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Making the recruitment decision for fresh university graduates: a study of employment in an industrial organisation

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Abstract: Owing to the intense need for educated and talented workforce, especially in developing countries, recruiting fresh university graduates has become an important issue for organisations. However, conventional recruitment and personnel selection methods may be unable to fulfil the task due to some uncertainties and complexities such as lack of past work experience or creeping subjectivity into the recruitment process of fresh graduates. This paper addresses the problem by proposing a two-fold recruitment approach which benefits from human resource personnel selection methods and analytic hierarchy process (AHP). A study of employment for an industrial organisation in Malaysia was conducted and the proposed model was applied. The study has shown the overriding role of university lecturers for the recruitment of fresh graduates. The consistency and validation of the model was examined through experimental procedures based on consistency test and sensitivity analysis.

Keywords: recruitment; employment; fresh graduates; analytic hierarchy process; AHP; validation; résumé screening; job analysis; structured interview; manufacturing; industrial; Malaysia.

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1 Introduction

The fast-changing and complicated environment of today's industries demands recruitment and personnel selection methods that can deal with the challenges and choose the right candidates for job positions. Finding such approaches has turned into a critical concern for business managers. Due to the high level of complexity in industries, predicting the performance of individuals needs a variety of knowledge. However, recruitment methods that can fully deal with this challenge are rare (Wickens et al., 2004). Managers, especially in industrial organisations, have been seeking for reliable ways which select the most appropriate individuals to fulfil the demands of vacant positions. Poor selection of personnel can lead to severe consequences such as unsuccessful performance in the job and imposing extra cost (e.g., extra training cost) to the company (Aswathappa, 2008).

Despite the growing application of human resource (HR) recruitment and selection methods and their increased validity, there are situations in which these methods do not suffice (Lievens et al., 2002). The first reason is that most of the HR methods rely on historical data. Nowadays, it is not unlikely that individuals need to be recruited for a newly created job, where there is no historical data to support the application of traditional personnel selection methods (Lievens et al., 2002). Second, fast paced technological changes, globalisation, social trends and changes in companies make the jobs in industrial organisations and supply chains more sophisticated than ever before. The traditional selection methods may no longer be suitable since they are only based on stable and individual jobs, while nowadays jobs are much different from those in the past (Lievens et al., 2002). The nature of such jobs needs consideration of multiple, usually conflicting, criteria. Third, creeping certain problems into traditional selection methods is inevitable. One of the most important problems that may appear during job interviews is the halo effect. It is defined as the tendency of the interviewer that causes one of the attributes of a candidate, such as being handsome or generally likable, to influence his or her overall assessment (Gibney and Shang, 2007). Other flaws such as the first impression, contrast effect, and similar-to-me effect are very likely to penetrate into the recruitment process (Anderson and Shackleton, 1993).

In order to overcome the abovementioned shortcomings, application of analytic hierarchy process (AHP) has shown to be an instrumental approach in the context of recruitment and selection for HR scholars and practitioners (Unal, 2011). AHP is a promising decision-making tool that takes the benefit from the judgements of experts, and does not require the past data of a job. Moreover, it is a multiple-criteria decision-making (MCDM) method which can deal with the sophistication and diversity of knowledge when multiple and non-congruent criteria exist. It breaks down the problem into several sub-problems in hierarchies and uses the human natural ability to make sound judgements about each small problem by making pairwise comparisons (Saaty, 1994). In essence, it offers a solution for handling complex, real-life quantitative

problems in which humans generally fail to fulfil the task (Gungor et al., 2009). Finally, AHP is a group decision-making technique that aggregates the judgements of a team to make comparison between candidates. Thus, it can eliminate individual biases such as halo effect during the decision making process by considering the ideas of a group.

Various studies can be found in the literature applying MCDM methods to recruitment and personnel selection problems in order to deal with the disadvantages of conventional methods. Korkmaz et al. (2008) have applied AHP with two-sided matching for military personnel assignment. They have taken benefits from a programme that generates position preferences and personnel competence profiles using AHP, and then assigns military personnel to positions by two-sided matching. This method takes the eligibility of each candidate into account, as well as his or her tendency to do a job. Gungor et al. (2009) have proposed a fuzzy AHP method for a personnel selection problem. In order to evaluate their method, they have made a comparison between their results and the ones from the Yager's weighted goals method, and found that the ranking of alternatives in both methods is close to each other. In this vein, it should be stressed that although AHP has shown its competency, it cannot be applied to every recruitment problem. Lin (2010) has investigated the selection of an electrical engineer in an environment with high levels of vagueness and interdependency between criteria. He has proposed that the application of analytic network process (ANP) with fuzzy logic can outperform AHP alone if the relationship between the criteria is considerable and the personnel characteristics are ambiguous and cannot be measured precisely.

Despite the widespread application of MCDM methods, and in particular AHP, to the recruitment and selection context, implementing these methods along with HR techniques has not yet received enough attention. It is of great importance to note that using MCDM methods such as AHP or ANP solely for the purpose of selection may deprive the employers from the advantages of existing methods. Coupling quantitative tools with qualitative methods is a crucial necessity of today's recruitment programmes since it can explore new assumptions and dynamics of such practices and open new horizons to the HR scholars (Brannan and Hawkins, 2007).

In the past decades, the requirement for educated workforce shows an upsurge in many countries, especially the developing ones (Derouen and Kleiner, 1994). Increase of labour costs and shortage of experienced educated candidates have moved the employers towards selecting talented fresh university graduates. However, the task is not easy since hardly any prior work experience or record of performance in the workplace is in hand upon which the recruitment decision can be made. This impedes the employers to use many of the existing recruitment methods for fresh graduates as those methods utilise work experience as a part of their procedure. In addition, just a handful of empirical studies have been devoted to the selection of fresh graduates in any industry (please see Gammie, 1996; Keenan, 1995; Nicholson and Arnold, 1991; Velasco, 2012). Thus, the question of 'how to choose the most eligible candidate among the fresh graduates applying for the job?' remains an open issue to both researchers and practitioners.

This paper is distinguished from other studies in two ways. First, it deploys HR techniques along with AHP by proposing a two-phase approach. Each phase eliminates the shortcomings of the other phase while improving the recruitment process by its very own advantages. Second, it offers a novel solution for the recruitment of newly graduated students. We have used the idea of lecturers who taught the candidates during their study as the input of our AHP model to eliminate the need for candidates' past records. We believe that lecturers are great references and can provide valuable information that can

be used for making decision on hiring fresh graduates. To the best of our knowledge, no other research has been conducted for the purpose of recruiting fresh graduates in industrial organisations through academia with the scope of this paper.

