HEURISTIC
Vol. 22, No. 2, October 2025
ISSN(p) 1693-8232
ISSN(e) 2723-1585

Formulation of Qualification Criteria for Industrial Engineering Graduates as Production Supervisors in the Manufacturing Industry

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Article history:
Received: 25 November 2025
Accepted: 25 December 2025
Published: 26 December 2025

Keywords:
Competency Assessment;
Industrial Engineer;
Manufacturing Industry;
Production Supervisor;
Qualification Criteria

ABSTRACT

The role of a production supervisor in manufacturing operations is a key factor in maintaining quality, stability, and the success of the production process. A production supervisor must maintain process effectiveness, output quality, and daily operational stability. Empirically, the scientific field that aligns with the scope of work of a production supervisor is Industrial Engineering. However, there is still a gap between the competencies of Industrial Engineering graduates and the qualifications required by companies for production supervisor positions. To fill this gap, this article aims to formulate qualification criteria for Industrial Engineering graduates interested in filling Production Supervisor positions in the manufacturing industry. The formulation of qualification criteria is based on job qualifications and requirements data from various types of manufacturers, collected through interviews with human resources department representatives and field observations. The research method used is a survey of experts experienced in the selection and development of human capital. Using the affinity diagram, the job qualifications and requirements are grouped into objective criteria, subjective criteria, and absolute requirements. Then, integrating the Pareto principle with the LINMAP method yields prominent qualification criteria. The results show that companies place the greatest emphasis on subjective qualifications, especially attitude (0,43) and software proficiency (0,43), followed by objective qualifications such as technical knowledge (0,36) and educational background (0,3). These findings can be a basis for industry in the employee selection process and for universities in designing competency development programs and career preparation for Industrial Engineering students interested in careers as production supervisors.

INTRODUCTION

The manufacturing industry plays a crucial and strategic role in increasing Indonesia's Gross Domestic Product (GDP) [1]. Another contribution made by the manufacturing industry is its significant employment absorption [2]. The manufacturing industry is a key sector attracting numerous domestic investors [3]. Therefore, the manufacturing industry is a crucial element in Indonesia's economic development [4]. Awareness of the manufacturing industry's important role has led to greater recognition of the need to maintain operational quality, which is highly dependent on the effectiveness of production systems, process efficiency, output quality, and daily operational stability. On a micro scale, these conditions are inextricably linked to the role of production supervisors in every manufacturing company. Specifically, some of the primary duties of production supervisors include supervising operators, coordinating production-related divisions (such as quality assurance, maintenance, and PPIC), reviewing KPIs, troubleshooting, and controlling processes. Given the scope of these duties, the position of production supervisor requires qualifications across many areas, including managerial skills, behavioral skills, interpersonal skills, communication skills, and an understanding of manufacturing-related sciences [5], [6]. From a manufacturing-related perspective, one academic major that aligns with these requirements is Industrial Engineering [7], [8]. Therefore, an Industrial Engineering graduate's understanding of manufacturing systems will bolster their qualifications for a production supervisor position [9].

However, fully matching the qualifications of Industrial Engineering fresh graduates to those of a production supervisor position remains difficult [10], [11]. This mismatch can be caused by a lack of practical, real-world experience, inadequate supervisory skills, weak soft skills, or other factors that the company expects. Fresh graduates are unprepared to handle operational dynamics, such as workload variations, daily troubleshooting, and people management. This situation indicates a practical gap that deserves addressing. Formulating more concrete qualification criteria that are relevant to industry needs is one of the objectives of this article. This research was conducted to bridge the gap between universities, as providers of employees, and companies, as users of graduates. Therefore, identifying qualification criteria is necessary to assist the industry in selecting prospective employees and developing new employees for production supervisor positions. For universities, identifying these criteria can serve as a basis for developing student career-preparation programs tailored to their talents and interests.

The importance of aligning student career-preparation programs underscores the urgency of the research presented in this article. Prior research has largely evaluated the competencies of Industrial Engineering graduates in general [9], [12]. It has been discussed that Industrial Engineering graduates apply management and technical skills to design products or services, improve manufacturing processes, and integrate production and information systems. However, research specifically examining the suitability of Industrial Engineering graduate qualifications for production supervisors in the manufacturing sector has not been discussed, despite prior research addressing production supervisor competencies [5]. This initial research was conducted to review and update the Industrial Engineering curriculum to keep pace with current developments [9]. Other similar studies have focused more on technical competencies, such as an understanding of Industrial Engineering [8]. On the other hand, non-technical competencies of Industrial Engineering graduates, such as readiness to work in shifts, cross-divisional communication, and socialization in a diverse environment, have not been discussed in previous studies, particularly in relation to production supervisor qualifications in the manufacturing sector. Consequently, students interested in working in the production sector must guess the appropriate qualification criteria. This article aims to formulate qualification criteria for Industrial Engineering graduates suitable for the Production Supervisor position in the manufacturing industry, based on interviews and observations conducted at various manufacturing companies in Indonesia. The results of this study are criteria that are systematically formulated and validated by industry practitioners. The implication is that the formulated criteria serve as the basis for designing a multi-criteria decision-making model in the employee selection process or talent scouting in universities for students who will graduate and are interested in working in the production system field. Thus, the practical contribution of this article can be provided in the short or long term.

MATERIALS AND METHODS

The research steps taken to fulfill the objectives of this article are presented in Figure 1.

