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Recommendation of Documentary Units in a Progressively Intelligent City

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Abstract

The large cities and capitals of developing countries are becoming larger and more populated. These cities are modernizing day by day in order to increase the standard of living of their constantly growing population. To do this, they are equipping themselves with the latest generation of intelligent infrastructures that can make a city very autonomous. Information and communication technologies (ICT) and information technology infrastructure (ITI) are at the heart of these new autonomous cities, enabling highly integrated services and real-time city monitoring through a network of sensors, wireless devices, cameras and unified portals connected to massive data centers. The populations of these cities in developing countries are mostly poorly educated and often need help and assistance to be able to live properly in a smart city. The solution we propose is a recommendation system that will use a software assistant to offer suggestions to a user in need. A first experiment will be made in Ouagadougou to offer recommendations of documentary units to the inhabitants of the city. In this way, we hope to guide the inhabitants of this city and create a high quality of life.

Keywords

Smart City, Recommendation, IAAS, Documentary Unit

1. Introduction

The modernization of cities in developing countries is often very rapid. Large-scale national projects are transforming these cities into smart cities. This means that the infrastructure, economy and demography of the city are changing rapidly. This can

include smart buildings, smart governance, smart healthcare, smart transport, smart security, smart energy, smart commerce and smart infrastructure. The use of smart information systems can be the key to the rapid and effective implementation of smart city projects. But can the people in these cities keep up with the development? It is clear that these poorly educated people need assistance to be able to live well in these transformed cities and to take advantage of the infrastructure available to them. In our article, we explain how a referral system can be put in place to solve the problem of disorientation of the inhabitants of these cities.

2. Study Area

We take Ouagadougou, the capital of Burkina Faso, as our study area.

Ouagadougou is the largest city in Burkina Faso, with a rapidly growing population: it had 2.5 million inhabitants in 2015. In 2021, its population is estimated to be 3,000,000 according to the city hall. It is the cultural, economic and administrative centre of the country. Ouagadougou is a city that is gradually being modernised: the bus system is being set up, buildings and roads are being upgraded to resemble large European cities.

Ouagadougou has an area of 520 km^2. It is a city located at an altitude of 305 m above sea level with meteorological indicators such as 24˚C, wind W at 3 km/h, 38% humidity according to the weather.com website

3. Literature On Documentary Units

In the course of using a computer system, access to the desired information is the interesting part for the user [1]. A prerequisite for this access is the retrieval of the information. The latter is a problem addressed in the form of passage retrieval, such as answering questions and summarising. Passage retrieval has been of interest to researchers since the 1970s [2] [3]. It involves retrieving only those parts of a document that relate to a particular information need. This limits the amount of irrelevant information presented to a user in order to help the information seeker locate the relevant parts of documents more quickly.

This concern for reducing the information presented to the user leads us to another interesting issue, which is the granularity (or unit) of the information to be returned to the user. In response to an implicit or explicit query, most traditional information access systems return a set of documents. This "document" granularity does not always satisfy the user: a document may contain other irrelevant information, or the relevant information may be scattered throughout the document. It may indeed be more satisfactory for the user, in some cases, to return only a portion of the document, or even a set of information from different documents to ensure that the relevant information is not too dispersed [4]. Furthermore, dividing the document into several small units of information can help the information access process [5]: comparing a query with a part of a document is more efficient than comparing it with a whole document. These considerations are not recent. They can be found before the appearance of semi-structured documents.

They have been widely studied in what is commonly called passage retrieval [6] [7].

In the context of information retrieval in XML documents, the unit of information "naturally" corresponds to a node of the tree representing the document structure, *i.e.* a sub-tree. The relevance of a node in response to a query can be measured along two dimensions: completeness and specificity [8] [9]. More precisely, a unit of information is said to be exhaustive to a query if it contains all the information required by the query and specific if all its content is relevant to the query. Therefore, a system should always retrieve the most exhaustive and specific unit of information that matches a query [10].

