ATU
PRESS

Feasibility of Using V-SAT Satellites in Library Services

Adel Soleimani Nejad (iD) | Associate Professor; Department of Information Science & Knowledge Studies, University of Kerman Shahid Bahonar, Kerman, Iran

Tahereh Haji Mozafari (iD) | Ph.D. Candidate in Knowledge and Information Science, Islamic Azad University, Tehran North Branch. Tehran, Iran

Fariborz Doroudi (iD)∗ | Assistant professor; Iranian Research Institute for Information Science and Technology (IranDoc), Tehran, Iran

Abstract

Purpose: The main purpose of this research is to assess the feasibility of using VSAT satellites in the information services of university libraries.

Method: The research method is a survey using the TOPSIS model, which indicates that the optimal method of providing the Internet is the method that has the greatest distance from negative factors and the least distance from positive factors. The opinions of user organizations, i.e. academic libraries and information centers, have been examined to clarify the necessity of using this method as well as its characteristics and advantages compared to other ways of providing the Internet.

Findings: The findings show that VSAT satellite internet can have better conditions for providing services compared to other services such as ADSL, optical fiber, Wi-Fi and Wi-MAX. Also, their assessment determined that VSAT satellite internet is currently the best way to provide internet based on the criteria of service, support, cost, trust and quality, and ranks second in criteria such as security, confidentiality and service. In conclusion, the priority of solutions to provide library internet using TOPSIS analysis is: VSAT service; Optical fiber; ADSL service; Wi-Max services and wireless services.

Conclusion: The results indicate that the VSAT satellite network, with advantages in the use of Internet services by libraries, plays an important role

in improving the quality of these services.

Introduction

Academic libraries are a great source of information and knowledge to provide a wide range of services to meet the needs of the end user (Iqbal et al., 2020). These libraries have a fundamental role for the educational and research activities of their institutions (Corrall & Jolly, 2019) and mainly have a great influence on the fields of information (educational, research and information abilities of users), cultural and scientific society. (Głowacka, 2019). Studies show that a shared vision is the key to academic library leadership that prepares staff for organizational changes and reduces resistance to change (Aslam, 2019) and information plays a major role in helping to clearly understand the changing needs of academic library users, and assisting libraries to innovate in their services and procedures (Hamad et al., 2021).

Library managers often discuss the challenges in designing flexible and sustainable professional development programs that meet the diverse needs and interests of library staff (Carroll & Mallon, 2021). Academic library management requires innovative skills and competencies, effective communication abilities and a new way of thinking to face challenges and create a willingness to adapt to changes (Aslam, 2020) and for this reason, libraries need to keep up with major changes and trends in the fields. Information science and higher education in general are facing challenges (Saunders, 2020), which are unprecedented and accompanied by unique changes. One is that the role of the physical library, that is, the library as a place, is changing (Sennyey, Ross & Mills, 2009). Another thing is that university libraries are currently operating in an environment that is accompanied by rapid changes. Being aware of what is changing and ensuring that libraries can continue to play a useful role in higher education is a deep and ongoing challenge .

In addition, it should be stated that the university or academic library is an integral partner in the evolution of higher education (Llewellyn, 2019). Also, in the contemporary era, academic libraries are expected to maintain their value by providing innovative services to meet the continuous changes in the information needs of users and they play an important role in attaining the goals. In fact, they have a strategy to create diversity in higher education. Meanwhile, rapidly changing technologies affect how, where and when students and staff access university services (Atkinson, 2019). Therefore, the development of technology has added new dimensions to the management of scientific

content of academic libraries (Chisita & Chiparausha, 2019). Therefore, digital developments have had a significant impact on the nature of learning and have provided new opportunities for academic libraries (Llewellyn, 2019).

Considering that the Internet is currently growing rapidly, the need for rapid development in the use of the Internet requires a balance in providing the facilities of this space. The standard Internet service is the continuity of the connection of this wide network, and the connection between the networks must be done continuously; but communication is not always implemented without problems, there are many obstacles or disturbances so that communication is not done properly. One of the best ways to connect the Internet is through VSAT satellites.

