International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

# Intelligent Agents as Staff Allocation Optimization Assistants in ICT Services Support

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**Abstract:** ***Organizational Information and Communication Technology (ICT) services are becoming more critical and complex and this growing dependency leads to growing requirement for quality support. This paper explores how the concept of Intelligent Agents can be utilized to enhance performance in ICT services support. The study was conducted to investigate the process of ICT staff allocation in Kenya Revenue Authority's (KRA) ICT department. The findings revealed that currently, the ICT department does not serve the organization's demands adequately due to challenges attributed to uncoordinated, unmanaged and under-resourced ICT services. The study concluded that due to the increasing demand in speed and performance in the delivery of quality business operations, organizations must learn to exploit various trends for optimizing staff workloads. By playing the role of staff allocation optimization assistants, Intelligent Agents may offer such solutions thus change how businesses deliver, evolve and grow. The study recommended the development of an Intelligent Agent to aid in both intra and inter-departmental support services.***

**Keywords:** Intelligent Agents, ICT, ICT Department, ICT Services Support, Optimization Assistants

## 1. Introduction

Worldwide today, it has been recognized that organizations are becoming increasingly dependent on Information and Communication Technology (ICT) in order to satisfy their corporate aims and meet their business needs. This implies that the growing dependency on services leads to growing requirement for quality ICT services support. According to [1], organizational ICT services and information systems are becoming more critical and complex; as a result, the level of ICT service support and integration becomes even deeper.

Studies indicate that most developing countries are characterized by limited ICT infrastructure and shortage of skilled manpower to operate and support their organizational systems. A study by [2] observes that this situation exists largely due to lack of coordination at different levels in making effective use of the ICTs. The author recognizes that a combination of knowledge and ICTs makes a powerful tool for change since ICTs have a great potential to transform organizational business and provide an enabling environment for the development of technology-based social systems. Another study by [3] justifies this situation by identifying various challenges that affect the successful implementation of ICT projects in the public sector. The author identifies among other characteristics: inadequate ICT budgets, lack of ICT policies and master plans to guide investment, unstable ICT resources and a focus on ICT applications that support traditional administrative and functional business transactions rather than those that focus on organizational efficiency.

Although studies in ICTs have acknowledged that the successful management of an organization's ICT resources must combine knowledge with a thorough understanding of business strategy to guide the development of information resources, there have not been any indications as to how human resources need to accomplish and manage such ICT resources. For instance, the Government of Kenya has committed to using ICT in its efforts towards effective and efficient citizen service delivery. However, the extent of demand and the current scale of composition of ICT workforce present both opportunities and challenges [4]. In particular, consideration of factors such as the tasks to be performed, how many people to be involved and the required technical skills for such staff in such an organizational perspective is very important.

In order to address this disconnect between ICT service delivery and ICT workforce, any ICT department requires different skill sets to provide services to customers that vary in nature and importance [5]. The author further notes that the focus on ICT functions is important because functions provide specialization and visibility to ICT work which provide the how-to and span multiple roles, sections and ICT staff members. It is therefore, important to harness the power of technology to make smarter and faster decisions [4]. This paper provides additional insight into how Intelligent Agents can play the role of staff optimization assistants in organizational ICT Departments. By adopting such agents, ICT departments can appropriately meet the needs of customers, be appropriate to the business environment, represent value for money and also remain effective and competitive.

## 2. Background of the Study

The study was conducted at Kenya Revenue Authority (KRA), an organization that is charged with the responsibility of the assessment, collection, administration and enforcement of laws relating to revenue on behalf of the Government of Kenya [6]. In KRA, ICTs are a key component in enhancing global competitiveness and encouraging and supporting innovation [7]. The Authority's ICT resources are used to tie together the operations of disparate business units so that they can act


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as a whole which enables ICT to have an impact on individuals, organizations and society at large. This further entails provision of the essential framework for the Authority to maintain stakeholders' confidence in their services. In order to offer better single-window services to taxpayers and other stakeholders, KRA is divided into five Regions namely: (1) Rift Valley Region, (2) Western Region, (3) Southern Region, (4) Northern Region and (5) Central Region with the headquarters situated in Nairobi, Times Tower. Currently, ICTs are incorporated to support services in order to enhance revenue collection both internally and externally [8].

