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POTENTIAL FOR SCIENCE LABORATORY DEVELOPMENT: A SWOT ANALYSIS

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Abstract

The laboratory is inseparable from the learning process at the Faculty of Science and Technology. Therefore, it is important to have quality standards that are a benchmark and reference in laboratory work. These quality standards include laboratory buildings/rooms, quality control, facilities and equipment, risk management, and waste disposal. Laboratories that comply with these standards have great potential to grow. This study aims to identify strategies to implement in the management and development of the Faculty of Science and Technology laboratories. This study uses a SWOT analysis method through a qualitative approach obtained from interviews with laboratory heads and workers. The SWOT analysis results show that the FST laboratory is in quadrant I, where strengths and opportunities can be utilized. The results of IFE internal factors and EFE external factors obtained a strength and *opportunities* (SO) value of 3.75, *strength* and *threats* (ST) of 3.55, *weakness* and *opportunities* (WO) of 3.64; and *weakness* and *threats* (WT) of 3.44 indicate a fairly good position. The data from this research can be used as a reference in designing the formulation of the right strategy for developing the Faculty of Science and Technology laboratory. The latest research significantly contributes to the potential development of science laboratories at the university level under the Ministry of Religion.

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INTRODUCTION

The laboratory functions as one of the supporting facilities in the learning process at the university level, especially at the Faculty of Science and Technology (FST). In this case, laboratories are an inseparable part of learning at FST (Amri et al., 2024). Every laboratory must have a standard operating procedure (SOP) as a benchmark and reference when working in the laboratory. In essence, SOPs help laboratory management, avoid miscommunication, prevent accidents, and maintain uniformity in work patterns (Wahab et al., 2021). Laboratory standards have a crucial role in determining quality assurance. FST laboratories have quality standards based on the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) 17025:2017, a requirement for testing and calibration laboratories (Krismastuti & Habibie, 2022). The aspects that become laboratory standards include laboratory buildings/rooms, quality control, facilities and equipment, risk management, and waste disposal (Fatimah et al., 2022). Satibi et al. (2023) revealed that laboratory management is needed to achieve a good laboratory according to standards.

Laboratory management is a supporting factor in increasing the effectiveness of student learning, characterized by a structured organizational system, development funds, and adequate facilities (Aisyah et al., 2024). The proper implementation of all activities in the FST laboratory must have an expert laboratory head and an educational laboratory institution that is certified competent in its field, highly dedicated, and responsible for problems in the laboratory (Syahputri et al., 2023). A good and detailed allocation of funding can support the success of laboratory development. FST laboratory managers must prioritize laboratory needs and laboratory priority scales (Gustini & Wulandari, 2020). The fulfillment of laboratory needs, such as adequate facilities, can improve the quality of student learning so that they have scientific theoretical skills, theoretical testing, and proof of a research trial (Permana et al., 2024). Conducting a Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis is necessary to find other supporting factors that can develop FST laboratories.

SWOT analysis is one of the modeling methods in analyzing internal and external factors that affect an organization. Internal factors include strengths and weaknesses, while external factors include opportunities, challenges, or threats (Santoso et al., 2024). Risyah (2023) said that the development of laboratories and information technology at the Institute of Domestic Government West Kalimantan Campus, after conducting a SWOT analysis, has not been maximized because it does not have competent human resources (HR), inadequate facilities, and curriculum preparation that has not been systematic. (Suryorini et al., 2024) also said that the SWOT approach at the Da'wah and Communication Laboratory of UIN Walisongo needs to focus on new products, opening new markets to get new customers, building cooperation, and using new technology to meet customer demand.

Achieving performance in the laboratory is challenging without systematic design of SOPs and management. Safety in the laboratory is a shared responsibility and commitment from the manager and the user (Trasmini et al., 2021). Research conducted (Rahmantiyoko et al., 2019) stated that some accidents in the laboratory were caused by not following instructions or SOPs and standards that were not met. This research aims to determine strategies for managing and developing FST Laboratories that can be identified from various aspects. The problem-solving approach is carried out using SWOT-based analysis. The data from this analysis can be used as a reference source or for developing and managing FST laboratories.