The rest of this paper is as follows. The next section provides an introduction and the procedure of AHP. Section 3 introduces the proposed model and describes the steps in each phase. In Section 4, the application of the proposed model is illustrated and validated by using a real world example. Section 5 discusses the implications of the study and Section 6 provides conclusions and recommendations for future research.

2 An overview on AHP

AHP is a MCDM tool that was first introduced by Saaty in 1972 (Ishizaka and Labib, 2011). It breaks down the problem into several sub-problems, solves each sub-problem, and then aggregates them in order to gain an overall conclusion (Saaty, 1994). The results provide the decision maker with a ranked list from which the best alternative can be selected. In AHP, perceptions, feelings, memories, and judgements are organised into a framework that represents the forces which affect a decision. The basis of AHP is human's natural ability to make sound judgements on a small problem. It is also a promising tool for group decision making that can prevent bias when the judgement is made by a single individual (Ishizaka and Labib, 2011). A description on the procedure of AHP is as follows.

- *Step 1 – Defining the hierarchy:* In this step, at first, the overall goal should be defined clearly (e.g., selection of the most eligible candidate). The goal may be broken down into some sub-goals to give a clearer portrait of the problem. Second, the criteria contributing to satisfy the goal or sub-goals should be known. Here again, there may be some sub-criteria as well. Finally, the alternatives should be defined (e.g., candidates) (Saaty, 1994).
- *Step 2 – Making pairwise comparisons:* After the overall structure of AHP is modelled, it is time to make the pairwise comparisons. Pairwise comparison is at the heart of AHP and helps the decision maker to make a judgement between alternatives *a* and *b* having the same units. It is used to indicate how well each alternative scores on a specific criterion (Taylor, 2010). This judgement is made according to a relative verbal appreciation which is more familiar to our daily lives (Ishizaka and Labib, 2011). The standard preference scale used for AHP is shown in Table 1. The values are determined by experienced scholars of AHP to provide a logical basis for comparing between two alternatives.

  According to Table 1, if alternative *a* is 'moderately preferred' to alternative *b* under a particular criterion, then this comparison receives a value of 3. This is an indicator of preference of the decision maker for one alternative over the other. Note that it is not necessary to compare *b* to *a*, since this is an opposite comparison and its value is simply the reciprocal or inverse of the preference of *a* for *b*. Therefore, the preference value of *b* for *a* is 1/3. If *n* is the number of alternatives, then $n(n-1)/2$ comparisons should be made under each criterion. The comparisons are inserted in a positive reciprocal matrix as shown below, where a_{ij} is the result of the pairwise comparison between alternatives *i* and *j*.

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & \cdots & a_{ij} & \cdots \\ \cdots & a_{ji} = \dfrac{1}{a_{ij}} & \cdots & \cdots \\ a_{n1} & \cdots & \cdots & 1 \end{bmatrix}$$

Making pairwise comparisons continues until all the alternatives are compared and a matrix is generated for each criterion. Let us call these matrices as 'pairwise comparison matrices of alternatives'. A comparison between the criteria should be made as well and a matrix is developed in the same way which we call it as 'pairwise comparison matrix of criteria'. Note that the arrays of all generated matrices can be referred to as preferences, priorities, or weights.

- *Step 3 – Synthesisation:* After all the pairwise comparisons are made, 'the pairwise comparison matrices of alternatives' should be normalised by dividing the value of each column by its corresponding sum and then taking the average of the values in each row. The obtained values from each matrix are a one-column matrix that shows the priorities of alternatives with respect to their corresponding criterion. This ranking of decision alternatives is referred to as synthesisation. The one-column matrices resulting from synthesisation are put together to form a new matrix called 'preference matrix'. Then, the 'pairwise comparison matrix of criteria' should be synthesised in the same way and the results are summarised in a single matrix called 'criteria matrix'. Finally, the 'preference matrix' and 'criteria matrix' are multiplied and the result determines the overall ranking of alternatives. The alternatives are ranked according to their achieved values from high to low.
- *Step 4 – Consistency check:* After the results are obtained, the consistency of the developed model should be checked. This is important because a decision maker may sometimes lose track of his or her previous responses. It is essential that these responses are valid and consistent because they form the basis of AHP. Creeping inconsistencies into AHP is not unexpected especially when the decision maker is asked to make too many pairwise comparisons. Some degree of slight inconsistency is tolerable; however, an index is used to ensure that the degree of inconsistency is not too high. To check the consistency, the following steps are proposed (Taylor, 2010). Note that the procedure is described for the 'criteria matrix'. The consistency of the 'preference matrix' can be checked in the same way.
  - a multiply the unnormalised 'pairwise comparison matrix of criteria' by the 'criteria matrix'
  - b divide each of the obtained values by its corresponding weight derived from the 'criteria matrix' and then sum up all the values
  - c divide the summation by the number of criteria and call it λ
  - d calculate the consistency index, shown by *CI,* using equation (1).

$$CI = \frac{\lambda - n}{n - 1} \tag{1}$$

e If $CI = 0$, the decision making process is perfectly consistent; else, determine the level of consistency using equation (2):

$$Consistency\ level = \frac{CI}{RI} \tag{2}$$

where RI is the random index that can be obtained from Table 2.

Table 1 Preference scale for pairwise comparisons

Preference level	*Numeric value*
Equally preferred	1
Equally to moderately preferred	2
Moderately preferred	3
Moderately to strongly preferred	4
Strongly preferred	5
Strongly to very strongly preferred	6
Very strongly preferred	7
Very strongly to extremely preferred	8
Extremely preferred	9

Source: Ishizaka and Labib (2011)

Table 2 *RI* values for *n* items being compared

n	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

Source: Taylor (2010)

As a rule of thumb, a value of 0.1 or less is acceptable and shows that the degree of inconsistency is not too high (Saaty, 1994). If the value exceeds 0.1, there is a probability that the inconsistency is severe and the results obtained from AHP may not be reliable and meaningful.

3 The proposed model

In this section, a brief description on the proposed model is provided. The model consists of two main phases, each of which contains some steps as follows.

- Phase I (HR-based)
  Step 1 job analysis
  Step 2 résumé screening
  Step 3 structured interview.
- Phase II (MCDM-based)
  Step 1 AHP
  Step 2 validation of results through sensitivity analysis.

