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### Required competencies by the industry for logistic engineering graduates: A systematic review

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#### ABSTRACT

Logistic Engineering is a new-promising discipline that supports the ongoing trend of the logistics market in Indonesia. Vocational education has not accommodated the demands and needs of the industry. This paper aims to list the required skills for logistics professionals from a global perspective. A Systematic Literature Review (SLR) method using articles obtained from national and international journals in the last two decades. The skills required are divided into two, technical competencies and soft skills. The result of the findings states that graduates are required modern skills that involves cross-functional, IT, and environmental as their advanced competency based on the specific logistic professional scope. It is also noted that these advanced skills must expand to the direction of specific logistic skills to suit their profession responsibilities. Core or primary skills including logistic knowledge, management, and intrapersonal was summarized on general consensus of global profession requirements. Thus, vocational education must train current and advanced technical competencies to meet global requirements.

#### 1. Introduction

Logistics plays a vital role in driving the economic growth and development of a country. In recent years, Indonesia has emerged as one of Southeast Asia's fastest-growing economies, and logistics has played a crucial part in this expansion. Quoted from PT. Serasi Autoarya (Sera Astra, 2022) querying data from the Central Statistics Agency (BPS), the logistics sector has succeeded in pushing Indonesia's GDP is IDR 220.6 trillion or 5.57% of GDP in quarter II/2019. Supply Chain Indonesia (SCI) also said that in 2020 the transportation subsector increased by 8.97% or Rp. 806.8 trillion and the warehousing subsector by 9.8% or Rp. 161.9 trillion. The sector has witnessed tremendous growth and development over the years, and it is expected to grow even more in the coming years.

The growth of global trade has pushed industries to move ever so fast to expand their trade locally and internationally. The demand for skilled logistics professionals is also on the rise due to this, yet the number of available logistic professionals is poor in quality due to little learning taking

place in the educational and training sector (Marinho & Delgado, 2019). Fortunately, the technical and vocational education are aware of the urgency of logistics for the economy and developed a curriculum to proceed with professional training. One of them is logistic engineering, a discipline that combines engineering principles with logistics management. It focuses on the design, planning, and optimization of logistics systems to ensure the efficient and effective movement of goods and services.

The shift in technological advancement as well as market interest has led to a richer competency to proceed with a career (Wu, 2006). This has led to an increasing demand for logistics engineering graduates with the right set of competencies to navigate this complex landscape. Understanding important global skills are critical for reducing the risk of skill mismatch from industry to higher education establishments. This paper aims to map the demanded skills from the industry, the skills trained by higher education institutes, and the global perspective of logistic professionals' performance indicators. The relevance of these variables will summarize the primary competencies needed by logistic engineering graduates to succeed in the ever-growing market of logistics.

## 2. Method

A systematic evaluation of the literature was done to evaluate the literature related to the required competencies for logistics engineering graduates. The evaluation method consisted of four steps: database searching, record screening, eligibility assessment, and completed selection. The database search was conducted using keywords such as "logistics engineering," "global perspective," "industrial need," "logistic competencies," and "technical & vocational education" to discover relevant papers and web reports. Following that, we did a search of multiple databases, including Emerald, ResearchGate, Scopus, Google Scholar, and other journals, using the selected keywords.

We used inclusion and exclusion criteria to narrow down the search results. Articles published in English between 2003 and 2023 met the inclusion criteria. Local associations and news websites are also used to provide relevant supporting material. The requirements for the website utilized are alike to the referred articles. After evaluating the search results, we chose 22 publications and 3 web reports for review. The references were thoroughly studied and analyzed, and pertinent information was retrieved. The retrieved data were used to examine the recommended skills for undergraduate logistic engineering students. The overall process is illustrated in [figure 1].

