

Recommendation System: A New Approach to Recommend Potential Profile Using AHP Method

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ABSTRACT

The most challenging problem in human resources, especially in the IT digital services company, is to assign the best collaborators in the adequate project, then ensure the delivery performance. In this paper, the authors aim to develop a recommendation system using based content and collaborative filtering in order to recommend potential profiles for a new job offer. The principal parts of this recommendation is the matching between job offer of new project and collaborator profiles and the scoring using AHP method. In the first step, the authors propose a model of criteria to measure collective skills. They validate by a survey realized in the IT service company. They analyze the data collected using PCA method (principal component analysis). The results indicate six factors to measure collective skills of each collaborator (technical skill, proactivity, integrity, cooperation, communication, and benevolence/interpersonal relationship). These factors are used in AHP function to give a score for each collaborator then allow the recommendation for the adequate project.

KEYWORDS

AHP Method, Collective Skill, Dimensionality Reduction, PCA, Recommendation System, Trust Model

1. INTRODUCTION

In the Digital services company, In Human Resources domain, one of the most challenging problems is to affect the best profiles to the adequate project, to predict the success of collaborator and to ensure the delivery's performance. In this paper, we propose a recommendation system based on two approaches: based-content and collaborative filtering. The aims of our proposition are:

- The proposition of a new model to evaluate the skills of collaborators
- The proposition of a recommendation system for ranking/matching collaborators profiles, with content-based and collaborative filtering to assign the potentials profiles to the adequate project (profiles who have an estimated end date of actual project assignment).
- The prediction of the collaborator's success in the new job offer.

The measure of collective skill is taken into account through various studies. We quote on one hand the study of Janaina Macke (2016), who present an instrument to measure collectives skills in IT team and indicate four factors (Proactivity, Cooperation, Communication and Interpersonal-Relationship), on the other hand the study of Lucile Callebert (2017) who elaborate a multi-agent system that generates the behaviors of agents on the team in a virtual environment, he highlights

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the importance of trust for the team's performance, the criteria of trust are (Integrity, Benevolence, technical skill) , we note that these criteria are related to the Trust Model MDS (Mayer, David, Shoorman). Our proposition aims to take into account the trust in the measure of collective skills, therefore we propose a hybrid model that assembles these two models, we examine the validity of this proposition by a survey carried out in an IT Digital services company, the objective of this survey is to define the criteria to measure collective skills from the analysis of the collected data using PCA method. These criteria will be used in the AHP function to give score for each collaborator, then allow the recommendation to the adequate project. The structure of this paper is as follows: First, we introduce the literature review, our contribution, we discuss the results, conclude in the final section indicating the perspectives of our contribution.

2. LITERATURE REVIEW

There are many works related to Skill's management, despite the simplicity of this concept its application is complicated (Ruas, 2005). According to Bonotto (2005), there is two approaches related to this concept: individual and organizational. Otherwise, many authors take a great importance for the coordination of these skills and highlight their importance as a principal factor of success and performance (Dutra, 2007). The various studies of collective skills are based on the articulation between skills and organization by project, in the project management's context, there are autonomous or semi-autonomous teams and groups that emerge around a common professional objective (Loufrani-Fedida, 2012).

2.1 Individual Skill:

Skill is strongly related to a goal to be achieved. Being competent means having the ability to apply one's knowledge so that a goal could be achieved. Linked to success, skill remains inseparable from performance. This is according to Le Boterf (2003). We cannot consider that an individual is competent in himself, but rather toward a specific action. There are sometimes, specific cases when the knowledge or abilities cannot be exploited efficiently, and we cannot use it in a way that is favorable to the work that needs to be carried out. As a result, the situation highlights the real skills held by the individual.

2.2 Collective Skill:

Collective skill is a skill attributed to a collective group and or to a team autonomous or semi-autonomous teams, quality circles or informally arise when groups are articulated around a common professional objective.

Sabrina Loufrani-Fedida (2012) proposed a representation of collective skills as follows.

