

# Application of Multiple Criteria Decision-Making Methods in the Human Resource Recruitment Process

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## Abstract

Recruitment process pledges sourcing of valuable assets to exemplify boundless contribution to a company. The existing gap within inconsistent employee performance of the IT company relies under appropriateness of applicants to the position, company culture, and clients. Thus, the study aims to develop the recruitment process through Multiple Criteria Decision-Making methods, namely multilevel Analytic Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). The framework consists of three levels separated by 1<sup>st</sup> level sub-criteria of grammar skills and comprehension skills, 2<sup>nd</sup> level sub-criteria of experience, overall impression, spoken English, profile presentation, pre-written skills, education, and visual presentation, and 3<sup>rd</sup> level sub-criteria of written communication skills and analytical reasoning skills. Sequence of aforementioned sub-criteria in each level were arranged from highest to lowest weight percentage whereas multilevel AHP and TOPSIS produced the same order but with different sub-criteria values. Rank proximity between the two methods produced an average of at least 82.41% closeness. Consequently, multilevel AHP was more applicable in three level recruitment sub-criteria identification whereas TOPSIS was more appropriate for the entire framework of recruitment process. The recommended strategies systematically increase efficiency of recruitment process and credibility of applicants.

## Keywords

Recruitment Process, Multiple Criteria Decision-Making (MCDM), Multilevel Analytic Hierarchy Process (AHP), and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS).

## 1. Introduction

Human resource strategies continuously adapt to globalization. One of which is hiring diverse and talented people. Recruitment process includes posting of job advertisements, screening of applicants, hiring the best applicants, and matching the applicants to the most appropriate position. A rapidly growing company unceasingly looks for outstanding people with extensive experience. Pastor (2012) identified that efficiency and effectiveness of selection process are identified through suitability of applicants to the job and organization. The key people must be qualified to the job in terms of providing value to the company. Organizational goals and cultures must be aligned with individual attitudes and behaviors (Podolsky 2018). The gap recognized in company vision and mission lies under employees' inconsistencies. Therefore, many companies invest in selection process, training of employees, performance appraisal, and compensation package to alleviate problems within the enterprise (Olson et al. 2018).

Enterprises that frequently achieve business value is most likely a product of recruitment strategies. The core competence of structured recruitment process includes employee's performance and operational outcomes. Alamro et al. (2015) developed a problem-oriented concept model to address issues within the recruitment system; and the goal of the system is to fill urgent vacancies with qualified individuals. However, not all performing employees remain committed to the company. Ulferts et al. (2009) defined that one of the challenges that has always been present in any enterprises is predicting applicant's long-term commitment to the company. The immense challenge lies on how recruiters carefully assess the behavior of people. Nevertheless, subjective verdict is inevitable in hiring process. Thus, multiple criteria decision-making in the recruitment process influences decisions of management in a company.

The IT company evaluated in this study established a rigorous selection process to effectively identify the appropriateness of applicants to the position, company culture, and clients. However, recruitment process of the IT company has not proved definite factors relative to the most qualified applicant. The strategic role of human resource professionals today is to maximize resources for more diverse human resource strategies. The strategies are directly

linked to organization, group, and individual. If the aforementioned resources have produced competitive advantages, the linkages between company goals, human resources, and performance outcomes will materialize (Buller and Mcevoy 2012).

### **1.1 Objectives**

The aim of the study is to develop the existing recruitment process of the IT company in determining top-performing applicants that best fit the company by utilizing multilevel AHP and TOPSIS. This study is also beneficial in implementing systematized recruitment process to increase certainty of consistent and bias-free decisions. Moreover, the paper creates predictive process and credible source of applicants applicable in various fields.

## **2. Literature Review**

Multiple criteria decision-making (MCDM) methods have been widely used to complex problems that need optimal solutions (Dolan 2008). According to Waris et al. (2019), analytic hierarchy process (AHP) is the most common and effective MCDM technique in prioritizing significant criteria and addressing decision problems. The technique for order of preference by similarity to ideal solution (TOPSIS), on the other hand, is suitable in identifying the best alternative in relation to the criteria.

There were several studies that utilized AHP, TOPSIS, and different combination of mathematical models to the recruitment process. Kusumawardani and Agintiara (2015) utilized fuzzy AHP-TOPSIS to effectively select the most appropriate applicant to be deployed in a specific region. Hiring process, one of the human resource practices, has subsequent impact on organizational performance of employees which was analyzed through AHP and Data Envelopment Analysis (DEA) (Tseng and Lee 2009). Integration of fuzzy AHP and fuzzy Decision-Making Trial and Evaluation Laboratory (DEMATEL) was applied to identify critical criterion in hiring applicants (Abdullah and Zulkifli 2015). Applicants are ranked accordingly and best employee was identified through the use of TOPSIS (Rahim et al. 2018). TOPSIS, fuzzy TOPSIS, and fuzzy set theory were combined to enable decision makers to identify top applicants within limited time and resources (Doka et al. 2015). Correspondingly, Kelemenesis and Askounis (2010) used fuzzy TOPSIS to rank the applicants according to the 11 defined recruitment criteria. Another study by Alptekin (2017) established multilevel phase in selecting the best alternative and the context perceives that multilevel process is applicable in all MCDM approaches. These concepts were utilized in this study in formulating overall framework for multilevel AHP and TOPSIS with varying criteria and sub-criteria.

