



A review: The Role of Warehouse Laboratory for Higher Education

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ABSTRACTS

An unwell-prepared graduate from logistic education is being a key issue which has been being discussed by government, practitioners, educational institution and economic sector and the stakeholder such as the recruiter in the logistic field that seeking a competent graduate. Warehouse laboratory is the solution for fulfilling the gap where competencies could be developed which is required by industry. This paper aims to explain the process of implementation and utilization of warehouse laboratory at the higher education Introduction. Hence, warehouse laboratory has a pivotal role in the development logistics education that is not only for education and research but also for preparing graduate students to be a competent workforce which is required by industry.

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1. INTRODUCTION

Logistics Industry has experienced a rapid growth in recent years due to era of globalization. Based on research found by Lutz and Birou (2013), logistics experts will experience a job growth of 25 percent from 2020-2025. As these field have a growth rate compared to others, there is a potential for shortages of skilled employees in the future. Therefore, there are opportunities to strengthen the course offerings in higher education to better prepare graduates with practical and professional skills (Hoek, 2001; Myers et al., 2004).

Higher education in logistics has been criticized in terms of gaps between academia and market relevance (Niine & Koppel, 2015; Birou et al., 2022). It is debatable that in logistics education exist a balance between theory and practice, vocational and academic training. It should be noted that there are complexities in the modern logistical environment, where pure vocational education fails without understanding conceptual and developmental issues, whereas the degree education has to be much aware of the changing vocational perspective.

Based on the European Qualification Standards for Logistics Professionals (The ELAQF Qualification Standards) Senior Level and the Indonesian Supply Chain and Logistics Institute (ISLI) require Logistics Engineering to have facilities and infrastructure to support effective and efficient learning and teaching processes (Source: http://www.elalog.eu/sites/default/files/ELAQF_Qualification_Standards_2014.pdf). One of them is adequate, modern and efficient laboratory facilities (Jedliński et al., 2017).

To minimize the lack of human resource competencies in logistic sector, university provide laboratory to fulfil the needs in which the laboratory is a place to carry out various activities such as practicum, experiment, or research, where the aim of the activities is to produce skilled workers for industry and highly competent workers for research laboratories (Reid & Shah, 2007).

This article aims to provide an overview of the current situation in higher education, and explores what might be the purpose for today. It also argues that laboratory work in higher education cannot be seen in isolation. For most students it follows school laboratory experiences which are rapidly changing, and has to relate to the theory taught in lectures and tutorials. However, of greater importance is the need to see the 'hands-on' laboratory time as part of a wider process of learning (Reid & Shah, 2007). The aim of the article is to analyze the process of implementation and utilization of warehouse laboratory in the higher education.

2. METHODS

This paper reviews literature on the role of warehouse laboratory for the higher education. This research method is divided into two main parts, namely the search and sorting phase and the data analysis stage. The first step is to search and sort electronic databases using key words industrial education and social skills. The next stage is the data analysis stage. Where the database has been collected and sorted and then analyzed according to the purpose of writing this literature review.

3. RESULTS AND DISCUSSION

Warehouse laboratory is used to support academic activities which include education, research and community service. Laboratory functions as a cross-disciplinary development and application center in charge of carrying out development, research, study, cooperation, consultation and community service activities for the academic community.

The laboratory as a place for research, experimentation, observation and scientific testing has many functions, namely (Reid & Shah, 2007):

1. Balancing the theory and practice of science and unifying theory and practice.
2. Providing scientific work skills for researchers, whether from among students, lecturers, or other researchers. This is because the laboratory not only demands an understanding of the object under study, but also requires someone to carry out experimentation.
3. Providing and cultivating the courage of researchers (consisting of students, lecturers and all other scientific practitioners) to seek the nature of scientific truth from a scientific object.

Increasing the skills and expertise of researchers in using media tools available in the laboratory to find and determine scientific truth in accordance with various kinds of research or experimentation that will be carried out.