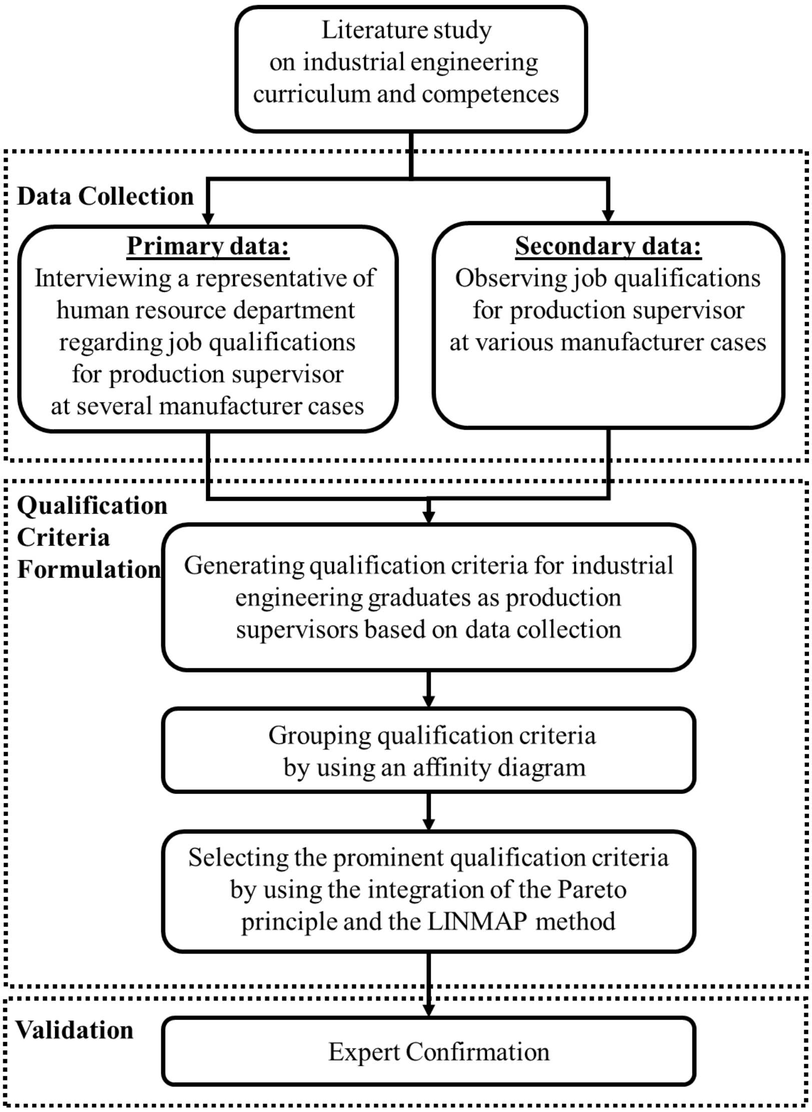

Figure 1. Research Methodology

The first step in this article's research is a literature review on the curriculum and competencies of Industrial Engineering. The Industrial Engineering curriculum standards in Indonesia are based on the curriculum development guidelines compiled by the Industrial Engineering Cooperation Agency (BKSTI), which are reinforced by national and international accreditation bodies. Furthermore, an understanding of Industrial Engineering study materials must be based on the Industrial Engineering Body of Knowledge (BoK). Thus, the process of collecting concepts and theories on work competencies, job qualifications, and manufacturing competency models aligns with the generally recognized competencies of Industrial Engineering graduates.

Information obtained from the literature study can be used to develop qualification criteria. The next research steps are data collection, formulation of qualification criteria, and validation.

Data Collection

Primary and secondary data collection in this study was conducted to generate ideas related to relevant qualification criteria. Several companies were selected as respondents. Primary data collection was conducted through interviews with representatives from the HR Departments of several manufacturing companies. In detail, several topics were explored in these interviews, including educational requirements, experience, technical abilities, soft skills, work behaviors, and the challenges fresh graduates often face in production supervisor positions. Meanwhile, secondary data were obtained through observations and analyses of job descriptions and requirements for Production Supervisor positions across various manufacturing companies, sourced from official company websites, recruitment portals, and available internal documents. The purpose of secondary data collection was to compare and support the practical data obtained from the interviews. Information obtained from primary and secondary data is presented in Table 1.

Table 1. Job qualifications and requirements

No	Company Name	Type of Manufacturing	Job Qualifications and Requirements
1	Fast Print Indonesia	Ink Production	Minimum education S1 in any major, minimum 2 years of experience as a production supervisor, understands ERP systems, has problem-solving skills, creative thinking & leadership, able to perform analysis, planning & forecast data, has good leadership, communication skills, willing to learn new things quickly, able to improve production line speed effectively and efficiently, placement at Surabaya Head Office (Monday–Saturday).
2	Berca Kawan Sejati	Cigarette Production	Maximum age 35, minimum education S1 Industrial Engineering, minimum 5 years of experience in PPIC in manufacturing, understands material & operational management, has strong analytical skills, punctual, disciplined, and responsible, placement in Malang.
3	Era Mulya Citra Warna	Paint Production	Male, max age 40, minimum education D3/S1 Industrial Engineering, minimum 1 year of experience in the same field, honest, disciplined, responsible, has high integrity & leadership, placement in Bekasi.
4	Adicitra Bhirawa	Automotive Body Manufacturing	Male, aged 35–45, preferably S1 Mechanical Engineering/Industrial Engineering, minimum 3 years of experience as a production supervisor, able to read engineering drawings, analytical & conceptual thinking, able to perform QC activities, operate MS Office & AutoCAD, disciplined, able to work individually or in teams, willing to be placed in Sunter.