In the first step of phase I, the employer should determine what criteria are exactly sought for the position. This is achieved through conducting a job analysis. The staff who have ample experience in the job as well as experts from the HR department can contribute in conducting the job analysis. Next, the employer screens the résumés received from the candidates and excludes the ones which do not meet the specifications required for the job. Specifications such as work experience, grade point average (GPA), extracurricular activities, and special qualifications according to the results of job analysis can be considered as the measures of screening. In the third step, the candidates who have been chosen according to résumé screening are invited for the job interview. Structured interview is highly preferable to traditional interview since it has shown to be considerably more productive and profitable (Cook, 2009). The outcomes of job analysis are used again to develop interview questions and checklists. At the end of phase I, the candidates whose specifications do not fit the position or the ones who do not have enough eligibility are rejected, while a shortlist of candidates with higher eligibility is in hand for further consideration.

The steps discussed in the first phase are applied in many recruitment and selection programmes by employers nowadays. However, these steps do not suffice in the following situations and environments:

1 where the job is critical and challenging

2 where assessment and evaluation of several factors are necessary and the recruitment process needs to be more scrutinised

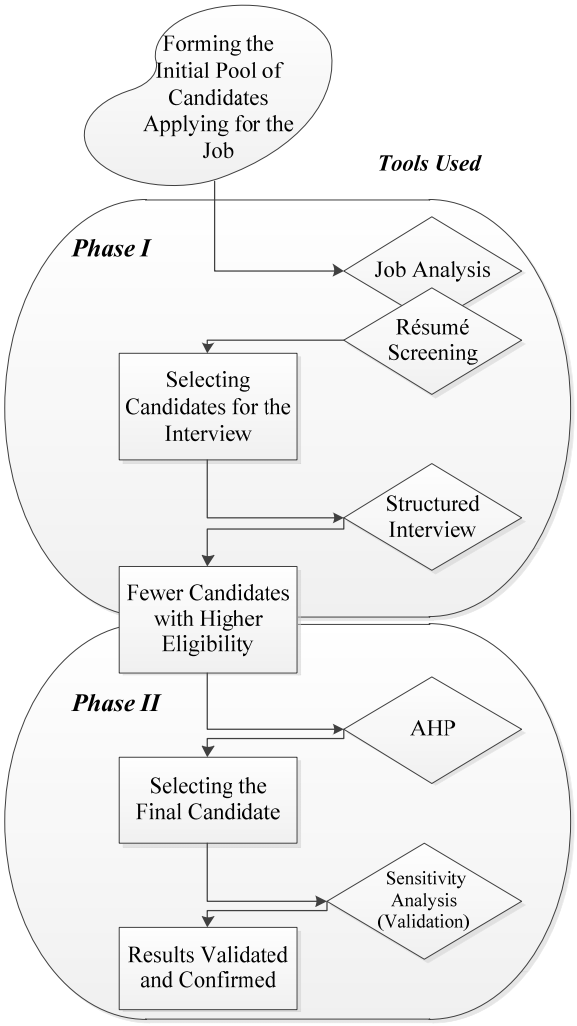
3 where the managers want to make their final decision while ensuring that subjective judgements do not creep into the selection process

4 where the number of accepted candidates from the interviews is more than the number of vacant positions and the managers need another decisive tool.

Regarding the last case, it has been shown that when there is more than one acceptable candidate for a position, the interviewer's interpretation becomes significantly subjective (Peppas, 2006). Generally speaking, industrial and manufacturing environments typify such conditions.

The second phase uses AHP to make the hiring decision. In the first step of this phase, the experts should determine the most significant criteria. They can use all or some of the criteria achieved from job analysis in phase I. It should be noted that job analysis only provides the criteria regardless of their relative importance or position in the decision making hierarchy. Application of AHP enables the experts to define exactly how preferable each criterion is over the other ones by assigning numerical scores. It is also probable that some criteria need to be classified under some others as subsets. This can be done by adding one or more levels to the hierarchy in AHP. In order to avoid flaws such as halo effect and individual misjudgement, it is preferable to use the preferences of a group of experts and then aggregating them. Finally, the validity of the results should be examined rigorously. We proposed an experimental procedure for validation based on sensitivity analysis. If the model is found to be unreliable, further discussion should be made by the experts to gain a consensus. A schematic representation of the proposed hybrid approach is shown in Figure 1.

Figure 1 The proposed hybrid model



4 Application of the proposed model

The proposed model was applied to a real-world industrial recruitment problem. In autumn 2011, a manufacturing company located in the state of Selangor, Malaysia, announced the need for hiring a new mechanical engineer. The factory is involved in the manufacturing, distribution and marketing of beverages and required qualified personnel for its production. Since the factory decided to hire a fresh graduate, the HR department asked the Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, as a leading university in Malaysia to cooperate in finding the right person. The faculty's graduate office informed the students through notice boards to send their résumés to the company. The procedure of applying the proposed model is explained in the rest of this section.

4.1 Job analysis

Job analysis is at the heart of any HR activity, including personnel selection (Singh, 2008). It provides the most useful informational base, upon which management decisions such as recruitment or training can be made (Landis et al., 1998; Siddique, 2004). Through job analysis, job descriptions and specifications are clearly defined and the employer knows what criteria are exactly needed to go on with the rest of recruitment process (Proenca and Oliveira, 2009; Kim and Lee, 2011). Therefore, it is essential to identify the key capabilities in the form of criteria prior to any other action. For the studied company, the staff of HR department consulted the personnel of the manufacturing department who had the expertise in the position of mechanical engineering. Using the ideas of experts is a promising approach to carry out the job analysis (Singh, 2008). Accordingly, 15 initial criteria were realised to be effective for the job. They are presented in Table 3. These criteria are in line with the position's requirements as well as the company's goals, mission, vision, and culture. For instance, problem solving abilities and adaptation to situations and flexibility (criterion 8 and criterion 12) refer to the dynamic and challenging environment and culture of the company.

Table 3 Results of job analysis

1	Appearance: neatness and proper attire	9	Communication skills
2	Comportment: manner, behaviour and attitude	10	Ability to work in a team
3	Punctuality	11	Ability to handle pressure and multitask
4	Tone of voice	12	Adaptation to situations and flexibility
5	Confidence level	13	Creativity
6	Ability to understand and answer questions	14	Handling difficult situations
7	Knowledge	15	English speaking skills
8	Problem solving abilities		

4.2 Résumé screening

One of the main steps in almost every selection process is résumé screening (Tsai et al., 2011). Résumés provide the initial information on the applicant and create the first impression to the employer (Derous and Ryan, 2012; Thoms et al., 1999). According to the results of résumés evaluation, the candidates are invited for the pre-employment job interview. In fact, not far to say that the goal of résumés is to produce job interviews (Thoms et al., 1999).