Infrastructure and Facilities

Before building a new facility, planning and design of the facility is needed so that the goals set by the organization can be achieved. This needs to be done considering the importance of the function of the facilities as supporting facilities and infrastructure (Kurtaslan, 2020). Facility design needs to pay attention to several important aspects, one of which is planning for area requirements and facility layout. According to Fan, Li, Xie, Xu, and Liu (2017), layout planning is to minimize the cost of material handling equipment, increase the efficiency of space and labor use, reduce constraints during activities, and facilitate communication within the facility. Other aspects that could be abandoned are the planning for material handling tools, determining the size of the lot for material requirements, planning for the needs of workers, and calculating the organization's operational costs.

The Warehouse Laboratory serves as a place to introduce business processes, tools (material handling) and stored products / goods, besides that it is also a place to support the Expertise Group, curriculum, lecture materials and practicum, as well as the fields of expertise of lecturers used for research. and the development of warehousing science.

This laboratory facilitates practicum courses that are relevant to the scope of the laboratory including being a center for physical practicum activities for all integrated laboratories in the Logistics Engineering Study Program. Apart from being a practicum and research place, the Warehouse Laboratory is also a place to carry out competency certification scheme activities and a Competency Test Place that is according to standards. Based on these various considerations, it requires the prerequisites needed as a warehouse:

1. based on the stage in the supply chain, known as a warehouse for storage of raw materials, goods in process, and finished goods;
2. based on geographic area: for example, a regional warehouse to serve the whole world or several countries, a national warehouse to serve areas throughout the territory of one country, or a local warehouse to serve a certain area;
3. by product type: for example, warehouse for spare parts storage, assembly warehouse (for example for car assembly), frozen food, perishable food, and dangerous goods (dangerous good);
4. by function: for example, a warehouse for inventory storage, a warehouse for sorting (for example as a 'hub' of postal processing warehouse);
5. based on ownership: warehouse managed by users (for example producers or retailers) or warehouses managed by a logistics service provider (third-party logistics);

6. based on company usage: for example, a dedicated warehouse for one company (dedicated warehouse), or a warehouse that is shared (share-warehouse);
7. by area: warehouses with an area ranging from 100 square meters or less and warehouses with an area of more than 100,000 square meters;
8. by height: starting from a warehouse of about 3 meters to a warehouse “high-bay” with a height of more than 45 meters;
9. based on the tools used: from a warehouse that operates manually or a warehouse with automatic operations