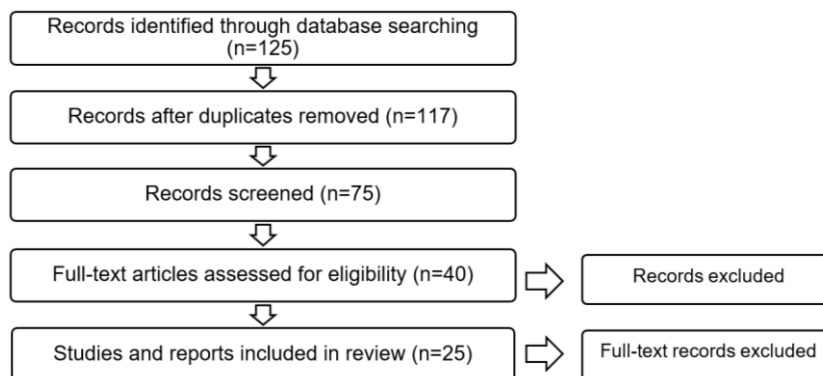


Figure 1. Relevant literature assessment by a systematic method

A comprehensive methodology is required to establish the essential competencies for TVET to create and train logistic undergraduates. This involves gathering viewpoints from a variety of sources, such as educators, practitioners, industry demands, and national and global standards. First, recommended competencies are listed based on the perspectives of practica and academe in logistics. Second, logistic engineering jobs are profiled by their occupation, job description, and standard competencies. Next, this information is then matched to national and international competency standards, and a primary and secondary skill list is generated. The resulting competency list will equip academic institutions with internationally relevant abilities that logistics

engineering graduates will find useful. It also guarantees that graduates are well-prepared to fulfill the needs of both domestic and global job occupancy.

### 3. Results and Discussion

#### 3.1. Recommended Logistic Competencies

There only pose a paltry difference between different logistic disciplines in which one part is more inclined toward mathematics' and 'science' as opposed to 'management and 'marketing' (Yen-Chun Jim Wu et al, 2003; G. Don Taylor, 2007). However, the essence of logistic vocational education is established by the confluence of sciences and technologies, with a focus on computer science and informatization (Vladimir Scherbakov et al, 2019). Logistic engineering is a profession that provides integrated support in system and equipment design and development, manufacture, construction, operation, maintenance, examination, assessment, as well as disposal/recycling (Vina Dwiyantri et al, 2021). Theoretically, logistic engineering in the era of technological disruption puts the utmost importance on science and technological application as their primary technical skills. However, from the standpoint of cross-national managers, an overall logistic career develops under the prerequisite of cross-functional skills, particularly in terms of boosting business competitiveness and strategy creation (Burcher et al, 2005).

As technology advances, the logistics industry is constantly evolving. However, the addition of international practices has made the industry more complex, raising concerns about whether institutions are teaching students vital skills. Practitioners demand a curriculum that is tailored to the industry, while educators struggle to balance cross-functional skills with logistics-specific skills. Despite these debates, finding a balance between industry relevance and theoretical soundness is crucial for the success of the global logistics industry (Pohlen, 2011). Practical or Academical heavy is arguable based on different higher education to choose from. However, the combination of both is superior to marking up the most effective skills to master for the graduates. Yen-Chun Jim Wu et al (2003) research link and match the perspectives of practica and academe in Taiwan using the BLM matrix to inquire about the skills with the highest importance in a logistic career [Table 1].

Table 1. Logistic professional competencies for graduates ranked by their importance level

Num.	Competencies Ranked by Importance Level		
	Primary	Secondary	Tertiary
1	Language	Customer social responsibility	Adventurous
2	Communication	Customs regulation	Good sense of humor
3	International perspective	Organizational leadership	Appearance
4	System and process integration	Raw material planning	Patent analysis
5	Information integration	Delivery management	Profit allocation
6	International trade	Honesty and integrity	M&A
7	Logistic knowledge	Marketing	
8	EQ management	Assigning task effectively	
9	Risk management	Financial management	
10	Innovative		

Logistic vocational education in Russia has a similar approach to the principle of training in which cross-functional skills should be present. A modern logistician is someone who connects to the digital society through self-organization, self-education, and self-realization through qualification acquisition/improvement and professional competency development (Vladimir Scherbakov et al, 2019). Based on the previous hypothesis; skills are divided into modern and traditional. Table 2 list the information based on those corresponding skill group.

Table 2. Logistic professional competencies for graduates in correspond to generational practice

Num.	Competencies Categorized by Generational Practice	
	Modern	Traditional
1	Systemic thinking	Solving complex problems
2	Inter-industry communication skills	Critical thinking
3	Project management	Creativity
4	Lean manufacturing	People management
5	Programming/robotics/AI	Ability to coordinate with others
6	Customer focus	Emotional intelligence
7	Multilanguage and multiculturalism	Ability to make decisions
8	Teamwork	Service orientation
9	Work in uncertain conditions	Ability to negotiate
10	Environmental thinking	Cognitive flexibility

In correspondence to the skills recommended by Russians and Taiwanese researchers, others have spoken similarly regarding competencies for global logistics operations. As organizations expand their operations abroad, the capacity to manage these discrepancies among nations has become an absolute requirement (Yen-Chun Jim Wu et al, 2003). The complexity underlying international trade compels logistic professionals to sustain a competitive advantage through effective logistic operations (Carneiro, 2007). The skill for such requirements specifies mostly in management, communication, interpersonal relationships, and analysis (McKinnon et al, 2017; Wagner et al, 2020; Putu Diva Ariesthana Sadri, et al 2021).