We will apply these notions of specificity and completeness to the processing of document units. Generally, the part of the document returned by a system must be self-explanatory, *i.e.* it must not depend on the rest of the document to be understood. This part of the document returned by the system will constitute the documentary unit sought.

For our work we consider a domain characterised by a collection of documents whose description in documentary units is carried out in a database of document descriptors. The user queries the information system with keywords. We consider the result of the interrogation as a list of references of documentary units.

The use of documentary units will allow users to easily access parts of documents with precision.

A documentary unit is a part of a document which can be an image region, an audio segment, a video sequence or a textual unit. For example, the textual unit may be a chapter, section, paragraph or any other portion of text. The class diagram defined in **Figure 1** describes a documentary unit used in the subject area.

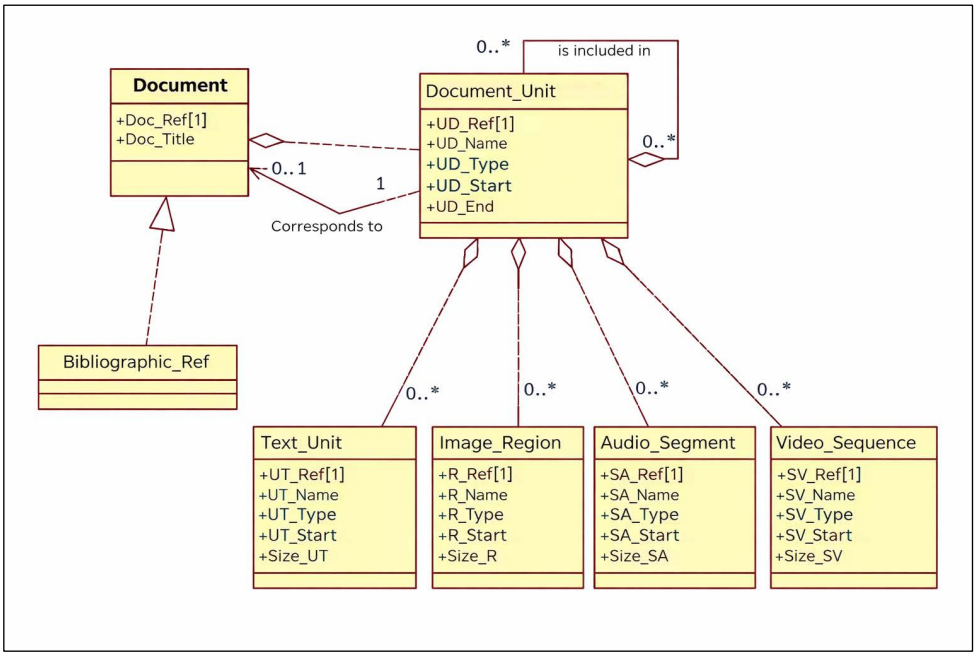

Figure 1. Document meta-model [1].

A document will be uniquely identified by a reference (Ref_Doc) and its title. In addition, it will be associated with its classic bibliographic references (Author, Date of publication, Publisher, Etc.). The document will be considered as a set of documentary units, and is itself considered as a documentary unit in its own right (Relation "Corresponds to").

A Documentary Unit (DU) will be identified by a unique reference (Ref_UD), a start line in the document (Start_UD) and an end line (End_UD). The DU will have a Name (optional) and a type (TU = Textual Unit, Image, Audio, Video, M = Mixed). A DU can be composed of several other DUs. This composition will allow the granularity of the DUs to be refined at will.

A DU will therefore be considered as a set of Text, Image, Sound and Video units. The latter will be characterised by their reference (Ref_*), their name (optional), Type, start line, and their size. The attribute Type_UT can take the values (Part, Chapter, Paragraph, Text). Size_UT represents the number of lines in the text.

4. A Recommendation System as a Solution

4.1. "Information Access Assistance Service" (IAAS) as an Adaptative System

The user of a computerised information system will make queries and will receive results to his queries. Our "Information Access Assistance Service" (IAAS) [1] [11] performs some processing that leads to adapting the result obtained to the user's profile and the user's query. Thus, two different users who are not in the same group may receive different results for the same request sent to the system. The system that is asked to resolve the query will use the user's profile to adapt the result to be returned. This aspect can be seen in **Figure 2**, the following image.