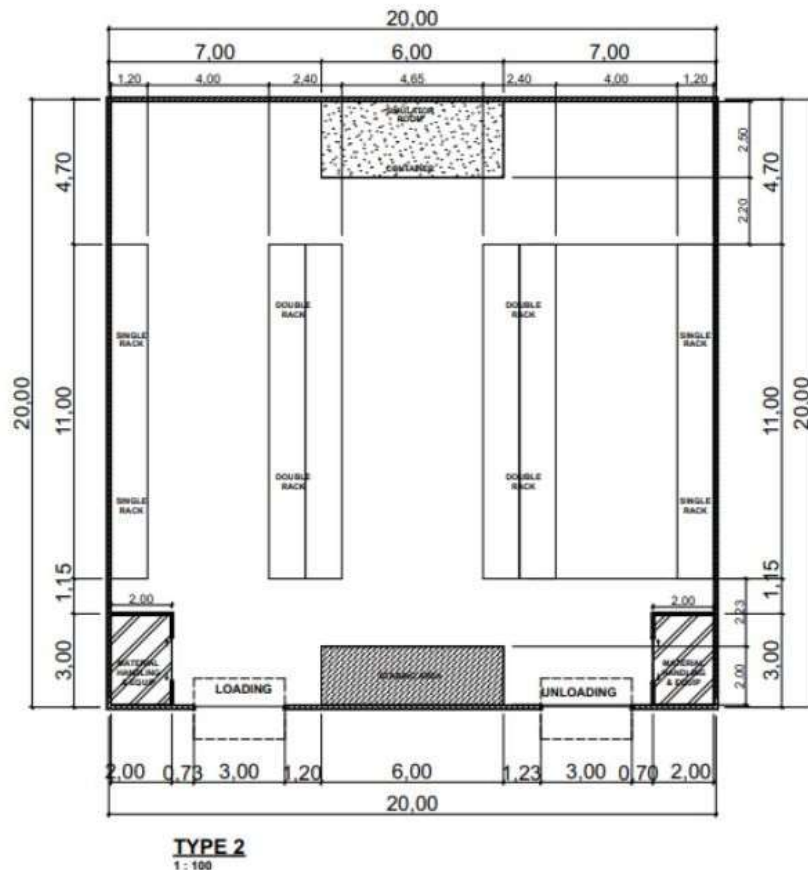


Figure 1. Layout Warehouse Laboratory

According to **Figure 1.** shows that the space layout for laboratory is 200 m² which is to accommodate the racking, space for material handling, gate loading and unloading, staging area and maneuvers for forklift. Based on the types above, it can be said that the warehousing lab that is made needs to consider (Khazode & Shah, 2017):

1. Warehouse layout plan includes storage area plan, aisle plan, shelf types and sizes, dock plan.
2. Warehouse material handling plan includes material handling equipment plan and personnel plan.
3. Warehouse operation plan includes placement / picking polices and assignment polices.
4. Layout and material handling really determine the size to be made for the laboratory level, this is so that the 3 desired functions can be achieved.

On the basis of a prepared plan the main warehouse infrastructure is as following: warehouse shelving, vertical storage carousel, forklift simulator, roller conveyor, lock seals, high-speed door, order picking table, hand pallet trucks, workbench, different types of containers, different types of pallets, products phantoms.



Figure 2. Skill Boss Logistics Supply Chain Automation Training & Assessment

Source: <https://amatrol.com/product/skill-boss-logistics/>

Figure 2. shows that Amatrol's Skill Boss Logistics (95-MSB3) offers material handling organizations performance-based assessment for evaluating the skill levels and competencies of future supply chain automation technicians which could assist student to understand the real situation in warehouse by using this tool. This tool also could simulate the process of goods which are moving starting barcoding to put away to storage. Moreover, it has three courses that could be learnt by student namely, Equipment Maintenance, Equipment repair and Network repair.



Figure 3a. Reach Lift Truck Simulator



Figure 3b. Forklift Simulator

Source: <https://www.simlog.com/>

Figure 3a. and **Figure 3b.** illustrate the function of simulator in warehouse laboratory, scenarios are typical of transportation service centres, factories, warehouses, and distribution centers, with a wide variety of loads and storage arrangements, along with truck bays for loading and unloading and a flatbed truck outside. This simulator is effective and efficient tool in warehouse laboratory because this simulator can help student driving the forklift and reach lift truck without having accident.

The automatization is provided by implementation technologies to support warehouse management. It consists of: barcode technology, RFID, pick-by-light, pick-by-voice. Within the automatization application the appropriate devices and materials are utilized. There are barcode and RFID terminals, pick-by-voice terminals, RFID and barcode printer, different types of labels and transponders operated during the simulation of typical warehouse processes: receiving, storage, order-picking, shipping.

All the processes are managed by using the warehouse management system, allowing user to identify and check the facilities of the software and level of its integration with the equipment. Warehouse management system is one of the software, that fulfil the needs required in the concept of the laboratory. However, there are many other IT solutions, that were obtained for the purpose of management, simulation and modelling, analysis and evaluation of logistics systems and process.

Warehouse Laboratory has big roles in settling graduate student which are elaborated below.