### 3.2. Demanded Logistic Occupation

Indonesian national newspaper named Republica (2019) interviewed the Head Department of PT POS Indonesia, Suntoro, which stated that Indonesia needs roughly 17.000 logistics professionals yearly. He assumed that at least two experts are employed per company, which means that logistic professionals are not bound to logistic-focused industries. Logistics is also a human-based industry; thus, it is bound for people to seek its services whenever available. Aside from the intricacies of Indonesia's logistics, Indonesia itself has the potential to become Southeast Asia's economic powerhouse (Fino Wahyudi Abdul et al., 2017). Khresna Sangka (2017) posted questionnaires to five multinational logistics providers, and five large local logistics providers operating in Indonesia. All Multinational Corporations (MNCs) and local companies that have operated for over 20 years both choose logistic competencies as their priority. These are transportation and distribution, warehouse and inventory, and project management competency. The secondary skills following are managing results, continuous improvement, leadership, dan teamwork.

The MNCs which demand logistic competencies the highest are electronics, automotive, chemical, healthcare, consumer goods, and fashion. Local Indonesian companies which desired logistic manpower are also from the same background with the addition of consumer goods, technology, oils, gas, pharmaceutical, machinery, and automotive. Based on their backgrounds, the level of such industries must design their operations meticulously rather than manufacturing processes in quality control and aiming to eliminate variance in production before it can occur (Will Kenton, 2021). It is achieved by the combination of system and equipment design and development, manufacture, operation, and maintenance, procuring, storing, distributing, assessment with precision aided by modern technologies. Logistic engineering comes into the picture by designing the logistic process system using relevant techniques and technologies to maintain the quality level.

Indonesia currently lacks sufficient data on the development of logistic engineering professionals, but there is a National Occupation Map for Logistics and Supply Chain that outlines 38 professions based on procurement, warehousing, distribution, and cross-functional work. This is then condensed to six occupations with a focus on science and IT. However, the country's perspective on logistic and supply chain professional roles does not currently include a specific engineering focus on computer science and informatization. International cross-referencing is necessary to prepare adaptive graduates. Russia, with one of the highest Logistic Index

Performance (LIP), provides its take on logistic profession 2.0 in the transport industry. The professions are listed in [Table 3].

Table 3. Primary profession 2.0 for logistic professionals in Russia (Source: Conceptual model of Logistics Vocational Education in the Digital Economy, and Atlas of Emerging Jobs)

<b>Num.</b>	<b>Profession</b>	<b>Job Description</b>
1	Procurement senior staff	Collect and analyze information related to goods and services to be held, Compile specifications of goods or services to be held, and review the suitability of activity reports
2	Procurement coordinator	Arrange the needs and budget for the procurement of goods/services, protect the security of electronic data information systems, protect the security of electronic data information systems
3	Procurement supervisor	Procurement preparation and contract drafting, supplier selection and management for domestic and foreign acquisitions, needs and budget preparation for procurement of goods/services, and security protection for electronic data information systems
4	Warehouse Operation Officer	Identify products and store them in designated areas, monitor storage facilities Implement and monitor occupational health and safety procedures, use information technology equipment in the workplace Create written reports, use systems to manage stock
5	Inventory control specialist	Manage facility and inventory requirements, undertake inventory procedures, carry out basic procurement, collect and analyze information, implement effective communication, implement quality systems, administer inventory systems
6	Freight handler	Organizing goods/cargo transportation, analyzing road maps and navigating routes, identifying and labeling dangerous goods, consolidating freight, planning/organizing/managing international freight forwarding transport, applying knowledge of freight forwarding documentation and permits, estimating/calculating area and dimensions, performing vehicle inspection
7	Cross-logistics operator	Using multiple modes of transportation to deliver goods and move people, monitor and rectify traffic flows, check the passing ability of transport hubs, and reroute traffic flows
8	Designer of intermodal hubs	A distribution network designer for freight and passenger flows, with experience in substantiating transport capabilities, evaluating wear characteristics, and assessing development possibilities.
9	Transportation network safety engineer	Analyzing and monitoring information, environmental, and technical hazards to transportation networks as a professional. In contrast to traffic safety experts, these engineers assess and avoid problems associated with the operation of entire transportation networks.
10	Architect of intelligence control systems	Controls smart management systems and develops software for unmanned vehicles and traffic management systems. Manages the servicing of robotic transportation networks and the configuration of computer software for unmanned robotic systems and vehicles.