## **3. Methodology**

### **3.1 Recruitment Process**

Synopsis of the IT company's recruitment process was reflected in figure 1. A multiple-choice type of test with four options was applied in the 1<sup>st</sup> level. Grammar examination has 60 questions while comprehension examination has 70 questions; each has a passing rate of 60%, specifically, 36 points for grammar and 42 points for comprehension. Applicants who passed the 1<sup>st</sup> level were invited to attend Zoom video interview and to finish pre-interview questionnaire. Recruiters then rated applicants' performance according to the seven sub-criteria. Applicants who passed the 2<sup>nd</sup> level of the process were invited to the last level. On the other hand, there were some instances where applicants acquired less than 7 of raw score in some sub-criteria but were placed under the waitlist and were not automatically rejected. The 3<sup>rd</sup> level consists of advanced problem solving (APS) test and text interview. The APS test consists of 35 logical reasoning questions with a passing score of 25 points. Twelve (12) standard questions were prepared beforehand to test written communication skills of applicants. Applicants received rejection letter if they scored < 7 on the text interview regardless of the results on their APS test. There were instances where applicants passed text interview but failed APS test; thus, applicants were endorsed to waitlist. Furthermore, an applicant who passed both text interview and APS test were endorsed directly to the CTO and team leader for the job offer.

Meanwhile, varying outcomes were expected once recruiters send 2<sup>nd</sup> level and 3<sup>rd</sup> level email invitation to the applicants. Some applicants withdraw their applications because they received an offer in a different company. Recruiters were required to send 3 follow-ups to applicants who haven't booked a schedule yet. Failure to book within 3 follow-ups automatically invalidate the applicant's application and tagged by recruiters as unresponsive. At some instances, there were applicants who does not show up during the scheduled interview. There were also applicants who had poor internet connection that were rescheduled. It was previously mentioned that there were instances where applicants were placed under waitlist. Intermittently, a recruiter finds potential in an applicant who failed to score 7 in all sub-criteria. Therefore, deliberation of recruiter, team leader, and CTO were conducted to finalize the decision.