1. Lecture and Research Purpose

Nowadays learning is centered on students (student centered) which is used as an approach in the learning process. Learning is a combination composed of human, material, facilities, equipment and procedures that influence each other in achieving learning objectives. Learning is essentially a process of interaction between students and their environment so that behavior changes towards a better direction. Many factors influence the learning process, both internal and external factors (Hafrizal et al., 2021; Pipitcahyani, 2021)). The main task of educators is to condition the environment to support behavior change for students. Learning activities are directed to empower all the potential that students have. The outcome of this is that students will have competencies through efforts to grow and develop attitudes, knowledge, and skills.

One way to empower the potential of students is to provide a laboratory. The laboratory is needed as a means of increasing the knowledge and skills of students in learning activities by applying scientific theory, theoretical testing, proving trials, research and so on by using tools that are complementary to facilities with adequate quantity and quality. The laboratory is a learning infrastructure that can be used as a place to train participants to understand concepts and improve skills by conducting an experiment or conducting a simulation.

University should ensure that all logistics programs must be able to produce competent graduates in logistics (Dazmin & Ab Talib, 2013). Graduate students are facing a situation called “educational gap” when a logistics graduates fail to apply what they learnt from the university into working environment. Therefore, warehouse laboratory exists to fill the gap which could cope the problem. The warehouse was recommended as a pure logistics environment which allows for implementing various running strategies and automatization.

It is important to note that the outcomes from such work in that the university classes are drawn from those who have experienced laboratories at school before they arrive at university. At the school level, there have been many lists of aims and objectives (Reid & Shah, 2007). All of them tend to refer to scientific experimentation skills and techniques, as well as skills related to conducting experiments in a scientific manner. Some have placed a strong emphasis on affective goals, while others have placed a strong emphasis on other goals, such as how laboratories can demonstrate scientific method, build confidence, and improve understanding.

One of the courses taught in the laboratory is the Warehouse Management system, which is structured and developed so that students are able to understand the concepts and principles of warehouse management systems (WMS) and the main issues of international logistics and global warehousing. The main objective of the warehouse management system is how company management can effectively manage warehouse business processes and activities; such as, receiving, put-away, picking, shipping, and inventory. In addition, WMS aims to ensure and support good communication through a warehouse information system that allows real-time data transfer between the warehouse system and personnel (operators). WMS should support the company's goal of reducing transaction errors, maximizing space utilization and minimizing material handling, transportation and distribution times, by optimizing the warehousing process. Therefore, some of the parts that become the main focus in this course are understanding the role and function of the warehouse, processes in warehouse operations, warehouse layout, warehouse management systems, warehouse costs, warehouse performance measurement standards, outsourcing decisions and understanding the impact of warehouse operations on environment, outcome this course:

1. Students are expected to be able to explain the roles and functions of warehouses and inventory in the supply chain system and be able to understand various important issues related to warehousing and international logistics systems.
2. Students are expected to be able to apply various methods and approaches that are appropriate in managing warehouse personnel, systems and processes within the scope of warehouse management systems and functions.
3. Students are expected to be able to evaluate and select the best warehouse management system in global distribution companies and logistics business operations.

Figure 4. illustrates the main activities in warehouse which has been provided in laboratory.