No	Company Name	Type of Manufacturing	Job Qualifications and Requirements
5	Polytron	Electronics Production	Minimum D3/S1 Mechanical/Electrical/Industrial Engineering with GPA ≥ 2.75; fresh graduates are welcome; willing to work shifts; has good communication & leadership skills; placement in Sayung, Demak, & Kudus.
6	Indofood Group	Food & Beverage Production	Male, S1 Industrial Engineering/Chemical Engineering, GPA ≥ 3.00, minimum 3 years of experience in PPIC, proficient in MS Office, placement in Palembang.
7	Indoseiki Metal Utama	Forging	Male, max age 30, D3/S1 Mechanical/Industrial Engineering, GPA ≥ 3.00, minimum 1 year of experience in the same position, manufacturing experience preferred, leadership, systematic, communicative, and detail-oriented, placement in Jatake – Tangerang.
8	Luby Indonesia	Lamp Production	Male, max age 30, D3/S1 Electrical/Mechanical/Industrial Engineering, minimum 5 years experience as PPIC supervisor in retail/manufacturing, ISO experience preferred, strong production & inventory control knowledge, strong leadership & communication, willing to be placed in Pasar Kemis, Tangerang.
9	Fajar Surya Wisesa	Paper Packaging Production	S1 Industrial Engineering, minimum 1 year experience in PPIC (fresh graduates allowed), experience in the paper industry preferred, proficient in MS Office, placement in Gresik (East Java).
10	Unitama Sarimas	Lime Powder Production	Minimum education D3/S1 Industrial/Mechanical/Technical Chemistry/Pharmacy, experience as a production supervisor in FMCG, minimum 1 year, handles 20+ operators, production result-oriented, understands SAP, 5R, Continuous Improvement, ISO 9001:2015, leadership, proactive, analytical, placement Pluit – North Jakarta.
11	Subur Indah Perkasa	Electrical Components Production	Male, max age 40, minimum D3/S1, good health, minimum 2-years' experience as production supervisor, honest, responsible, initiative, innovative, high work ethic, willing to work under pressure, fresh graduates encouraged to try.
12	CS2 Pola Sehat	Beverage & Packaging Production	S1 Industrial/Electrical/Mechanical Engineering, GPA ≥ 3.00, fresh graduate, has good analytical & leadership skills, strong interpersonal communication.

Qualification Criteria Formulation

Based on job qualification and requirement data, qualification criteria are generated based on keywords or qualification elements such as technical, managerial, soft skills, behavioral, work readiness, and general knowledge. Redundant qualifications are then eliminated. The result of generating qualification criteria is a complete draft, ready for grouping.

The list of qualification criteria is then grouped based on similarities in meaning, function, and scope of work. Technically, the qualification criteria are grouped systematically using an affinity diagram. The purpose of this grouping is to align terminology and ensure that each criterion is at the appropriate level within the context of the Production Supervisor role. In this study, the affinity diagram generated three groups of qualification criteria: objective criteria, subjective criteria, and absolute requirements. This grouping is based on the definition of criteria, which always contain the same attributes and objective. Objective criteria are a set of job qualifications and requirements that reflect objective assessments, enabling the qualifications of Industrial Engineering graduates to be consistently evaluated by diverse stakeholders. Conversely, subjective criteria are a set of job qualifications and requirements that reflect subjective assessments. Therefore, these criteria still need to be provided so that experts, as users of graduates, can continue to assess based on their experience. The final group consists of absolute requirements, which serve as key requirements that unlock the assessment of other qualification criteria. If these absolute requirements are not met, further assessment cannot be conducted.

Next, the objective and subjective criteria groups are reviewed to create smaller groupings. Criteria that are duplicative, too general, or insignificant are eliminated or combined with other, more representative and simpler criteria. Based on the 80%-20% Pareto principle, subsequent qualification criteria are formulated by selecting the most impactful and most relevant. The use of a Pareto Chart facilitates the identification of critical areas of concern. The percentage of occurrence in the data and the urgency of the criterion, as determined by the company, serve as the basis for selecting this qualification criterion. The occurrence percentage indicates how often companies request the related qualification, thus reflecting its dominance and urgency. Table 2 displays the results of a review of objective criteria for the percentage of occurrence. Meanwhile, Table 3 displays the results of a review of subjective criteria.

Table 2. Review of the objective criteria for urgency

No	Objective Qualification	Percentage (%)
	Criteria of Education	
OE-1	Minimum education of a Bachelor's Degree in Industrial Engineering	34
OE-2	Minimum vocational education in Industrial Engineering	20
OE-3	Minimum education of a bachelor's degree or vocational education in Mechanical Engineering	17
OE-4	Minimum education of a bachelor's degree or vocational education in Electronics Engineering	11
OE-5	Minimum education of a bachelor's degree or vocational education in Pharmacy	9
OE-6	Minimum education of a Bachelor's Degree in Chemical Engineering	9
	Criteria of Mark	
OM-1	Minimum GPA 3.00	75
OM-2	Minimum GPA 2.75	25
	Criteria of Age	
OA-1	Fresh graduate (22-23 years old)	44
OA-2	Maximum age of 30 years old	22
OA-3	Maximum age of 35 years old	11

No	Objective Qualification	Percentage (%)
OA-4	Maximum age of 40 years old	11
OA-5	Age of 35-45 years old	11
	Criteria of Gender	
OG-1	No gender mentioned	92
OG-2	Man	8
	Criteria of Placement	
OP-1	Mention the placement area	75
OP-2	No placement mentioned	25
	Criteria of Knowledge	
OK-1	Having the ability to analyze constraints, work planning & data forecasting	14
OK-2	Being able to carry out QC activities (able to use measuring tools and read technical drawings)	14
OK-3	Mastering material and operational management	14
OK-4	Having good knowledge and skills in production planning and inventory control	14
OK-5	Understanding production quality	14
OK-6	Understand 5S and continuous improvement	14
OK-7	Understand ISO 9001:2015 and GMP	14