METHOD

The method used in this study is to use a qualitative approach. The source of qualitative data obtained came from informants through interviews with laboratory heads and laboratory workers. After that, the data received will be analyzed based on SWOT. Astuti & Ratnawati (2020) stated that this analysis assumes that an effective strategy can maximize strengths and opportunities and minimize weaknesses and threats. SWOT analysis emphasizes systematic identification based on matrix parameters, which include weight, rating, and weight score (Arianti et al., 2024). Based on Figure 1, the parameters of this matrix will show the existence of 4 quadrant maps where each quadrant has its evaluation and strategy (Suliswiyadi, 2019). Quadrant maps can be used to determine relevant strategies in laboratory development.

Figure 1. SWOT analysis Quadrant Map

RESULT

Internal Factor Evaluation Matrix Analysis

The *Internal Factor Evaluation* (IFE) matrix is used to find out what and how much the role of internal factors in achieving the goals that have been determined through a strategic design for all activities in the laboratory. Choerunisa (2024), in his research, said that the IFE matrix approach makes it easier to determine strategies based on the sum of the weighted values of 10 respondents in each indicator. Human resources are one of the areas of focus in the FST laboratory. According to Yuniyanti (2024), success can be seen in the available human resources. One of the programs carried out by UIN Syarif Hidayatullah Jakarta is the entrepreneur social empowerment program. This IFE matrix consists of the strengths and weaknesses of the laboratory calculated from the weight value and rating. The matrix is found in Table 1.

Table 1. IFE Matrix of FST Laboratory UIN Sulthan Thaha Saifuddin Jambi

Internal Factors	Weight	Rating	Weight Score
Strength			
1. The building and laboratory area of the Faculty of Science and Technology are spacious and very possible to be divided into laboratory spaces for study programs in the Faculty of Science and Technology (*Machine*/Material)	0.13	5	0.65
2. The leadership in the FST Laboratory and the Dean of FST have a good capacity and are heard by the rectorate's decision-makers (*Man*)	0.12	5	0.6
3. Human resource qualifications are following laboratories at FST, although the quantity is still lacking for some disciplines (*Man*)	0.11	5	0.55
4. The Faculty of Science and Technology within the Ministry of Religion has a special revitalization fund for the construction of the Faculty of Science and Technology (*Money*)	0.08	4	0.32
Total	**0.44**		**2.12**
Weakness			
1. The quantity of human resources for several fields of science is still lacking, and competency development for existing human resources has never been done (*Man*)	0.11	5	0.55
2. The procurement of equipment and materials per year is not following the number of needs for learning and research support activities (*Money*)	0.11	4	0.44
3. There is no K3 system for the Science and Technology Laboratory (*Method*)	0.1	3	0.3
4. There is no standard for laboratory services, either administrative or technical (*Method*)	0.09	3	0.27
5. Learning activities are still concentrated in one room for 10 practicum courses, as well as research activities for final project students	0.09	3	0.27
6. There is no laboratory waste treatment system yet.	0.06	3	0.18
Total	**0.56**		**2.01**
Total IFE	**1**		**4.13**

EFE Matrix Analysis

The *External Factor Evaluation* (EFE) matrix determines what and how much external factors play a role in maximizing all opportunities and minimizing existing threats to achieve a laboratory's goals. (Manurung, 2024) the EFE matrix approach makes it easier to see opportunities to mitigate the negative impact of any potential threat. This EFE matrix comprises Laboratory Opportunities and Threats calculated from weight values and ratings. The matrix is found in Table 2.