Figure 1. Collective Skill



2.3 The Model to Measure Collective Skills

There are Many studies related to the measure of skills in a team, Janaina Macke and Kelly Menezes Crespi (2016), have developed an instrument to measure the collective skills of IT teams. This study focuses on the characteristics of these teams. This research is based on a quantitative study whose data are collected through a survey with 110 employees. The results indicate that four factors can measure the collaborator's skills (Proactivity, Cooperation, Communication, Interpersonal Relationship),

We introduce below the definition of each criterion:

- **Proactivity:** According to Zarifian (2001) Proactivity is an important attitude for the development of skills, it presents a strong relation between skill and capacity to take responsibilities toward a complicated situation in the work.
- **Cooperation:** According to Zarifian (2001), Cooperation is the mutualization of the ways to solve problems.
- **Communication:** According to (Le Boterf, (2003)) the communication cannot eliminate the tension and conflict but allows the members of team to manage it and consider it as normal.
- **Inter-personal Relationship:** Colleagues need to know each other's strengths and weaknesses so that they can diagnose each other's needs and plan adequate actions.

2.4 Model of TRUST

Trust is a basic element for group's performance. According to Lucile Callebert (2017), and related to the trust model proposed by MDS (Mayer, David, Shoorman) (Shoorman, 2007),(Bowen, 2018) trustor's intention to trust relies on the assessment of the following characteristics of the trustee:

- **Technical skill:** The evaluation of the trustee's skill by the trustor is related to a specific field.
- **Integrity:** Integrity is linked to the regularity of the trustee's behavior and to the coherence between his words and his actions.
- **Benevolence:** The trustor will perceive the trustee as benevolent if he has the impression that the trustee wants his property.

According the studies related to the description of criteria that influences the group's performance and the description the collective skill, we note that the instrument proposed by Janina Macke is relatively limited. Many factors can influence the collective skill, especially the factors related to the trust model (technical skill, integrity, benevolence). Therefore, we will propose a model that assembles these criteria to have a better definition of how to measure a collective skill.

3. CONTRIBUTION

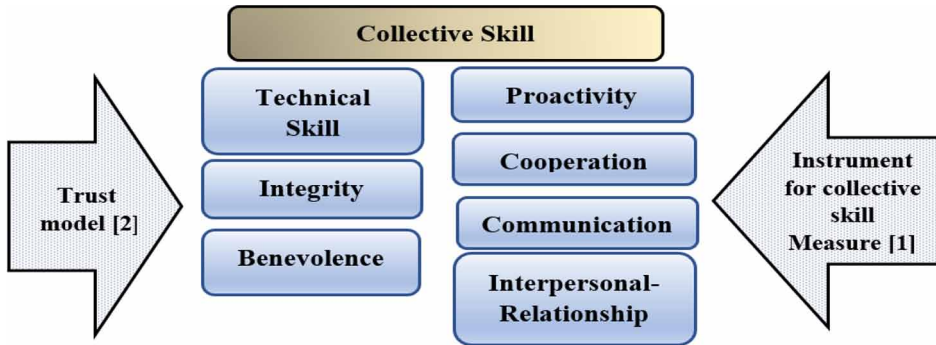
3.1 Proposition of a Hybrid Model of Skill's Measure

According to the literature review above , specially the comparison of the two studies (Macke, 2016) ; (Callebert, 2017) , we propose in this paragraph a new model We propose a Hybrid model that is supposed to evaluate collective skill, We will proceed in the next paragraph by evaluating the reliability of this model by a case study in an IT service company to highlight the criteria to measure collective skill.

In order to test the validity of the model to measure collective skill, the methodology is to process with a survey carried out in an IT service company, the data are analyzed by the PCA method in order to determine factors of measure collective skill.

The different steps of this study are as follows:

Figure 2. The proposed model for measuring collective skill



- Description of the work teams
- The conception of the hypotheses of the survey and collects data
- Data analysis
- Results and discussion

3.1.1 Conception of the Hypotheses of the Survey and Data Collect

The formulation of the hypotheses of the survey is based on the study of Janaina Macke(2016) and following the studies (Closs, 2004), (Pereira, 2007), (Rosa, 2007).Related to the criteria of Trust model (technical skill, integrity, benevolence), we make a new hypotheses based on the definition adopted by different authors. the survey includes the description of the attitudes and behaviors of the collaborators in the Team, there are 43 hypotheses. The response are the opinions on the hypotheses based on five Likert-type scale levels, 1 to 5, (1 for strongly disagree and 5 for strongly agree).