Table 3. Review of the subjective criteria for urgency

No	Subjective Qualification	Percentage (%)
	Criteria for Mastering Software	
SMS-1	Mastering MS Office (Word, Excel, PowerPoint)	50
SMS-2	Understanding ERP (Enterprise Resource Planning) systems	17
SMS-3	Mastering Autocad	17
SMS-4	Operating SAP or similar programs	17
	Criteria of Work Skill	
SWS-1	Leadership	19
SWS-2	Good analytical and conceptual power	12
SWS-3	Have good communication	9
SWS-4	Working in a team	9
SWS-5	Individual work	5
SWS-6	Good interpersonal	5
SWS-7	Having good problem-solving	2
SWS-8	Thinking creatively	2
SWS-9	Learning new things quickly	2
SWS-10	Smart	2
SWS-11	Having a high motivation	2
SWS-12	Systematic	2
SWS-13	Details in the work	2
SWS-14	Responsible	2
SWS-15	Working under pressure	2

No	Subjective Qualification	Percentage (%)
SWS-16	Good presentation skills	2
SWS-17	Oriented towards production results	2
SWS-18	Proactive	2
SWS-19	Having excellent health	2
SWS-20	Being able to work to deadlines	2
SWS-21	Hard Worker	2
SWS-22	Active	2
SWS-23	Innovative	2
SWS-24	Highly dedicated	2
	Criteria of Attitude	
SA-1	Firm	27
SA-2	Discipline	27
SA-3	Honest	18
SA-4	Responsibility	18
SA-5	Authoritative	9
	Criteria of Work Flexibility	
SWF-1	Does not mention willingness to work in shifts	75
SWF-2	Willing to work in shifts	25

To investigate the company's desired criteria and sub-criteria, the preference values for each are calculated using several Multi-Criteria Decision Making (MCDM) methods. Some of the most widely used tools are the Simple Additive Weighing (SAW) method, the Analytical Hierarchy Process (AHP), and the Linear Programming Technique for Multidimensional Analysis of Preference (LINMAP). Although all three tools aim to produce alternative rankings, they each have distinct advantages and disadvantages. SAW is the simplest method because alternative rankings are determined by summing the normalized weighted values of the alternatives linearly [13], [14], [15], [16]. Based on this method, SAW is more practical to implement and maintains transparency in the calculation of alternative weights. However, this method will be greatly influenced by the accuracy of the initial criteria weights used to calculate the alternative weighted values. The SAW method is suitable for cases where there is a linear relationship between criteria and substitutes. Compared to AHP, AHP can describe the relationships among goals, criteria, and alternatives in a hierarchy [17], [18]. In addition, the quantitative relationship between criteria or between criteria and alternatives can be demonstrated through pairwise comparisons. Therefore, the AHP method has a stronger conceptual basis than SAW. However, AHP has limitations in pairwise evaluation when the number of criteria or alternatives increases. In this case, consistent evaluation results are difficult to achieve.

Unlike SAW and AHP, LINMAP is an MCDM tool that can rank without being influenced by the number of criteria or alternatives. Ranking is based on evaluating the distance of alternatives to the ideal or anti-ideal solution [19], [20], [21], [22], [23]. This reduces subjective bias and the decision maker's cognitive burden. Therefore, LINMAP is considered superior because it produces more robust, objective, and mathematically stable solutions, especially in complex decision problems that require accuracy and strong analytical justification. This article uses the LINMAP method to calculate the preference values of sub-criteria after the criteria weights have been determined based on expert judgment. In general, the LINMAP method consists of five steps. In detail, Figure 2 shows the problem-solving steps using affinity diagrams, the Pareto principle, and the LINMAP method.