In the case study of this paper, a total of 42 résumés were sent to the company after the announcement by the faculty (N = 42). Among them, 38 (90.5%) were males, and the mean age was 23.5 (standard deviation = 0.50). In addition, 38 candidates (90.5%) were Malay and the other four candidates were Chinese, Turkish and Yemeni (two candidates). In order to evaluate the résumés, the HR department first focused on the academic achievements and more particularly GPA. To do this, they sorted the students according to their GPA from high to low. GPA is most frequently used for entry-level positions in

personnel selection. Application of GPA for résumé screening has been studied and advocated in the literature (Chen et al., 2011; Cole et al., 2007; Knouse, 1994; Thoms et al., 1999; Tsai et al., 2011). Next, the attention was devoted to past job experience as it forms the most important section of a résumé together with education (Knouse, 1994). However, since the fresh graduates or final year students usually do not have much job experience, this gap was filled by redirecting the attention towards extracurricular activities as proposed in Cole et al. (2007) and industrial trainings. Finally, the HR department eliminated the candidates who were poor in both GPA and extracurricular activities. As the result of résumé screening, the pool of candidates was downsized to 33 (acceptance level = 78.6%). The list of accepted candidates along with their résumés were sent to the faculty to be invited for the interview.

4.3 Structured interview

Interview can be defined as a formal, deep conversation conducted for the purpose of estimating the applicant's acceptability (Aswathappa, 2008). It is the most widely used method for personnel selection; more than 70% of US and more than 80% of European employers use it for the selection process. However, the validity and reliability of this method is shown to be comparatively low (Cook, 2009; Lowry, 1994). In order to deal with the drawbacks, structured interview has been proposed and become rapidly widespread since 1980. The difference between these two is that in traditional interview, the interviewer usually does not have a job description, person specification and prepared questions. He is just seeking for 'someone who will fit in the job' or 'the right sort of person'. While in structured interview, the interviewer has structured and organised questions and the judgements are made according to some rating scales or checklists. Application of structured interview has improved the reliability of traditional interview significantly (Cook, 2009). For a comprehensive review on the literature, design, and procedure of the structured interview, readers are directed to one of the most recent papers in this area (Levashina et al., 2014).

Moreover, grounding the structured interview on the results of job analysis is one promising way to make the interview highly valid and reliable (Pettersen and Durivage, 2008; Pulakos et al., 1996; Roulin and Bangerter, 2012). It ensures that the questions and judgements are job-related and avoids the interview process from circling in confusion. Thus, the interviewer knows what should be exactly sought and evaluated during the interview.

4.3.1 Designing the interview forms

Since the managers of the company decided to conduct the structured interview, the HR department started to design forms and checklists based on the results of job analysis to be used for the interview. They fulfilled the task by generating two types of forms. The first form consisted of the questions that were going to be asked during the interview. These questions were derived from job analysis and aimed at measuring the ability of the candidate in each criterion. Some examples were: 'Sometimes, it is necessary to decide in unsettled and rapidly changing situations. Explain what have you done when you found yourself in such a situation' for criterion 12 in Table 3; or 'Describe an example of the time when you cannot deal with a problem alone and you need to form a team effort to work' for criterion 10. Such role-play and situational questions are very common in a

structured interview and are thought to increase its reliability and validity (Brannan and Hawkins, 2007). The second form contained a table by which the interviewer could rate the candidate for each criterion with the scales excellent (4), good (3), average (2), and poor (1), a blank area to give comments on the candidate, and a checkbox for his overall opinion on accepting or rejecting the candidate.

4.3.2 Carrying out the interview

Having designed the interview forms, the HR department sent the forms (together with the list of accepted students from the résumé screening process) to the university. Three lecturers were appointed to conduct the recruitment process from here on. We believe that for hiring newly graduated students with no prior work experience, university lecturers can forecast the performance of students very well since they are familiar with the capabilities and qualifications of the students.

The interviews were conducted in the university where the students would feel more comfortable and the lecturers were available. Each interview lasted about 20 to 30 minutes and was held by one lecturer only. It was also possible to hold each interview by more than one lecturer where each lecturer asks a specific set of questions to all the candidates. Such a procedure is referred to as panel interview in the literature (Levashina et al., 2014). Panel interview would be more beneficial when each interviewer (lecturer) is expert at a special set of questions to be asked during the interview. However, in the case study of this paper there was no difference between lecturers in terms of their areas of expertise and hence, each candidate was interviewed by one lecturer. On the other side, an effort was made to assign each student to the lecturer who had taught that student and can predict the student's future job performance. In other words, instead of breaking down the questions and asking each lecturer to ask a special cluster of questions to all the students (panel interview), the students were clustered and each cluster was assigned to a special lecturer for a complete interview. Broadly speaking, if the interviewers and the interviewees only meet each other at the interview venue and the interviewers have different areas of expertise, panel interview would bring more consistency.

All the 33 candidates were exposed to the same questions existing in the designed form for the sake of consistency of the interview process. The interviewer rated each candidate for each criterion, gave his idea about the candidate if necessary, and made his judgement to accept or reject the candidate. Finally, five students were accepted as the results of the structured interviews.

4.4 AHP

4.4.1 Necessity of AHP

After the interviews were held, a discussion was triggered among the lecturers for selecting the most eligible individual out of the five current candidates. The lecturers believed that all the selected candidates suit the requirements of the job and can be introduced to the company. Since the company called for just one vacant position, it was necessary to apply a more accurate tool that is capable of prioritising the criteria and evaluating the individuals with a more insightful look. At this point, the authors proposed the use of AHP as a group decision making tool to come to a consensual conclusion. It should be noted that AHP could not be applied as an initial selection tool to replace the

steps in the first phase, because one cannot compare more than seven elements (candidates in the context of selection) without increasing the overall inconsistency of the judgements in AHP (Saaty and Shang, 2011). On the other hand, application of structured interview could not help anymore at this point since it is unable to structure the group decision hierarchy, take the relative importance of every judgement into account, and determine the inconsistencies of the judgements to make the final decision. Hence, AHP was applied to scrutinise the problem in the last and most critical step and choose the best candidate.

