Framework for Formulating Internal Environment Strengthening Strategy for Developing Testing Laboratories (Case Study: Universitas Sebelas Maret)

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Abstract. Universitas Sebelas Maret (UNS) is one of the universities that aimed to become Legal State University (PTN BH). In order to accelerate towards PTN BH status, UNS needs to improve the quality of the service business which has been operated, namely testing laboratory service business so that UNS can do better in revenue generating. In other words, the quality of laboratories needs to be improved by fulfilling standard requirements which has been stated in Indonesian National Standard (SNI) for testing laboratories, namely SNI ISO/IEC 17025. Thus, laboratories in UNS can achieve accreditation to comply with the PTN BH status. The selection of the right strategy needs to be considered in implementing SNI ISO/IEC 17025 in order to obtain accreditation for the laboratory. In this paper, a framework for formulating strategy to strengthen laboratory’s internal environment are designed. This paper results a questionnaire to assess laboratory’s strength and weakness.

Keywords: accreditation, strategy, testing laboratory

1. Introduction
Rapid progress in the field of research and technology is encouraging the government to improve the quality of education in Indonesia, especially higher education. To produce quality higher education, the government provides autonomy in revenue generating for State Universities (PTN) to manage their own institutions by implementing financial management pattern of the Badan Layanan Umum (Public Service Agency) or by establishing a Legal State University/PTN BH) [1]. Based on [2], PTN BH is a university established by the government that is an autonomous public legal entity. One form of autonomy that can be done by PTN BH is the management of funds from sources other than the state budget and expenditure. The source of funds referred to one of them comes from PTN BH’s business, which is all forms of services based on the vision of college in Indonesia.

Universitas Sebelas Maret (UNS) is one of the universities that aimed to become PTN-BH. One form of service business offered by UNS is laboratory testing services. There are 18 laboratories that can offers testing services. One of them is the UPT Laboratorium Terpadu, the only laboratory in UNS that has been accredited based on the general requirements of competence in conducting testing, as stated in SNI ISO/IEC 17025. Meanwhile, other 17 laboratories spread over four faculties namely the...
Faculty of Medicine, Engineering, Mathematics and Science (MIPA) and Agriculture have not been accredited. These laboratories are shown in Table 1.

**Table 1. Non accredited Laboratories**

| No. | Laboratory Name                                           | Location                  |
|-----|-----------------------------------------------------------|---------------------------|
| 1.  | Anatomy Laboratory                                        | Faculty of Medicine       |
| 2.  | Laboratory of Histology, Pathology and Biology            |                           |
| 3.  | Pharmacology Laboratory                                   |                           |
| 4.  | Work System Design and Ergonomics Laboratory              | Faculty of Engineering    |
| 5.  | Laboratory of Thermodynamics & Fluid Mechanics            |                           |
| 6.  | Material Laboratory                                       |                           |
| 7.  | Nano Bioenergy Laboratory                                 | Faculty of Engineering    |
| 8.  | Soil Mechanics Laboratory                                 |                           |
| 9.  | Structural Laboratory                                     |                           |
| 10. | Basic Laboratory                                          |                           |
| 11. | Laboratory of Food Chemistry & Biochemistry               |                           |
| 12. | Physics & Soil Conservation Laboratory                    |                           |
| 13. | Laboratory of Chemistry & Soil Fertility                 |                           |
| 14. | Biology & Biotechnology Laboratory                        | Faculty of Agriculture    |
| 15. | Plant Breeding Laboratory                                 |                           |
| 16. | Plant Physiology Laboratory                               |                           |
| 17. | Integrated MIPA Laboratory                                | Faculty of Mathematics and Science |

In order to accelerate towards PTN BH status, UNS needs to improve the quality of the testing service business. It means that the quality of laboratories needs to be improved by obtaining accreditation. The accreditation for testing laboratories is governed in SNI ISO/IEC 17025. This is because laboratory accreditation can help the laboratory to produce results that are consistent with how to implement a documented quality system framework [3]. In addition, implementing ISO/IEC 17025 requirements makes laboratory can be more effective with the ability to adapt its resources to the kind and volume of work to be done. Moreover, the establishment of ISO 17025 requirements makes work easier, prevents personnel from carrying out improvised actions, and facilitates the entrance of new workers into the laboratory [4].