VSAT enables the widespread use of satellite communications (Karmakar, Padhi, & Aditya, 2000) and satellite communications play an important role in the communication infrastructure supporting multimedia services. Today, satellite communication networks using very small aperture terminals (VSAT) are useful communication infrastructures that support various application requests (Fujisaki & Tateiba, 2015). Recommendations for VSAT technology selection methods have been made in order to establish a satellite communication network. These methods include: list of goals and tasks, requirements of a network, choice of topology, choice of network type, choice of multiple access protocols (Moroz, 2007). As we know, satellite communication is suitable for long-distance transmission and distribution services based on telecommunications (Hong et al., 2014) and VSATs can be equipped with multiple antennas that enable parallel transmission to several satellites (Röper et al., 2023). Therefore, in order to meet the various needs for communication in daily life, the multi-mode terrestrial satellite (VSAT) very small aperture terminal has been developed using radio waves.

Satellite-based library services can play an effective role in promoting the status of university libraries. Among the effective tools to facilitate communication needs, telecommunication systems have a unique position. This special position is due to the advantages of satellite communication in terms of variety of services, flexibility, influence of natural resources, high speed of communication, wide coverage and relatively low cost in long distances. Therefore, the current study deals with the feasibility of using VSAT satellites in information services. In this research, seven indicators are considered,

which include confidentiality, service, security, quality, support, reliability and cost. VSAT satellite network is a dedicated two-way digital network, which has received attention in many countries, including Iran, in recent years and has been widely used in various fields of telecommunications, especially data transmission, under various protocols.

The reasons for encouraging the use of this type of internet in libraries transpire by comparing it with other methods of providing internet such as ADSL, Wi-Fi, Wi-MAX, and optical fiber using TOPSIS method which is based on measuring the minimum distance and examining the positive ideal solution (the best possible state) and the farthest distance from the negative ideal solution (the worst possible state). The general purpose of the research is to investigate the feasibility of using VSAT satellite in information services. The research questions are: 1. what are the criteria and indicators investigated regarding the provision of internet for information centers? 2. Is the use of satellite internet a suitable alternative for other means of providing internet for libraries and information centers?

Literature Review
To write the present article, the researchers have had to study and consult many references and trustworthy sources of information pertaining to the given topic. But not many related profiles were found. Nevertheless, an attempt was made to bring the profiles close to the subject.

Conducting research into the use of new technologies shows that the problem of many small university libraries is to provide face-to-face library education to students without having the resources and/or staff to do this. In order to better guide them in the activities of information technology, satellites play an important role . The results show that satellite technology can support students' needs to send information and resources well and help to optimize their library skills. The results of this study showed that, regardless of the level of technology, the most preferred method of providing library education to students is through technology and software that can be adapted to satellite-based information services (Ismail, 2016). In another research, the status of satellite libraries has been studied, the results show that it is necessary to support the main library to achieve the vision and accomplish the mission of these types of libraries. Hence, their inefficiency affects the

parent institution.

Also, the findings indicate that satellite libraries are consistent with organizational goals in realizing the vision and mission. The management and challenges of satellite libraries are more than the main libraries of the mother organization, and it requires planning and providing necessary training for librarians and information science specialists so that they can work better with these libraries and have more appropriate activities (Filson & Edumadze, 2017). A further research has been conducted into the evaluation of the capacity of open source libraries to manage satellite data resources, the results of which show that the traditional methods of managing information data provided by libraries are less effective than providing information resources via satellite.

Also, remote satellite data management increases the demand for library information services and provides better conditions for their activities. In addition, various applications for metadata generation, data organization, cataloging, and data retrieval through satellite services provide better conditions for optimal information services (Sharma et al., 2017). In another research, regarding the role of satellite in regular planning, effective cooperation between the stakeholders of the main library and the satellite library was carried out, the results showed that satellite libraries as a beneficial factor in the development of the academic library system have a positive impact on sharing and extensive cooperation of resources.

It was also found that the role, structure, usefulness and support of satellite libraries in universities are welcomed by librarians and are used in many activities for holding conferences, professional services, and specialized activities. Satellite libraries that use software facilities and new technologies to identify teaching and research materials are physically and administratively separated from the main university libraries, but they are recognized as libraries on the university campus and are supported by the organization to discover users. They have the possibility of optimal support of library services and materials (Turner, 2017). In the research that has been done into the role of innovation in the technologies needed by libraries, the results indicate that the real change does not take place only through technology, but rather in the way we use it. Libraries have always been places of innovation and education, and academic librarians have contributed greatly to the development of electronic technology. One of these technologies is in

the field of satellite, and the results show that the use of data with the help of satellite technology can increase the level of quality of information services and provide better grounds for library activity.