This image in **Figure 1** shows that two users, U1 and U2, who will each submit a query to IAAS, will receive results adapted to their profiles. These two results can therefore be different.

4.2. The Prediction and Recommendation Approach

At the heart of IAAS is the issuing of recommendation notices. It is the driving force behind the success of the entire system. Adaptation to profiles will be made on the basis of relevance ratings. Relevance ratings can be seen as recommendations made by users to systems to improve the satisfaction of other users.

Based on the relevance ratings that a profile will gather, recommendations will automatically be made to the users concerned by these profiles. When a user logs on to the system, IAAS will suggest lists of documentary units and the user can find satisfaction without even having to make a single query.

In this way, like in **Figure 3**, IAAS can predict what the user needs without the user even having to start querying.

4.3. Towards a Filtering System

The filtering aspect in the operation of IAAS can already be seen in the adaptation

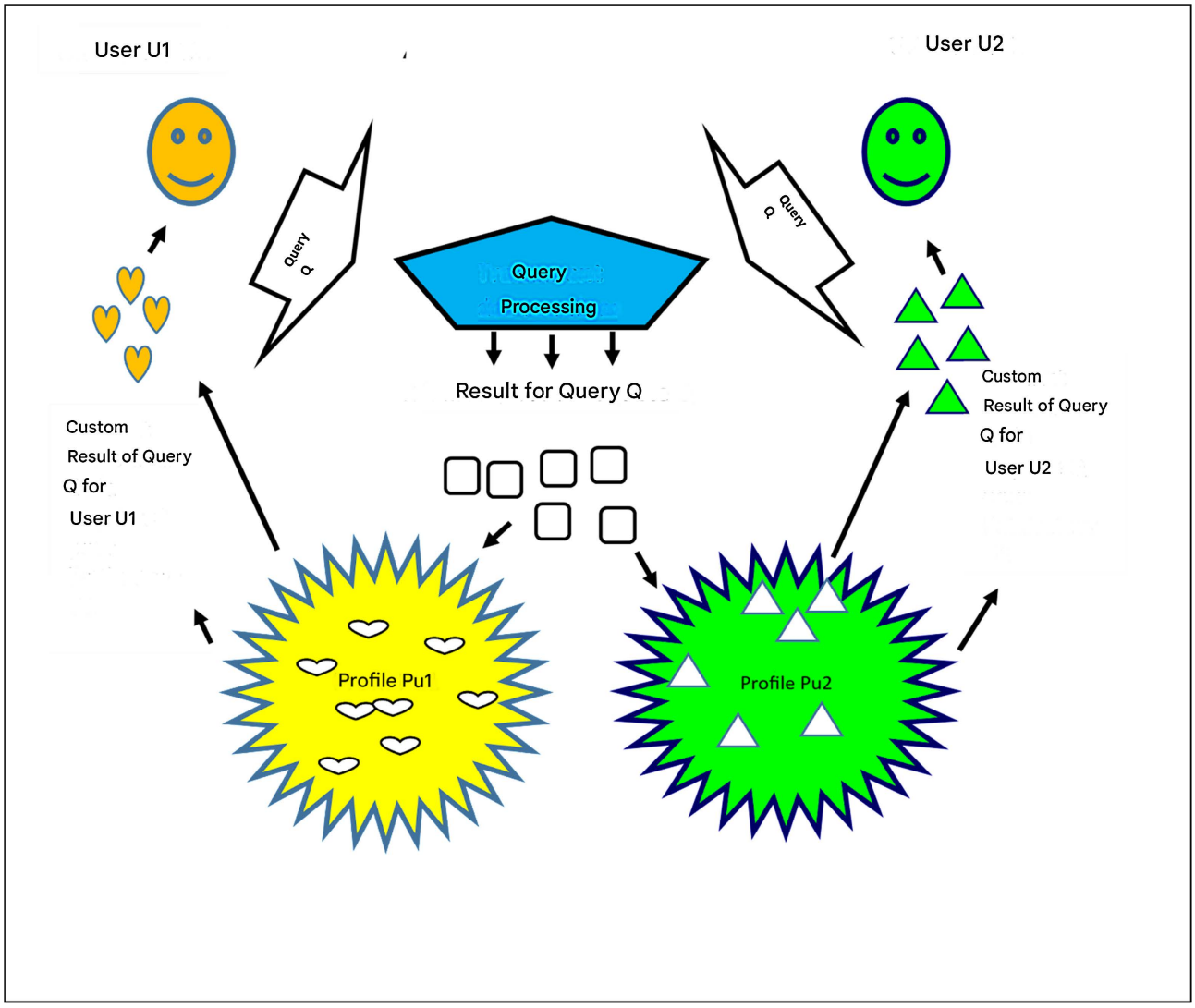

Figure 2. Adaptation of query results to user profiles.

of the query results, as some of the SUs in the initial result of the query execution will be hidden. Then, when reordering the resulting lists, the last ranked SUs may not be seen by the user. In this way, the SUs will be filtered to leave only those that are supposed to be of interest to the user.

4.4. Impact of Using Groups

The interest in using user groups lies in the fact that it allows several users to benefit from a relevance notice issued at once to that user group.

We assume the existence of a single member group with the name of the single member. This allows relevance notices to be issued to one person instead of several.

5. The Captive System to Be Set Up

In this article, we propose adapting the IAAS system for widespread use in the city of Ouagadougou (**Figure 4**). To do this, a number of experimental steps are to be

followed:

1) Ensuring that IAAS can give satisfactory recommendations: this is obvious,

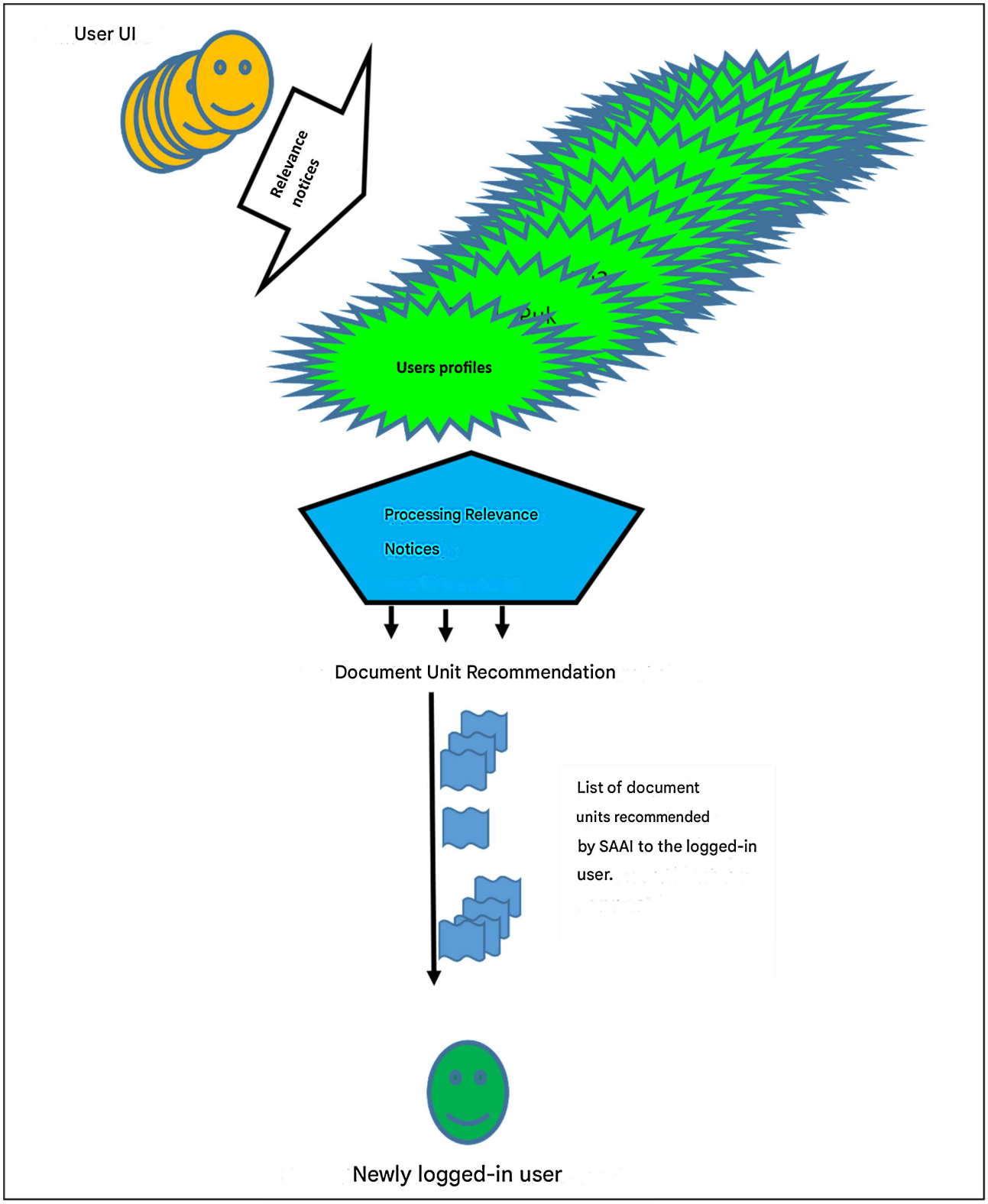

Figure 3. Prediction and Recommendation of DUs to a newly logged-in user.