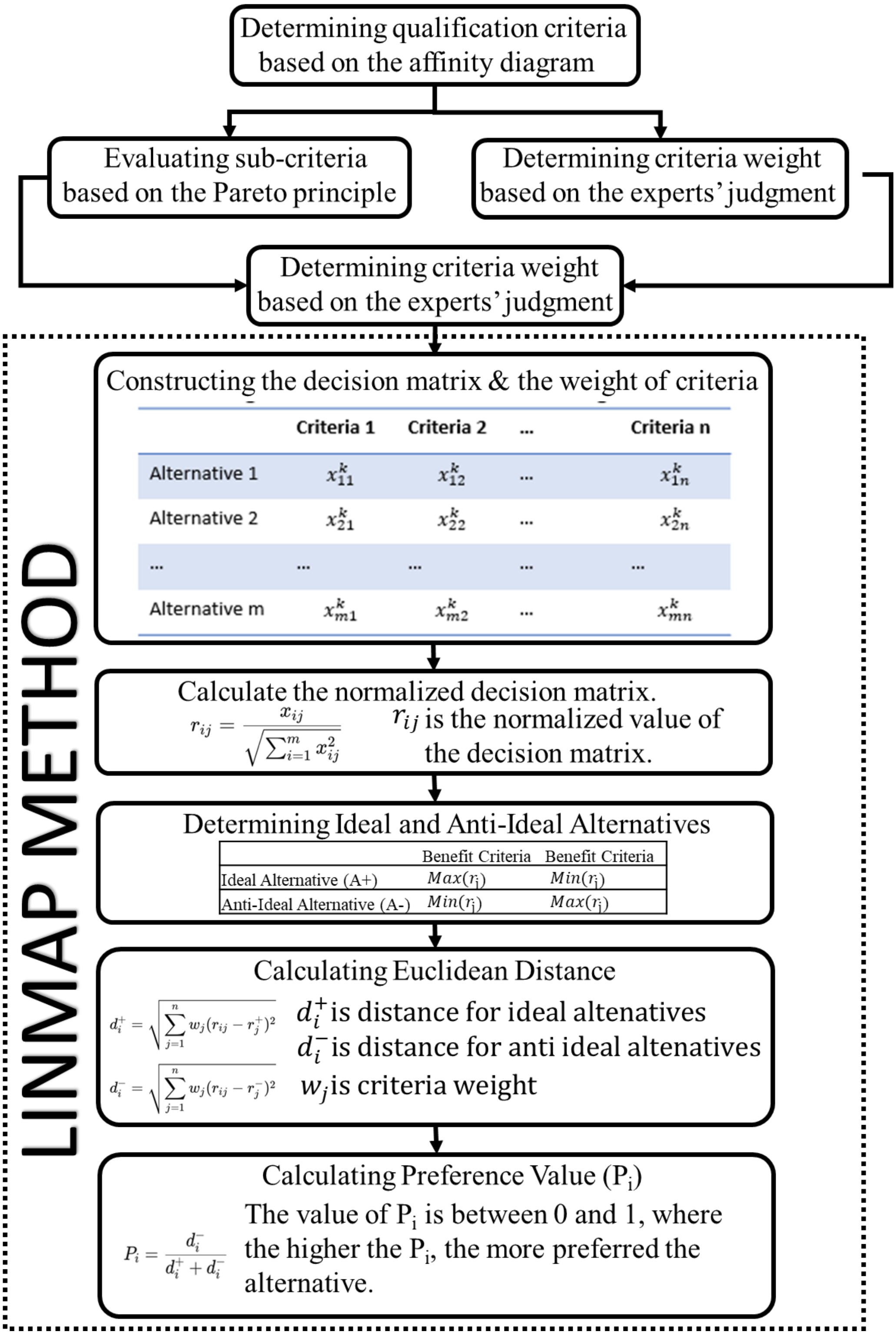

Figure 2. Investigation of criteria and sub-criteria preference values

In this study, the decision matrix was developed by determining the criteria weights. The expert respondents were asked to compare and assess the preference levels of the qualification criteria in the objective and subjective criteria. Afterward, each qualification criterion in the objective and subjective criteria was classified as a benefit criterion or a cost criterion. This classification will influence the determination of ideal and anti-ideal solutions. Furthermore, the determination of ideal and anti-ideal solutions will influence the final preference values of the criteria. Table 4 shows the criteria weights and their types.

Table 4. Criteria weight and type

Notation	**Criteria name**	**Weight (w_j)**	**Type**
Obj.C1	Criteria of Education	0,3	Benefit
Obj.C2	Criteria of Mark	0,04	Benefit
Obj.C3	Criteria of Age	0,12	Cost
Obj.C4	Criteria of Gender	0,13	Cost
Obj.C5	Criteria of Placement	0,05	Benefit
Obj.C6	Criteria of Knowledge	0,36	Benefit
Subj.C1	Criteria for Mastering Software	0,43	Benefit
Subj.C2	Criteria of Work Skill	0,1	Benefit
Subj.C3	Criteria of Attitude	0,43	Benefit
Subj.C4	Criteria of Work Flexibility	0,04	Benefit

In this study, the purpose of weighting is for sub-criteria in each objective and subjective criteria. Reviewing the steps of the LINMAP method, the sub-criteria are positioned at the same level as the alternatives. Evaluation of the sub-criteria using the Pareto principle provides real-world data for sub-criteria assessment. The Pareto analysis results in Tables 2 and 3 are then used to assess each sub-criterion against the relevant criteria. The data in Tables 2 and 3 demonstrate the intensity with which companies select the relevant sub-criteria when selecting production supervisor applicants. This results in a decision matrix ready for processing, as shown in Tables 5 and 6.

Tabel 5. Decision matrix for objective criteria

	Obj.C1	**Obj.C2**	**Obj.C3**	**Obj.C4**	**Obj.C5**	**Obj.C6**
OE-1	34	0	0	0	0	0
OE-2	20	0	0	0	0	0
OE-3	17	0	0	0	0	0
OE-4	11	0	0	0	0	0
OE-5	9	0	0	0	0	0
OE-6	9	0	0	0	0	0
OM-1	0	75	0	0	0	0
OM-2	0	25	0	0	0	0
OA-1	0	0	44	0	0	0
OA-2	0	0	22	0	0	0
OA-3	0	0	11	0	0	0

	Obj.C1	Obj.C2	Obj.C3	Obj.C4	Obj.C5	Obj.C6
OA-4	0	0	11	0	0	0
OA-5	0	0	11	0	0	0
OG-1	0	0	0	92	0	0
OG-2	0	0	0	8	0	0
OP-1	0	0	0	0	75	0
OP-2	0	0	0	0	25	0
OK-1	0	0	0	0	0	14
OK-2	0	0	0	0	0	14
OK-3	0	0	0	0	0	14
OK-4	0	0	0	0	0	14
OK-5	0	0	0	0	0	14
OK-6	0	0	0	0	0	14
OK-7	0	0	0	0	0	14

Tabel 6. Decision matrix for subjective criteria

	Subj.C1	Subj.C2	Subj.C3	Subj.C4
SMS-1	50	0	0	0
SMS-2	17	0	0	0
SMS-3	17	0	0	0
SMS-4	17	0	0	0
SWS-1	0	19	0	0
SWS-2	0	12	0	0
SWS-3	0	9	0	0
SWS-4	0	9	0	0
SWS-5	0	5	0	0
SWS-6	0	5	0	0
SWS-7	0	2	0	0
SWS-8	0	2	0	0
SWS-9	0	2	0	0
SWS-10	0	2	0	0
SWS-11	0	2	0	0
SWS-12	0	2	0	0
SWS-13	0	2	0	0
SWS-14	0	2	0	0
SWS-15	0	2	0	0
SWS-16	0	2	0	0
SWS-17	0	2	0	0
SWS-18	0	2	0	0
SWS-19	0	2	0	0
SWS-20	0	2	0	0