### 3.3. Summarized Recommended Skills

Recommended skills are categorized by their significance and period to the required logistic competencies. However, tertiary skills will not be mentioned in the list since almost no other research overlap with these qualities. Primary skills are paired with modern competencies with the intention of the given global shift in the logistics industry. Primary skills serve as the criterion for the general conception of which type of competency a graduate must possess.

Modern skills on the hand play a role to provide further improvement to such said basic-main competencies. This revolution invites new skills such as technology, multicultural & multilanguage, and lean manufacturing. Multicultural quotient adds awareness of the cultural expectations of others, people must know how those expectations are different from their own and then, to navigate those differences effectively, be willing to expend effort to be flexible, open, and empathetic in the way they communicate (Alex Casillas et al, 2017). Communication is often associated with lingual prowess in terms of an individual's fluency in more than his mother tongue. The succession of business relationships is in tandem with the ability to communicate. Logisticians should learn another language and exhibit cross-cultural sensitivity (Yen-Chun Jim Wu et al, 2013). As a result, the organization will actively seek personnel candidates who are fluent in a foreign language (Putu Diva Ariesthana Sadri, 2021).

Environmental thinking is supposedly one of the most anticipated competencies for professionals. Considering global environmental concerns and shifting regulations, environmental thinking is no more a luxury or a "nice-to-have" element for businesses, but rather a "must-have" one for them to survive and develop in the long run (Thoo Ai Chin et al, 2015). Social pressure has pushed firms to implement environmental recognition in hopes of using less energy, producing less waste, conserving water, emitting fewer pollutants, and employing fewer dangerous chemicals. Sustainable and eco-friendly business strategies possess some trade-offs, to which professionals must develop an environmental strategy to benefit both the company and society (Sandria S. Stephenson et al, 2014). Lean manufacturing is crucial to production to eliminate all types of losses which involve each employee in the process of business optimization and customer orientation maximization (Vladimir Scherbakov et al, 2019).

Secondary skills are paired with traditional ones. Traditional engineering education has received criticism for restricting student learning and experiences to practical skills development while ignoring the significance of fostering cognitive skills that encourage higher-order thinking, criticality, and self-reflexivity (Kashif Raza et al, 2022). Although traditional competency appears to be lacking from a modern standpoint, humans continue to rely on pedagogical ideals since no technology can replace the human component of interacting with a living individual (Kudratova Umida Rakhmatovna, 2023). These cases fall on cross-functional skills in the area of management, intrapersonal skills, and other basic qualities. Management skills are crucial to achieving personal change to be more successful. These skills are obtainable by the perquisite of change management and negotiation skills, even though the value change is far below the first important competency, to ensure thoughtful planning and sensitive implementation (Khresna Sangka, 2017).

Logistic engineering professionals must also exude intrapersonal qualities like creativity, critical thinking, problem-solving, task efficiency, decision-making, and cognitive flexibility. Although certain skills, such as integrity and ethical behavior, may not have an immediate impact on the logistics sector's ongoing activities, they are crucial for students and employees. These qualities are particularly important for leaders who hold significant responsibilities in managing organizational resources and other team members, as pointed out by Alex Casillas et al. (2017).

### 3.4. Summarized Required Skills by The Industry

An organization may only achieve its goals due to its sufficient human resources (Anastasiou, 2012). As stated in the Presidential Regulation (Pepres) No. 26 the Year 2012 about Blueprint for the Development of the National Logistics System (Sislognas), having competent workers from operational to managerial at multiple competency levels is one of the cornerstones to improving national logistics. Indonesia introduced 8 levels of the profession for logistics and supply chain professionals. These levels represent the position concerning the amount of authority they hold in their respective company. Level 1-5 only requires logistic vocational to diploma-3 graduates or 1-2 years' worth of experience as the bare minimum.

The listed jobs (1-6) were selected not only from their relevance to logistic engineering topics but also to their performance counterpart. Logistic engineering graduates might only be able to satisfy the requirements up to level 5. Above those criteria, present a lot more advanced skills that demand future professionals to execute peak efficiency with enough experience to support their performance. The same condition is also applied to the Russian professions which only present several specific/advanced skills in their respective jobs. Even though the notion of these futuristic jobs is modernized in comparison to the Indonesians, their competency is still within the scope of reachable range for undergraduates while being more inclined to the application of 'science' and 'IT' [table 4]. The [Table 4] is skill coded based on each professions as follows: A (Cautious & Accurate), B (Creativity), C (Customer Focus), D (Demand Forecasting), E (Environmental Thinking), F (Financial Management), G (Freight Forwarding), H (Hazardous Material Handling), I (Lean Manufacturing), J (Multilanguage), K (Multiculturalism), L (Negotiation), M (Procurement), N (Programming/AI), O (Raw Material Planning), P (Risk Management), Q (Statistics & Analysis). (Source: Conceptual model of Logistics Vocational Education in the Digital Economy, and Atlas of Emerging Jobs)

Table 4. Primary profession 2.0 for logistic professionals in Russia with their required skills.

