Design and Evaluate the Efficiency of Ethiopic Local Integrating System in Open-Source Database

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ABSTRACT The software includes models of internationalization over the entire world. However, the localization work which has been conducted on Amharic locale development has limitations such as managing Ethiopian calendar and numbers. This has a considerable impact in managing the Amharic locale data in a database as well as in other software systems. Even though there are some researches reporting Amharic locale data is managed by the existing Database Management Systems/DBMS/, the data management way is noticeably exposed to error. However, these kinds of errors are handled in this research by introducing new and appropriate exception handling mechanisms. In this regard, it was not found in the literature review to overcome these problems. In this work, an Amharic Locale Extension module named am_ET was developed to integrate into an open source database environment. The most suitable open-source DBMS PostgreSQL and the C programming language were used. User acceptance testing was conducted to evaluate Amharic locale extension functionalities based on the ISO 9241-11 usability testing attributes, such as user satisfaction, effectiveness and efficiency. To validate it, 35 voluntary potential users were randomly selected to participate in the usability test of the developed system. A descriptive statistical analysis and percentage method had been used to test the collected data. Accordingly, the usability test result showed that a positive opinion for the users and developers to manage Amharic local data as it easily manages data formatted to suit Ethiopian locales system such as currency, calendar, and date/time, reduced costs for developers, and better understanding of product functionalities. Consequently, the developed Amharic locale extension solved problems of data management with Ethiopian locales. The paper found that integrated extension module is helpful in localization and design application areas for all entities that are using Amharic locale in open source databases.

INDEX TERMS Ethiopian locale, integrating system, amharic scripts, natural language, open source database.

I. INTRODUCTION
A database to be truly purposeful, it should not only store huge amounts of records, but also be easily available, accessible and reliable. In addition, new information and modifications would also be reliable, accessible, store large amount of data, and fairly easy to input. An efficient database system should have a program that accomplishes the queries and data stored on the system must be integrated [1]. Due to the tremendously increasing volumes of the local data, which are a by-product of modern life, there is a growing need of an appropriate database that require efficient methods for their management and retrieval. Storing and accessing data in their original representation is very important, since converted data sometimes may result to loss of information [2]. Open source databases become by their own to stand as solutions for every data management need in the enterprise.
The process of adapting a product to new linguistic and cultural specifics of content to a given geographical aspect (local) is localization. The Ethiopic script (i.e., here Amharic script/Ge’ez) used as the writing method of Semitic language spoken in Ethiopia and it includes more than 400 characters. Although the language (Ge’ez) has only been used in dialect speech (it now serves as a liturgical purpose only), the inscription is still broadly used for the writing system of both the Ethiopian and Eritrean Semitic languages such as Tigré and Amharic [3], [4]. The ancient calendar of Ethiopia has differences from the Gregorian calendar in terms of day, month and year. The Ethiopic calendar has 13 months, of which 12 months have 30 days and the 13th month comes at the end of the year with 5 or 6 days depending on whether the year is a leap year or not [1], [5]. As a result, a huge amount of data in Ethiopic script uses Ethiopian calendar which needs to be stored in databases according to Ethiopian locale system.

Generally, programs are culturally neutral. They have an interaction between many components which are arranged in specific patterns and have performed many tasks. When the linguistic and cultural specificity are added to these programs many more people are comfortable with their native language. Most of the existing environmental systems including the models for internationalization are used to allow software developers to develop easily that support different locales [6]. Even though, software’s including models of internationalization, the localization work conducted on Amharic locale development has limitations. This has a considerable impact on managing the Amharic locale data in database as well as in other software system. Calendar and collation sequences are examples of Amharic locales which did not manage in the current software environment. A calendar as described in [7] is a human abstraction of the physical timeline. It can measure periods and times using any well-defined time unit. A typical calendar property is the language in which time values are expressed. For example, in the Ethiopian calendar Amharic and Geez are used to express periods of time, but in the Gregorian calendar English is used to express periods of time in the United States. In almost all countries, the usage and practice of a calendar are influenced by the national, cultural, legal, and even business orientation of the user. Most of the existing operating system uses the Gregorian calendar system, foreign cultural systems such as numbers, currencies, calendars, date & time, etc., and managing of such data in the databases. However, most of the data in Ethiopia are available with Ethiopian calendar system and users in Ethiopia are not convenient with the Gregorian calendar since they use Ethiopian calendar in their day-to-day activities. This usually creates inconvenience when the user wants to have a reference to Ethiopic date as they had Gregorian calendar and date & time, foreign currency and numbers at their operating system.

