# An SMA Model for the Management of Human Resources in an Industrial Company

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***Abstract*— This article presents an approach for conducting the decision-making process within a company, assisted by intelligent agents. The interest here is centered on the management functions of human resources. The multi agent system has been put in place, in the validation phase for a big brewing enterprise, and is made up of expert agents for each process of HR (Human Resource) in the enterprise. These agents analyze the indicators and produce reports in case there is a problem. This makes it possible for managers to concentrate on the strategic roles on the one hand, leaving part of the follow-up to the agents, and on the other hand to capitalize the knowledge, experiments and expertise within the company.**

***Index Term*— Intelligent agent, multi agent system, human resource, assistance, management (key words)**

## I. INTRODUCTION

The main tools for directing within an enterprise are the display board based systems. They contain all the indicators making it possible to be informed on the state of the follow-up processes. The manager in this context identifies the different objectives to be achieved, indicators to be followed, and monitors these indicators, which is usually done through consultation with other data sources. It is thus crucial to assist the manager during these processes. This assistance needs the implementation of an intelligent system which can simulate the human reasoning in a display board. The system is a set of expert agents which do not only analyze the indicators to be followed, but also capitalizes knowledge within the company. Each agent refers to the indicators of a given functional process of the human resource. Within the framework of the implementation of this system, are presented respectively: decision making, contribution of the intelligent agents in the process, concept of management of human resources, the design of the system through the PASSI(Process for Agent Societies Specification and Implementation)[2] method and the development of a prototype.

## II. DECISION-MAKING AND CONTRIBUTION OF INTELLIGENT AGENTS

The process of decision making aims to select the best alternative for any given situation. The elements involved in this choice are: information, criteria, procedures and the "art" of the decision-maker [3]. The levels of decisions can be strategic (long-term objectives), managerial (regulations, procedures and programs for the achievement of the strategy) and operational (execution of the daily activities). The decision-making process is composed of 03 steps to which a step for feedback can be added to measure the effectiveness of the decisions taken [4]. These steps are:

- Intelligence: this concerns the taking into account of all the information. These latter in this case are mainly those that contains the decision-maker display board.
- Modeling: this is the data processing and research for potential solutions.
- The choice of the best decision: the best decision adapted to the encountered situation is selected. The apprehension of the decision-maker can extend this step.

In the context of computerization, the decisions can either be programmable or not. The first ones are repetitive and routine, while the second ones are unstructured and unique. Artificial intelligence (IA), especially through the simulation of human reasoning has a considerable role in nonprogrammable decision making.

The use of intelligent agents to assist decision making has many advantages. Table 1 presents the value-added for assistance provided by intelligent agents in the decision-making process from the display board and the description of the value-added due to the intelligent agents. It depends on the responsibilities of the manager within the framework of steering taking into account the presence or absence of intelligent agents. The word 'agents' is present in the case where there are intelligent agents involved.

TABLE I.
CONTRIBUTION OF INTELLIGENT AGENT TO INTERPRETATION DISPLAY BOARDS [5]

| System | Directing based on Display boards | Display boards coupled to intelligent Agents |
|---|---|---|
| Information collection | manager | Agents |
| KPIanalysing | manager | Agents |
| Solution choice | manager | Manager |
| Feedback | manager | Agents |

Each column in the table 1 represents a phase of the decision-making process from the collection of information (intelligence) to the feedback. The responsibility of the manager is reduced through the intelligent agents that perform the tasks collection, processing and feedback. The decision maker is only concerned with the choice of the best decision from the ones proposed by the different agents. It may also refine if necessary [5][7].

## III. DESIGN OF THE SYSTEM

Human resource management is essentially comprised of management processes summarized in figure 1. These processes can be grouped into four functions: Attract, Manage, Retain and Directing.

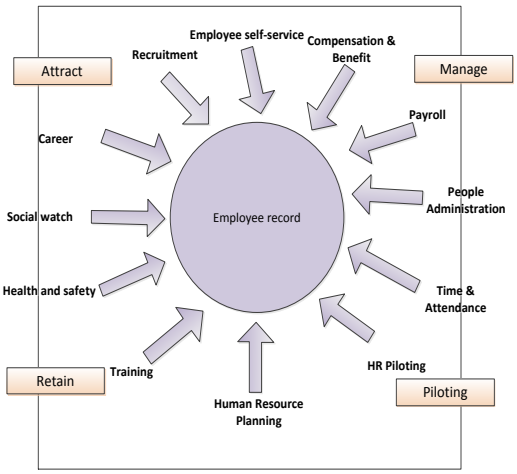


Fig. 1. Setting for document template

Figure 1 identifies 12 HR processes that are: recruitment, HR self-service, management, payroll, administrative management of staff, the management of time and activities (MTA), the directing of human resources, jobs and skills management planning (GSMP), training, health and safety management, social welfare, and career management. All these processes are centered on the record of the employee and represent the database containing all relevant information. Each of these processes will be represented in the SMA for a specific agent.