SNI ISO/IEC 17025 is a standard that contains provisions for general requirements of laboratory competence in conducting testing and/or calibration [5]. Implementation of this standard for laboratories can provide a system for continuous improvement in laboratory practices. The benefits of implementing this standard include faster identification and problem solving, increased customer satisfaction, fulfillment of quality demands from certain customers, and overall improvement in the laboratory business [6]. In addition, by implementing an ISO 17025 quality assurance system, the laboratory can prove the reliability of test results and technical competence to customers [7]. Furthermore, quality, reliability, accuracy and consistency of products, services and processes, and customer satisfaction can also be improved if the laboratory has been accredited based on ISO 17025 so that customer loyalty and competitiveness in the market can increase [8].

The selection of the right strategy needs to be considered in the application of SNI ISO/IEC 17025 in order to obtain accreditation for the laboratory. In this case, laboratories that have not been accredited need to improve internal performance, including the quality, administrative and technical management systems required in SNI ISO/IEC 17025 to fulfill the accreditation. In this case, it is necessary to first strengthen the internal environment for the laboratory to be able to meet the standardized requirements.
In the process of formulating strategies, it is important for an organization to identify and evaluate the strengths and weaknesses of its internal environment [9]. By choosing the right strategy, the weaknesses of an organization can be improved and converted into strength so that it can improve the competence of the organization.

Formulating strategy can be organized by using Strength, Weakness, Opportunity, Threat (SWOT) framework. It means that assessing the internal strength and weakness is a critical step to formulate strategy [10]. There has been many research conducted to assess a firm’s or system’s strength and weakness, i.e. [11,12,13,14,15]. Meanwhile, some researchers have also conducted research in strategy development, i.e. [16,17,18,19]. Moreover, some researchers have also used the SWOT framework to generate strategy, i.e. [20,21,22,23].

David [9] has developed an internal audit model to determine factors that influence organizational strengths and weaknesses. Meanwhile, Grochau & Caten [24] has identified 16 processes involved in conducting tests in the laboratory. These two model will be used to develop a framework to formulate internal strengthening strategy in for testing laboratories in UNS.

2. Research Methodology
This research was conducted through four stages. Early stage began with two steps at once: (1) identifying criteria and sub-criteria for internal assessment based on David’s model [9] and (2) identifying processes involved in conducting tests in the laboratory based on Grochau and Caten’s model [24]. There are 6 criteria used in assessing internal strengths and weakness, i.e. firm’s management, marketing, operation, finance, research and development (RnD) and management information system. Meanwhile, Grochau and Caten grouped those 16 processes in conducting tests in laboratory into 5 macro processes, i.e. product realization, system management, resource management, effectiveness of quality management system and its improvement, and quality assurance. Furthermore, Grochau and Caten listed the activities in each process along with the corresponding standard items in ISO/IEC 17025.

The second stage was generating sets of testing process and activity which match to criteria and sub-criteria that had been identified. In this stage, we compared the criteria and sub-criteria of internal audit factors with the process and activity elements in conducting testing services in laboratory. This step aimed to distribute activities in the provision of laboratory testing services to matching sub criteria.

The third stage was generating set of indicators for questionnaire compiling. We highlighted criteria, sub-criteria, process elements and standard items on the previous stage to be employed in this stage. Furthermore, we referred the explanations of each standard item in ISO/IEC 17025. The explanation of each standard item in each process elements then summarized into set of indicators of the questionnaire.