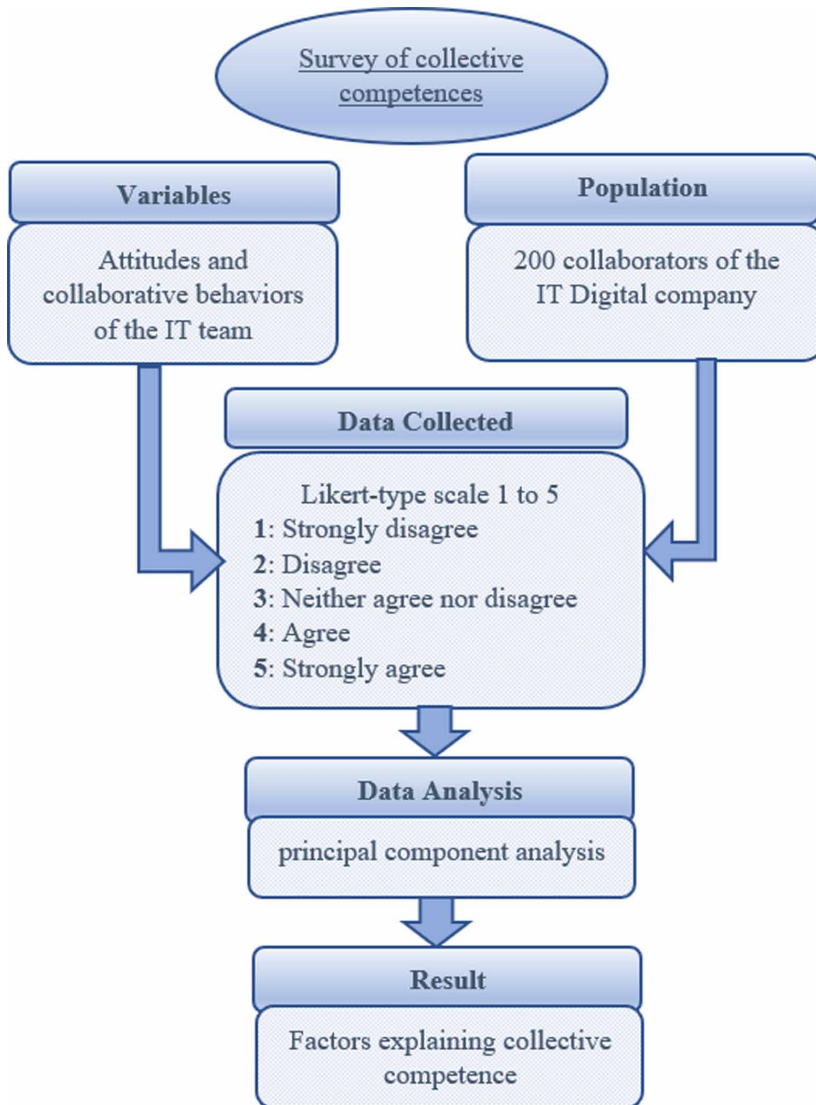
3.1.2 Data Analysis

The analysis is carried out using the dimensionality reduction, and specially the PCA method (Principal Component Analysis):

1. Dimensionality reduction: is a method used to project data from a large space into a smaller space. This operation is crucial in machine learning to fight against what is called the scourge of large dimensions (the fact that large dimension alters the efficiency of methods).
2. PCA method: The principal Component Analysis (Liu et al., 2016) is a powerful tool for information compression and synthesis, very useful when there is a large quantitative data to be processed and interpreted, this method is a factorial analysis, it produces factors that present a linear combination of the initial, hierarchical and independent variables. It is mostly used as exploratory data analysis to make predictive models.

The survey includes 43 hypotheses, the survey is destined to 200 collaborators who have to give a response for each variable, to analyze the resulting data, we have to reduce the dimensionality of these variables using PCA method in order to obtain a better explanation. The analysis is carried with Varimax rotation, a Kaiser-Meyer-Olkin (KMO) adequacy index of 0.912 and a Bartlett sphericity test of 0.000.The first cycle of the analysis identified eight factors, with variables with a low factor load, and other that significantly saturates on more than one factor, this signifies that these variables should be removed from the analysis, these variables are excluded from the second cycle. In the second cycle of our analysis, six factors of collective skills are found with an explained variance about 90%.

Figure 3. presentation of the study process



the presentation of the variables is significant only on five factors, after a Varimax rotation of the factorial planes, normalization of Kaiser with convergence, we obtain a presentation on six factors as presented in the next paragraph.