The identification of HR processes having been done, it is possible to model the system. The study carried out for the selection of a methodology resulted in PASSI (Process for Agent Societies Specification and Implementation) [2]. This is a FIPA compatible methodology and is supported by a dedicated tool: PASSI Toolkit abbreviated as PTK. It reuses the form of UML and allows among other things to model the ontology. It is divided into models, each consisting of a set of phases, each phase having one or more diagrams. Here the emphasis is on the phases of: identification of needs, identification of agents, definition of roles, specification of tasks, ontology description and roles description. A context diagram is initially proposed. It is provided in PTK as a first step in modeling and represents the interaction between the entire system and its environment.

### A. Context diagram

The system proposed consists of three actors namely: the administrator who is responsible for all configurations, the manager who receives alerts from the system and HRIS (Human Resource Integrated System), more specifically its module consists of display boards that provide the required indicators. Figure 2 is an illustration; it shows the global view of the system in interaction with its environment.

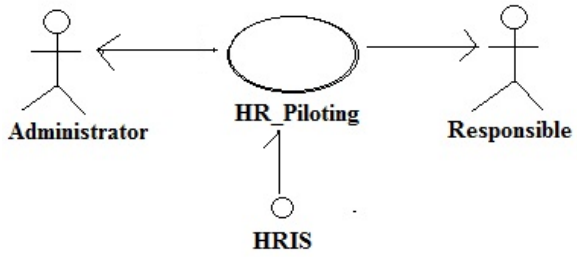


Fig. 2. Context diagram

### B. Uses cases diagram

The case diagram is defined and represents the internal functioning of the system when interacting with its environment. These user cases include those relating to the system configurations and those which refer to the analysis of indicators. So, Figure 3 shows the diagram of the system requirements with two set of requirements: Administrate and Alert. Both sets are extended or extend many use cases we have not shown in Figure 3.

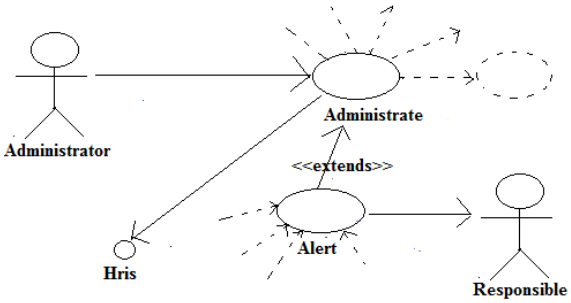


Fig. 3. Domain description diagram

Use case “Administrate” is extended by: “Configure Agent”, “Load configuration”, “give Right” and includes use case “Connection”.

Use case Alert is extended by : “follow competence”, “follow recruitment”, “follow talent”, “follow performance”, “follow social”, “follow health and safety”, “follow hris”, “follow training”, “follow HRP”, “follow compensation”, “follow administration”.

### C. Identification of Agents

The use cases above have led to the identification of 1 interface Agent and 11 expert agents, each denoting a given HR process: “administration_Expert” for the “follow administration”, “recruitment_expert” for the “follow recruitment”, “hris_expert” for the “follow hris”, “talent_expert” for the “follow talent”, “performence_expert” for the “follow performance”, “training_expert” for the “follow training”, “HRP_Expert” for the “follow HRP”, “Competence_expert” for the “follow competence”, “Social_expert” for the “follow social”, “health_safty_expert” for the “health and safety”.

The interface agent is a central agent that allows communication of the system with its environment. Each HR process is represented by an agent (training_expert,

talent_expert, etc.). The relevant actor receives messages from the interface agent. HRIS provides data while the administrator configures the system.

### D. Rules identification phase

It represents a set of sequence diagrams defining the role of each one within the context of interactions to achieve the set objectives. System configuration and monitoring of an expert are overriding scenarios.

Figure 4 shows a system configuration scenario. In the context of configuration, the administrator modifies the parameters of an agent through the interface, which plays the role of 'register'. The latter is responsible for saving the new settings and to notify the agent concerned ("inform"), here referred to as administration_expert for considering the modifications.