Num.	Profession Competencies	
	Profession	Skill Code of Specific Skills
1	Procurement senior staff	B – C
2	Procurement coordinator	I – C – B – P
3	Procurement supervisor	K – L – N – Q
4	Warehouse Operation Officer	R – O
5	Inventory control specialist	H – I – D – F – M
6	Freight handler	G – K – L – A – E – Q – M
7	Cross-logistics operator	I – K – L – C
8	Designer of intermodal hubs	I – K – L – E
9	Transportation network safety engineer	K – L – O – Q
10	Architect of intelligence control systems	K – L – O – Q

### 3.5. Required Skills for Logistics Undergraduates

The father of vocational education, Charles Allen Prosser (1949), stated that vocational education will be beneficial in proportion to how well it trains the individual in the cognitive and manipulating habits demanded by the occupation itself. He also later stated that vocational education must recognize the demands of the 'market' even if it is true that more efficient methods of carrying out the profession are known and that better working circumstances are highly desirable. His theory explained that even if one aspect is theoretically worse than others, if the industry demands it, none may say otherwise. The keyword is that the 'market' of the logistic is very complex in the current globalization. Pratica and academe may say what is best and yet the optimal solution to profile the core competencies to develop must always be tailored to the standards of the industry.

The preceding part presented an overview of the skills and work requirements in logistic engineering, emphasizing the major competencies that a graduate should possess to thrive in their professional career. These competencies can be divided into two categories: basic and advanced. For higher-level roles that demand competence in technology, international relations, and social and cultural responsibility, advanced skills are required. Senior employees, specialist staff, and supervisors are examples of such roles. The skills in question for this are: a) customer focus, b) lean manufacturing, d) multilingual and multicultural knowledge, e) programming/robotics/AI, f) risk management, g) environmental thinking, and h) ability to negotiate. These skills have been discussed previously in summarized recommended skills, however, customer focus is supposedly posed as the core for business logistics. Customer focus is the transition from mass customer service which applies the ability to work with consumer requests in a more exclusive environment (Vladimir Scherbakov et al, 2019). The essence of mutualism is more dignified in a deeper partner relationship in which customer focus is a key idea in solving all economic challenges.

Primary skills on the other hand are more generalized and directed toward the main qualities of how a professional should perform in the workplace. It is the main priority to develop as every profession in logistics can only run by the combination of these skills. Although it is set as the core of all skills, by no means are the skills listed for this category secondary. The abilities for primary competencies may suit every graduate into becoming fit for playing in any lower and intermediate roles with ease. The preference for applicants with high-quality critical thinking skills is likely to continue to increase, particularly concerning college-educated workers, for whom demands on cognitive ability and effective problem-solving are increasing (Alex Casillas et al, 2017). These skills are: a) creativity, b) interpersonal proficiency, c) system & process integration, d) information integration, e) logistic knowledge, f) systemic thinking, g) project management, h) work under certainties, i) critical thinking, j) people management, and k) assigning task efficiently.

### 3.6. The Impact to Education

This study's findings may add some insights to the establishment of vocational education programs in Indonesia. The findings indicate that modern and advanced technical competences, such as cross-functional, IT, and environmental skills, should be incorporated into the logistics curriculum. This would help to ensure that graduates have the essential skills to meet the industry's demands and needs. Furthermore, these advanced abilities must be adjusted to certain logistic professional scopes, which may vary according on the profession's obligations. Furthermore, this study emphasizes the importance of fundamental or primary abilities required for a successful career in logistics, such as logistic knowledge, management, and interpersonal skills.

## 4. Conclusion

This study emphasizes the importance of vocational education programs including current and advanced technical competencies into their logistics curriculum in order to meet the industry's demands and needs. This research has implications for the development of logistics education programs in Indonesia, emphasizing the need of connecting educational programs with industry demands. As Indonesia's logistics business expands, it is critical that vocational education institutions adapt and provide their graduates with the essential skills to compete in the field. Thus, allowing vocational education contribute to the country's economic growth and development while also providing competent individuals to the logistics business.

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