	Subj.C1	Subj.C2	Subj.C3	Subj.C4
SWS-21	0	2	0	0
SWS-22	0	2	0	0
SWS-23	0	2	0	0
SWS-24	0	2	0	0
SA-1	0	0	27	0
SA-2	0	0	27	0
SA-3	0	0	18	0
SA-4	0	0	18	0
SA-5	0	0	9	0
SWF-1	0	0	0	75
SWF-2	0	0	0	25

The decision matrices in Tables 5 and 6 are then normalized by dividing each sub-criterion assessment on the related criterion by the square root of the sum of all sub-criterion evaluations on the related criterion. For example, normalization for sub-criteria assessment OE-1 can be done as follows:

$$r_{11} = \frac{34}{\sqrt{34^2 + 20^2 + \cdots + 0^2}} = 0{,}74$$

Tables 7 and 8 are the results of the normalization of the decision matrix for objective criteria and subjective criteria.

Table 7. The normalized decision matrix for objective criteria

	Obj.C1	Obj.C2	Obj.C3	Obj.C4	Obj.C5	Obj.C6
OE-1	0,74	0	0	0	0	0
OE-2	0,43	0	0	0	0	0
OE-3	0,37	0	0	0	0	0
OE-4	0,24	0	0	0	0	0
OE-5	0,2	0	0	0	0	0
OE-6	0,2	0	0	0	0	0
OM-1	0	0,95	0	0	0	0
OM-2	0	0,32	0	0	0	0
OA-1	0	0	0,83	0	0	0
OA-2	0	0	0,42	0	0	0
OA-3	0	0	0,21	0	0	0
OA-4	0	0	0,21	0	0	0
OA-5	0	0	0,21	0	0	0
OG-1	0	0	0	1	0	0
OG-2	0	0	0	0,09	0	0
OP-1	0	0	0	0	0,95	0
OP-2	0	0	0	0	0,32	0
OK-1	0	0	0	0	0	0,38

	Obj.C1	Obj.C2	Obj.C3	Obj.C4	Obj.C5	Obj.C6
OK-2	0	0	0	0	0	0,38
OK-3	0	0	0	0	0	0,38
OK-4	0	0	0	0	0	0,38
OK-5	0	0	0	0	0	0,38
OK-6	0	0	0	0	0	0,38
OK-7	0	0	0	0	0	0,38

Table 8. The normalized decision matrix for subjective criteria

	Subj.C1	Subj.C2	Subj.C3	Subj.C4
SMS-1	0,86	0	0	0
SMS-2	0,29	0	0	0
SMS-3	0,29	0	0	0
SMS-4	0,29	0	0	0
SWS-1	0	0,68	0	0
SWS-2	0	0,43	0	0
SWS-3	0	0,32	0	0
SWS-4	0	0,32	0	0
SWS-5	0	0,18	0	0
SWS-6	0	0,18	0	0
SWS-7	0	0,07	0	0
SWS-8	0	0,07	0	0
SWS-9	0	0,07	0	0
SWS-10	0	0,07	0	0
SWS-11	0	0,07	0	0
SWS-12	0	0,07	0	0
SWS-13	0	0,07	0	0
SWS-14	0	0,07	0	0
SWS-15	0	0,07	0	0
SWS-16	0	0,07	0	0
SWS-17	0	0,07	0	0
SWS-18	0	0,07	0	0
SWS-19	0	0,07	0	0
SWS-20	0	0,07	0	0
SWS-21	0	0,07	0	0
SWS-22	0	0,07	0	0
SWS-23	0	0,07	0	0
SWS-24	0	0,07	0	0
SA-1	0	0	0,58	0
SA-2	0	0	0,58	0
SA-3	0	0	0,38	0
SA-4	0	0	0,38	0

	Subj.C1	**Subj.C2**	**Subj.C3**	**Subj.C4**
SA-5	0	0	0,19	0
SWF-1	0	0	0	0,95
SWF-2	0	0	0	0,32

Based on the normalized matrix, the ideal and anti-ideal solutions for each criterion can be determined. The ideal solution (A^+) for the benefit criterion is the maximum value of all normalized sub-criterion values. Meanwhile, the anti-ideal solution (A^-) for the benefit criterion is the minimum value of all normalized sub-criterion values. Table 9 shows the ideal and anti-ideal solutions for the objective and subjective criteria.

Table 9. The ideal and anti-ideal solutions for the objective and subjective criteria

Notation	**Criteria name**	**A^+**	**A^-**
Obj.C1	Criteria of Education	0,74	0
Obj.C2	Criteria of Mark	0,95	0
Obj.C3	Criteria of Age	0	0,83
Obj.C4	Criteria of Gender	0	1
Obj.C5	Criteria of Placement	0,95	0
Obj.C6	Criteria of Knowledge	0,38	0
Subj.C1	Criteria for Mastering Software	0,86	0
Subj.C2	Criteria of Work Skill	0,68	0
Subj.C3	Criteria of Attitude	0,58	0
Subj.C4	Criteria of Work Flexibility	0,95	0

The A^+ and A^- values then serve as a reference in calculating the distance between each sub-criterion value. The greater the distance between the sub-criterion value and the ideal solution, the less preferred it is. The Euclidean distance is a measure of the distance between a sub-criterion and the ideal or anti-ideal solution. The distance to the ideal solution is denoted by d^+. Meanwhile, the distance to the anti-ideal solution is denoted by d^-. Next, the proportion between d^- and the sum of d^+ and d^- becomes the preference value (P_i) of each sub-criterion. The P_i value lies between 0 and 1. The greater the P_i value of a sub-criterion, the more desirable the sub-criterion is for the company to consider when selecting a production supervisor. Table 10 shows the results of the d^+, d^-, and P_i calculations for each sub-criterion.