The final stage was designing the questionnaire. Based on the indicators generated from 3rd stage, the question for each indicator was made. The questionnaire consists of 9 parts, i.e. planning, organizing, staffing, controlling, service selling, service planning, resources, quality and information system management section. The research methodology is presented in Figure 1.
3. Result and Discussion
A framework for formulating internal strengthening strategy in developing testing laboratories was generated. This framework uses 4 criteria to assess internal strengths and weaknesses, i.e. laboratory’s management, marketing, operation and management information system. The sub-criteria used in assessing laboratory’s management performance are planning, organizing, staffing and controlling. Besides, two sub-criteria are used to assess laboratory’s marketing performance, i.e. selling services and service planning. Moreover, two sub-criteria were used in assessing laboratory’s operation performance, i.e. resource and quality. Furthermore, the corresponding processes for each sub-criteria are shown in the framework in Figure 2. The framework considers organizational audit factors, the process elements in conducting test in laboratory and testing laboratory standard requirements.
Afterwards, the questionnaires were made to implement the framework. The processes stated in the framework will become the variable for the indicators. Then, those indicators will be modified into the question items for the questionnaire. The questionnaire generated from this research can be used as a tool to measure laboratories readiness in complying with the standard requirements in order to develop the university laboratories into accredited laboratories.

The questionnaires will be tested in the future research in order to collect data by conducting a survey to the potential laboratories mentioned in section 1. Then the data will be processed using descriptive analysis to map the laboratories’ strengths and weaknesses. Based on the weaknesses found from the survey, strategies to strengthen those weaknesses will be formulated by adapting the corresponding standard requirements. The questionnaire design is shown in Table 2.

**Table 2. Questionnaire Design**

| Variable            | Indicator                                                                 |
|---------------------|---------------------------------------------------------------------------|
| Policy and objectives | Establishment, application and maintenance of management systems         |
|                     | Documentation of policies, systems, programs, procedures and instructions |
|                     | Communication of documentation to all personnel                          |
|                     | Understanding of documentation by all personnel                           |

**Figure 2.** Framework for formulating internal strengthening strategy in developing testing laboratories


| Variable                                      | Indicator                                                                 |
|-----------------------------------------------|---------------------------------------------------------------------------|
| **Policy and objectives**                     | Availability of documentation for all personnel                           |
|                                               | Application of documentation by all personnel                              |
|                                               | Laboratory management system policy statement in the quality guidelines    |
|                                               | Determination of quality objectives                                       |
|                                               | Issuance of a quality policy statement under the authority of top management |
|                                               | Matters that have been included in the quality policy                     |
| **Management responsibility**                 | Determination of organizational structure and laboratory management       |
|                                               | Determination of management positions within the parent organization       |
|                                               | Determination of the relationship between quality management, technical activities and supporting services |
|                                               | Determination of responsibility, authority and relations between all personnel |
| **Personnel**                                 | Managerial and technical personnel                                       |
|                                               | Tasks assigned to managerial and technical personnel                      |
|                                               | Adequate supervision of testing and calibration staff                     |
|                                               | The technical management.                                                 |
|                                               | The provision of quality manager                                          |
|                                               | Direct access from the quality manager to the highest leader              |
|                                               | Appointment of deputies for core management personnel                     |
|                                               | Ensuring the competence of all personnel who operate the equipment        |
|                                               | Qualification of the competence of all personnel                          |
|                                               | Appropriate supervision of staff undergoing training                      |
|                                               | Formulation of personnel qualifications:                                 |
| **Personnel**                                 | Policies and procedures for identifying the training required by personnel. |
|                                               | Policies and procedures for organize personnel training                   |
|                                               | Evaluation of the effectiveness of training activities                   |
|                                               | Contract personnel                                                       |
|                                               | Contract personnel are supervised according to the management system      |
|                                               | Contract personnel competency is in accordance with the management system |
|                                               | Maintenance of job descriptions that apply to personnel involved in testing|
|                                               | Authority given to personnel:                                            |
|                                               | Maintenance of records / relevant documents related to authority, competence, professional education and qualifications, training, skills and experience all technical personnel |
|                                               | Availability of information regarding authority, competence, professional education and qualifications, training, skills and experience all technical personnel |
| **Complaint**                                 | Determination of policies and procedures for resolving complaints received from customers or other parties . |
|                                               | Maintenance of records of complaints and investigations as well as corrective actions taken by the laboratory |
| **Nonconformities, corrective and preventive actions** | Determination of inappropriate policies and procedures for controlling testing |
|                                               | Matters that have been determined in policies and procedures              |
|                                               | Increasing the effectiveness of management systems in a sustainable manner |
|                                               | Determination of policies and procedures to take corrective action if there are jobs that are not appropriate or there are irregularities in policies and procedures in the management system |
|                                               | Determination of procedures for preventive action against job mismatches and policy irregularities |
Table 2. Questionnaire Design (Cont.)

