						CR=	0

Table 6 : Offering Institution AHP Matrix

	Course 1	Course 2	Course 3	Course 4	Weighted Sum Value	Criteria Weight	
Course 1	0.176004902	0.121838235	0.271593137	0.176004902	0.745441176	0.176004902	4.235343267
Course 2	0.88002451	0.609191176	0.349191176	0.88002451	2.718431373	0.609191176	4.462361698
Course 3	0.025143557	0.067687908	0.03879902	0.025143557	0.156774043	0.03879902	4.040670216
Course 4	0.176004902	0.121838235	0.271593137	0.176004902	0.745441176	0.176004902	4.235343267
						Lambda Max=	4.243429612
						CI=	0.081143204
						CR=	0.090159116

Table 7 : Course Content AHP Matrix

	Course 1	Course 2	Course 3	Course 4	Weighted Sum Value	Criteria Weight	
Course 1	0.096703297	0.083882784	0.096703297	0.110989011	0.388278388	0.096703297	4.015151515
Course 2	0.29010989	0.251648352	0.29010989	0.184981685	1.016849817	0.251648352	4.040756914
Course 3	0.096703297	0.083882784	0.096703297	0.110989011	0.388278388	0.096703297	4.015151515
Course 4	0.483516484	0.754945055	0.483516484	0.554945055	2.276923077	0.554945055	4.102970297
						Lambda Max=	4.04350756
						CI=	0.01450252
						CR=	0.016113911

Table 8 : Instructor Profile AHP Matrix

	Course 1	Course 2	Course 3	Course 4	Weighted Sum Value	Criteria Weight	
Course 1	0.291348358	0.452062643	0.335179526	0.16364273	1.242233257	0.291348358	4.263738665
Course 2	0.097116119	0.150687548	0.201107716	0.16364273	0.612554113	0.150687548	4.065061259
Course 3	0.058269672	0.050229183	0.067035905	0.098185638	0.273720397	0.067035905	4.083190883
Course 4	0.874045073	0.452062643	0.335179526	0.490928189	2.152215432	0.490928189	4.38397199
						Lambda Max=	4.198990699
						CI=	0.066330233
						CR=	0.073700259

Table 9 : Usefulness in University Curriculum AHP Matrix

	Course 1	Course 2	Course 3	Course 4	Weighted Sum Value	Criteria Weight	
Course 1	0.0625	0.0625	0.0625	0.0625	0.25	0.0625	4
Course 2	0.4375	0.4375	0.4375	0.4375	1.75	0.4375	4
Course 3	0.0625	0.0625	0.0625	0.0625	0.25	0.0625	4
Course 4	0.4375	0.4375	0.4375	0.4375	1.75	0.4375	4
						Lambda Max=	4
						CI=	0
						CR=	0

The Criteria Weight from all the AHP matrix is used to create Priorities for each of the courses. The Criteria are assigned Priorities based on their weights as a lower priority for lower weights and higher priority for higher weights. This is represented as a horizontal bar graph in fig 2 shows the priorities assigned to all the criteria by learners while choosing a MOOC, fig 3 shows the priorities assigned by learners to all the courses in their respective criteria.
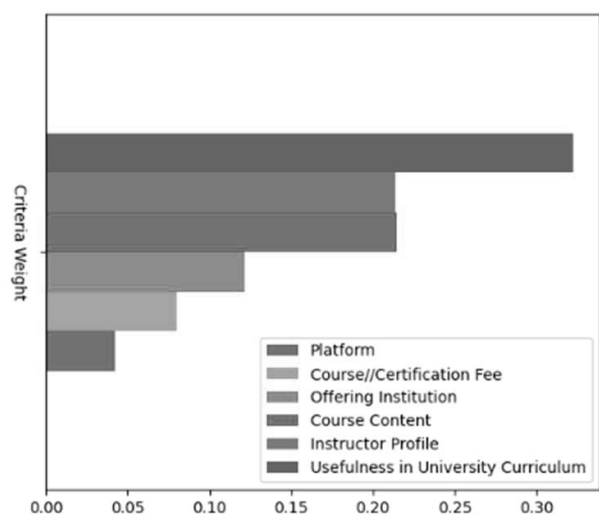
Fig. 2 : Criteria Weight of Attributes
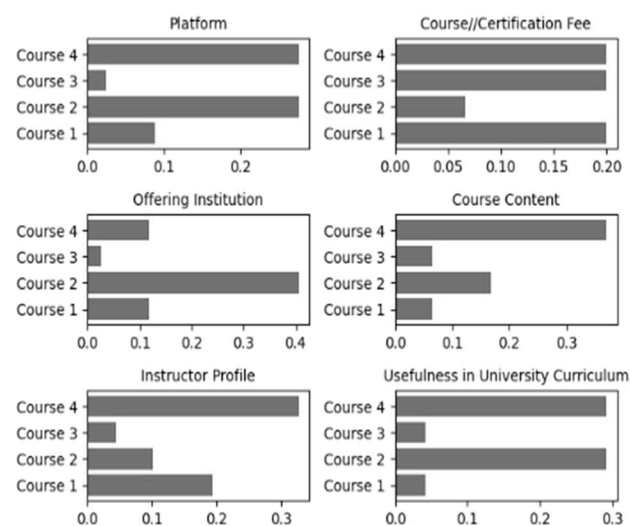
Fig. 3: Criteria Weights of Alternatives in each Attribute

Then, the criteria weights of each course are multiplied to the criteria weight of that category and their sum is calculated which gives us the final critical weight of each course. This critical weight is then used to assign a ranking to each course which is given in the figure below.