Table 2. EFE Matrix FST Laboratory UIN Sulthan Thaha Saifuddin Jambi

Internal Factors	Weight	Rating	Weight Score
Opportunities			
1. The research needs of students and lecturers for a lot of laboratory instrument equipment, if it can be done in their laboratory, will save research costs, increase the value and quality of research outputs	0.09	5	0.45
2. Study programs in the faculty of science and technology will hold accreditation with superior targets	0.11	5	0.55
3. Certain laboratory equipment can be used to increase the cost of BLU input (making acquires, renting computers for CBT)	0.09	4	0.36
4. Certain laboratory equipment that can increase the cost of BLU input will potentially divert funds for science and technology laboratories to help with operational costs (urgent consumables, e.g., tissues, masks, gloves, etc.) as well as technical damage (e.g., broken pipes, broken water pumps, etc.)	0.09	3	0.27
5. Laboratory users need services that have a clear and effective flow	0.05	4	0.2
6. Cooperation with third parties will add value to the laboratory and increase the value of accreditation.	0.1	4	0.4
Total	**0.53**		**1.63**
Threat			
1. The request for the formation of laboratory human resource needs at the center is not possible	0.1	5	0.5
2. Lack of awareness of Laboratory K3 for laboratory users	0.07	4	0.28
3. Laboratory users often do not report breakdowns of glassware, which reduces the use of good, effective tools	0.05	3	0.15
4. The university's focus is on building new faculties that require large funds	0.1	5	0.5
5. Faculty revitalization does not every year decrease	0.08	4	0.32
6. Laboratory users often do not report breakdowns of glassware, which reduces the use of good, effective tools	0.07	4	0.28
Total	**0.47**		**1.43**
Total EFE	**1**		**3.06**