This study focused on the investigation of locale integration in database environment, identifying techniques and methods that have been applied in the area of database localization. Moreover, it has been a duty in designing an appropriate Amharic locale extension module to integrate into PostgreSQL; and evaluating its efficiency, advantages and reliability for the requirement of Amharic integration in the database system.

The currently used database by the selected organization (Private Organizations’ Employees Social Security Agency – POESSA) is known as Employee Social Security Management System (ESSMS) developed using a DBMS of the SQL server. We have selected three tables (Employee, Service, and Family) of the database for the experimental results by introducing new data types such as ethdate and ethmoney on the existing DBMS to evaluate the proposed solution by comparing with the existing DBMS and the created extension. After the experiment the currency, the calendar, the number entered to the system is retrieved and managed without error(s) and hence the result shows that the proposed/developed Amharic locale extension has a positive impact to the study of localization.

The aim of this research work is to develop Amharic locale extension module to integrate in open-source database, and evaluating its efficiency. Specifically, it is aimed to explore related works in locale integration in database environment; identify different techniques and methods that have been used in the area of database localization; identify the DBMS components that are linked to locale integration; identify the requirement of Amharic locale integration in database systems; design an appropriate Amharic locale integrating system using a selected open source database; and test the prototype and evaluate the system’s efficiency.

Accordingly, the following questions have been obtained by the researchers to be replied at the end of the research work:

- What suggestions and opinions by the users (i.e the end-users and database admins) have been entertained on the Module’s Qualification of using Amharic Locale Extension (am_ET)?
- How Satisfied are the users (i.e the end-users and database admins) about the use of am_ET module of the Amharic Local Extension?
- What opinion of the users (i.e the end-users and database admins) about the Usefulness of the Amharic Locale Extension (am_ET) module?
- What suggestions and opinions by the users (i.e the end-users and database admins) about the Quality Attributes of Amharic Locale Extension (am_ET) module?

II. BACKGROUND

A. THE AMHARIC LANGUAGE AND ITS WRITING SYSTEM

It’s believed that Amharic, Ethiopian official language, has more than 25 million speakers as a mother tongue language and as a second language [8]. A set of 38 phonetics, seven vowels and 31 consonants, marks up the full list of sounds for the Amharic language [9]. Consonants are commonly categorized as stops, fricatives, nasals, liquids and semi-vowels. Some sounds have similarities with English but are character-
ized using dissimilar symbols. These include ዋ [ch], ካ [nx], ዋኔ [sx] and ዋን [zx]. Sounds that are the features of Amharic but not found in English are ር [px], ይ [tx], ወ [xx], ዋኔ [cx] and ዋን [q] [10]. In Amharic language, all consonants except ወ/ḥ/ and ሳ/ḥx/ might come about in either a geminated or a non-geminated method. Germination in Amharic is one of the most unique features of the rhythm of the speech, and also brings a very substantial semantic and syntactic functional weight [11]. When Amharic sentence is observed from grammatical construction point of view it is a grouping of noun phrase and verb phrase. The noun phrase emanates first and then the verb phrase. Based on the number of expressions or phrases they comprise, sentences in Amharic are categorized under two basic categories simple and complex sentence. The simple sentence only comprises a single verb while the complex sentence is built by combining more than one noun phrases and verb phrases.

Therefore, due to such variety and complex characteristics of the Amharic culture, vowels and calendars, development and integration of the Amharic Locale into an open source will make the data management routine easier.

B. LOCALIZING SCRIPTS AND CALENDARS

In Amharic script system, numbers can be characterized using either the symbols of Arabic number system or the symbols of the Ethiopic number system or using words and symbols of the Arabic number system.