The results of LINMAP method produced a list of qualification criteria that is focused, applicable, and reflects the qualification requirements for the Production Supervisor position in the field. This list was then prepared for validation by experts.

Table 10. Calculation of sub-criterion preference values

Criteria Type	**Sub-criteria**	**d^+**	**d^-**	**P_i**	**Normalized P_i**	**Rank**
Objective	OE-1	0,36	0,61	0,63	0,0547	1
Objective	OE-2	0,4	0,52	0,57	0,0495	2
Objective	OE-3	0,42	0,5	0,54	0,0469	3
Objective	OE-4	0,45	0,48	0,52	0,0451	4

Criteria Type	Sub-criteria	d^+	d^-	P_i	Normalized P_i	Rank
Objective	OE-5	0,47	0,47	0,5	0,0434	5
Objective	OE-6	0,47	0,47	0,5	0,0434	5
Objective	OM-1	0,51	0,5	0,5	0,0434	5
Objective	OM-2	0,53	0,47	0,47	0,0408	16
Objective	OA-1	0,62	0,36	0,37	0,0321	23
Objective	OA-2	0,56	0,39	0,41	0,0356	22
Objective	OA-3	0,55	0,42	0,43	0,0373	19
Objective	OA-4	0,55	0,42	0,43	0,0373	19
Objective	OA-5	0,55	0,42	0,43	0,0373	19
Objective	OG-1	0,65	0,29	0,31	0,0269	24
Objective	OG-2	0,55	0,44	0,44	0,0382	18
Objective	OP-1	0,5	0,51	0,5	0,0434	5
Objective	OP-2	0,52	0,47	0,47	0,0408	16
Objective	OK-1	0,5	0,51	0,5	0,0434	5
Objective	OK-2	0,5	0,51	0,5	0,0434	5
Objective	OK-3	0,5	0,51	0,5	0,0434	5
Objective	OK-4	0,5	0,51	0,5	0,0434	5
Objective	OK-5	0,5	0,51	0,5	0,0434	5
Objective	OK-6	0,5	0,51	0,5	0,0434	5
Objective	OK-7	0,5	0,51	0,5	0,0434	5
Subjective	SMS-1	0,48	0,56	0,54	0,1459	1
Subjective	SMS-2	0,6	0,19	0,24	0,0649	6
Subjective	SMS-3	0,6	0,19	0,24	0,0649	6
Subjective	SMS-4	0,6	0,19	0,24	0,0649	6
Subjective	SWS-1	0,71	0,21	0,23	0,0622	9
Subjective	SWS-2	0,71	0,13	0,15	0,0405	12
Subjective	SWS-3	0,72	0,1	0,12	0,0324	13
Subjective	SWS-4	0,72	0,1	0,12	0,0324	13
Subjective	SWS-5	0,72	0,05	0,06	0,0162	15
Subjective	SWS-6	0,72	0,05	0,06	0,0162	15
Subjective	SWS-7	0,73	0	0	0	17
Subjective	SWS-8	0,73	0	0	0	17
Subjective	SWS-9	0,73	0	0	0	17
Subjective	SWS-10	0,73	0	0	0	17
Subjective	SWS-11	0,73	0	0	0	17
Subjective	SWS-12	0,73	0	0	0	17
Subjective	SWS-13	0,73	0	0	0	17
Subjective	SWS-14	0,73	0	0	0	17
Subjective	SWS-15	0,73	0	0	0	17
Subjective	SWS-16	0,73	0	0	0	17
Subjective	SWS-17	0,73	0	0	0	17
Subjective	SWS-18	0,73	0	0	0	17
Subjective	SWS-19	0,73	0	0	0	17
Subjective	SWS-20	0,73	0	0	0	17
Subjective	SWS-21	0,73	0	0	0	17
Subjective	SWS-22	0,73	0	0	0	17
Subjective	SWS-23	0,73	0	0	0	17
Subjective	SWS-24	0,73	0	0	0	17
Subjective	SA-1	0,63	0,38	0,38	0,1027	2
Subjective	SA-2	0,63	0,38	0,38	0,1027	2
Subjective	SA-3	0,65	0,25	0,28	0,0757	4
Subjective	SA-4	0,65	0,25	0,28	0,0757	4
Subjective	SA-5	0,68	0,13	0,16	0,0432	11
Subjective	SWF-1	0,71	0,2	0,22	0,0595	10
Subjective	SWF-2	0,73	0	0	0	17

Validation

The final step in the qualification criteria formulation process is validation, which involves expert representatives from several companies. The specialist selection criteria are for company representatives with knowledge and experience in the employee recruitment process. At this stage, the expert determines the importance of the requirements in selecting candidates for the company through interviews and questionnaires. The interviews are conducted to explore the feasibility, relevance, clarity, and completeness of the qualification criteria prepared. Meanwhile, the questionnaire is intended to assess the level of importance of objective and subjective criteria. The results of this validation process are used to make improvements, adjustments, and refinements to the qualification list. Based on the validation process, the experts are subsequently concerned about knowledge, education, gender, age, placement, and marks for objective qualification criteria. Meanwhile, attitude and mastery of software, work skills, and work flexibility are the order of subjective qualification criteria.

RESULTS AND DISCUSSIONS

Results

Based on the qualification criteria formulation process, there are two types of qualification criteria that companies can use to select prospective employees. The universities can use them to prepare Industrial Engineering graduates interested in becoming production supervisors. These qualification criteria are both objective and subjective. Using the Pareto principle and the expert validation process, it is evident that subjective criteria related to attitude and software proficiency are a major concern for companies when assessing prospective employees. This is followed by objective criteria related to knowledge and educational background, which are also a major concern. Furthermore, the results of the qualification criteria formulation also show that several job qualifications and requirements mentioned by companies are not necessarily major concerns, such as the willingness to be assigned to a specific area. The results of the formulation of qualification criteria for Industrial Engineering graduates for the position of Production Supervisor are visualized in Figure 3.