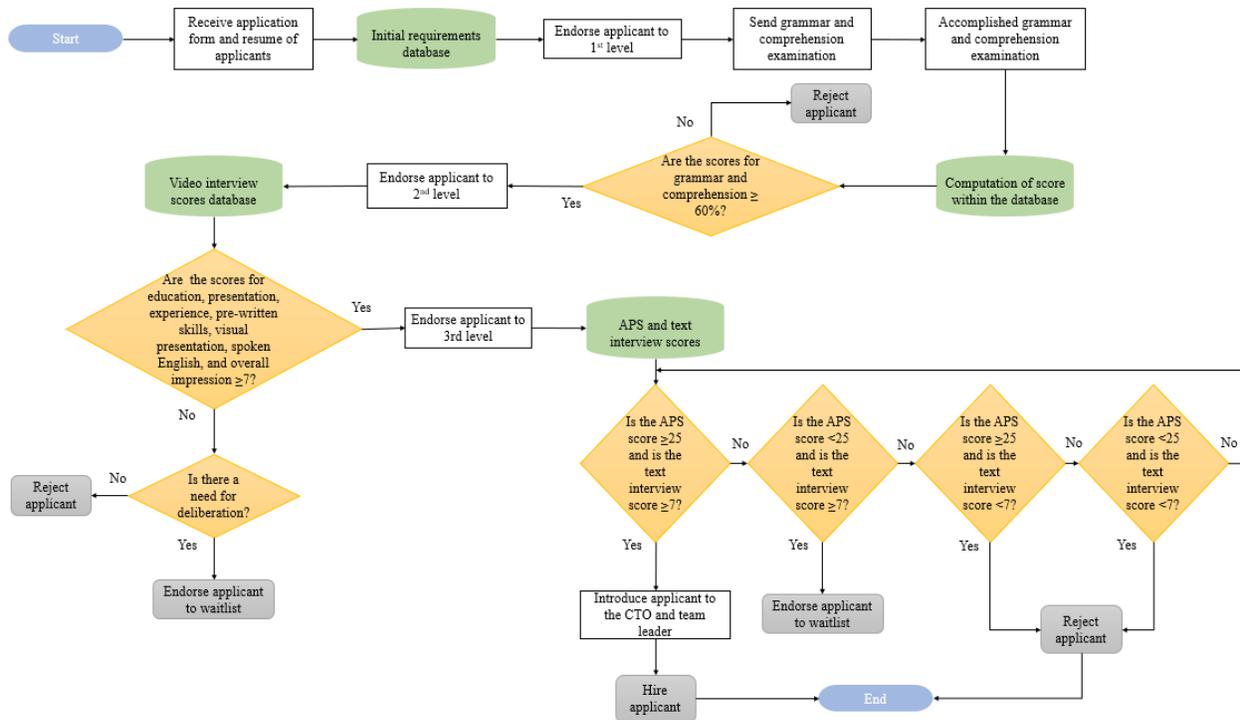


Figure 1. Recruitment Process Flow Chart

### 3.2 Multilevel Analytic Hierarchy Process (AHP)

Analytic hierarchy process (AHP) is one of the multicriteria decision-making methods that examines the problems in systematic approach (Narasimhan 1983). Hence, it guides decision makers to approach the goal with optimal judgment. Figure 2 shows the multilevel AHP that consists of one goal applicable to every level but with different criteria and sub-criteria. The 1<sup>st</sup> level of hiring process comprised of a criterion and two sub-criteria. Linguistic intelligence aims to test grammar and comprehension skills of applicants. Grammar skills reflect the general knowledge of applicants in the English language while comprehension skills assess capability of applicants in interpreting a given context. Successful applicants from the 1<sup>st</sup> level were invited for interview, whereby recruitment specialists rated the applicants according to the 2<sup>nd</sup> level criteria and sub-criteria. Personal and professional credentials refer to the contents within resume, curriculum vitae, and application forms sent by applicants. Education sub-criterion denotes educational attainment and performance. Profile presentation refers to presentable accounts and consistent information on public social media profile (Facebook, Instagram, Twitter, etc.) and professional profile (LinkedIn, OnlineJobs, etc.) of applicants. The experience sub-criterion pertains to the relevance of experience to the position. Impression on applicant’s writing skills was then reflected on the pre-written skills. Additionally, the second criteria under the 2<sup>nd</sup> level aims to assess visual presentation, spoken English, and overall impression. On the day of online video interview, visual presentation must be appealing. Applicants were expected to present themselves professionally. Throughout the interview, oral English communications skills were assessed since clients of the IT company were executives and business owners from the United States; thus, spoken English reflects applicants’ English proficiency. Personality traits and professionalism of applicants were scrutinized as well and were reflected on overall impression. Similarly, applicants who passed the 2<sup>nd</sup> level proceed to the 3<sup>rd</sup> level. The 3<sup>rd</sup> level of the multilevel AHP model consists of APS test and text interview. APS measures analytical reasoning skills of applicants. Critical thinking and logic skills were the key elements. Moreover, written communication skills were determined through the text interview. Text-based discussion aims to evaluate applicants’ English proficiency in written form.

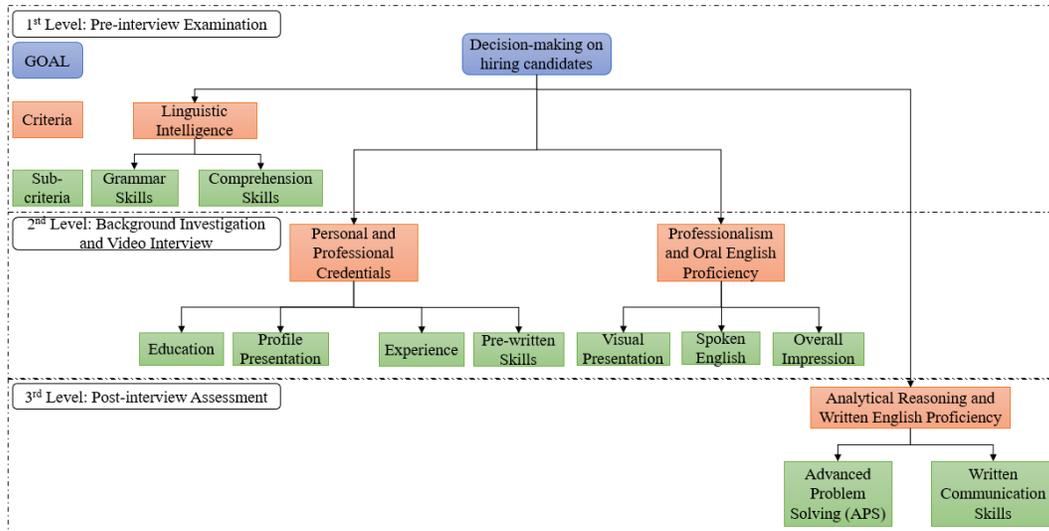


Figure 2. Multilevel Analytic Hierarchy Process

Hierarchical structure of the multilevel AHP framework was further established by measuring importance of criteria and sub-criteria through AHP questionnaire answered by three executives directly related to recruitment process. Instructions were explained to the three executives who answered the questionnaire. The multilevel AHP questionnaire were constructed in three different levels as criteria and sub-criteria vary from one level to another. Respondents were asked to choose a number from 1 to 9 according to their choice of preference. Specifically, 1 is equivalent to criteria and sub-criteria with equal importance and a value of 9 means that one criterion or sub-criterion is extremely important compared to the other one. Therefore, intensity of importance increases as the value increases. Responses of the top management for the multilevel AHP questionnaire were collected for the pairwise comparison process. Decision matrix was established in all criteria and sub-criteria of each level. The pairwise comparison process started through integration of multilevel AHP questionnaire values in the pairwise comparison matrix. Afterwards, the value of respective criterion and sub-criterion were divided to the total value of criteria and sub-criteria, respectively, to produce normalized pairwise comparison matrix. At the end of the process, criteria and sub-criteria weights were generated through the calculated average value of criteria and sub-criteria to its corresponding row in the matrix. Mathematical formulas used in this particular section were based on the study conducted by Saaty (1987).

Table 1 shows an example of AHP computation process. A total of 7 sub-criteria were evaluated under the 2<sup>nd</sup> level of multilevel AHP framework. These sub-criteria were compared to one another, and a total of 21 comparisons were evaluated. Results were then transferred in a normalized pairwise comparison matrix. Subsequently, corresponding weight of sub-criteria were calculated on account of the same mathematical formulas and procedures used in all levels.