There are cultural beliefs around the world that lead people to use their calendar which is entirely different or the same to some extent as the western Gregorian calendar. However, they put up with the rule of 12 months a year. An Ethiopian year is contained of 13 months, and is seven years late than the Gregorian calendar. In fact, Ethiopians celebrated the new second millennium on September 11, 2007; this is because the Ethiopians continued with the same calendar that the Roman church amended in 525 AD. While the first 12 months have 30 days, the last month, called Pagume, has five or six days depending on a leap year. Ethiopia, being one of the rare countries in the world, quite uses its own calendar system.

The country celebrates some vital holidays on days that are unlike the rest of the world [12].

Lielet [13] localized some contents of the open source web development tool (specifically Joomla) into Amharic to create professional and nonprofessional users who take part in website development has been conducted who want to develop a website comfortably. The Amharic translations are issued in the front and back end interfaces. A virtual keyboard is designed To make Amharic text entry easier and make the web content manageable ny the user, a virtual keyboard is designed and implemented. However, this work also does not take into consideration the different locales of Ethiopia like calendar, date/time format, sorting/collation order, regular expression etc.

In Sarfraz et al. [14] study, the authors presented the process used to localize a set of open-source software applications that developed in English language for Urdu speakers in Pakistan. The software applications were selected are web browser, an email client, instant messaging client, word processor, graphics editor and webpage development tool. The paper presents the criterion for localizing software was that the application must be internationalized. Since, internationalized development facilitates an efficient and convenient localization process by separating the resource file that need to be customized (localized) for a target locale.

Bader [15] presented the analysis and the technique of website localization from the source language (English) to the target language (Arabic). The key points considered to localize a website to the target language (Arabic) were resource file and the database table. The author localized and put a separate resource file for the target language. Since the software localization process must include database design adjustments in order to enable the target language supported by the localized software. The author uses a commonly used method for developing a multilingual database is to create two tables.

According to Oracle Database Globalization Support Guide [16], Oracle support globalization as National Language Support (NLS) features to decide on a national or official language and store data in a definite character set and executed with Oracle NLS Runtime Library. The NLS Runtime Library provides a collection of language-independent functions that perform appropriate text, character processing and linguistic-convention operations.

According to Axmark and Widenius [17], to store and retrieve data, database tables were used in different languages and character sets differently. As such, MySQL included model of internationalization and localization for adapting different locale system for efficient data management. MySQL support different character set for SQL statement, languages for error messages, locale time at different levels, for example, the server, database, table, and column level.

The literature reviews indicated and suggested that Amharic scripts and calendars can be localized based on different localization methods.

C. INTEGRATING THE ETHIOPIC LOCAL IN TO OPEN SOURCE DATABASES

According to Elmasri [18], a database is an organized and structured collection of records and data that is stored in a computer system. A very high effective and efficient database system should have a program that manages and executes the queries, data and information stored on the system should be incorporated and integrated.

Due to tremendously increasing volumes of local data, which are a by-product of modern life, there is a growing need of an appropriate database that require efficient methods for their management and retrieval. Storing and accessing data in their original representation is very important, since converted data sometimes may result to loss of information [2]. Open source databases have come into their own to stand as solutions for every data management need in the enterprise.
According to reports of DB-Engines [19], an online initiative to collect and put-into information on database management systems, popularity of open source databases are growing faster than commercial databases. The process of adapting a product to new linguistic and cultural specifics of content to a given geographical aspect (locale) is localization. The Ethiopic script (Ge’ez) is used as the writing system of Semitic language broadly spoken in Ethiopia and it includes more than 400 characters. Although the language (Ge’ez) only to be used in vernacular speech as it is now serves a liturgical function only, the script is still mostly used for characterizing the Ethiopian and Eritrean Semitic languages such as Amharic, Tigré and Tigrinya [3], [4]. As a result, a huge amount of data in Ethiopic script use Ethiopian calendar in which it needs to be stored in databases according to Ethiopian locale system. Therefore, managing the sorting and searching of data in the database system is the main important operations in database system and hence developing a module/extension that incorporates the Amharic Locale data type to integrate into an open source database is useful.

III. METHODS

A. RESEARCH DESIGN

The study was conducted from January – November, 2021, at Private Organizations’ Employee Social Security Agency (POESSA), Ethiopia, using the model-driven and experimental method of research approach. The survey was carried out for two types of users (ordinary users that always work for the system and database experts in the organization). An Amharic Locale Extension module (am_ET) that has been developed by the researchers was used in the research work.

