

An Agent-based Performance Evaluation System

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Abstract

Performance evaluation is one of the major factors that determine the growth and development of any organization. Competent and hardworking employees are identified proper appraisal, and promotion and gratuity are justly applied. Lack of clarity of performance metrics and bias create improper appraisal in organizations, with evaluation process mostly inconclusive, incomplete, and unfair, affecting the effectiveness of the result. This study, therefore, focused on developing a model and application towards achieving a staff-centric, task-centric and environment-centric computer-based appraisal system. In developing the proposed system, the spiral model of the Software Development Life Cycle was adopted. The software development environment consists of Netbeans Integrated Development Environment, Hypertext Mark-up language, MySQL, MySQL DB connector, Apache and PHPmyAdmin. The metrics that were used by the system to evaluate performance include attendance, employee responsiveness, punctuality and projects. The model was created and an agent-based performance evaluation application was developed as an instantiation of the model. The system revealed employee strengths and weaknesses regarding execution of a particular project.

Keywords: Performance Evaluation; Agent; Appraisal; Performance Metrics; Auto-Scoring.

1. Introduction

Largely, the need for evaluation is to reward high performing employees, recognize areas for improvement of staff as well as organizations, and provide recommendation in case of un-reconcilable negligence of staff [1]. Though these reasons should make any organization want to adopt evaluation system, most organizations that perform evaluations disrupts the system with too many human interpretations or bias. Performance evaluations are usually not as effective as they should be because some organization's performance process lack credibility; no clarity in the aspect of Job being evaluated, no standards against which performance is measured [13].

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A recent investigation of major U.S organizations revealed that 40% of managers admitted to forging or controlling performance data because it was clear to them that the evaluation served no valuable purpose in the way it was managed in their Organization [9]. Performance Evaluation is bias, manual, vague and incomplete in most Organizations [8]. Most Organizations do not have intelligent systems to appraise their staff thereby adopting manual process, which injects subjectivity into staff appraisal [7]. Appraisal system should track targets, accomplishments and projects of each employee, otherwise, a staff is appraised based on human judgments and traits. Employee is then evaluated by finding a score that best characterizes his or her level of performance for every quality rather than the competence and accomplishment of tasks.

Organizations ceaselessly look for solutions to manage and maximize the performance of their workforce. They perceive that there has been a shift in the business environment from a tangible asset economy to an intangible asset economy [12]. However, the challenge of recognizing every employee's abilities, capacities, and areas for development to encourage positive commitment and managing poor performance can be overwhelming.

The problem of performance evaluation is a hydra-headed monster which includes non-existence of the process in many organizations. Organizations that put checks and balances into their operations are few. Those who do, spend hours of valuable man-power trying to manually arrive at the staff performance evaluation. When these are done, various data are exposed to personal bias. At other times the performance evaluation are inconclusive and incomplete as there is no clarity of performance metrics; thus, affecting the effectiveness of the result. Hence, in order to achieve the goal of objectivity, credibility and trust in staff appraisal, a system that achieves comprehensive and self-information gathering must be considered, which the study focused upon.

The objectives of this study were to develop an agent-based Intelligent Performance evaluation model for managing staff-work information and auto-Scoring based on organization's predefined uniform company-wide appraisal score-weights, create a prototype of the proposed model, and evaluate the prototype.

An extensive literature review provided the basis for developing an appreciation of the relevant issues in the study. The knowledge gained from the literature survey was used to construct a theoretical background of the research. The organization's predefined uniform company-wide appraisal score-weights served as the basis for proposing the model of the agent-based performance evaluation system to be used in managing staff-work information and auto-Scoring. The prototype of the proposed model was developed using the Netbeans IDE, Hypertext Markup language (HTML), MySQL, MySQL DB connector, Apache and PHPmyAdmin. The prototype of the proposed system was simulated and implemented to demonstrate the degree of exactness of the system and the extent to which bias had been eradicated through automatic and intelligent information gathering about staff. The evaluation of the model was carried using an organization as a Case-Study.