| Variable                                      | Indicator                                                                 |
|-----------------------------------------------|---------------------------------------------------------------------------|
| Nonconformities, corrective and preventive actions | Procedures for preventive action to cover the early stages of action and application of controls to ensure effectiveness. |
| Audits                                        | Determination of schedules and procedures for internal audit              |
|                                               | Periodic internal audit                                                   |
|                                               | The purpose of testing and / or calibration is included in the elements that must be audited |
|                                               | Planning and organizing audits done by the quality manager                |
|                                               | The audit is carried out by trained personnel and is independent of the activities being audited |
| Management review                             | Determination of schedule and laboratory management review procedures     |
|                                               | Implementation of review on laboratory management system and periodic testing and / or calibration activities |
|                                               | The coverage of the management review                                      |
| Review of requests, tenders and contracts     | Determination and maintenance of customer request review procedures       |
|                                               | Determination and maintenance of tender review procedures                 |
|                                               | The establishment and maintenance of the contract review procedure        |
|                                               | Determination of requirements and testing methods to be used in the testing contract procedure |
|                                               | Documentation of testing contract procedures                              |
|                                               | The laboratory has the ability and resources to meet the requirements     |
|                                               | Selection of appropriate testing methods to meet customer requirements    |
|                                               | Contract approval by the laboratory and customers                          |
| Customer service                              | Determination of test sampling procedures                                 |
|                                               | Determination of test sampling plan                                       |
|                                               | Preparation of test sampling plans based on appropriate statistical methods |
|                                               | Determination of the procedure for recording the sample sampling data     |
|                                               | Search feedback from customers through customer surveys                   |
|                                               | Determination of customer survey procedures                               |
|                                               | Use feedback for evaluating management systems, testing activities and service to customers |
| Testing                                       | Does the laboratory subcontract testing work?                             |
|                                               | Determination of testing subcontracting procedures                       |
|                                               | Determination of procedures for transporting goods tested                 |
|                                               | Determination of procedures for receiving goods tested                    |
|                                               | Determination of procedures for handling the items being tested deterioration, loss or damage |
|                                               | Determination of procedures for the protection of goods tested            |
|                                               | Determination of the procedure for storing the items tested               |
|                                               | Determination of the procedure for identifying the items tested           |
|                                               | The goods identification procedure facilitates the distribution of goods and the transfer of goods within and from the laboratory |
|                                               | Recording the condition of goods tested when received by laboratory staff |
|                                               | Consultation with customers if the items to be tested are received in conditions not in accordance with the specifications |
|                                               | Recording discussions between customers and laboratories                  |
### Table 2. Questionnaire Design (Cont.)