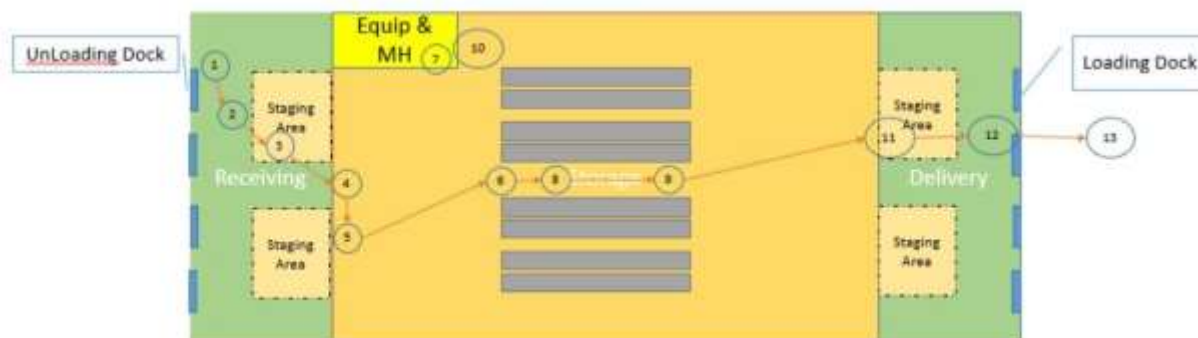


Figure 4. Activities in the Warehouse Laboratory

Source: (Dodi Permadi, 2020)

1. Unloading : preparing cargo list/manifest
2. Preparing material handling
3. Checking material
4. Input material to the system
5. Mapping material to storage
6. Put away
7. Material handling
8. Customer order

9. Picking order
10. Material handling
11. Checking material
12. Loading
13. Consolidate cargo

To further enhance the understanding of theoretical principles given in lectures, a demonstration can be given in Laboratory. Demonstrations should be designed to illustrate the principles behind the theoretical given in lectures, and should be held not too long after the lecture (same semester) so that the relevant principles haven't been forgotten. To be noted, the demonstration shouldn't be conducted before the lectures as the principle behind the theoretical would not be known. After the demonstration, an exercise can be followed, where the students follow precise instructions and acquire observational and manipulative skills. In a limited way, the students can confirm the theory given in lectures and hence impart new scientific information.

Other activities that can be done in Warehouse Laboratory which support the development of skills for the students are how a simulation can be conducted within. The importance of simulation conducted in laboratory is the students can get an experience of how to do things before they enter the 'real world'. It is based on an assumption that learning by doing is best for acquiring technical skills. Take for example, in warehouse laboratory a simulation of driving a forklift can be conducted by using forklift simulator desktop version. By doing this, the student can get an experience beforehand so that when they simulate on driving the real forklift, they already have a basic understanding and experience of how to drive a real forklift. These experiences will also contribute when the students want to get a certified competency.

A simulation conducted in laboratory, not only benefit the students for the learning purpose but also for research purpose. Research is defined as careful consideration of study regarding a particular concern or problem using scientific methods. Research activities that can be done in laboratory can be in form of open-ended enquiries or projects. Open ended enquiries require the researcher to identify a problem, formulate a solution, develop experimental procedures, interpret results and recognize implications. This type of research will give a good practice especially for the students as it tests the ability to solving problems. At this level learning is moving beyond mere understanding and is likely to be at the application level, if not beyond.

The other one form of research is projects. Projects are based on long experiment and usually carried out in the final years of a first degree. A project offers a good learning experience for the students but it can be time consuming. The purpose of projects is to explore a field deeply, develop initiative and resourcefulness, increase intellectual curiosity, and develop innovative skills. An example of research that can be conducted in warehouse laboratory are Development of Visual Guided Picking (order picking with data glasses), Testing of pattern recognition systems, Motion tracking for user guidance, Extensions of RFID applications, Inventory optimization using inventory evaluation software and Reduced path through multi-order picking (Wu et al., 2011).

2. Workplace Assessment

Competence is a person's work ability covering aspects of knowledge, skills, and work attitudes in accordance with certain standards (Škrinjarić, 2022; Khasanov, 2022). On the other hand, profession is a field of work that has certain competencies that are recognized by society (Nubatonis & Permana, 2021; Wangi & Baskara, 2021). Therefore, it can be seen that competence and profession are two different things, but in the process of implementation both require certain knowledge, skills and standardization that bind each actor.

Warehouse laboratory also could be place for student asses their competencies which is arranged in order to meet the needs of competent workforce in the transportation and warehousing sector, the main categories of warehousing and transportation support activities in the logistics sector, which are needed now and in the future (Sulistiono & Ningsih, 2020).