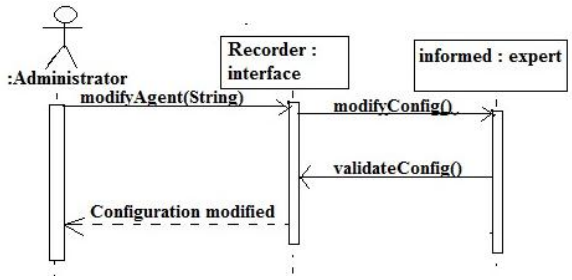


Fig. 4. Agent configuration

Figure 5 represents a case of an alert sent by an expert, here referred to as administration_expert, that plays the role of 'expert' to the interface agent. The latter is responsible for identifying those responsible to be informed and to send them the report produced by the expert.

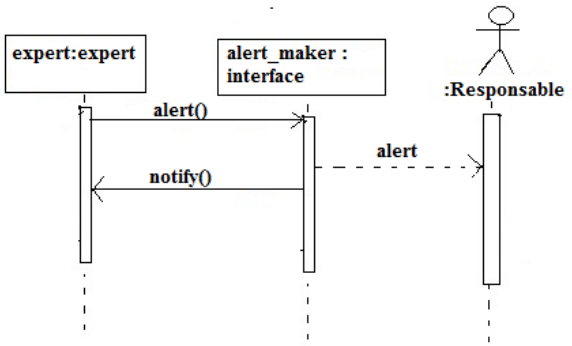


Fig. 5. Expert Alert

### E. Task specification phase

Figure 6 represents the activity of the interface agent. The latter manages connections ("gérerConnexion") by allowing an administrator to connect ("administrateur.seConnecter"). It has a 'listener' to receive alerts ("alert") and configurations ("admettreConfiguration"). Periodically, it loads the performance indicators contained in the HRIS («chargerDonnees»).

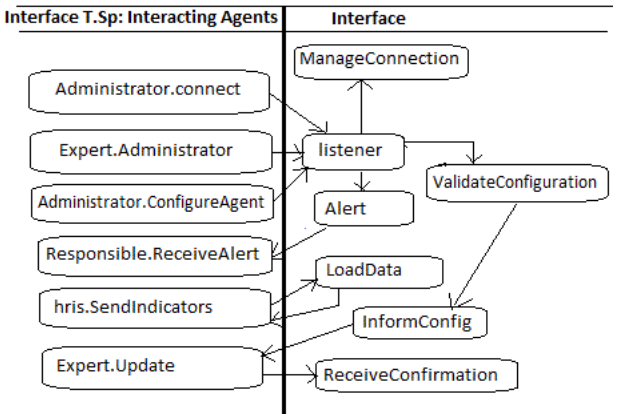


Fig. 6. Task specification diagram (interface agent)

From the models presented above, it follows the general architecture, shown in figure 7.

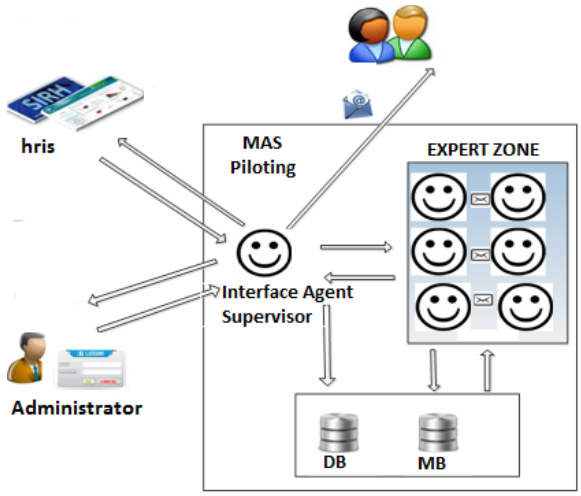


Fig. 7. General MAS architecture

This architecture represents the system and its components. They interact for the analysis of indicators of performance by expert agents and the increase in alerts to the officials. Interactions between agents are done according to certain semantics leading to the definition of ontologies.

### F. Ontology description phase

The system takes into account an ontology involving the notions of concepts, predicates and actions. This ontology leads to the definition of the semantics of communication between agents. Figure 8 represents the ontology of the system.