The proposed approach will enable an auto-determinant appraisal scores for every staff. A manager or project team head can provide weight values to agreed appraisal metrics. Management can detect staff's attitude to work automatically through intelligent approaches such as Staff-Computer Inactivity Time, Staff-Email response time. An appraisal administrator can view non-editable appraisal scores at will and it also allows management provide informed judgements and decisions based on the appraisal outputs. This approach will go a long way in

enhancing the work-experiences, staff outputs and overall company achievement as they can share and learn from genuine and unbiased appraisal reportage.

2. Outcomes and discussions

2.1 The Model

The architecture of the agent-based Intelligent Performance evaluation model is presented in Figure 1. The model consists of three tiers, namely the Staff Client Agent or Staff-Agent tier, the Data Interpreter Server tier, and the Score tier. These are further discussed subsequently.

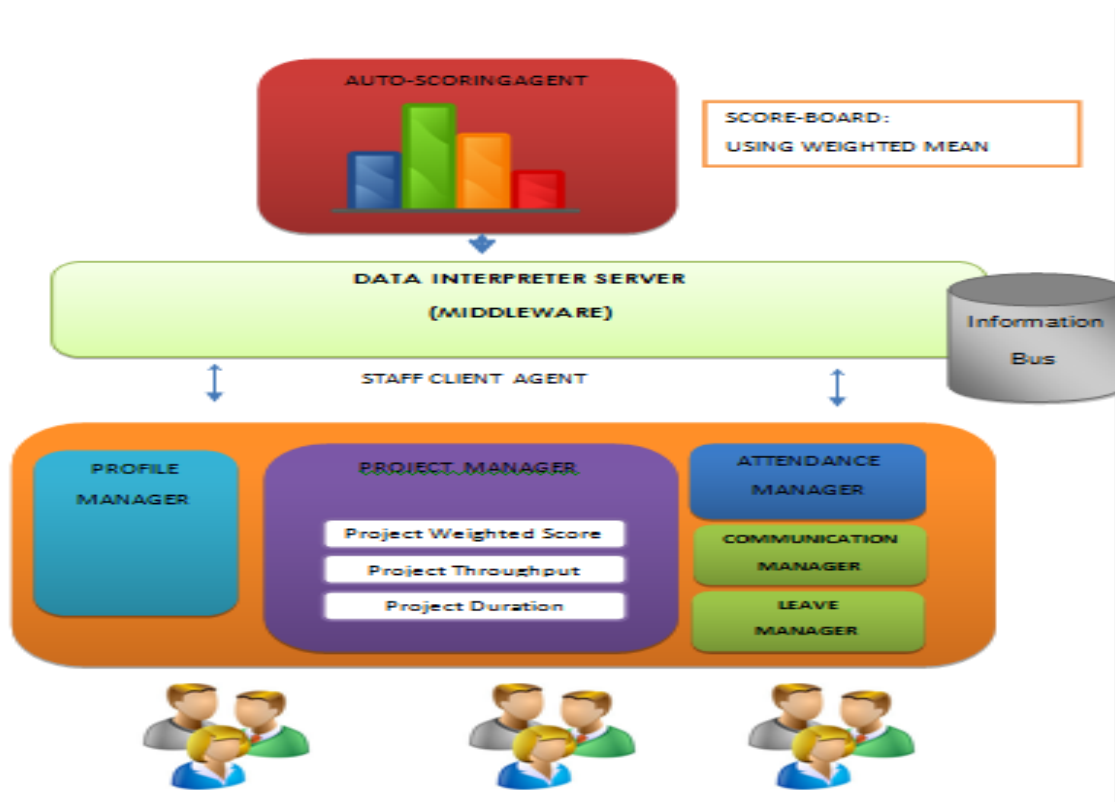


Figure 1: Architecture of the Model

1st Tier: The Staff Client Agent or Staff-Agent Tier

This is the major component where data about staff and the context or computing environment of staff, otherwise called staff service-delivery environment, is provided to the data interpreter middleware. The followings are the sub components of the Staff Client Agent: Profile Manager, Project Manager, Attendance Manager, Communication Manager, and Leave Manager.