B. PARTICIPANTS

Randomly selected and voluntary technically skilled personnel in the area of employees’ social security of the existing database were identified. Moreover, 25 database users having good skills in basic computer systems and 10 database admins from the selected organization (POSSA) were invited for the trial of the developed Amharic Locale Extension module integrated into the open-source database known by PostgreSQL server to prove and verify the acceptability of the extension/module as a localization platform. According to Kozmichuk et al. [20], the PostgreSQL server is preferable as it implements the most recent ISO and ANSI standards and gives best services of backup and recovery, and also gives local storage (temporary) and storage in the cloud. Fraenkel et al. [21] suggested that “there are no rules for determining the size of groups (p. 267)” in an experimental research. Both types of users’ ages ranged between 25 and 37 and their experience in the organization ranged from three to nine years. 25% and 75% of the users were female and male, respectively.

C. PROTOTYPE AND ALGORITHMS

The algorithm used to design the system is depicted as follows:

Algorithm for Ethiopian date internal form

if month name is equal with predefined Ethiopian month name

the month is correct for Ethiopian calendar

if day is equal with predefined Ethiopian day values

the month is correct for Ethiopian calendar

If Ethiopian month is between 1 and 12

Ethiopian date is between 1 and 30

Else If (Ethiopian month is 1 or 13)

If is Ethiopian leap year true

Ethiopian date is between 1 and 6

Else

Ethiopian date is between 1 and 5.

if day, month and year are in allowed range

store them as correct Ethiopian date value

Algorithm for Ethiopian currency internal form

if money value is with Arabic number and the currency unit is null or ዋč

store as correct Ethiopian currency

else if money value is with Ge’ez number and the currency unit is null or ዋč

change to equivalent Arabic number and store as Ethiopian currency

Algorithm for Ethiopian date external form

get Ethiopian date

display as DD-MM-YYYY format

where YYYY represents the calendar year, MM is the ordinal number of month within the calendar and DD is the ordinal number of day within the calendar.

Algorithm for Ethiopian currency output (external) form

get Ethiopian currency value

display currency value with currency unit ዋč ዬን ከ

Architectural support is provided for the addition and modification of the database management system components (especially in PostgreSQL) that impose a particular interpretation on locale values. As shown in Figure 1, the architecture to extend PostgreSQL DBMS is composed of two major components: PostgreSQL server and extension module. To support locale specification at all levels of a database (database catalog, schema, table, record and attribute) we proposed new data types. The data types implemented as the
We identified locales which universally explain cultural-dependent aspects of a data. More specifically, there are properties that define the internal mechanisms of how data should be managed in a database. After the locales are identified, we need a real implementation to support Amharic locale in database system. We have used a C code as real implementation of Amharic locale extension. We used C Programming language as it is preferable for bilingual model and has nothing to do with any particular hardware or system [22]. As we mentioned earlier, to support Amharic locale in PostgreSQL we proposed new data types. New data type creation requires implementing external form and the internal form of a value. These functions (internal and external forms) determine how the type appears for input by the user, output to the user and how the type is organized in memory.

The control file specifies properties/metadata about the Amharic locale extension, which tells the basics about extension to PostgreSQL to register in its system catalog, and must be placed in the installation’s SHAREDIR/extension directory. The file is am_ET.control. Parameters inside this file follows the same convention as postgresql.conf file (i.e. parameter_name = parameter_value).

SQL script is mapping file, which we used to map all the SQL function with the corresponding C function of the extension (am_ET). It contains SQL commands about functions, types and operators of the Amharic locale. It also includes the required DDL and DML operations of extension. The file is am_ET—1.0.sql.

Once the extension module is loaded into PostgreSQL server, database operations can be performed on the Ethiopian locale data according to Amharic locale convention. In order to manage Amharic locale data, the database user must write SQL statement on a query tool and execute it. By using Amharic extension module, DDL and DML operations can be performed on the database as shown in figure 3.

Adding values to the table can be performed by inserting insert command into the statement. Figure 4 shows how the database users add values for the columns of the table.