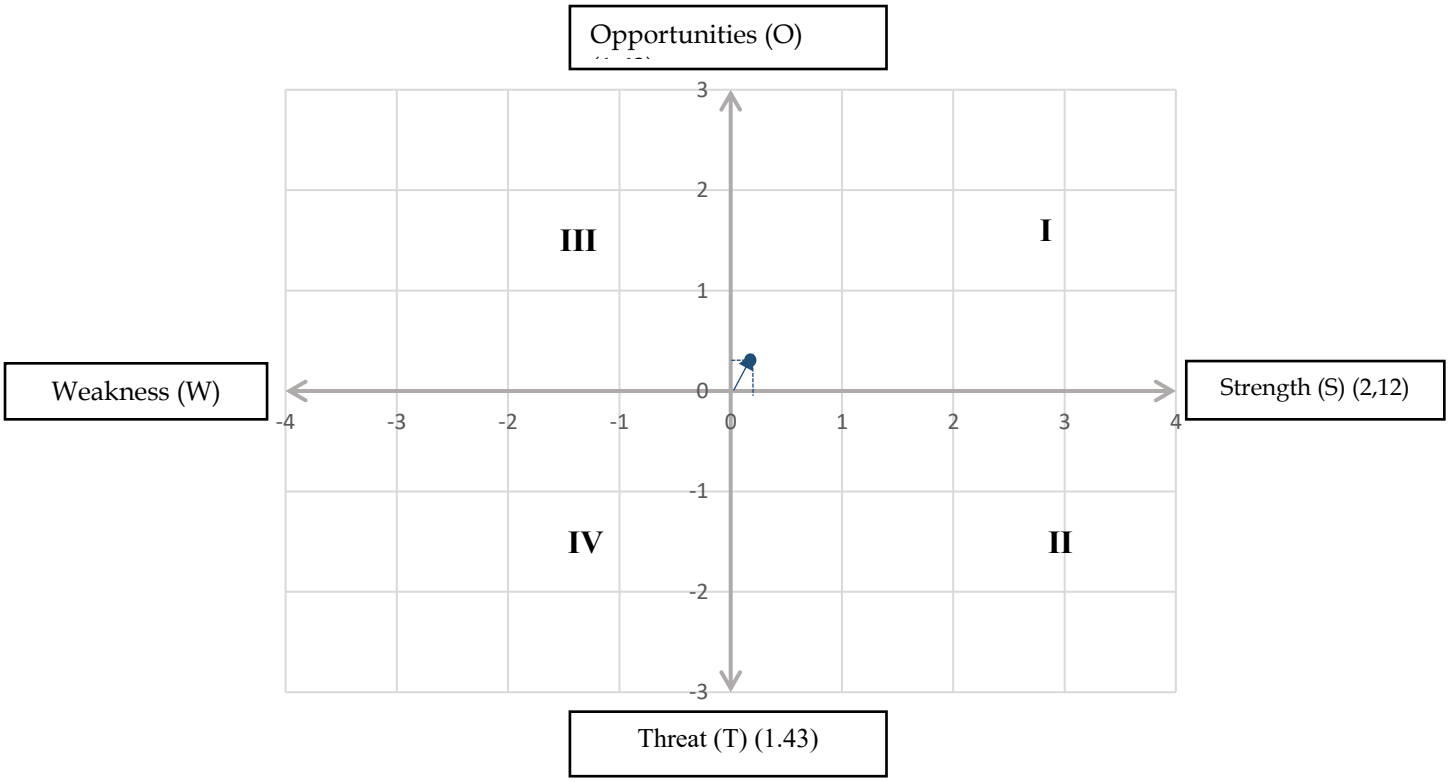

Figure 2. Quadrant Diagram of SWOT Analysis of FST Laboratory UIN Sulthan Thaha Saifuddin Jambi

The SWOT matrix shows opportunities, threats, strengths, and weaknesses. The matrix consists of four quadrants, each containing its strategy. Based on Figure 2. The results of the SWOT analysis diagram of the FST laboratory placed the position point in quadrant I. The position in quadrant I makes the FST laboratory very favorable. This position shows that the FST Laboratory has great opportunities and strengths and can exploit the existing opportunities. SWOT analysis helps in the management approach of the chosen strategy effectively and efficiently. The relevant strategy that must be implemented is to support an aggressive growth policy (*growth-oriented strategy*) so that the FST laboratory has the potential to develop and build its capabilities (Mashuri & Nurjannah, 2020). Careful strategic planning can improve quality effectiveness and ensure the achievement of the goals that have been set (Livianti et al., 2024). This aligns with the definition of strategy, which is the motive behind allocating organizational resources to maintain performance. Risyah (2023) stated that strategic policies are very influential in the development process of FST laboratories.

Table 3. SWOT Matrix of FST Laboratory UIN Sulthan Thaha Saifuddin Jambi

Internal	**Strength (S)**	**Weakness (W)**
	1. The building and laboratory area of the Faculty of Science and Technology are spacious and very possible to be divided into laboratory spaces for study programs in the Faculty of Science and Technology (Machine/Material) 2. The leadership in the FST Laboratory and the Dean of FST have a good capacity and are heard by the rectorate's decision-makers (Man) 3. Human resource qualifications are following laboratories at FST, although the quantity is still lacking for some disciplines (Man) 4. The Faculty of Science and Technology within the Ministry of Religion has a special revitalization fund for the construction of the Faculty of Science and Technology (Money)	1. The quantity of human resources for several fields of science is still lacking, and competency development for existing human resources has never been done (Man) 2. The procurement of equipment and materials per year is not following the number of needs for learning and research support activities (Money) 3. There is no K3 system for the Science and Technology Laboratory (Method) 4. There is no standard for laboratory services, either administrative or technical (Method) 5. Learning activities are still concentrated in one room for 10 practicum courses, as well as research activities for final project students 6. There is no laboratory waste treatment system yet
External		

Opportunities (O)	Strategy SO	Strategy WO
1. The research needs of students and lecturers for a lot of laboratory instrument equipment, if it can be done in their laboratory, will save research costs and increase the value and quality of research outputs. 2. Study programs in the faculty of science and technology will hold accreditation with superior targets. 3. Certain laboratory equipment can be used to increase the cost of BLU input (making acquires, renting computers for CBT) 4. Certain laboratory equipment that can increase the cost of BLU input will potentially divert funds for science and technology laboratories to help with operational costs (urgent consumables, e.g., tissues, masks, gloves, etc.) as well as technical damage (e.g., broken pipes, broken water pumps, etc.) 5. Laboratory users need services that have a clear and effective flow 6. Cooperation with third parties will add value to the laboratory and increase the value of accreditation	1. Procurement of laboratory instruments that can help increase research value 2. Convincing and persuading decision-makers to approve procurement 3. Providing equipment that can help BLU input and conducting training for specific tools needed 4. Create effective service flows and ensure flows and documents run 5. Conducting third-party cooperation that can increase laboratory values and accreditation values	1. Hold formations related to the required human resource qualifications and conduct training/certification of existing human resources. 2. Ensuring procurement per year following the needs of laboratory activities 3. Building a laboratory K3 system and ensuring that the system runs 4. Developing laboratories according to the number of needs and types of fields of science needed for each study program 1. Building a waste management system