The Profile Manager is a reader component, for retrieving useful staff information needed for the appraisal computation. The required staff profile information is categorized as Micro and Macro. Staff-Micro information includes privacy non-sensitive data such as Hire-Date, Staff-Department, Gender, Staff-Reporting Line Manager

and other information such as Staff Position.

Macro information includes the Staff Internet Protocol Address and Staff Date of Birth. The profile information serves as input required at the middleware component.

The Project Manager Component, which focuses on the tasks and projects delivered by a staff, is an important component of the staff-agent. The project manager has three major functions, namely Project Weighted Score Computation, Project Throughput Scoring Manager, and Project Duration Store.

a. Project Weighted Score Computation

In a service-delivery environment, the role of the Project Manager (PM) component is to extract project title and its weighted score value. The PM component achieves this through direct request from line-manager or a project scoring document.

b. Project Throughput Scoring

This function is carried out after a successful project sign-off. This PM function computes the rate at which project are delivered efficiently

c. Project Duration

This function gives the time frame of a project. Managers must estimate the calendar time required for executing a project successfully.

The Attendance Manager Component is a primary component for retrieving punctuality information of each staff. This component informs the appraisal system of the attendance rate of every staff. **The Communication Manager Component** retrieves useful information about the staff-response rate per email. This component interacts with the mailing system and retrieves useful mail information. The communication manager component helps to determine staff effectiveness, collaborations and contributions in organizational tasks, projects and duties.

Table 1 shows the rate of staff response per email for an organization. **The Leave Manager Component** captures Leave information per staff, Leave Frequency, and Current staff pending projects on the Leave Handover document.

2nd Tier: The Data Interpreter Server

This is the middle tier component. This component interprets information retrieved from the 1st Tier of the architecture. The 2nd Tier manages all information received from the components of the 1st-Tier. Other roles played by these components include representation of information in format acceptable by the 3rd tier. The information bus stores all information about staff, project, communications and attendance per time.

Table 1: Staff-Response Rate per Email

RECORD-IN	Date	Count of Mails Received	Mails Directly Addressed To:	Mails Partially Addressed CC:
	22-10-2016	10	7	9

RECORD-OUT	Date	Count of Mails (Initiated)	Directly Addressed To: (Reply)	Partially Addressed To: Reply to CC.
	22-10-2016	9	6	4

The Weighted Mean

The proposed architecture adopts a weighted mean approach such that a weight is attached to each significant component of the appraisal, and staff is scored based on a weighted mean value.

Table 2 defines the metrics and weight for the proposed architecture.

Table 2: Metrics and Weight definition

	Metrics	Weight of 100
1	Project	60% of Total Project Score
2	Leave	-(0.5* SUM (Non_Annual_Leave Days)
3	Email Communication / Staff Responsiveness	30% of (Total Communication Score in 100 th)
4	Attendance	-(1.0) * Total Days Absent
5	Punctuality	10% (Total Number of Work-Days in 100 th)

The 3rd Tier: The Score Tier

A staff-friendly metrics were selected and infused flexibly by allowing organization appraisal human resource manager input weight worth/value per metric. Staff weighted means computations are managed by the Score-Manager component. The second tier provides the weighted values per metrics. These weighted values of the metrics are retrieved by the various component of the 1st Tier.