| Variable          | Indicator                                                                 |
|-------------------|---------------------------------------------------------------------------|
| **Purchase**      | Determination of policies and procedures for selecting and buying services and per preparation |
|                   | Determination of procedures for purchasing, receiving and storing reagents and laboratory consumables |
|                   | Evaluation of suppliers of consumables, supplies and services             |
|                   | Maintenance of supplier evaluation records                               |
| **Infrastructure**| Laboratory conditions such as energy sources, lighting conditions and the environment are able to facilitate testing activities well |
|                   | Determination of procedures for guaranteeing accommodation conditions and laboratory environment |
|                   | Documenting technical requirements for accommodation and environmental conditions that can affect test results |
|                   | Determination of procedures for access to and use of the room            |
| **Methods**       | Use of appropriate methods and procedures for all tests performed         |
|                   | Determination of instructions for using and operating all equipment       |
|                   | Determination of instructions for handling and preparing goods tested     |
|                   | Documentation of instructions, standards, guidelines and reference data relevant to laboratory work |
|                   | Determination of procedures for estimating measurement uncertainty        |
| **Equipment**     | Determination of procedures for handling, transferring, storing, using and maintaining measuring equipment |
| **External Quality Control** | All equipment used for testing has been calibrated before being used |
|                   | Determination of programs and procedures for equipment calibration       |
| **Internal Quality Control** | Implementation of the intermediate checks to maintain confidence in the calibration status of equipment |
|                   | Determination of the checking procedure between equipment calibration status |
|                   | Determination of procedures for handling, transporting, storing and using reference standards and reference materials |
|                   | Determination of quality control procedures to monitor the validity of test result |
|                   | Quality control data recording                                           |
|                   | Coverage of quality control monitoring                                    |
|                   | Implementation of quality control data analysis                          |
|                   | Determination of quality control data analysis procedures                |
|                   | Implementation of actions to correct problems and prevent reporting of wrong results |
| **Information management** | Determination and maintenance of document control procedures |
|                   | Determination and maintenance of quality and technical control procedures |
|                   | Coverage of recording quality                                             |
|                   | Determination of procedures for recording and protecting backups         |
|                   | Reporting the results of the test accurately, clearly, not confusing and objectively, and in accordance with each specific instruction in the test method |
4. Conclusion
This research has developed framework for formulating strategy to strengthen the internal environment of testing laboratories by assessing their strengths and weaknesses using the developed model. This research generated a questionnaire to measure the laboratory strength and weakness, by evaluating the indicators fulfillment. Further research can be done by implementing the model in a survey to non-accredited laboratories mentioned above.