D. DATA COLLECTION TOOLS
User acceptance testing was conducted to evaluate Amharic locale extension functionalities which was done based on the ISO 9241-11 usability testing characteristics, such as efficiency, effectiveness (referring the completeness and accuracy) and user satisfaction and the enquiry of the usability methods of any developed system must be validated alongside potential users [23]. This paper proposed different criteria for evaluating the quality of a developed system and finally adapted suitable criteria from Cavus [24] that best fits the developed module to evaluate its efficiency, usability, and reliability. These assessment methods and techniques are presented with respect to each development phase of the extension module. Then end-users’ and database admins’ feeling was taken. In the final of all these assessments and evaluations, the authors enhanced the extension module consequently based on assessment and evaluation results. In this
regard, the study engaged on quantitative data, which were collected over the questionnaire named “Database Admins’ and End-users’ Feelings about the Developed and Integrated Amharic Locale Extension module and Integrated into the Open Source database Acceptance” that was compiled and developed by the researchers. But some of the questions and items are taken on and adopted from Cavus [24]. The content, quality, legitimacy and validity of the organized questionnaire were checked by 4 professionals, comprising 2 database specialists and 2 software testing professionals and were approved that it is possible to use in the research study and the consistency and reliability of the data collection tools were determined to be 0.89 using Cronbach’s alpha, which is much advanced than the absolute value of 0.72 [25] indicating a higher degree of validity. The prepared questionnaire comprises of four parts. The first part consists of seven questions and it was used to assess and evaluates the integrated extension module’s qualification. Five-point Likert scale (having values of strongly agree-SA (5), agree-A (4), neutral-LA (3), disagree-DA (2) and strongly disagree-SD (1)) for the responses of the items and questions were used as it is easy to understand and interpret. The second part of the designed questionnaire was used to test the module usability of the developed extension module and consists of 7 items. Usability is designated as the practice quality of a method or system from the perception of users (end-users/database admins). The third part having seven questions was used to prove the usefulness of the modules based on the attitudes of the end users and database admins. The questionnaire consists again the 5-point Likert scale type questions which strongly agree was indicating score 5 and strongly disagree was representing score 1. Strongly agree interpreted a positive attitude of the participants to the am_ET Amharic Locale Extension module. The last part of the questionnaire consists of 6 items about the satisfaction of end-users and database admins with respect to using the am_ET Amharic Locale Extension module.

E. DATA ANALYSIS
In this research work, statistical method of analysis such as descriptive analysis (averaging, standard deviation and mean), was conducted to interpret the data obtained by the questionnaire. The statistical package that we have been used for the analysis process was SPSS.

F. PROCEDURE
After developed the extension module and integrated into the open source database, the system is hosted in the local server of the selected organization (POSSA). By introducing the am-ET Amharic Locale Extension module and all the information into the selected and volunteer participants regarding the experimental study, each participant was using...
their own laptops or desktop computers in the computer training room of POSSA, just given permission for this purpose. In order to make sure that the extension module is working correctly according to Amharic locale convention, unit and system testing were applied. The first testing is testing on the calendar. The Ethiopian calendar is based on the Ethiopian Orthodox church computational practices. The church uses its own calculation to create a calendar for the country. The calendar is checked with other developed Ethiopian calendar system. In the evaluation, users were participated in the testing. A detailed and completed description about the extension has been given to those who participate in the experimental assessment before conducting the evaluation process, as it helps them in having an insight to the developed extension. The participants were asked to use the extension module on their own for four weeks (four hours a week) with their laptops or desktops in the training room just after the demonstration of the developed extension. Finally, participants were provided with respective questionnaire. To select representative number of participants, random sampling technique was applied. The choice of participants in the evaluation process was taken by considering their knowledge of the basics of computer skills and positions in the organization they have. Finally, each dimensions of the responses on the questionnaire were calculated, measured and analyzed.