Table 3 defines the metrics and weight of the proposed architecture with relevant components

Table 3: Metrics and Weight definition with the relevant components

	Metrics	RELEVANT COMPONENT	Weight of 100
1	Project	PROJECT MANAGER COMPONENT	60% of Total Project Score
2	Leave	LEAVE MANAGER COMPONENT	-(0.5 * SUM(Non_Annual_Leave Days))
3	Email Communication / Staff Responsiveness	COMMUNICATION COMPONENT	30% of (Total Communication Score in 100 Th)
4	Attendance	ATTENDANCE COMPONENT	-(1.0) * Total Days Absent
5	Punctuality	ATTENDANCE COMPONENT	10% (Total Number of Work-Days in 100 th)

2.2 The Application

Figure 2 shows the work details page of the web application. This is where the employee work details are captured and who the supervisor is also assigned. The system captures some details about the work schedule of an employee as well as the supervisor for that project.

Figure 3 shows the page of the web application where new employees are added. This section allows new project to be included stating explicitly, the duration of the project, the project description, name of the project and who will be the supervisor of the project. As many projects as desired can be added in this section. This page is also used to enter new employee’s details i.e. new employee registration. This section allows employee

to be added to the system. It accepts valid information about the employee such as the name, contact details, date of birth, residential address, emergency contact details, and so on. As many employee as desired can be added to the system via this platform.