Table 1. Presentation of variables and factors

Variable	Hypotheses	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
V1	Our team often finds creative ways to solve problems.	,777	-,036	,037	,007	,096	-,018
V2	On our team, there is a balanced distribution of tasks among members	,700	-,036	,037	,007	,096	-,018
V3	In our team, people are interested in learning more about their colleagues.	,650	-,036	,037	,007	,096	-,018
V4	When a problem hinders our progress, team members show motivation to solve it.	,644	-,036	,037	,007	,096	-,018
V5	In our team colleagues usually share their knowledge.	,640	-,036	,037	,007	,096	-,018
V6	My colleagues often cooperate so that the team can achieve their goals.	,630	-,036	,037	,007	,096	-,018
V7	When I have problems, my teammates usually help me.	,600	-,036	,037	,007	,096	-,018
V8	My colleagues encourage me to meet or exceed my personal and professional goals	-,078	,750	,069	,073	,216	,211
V9	We often adopt the goals of other team members in an altruistic manner	-,078	,750	,079	,073	,216	,211
V10	We always trust that each teammate helps us to achieve the collective goal	-,068	,700	,069	,073	,216	,211
V11	My colleagues understand my strengths and weaknesses.	-,078	,650	,089	,073	,216	,211
V12	When I have a complaint, I feel free to talk to a colleague(s) about it.	-,068	,644	,069	,073	,216	,211
V13	The team members have proved their kindness many times. Their help was indispensable in the various problems encountered.	-,066	,600	,069	,073	,216	,211
V14	Delivery times are always respected	,039	,037	,800	,127	,061	,086
V15	We always make the privilege of collective goals on personal goals in order to succeed together	,039	,027	,750	,127	,061	,076
V16	We are honest about our words; we think what we say and we say what we think	,071	,129	,700	-,116	,076	,042
V17	We are always honest and committed to our collective goal	,071	,159	,650	-,116	,066	,042
V18	In our team the members privilege the realization of the tasks for which they are competent	-,148	,040	-,105	,915	,100	,134
V19	The skill of the team members is crucial for the success of the project	-,148	,24	-,105	,900	,100	,134
V20	We often trust the teammate's skill to do a common task	,211	,174	,143	,831	-,130	-,221
V21	We measure the levels of skill with the resultant levels or the execution time of tasks requiring this skill	,211	,174	,143	,831	-,130	-,221
V22	We pay attention to the moods in our team.	,267	,496	,109	-,008	,820	,020
V23	Relationships in our team are based on cooperation.	,267	,496	,109	-,008	,790	,020
V24	My colleagues have ways to show they care about each other.	,267	,496	,109	-,008	,700	,020
V25	In our team we recognize the efforts of colleagues	,267	,496	,109	-,008	,650	,020
V26	In our team we tell colleagues if they are doing something considered unacceptable	-,024	,385	,090	-,033	,017	,750
V27	We often discuss how to manage our difficulties.	-,024	,385	,090	-,033	,017	,730
V28	We recognize a tense situation and talk about it with team members.	-,024	,385	,090	-,033	,017	,700

3.1.3 Results and Discussions

Explanation of factors:

- **[Proactivity]:** V1 to V7 (table above). Proactivity is very important element for the evaluation of collective skill. According to Zarifian, (2003) one of the most important attitudes to skills development is proactivity, which means that skill is related to one's ability to take responsibility for working situations as well as act proactively in the face of unexpected events. According to Le Boterf (2018) to be competent means to be able to act and take initiatives, evaluation can no longer be reduced to controlling the compliance with a standard.
- **[Benevolence /Interpersonal relationship]:** V8 à V13, this factor reassembles benevolence and interpersonal relationships. Benevolence can refer to a specific relationship between the Trustor and Trustee, therefore, it is more important when the Trustor and the trustee strongly know each other (Callebert, 2017).
- **[Integrity]:** V14 à V17, these four variables are the most important determinants of integrity, the integrity is essential in the determination of the collective skill. To achieve the common goal every team member must be honest and dedicated toward his or her engagements as well as respect the planning and task completion.
- **[Technical skill]:** V18 à V21, these variables are mainly associated with technical skill. This factor is a determinant of trust and group's performance, according to Sabrina Loufrani-Fedida (2012), individual skill is a key element in achieving collective skill.
- **[Cooperation]:** V22 à V25, these variables are mainly associated with cooperation. According to the work (Macke, 2016), cooperation is a way to converge the actions and processes between collaborators. This factor is essential in the group's performance.
- **[Communication]:** V26 à V28, these variables are the most closely associated with the communication. Communication is a very important element in teamwork, according to le Boterf (2003). Being able to communicate does not eliminate the problems and crises but promotes the ability to manage and consider them as normal.