Table 1. Normalized Pairwise Comparison Matrix of 2<sup>nd</sup> Level Sub-criteria

Sub-criteria	Education	Profile Presentation	Experience	Pre-written Skills	Visual Presentation	Spoken English	Overall Impression
Education	0.05	0.03	0.07	0.03	0.11	0.03	0.05
Profile Presentation	0.15	0.08	0.09	0.13	0.11	0.05	0.07
Experience	0.24	0.32	0.35	0.33	0.26	0.28	0.43
Pre-written Skills	0.10	0.04	0.07	0.07	0.11	0.04	0.11
Visual Presentation	0.02	0.04	0.07	0.03	0.05	0.05	0.05
Spoken English	0.24	0.24	0.18	0.27	0.16	0.14	0.07

Overall Impression	0.20	0.24	0.18	0.13	0.21	0.42	0.21
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Afterwards, consistency of judgment was computed for the sub-criteria of multilevel AHP's 2<sup>nd</sup> level. If consistency ratio is  $\leq 0.1$ , then responses are logical and acceptable (Saaty 1987). Otherwise, pairwise comparison matrix is inconsistent. Meanwhile, maximum lambda was 7.44, consistency index was 0.07, random index was 1.35, and consistency ratio generated was 0.05 which signifies consistent judgment.

### 3.3 Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)

TOPSIS method allowed sub-criteria comparison for ideal and non-ideal solution. The intensity of rating scale varies from 1-10. Particularly, 1 had the lowest or most negligible impact and 10 had the highest or extreme impact to each sub-criteria of recruitment process. Similar to multilevel AHP process, TOPSIS method also utilized judgement from the top management. Afterwards, attribute weight was computed by calculating the average value rated by the decision makers.

Table 2 shows significant figures for TOPSIS method applied in each level and in all sub-criteria. Applicants' raw scores for the 1<sup>st</sup> level were generated from grammar and comprehension tests. On the other hand, scores for the 2<sup>nd</sup> and 3<sup>rd</sup> level of the process were rated by recruitment specialist assigned to the applicant. Applicants were rated from 1-10; wherein 1 was accounted for unacceptable performance and 10 for impressive performance. Raw scores in each sub-criterion were transformed in a weighted standardized decision matrix. Specifically, values in standardized decision matrix were multiplied to the corresponding attribute weights. TOPSIS calculation in ideal and negative ideal solution were presented as well. As a result, relative closeness was calculated by dividing the sum of negative ideal solution to the sum of ideal and negative ideal solution. The best solution was then identified with the highest relative closeness. Results were entirely different when relative closeness was compared to each level because of varying raw scores and sub-criteria weights.

Table 2. TOPSIS Relative Closeness Calculation for the Three Levels

Applicant	1 <sup>st</sup> Level Sum of Ideal and Negative Ideal Solution	1 <sup>st</sup> Level Relative Closeness	2 <sup>nd</sup> Level Sum of Ideal and Negative Ideal Solution	2 <sup>nd</sup> Level Relative Closeness	3 <sup>rd</sup> Level Sum of Ideal and Negative Ideal Solution	3 <sup>rd</sup> Level Relative Closeness
A5	0.2681	0.0000	1.2495	0.4928	1.0649	0.0321
A61	0.1861	0.9256	1.5109	0.3280	1.1373	0.0060
A63	0.2460	0.9146	1.2538	0.2958	1.0288	0.1275
A64	0.1396	0.3650	1.6442	0.4804	1.1726	0.0032
A67	0.1597	0.5809	1.1487	0.1717	1.2483	0.2274
A170	0.1438	0.4158	1.3870	0.7266	1.1627	0.1084
A283	0.1710	0.1439	1.1597	0.2478	1.1547	0.2500
A294	0.2232	0.0343	1.5204	0.0686	1.1028	0.1151
A322	0.1743	0.1892	1.4747	0.9216	1.1547	0.2500
A337	0.2220	0.0698	1.3429	0.4760	1.1373	0.2552
A395	0.1524	0.2960	1.0764	0.2580	1.1203	0.2607
A499	0.1355	0.4336	1.3733	0.6858	1.2096	0.2357
A521	0.1492	0.2463	1.4637	0.2175	1.0649	0.0321
A531	0.2323	0.0089	1.5470	0.1488	1.2288	0.0008
A645	0.1454	0.2544	1.3733	0.5580	1.2096	0.2357
A646	0.2120	0.9472	1.4668	0.0802	1.2096	0.0014
A766	0.1868	0.8698	1.4668	0.1506	1.2096	0.0014
A767	0.1903	0.9517	1.3733	0.5892	1.1203	0.2607
A791	0.1438	0.4158	1.4101	0.7089	1.1423	0.1104
A807	0.1603	0.6864	1.3558	0.1072	0.9943	0.0403
A809	0.1376	0.6547	1.9374	0.0000	0.7845	0.7585
A828	0.1356	0.4281	1.1597	0.2566	1.2887	1.0000
A894	0.1481	0.5417	1.3429	0.3769	0.9155	0.8397

A895	0.2323	0.1469	1.5501	0.2849	1.0415	0.7079
A937	0.1496	0.7341	1.3777	0.1863	1.0932	0.9700
A983	0.1365	0.6326	1.5391	0.1723	0.9155	0.8397
A986	0.1710	0.8561	1.3364	0.1819	1.0955	0.7306

#### 4. Data Collection

Cutting-edge rigorous selection process was utilized by the IT company to hire top talents. The study acquired responses from 3 professionals accountable in the recruitment process; specifically, it includes the chief executive officer (CEO), chief technology officer (CTO), and recruitment team leader. Each executive answered the multilevel AHP questionnaire and TOPSIS criteria weight questionnaire. Although different perspectives were received, all results were considered. Moreover, a total of 885 applicants were processed by the IT company from June 1, 2020 to August 14, 2020 with varying gender, age, and educational background as shown in table 3. Out of 885 applicants, 376 were endorsed (42.49%) to the 2<sup>nd</sup> level, and 160 were endorsed (18.08%) to the 3<sup>rd</sup> level of the process. In the latter part of the process, 27 applicants were successfully hired and conquered the entire recruitment process.