### 2.1 The Role of ICT Departments

According to [1], the current organizational structures of in-house providers of ICT services have often evolved over years. The author attributes this to the changing demands from customers, the need to contain costs, to improve services, to be more business-like, and increasingly the need to compete with external companies. All these drivers are compelling ICT departments to not only look critically at their existing organizational structures but also ensure they remain relevant and appropriate as argued by [9].

The substantial value added utility of ICT in the provision of, and access to, information services for improved planning and organizational management has become more widely recognized [10]. To this end, it can be argued that the overall benefits from a well designed ICT directorate is in ensuring business areas receive services that match their requirements. Drawing significance to this, [1] states that, ICT directorates should be judged against three main criteria. Firstly, service delivery should be according to business needs and agreed standards and this also includes customer satisfaction and the style and level of customer interaction. Secondly, the cost of services delivered should be as economically and efficiently as possible. Thirdly, the ICT directorate should be flexible in that it can respond to changes in current and future business needs.

This premise underscores the need for comparing existing ICT Portfolio with the ICT staff numbers and skills with the structure in order to identify any shortages and surpluses for provision of ICT services. Hence, establishing a structure which will support good communications with customers must be a prime aim of ICT service providers such as the one for KRA ICT department.

### 2.2 The Need for ICT Portfolio

ICT Portfolio refers to a collection of ICT investments, infrastructure and other resources of an organization's ICT directorate/department [11]. For the purpose of this paper, the term refers to the technologies, projects, programs, policies and guidelines, operations and ICT services which are managed as a group in a coordinated fashion to achieve the organizational strategic objectives. According to Center for information Systems Research [11], organizations invest in ICT to achieve four different management objectives: (1) strategic (to gain competitive advantage), (2) Informational (to provide management information), (3) Transactional (to process transactions and cut costs) and (4) Infrastructural (to provide shared services and integration). Hence, just as investors have portfolios to address their multiple investment objectives, it is necessary for organizations to have portfolios of information technology investments.

The organizational structure adopted by a particular organization depends on its particular circumstances such as provision of services from a common point to other areas or devolution of responsibilities for services to business areas. It is important to note that organizations vary too much for any guidance to be given with confidence on how many staff will be required in ICT services since numbers will depend on particular circumstances such as organizational-wide infrastructure, personnel to be offered support, scope of service delivery and the structure of the organization in general. This is a clear indication that for an existing organization like KRA, the number of staff required can often be judged by how functions will be grouped on the ICT structure, breaking down current work into tasks and identifying the time taken to carry out such tasks. This can also be said to include control over changes required during the implementation as well as day-to-day running of the ICT infrastructure. However, all these will entirely depend on KRA's ability to provide the necessary ICT infrastructure and also to ensure the ICT Portfolio is balanced to achieve alignment with the business strategy and the desired combination of the organizational short and long term goals.

### 2.3 The Concept of Intelligent Agents

According to Crowston & Malone [12], the idea of an intelligent agent refers to a system that, when given a goal, can carry out the details of the appropriate computer operations and can ask for and receive advice, offered in human terms, when it is stuck. Other authors have different views on how agents work. For example, [13] define an intelligent agent as anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors. We can therefore, conclude that an Intelligent Agent is something that processes internal information in order to do something purposeful on behalf of something else. This means that an intelligent agent is something that is capable of making decisions about how it acts based on experience.

### 2.4 Application of Intelligent Agents

There are several reasons that intelligent agents will be part of most if not all future applications developed. To-date, a number of significant applications utilizing agent technology have already been developed. [14] identify various application areas of Intelligent Agents including: distributed project management, electronic commerce, information retrieval, medical field, military, manufacturing, networking, planning and scheduling among other areas. Thus, whether you are surfing the Internet, shopping online, seeking a medical diagnosis, planning and scheduling activities, today, intelligent agents are likely to play a key role in the process. For the purpose


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of this study, the intelligent agent was focused on how a computer program can perform the planning and scheduling of tasks.