A professional workplace or a place that has facilities and infrastructure with criteria equivalent to a professional workplace verified by a Professional Certification Institute to be a place for competency testing. Its duties are: To provide and maintain the infrastructure needed to carry out the competency test in accordance with the required standards.

The current position of warehouse supervisor is expanding to an authoritative level and is very important for logistics performance and warehouse operations (Erturgut & Soyşekerçi, 2011). As a result, warehouse supervisor competencies should be run in warehouse laboratory due to the lack of a competent workforce.

Table 1. List of Competencies for Warehouse Supervisor

Source: Indonesian national work competency standard (SKKNI) number 094 of 2019

NO	Unit Code	Title Unit	Standard Type
1	H.52LOG00.015.1	Managing Delivery of Goods / Cargo	SKKNI
2	H.52LOG00.016.1	Using the System to Manage Stock	SKKNI
3	H.52LOG00.017.1	Monitoring Storage Facilities	SKKNI
4	H.52LOG00.018.1	Perform the Induction Process	SKKNI
5	H.52LOG00.019.1	Leading the Team / Working Group	SKKNI
6	H.52LOG00.020.1	Consolidating Shipments	SKKNI
7	H.52LOG00.021.1	Collecting, Analyzing Workplace Data and Information	SKKNI
8	H.52LOG00.022.1	Assessing and Confirming Customer's Transportation Needs	SKKNI
9	H.52LOG00.023.1	Implement and Monitor Occupational Health and Safety Procedures	SKKNI

Source: <https://kemenperin.go.id/kompetensi/download.php?id=205>

Apart from standard competency skills with warehouse supervisors, there are junior warehouse managers with the following qualifications of competency skills:(Palšaitis et al., 2017) state that the required knowledge of EJLog – Junior level (supervisory/operational management level) should encompass the following areas: general understanding of the supply chain, main managerial skills, inventory management, production planning, supply, procurement, warehouse operations management. Therefore, the required competencies are as follows:

Warehousing:

1. Assesses warehousing environment;
2. Coordinates objectives of the warehouse activities;
3. Manages the receipt, storage, packaging and shipping of orders;
4. Manages inventory control; maintains warehouse equipment;
5. Deploys IT in warehousing activities;

6. Observes warehouse operations and controls its quality;
7. Ensures that warehouse activities are in line with legal framework;
8. Contributes to plans and processes of reverse logistics development;
9. Contributes to warehousing processes and procedure development

After taking a assessment competency, the output of having a competency certificate are :

- a. Increase industry confidence in the implementation of competency certification;
- b. Create a good collaborative ecosystem between universities, industry and professional associations in strengthening collaborative work-based partnerships to build nation;
- c. Increase public awareness related to vocational education;
- d. Become a qualification level correction system for universities in preparing graduates;
- e. Education and training graduates will suit industry needs. Entrepreneurs can have personal branding to increase their selling power.
- f. Increase labor competitiveness.
- g. Increase referrals for universities that have logistics study programs in developing learning patterns that refer to industrial needs;
- h. There is a national logistical standard for universities so that the results produced do not stop at learning outcomes.

Students can obtain a certificate of vocational qualification after completing a vocational training program and passing a qualifying exam. Vocational qualification certificates provide students to work for individuals, public, budget agencies and organizations, public and private companies.

4. CONCLUSION

Taking into account information coming from the labor market, student standards and surveys, it is recognized that the introduction of practice in the field of study (even on general academic profiles) is a desirable trend. Future work predicts the need for hardware and software integration, as well as increased functionality of IT solutions which is quite important for students and prospective employers is also the ability to provide an introduction level certificate of software facilities and the competencies acquired. In addition, soft aspects should also be strengthened during laboratory classes, namely staff management and communication systems.

The implementation process of the laboratory classroom but the warehouse laboratory provides the ability to transform and provide a learning process, being a driving force to develop further ideas about research and infrastructure development. The concept elaborates the creation of a laboratory that allows to analyze and simulate warehouse work processes.

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