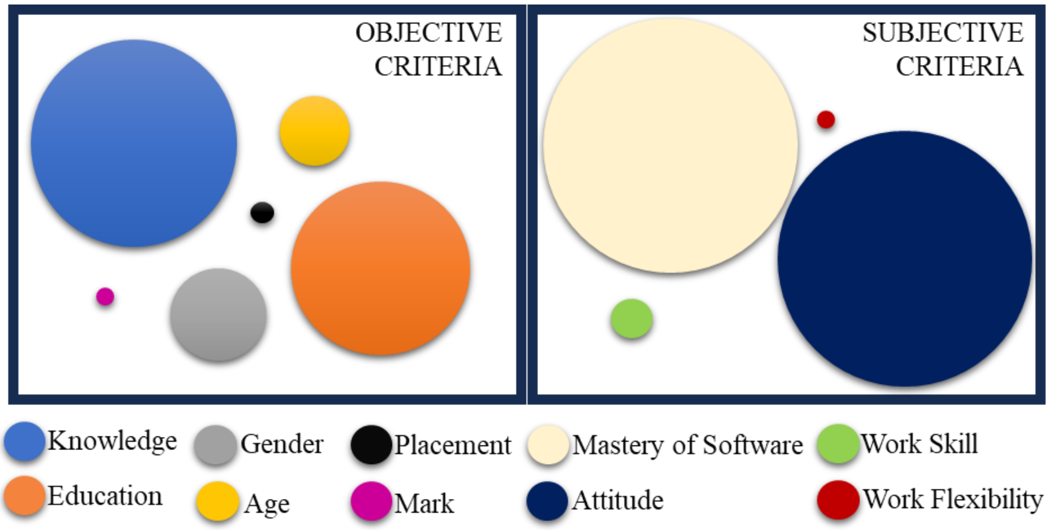

Figure 3. The attention level of the qualification criteria

Figure 3 was compiled based on expert validation results after a Pareto-based grouping and selection process. The circle's size indicates the level of attention. The larger the circle, the greater the company's attention to that criterion. This allows for easier identification of the importance of qualification criteria. Furthermore, comparisons between criteria can also be made easily. For example, companies will place greater importance on the attitude than on the mark. However, the company's attention to the attitude is not as strong as its software mastery. Based on this information, job qualifications and requirements can be tailored to suit individual needs.

For additional information, preference scores for sub-criterions frequently used as job qualifications and requirements can be learned from Table 10. The sub-criteria that companies pay most attention to when searching for production supervisors are OE-1 (Minimum education of a Bachelor's Degree in Industrial Engineering) for objective criteria and SMS-1 (Mastering MS Office) for subjective criteria. The preference score for OE-1 is 0.63 and SMS-1 is 0.54. In this case, educational background is more important than mastery of MS Office. Based on Table 10, sub-criteria grouping can also be done based on their ranking. Another information that can be utilized is the criteria weight obtained from expert assessments. Attitude criteria are considered as important as software mastery. The weight for each of these criteria is 0.43. Furthermore, objective qualification criteria related to knowledge received a weight of 0.36 and educational background received a weight of 0.3 from experts.

Discussion

Figure 3 is compiled from the company's perspective, so it will be useful for universities in prioritizing the qualifications that should be developed for prospective Industrial Engineering graduates. This serves as the basis for university career centers to develop each program based on prospective graduates' interests and talents. For example, prospective Industrial Engineering graduates who want a career in manufacturing can start their career as a production supervisor. The program provided by the career center for this case study should develop qualifications related to attitude, software mastery, knowledge, and education. This will ensure alignment between university graduates and the needs of the manufacturing industry. Furthermore, Figure 3 can serve as a reference for small companies unsure of the qualifications required of a production supervisor. Consequently, these criteria can be used in employee selection processes and employee skill development. This is possible because the qualification criteria are derived from several types of manufacturing industries operating in Indonesia at small, medium, and large scales. Furthermore, Figure 3 can be examined in more detail by applying multi-criteria decision-making tools to determine the precise weighting of each criterion.

Compared with previous research, this study's results provide a clear statement of the dominant criteria for an industrial engineering graduate interested in a production supervisor position across various types of manufacturing, both hard and soft skills. Several previous studies discussed the competencies of industrial engineering graduates in terms of hard skills, with the intention of improving the industrial engineering curriculum. However, the discussion of hard skills and soft skills of industrial engineering for a job position has not been addressed. Thus, future research opportunities are also available for job positions other than production supervisors within the scope of the industrial engineering field. The implication of this research result is the need to prepare graduates in both hard and soft skills for various job positions.

CONCLUSION

In this study, the formulation of qualification criteria was carried out systematically. The list of qualification criteria was developed based on job qualification and requirement data obtained from interviews with human resources department representatives and field observations. The final stage of qualification criteria formulation was validation by experts involved in the employee selection and development process. The results of this study indicate that the company places greater emphasis on subjective qualifications, particularly attitudes (0,43) and software mastery (0,43). Furthermore, objective qualification criteria related to knowledge (0,36) and educational background (0,3) are a major concern for the company in handling daily problems on the production floor. The results of this study provide practical contributions to companies and universities. For companies, the results of this study can serve as a reference for recruitment and employee development. For universities, the results of this study can be used as consideration in developing programs in the career center to be more targeted to students. As a basis for future research, the compiled criteria could be used to produce a multicriteria decision-making (MCDM) model to create a more objective and standardized employee selection system.

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