## 3. Statement of the Problem

ICT Services are supposed to be structured to help facilitate the user to effectively and efficiently achieve their goals. ICT directorates exist to provide services to its customers that vary in nature and importance, hence require different skill sets from its providers. At KRA, the current situation of the ICT staff structure does not serve the organization's demand with the degree of satisfaction required. There is significant unco-ordination of the limited ICT staff to monitor the ICT infrastructure and critical business and support systems, which means that their utility values cannot be ascertained. As a result, there is the uncertainty regarding the distribution of work causing a lot of duplication and conflicting activities offered by the ICT staff leading to further consequences of unclear and uncoordinated ICT services thus hindering the organization's goals. Due to the foregoing problems, there is need to re-organize how the KRA ICT staff work by identifying any shortages and surpluses thus enhance work distribution and allow proper and appropriate staff to offer optimum ICT services in order to contribute to the stability and reliability of KRA's intrinsic infrastructure. In response to these problems, the study explores how intelligent agents can be applied as optimization assistants for allocation of staff in the delivery of ICT services.

## 4. Aim of the Study

The study was conducted to investigate the process of ICT staff allocation at KRA and develop a prototype intelligent agent for optimizing staff allocation in ICT services.
The study was guided by the following objectives:
1) Document the current ICT staff allocation system; and
2) Develop a prototype intelligent agent for optimizing staff allocation.

## 5. Approach and Methodology

The study adopted qualitative case study research design for data collection and actualized through experimental design for the Intelligent Agent development**.** According to [15], experimental research design is particularly suited where we want to predict phenomenon. This is an experiment where the researchers manipulate one variable, and control/randomizes the rest of the variables. It has a control group, in this case the ICT staff; the subjects have been randomly assigned between the groups, in this case only selected ICT functions are used to represent the tasks and finally, the researcher only tests one effect at a time, for this study, one staff is allocated a particular task at a given time based on prioritization and availability of the required staff. The study sought to test an idea to determine the effect on an outcome. This meant that new insights were gathered from the users and the requirements later used to develop an Intelligent Agent prototype that would influence the allocation of tasks for ICT services support. Building the Intelligent Agent entailed analyzing the ICT staff problems with existing information systems, assessing staff information needs, selecting appropriate technology and re-designing procedures and jobs.

## 6. Results and Discussions

### 6.1 ICT Staff Allocation System at KRA

The study established that the ICT department comprised of four divisions extended further into ten functional units as shown in the following Table 1.

**Table 1:** Scope of KRA ICT Functional Units

| Unit | Responsibilities |
|---|---|
| 1.Service Desk | Customer relationship management, business perspective and feedback. |
| 2.Regional Support Teams | Receiving customer issues/complaints from tax payers and records. |
| 3.Business Systems Development | Analysis of requirements, application development, deployment and maintenance of business systems. |
| 4.Service Monitoring | System administration and ensuring data centre management. |
| 5.Infrastructure Management | Design, planning, deployment and providing technical support to all stakeholders. |
| 6.Database Administration | Database administration and maintenance. |
| 7.Quality Management | Quality assurance and ensuring change control. |
| 8.Projects | Projects strategy and performance management. |
| 9.Operations | Provision of Human Resource as well as liaison and planning for all ICT staff. |
| 10.Information Systems Security | The general management of information systems and ICTs security. |

The existing system was analyzed and from the investigations carried out, it was established that the main functions of the ICT department included:
a) To identify, implement, manage and support ICT projects to deliver systems and processes to the Authority's stakeholders;
b) To ensure efficient and effective delivery of all KRA operations;
c) To enhance information systems, business operations and ICT system availability and reliability with the Authority's stakeholders,
d) To implement policies and strategies geared towards re-aligning procedures and business processes in support of the Authority's corporate objects; and
e) To coordinate and manage quality management systems to the Authority's stakeholders.