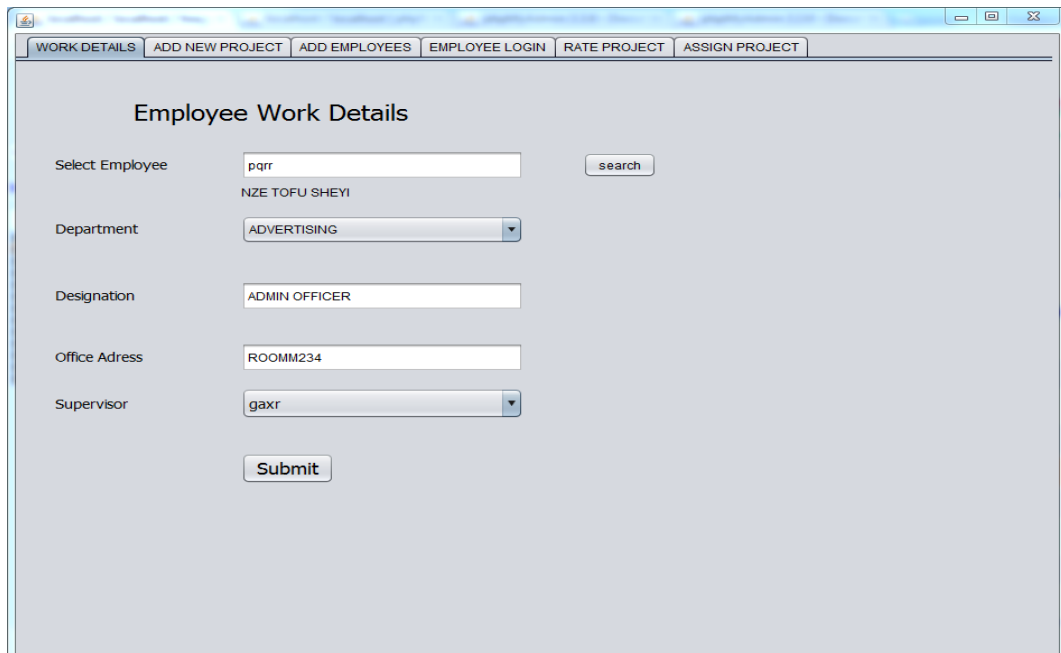


Figure 2: Work Details Page

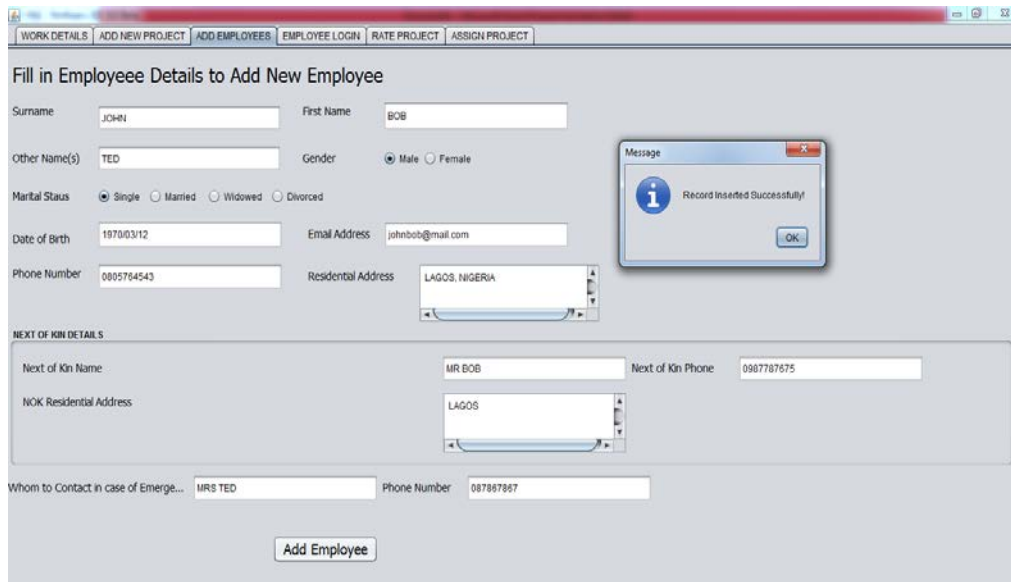


Figure 3: Add Employees Page

Figure 4 shows the page of the web application where projects are rated. This page allows supervisor check the status of projects if it has been completed or not. It also provided reevant information as regards a project. Information that can be gotten include project description, project start date, expected date of project completion, status of project.

PROJECT ID	PROJECT NAME	START DATE	EXPECTED END DATE	DATE COMPLETED	STATUS
PRr1ob1	CRISIS	2016-04-05	2016-04-05	2016-04-12	INCOMPLETE
PRv1ob1	NEW APP	2016-05-02	2016-05-02	2016-04-12	INCOMPLETE
PRd1ob1	NEW COMPUTERS	2016-02-03	2016-03-03	2016-04-12	INCOMPLETE

PRr1ob1
 CHECK AS COMPLETED PROJECT

Figure 4: Rate Project Page

2.3 Evaluation Results

The system developed was evaluated in a social context so as to examine its social benefits in addition to the various benefits it provides. It was tested at a printing company.

The company specializes in all kinds of media printing (posters, handbills, magazines, books, and journals, among others). The system was tested with just one project and the project had four (4) employees assigned to it. The Human Resource (HR) manager decided to use punctuality, responsiveness, project completion and attendance as the metrics for the evaluation. The system performed the evaluation for the staffs after the completion of the assigned project which lasted for two weeks. The system gave the employees rating in regards to how they performed and the employee were satisfied with the results.

The evaluation of the system was majorly based on two of its requirements which are; the system's efficiency (how efficient did the system rid biasness during the performance evaluation of the staffs), and its usability (how easy was it to navigate through the system). The system HR manager had little to do with the appraisal of the staff because all he did was to assign projects and set the factors to be used for the performance. This allows little/no room for manipulation of data during the appraisal process. The system does all the computing by assessing the employees' responsiveness and punctuality.

Sequel to the hands on deployment of the system, a follow up questions were administered via oral interview as a result of time constraints and its effectiveness for the evaluation purpose. The responses show that there was a positive learning in terms of acceptance of the system.

Related Work

A distinction between a decent and poor performer at work is necessary for an organization to run successfully

[2]. The management of performance in an organization determines to a high level, the achievements and failures of the organization [6]. Researchers have contended that, to have a successful human resource system for an organization, the utilization of an appraisal system which is dependable and accurate is required [10]; [3]. Performance appraisal is required for a more responsive method for assessing the quality of employees. An automated performance evaluation system is needed for an accurate and undisputable result.