The results showed that moving in the smart environment of new technologies based on satellites means changing the paradigm of information resources and services (Rognoni & Pastorini, 2019). In a research conducted into satellite library services at Savannah State University, the results indicate that the use of satellite facilities in the library creates a new library position, and increases access to the library and advances information literacy programs in the library. There are social spaces throughout the campus. In addition, the use of satellite facilities has led to the development and progress of research services, supported new information programs in virtual services and library spaces and other places of the university (Koopmans, 2020). The results of another research into the Internet with regard to the satellite approach in the library, show that despite the advancements of space technology, with the activity of several companies planning in the field of satellite to provide broadband Internet services, there are still many uncertainties about the design of these networks. The analysis carried out indicates that satellite links significantly reduce the delay in Internet time changes, have more flexibility and can provide over a treble amount of output for Internet services (Hauri et al., 2020).

The review of studies and research shows that the use of satellites in libraries has an effective role in providing services and using the Internet, and this technology can greatly expand the needs of users to use library services. Also, internet services and satellite technologies have a profound impact on the development of the professional activities of libraries and information centers and enhance their activities.

Method

The current research is applied in terms of nature, and as regards hypothesis analysis, it is a field research. TOPSIS model has been applied to check the feasibility of using VSAT satellite in information services in academic libraries. This technique is based on the concept that suitable options are those with the least distance to the positive ideal solution (the best possible state) and the farthest distance to the negative ideal solution (the worst possible state). The TOPSIS model is completed in 6 steps:

First step: identification of criteria and options; Second step: preparation of unscaled matrix; Third step: preparation of balanced scale less than matrix; Fourth step: calculation of positive and negative ideals; Fifth step: calculating the distance of each option from positive and negative ideals; and Sixth step: calculating the ideal solution.

The statistical population of the research consists of all informatics managers of 14 universities in Tehran and Qom (8 Government-sponsored universities, 5 Islamic Azad universities and 1 private university), whose total number is 11 according to the statistics obtained. 9 libraries were central type and 2 were faculty libraries. Due to the limitation of the statistical population, the total census method was used. The tool for collecting information was a questionnaire. The validity of the questionnaire was done based on the face validity method by a number of experts in information science and epistemology, and based on their opinions, some questions were deleted, some were added, and some were combined. The reliability of the questionnaire was also determined by Cronbach's alpha test, and its value was determined as 0.812.

Results

The characteristics of the respondents in Table 1.

Table 1. Demographic profile of respondents

gender				work experience (years)						Grade			
Male		Female		up to 10		up to 20		Above 20		Masters		Masters and above	
no	percent	no	percent	no	percent	no	percent	no	percent	no	percent	no	percent
11	79	3	21	4	28	8	58	2	14	9	64	5	36

The descriptive statistics of the seven research variables have been examined in terms of importance in Table 2.

Table 2. Descriptive statistics of research variables in the sample - degree of importance

Row	Components	Average	Standard Deviation	Min.	Max.
1	Security	4.45	0/688	3	5
2	Importance of Confidentiality	4.52	0/305	4	5
3	Service and Support	4.20	0/179	4	4/4

Row	Components	Average	Standard Deviation	Min.	Max.
4	Cost	3.89	0/387	3/5	4/5
5	Reliability	3.86	0/529	3/25	4/75
6	Service	4.50	0/314	4	5
7	Quality	4.24	0/565	3/5	5

According to the data in Table 2, the importance of confidentiality has obtained the highest average, specifically 4.52. After that, service and support is placed with an average of 4.5 and then security with an average of 4.45. Reliability is at the lowest level with an average of 3.86.

Table 3. Descriptive statistics of research variables in the sample - current situation

Row	Components	Average	Standard Deviation	Min.	Max.
1	Security	2/45	1/128	1	4
2	Importance of Confidentiality	2/77	0/984	1/25	4
3	Service and Support	2/73	0/484	1/8	3/4
4	Cost	2/43	0/531	1/75	3/63
5	Reliability	3/4	0/451	2/75	4/25
6	Service	3/67	0/634	1/6	3/6
7	Quality	2/97	0/547	2/17	3/67

Currently, in libraries, the service variable is at the highest level with an average of 3.67 and the cost variable is at the lowest level with an average of 2.43.

What are the criteria and indicators to be studied regarding the Internet provision of information centers?

Regarding the answer to the above question, it is necessary to use the degree of importance and the need of the information centers on the provision of the Internet. Due to the fact that the degree of importance of the criteria and indicators under investigation regarding internet provision of information centers has a normal distribution, therefore, the parametric t test of one sample will be used for the test.

With the assumption that μ: is the real mean of the importance of the criteria and understudied indicators regarding the provision of Internet information centers in the understudied society, the results are presented in the table below.