Table 3. Demographic Profile of Applicants

Characteristic	Category	Sample Size	Percentage
Gender	Male	265	29.94%
	Female	620	70.06%
Age	18-21	31	3.50%
	22-29	478	54.01%
	30-39	255	28.81%
	40-49	98	11.07%
	50-65	23	2.60%
Type of School	Public School	296	33.45%
	Private School	589	66.55%
Location of School	Within NCR	534	60.34%
	Outside NCR	351	39.66%
College Degree	Arts	77	8.70%
	Engineering	88	9.94%
	Science	288	32.54%
	Social Sciences	432	48.81%

#### 5. Results and Discussion

##### 5.1 Multilevel AHP and TOPSIS Results

Information correlated to the 27 hired applicants was used in the succeeding section. The aforementioned multilevel AHP sub-criteria weights were utilized to rank the applicants. As shown in table 4, ranking of applicants vary from one level to another. Each applicant has their own strength and weakness. For example, A63 ranked 1<sup>st</sup> for the first level which means that the applicant acquired outstanding examination scores for grammar and comprehension test. For level 2 and level 3, A63 ranked 11 out of 27 applicants. The applicant bested the remaining 16 applicants and scored greater than 59.26% from their weighted scores. The results proved that other applicants had lower weighted score in level 1 but had good performance in level 2 and level 3.

Table 4. Ranking of Applicants Using the Multilevel AHP Method

Rank	Applicant	Level 1 Weighted Score	Applicant	Level 2 Weighted Score	Applicant	Level 3 Weighted Score
1	A63	9.13	A322	9.47	A828	10.00
2	A646	9.13	A170	9.14	A395	9.93
3	A767	9.10	A791	9.09	A767	9.93
4	A61	8.97	A499	8.75	A337	9.86
5	A766	8.77	A645	8.72	A283	9.79

6	A986	8.70	A337	8.61	A322	9.79
7	A937	8.57	A64	8.61	A499	9.57
8	A67	8.37	A767	8.43	A645	9.57
9	A809	8.31	A5	8.33	A67	9.43
10	A983	8.25	A61	8.24	A937	9.18
11	A807	8.24	A63	8.18	A63	9.04
12	A894	8.23	A828	8.14	A294	8.75
13	A170	7.97	A395	8.05	A791	8.61
14	A791	7.97	A283	8.02	A170	8.54
15	A499	7.93	A894	7.99	A807	8.43
16	A828	7.86	A67	7.95	A894	8.21
17	A64	7.83	A521	7.94	A983	8.21
18	A395	7.73	A895	7.85	A5	8.14
19	A521	7.60	A807	7.83	A521	8.14
20	A645	7.50	A531	7.80	A809	8.00
21	A322	7.47	A937	7.79	A61	7.61
22	A283	7.33	A983	7.71	A986	7.54
23	A895	7.20	A986	7.71	A64	7.46
24	A337	6.93	A766	7.70	A895	7.46
25	A294	6.77	A646	7.52	A646	7.32
26	A531	6.57	A294	7.35	A766	7.32
27	A5	6.27	A809	7.00	A531	7.25

Relative closeness is similar to identification of the best applicant from the computed ideal and negative ideal solution. Table 5 shows the best applicant in each level through the TOPSIS method. Particularly, A767 ranked 1<sup>st</sup> in level 1, A322 ranked 1<sup>st</sup> in level 2, and A828 ranked 1<sup>st</sup> in level 3. Each applicant has varying rank that depends on their skill sets in each level. For example, A767 ranked 1<sup>st</sup> in level 1, ranked 5<sup>th</sup> in level 2, and ranked 9<sup>th</sup> in level 3. Relative closeness scores of A767 were quite good since A767 excelled during English grammar and comprehension exam but other applicants scored better than A767 in 2<sup>nd</sup> and 3<sup>rd</sup> level.

Table 5. Ranking of Applicants Using the TOPSIS Method

Rank	Applicant	Level 1 Relative Closeness	Applicant	Level 2 Relative Closeness	Applicant	Level 3 Relative Closeness
1	A767	0.95	A322	0.92	A828	1.00
2	A646	0.95	A170	0.73	A937	0.97
3	A61	0.93	A791	0.71	A894	0.84
4	A63	0.91	A499	0.69	A983	0.84
5	A766	0.87	A767	0.59	A809	0.76
6	A986	0.86	A645	0.56	A986	0.73
7	A937	0.73	A5	0.49	A895	0.71
8	A807	0.69	A64	0.48	A395	0.26
9	A809	0.65	A337	0.48	A767	0.26
10	A983	0.63	A894	0.38	A337	0.26
11	A67	0.58	A61	0.33	A283	0.25
12	A894	0.54	A63	0.30	A322	0.25
13	A499	0.43	A895	0.28	A499	0.24
14	A828	0.43	A395	0.26	A645	0.24
15	A170	0.42	A828	0.26	A67	0.23
16	A791	0.42	A283	0.25	A63	0.13
17	A64	0.36	A521	0.22	A294	0.12
18	A395	0.30	A937	0.19	A791	0.11
19	A645	0.25	A986	0.18	A170	0.11