In order to carry out the above stated functions, the ICT Department was guided by the following objectives;
1) To effectively provide timely feedback to all customers through undertaking of request and changes and producing performance reports to monitor and improve ICT service provision;
2) To manage all reported cases on all ICT services by providing immediate solutions/workarounds and proactively monitoring all incidents and ensuring timely and quality release of workarounds while ensuring feedback;
3) To provide special attention to business/revenue systems by ensuring that all cases are handled within


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the agreed Internal Standards with mechanism to monitor and report on performance;
4) To manage the computing infrastructure at the nerve centre (systems, applications, databases, communication);
5) To provide the essential administrative support and ensure that the information security (pro-active/reactive) while responding to any threats to provide the required confidence in the computing environment; and
6) To ensure timely delivery of planned projects in liaison with all stakeholders (ICT and business).

The study further established that the ICT staff was categorized into three groups: (i) FAST RESPONSE GROUP: to handle all existing and future services that cause user complaints. (ii) STABILIZING GROUP: a back-up team to ensure a stable computing environment and expected to stabilize the current ICT infrastructure. (iii) STRATEGIC GROUP: the planning team that seeks to handle new/long term initiatives that may be cross-cutting both Intra-ICT and Inter-departmental. The system under investigation was therefore, concerned with managing all ICT portfolio, infrastructure, staff and services in order to provide delivery of effective and essential support to both internal and external users.

#### 5.2 Challenges of Current Staff Allocation System

The following Table 2 represents a summary of the challenges experienced in the ICT Department.

**Table 2:** Challenges experienced in ICT Department

| *Challenges* | *Manifestation* |
|---|---|
| • Loss of faith in the service desk | ✓ Reluctance to call/inform Service Desk choosing to seek other officers due to bureaucracy in work order escalation. |
| • Operations and administration of business systems | ✓ Large number of complaints due to lack of maintenance of the systems. |
| • Delayed service provision | ✓ Customers' engagement/feedback complaints which include delayed access to systems and service provision. |
| • Lack of /poor interventions | ✓ Interventions and/or workarounds coming too late and becoming the ultimate solutions. |
| • Lack of proper prioritization of problems | ✓ The latest problems become the hottest and complaints on the previous ones such as timeliness being static or entirely overlooked. |
| • Lack of monitoring | ✓ Lack of efficient monitoring of critical systems and services. |
| • Staff allocation of tasks | ✓ Lack of staff rotation leads to difficulties in allocation of specific tasks to staff due to having different working teams. |

It was established that it took a lot of time for the KRA users to request for staff for ICT support services. It was evident that the ICT Department could not conclusively decide who was the best person to perform a given task due to some of the following reasons: insufficient ICT personnel in the department, overwhelming feedback from customer complaints, interventions by ICT staff coming too late, prioritization of required ICT support services could be outside the control of the ICT department and more so, KRA policies could constrain the options available to the department to address problems in the requesting departments. Again, it was thus important to identify the sections that performed similar work by conducting meaningful comparisons so as to avoid role redundancy.

This premise could be used in future to guide ICT departments into the planning and designing of a structure that would require adequate staff to accomplish various tasks. Again, there was no clear policy indicating on-the-job training which would equip the department with the necessary knowledge and skills to embrace the ever changing ICTs. This finding was supported by past studies that propose the need to address the mismatch between the Information Systems being developed and the required personnel to manage these systems. Hence it is important to address the shortage of skilled manpower required to operate and support information systems.

## 6. Development of the Intelligent Agent Prototype

The study further sought to find out how an Intelligent Agent could be used as an optimization assistant for staff allocation to support ICT services. From the preliminary investigations, the study identified both the functional and non functional requirements that were used as the basis for designing and developing the Intelligent Agent prototype. The system would automate most manual operations of requests, description of tasks, prioritization of tasks, estimates of duration of tasks, provide procedure for assignment of tasks and lastly assign and/or un-assign tasks to the ICT personnel to perform their departmental roles.