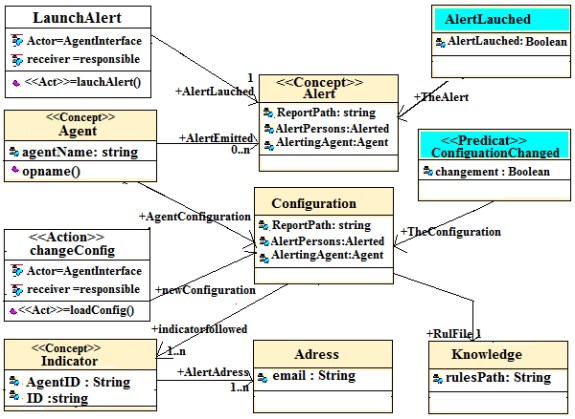


Fig. 8. Ontology Model

Three important notions can be identified namely: concepts, predicates and actions. The concepts are: alert, agent, configuration, address, indicator and knowledge. Two predicates: AlerteEmise, ConfigurationChangée, and two actions: lancerAlerte and chargerConfig. An agent is the author of an alert. It also has a configuration that includes its address, followed by indicators and the knowledge from which it can draw inferences. A configuration can be loaded or modified. An alert may be issued to an alert destination.

### *G. Description role phase*

Figure 9 shows the communication between an interface agent and an expert. The interface plays the roles of 'recorder' and 'alerter' while the expert plays the roles 'informed' and 'expert '.

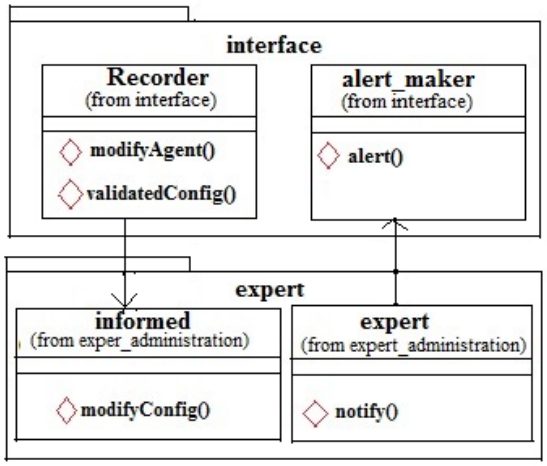


Fig. 9. Role description diagram

Alongside with the PASSI modeling and considering the architecture of the system, it was necessary to represent the structure of the database models. It includes a set of rule files with each having the extension '.rules '. It is these rules that the expert agents infer. Figure 10 shows the structure of a rules file.

```
IndicateurGlobal1
Sous_indicateur1 = etat1 ... Sous_indicateur n = etatn : <action1> ... <action n>
IndicateurGlobal2
Sous_indicateur1 = etat1 ... Sous_indicateur n = etatn : <action1> ... <action n>
....
IndicateurGlobaln
Sous_indicateur1 = etat1 ... Sous_indicateur n = etatn : <action1> ... <action n>
```

Fig. 10. Structure of role file

- "IndicateurGlobal i": indicator effectively followed.
- "Sous_indicateur i": action variable
- «etati »: State of an indicator (good, bad, marginal).

The database contains the set of indicators and alert report tables. It is in this latter that expert agents draw all the facts they need for their inferences. It contains all the values of the indicators.

## IV. IMPLEMENTATION

The tools used for implementation are the following:

- PTK: A modeling toolPASSI [2]
- JADE: Middleware for creating agents in JAVA [1]
- JESS: Rules' engine for inference [6]

Our prototype consists of two agents: an 'interface' agent and an 'expert' agent (agent GPEC), responsible for the monitoring of indicators relating to the forecast management of jobs and skills, the core business of the HRM.

The 'interface' agent is responsible for configuring the system and sending alerts to managers. The 'interface' agent communicates to the agent GPEC all information about configurations (basis of knowledge, indicators, notifications for alerts, etc.).

The agent GPEC periodically infers on its rules file, generates a report in case of anomaly and informs the 'interface' agent. It has as objective to analyze the rate of poor performance under the rules presented in figure 11.

```
TauxMauvaisesPerformances
RealisationRecrutement=0 TauxFormation=0 tauxSuiviFormation=0!Chercher aupres concerne
RealisationRecrutement=1 TauxFormation=-1 tauxSuiviFormation=-1!Revoir la formation
RealisationRecrutement=rouge TauxFormation=vert!Revoir le recrutement
```

Fig. 11. File of rules

The 'rules' file concerns the rate of poor performance. This indicator depends on the rate of implementation of the recruitment plan ("RealisationRecrutement"), the rate of implementation of the training plan ("TauxFormation") and the rate of people with poor performance after receiving training ("TauxSuiviFormation").