A fuzzy evaluation technique was proposed to interpret and measure imprecise appraisal data for performance measurements [11]. A fuzzy reference was proposed using IF and Else construct as similar to expert systems. The method uses fuzzy to capture imprecise data without a practical or technical prototypical representation of the proposed methods. Fuzzy deals with imprecise data and are probabilistic. The proposed fuzzy evaluation technique makes all appraisal staff data precise by assigning exact values to appraisal metrics. These values or scores are assigned real-time to predefined metrics from a staff work context or environment. Advantageously, the proposed solution is custom-based, customizable to each organization. This is achieved through custom metrics defined uniformly for all staff. The data-values assigned to these metrics are automatic thereby eradicating bias.

Similarly, to tackle the issue that weighs on every attribute of staff performance, managements are often decided subjectively in multi-attribute assessment. An entire staff performance management evaluation model based on fuzzy partial ordering and rough set theory was proposed [14]. Test values having been standardized, each sample is ranked by a fuzzy partial rank model. A decision making information list of continuous value is built in order to solve the problem that there must be decision making information list in general rough sets. Then, the weight coefficient of each attribute value is calculated based on generalized significance of the attribute. This is done so as to avoid the terrible eventual outcome worked by dispersing attribute values sensitized to noise. Then, the practicality and feasibility of post-evaluation of entire staff performance management is verified by fuzzy partial ordering and rough sets strategy. The fuzzy methods are based on estimated scores as against actual and automated scoring proposed in this study. Actual scoring is precise, values are not vague or arbitrarily.

The behavioural anchored rating appraisal technique was also employed to implement a quantitative and hierarchical assessment index system and an interactive e-appraisal system in a power enterprise organization [5]. It was argued that the proposed solution can guide human resource management effectively and promote the enterprises rapid development. It is worth noting that the metrics and scoring was based on human judgment as against an automated scoring proposed in this study.

Process Algebra, Model Checking and Markov chains were utilized in proposing a model for performance evaluation [4]. Markov chains are generally used as a practice to decide system performance and reliability characteristics. It was indicated how effective model specification and analysis techniques from concurrency theory can be applied to performance evaluation. The specification of Continuous Time Markov Chains (CTMCs) is bolstered by stochastic process algebra, while the quantitative analysis of these models is handled by methods for model checking. Process algebra provides: (i) a high-level specification formalism for describing CTMCs in an exact, modular and constraint-oriented way, and (ii) means for the automated generation and

aggregation of CTMCs. Temporal logic model checking provides: (i) a formalism to determine complex measures-of-interest in a clear, conservative and flexible way, (ii) automated means to quantify these measures over CTMCs, and (iii) automated measure-driven aggregation (lumping) of CTMCs. Combining process algebra and model checking constitutes a coherent structure for performance assessment based on CTMCs.

3. Conclusion

Performance evaluation is a continuous and systematic process that helps the organization assess its candidate to give appropriate appraisal to the individual. Proper evaluation of performance for employees will help determine the productivity of every employee in the organization. Thus, there is need for a proper evaluation and avoidance of biasness to get the adequate productivity level of employees in the organization. This work has developed a model that will eradicate biasness in performance evaluation because some previous performance appraisal models allow/give room to biasness which has made productive employees in a firm to be laid off due to favouritism towards some other employees. This model will help those that are worthy of keeping their jobs keep it and help improve employees that need to work on some specific areas to develop themselves as plainly revealed.

4. Recommendations

It is recommended that the automation of staff performance using unbiased and complete model should be adopted because such performance approach will allow organizations achieve transparent performance rating for members of staff. The approach will go a long way in enhancing the work-experiences, staff outputs and overall company achievement as they can share and learn from genuine and unbiased appraisal reportage.

5. Suggestion for future works

The proposed model can be worked upon to totally reduce/eradicate human intervention thereby making the software completely autonomous. Features like biometrics can be incorporated and used to monitor attendance and punctuality of employees in the organization. A platform where employees could communicate and share ideas can also be incorporated into the system so as enable employees help, build and improve one another's skills. The application could also be mobile-based.

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