20	A521	0.25	A983	0.17	A807	0.04
21	A322	0.19	A67	0.17	A5	0.03
22	A895	0.15	A766	0.15	A521	0.03
23	A283	0.14	A531	0.15	A61	0.01
24	A337	0.07	A807	0.11	A64	0.00
25	A294	0.03	A646	0.08	A646	0.00
26	A531	0.01	A294	0.07	A766	0.00
27	A5	0.00	A809	0.00	A531	0.00

## 5.2 Comparison of Multilevel AHP and TOPSIS method

Varying sub-criteria weights for each level and method were reflected in table 6. In the 1<sup>st</sup> level, grammar had heavier weight compared to comprehension. An applicant who has good grammar is expected to fluently communicate in English and has in depth knowledge in English language. Moreover, experience had the highest weight among the 7 sub-criteria of 2<sup>nd</sup> level. Work experience must be relevant to the open positions so as the skills and knowledge were developed and applied. Excellence awards, promotions, and work attitudes were underlying factors of experience as well. Overall impression, 2<sup>nd</sup> to the highest, refers to professionalism and personality traits of the applicants. This sub-criterion aims to scrutinize inner personality of prospect applicants. Spoken English ranked 3<sup>rd</sup> since applicants were expected to easily convey their thoughts in English and can speak with substance and depth. Profile presentation ranked 4<sup>th</sup> which pertains to the background checking of applicants' profiles. The 5<sup>th</sup> to the highest was the pre-written skills wherein capability of applicants to write was simultaneously assessed with their capability to speak. Education ranked 6<sup>th</sup> to the highest and aims to identify highest educational attainment of applicants – including postgraduate studies. Scholarships, awards, research publications, and involvement with organizations were assessed at the same time. Visual presentation ranked the least because the management thinks that factors relative to dress code, background, lighting, audio, and internet connection were manageable and easy to fix; whereas other factors have no means to improve at the moment. Lastly, the 3<sup>rd</sup> level shows that written skills hold heavier weight compared to analytical reasoning skills. Top management prefers good writing skills than reasoning skills.

The closeness of applicants' ranking was formulated to further assess the differences of weights generated through multilevel AHP and TOPSIS method. Although there was only minimal difference under grammar and no difference under comprehension, result shows that 13 out of 27 (48.15%) applicants had different rank and 14 (51.58%) had similar rank. A63, A67, and A807 garnered the smallest proximity level of 85% which was still close to 100% similarity rating. Additionally, there was a huge difference in the declared weights under the 2<sup>nd</sup> level when multilevel AHP and TOPSIS were compared. Results show that 8 out of 27 (30%) applicants had similar rank when multilevel AHP and TOPSIS were utilized. The least proximity level was 83.33% for A894. Nevertheless, the value had a proximity level that was 16.67% away from 100%. Furthermore, weight difference between written and reasoning skills were only 5% and 8.33% respectively. However, there were only 4 applicants (14.81%) who had similar rank and the remaining 85.19% were entirely different. Average rank proximity percentage for the 1<sup>st</sup> level was quite high (96.30%) compared to the other two. Thus, sub-criteria weights used in multilevel AHP and TOPSIS almost produced similar results on the 1<sup>st</sup> level. For the 2<sup>nd</sup> level, huge difference of weights shown in table 6 did not create vast impact in the ranking proximity. Specifically, average rank proximity for 2<sup>nd</sup> level was 93.38%. However, the 3<sup>rd</sup> level incurred lesser average (82.41%) compared to others though weight difference was minimal.

Table 6. Comparison of Weights Generated through Multilevel AHP and TOPSIS

Level	Sub-criteria	Multilevel AHP Weight	TOPSIS Weight	Weight Difference	Greater Weight
1	Grammar Skills	66.67%	50.00%	16.67%	Multilevel AHP
	Comprehension Skills	33.33%	33.33%	0.00%	Identical Weight
2	Experience	31.74%	90.00%	58.26%	TOPSIS
	Overall Impression	23.53%	86.67%	63.14%	TOPSIS
	Spoken English	18.66%	80.00%	61.34%	TOPSIS
	Profile Presentation	9.44%	73.33%	63.90%	TOPSIS
	Pre-written Skills	7.20%	66.67%	59.46%	TOPSIS
	Education	4.92%	63.33%	58.41%	TOPSIS
	Visual Presentation	4.51%	56.67%	52.16%	TOPSIS

3	Written Communication Skills	75.00%	80.00%	5.00%	TOPSIS
	Analytical Reasoning Skills	25.00%	33.33%	8.33%	TOPSIS

Supplementary comparison between multilevel AHP and TOPSIS was also assessed in this study. Multilevel AHP model or framework was needed to establish criteria and sub-criteria in each level, while criteria and sub-criteria for TOPSIS were developed through identification method. Different questionnaires were established for multilevel AHP and TOPSIS. In multilevel AHP, raw scores of criteria and sub-criteria were compared to one another and were dependent on respective level. On the other hand, TOPSIS method allowed independent scoring from 1-10 without considering the scores of other criteria and sub-criteria. Timeliness, one of the resulting factors, were different for multilevel AHP and TOPSIS. The process of multilevel AHP was deemed to be moderate, yet in a timely manner since multiple comparison and structure of model took a while. TOPSIS process is quicker compared to multilevel AHP since decision makers rated the scores swiftly and creation of model was not needed. Moreover, checking of consistency was included in the multilevel AHP process while it was excluded in the TOPSIS process. In this manner, weighted scores formulated under the multilevel AHP method were more certain compared to the TOPSIS method. Mathematical formulas and processes were described as tolerable for the two MCDM methods. Although one has each own advantage and disadvantage but each MCDM method produced reliable results.