Threat (T)	Strategy ST	Strategy WT
1. The request to form laboratory human resource needs at the center is impossible. 2. Lack of awareness of Laboratory K3 for laboratory users 3. Laboratory users often do not report breakdowns of glassware, which reduces the use of good, effective tools 4. The university's focus is on building new faculties that require large funds 5. Faculty revitalization does not every year decrease 6. Regulations in Indonesia are changing rapidly	1. Hold formations for BLU contract employees for special laboratory assignments in the laboratory following the qualifications of the required field of science. 2. Ensuring that the K3 system runs, installing K3 signs, and socializing with laboratory users 3. Maximizing the tool handover checklist with the help of practicum assistants 4. Limiting the borrowing of glassware for research students during the practicum	1. Ensuring the procurement of contract formations according to laboratory needs 2. Imposing sanctions for violations by laboratory users 3. Saving the use of consumables for practicum, management of the use of tools for practicum

Table 3 provides an overview of strategies for laboratories that are suitable in each aspect of their management. Laboratories that comply with the quality standard (ISO/IEC) 17025:2017 in laboratory management will be able to limit existing obstacles or challenges. This standard includes 6 clauses in the form of general requirements, structural requirements, resource requirements, process requirements, and management system requirements. This clause can be used as a reference in the laboratory development process. Research conducted by Krismastuti (2022) reported that the laboratory of the Department of Environmental Engineering, Andalas University, Indonesia, has experienced its transition progress by implementing laboratory quality based on ISO/IEC 17025:2017. In addition, a SWOT analysis is necessary to understand better the factors and strategies that affect the laboratory's development. This aligns with research by Anggreani (2021) that strategic decision-making is always closely related to developing the company or agency's vision, mission, and policies. SWOT analyzes an organization based on strengths, opportunities, weaknesses, and threats (Pagot & Andrighetto, 2024).

DISCUSSION

In Table 1. It can be seen that the results of the evaluation of IFE internal factors obtained a score of 4.13. Lestariningsih (2024) said a rating score above 2.5 indicates a strong internal position, while a score below 2.5 indicates a weak internal position. This suggests that the internal position of the science and

technology laboratory is quite strong. The strength of the Science and Technology Laboratory, namely the large building and laboratory area, which can be divided into laboratory space for study programs in the Faculty of Science and Technology, is the main strength, with a score of 0.65. In the second place, the leadership in the FST Laboratory and the Dean of FST have a good capacity and are heard by the rectorate decision-makers with a score of 0.6. Third, there is the existing human resource qualification following the laboratory in FST, although the quantity is still lacking for some disciplines, with a score of 0.55. The last is that the Faculty of Science and Technology within the Ministry of Religion has a special revitalization fund for developing the faculty of science and technology with a score of 0.32.

As for the weakness, in the first position, the quantity of human resources for several fields of science is still lacking, with a score of 0.55. The second position of procurement of equipment and materials per year does not follow the number of learning and research support activities needed, with a score of 0.44. The third position is that there is no K3 system for the Science and Technology Laboratory, which has a score of 0.3. After that, the fourth position has two factors: the lack of good laboratory service standards and learning activities, which are still concentrated in one room with the same score of 0.27. The last order is that no laboratory waste treatment system scores 0.18.

Based on Table 2. The evaluation of external factors showed that the science and technology laboratory was quite good, with a total score of 3.06. The main opportunity that the first Science and Technology Laboratory can take advantage of is that the study programs at the Faculty of Science and Technology will hold accreditation with a superior target score of 0.55. Second, the research needs of students and lecturers for a lot of laboratory equipment with a score of 0.45. Third, cooperation with third parties will add value to the laboratory and increase the accreditation value with a score of 0.4.