The system has been implemented in client/server mode with respect to the architecture model-view-controller (MVC) whose logical architecture is shown in figure 12.

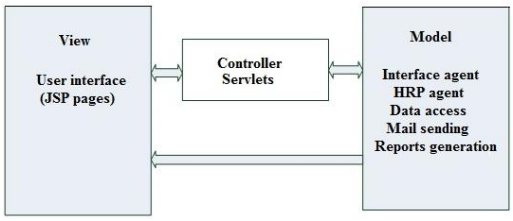


Fig. 12. Prototype Architecture

It is actually a web application. The view represents the set of user interfaces. It can be summarized as a set of JSPpages (JavaServer Pages). With regard to the model it includes a package for the creation of agents, a package for interaction with the database, a package for sending notifications and another for the generation of reports. The controller is the link between the model and the view. It allows the user to perform various actions that can be summarized mainly as setup agents. However, it is possible for the model to directly access the view, notably through the interface agent.

## V. RESULTS AND VALIDATION

The implemented system presents a Web part and an agent part. The interfaces Web allow the various configurations after connection. The validation environment is that of the SABC. This later is a brewing company in Cameroon. Figure 13 represents the interface of connection to the system.


Fig. 13. Interface of connection

We are currently interested in the Department of GPEC (forecast management of jobs and skills). Figure 14 allows changing of the parameters of an agent (indicators, threshold, periodicity, etc.). It also provides access to all the reports produced by an agent.


Fig. 14. Setting Agent

The aims of the Department of GPEC are to: recruit skilled people, carryout training and evaluate the post-training performance of staff. Hence the implementation of the three following indicators made available by the HRIS system indicators:

- Recruitment (RealisationRecrutement): for the mo nitoring of the quality and quantity of employees;
- Training rate (TauxFormation): to follow up the number of trainings executed with respect to a periodic forecast;
- Follow-up training (TauxSuiviFormation): for post-training evaluation.

The tests were carried out taking into account the cases previously described. With the following facts: Recruiting achievement = bad (RéalisationRecrutement = Mauvais); training rate =good (Tauxformation = bon); Training follow up=good (TauxSuiviFormation=bon). The report obtained as a result of the inferences of the agent GPEC on rules generates the report of figure 15. The later shows the rate of progress of training and monitoring of training rates are correct, while the rate of recruitment is in the red (RéalisationRecrutement = Rouge). It shows a disruption in the chain of staff availability to the company by the HRD and conformance of the training unit since all the training and evaluations were performed successfully.

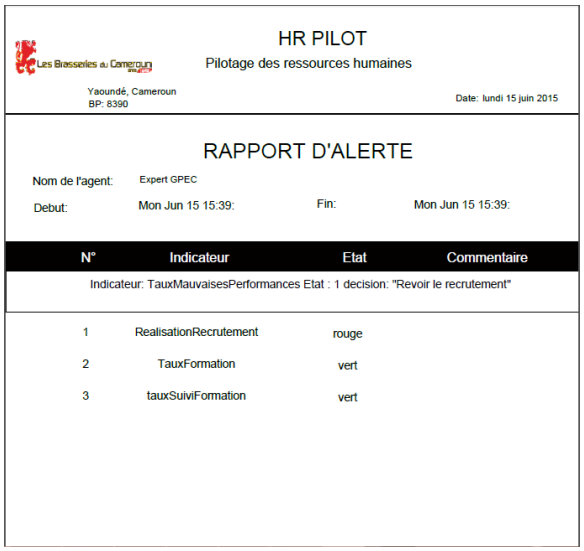


Fig. 15. An alert report

## VI. CONCLUSION AND PROSPECTS

The decisions taken within the company determine its productivity and profitability. It is therefore necessary to ensure that there adequate tools that aid in reliable and efficient decision-making. This article contributes to this end, through a multi agent human resources management system. Each agent of the system is an expert in HR processes. Thus, there is a transfer of knowledge from the manager to the agent as a way of delegating the rule of analysis of the indicators. Consequently, it is possible to analyze a large number of

indicators at a high frequency and maintain this know-how within the company even in case of withdrawals. For the time being, the authentication was convincing for a department of management of human resources, the medium term objective is to extend it to all departments of the company and then to generalize on any type of business in the long term.

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