### 5.3 Proposed Improvements

It was previously discussed that the current process holds until 1<sup>st</sup> sub-criteria for the multilevel AHP framework. Table 7 shows additional sub-criteria to further improve the establishment of weights. In the 1<sup>st</sup> level, underlying factors within grammar and comprehension were different. For the grammar skills, recognition of words, tense identification, and English sentence construction were evaluated. Comprehension skills sought more details about applicant's knowledge on English vocabulary, ability to perceive the message behind the context, and efficiency on reading passages. The 2<sup>nd</sup> level was expanded with 2<sup>nd</sup> level sub-criteria as well. The identified 2<sup>nd</sup> level sub-criteria were currently utilized as factors for recruiter's evaluation by the IT company but rubrics were not set within. For the 3<sup>rd</sup> level of the process, analytical reasoning skills were conducted to assess applicant's logical skills in perceiving the reflected problem, familiarity on positions of the images, fundamental mathematical skills, and attention to details and patterns. Written communication skills, on the other hand, have almost similar purpose based on the previous level. Nevertheless, timeliness of responses and professionalism were further assessed in 3<sup>rd</sup> level.

Table 7. Recommended 2<sup>nd</sup> Sub-criteria of the Multilevel Analytic Hierarchy Process

Level	Criteria	1 <sup>st</sup> Sub-criteria	2 <sup>nd</sup> Sub-criteria
1	Linguistic intelligence	Grammar skills	Word recognition, tense identification, and sentence construction
		Comprehension skills	Vocabulary, context message, and reading strategy
2	Personal and professional credentials	Education	Educational attainment, academic achievements, and extracurricular activities
		Profile presentation	Public social media profile, professional profile, and email conversation
		Experience	Relevance of experience, upward mobility, and work attitude
		Pre-written skills	Written grammatical skills, written comprehension skills, and content's substance and depth
	Professionalism and oral English proficiency	Visual presentation	Dress code, background, lighting, audio, and internet connection
		Spoken English	Fluency, oral grammatical skills, oral comprehension skills, pronunciation & accent, and substance & depth
3	Analytical reasoning and written English proficiency	Analytical reasoning skills	Logical skills, familiarity on images, mathematical skills, and attention to details
		Written communication skills	Written grammatical skills, written comprehension skills, content's substance and depth, timeliness of response, and professionalism

Another recommendation for this study is encompassed within the advantages of multilevel AHP and TOPSIS from the identified context shown in table 8. In terms of accuracy, the multilevel AHP accurately classifies criteria and sub-criteria in three levels since multilevel AHP framework best describes the three-level model. TOPSIS, on the other hand, has the capability to promptly identify criteria and sub-criteria in a single frame; thus, three-level model is not needed. Criteria and sub-criteria weights in the corresponding three levels were compared extensively using the multilevel AHP method. But if the IT company wishes to independently compare criteria and sub-criteria without considering the three levels, then TOPSIS performs better. The best applicant was also identified by means of multilevel AHP and TOPSIS method. Multilevel AHP method generates best applicant in each level and applicant who performs well in each criterion and each sub-criterion in three different levels. However, TOPSIS is unable to produce identical result since the method considers weights assigned in a single framework. Hence, TOPSIS achieves better result in identifying the best applicant that considers all criteria and sub-criteria without the levelling method. Lastly, if the IT company hopes to validate consistency of criteria and sub-criteria weights, multilevel AHP has consistency judgment process whereas TOPSIS fails to possess.

Table 8. MCDM Methods Recommendation

Parameter	Preferred MCDM Method
Accurate identification of criteria and sub-criteria in multiple levels	Multilevel AHP
Prompt identification of criteria and sub-criteria in the whole framework	TOPSIS
Assessment of criteria and sub-criteria weights in multiple levels	Multilevel AHP
Assessment of criteria and sub-criteria weights in single level	TOPSIS
Identification of best applicant in different levels	Multilevel AHP
Identification of best applicant in the whole framework	TOPSIS
Criteria and sub-criteria weights consistency	Multilevel AHP

In addition to MCDM methods, the last recommendation is to incorporate predictive model by utilizing decision tree model generated through SPSS Statistics 26. Five demographic characteristics, namely gender, age, type of school, location of school, and college degree, were considered as previously discussed in table 3 Predictive approach generated in this study encompass suitability of applicant to the company's open positions and organizational culture. This approach also aims to mitigate decision uncertainty and to increase recruitment process efficiency. Recruiters will then have enough time to scrutinize more applicants that best fit the established metrics.