Table 4. The results of Student's t-test for the degree of importance of the criteria and indicators regarding the provision of internet in information centers.

Components	Average	Standard Deviation	Statistics T	Degrees of Freedom	Meaningful Level
Security	4/45	0/688	7/02	10	0/00001
Importance of Confidentiality	4/52	0/305	16/54	10	0/00001
Service and Support	4/2	0/179	22/25	10	0/00001
Cost	3/89	0/387	7/7	10	0/00001
Reliability	3/86	0/529	5/42	10	0/00001
Service	4/5	0/314	5/91	10	0/00001
Quality	4/24	0/565	7/3	10	0/00001

As it can be seen from the results of Table 4, the significance level is lower than 0.05 in all cases. Therefore, at level $\alpha = 0.05$, we reject the null hypothesis and accept the opposite hypothesis, that is, the degree of importance of the investigated criteria and indicators regarding the Internet provision of information centers is high. But now the question arises as to which of these criteria are more important. To find out, it is necessary to determine the priorities using the Friedman test

Table 5. The results of Friedman's test for the priority of the importance of the criteria and indicators under investigation regarding the provision of Internet for information centers.

Row	Statistics	Quantity
1	Friedman test	16/945
2	Degrees of freedom	6
3	Meaningful Level	0/009

As seen in Table 5, since the significance level of Friedman's test is equal to 0.009, therefore, we reject the null hypothesis and accept the one hypothesis. It means that all the criteria and indicators investigated regarding the provision of internet in information centers have importance and priority.

Table 6. The average ratings for the priority of the importance of the criteria and indicators under investigation regarding the provision of internet for information centers

Components	Average Rank	Priority
Security	4/59	3rd
Importance of Confidentiality	5/14	1st
Service and Support	3/64	5th
Cost	2/59	7th
Reliability	2/68	6th
Service	5/13	2nd
Quality	4/23	4th

According to the results of the Friedman test, the priorities are as follows: 1. Confidentiality; 2. Services; 3. Security; 4. Quality; 5. Service and support; 6. Reliability; 7. Cost.

Is the use of satellite internet a suitable substitute for other means of providing internet to libraries and information centers?

Regarding the answer to the above question, it is necessary to use the existing situation of information centers regarding internet provision. Due to the fact that the existing status of the criteria and understudied indicators regarding the provision of Internet in information centers has a normal distribution, therefore, the one-sample parametric t test will be used for the test. Now, if we assume that: μ is the real mean of the existing status of the standards and understudied indicators regarding the provision of Internet information centers in the understudied society , the results can be seen in Table 7.

Table 7. The results of the Student's t-test for the current status of the criteria and understudied indicators regarding the provision of Internet in information centers.

Components	Average	Standard Deviation	Statistics T	Degrees of Freedom	Meaningful Level
Security	2/45	1/128	-1/6	10	0/93
Importance of Confidentiality	2/77	0/984	-0/77	10	0/77
Service and Support	2/73	0/484	-1/87	10	0/95
Cost	2/43	0/531	-3/55	10	0/99
Reliability	3/4	0/451	3/01	10	0/0066
Service	3/67	0/634	-1/71	10	0/94
Quality	2/97	0/547	-0/18	10	0/57

As it can be seen from the results of the above table, because the significance level is greater than 0.05 in all cases except for reliability, therefore, we do not reject the null hypothesis at the level of $\alpha = 0.05$ and we accept it, that is, the current status of the criteria and understudied indicators, regarding the provision of Internet in information centers is not enough. Only reliability is optimal. Now, by using the gap between the degree of importance and the existing status of the criteria and understudied indicators regarding the provision of internet for information centers, we will provide a way to show the importance of the attitude towards the criteria.

Table 8. The results of Friedman's test for the priority of the importance gap and the existing status of the investigated criteria and indicators regarding the provision of internet for information centers.

Row	Statistics	Quantity
1	Friedman test	24/7
2	Degrees of freedom	6
3	Meaningful Level	0/000

As it can be seen from the above table, because the significance level of the Friedman test is equal to 0.009, therefore, we reject the null hypothesis and accept the 1st hypothesis; it means there is a priority.

Table 9. Average ratings and rating for the priority of the importance gap and the existing situation, the understudied criteria and indicators regarding the provision of Internet in information centers.

Components	Average Rank	Priority
Security	5/05	1st
Importance of Confidentiality	4/82	3rd
Service and Support	3/91	5th
Cost	4/5	4th
Reliability	1/45	7th
Service	5/09	2nd
Quality	3/18	6th

According to the results of the Friedman test, the priorities are as follows: 1. Security; 2. Services; 3. Confidentiality; 4. Cost; 5. Service and support; 6. Quality; 7. Reliability. Now we are choosing the appropriate internet provision method using TOPSIS technique.