#### 6.1 The Intelligent Agent Prototype Architecture

[12] uses the term agent as a comparison of an agent to an hardware or (more usually) a software-based system that enjoys the following properties: *Autonomy*: agents operate without the direct intervention of humans or others and have some kind of control to their actions and internal states. *Social ability*: agents interact with other agents including human beings through some kind of agent-communication language. *Reactivity*: agents perceive their environment which may be the physical world that includes a user, a collection of other agents, the internet, or even all of these combined and respond in a timely fashion to changes that occur in it from such environments. *Pro-activeness*: agents do not simply act in response to their environment, they are able to also exhibit goal-directly behaviour by taking the initiative to interact without direct intervention.

We can describe the framework of the intelligent agent using the following components:
1) *Incremental Knowledge Formation Process*: this process acquires knowledge from the expert accompanied by the information retrieved from the analyst.
2) *The knowledge Base*: is a dynamic knowledge base represented in a form of hierarchy.


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3) *The Inference Engine*: is used to search for the knowledge.
4) *Database*: is a collection of all inter-related organizational data.
5) *User*: is the end-user of the intelligent agent.

It is clear that Intelligent Agents have the potential to change the way we design, visualize, and build software in that agents can naturally model actors [16]. Actors, for example, staff and ICT services are required to accomplish tasks at KRA and are real world entities that can show autonomy and proactiveness. Additionally, social agents naturally can model human organizations including business structure and processes.

The Intelligent Agent prototype was built based on three main subsystems as adopted from [17] as interpreted in the following Figure 1.

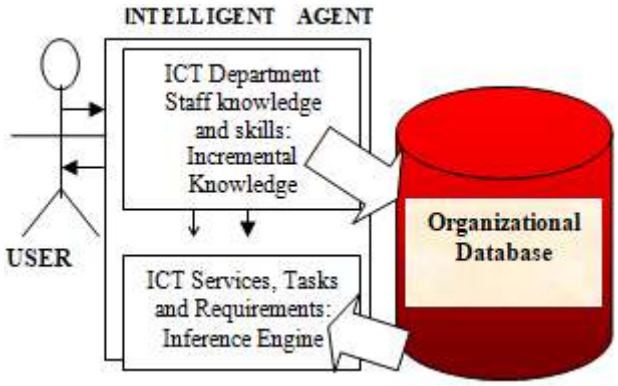


**Figure 1:** The components of the Intelligent Agent System

As indicated earlier in the study, the aim of any intelligent agent is to imitate human problem-solving by referencing to a database of knowledge on a particular subject. According to the above architecture, the Intelligent Agent framework can be described in the following three areas:

a) *Incremental Knowledge Formation Process*: this entailed acquiring knowledge from the staff, updating the knowledge base and making generalization and sub-generalization concepts. This was achieved by capturing all the ICT Department's requirements and specifications of the staff profile including their professional qualifications and skills, the roles and functions of each unit and the responsibilities and activities and tasks to be performed by staff from each section in the department.
b) *The knowledge Base*: this was where all the dynamic details of all ICT departments' sections were stored in form of a database. This included all the details of the ICT staff, information pertaining to their knowledge and skills, the functions and roles of each section and the job descriptions of each cadre of the ICT personnel and tasks to be performed. This component was therefore to form a representation of the problem in hand using IF THEN rules, it entailed data which was specific to the problem being solved. This meant that the inference engine further derived recommendations or feedback for assigning staff to perform specific tasks.
c) *The Inference Engine*: was implemented using an opportunistic search approach and was used to search for the knowledge. This was where analysis of the requirements was done by comparing the requests and mapping to the requirements. The inference engine was concerned with processing the user requests. For example, the system would check the legality or illegality of the user's request and either proceed with the request or terminate the request. The inference engine tried to derive answers from the knowledge base, for the ultimate purpose of formulating new conclusions. This component further served as a global database representing the facts or assertions about the ICT Department using a set of rules. Finally, the inference engine was used to determine which rules were relevant to a given data store configuration and choose which one(s) to apply to solve a given problem.