The 1<sup>st</sup> level is focused on examination skills of the applicants, particularly English grammar and comprehension examination; 42.5% of the applicants were endorsed to the next level and 57.5% were rejected. Result shows that male (46.8%) had a higher endorse rate compared to female (40.6%), but male (29.9%) had lower percentage of total population while female (70.1%) had greater percentage. If an applicant is male, then there is a higher chance to be endorsed to the 2<sup>nd</sup> level considering that the applicant has a degree in social sciences or arts with a school location within the NCR. On the other hand, there is higher chance for female candidates with social sciences degree from a public school and science degree from a school within the NCR. Furthermore, the 2<sup>nd</sup> level of the decision tree model generated two significant demographic characteristics, namely gender and age, and 42.6% were endorsed to the 3<sup>rd</sup> level while 57.4% were rejected. Female had a higher population percentage (67%) compared to male (33%). Subsequently, the endorse rate for female (47.2%) was higher compared to male (33.1%). Reject rates for both genders were quite high compared to the endorse rates. In a nutshell, female applicants ages 26-37 (57.5%) will most likely proceed to the 3<sup>rd</sup> level, followed by ages  $\leq 25$  (40.2%), and the least is candidates with ages  $\geq 38$  (13.3%). Ages of male applicants were divided into two sub-groups. Higher endorse rate was generated for male applicants with ages  $\leq 30$  (39.4%) compared to ages  $\geq 31$  (24.5%). Lastly, the 3<sup>rd</sup> level of the decision tree was shown in figure 3. There were only 16.9% applicants who successfully passed all requirements while the remaining 83.1% failed to meet the requirements. In the 3<sup>rd</sup> level, three significant factors were identified, namely gender, type of school, and age. Endorse rate for female applicants was 29.2% which was higher compared to male applicants with 7.3% only. Female applicants from private college with ages  $\leq 26$  were deemed as successful applicants for the entire process.

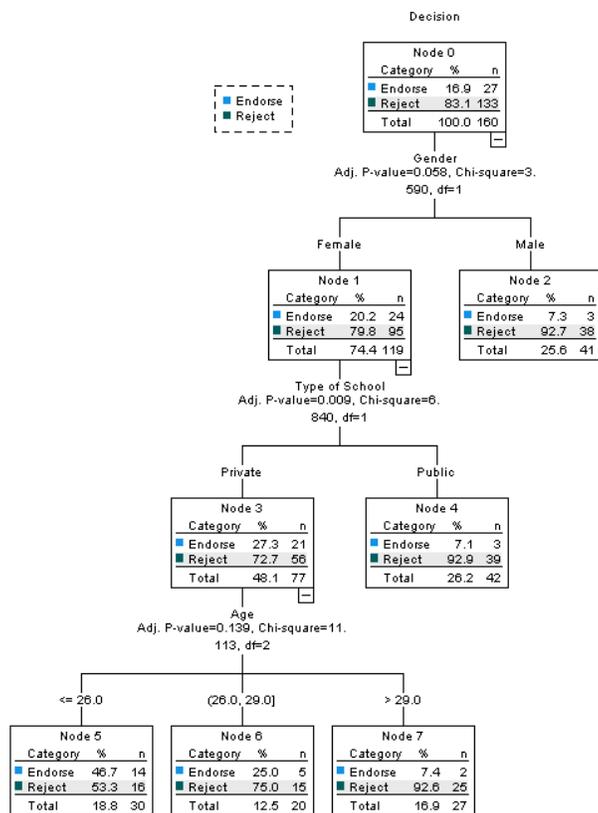


Figure 3. Decision Tree Model for the 3<sup>rd</sup> Level of Recruitment Process

## 6. Conclusion

Human resources strategic plan of the IT company comprises rigorous recruitment process. Currently, the IT company's recruitment process encompassed three levels: (1) English proficiency examination; (2) video interview; and (3) text interview and advanced problem solving test. In characterizing a system to generate the most qualified applicant, multilevel AHP and TOPSIS were used. Three executives with direct responsibilities in the recruitment process were asked to complete AHP and TOPSIS questionnaires. Computed sub-criteria weights were different in both MCDM methods but were similar on executives' ranking perception. The average ranking proximity values between AHP and TOPSIS were 96.30% for the 1<sup>st</sup> level, 93.38% for the 2<sup>nd</sup> level, and 82.41% for the 3<sup>rd</sup> level. Values are relatively high and at least 82.41% adjacent to 100% accuracy. Furthermore, multilevel AHP and TOPSIS were compared to the established parameters. It was highly recommended to use multilevel AHP in evaluating criteria and sub-criteria in three different levels to determine the top-performing applicant in each level. Consistency of weights was performed to discern credibility of results. On the other hand, TOPSIS achieved better result in prompt identification of criteria and sub-criteria for the entire recruitment and was more appropriate in a single level approach. The best applicant was identified through wide-range recruitment process incorporated with MCDM methods.

The existing methods were further developed through a multilevel framework incorporated with 2<sup>nd</sup> level of sub-criteria. Consequently, it is expected to produce extensive results if 2<sup>nd</sup> level sub-criteria were evaluated. Moreover, predictive model was generated to assess significant demographic factors relative to the most qualified applicants. In 1<sup>st</sup> level, male applicants with social sciences or arts degree from NCR college have higher chances to proceed to the next level. Female applicants with ages of 26-37 years have higher chances in the 2<sup>nd</sup> level. Lastly, female applicants who came from private school and with ages ≤ 26 years have higher chances to be hired by the IT company. As a result, overview of credible and quality applicants was produced. The recommended recruitment policies clearly showed outline of system development through scientific and rational MCDM methods.

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