Furthermore, the four positions of certain laboratory equipment can increase the BLU input cost with a score of 0.36. Fifth, certain laboratory equipment that can increase BLU input costs will have the potential to circulate funds for FST laboratories to help with operational costs and technical damage with a score of 0.27. Sixth, laboratory users need services with a clear and effective flow, with a score of 0.2.

Then there are two threats to the first laboratory: the demand for the formation of laboratory human resource needs to the center is impossible, and the university's focus is fixated on constructing a new faculty that requires large funds with a score of 0.5. Second, faculty revitalization does not fall annually, with a score of 0.32. Third, there are also two factors, namely the lack of awareness of Laboratory K3 for laboratory users and the fact that the regulations in Indonesia are changing quickly, with a score of 0.28. Finally, laboratory users often do not report damage to glassware, reducing good and effective tools being used with a score of 0.15.

SWOT Matrix Analysis for SO Strategy

The matrix for this strategy can take advantage of opportunities as an alternative by using the strengths or advantages possessed by an agency (Kamaluddin, 2020). Opportunity refers to conditions that can benefit an organization/agency for the present or future (Hartinah et al., 2024). In laboratory development, strengths and opportunities can be optimized by procuring instruments to help increase research value, providing equipment that can help BLU input, and collaborating with third parties to increase the value of laboratory accreditation (Idedhyana et al., 2022). The SO strategy can be applied to the results of the SWOT analysis in quadrant I. Research conducted by Sitompul (2021) also uses this strategy in the marketing development process.

SWOT Matrix Analysis for WO Strategy

FST laboratories can design strategies to minimize weaknesses by examining the existing opportunities through various efforts (Astuti & Ratnawati, 2020). Efforts that can be made include building a laboratory K3 system, developing laboratories following the fields of science needed for each study program, building a waste management system, and establishing the required human resource qualifications and certifications. Research conducted by Risyah (2023) explained that human resources are a crucial factor that must be overcome immediately to improve the quality of laboratories.

SWOT Matrix Analysis for ST Strategy

If not addressed, a threat can have long-term effects and create obstacles to achieving a goal. Threats can be assessed based on their level of impact (*severity*) and probability of occurrence (*probability*) (Hartinah et al., 2024). Judging from the strengths and threats, the FST laboratory uses its strength to overcome unexpected threats by holding formations for BLU contract employees, assigning laboratory workers in the laboratory following the qualifications of the required fields of science, ensuring that the K3 system runs, installing K3 signs, socializing to laboratory users, maximizing the checklist of equipment handover lists, and limiting the borrowing of glass tools for research students during the practicum.

SWOT Matrix Analysis for WT Strategy

The WT strategy implements the strategy by minimizing internal weaknesses to avoid threats from the outside (Sari et al., 2021). This can be done by ensuring the procurement of contract formations according to laboratory needs, imposing sanctions for violations by laboratory users, managing equipment use, and saving consumables.

CONCLUSION

Based on the results of the calculation using the SWOT method, it can be concluded that the position of the FST laboratory of UIN Sulthan Thaha Saifuddin Jambi is in quadrant I, so it shows a very favorable situation for the laboratory and faculty to carry out aggressive / growth strategies. Then, the results of the internal factors of IFE and external factors of EFE obtained *a strength* and *opportunities* (SO) value of 3.75, *strength* and *threats* (ST) of 3.55, *weakness* and *opportunities* (WO) of 3.64 and *weakness* and *threats* (WT) of 3.44. The results of this analysis can be used as a reference when designing the formulation of FST laboratory development strategies. The information from the SWOT analysis is useful as feedback in sharpening the rational formulation of goals and missions and as a reference in strategizing the activity plan. Four strategies that can be implemented include building a laboratory K3 system, collaborating with third parties, establishing the necessary human resource qualifications and certifications, and imposing sanctions for violations by laboratory users.

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