Choosing the right internet provision method using TOPSIS technique:

In this research, TOPSIS technique has been used to choose the appropriate internet provision method. The best way to provide internet is the one with the most distance from negative factors and the least distance from positive factors.

Discussion

-The first step: identifying criteria and options

The main indicators (criteria) and options (methods of internet provision) have been identified. Therefore, the scoring matrix of the options has been formed based on the criteria. A 9-Point Likert scale has been used to score internet provision methods based on each criterion. The appropriate score for each of the Internet provision methods based on the indicators according to the geometric mean of the experts' opinions is presented in Table 10:

Table 10. TOPSIS technique decision matrix

Components	Security	Importance of Confidentiality	Service and Support	Cost	Reliability	Service	Quality
ADSL	7/765	4/939	5/724	6/000	7/039	8/165	7/789
V-Sat	7/560	5/827	6/093	5/748	6/722	6/320	6/544
Light Fiber	7/892	7/331	6/575	6/233	7/237	7/610	7/456
Wimax	7/765	7/300	8/360	7/560	8/386	7/892	7/789
Wireless	6/382	5/426	6/673	5/547	6/554	6/554	5/650

In order to calculate these values, a questionnaire composed of 33 questions was used, which evaluated each of the seven criteria for making a decision about the Internet provision method. When the opinions of more than one expert are used to determine the priority of criteria and sub-criteria, there are several techniques to reach a general view. Axel and Saati (1983) have introduced the use of geometric mean as the best method for combining pairwise comparisons. For this reason, the geometric mean has been used in this study. The values listed in Table 2 must be scaled for use in the TOPSIS technique.

-**The second step: preparing the unscaled matrix**
In the second step, the de-scaling of the decision-making matrix has been done with a norm. If each element of the descaled matrix is denoted by n_{ij} and each corresponding element in the original matrix is represented by a_{ij}, then each n_{ij} is calculated by dividing the corresponding element in the original matrix by the square root of the sum of the squares of the corresponding column elements and is calculated as follows:

$$n_{ij} = \frac{a_{ij}}{\sqrt{\sum_{1}^{m} a_{ij}^2}}$$

For example, the α_{11} wireless technology score is based on the security standard, which is calculated as 7.65. To calculate the unscaled equivalent of the α_{11} value, which is shown as n_{11}, the number 7.65 must be divided by the square of the sum of the second power of each value

in the column related to security. Its mathematical expression is as follows:

$$n_{11} = \frac{7.765}{\sqrt{(7.765)^2 + (7.560)^2 + (7.892)^2 + (7.765)^2 + (6.382)^2}} = 0.463$$

This operation has been done for each matrix listed in Table 11. Therefore, the output of TOPSIS software for the unscaled matrix N is as follows:

Table 11. Unscaled decision matrix

Components	Security	Importance of Confidentiality	Service and Support	Cost	Reliability	Service	Quality
ADSL	0/463	0/354	0/379	0/429	0/436	0/497	0/491
V-Sat	0/451	0/446	0/437	0/455	0/463	0/443	0/473
Optical Fiber	0/471	0/525	0/436	0/445	0/448	0/463	0/470
Wimax	0/463	0/523	0/554	0/540	0/520	0/481	0/491
Wireless	0/381	0/389	0/442	0/396	0/406	0/399	0/356

-The third step: preparing the balanced unscaled matrix

In the third step, the dimensionless matrix (N) should be converted into the weighted dimensionless matrix (V). In order to obtain the weighted dimensionless matrix, we must have the weights of the indices. The weight of each index has been calculated using the Friedman test, which is shown in Table 12.

Table 12- The weight of the main criteria and the normalized value

Components	Friedman test	Normal value
Security	3/5	0/125
Importance of Confidentiality	4/09	0/14607
Service and Support	3/91	0/13964
Cost	2	0/07143
Reliability	5/73	0/20464
Service	3/32	0/11857
Quality	5/45	0/19464

For this purpose, we multiply the unscaled matrix in the square matrix (Wnxn) whose main diagonal elements are the weights of the indices and the other element is zero. The resulting matrix is called weighted unscaled matrix and is denoted by V. (Momini and Sharifi, 1389: 153)

$$V = N \times W_{nxn}$$

The result of this calculation is summarized in the table13:

Table 13. Weighted unscaled or scaleless matrix

Components	Security+	Importance of+ Confidentiality	Service and + Support	Cost-	Reliability+	Service+	Quality+
ADSL	0/0579	0/0517	0/0531	0/0304	0/0894	0/0592	0/0957
V-Sat	0/1250	0/0652	0/0611	0/0323	0/0949	0/0528	0/0923
Optical Fiber	0/0569	0/0652	0/0610	0/0316	0/0919	0/0551	0/0916
Wimax	0/0579	0/0579	0/0764	0/0384	0/0618	0/0572	0/0957
Wireless	0/0476	0/0568	0/0619	0/0281	0/0833	0/0475	0/0694

-Fourth step: Calculation of positive and negative ideals

In this step, a positive ideal (V+) and a negative ideal (V-) are calculated for each index. In the present decision, the indicators of security, confidentiality, service and support, reliability, service and quality are positive and only the cost indicator is negative. Now it is necessary to obtain positive and negative ideals for each indicator.

- For each positive index, the positive ideal is the largest value of the corresponding column in the v matrix.

- For each positive index, the negative ideal is the smallest value of the corresponding column in the v matrix.

- For each negative index, the positive ideal is the smallest value of the corresponding column in the v matrix.
- For each negative index, the negative ideal is the largest value of the corresponding column in the v matrix.

Therefore, the ideal positive and negative value for this decision making situation are as follows:

Table 14. Negative and positive limit

V+	0/1250	0/0652	0/0764	0/0281	0/0949	0/0592	0/0957
V-	0/0476	0/0517	0/0531	0/0384	0/0618	0/0475	0/0694

-The fifth step: calculating the distance of each option from positive and negative ideals

The distance of each option from the positive ideal is shown by d+ and the distance from the negative ideal is shown by d-. The output of TOPSIS software for these equations is presented in the Table below:

Table 15. Calculations d+ & d-

Components	d_i^+	d_i^-
ADSL	0/0725	0/04192
V-Sat	0/01737	0/08898
Optical Fiber	0/06828	0/04329
Wimax	0/07584	0/03825
Wireless	0/08504	0/02582

- Step six: Calculation of the ideal solution

In this step, the relative closeness of each option to the ideal solution is calculated. For this, we use the following formula:

$CL_i^* = d_i^- / (d_i^- + d_i^+)$

CL value is between zero and one. The closer this value is to one, the closer the solution will be to the ideal solution, that is, the better one. (Habibi, 1390: 1) These values are given in the following Table:

Table 16. Calculations d+ & d-

Internet services	CL value
ADSL	0/3664
V-Sat	0/8367
Optical Fiber	0/3880
Wimax	0/3358
Wireless	0/2329

Therefore, according to the calculated values listed in Table 7, it can be concluded that the best option is to use the services of VSAT The priority of solutions using TOPSIS analysis is as follows:

1. VSAT Services; 2. Optical fiber; 3. ADSL services; 4. Wi-max services; 5. Wireless services.r

In addition to determining the priority of internet provision methods based on all the identified criteria, or on each of the identified criteria, the priority of internet provision methods was determined. For this purpose, the descaled matrix of the second step has been used, with the difference that the values in this table must be normalized. After normalizing, the sum of the elements of each column should be 1.

In the right column of each criterion, the score related to the Internet provision method using that criterion is entered, and under the left column of each criterion, the rank related to the Internet provision method using that criterion is entered. According to the calculations made, VSAT method based on service and support criteria, cost, trust and quality is the best method of internet provision and it has the second priority in other criteria as well. Therefore, the results of this research based on determining the priority of internet provision methods based on all the studied criteria are not far from expected. And it can be expected that VSAT technology be the best option for internet provision.

Conclusion

Various criteria and indicators are used to evaluate and inform about the current status of internet provider services. It was found that the degree of importance of the investigated criteria and indicators regarding the provision of internet for information centers has a normal distribution. The results show the following regarding the measurement of the seven factors.

The significance level is lower than 0.05 in all cases, which means that the degree of importance of the investigated criteria and indicators regarding the provision of internet for information centers is at a high level. The results of the Friedman test presented the priorities as follows: 1. Confidentiality; 2. Services; 3. Security; 4. Quality; 5. Service and support; 6. Reliability and 7. Cost.

The results of feasibility assessment of using VSAT satellites to measure the current and optimal situation and evaluate the methods used by libraries to provide their internet, indicate that the VSAT satellite network has advantages in the use of Internet services by libraries and plays an important role in the quality enhancement. This type of internet does not require cabling and the limitations of wiring networks and the related areas of this system. In fact, a VSAT can be installed and launched anywhere on the earth's surface that the satellite covers.