4.4.2 Forming the hierarchy and making pairwise comparisons

Prior to conducting AHP, the lecturers have consulted the company's experts about the criteria and reduced them to five. They believed that these five criteria can reflect both individual and group qualifications needed for the job. Moreover, according to the ideas of the experts, the position involves many interactions with the people in the workplace, and thus the criteria related to group performance should be weightier. The selected five criteria are presented in Table 4. As can be seen, criteria 3 and 4 correspond to team performance and the rest are pertaining to individual performance of the candidate in the position.

Table 4 Criteria for the recruitment problem

Cr. 1	Ability to understand and answer questions
Cr. 2	Problem solving abilities
Cr. 3	Communication skills
Cr. 4	Ability to work in a team
Cr. 5	Adaptation to situations and flexibility

Having defined the criteria, the AHP process was started by asking the lecturers to make pairwise comparisons between the candidates for each criterion and between the criteria themselves. This is one of the significant features of AHP that prioritises not only the candidates but also the criteria of recruitment. In order to compare criteria, the lecturers sought advice from company experts who had already conducted job analysis.

Consequently, the decision matrices were formed and the inconsistency was calculated for each matrix. The judgements of lecturers one and two were consistent enough, while the preferences of the third lecturer showed some inconsistencies more than the acceptable level. In such cases, the decision maker should be asked to make his judgements again with more focus and accuracy to prevent bias in the results of AHP. If the problem is not solved by making the judgements again, collecting more data or reexamining the framework of hierarchy is recommended (Saaty, 1994). Here, the third lecturer made his judgements again and could reach an acceptable level of consistency this time.

4.4.3 Aggregation of preferences and obtaining the results

Three sets of data gathered from three lecturers should be aggregated to give a single result. In order to do this, several methods have been proposed in the literature. A study by Forman and Peniwati (1998) has proposed two methods in order to aggregate the individual judgements and priorities. They have found that using either the aggregation of

individual judgements (AIJ) or the aggregation of individual priorities (AIP) can bring the most fruitful results. According to that study, when the involved group in the decision making process behaves as separate individuals, the application of AIP is recommended. On the other hand, when the individuals work together based on the preferences of the group or organisation, it is best to use AIJ. In this study, the lecturers acted in their own rights and each one had the freedom to use his own preferences regardless of the ideas of the other two lecturers.

In order to aggregate the ideas by AIP, both geometric and arithmetic means are applicable. Arithmetic mean is what generally referred to as the mean or average and is found more comfortable by most people to be used. However, geometric mean shows more consistency for both judgements and priorities in AHP according to Forman and Peniwati (1998). Therefore, the geometric mean was selected to be used for the aggregation of lecturers' preferences.

Before applying the geometric mean, the weight of decision makers' ideas should be investigated. It should be noted that assigning weights to decision makers is a vital step in AHP which should not be affected by other recruitment methods used prior to AHP. In other words, when the preferences of decision makers are deemed to be unequally important, their preferences must be weighted before aggregation in AHP even if they were previously treated as equal during job interviews or résumé screening. The way that the interviews were conducted (e.g., structured or traditional, single or panel) also does not influence the necessity of weighting in AHP as the final decision making tool.

In case that the judgements of all individuals are of equal importance, simple geometric mean must be used. On the other hand, when their judgements have different importance, they must be weighted using weighted geometric mean method (WGMM). Xu (2000) indicated that WGMM is the most common method for aggregation of preferences in the literature of AHP. He has then proven that if the judgement matrices of an AHP model are fairly consistent, the resulting WGMM is of acceptable consistency. Therefore, consistency check can be skipped for the aggregated preferences. In our case study, two of the lecturers knew all the selected students before the initial interview, while the third lecturer met some of them just in the interview venue. Accordingly, the judgements of those two lecturers about the students were more insightful in comparison with the third one and should receive more weight. This conclusion could also be drawn from the level of inconsistency in the judgements of the third lecturer.

The procedure of WGMM can be described briefly as follows. At first, the weight of each decision maker's preferences must be evaluated. Let us assume that the preferences of each of the first and second lecturers carry twice the weight of preferences of the third lecturer. If the weights of the three lecturers are denoted by λ_1, λ_2 and λ_3 respectively, they can be formulated as shown in equation (3).

$$\lambda_1 = \lambda_2 = 2\lambda_3 \tag{3}$$

The summation of weights should be equal to 1 as shown in equation (4).

$$\sum_{i=1}^{3} \lambda_i = 1 \tag{4}$$

Therefore, the weights were calculated as shown in equation (5).

$$\lambda_1 = \lambda_2 = 0.4,\ \ \lambda_3 = 0.2 \tag{5}$$

If the set of $X = \{x_1, x_2, x_3\}$ is the set comprising the preferences of three decision makers for the first pairwise comparison within the first criterion, the first array of the aggregated matrix within this criterion using the weighted geometric mean is calculated according to equation (6).

$$\bar{x} = \prod_{i=1}^{3} x_i^{\lambda_i} \tag{6}$$

In our example, if the set of $X = \left\{3, 4, \frac{1}{7}\right\}$ shows the preferences of the three lecturers for a pairwise comparison within the criterion '*Ability to understand and answer questions*', while the weights are $\lambda_1 = \lambda_2 = 0.4$ and $\lambda_3 = 0.2$, then the aggregated importance for this set of preferences using WGMM would be $\left(3^{0.4} \times 4^{0.4} \times \frac{1}{7}^{0.2}\right) = 1.83.$

The rest of the preferences were aggregated in the same way and inserted into the matrices. The aggregated preferences for all the pairwise comparisons of candidates are shown in Table 5. The priorities in Table 5 are calculated based on step three (synthesisation) as described in Section 2. Note that candidates 1 to 5 are denoted by C1 to C5.

The criteria should also be aggregated in the same way and then their priorities should be calculated as mentioned previously. The results are presented in Table 6. Since the consistency level of judgements was initially acceptable, the consistency check for the data in Tables 5 and 6 was not needed. Note that the names of the criteria are not mentioned in the first row of Table 6 for the sake of simplicity. The priorities of Table 6 are graphically illustrated in Figure 2 using AHP software called *Expert Choice*.