In order to design the Intelligent Agent Prototype, a number of factors were taken into consideration depending on particular circumstances. For example, the process of allocation of tasks to staff was to be judged based on the following steps:

- Break down the current work;
- Group the tasks into various ICT functions and combine roles where this was feasible;
- Identify the role descriptions and transform these to job descriptions;
- Identify the necessary skills required for each function/role;
- Identify the estimated time taken to carry out each task;
- Assess the workload of each position held, it should be possible to assess how many staff (more or less than current) were required;
- Grade staff depending on levels of responsibility and the importance of each function;
- Establish existing ICT practices against which to map current and future needs of the ICT department; and
- Identify the staff required to complete the task or tasks depending on particular circumstances.

The Use Case Diagram below summarizes the functional requirements in terms of activities that were involved in the request for ICT staff using the KRA Intelligent Agent.

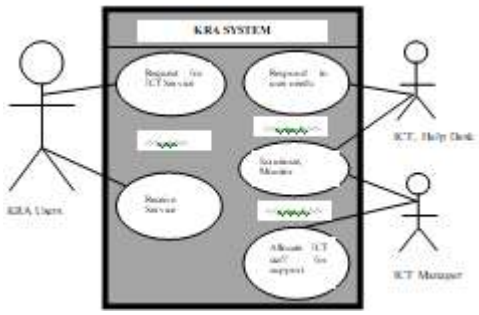


**Figure 2:** Use Case Diagram Showing Major Activities involved in staff request

The following scenario using IF THEN rules provides a sequence of events that was a representation of some of the functional and non functional requirements for the system. First, the process is initiated by the Customer/User who contacts the Service Desk. The Service Desk Personnel captures the request details and forwards the same to the Manager. Using the Intelligent Agent, the user then initiates the process. Whilst the details are being validated,


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the requirements are elicited as demonstrated in the scenario below:

```
IF the customer/user fails the
   validation procedure,
THEN the request process terminates.
IF the user's validation is successful,
THEN the request is recorded and mapped
   against the ICT Service Requirements
   and ICT Personnel details in the
   Intelligent System's Database and
   Inference Engine.
IF matching occurs and Intelligent Agent
   is satisfied with the current
   contents,
THEN the Intelligent Agent identifies
   the ICT service and personnel
   requirements' profile and selects the
   possible rule.
IF the requirements are met,
THEN the ICT services requirement
   request is executed.
IF the desired ICT Service and Personnel
   is legal,
THEN the entire process continues.
IF the desired request is illegal,
THEN the entire process terminates and
   the user is informed. In this case,
   the Intelligent Agent will request
   further information and the user must
   correct the data or enter new data
   altogether.
IF there is any uncertainty about the
   request legality,
THEN the process is suspended while
   further information is obtained from
   the user.
```

Finally, the Intelligent Agent executes and displays the allocation of the ICT service requirements by providing the staff, the task to be performed, the priority of the task, the estimated time to complete the task and finally an alert is received by both the manager and the allocated staff about the situation. The above process is facilitated by the three main elements of the inference engine as described here under:

1) *An Interpreter*: this element executes the chosen agenda items by applying the corresponding base rules.
2) *A Scheduler*: this element maintains control over the agenda by allocating the effects of applying inference rules in light of item priorities or other criteria on the agenda.
3) *A Consistency Enforcer*: this element attempts to maintain a consistent representation of the emerging solution.

The Inference Engine facilitates the above execution in a cycle consisting of three action states namely: (1) match rules - while performing the matching rules, the inference engine finds all of the rules that are satisfied by the current contents of the data store and which must be candidates for execution known as a conflict set. (2) select rule - here the inference engine applies some selection strategy to determine which rules will actually be executed otherwise known as heuristics. (3) execution rules – this is where firing or processing of the selected strategy occurs to solve the problem at hand. The above sequence of actions can further be summarized using the following Sequence Diagram.