Facilitating the use and improving the conditions of using this type of satellite internet service can save money on physical costs and its structure. At the same time, it has a positive and favorable effect on saving manpower and energy for the desired activity. This finding is consistent with the research results conducted by Sharma et al.,in 2017 regarding the benefits of satellite internet.

In addition, VSAT is able to send and receive any type of information content at a high speed regardless of proximity to the telecommunication switch center. This is of great importance in providing library services and tools used to strengthen their information infrastructure. Performing specialized activities is always accompanied by technical support. In such a way that the level of service increases and provides better user satisfaction. This category is aligned with the research results of (Ismail, 2016) and (Koopmans, 2020) regarding the dimensions of services and professional activities based on satellites.

Also, being economical in Internet costs, and reducing the budget in this field can bring about good conditions for the financial management of the library. The discussion of financial management is always very important in the administration of libraries. This category helps library management to meet other needs in different parts of the library by optimizing costs. Also, regarding the participation and cooperation between libraries, the influence of this factor is significant. The use of modern technologies in this system has led to the development of professional cooperation and will improve the quality

of librarians' work and broaden their professional expertise.

This is consistent with the research results conducted by Turner in 2017. Among the other advantages of using VSAT satellite internet are the very good quality of data communication, reliability (reliability coefficient more than 95.99%), ease and speed in changing the system configuration, provision of different communication speeds and protocols. The stated technical issues play an important role in supporting library services. These categories increase the quality of work in libraries and place technological processes in the right direction. Basically, technology plays an important role in improving the quality of professional activities of librarians and information service providers.

Today, information services are provided to the user through various technological tools. Information search and retrieval in the web environment and databases, digital content production, use of library software, current awareness methods and selective information dissemination, and other library services are provided in the context of technology. This category, i.e. the role of satellite internet in improving the quality of using technology, is aligned with the researches by Rognoni & Pastorini (2019) and Hauri et al. (2020).

It was found that the wide security capabilities of data exchange, speed in diagnosing and fixing defects, expandability, diverse telecommunication services, centralized management, and the possibility of monitoring the network's real-time performance and diagnosing possible problems have caused this use of VSAT satellites based on service and support standards. Cost, reliability and quality should be recognized as the most salient features of the best Internet provision methods.

Considering the organizational goals and missions of libraries, these categories are closely consistent with research results by (Filson & Edumadze, 2017) and with technical aspects of the research done by Rognoni & Pastorini, in 2019. Therefore, based on the results obtained from this research, and by determining the priority of Internet provision methods based on all the studied criteria, VSAT Satellite Internet technology can be expected to be one of the reliable and desirable options for providing Internet to libraries and information centers.

Based on the research findings, it is suggested that:

The specialized services of university libraries based on essential information technologies should be explained and their compatibility

with satellite internet facilities should be examined in terms of costs. In case of appropriate compliance, this type of satellite internet service should be used.

Also, considering the positive and acceptable uses of satellite internet, the use of this type of internet service should be on the agenda of libraries and the necessary planning should be done for its use. Numerous components in terms of technical issues, expandability, reliability, centralized management regarding the services of university libraries in connection with satellite internet should be analyzed in detail with the opinions of experts in the field of information technology.

In their strategic and operational planning, academic libraries should pay attention to the Internet relevant infrastructures and technologies, according to their activity levels.

CONFLICT OF INTEREST: The authors declare that they have no conflicts of interest regarding the publication of this manuscript.

References

Aslam, M. (2019). Leadership challenges and issues facing academic libraries. *Library Philosophy and Practice*, 2227, 1-28.

Aslam, M. (2020), "Leadership in challenging times of academic libraries", *Global Knowledge, Memory and Communication*, 69 (3), 135-149. DOI: https://doi.org/10.1108/GKMC-03-2019-0038

Atkinson, J. (2019). Collaboration by academic libraries: What are the benefits, what are the constraints, and what do you need to do to be successful? *New Review of Academic Librarianship*, *25*(1), 1-7. DOI: https://doi.org/10.1080/13614533.2019.1575016

Carroll, A. J., & Mallon, M. N. (2021). Using digital environments to design inclusive and sustainable communities of practice in academic libraries. *The Journal of Academic Librarianship*, *47*(5), 102380. DOI: https://doi.org/10.1016/j.acalib.2021.102380