5. References
[1] Republic of Indonesia Government 2012 Undang-Undang No. 12 Tahun 2012 Tentang Pendidikan Tinggi (Trans: Law No. 12 of 2012 about College) [online], Available: http://diktis.kemenag.go.id/prodi/dokumen/PP-Nomor-12-Tahun-2012-ttg-Pendidikan-Tinggi.pdf
[2] Republic of Indonesia Government 2015 Peraturan Pemerintah Nomor 26 Tahun 2015 tentang Bentuk dan Mekanisme Pola Pendanaan Perguruan Tinggi Negeri Badan Hukum (PTN BH) (Trans: Government Regulation Number 26 of 2015 concerning the Form and Mechanism of Legal State University Funding Funds) [online], Available: http://kelembagaan.ristekdikti.go.id/wp-content/uploads/2016/08/PP-26-Tahun-2015.pdf
[3] Beckett J and Slay J 2011 Scientific underpinnings and background to standards and accreditation in digital forensics Digital Investigation 8 114 – 121
[4] Zapata-Garcia D, Llaurado M, Rauret G 2007 Experience of implementing ISO 17025 for the accreditation of a university testing laboratory Accreditation and Quality Assurance 12 317–322
[5] SNI ISO/IEC 17025:2008 Persyaratan umum kompetensi laboratorium pengujian dan laboratorium kalibrasi (Trans: General requirements for the competence of testing and laboratory laboratories)
[6] Honsa J D and McIntyre D A 2003 ISO 17025: Practical Benefits of Implementing a Quality System Journal of AOAC International 86 1038-1044
[7] Vlachos N A, Michail C and Sotiropoulou D 2002 Is ISO/IEC 17025 Accreditation a Benefit or Hindrance to Testing Laboratories? The Greek Experience Journal of Food Composition and Analysis 15 749-757
[8] Sadikoglu E and Temur T 2012 The Relationship Between ISO 17025 Quality Management System Accreditation and Laboratory Performance Quality Management and Practices 221-230
[9] David F R 2011 Strategic Management: Concepts and Cases 13th ed (New Jersey: Pearson Education)
[10] Pratiwi A, Sutopo W, Zakaria R, Rasli A 2016 Formulating Strategy Through QSPM Based on SWOT Framework: A Case Study: Spin-Off Company in Malaysia Abasyn Journal of Social Sciences – Special Issue: AIC 2016
[11] Fertel C, Bahn O, Vaillancourt K, Waaub J 2013 Canadian energy and climate policies: A SWOT analysis in search of federal/provincial coherence Energy Policy 63 1139-1150
[12] Ghazinoory S, Abdi M and Azadegan-Mehr M 2011 Swot Methodology: A State-of-the-Art Review for the Past, A Framework for the Future Journal of Business Economics and Management 12 24-48
[13] Martín-Collado D, Díaz J C, Mañé-Tanila A, Colinet F, Duclos D, Hiemstra S J, EURECA Consortium and Gandini G 2013 The use of SWOT analysis to explore and prioritize conservation and development strategies for local cattle breeds Animal 7 885-894
[14] Wetherington J D, Pfister M, Banfield C, Stone J A 2010 Model-Based Drug Development: Strengths, Weaknesses, Opportunities, and Threats for Broad Application of Pharmacometrics in Drug Development,” J Clin. Pharmacol. 50 31S-46S
[15] Ommani A R 2011 Strengths, weaknesses, opportunities and threats (SWOT) analysis for farming system businesses management: Case of wheat farmers of Shadervan District, Shoushtar Township, Iran African Journal of Business Management 5 9448-9454
[16] Caruana C D, Wasilewska-Radwanska M, Aurengo A, Dendy P P, Karenauskaite V, Malisan M R, Mattson S, Meijer J H, Mihov D, Mornstein V, Rokita E, Vano E, Weckstrom M, Wucherer
A strategic development model for the role of the biomedical physicist in the education of healthcare professionals in Europe. *Physica Medica* 28 307-318

Kash B A and Deshmukh A A 2013 Developing a Strategic Marketing Plan for Physical and Occupational Therapy Services: A Collaborative Project Between a Critical Access Hospital and a Graduate Program in Health Care Management. *Health Marketing Quarterly* 30 263-280

Gill A 2016 Floundering in a deregulated market: an energy company seeks new strategies,” *Journal of Business Strategy* 37 27-35

Lu S, Huang M, Su P, Tseng K, Chen F 2013 Development strategy of green energy industry for Taipei-A modern medium-sized city. *Energy Policy*

Aslan I, Çınar O and Kumpikaitė V 2012 Creating strategies from TOWS matrix for strategic sustainable development of Kipaş Group. *Journal of Business Economics and Management* 13 95-110

Koo H, Chau K, Koo L, Liu D, Tsui S 2011 A structured SWOT approach to develop strategies for the government of Macau, SAR. *Journal of Strategy and Management* 4 62-81

Weng W and Lin W 2014 Development Assessment and Strategy Planning in Mobile Computing Industry. *Proceedings of the 2014 IEEE ICMIT*

Marino E, Hernandez C, Planelles R, Madrigal J, Guijarro M and Sebastian A 2014 Forest fuel management for wildfire prevention in Spain: a quantitative SWOT analysis. *International Journal of Wildland Fire* 23 373–384

Grochau H and Caten C S 2012 A process approach to ISO/IEC 17025 in the implementation of a quality management system in testing laboratories. *Accreditation and Quality Assurance* 17 519–527