IV. EVALUATION RESULTS

A. MODULE’S QUALIFICATION OF USING AMHARIC LOCALE EXTENSION (am_ET)

As described in Table 1, the means scored in the opinions and the standard deviation of the participants indicated that the Amharic Locale Extension (am_ET) is efficient and useful. The means of answers to all questions to the questionnaires were above 4.20 and this result showed that the database admins and end-users had positive opinion in related to the qualification of the Amharic Locale Extension module. For example, as shown in Table 1, question 6, “How do you rate the extension can be used by any database user with basic knowledge of using the existing DBMS? (Mean = 4.8, SD = 0.35)” and question 7, “How do you rate the extension matches your expectation to manage (store, query and present) Amharic locale (calendar, currency, numerals phone number etc.)? (Mean = 4.9, SD = 0.39)” indicate that the database admins’ and end-users’ opinion of the developed extension module is useful and efficient.

B. SATISFACTION ABOUT THE USE OF am_ET MODULE OF THE AMHARIC LOCAL EXTENSION

The satisfaction of the users about the Amharic Local Extension am_ET module was measured by obtaining the following characteristics.

i Unicode Conversion: Converting input Unicode strings to Amharic locale data is easily implemented and practical with the am_ET module of the Amharic Local Extension.

| Questions to Module’s Usefulness | Admins (n = 10) | End-users (n = 25) |
|---------------------------------|---------------|-------------------|
| 1 How do you rate the extension is more appropriate to manage Amharic locale data according to Amharic locale convention? | 4.20 .20 | 4.40 .64 |
| 2 How do you rate the extension is complete enough to provide intended information? | 4.20 .20 | 4.52 .68 |
| 3 How do you rate the extension minimizes occurrence of errors when managing Amharic locale data and give description when the error occurs? | 4.70 .31 | 4.60 .71 |
| 4 How do you rate the extension is good enough to manage (store, retrieve and present) Amharic locale data (calendar, geez numerals, currency and phone number etc.)? | 4.50 .25 | 4.64 .79 |
| 5 How do you rate the expected function of the Amharic locale was present? | 4.40 .23 | 4.64 .75 |
| 6 How do you rate the extension can be used by any database user having basic knowledge of using the existing DBMS? | 4.80 .35 | 4.76 .85 |
| 7 How do you rate the extension matches your expectation to manage (store, query and present) Amharic locale (calendar, currency, numerals phone number etc.)? | 4.90 .39 | 4.68 .80 |

ii Integrated Testing: All the required tests were completed easily with the am_ET module of the Amharic Local Extension.

iii Data Management: The Extension module is added correctly to the existing PostgreSQL database to manage Amharic locale data.

iv Localization Needs: I can say that the am_ET module of the Amharic Local Extension satisfied all of Amharic Locale users’ need.

v Recommendations: It is recommended that the use of am_ET module of the Amharic Local Extension to other users/database users.

vi Satisfaction: I want to use the am_ET module of the Amharic Local Extension again.

vii Attractiveness: The use of the am_ET module of the Amharic Local Extension was very interesting and attractive.
The users’ satisfaction about the use of am_ET Amharic Locale extension is shown in percentage in Figure 5. According to Figure 5, the end-users and database admins were interested and satisfied in using the developed am_ET Amharic Locale Extension module. It was observed that the minimum opinion in percentage for end users had been 82.30% and for database admins had been 79.50% for the item “Unicode Conversion: Converting input Unicode strings to Amharic locale data is easily implemented and practical with the am_ET module of the Amharic Local Extension”. It was also observed that the maximum opinion in percentage for end users had been 98.30% and for the database admins had been 93.30% for the item “Localization Needs: I can say that the am_ET module of the Amharic Local Extension satisfied all of Amharic Locale users’ need.” In almost all items, it was observed that end-users are slightly more satisfied than the database admins. This slightly difference might come from repeatedly using of the old system and the newly integrated module as it has been known that it is their day to day duties of the end-users.

C. THE USEFULNESS OF THE AMHARIC LOCALE EXTENSION (am_ET) MODULE

In order to find the opinions and suggestions of participants (end-users and database admins) on the usefulness of the developed and integrated Amharic Locale extension module, the survey consisted of some questions and obtained evaluation results as shown in Table 2.