Table 5 Aggregation of pairwise comparisons for candidates

Cr. 1	*Ability to understand and answer questions*	*C1*	*C2*	*C3*	*C4*	*C5*	*Priorities*
C1		1	1.83	1.43	3.81	1.15	0.300
C2			1	0.63	1.48	0.56	0.143
C3				1	2.05	0.72	0.203
C4					1	0.37	0.093
C5						1	0.261
Cr. 2	*Problem solving abilities*						
C1		1	1.95	1.12	2.64	1.64	0.288
C2			1	0.43	0.89	0.89	0.131
C3				1	3.37	1.55	0.298
C4					1	0.61	0.111
C5						1	0.172
Cr. 3	*Communication skills*						
C1		1	0.89	1.18	2.66	1.00	0.228
C2			1	0.85	3.39	0.92	0.230
C3				1	3.1	1.25	0.242
C4					1	0.32	0.075
C5						1	0.225

Table 5 Aggregation of pairwise comparisons for candidates (continued)

Cr. 4	*Ability to work in a team*	*C1*	*C2*	*C3*	*C4*	*C5*	*Priorities*
C1		1	1.82	0.76	1.02	0.69	0.188
C2			1	0.44	0.46	0.32	0.097
C3				1	1.51	1.12	0.261
C4					1	1.15	0.210
C5						1	0.244
Cr. 5	*Adaptation to situations and flexibility*						
C1		1	1.38	0.26	1.02	0.69	0.138
C2			1	0.39	0.76	0.68	0.123
C3				1	2.63	2.05	0.402
C4					1	1.15	0.161
C5						1	0.176

Table 6 Aggregation of pairwise comparisons for criteria

Recruitment criteria		*Cr. 1*	*Cr. 2*	*Cr. 3*	*Cr. 4*	*Cr. 5*	*Priorities*
Cr. 1	Ability to understand and answer questions	1	1.00	0.55	0.74	1.67	0.171
Cr. 2	Problem solving abilities		1	0.85	0.93	2.06	0.205
Cr. 3	Communication skills			1	1.36	4.13	0.303
Cr. 4	Ability to work in a team				1	3.30	0.236
Cr. 5	Adaptation to situations and flexibility					1	0.086

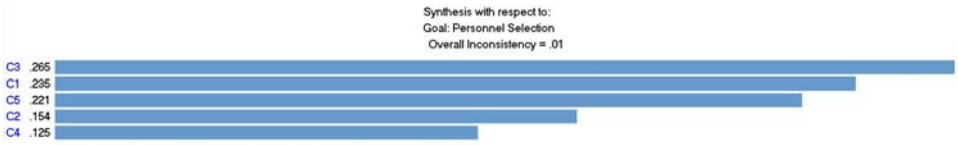
Figure 2 Graphical illustration of priorities for the criteria (see online version for colours)

As can be seen in Figure 2, criterion 3 (communication skills) is ranked as the most important criterion followed by criterion 4 (ability to work in a team). Recall that these criteria were pertaining to team performance of the employee in the job which means the position of mechanical engineer in the company requires teamwork and many interactions with other people in the workplace. Here again, it can be inferred that such a position is highly challenging and complicated. This conclusion is advocated by the literature of personnel selection where it has been stressed that in complex working environments, the importance of inter-job activities as well as teamwork should be highlighted (Singh, 2008).

In order to achieve the results of the AHP model, the priorities shown in Tables 5 and 6 should be multiplied based on step three (synthesisation) as described in Section 2. Figure 3 illustrates the ranking and priorities of candidates with respect to the goal. The

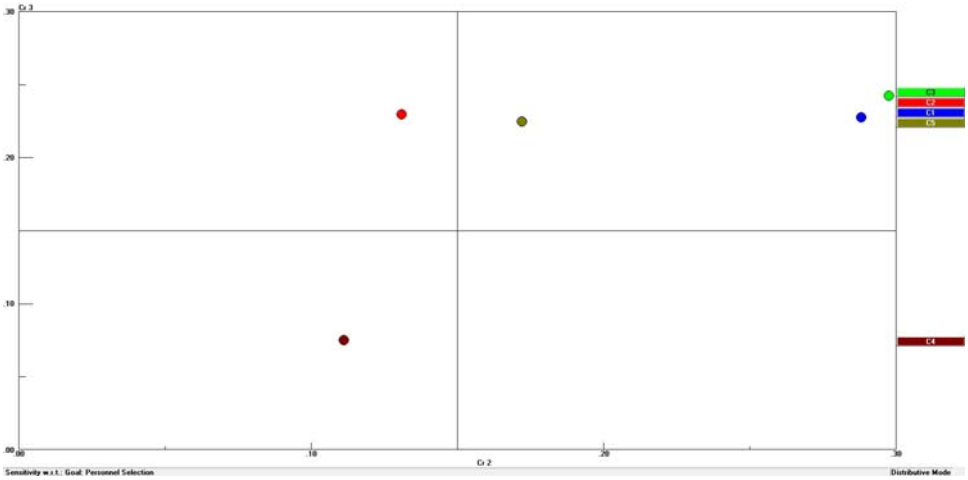
overall inconsistency of the model is equal to 0.01 which means that the lecturers made quite coherent judgements.

Figure 3 The AHP model results (see online version for colours)



Sometimes, the employers are interested in comparing the candidates with respect to some certain criteria. In our study for instance, the employer wanted to know how the candidates would perform in criterion 3 (the weightiest criterion pertaining to group skills) and criterion 2 (the weightiest criterion pertaining to individual skills). For this purpose, a two dimensional chart as shown in Figure 4 can be used. In this type of chart, each criterion is assigned to one dimension. Here, criterion 2 is shown on the X axis and criterion 3 is shown on the Y axis. The preferences of the candidates with respect to both criteria are shown by dots inside the plot. This type of chart is helpful when some special criteria are important for the managers or when they need to synthesise the results with more details.

Figure 4 Two-dimensional chart for the weightiest group and individual criteria (see online version for colours)



4.5 Validation

After applying a selection procedure, undertaking a validation study is the most important consideration. It ensures that the achieved results are based upon a sound scientific grounding and can be used as a measure to predict the future performance of candidates (Tippins et al., 2003). While the validity of widely used methods such as structured interview has been studied and investigated by many researchers (Milia and Gorodecki,