Table 10 : Course Ranking

	Platform	Course/Certification Fee	Offering Institution	Course Content	Instructor Profile	Usefulness in University Curriculum	Criteria Weight	Ranks
Course 1	0.005641771	0.023953848	0.021436411	0.020754769	0.062265357	0.020165918	0.154218075	3
Course 2	0.017605045	0.007984616	0.074196074	0.054009568	0.032204108	0.141161425	0.327160836	2
Course 3	0.001563382	0.023953848	0.004725503	0.020754769	0.014326542	0.020165918	0.085489963	4
Course 4	0.017605045	0.023953848	0.021436411	0.11910407	0.104918453	0.141161425	0.428179253	1

8. Conclusion

Many learners are opting for MOOCs now so they must select a course that is good and will be beneficial for them in the future, providing the best opportunities for them. By analyzing the data from the survey we found that learners preferred the criteria "usefulness in university curriculum" the most while "instructor profile" and "course content" were almost equally preferred. The lowest preference was given to "platform" while selecting a MOOC by learners. Furthermore, this data was used to rank 4 MOOCs based on these criteria. After analyzing the data, the courses were ranked based on final critical weight and the data showed that course 4 is ideal as it has the highest critical weight, thus it is ranked 1st. This shows us how AHP can guide us to decide which option is best among multiple courses by comparing them based on their criteria weight and help us to decide which course to choose.

References

[1] Alexander, M. (2012). Decision-Making using the Analytic Hierarchy Process (AHP). International Journal of Scientific Research, 3(6), 135–136. https://doi.org/10.15373/22778179/june2014/47

[2] Chen, D., Feng, Y., Zhao, Z., Jiang, J., & Yu, J. (2014). Does MOOC really work effectively. Proceedings of the 2014 IEEE International Conference on MOOCs, Innovation and Technology in Education, IEEE MITE 2014, 272–277. https://doi.org/10.1109/MITE.2014.7020287

[3] Chosy Yuda Sakti, Kelly Rossa Sungkono, & Riyanarto Sarno. (2019). Determination of Hospital Rank by Using Analytic Optimization on the Basis of Ratio Analysis. 178–183.

[4] Gandhi, S., Mangla, S. K., Kumar, P., & Kumar, D. (2016). A combined approach using AHP and DEMATEL for evaluating success factors in implementation of green supply chain management in Indian manufacturing industries. International Journal of Logistics Research and Applications, 19(6), 537–561. https://doi.org/10.1080/13675567.2016.1164126

[5] Gené, O. B., Núñez, M. M., & Blanco, Á. F. (2014). Gamification in MOOC. 215–220. https://doi.org/10.1145/2669711.2669902

[6] Harrold, J. W., & Sandland, J. (2018). The Influence of Immediate Homework Feedback on Student Performance and Satisfaction in an Engineering MOOC. Proceedings of 2018 Learning With MOOCS, LWMOOCS 2018, September, 90–93. https://doi.org/10.1109/LWMOOCS.2018.8534592

[7] Kuruoglu, E., Guldal, D., Mevsim, V., & Gunvar, T. (2015). Which family physician should I choose? The analytic hierarchy process approach for ranking of criteria in the selection of a family physician. BMC Medical Informatics and Decision Making, 15(1), 1–8. https://doi.org/10.1186/s12911-015-0183-1

[8] Lucy Bodenham. (2019). The advantages of learning via MOOCs. University of London. https://london.ac.uk/news-opinion/london-connection/feature/advantages-learning-moocs

[9] Obeidat, M. S., Qasim, T., & Khanfar, A. (2018). Implementing the AHP multi-criteria decision approach in buying an apartment in Jordan. Journal of Property Research, 35(1), 53–71.

https://doi.org/10.1080/09599916.2017.1413588

[10] Saaty, T. L. (1984). The Analytic Hierarchy Process: Decision Making in Complex Environments. Quantitative Assessment in Arms Control, 285–308. https://doi.org/10.1007/978-1-4613-2805-6_12

[11] Sachdeva, A., Singh, P. K., & Sharma, A. (2016). MOOCs: A comprehensive study to highlight its strengths and weaknesses. Proceedings of the 2015 IEEE 3rd International Conference on MOOCs, Innovation and Technology in Education, MITE 2015, 365–370. https://doi.org/10.1109/MITE.2015.7375346

[12] Shrivastava, A., Hasteer, N., & Soni, K. M. (2019). Perspectives on Curriculum Inclusive MOOCs for Engineering Education: Reflection & Learning. Proceedings - IEEE 10th International Conference on Technology for Education, T4E 2019, 34–37. https://doi.org/10.1109/T4E.2019.00015

[13] Shrivastava, A., Hasteer, N., & Soni, K. M. (2021). Implications of the Intertwined Effects of Curriculum Inclusive MOOCs. 11(6). https://doi.org/10.18178/ijiet.2021.11.6.1525

[14] Singh, P. K., Nand, P., & Gandhi, I. (2014). MOOCS : The Paradigm-shift in Indian Education. 317–320.