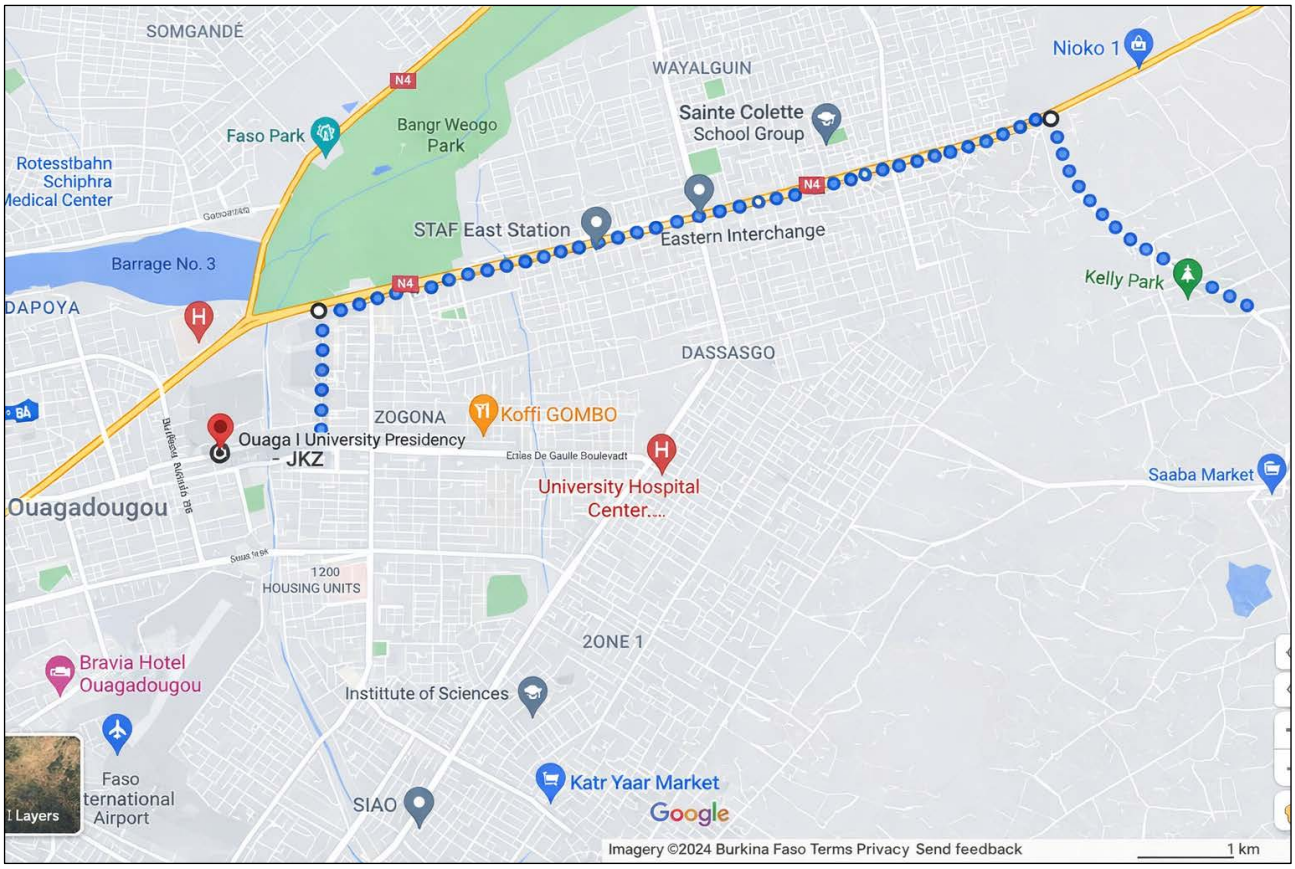

Figure 4. Experimental space.

because as shown in the literature already cited, IAAS is already used in library systems and gives satisfactory results [1] [11] [12].

2) Representation of information as a documentary unit: whatever the nature of the information, it can be considered as multimedia and therefore represented as a documentary unit. Thus, in the smart city, the objects that could be recommended as documentary units will be, for example, videos or parts of videos, directions to a place, indications on how to behave, audios or parts of audios, books or paragraphs of books, and so on.

3) Encourage the inhabitants of Ouagadougou to use the IAAS recommendation system. This requires the implementation of user-friendly mobile interfaces. Studies have already been carried out in this regard [13].

4) The implementation of a captive system allowing user mobility and service continuity in a given area. We propose the implementation of an experimental zone which is the 13 km route leading from the UJKZ of ZOGONA to the USTA of SAABA (**Figure 4**). This road is very frequented by all kinds of public but especially by students and teachers. This road is a large road that is constantly being modernised and is served by a very dense network of taxis and buses. On this road, the maximum distance between two bus stops is about one km. We intend to use the bus stops to set up a captive network. The implementation of this HI TECH network is in our perspectives. We are in discussion with the municipality for the

effectiveness of this solution.

6. Discussions

The work we conducted on the city of Ouagadougou is similar to many other existing studies, but it differs in several aspects:

1) Parvin [14] worked on recommendations for green and smart urbanization in the megacity of Dhaka. He sought to improve efficiency with limited resources. However, unlike our study, which focuses on an underdeveloped country, their work applies to an already developed city.

2) Like most of the recent studies we have read, the work of Chen [15] and Lyu [16] also focuses on already developed cities, and primarily concentrates on optimizing energy consumption.

Our work therefore has the merit of bringing the discussion to a developing country.

7. Conclusion

In the present study, we considered the need of inhabitants of a smart city who want to be assisted in their daily life during the use of the functionalities of new facilities in the city. We showed that IAAS could be used as a recommender system to offer recommendations of documentary units. The consideration of any information as a documentary unit made this ingenious idea possible which has never been proposed before. We have proposed this idea to the city of Ouagadougou, and we are negotiating with the municipality for the actual deployment of the captive system in this city on a 13 km long road. While waiting for impact studies on the lives of the inhabitants of Ouagadougou to be carried out, we anticipate that the use of our system will significantly improve the quality of life of the inhabitants of Ouagadougou who will use this system.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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