Throughout our study, we conclude that collective skill will be presented by the six following criteria: Technical skill, Integrity, Benevolence/interpersonal relationship, proactivity, cooperation, communication. Each of these criteria is important to the group's performance.

3.2 Recommendation System to Assign Collaborator to a Job Offer

3.2.1 Recommendation System in Human Resources

Recommendation systems provide users with suggestions to meet their needs and preferences. There are different approaches related to the recommendation system we quote: the approach by based-content filtering which makes recommendations by comparing the content of resources with the user's preferences (Yu et al., 2018), the approach by collaborative filtering which makes recommendations by analyzing the users' opinions and those of other users about the resources they have consulted (Mao et al., 2017). There are many works related to the recommendation system in Human resource, for the internal assignment in the company (Darmon et al., 2018) the author proposes a prototype of a recommendation engine based on a Big Human Resources Data platform, allowing to securely retrieve the best candidates (resume) for a specific mission, using the matching of CV-Mission and different type of scoring.

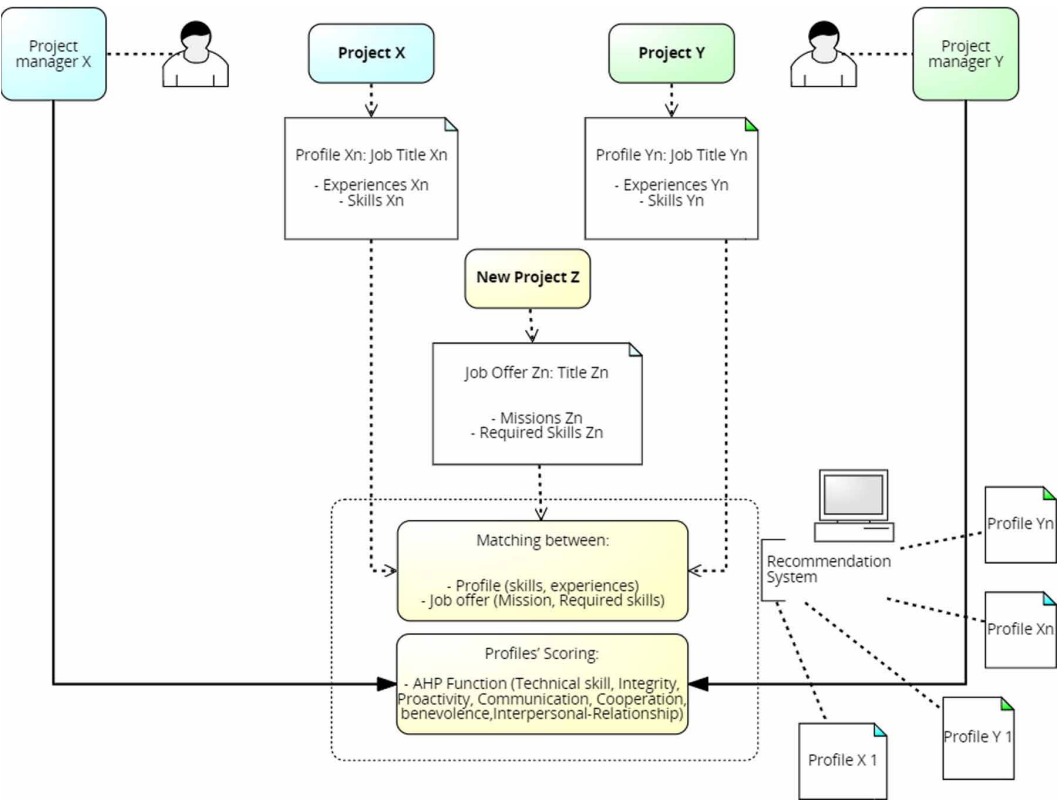
In the E-recruitment, we find many works in this field, we note the work (Casagrande et al., 2017), the author proposes a recommendation system using content-based filtering, it is possible to target relevant candidate profiles using the information provided by the recruiter without, to rely on candidate reviews by other recruiters. he uses the matching of the job offer and candidate profile by the indexation and full text search using the engine LUCENE, for ranking the candidate he uses a sous-