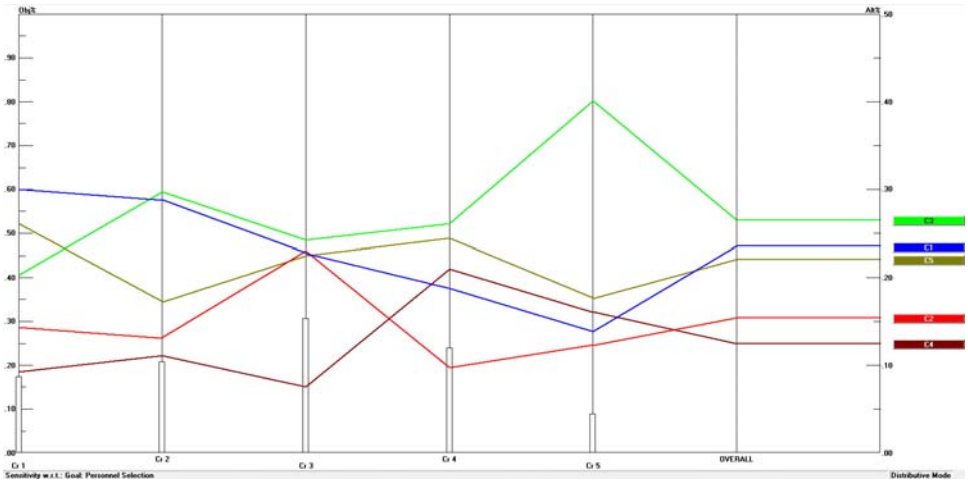
1997), the issue has not been addressed for the AHP-based personnel selection method. Generally, the validity of MCDM methods has not been discussed sufficiently due to the

1 lack of objective measures of the decision maker's values such as ratings or weights to be compared with the outcome of the MCDM method

2 unavailability of a universal optimum solution for the method that can be inclusively accepted (Yeh, 2003).

To tackle the problem, we propose the use of sensitivity analysis of the results in a certain way as a novel approach to test the validity of weights given to criteria. Sensitivity analysis is prevalently used by scholars in operations research and management to develop various scenarios and assess the impact of each scenario on the goal function. In the case study of this paper, since the lecturers expressed different preferences for the relative importance of each criterion over other criteria, the 'true' weight might be more or less than the final aggregated weight used in the model. Therefore, the weights of the criteria should be varied and the consequences on the results should be investigated. Figure 5 is a performance sensitivity graph that illustrates the current ranking of the candidates with respect to the criteria. The vertical bars (Cr 1 to Cr 5) show the relative importance of the criteria which is a result of AHP as already shown in Figure 2. The candidates are represented by horizontal coloured lines. The intersection of each vertical line by the candidates' lines represents the ranking with respect to the criterion on that vertical line; The candidate whose line intersects higher is ranked better with respect to that criterion. The overall ranking, shown on the right hand side of the graph, takes all the criteria and their weights into account. Through this graph, the weights of criteria (vertical bars) can be increased or decreased arbitrarily and the impact of these changes on the overall ranking of candidates can be observed. We varied the weights based on a one-criterion-at-a-time procedure. This kind of procedure allows us to clearly identify the influential criterion in case any meaningful variation is revealed.

Figure 5 Performance sensitivity graph with respect to the criteria (see online version for colours)



The extents by which the weights were varied have been determined using an upper bound and lower bound. These bounds propose a range within which the true indicator of the criterion weight exists. As a perception shared by the lecturers, the upper bound could not be more than twice the value of the current aggregated weight, while the lower bound could not be less than half of it. According to this, the weight of each criterion was doubled first, and then reduced by half. This process was conducted continuously and the ranking of the candidates was observed. By increasing and reducing the weights of five criteria to their predefined bounds, we generated and studied ten different scenarios. Among them, in nine cases the final ranking remained unchanged, while only one case showed some slight changes; when the value for criterion 4 was doubled, candidates 1 and 5 exchanged their positions as well as candidates 2 and 4. However, candidate 3 remained as the top candidate and did not change its position. Figure 6 shows the changes in the ranking results as the weight of criterion 4 doubles.

In order to have a closer look at the changes within the scenarios, another chart called gradient chart can be used. The chart for the aforementioned change in the ranking is shown in Figure 7. Using this chart, the ranking pattern of the candidates due to changes in the priority of a criterion can be traced and the point at which the candidates change their positions can be determined. The vertical line on the left shows the current priority of criterion 4. This line intersects the horizontal lines which represent the candidates. Here again, the candidate who intersects higher is ranked better. The dotted vertical line on the right indicates the point at which candidates 5 and 4 overtake candidates 1 and 2, respectively. Since the change occurs at a point relatively far from the current priority of criterion 4 and it does not affect the top candidate, we conclude that it might not have a considerable impact on the case practically.

Figure 6 Changes in the final ranking when the weight of criterion 4 is doubled (see online version for colours)

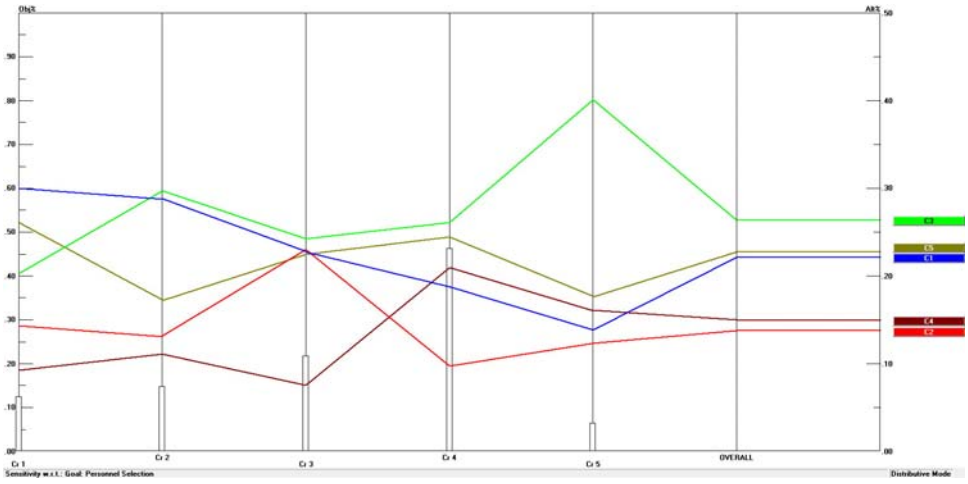
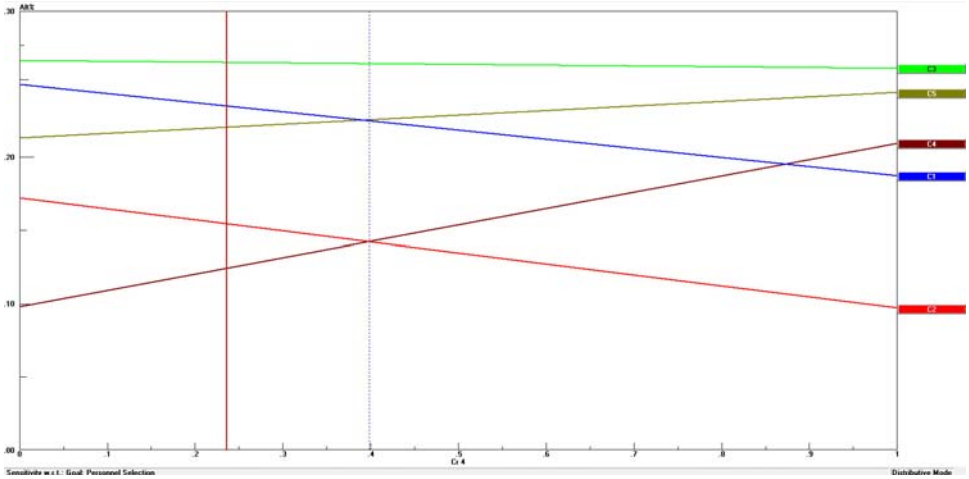