Chisita, C. T., & Chiparausha, B. (2019). Open Access initiatives in Zimbabwe: Case of academic libraries. *The Journal of Academic Librarianship*, *45*(5), 102047. DOI: https://doi.org/10.1016/j.acalib.2019.102047

Corrall, S., & Jolly, L. (2019). Innovations in learning and teaching in academic libraries: Alignment, collaboration, and the social turn. *New

Review of Academic Librarianship, *25*(2-4), 113-128. DOI: https://doi.org/10.1080/13614533.2019.1697099

Filson, C.K. & Edumadze, G.E. (2017), "Prospects and constraints of the University of Cape Coast satellite libraries", *The Bottom Line*, Vol. 30 No. 2, pp. 120-131. DOI: https://doi.org/10.1108/BL-12-2016-0042

Fujisaki, K., & Tateiba, M. (2015). Investigation of airplanes effects on VSAT satellite communication systems. *International Journal of Space-Based and Situated Computing*, *5*(4), 222-229.

Głowacka, E. (2019). Research on the impact of academic libraries–areas, methods, indicators. *Library Management,* 40 (8/9), 583-592. DOI: https://doi.org/10.1108/LM-02-2019-0005

Hamad, F., Al-Aamr, R., Jabbar, S. A., & Fakhuri, H. (2021). Business intelligence in academic libraries in Jordan: Opportunities and challenges. *IFLA journal*, *47*(1), 37-50. DOI: https://doi.org/10.1177/0340035220931882

Hauri, Y., Bhattacherjee, D., Grossmann, M., & Singla, A. (2020, November). "Internet from Space" without Inter-satellite Links. In *Proceedings of the 19th ACM Workshop on Hot Topics in Networks* (pp. 205-211).

Iqbal, N., Jamil, F., Ahmad, S., & Kim, D. (2020). Toward effective planning and management using predictive analytics based on rental book data of academic libraries. *IEEE Access*, *8*, 81978-81996. DOI: 10.1109/ACCESS.2020.2990765

Ismail, L. (2016). Removing the road block to students' success: in-person or online? Library instructional delivery preferences of satellite students. *Journal of Library & Information Services in Distance Learning*, *10*(3-4), 286-311. DOI: https://doi.org/10.1080/1533290X.2016.1219206

Karmakar, N. C., Padhi, S., & Aditya, S. (2000). Development of a portable VSAT antenna array for satellite communications. In *2000 Asia-Pacific Microwave Conference. Proceedings (Cat. No. 00TH8522)* (pp. 34-37). IEEE.

Koopmans, H. (2020). Stories from the Satellite Library: Lessons Learned from Launching a New Academic Branch Library. Georgia International Conference on Information Literacy. 72. Retrieved from: https://digitalcommons.georgiasouthern.edu/gaintlit/2020/2020/72 [accessed: 12, Sep., 2022]

Llewellyn, A. (2019). Innovations in learning and teaching in academic libraries: A literature review. *New Review of Academic Librarianship*, *25*(2-4), 129-149. DOI: https://doi.org/10.1080/13614533.2019.1678494

Rognoni, M., & Pastorini, A. M. (2019). Islands and bridges: academic

librarians towards Open Innovation and the Internet of Things. IFLA CPDWL Satellite Meeting 2019: Librarians and information professionals as (pro) motors of change: immersing, including and initiating digital transformation for smart societies Date: 20-21 August 2019, National and University Library, Zagreb, Croatia
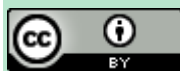
Röper, M., Matthiesen, B., Wübben, D., Popovski, P., & Dekorsy, A. (2023). Robust precoding via characteristic functions for vsat to multi-satellite uplink transmission. In: *IEEE International Conference on Communications (ICC), arXiv preprint arXiv:2301.12973*. DOI: https://doi.org/10.48550/arXiv.2301.12973

Saunders, L. (2020). Core knowledge and specialized skills in academic libraries. *College & Research Libraries*, *81*(2), 288. DOI: https://doi.org/10.5860/crl.81.2.288

Sharma, V. K., Amminedu, E., Rao, G. S., Nagamani, P. V., Mohan Rao, K. R., & Bhanumurthy, V. (2017). Assessing the potential of open-source libraries for managing satellite data products–A case study on disaster management. *Annals of GIS*, *23*(1), 55-65. DOI: https://doi.org/10.1080/19475683.2016.1231718

Turner, L. S. (2017). Embracing satellite libraries in academia. *Collection Building*, 36(2), 58-62. DOI: https://doi.org/10.1108/CB-12-2016-0034