scoring related to similarity of titles, number of skills, the difference between an experiences year of candidate and job offer. he progresses the accuracy of the system using the automatic detection of the activity area with supervised machine learning. There are many approaches to match the candidates profiles with the specific job offer, in the work (Rodriguez & Chavez, 2019) the author propose a system that adopt a clustering algorithm to match the profile of the job seekers and the requirements of the job posted by the employers. A Novel Approach for Learning How to Automatically Match Job Offers and Candidate Profiles is proposed in the work (Martinez-Gil et al., 2019), it is based on automatically computing transformation costs by using background knowledge (in the form of well-known taxonomies),this approach proposes a new method that involves collecting a wide range of partial measures, which can be strategically combined to replicate the behavior of the experts.

3.2.2 Proposed Model for the Recommendation of Potentials Profiles

The objective of our contribution is to develop a recommendation system for recommending potential collaborators, using tow approach :content-based (it is possible to target relevant candidate profiles using the information provided by the recruiter without) and collaborative filtering (to make

Figure 4. Proposed Model of Recommendation System



recommendation through the score given by the last project managers), the principal parts the proposed recommendation system are:

- 1- To match the subject and required skills of the job offer in the new project with the technical skills related to the experiences of the collaborator.
- 2- To rank each collaborator by the score given by the last project manager using the AHP method.

3.2.3 The Matching Between Skills, Experience of Profile and Job Offer

There are many studies that are related to the matching of job offer /candidate profiles, according to the works (Casagrande et al., 2017), (Dieng, 2016), the matching is done through the extraction of the useful information's from the job offer((Title, Skills, years of experience) , and profiles research (Indexation and full-text search for profiles using the Lucene engine(<https://lucene.apache.org/>) (Azzopardi & Moshfeghi, 2017) (Białecki & Muir, 2012)).

The search realized by the Lucene engine, is based on these fields, for example:

- The field **expfunc** to search for the job title of the offer in the jobs occupied during the experience of the profile.
- The field **skillname** to search for the skills extracted from the job offer among the skills of the collaborator's profile.

Example of query: **expfunc**="lead developer" **AND skillname**:(Technical design, Develop and execute unit tests)

3.2.4 Proposition of Function to Give a Score to the Collaborators

In our approach, we will propose a function that assembles the different criteria of the new proposed model to evaluate the collaborator , according to the studies on methods of multicriteria analysis (Domański & Kondrasiuk, 2002), (Gaikwad, 2016) we opted for the method AHP (Hierarchical Analysis Process.AHP is a process that is characterized by its way of determining the weights of criteria by binary combinations of each level of hierarchy with the consideration of the elements with the highest level; the main criteria are contained in the first level, followed by secondary criteria in the second level. The principles of the AHP method:

- The decomposition of the problem into a hierarchical structure (by levels)
- The binary combinations
- The determination of priorities
- The synthesis of priorities
- The consistency of judgments

According to the principles of the AHP method, the proposed function is

$$F(x) = \sum \alpha_i X_i (i = 1 \rightarrow n) (0 < \alpha_i < 1; \sum \alpha_i = 1)$$

Function 1: AHP Function to give a score to the collaborator

X_i = Criteria related to the validation of collective skill; α_i = Weight of each criteria

Table 2. Criteria matrix for determining the binary importance

	Technical skill	Benevolence / relationship	Integrity	Proactivity	Cooperation	Communication
Technical skill	1	4	4	4	4	4
Benevolence /Relationship	1/4	1	1/2	1/3	1/2	1/3
Integrity	1/4	2	1	2	2	2
Proactivity	1/4	3	1/2	1	2	2
Cooperation	1/4	2	1/2	1/2	1	2
Communication	1/4	3	1/2	1/2	1/2	1

- The criteria are: **X1** = Technical skill, **X2** = Integrity, **X3** = Proactivity, **X4** = Cooperation, **X5**=Benevolence /Interpersonal relationship, **X6** = Communication
- We define the weights of the criteria according to the expert's judgment

In the table below, we present the binary importance of each criteria given by the project managers

The objective is the comparison of the importance of criteria in line with the importance of criteria in column: 1= equal, 2= moderate, 3= strong, 4= very strong, 5= extreme. The next step is the calculation of the weighting of the criteria:

The final function is the following:

Table 3. Calculation of criteria's weight

	Technical skill	Benevolence / Relationship	Integrity	Proactivity	Cooperation	Communication	Criteria Average
Technical skill	0.44	0.266	0.57	0.48	0.4	0.35	0.417
Benevolence / Relationship	0.11	0.066	0.07	0.04	0.05	0.029	0.06
Integrity	0.11	0.13	0.14	0.24	0.2	0.176	0.166
Proactivity	0.11	0.2	0.07	0.12	0.2	0.176	0.146
Cooperation	0.11	0.13	0.07	0.06	0.1	0.176	0.107
Communication	0.11	0.2	0.07	0.06	0.05	0.088	0.096

Table 4. List of collaborators assigned to the new project

Job Offer	Required technical skill
15 Business Analyst	Strategic Planning, Reporting , Quotation ,Functional conception, Functional testing, ...
15 JAVA Consultants	Develop and execute unit tests, Technical design, Correct anomalies of the different test cycles, Struts 1, JSF 2, Swing/Awt...
20 .NET Consultants	Develop and execute unit tests ,Technical design, Correct anomalies of the different test cycles, Web development-ASP. NET AJAX ...

$$F(x) = 0.417 X1 + 0.166 X2 + 0.146 X3 + 0.107 X4 + 0.096 X5 + 0.06 X6$$

X1 = Technical skill, X2 = Integrity, X3 = Proactivity, X4 = Cooperation, X5 = Communication, X6 = Benevolence /Interpersonal relationship

3.2.5 Evaluation of the Recommendation System

The evaluation of the accuracy of our recommendation system, is taken manually for 60 collaborators who are assigned to a new project.

Methodology: Assignment in the new project with a specific job offers, we present in the table below the collaborators assigned to the new job offer.

The collaborators have a specific technical skills that are required for the new project, and also the different aspects of collective skills related to the behavior in the last team project (communication, cooperation, proactivity, integrity, benevolence/interpersonal relationship).these collaborators are assigned from different other projects, to the new project in where they spent six months.

- 1- We look for the evaluation's score given by the last project manager basing on the AHP function.
- 2- The recommendation of the collaborator having required skills for the new job, basing on the evaluation's score given in the step 1.
- 3- We look for the opinion of the new project manager regarding the performance of the collaborator in the new project.

After analysis of the different recommendation, and relating to the satisfaction of the new project manager regarding the performance of the collaborator we present an example of some recommendation's evaluation:

After the analysis of the evaluation's result (60 collaborators) we conclude that the obtained accuracy is about 80%, this result is relatively encouraging, we have to continue the analysis with other cases to conclude the different areas of improvement of the recommendation system.

Table 5. Example of some recommendation's evaluation

Collaborator	Rating in the last project assignment (with AHP function)	Recommendation	Performance in the current project	Recommendation Result
Business Analyst	2	Recommended	OK	Successful
Business analyst	2	Recommended	KO	Unsuccessful
JAVA Consultant	1	Recommended	OK	Successful
JAVA Consultant	4	Not Recommended	KO	Successful
.NET Consultant	1	Recommended	OK	Successful
.NET Consultant	2	Recommended	OK	Successful

4. CONCLUSION AND PERSPECTIVES

Many companies use management practices to plan, capture, develop and evaluate the skills needed to achieve their goals at different levels of the organization. In this paper, we have proposed a new criteria to evaluate the collaborator in the project, the six criteria are (Technical skill, Integrity, Proactivity, Communication, Cooperation, and Benevolence/Interpersonal Relationship). These criteria are used in a function defined by the AHP method that aims to give an evaluation' score for each collaborator. The proposed recommendation system is based on the collaborative and content-based filtering , it allow the recommendation of the collaborators (who have an end date of actual assignment) for the adequate project, through the matching of the subject and required skills of the job offer with the technical skills of the collaborator, and the ranking of the collaborator by the evaluation's score using the AHP method. This new model helps us to predict the collaborator's success in the adequate project, then ensure the delivery's performance of the company. The main limitations of this proposed recommendation system is the cold start problem, the system is based on collaborative filtering, for the new collaborator we don't have a score attributed by the project manager, in perspective we will use the data from social networks (Viadeo, LinkedIn ...) to recommend this new profile.

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