Figure 7 Gradient chart for criterion 4 (see online version for colours)



In the other nine scenarios, the variation of priorities did not affect the ranking of candidates. Therefore, the results produced by the model are highly valid and the current aggregation of preferences is unbiased and robust. Following the model validation, the procedure of applying AHP, its validation, and the name of the final candidate were passed to the HR department of the company. After reviewing the constructed model and its produced results, the company found the procedure quite convincing and confirmed the choice of the final candidate for the position.

5 Research implications and limitations

This paper aims to study the recruitment process in the industrial sector while drawing particular attention to the newly graduated students and seeks for improving such a process. Several research implications are noteworthy with respect to the proposed model. Firstly, it makes a great effort to eliminate the subjectivity from the selection process. We believe that the case of recruiting fresh graduates is potentially vulnerable to subjective judgements. That is because such candidates do not have prior work experience or past records to be used as an indicator of their future performance which leaves the selection decision highly dependent on the personal judgement of the selector. The proposed twofold approach tries to deal with the challenge by structuring the interview and aggregating the ideas of a group of experts using AHP. Combining these goal-oriented and rationalised methods turns the process into a more objective, controllable and scientific one.

Secondly, the proposed procedure for validation ensures that the relative importance of criteria reflects the true predictive job measures. When the validity of the selection process is examined by a systematic approach, the employment decision is highly reliable, accurate and non-discriminatory, and results in the selection of the best candidate (Jereb et al., 2005). The proposed validity examination of weights is simply applicable to any other MCDM method in the same way. This is especially favourable when the employer makes a thorough investigation by applying several methods on a

single pool of candidates. Since the methodology of this paper ends up with a MCDM method as the final selection tool, the proposed validation procedure at the final step reinforces the adopted recruitment policy and ensures the employer that the ranking of candidates is highly reliable. In practice, when a decision is to be made based solely on a single method of selection, applying more than one method and choosing the most valid one is strongly recommended (Hobbs et al., 1992).

Thirdly, in most hiring cases, the recruitment process is performed by HR departments whose staff are expert in deploying personnel selection and recruitment methods. Yet, due to the aforementioned shortcomings, especially with respect to fresh graduates, university lecturers can take a significant part in the recruitment process. Through this study, some successful areas of collaboration and work breakdown between the HR department and university have been underlined. For instance, HR staff helped the lecturers in assigning weights to criteria resulting from job analysis and the lecturers provided their insights about the graduates with whom they had known for years while each party preserved its defined duties throughout the process. In this regard, one might question about the reason of holding the interviews without the presence of a representative from the employing company. That is explainable due to the work breakdown and duty assignment procedure agreed by both parties. Since the interviews were fully structured, the procedure of interviews, the questions to be asked and their order, and the ratings were precisely defined by the HR department. This standardisation of the interview process eliminates the need for the physical attendance of a representative. Generally, such a collaboration and task division between two units from two totally different organisations can bring a synergetic outcome and considerably enriches the recruitment process whilst the boundaries of duties and action plans are clearly defined in such a way that the final decision is acceptable for everyone and any potential conflict is avoided.

Finally, although AHP was found as a viable tool for the studied case of recruitment, we urge managers and HR staff to investigate the conditions which bring about the need for the application of AHP in personnel selection and employment programmes (see Subsection 4.4.1.). If such conditions are not present, application of existing HR methods with some adjustments would suffice. For example, if the validity of interview is the only concern of employers, both taking notes and using multiple interviewers in the same interview can increase the structure level and validity of the interview to some extent (Campion et al., 1997). In such cases, using adjusted HR methods such as the ones proposed in the first phase can result in a favourable outcome without applying AHP.

Furthermore, note that the terms selection and recruitment have slight differences in the context of HR management. The recruitment process involves the steps from advertising and stimulating candidates to apply for the job to testing the skills required for the position, whilst selection aims at screening the candidates to choose the most suitable one for the offered position. However, in this paper, the terms are almost interchangeably used.

As research limitations, it should be noted that this paper does not offer a generalised approach for the recruitment of new graduates in industrial organisations; however, the proposed model can be modified according to the requirements of the organisation for the selection purpose. Since each company has its own characteristics, these modifications must be carefully applied by the HR staff so that they suit the needs of the company. As an example, if an interrelation is found between the criteria, AHP should be replaced with ANP.

Moreover, as already mentioned in Subsection 4.4.1, the number of criteria and alternatives used for AHP is limited. This confines the application of the second phase for the cases with a relatively high number of criteria or finalists. To address the issue, other MCDM methods such as technique for order of preference by similarity to ideal solution (TOPSIS) which has no limitation in the number of criteria or alternatives may be applicable.

6 Conclusions

The study casts a light upon the personnel selection and recruitment problem of new graduates in manufacturing systems by proposing a multidisciplinary approach which is capable of taking into account the descriptive nature of HR methods as well as the quantitative judgements of experts. Such a framework addresses the shortcomings of the conventional methods such as interviews whilst the advantages of such methods are preserved. It works best in manufacturing and industrial systems where high degrees of complexity and diversity of data exist and conventional methods cannot fulfil the requirements of selection. Moreover, the case study presented in this paper can illustrate a successful instance of cooperation between a university and an industry for hiring fresh graduates. In essence, industries can benefit from the knowledge and experience of lecturers to choose the most talented students as their workforce. Universities, on the other hand, can guide their students to select the career that best suits their capabilities. As a recommendation for future research, we suggest binding other MCDM techniques with the existing HR selection methods and comparing the results with the ones of this study.

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Notes

The interview forms are available on demand from the corresponding author.