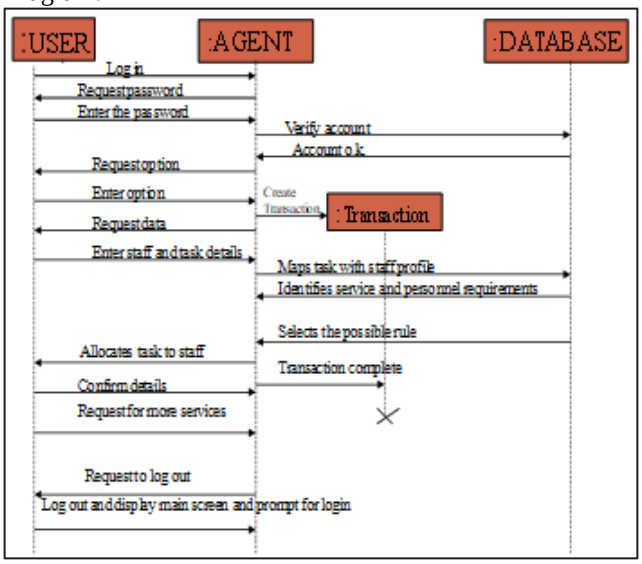


**Figure 3:** Sequence Diagram for Allocation of tasks to staff

The Intelligent Agent planning and design was performed as a centralized system. This means that when a task needs to be assigned, the ICT manager only assigned tasks to individuals and not groups of people working in a section. Then when starting a new task, the agent checks if the preconditions of the task are satisfied which include, the job to be done, the section responsible for the service and the availability of the qualified staff to perform the task. If the conditions are satisfied, the agent proceeds with the allocation and informs the individual selected about the expected situation. The agent then informs about the current status, so that the ICT manager could decide what to do in case of additional tasks. However, if the preconditions of the task are not satisfied, the agent displays information about the unexpected situation.

From the foregoing, it is evident that the Intelligent Agent needs a general knowledge of how its environment works, and what actions are available to it. As earlier discussed, for an Intelligent Agent to be autonomous, the agent can learn and modify itself and its data based on its current world experiences.

## 7. Conclusion

This paper gives an insight into how Intelligent Agents can be used as optimization assistants in allocation of staff in ICT services support. Many organizations have embraced ICT as a platform for enhanced service delivery which further necessitate heavy investments in IT infrastructure. The use of ICT is crucial in routine data processing, provision of business operations and routine correspondence with customers. Further, revolutionary advances in ICT have therefore, offered a berth of opportunity to reinvent service provision within organizations. The study concluded that digital transformation is becoming an increasingly vital priority in today's information age. Hence, the changing demands from customers, the need to contain costs and to improve services in business processes is a reality. Due to the


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increasing demand in speed and performance in the delivery of quality business operations, organizations must learn to exploit various trends for optimizing staff workloads. By playing the role of staff allocation optimization assistants, Intelligent Agents may offer such solutions thus change how businesses deliver, evolve and grow. It is therefore, evident that Intelligent Agents will support ICT directorates to be well managed, coordinated and well streamlined. The findings indicated that mere introduction of ICTs will not help ICT directorates achieve their goals and objectives. It is also important to consider the alignment of the ICT portfolio along with the staff profile.

## 8. Recommendations

From the findings and conclusion of this study the following recommendations were made to organizations:

- To explore the possibilities on how to improve the level and range of ICT investments and infrastructure. This is because it is impossible sensibly to consider the provision of ICT services without making references also to the equipment, functions and human resources available.
- To effect changes in the structure and functions of the ICT directorates before any ICT solutions are rolled out.
- To consider the adoption of Intelligent Agents as optimization assistants in ICT services support.

## 9. Future Scope

This study was mainly confined to KRA, ICT Department. There is need to study the design and implementation of a hybrid approach to develop multi-agents for the provision of distributed services in organizations. Thus, this is a direction that is worth pursuing in further research.

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