According to Table 2, when the database administrators inspected the developed am_ET Amharic Locale Extension module from the viewpoint of a database expert, they engrossed their positive opinions on the insert, update and drop the required information and the highest score was given to the 3rd, 4th and 6th questions, which were “How do you rate the usefulness of the Insert locale data module? (M = 4.90, SD = 0.45)”, “How do you rate the usefulness of the Update locale record module? (M = 4.90, SD = 0.39)”, and “How do you rate the usefulness of the Drop extension module? (M = 4.90, SD = 0.39)”, respectively. This positive impact goes to the end-users so that updating, inserting and dropping data to the system is very much useful. As it can be seen from the Table 2, for almost all items both end-users and database admins scores highly in their mean value and therefore the users were pleased to use the am_ET Amharic Locale Extension module as a localization platform.

D. QUALITY ATTRIBUTES OF AMHARIC LOCALE EXTENSION (am_ET) MODULE

In order to get and obtain the opinions and suggestions of participants (end-users and database admins) on the quality attributes of the developed and integrated Amharic Locale extension module, the survey contained of the following items.

- The Amharic Locale Extension (am_ET) module is functional.
- The Amharic Locale Extension (am_ET) module is reliable.
- The Amharic Locale Extension (am_ET) module is usable.
- The usability of the Amharic Locale Extension (am_ET) module is efficient.
- The Amharic Locale Extension (am_ET) module is maintainable.
- The Amharic Locale Extension (am_ET) module is portable.

According to one of software quality of the International Organization for Standardization (ISO), the ISO/IEC 9126-1 [26] standard divides software quality characteristics into six guidelines wherever they are used for the construction of
any kind of portable-based devices software applications and utilities. These guidelines are the competency and efficiency which is about the performance of a system; functionality telling about the expected behavior of a system; usability showing about how easy it is to use a system; reliability referring to the robustness of a system to make sure it is where the operation can be trusted under all circumstances; maintainability refers to keeping a system running without difficulties and upgrade it where it is important and necessary; and the portability of a system is about the capability to use a system in different backgrounds and environments to what it is designed for. During the designing, implementing and testing processes of a system, these quality attributes and characteristics can be measured and evaluated. As a result and its consequence, the users’ (database admins and end-users) perception of system quality can be resolve by determining the quality of the attributes in use.

As given in Figure 6, database admins and end-users were very satisfied about the quality attributes and characteristics of the system. The percentage results (Strongly Agree) show that the users were happy with the overall configuration of the extension module. As the gained values were between 84.50% and 95.40% for end-users, and between 79.80% and 91.50% for the database admins, the overall results were encouraging and this shows that the am_ET Amharic Locale Extension module can be used as a localization platform of Amharic texts, currencies, calendars, and numbers in POSSA and hence it can be used for any Ethiopian organizations.

V. DISCUSSION

Since the required operations related with Ethiopic numerals, Ethiopian currency and Ethiopian calendar are defined in the extension module we can perform operation as needed. To store phone number by using this extension module we can use varchar /text /char data type with fixed length and use function to_phone() to clear the difference between phone number with other text value. To manage geez number by using this extension module, integer data type and function to_number() can be used because the existing systems assume geez numbers as different character [27].

Managing Amharic locale data in the existing DBMS with western locale convention leads to miss information. For example, when inserting a value for a column እጋር/ ከጋር ከ/<option> (monthly salary) the amount is stored in $. In the existing DBMS, it is not possible to perform the required operations to manipulate Amharic locale data. However, by using the developed extension we can do different operations on Amharic locale data according to the locale convention. Even though Amharic locale data is managed [28] by the existing DBMS, the data management way is noticeably exposed to error, i.e. any invalid value for the column salary, date of birth, date of hire, Phone number and registration date can be inserted. However, these kinds of errors are handled by appropriate exception handling mechanisms on the developed extension module.

From the encouraging and promising estimations gained in the study, it is shown that end-user and database administrators of POSSA do not have any trouble in retrieving the required information and local data on the designed and integrated extension module whenever they need it without more effort; and its validity is approved based on [23]. In order to get the opinions and perceptions of participants on the quality attributes of the designed and developed am_ET extension, the survey considers for its functionality, reliability, usability, efficiency and maintainability as it could be adopted from Cavus [24]. The assessment of the localization applications is specifically relevant; however, few researchers have addressed these measurement criteria using laboratory experimental studies with database administrators and end-users in real areas. According to Kumar [29] a Heuristics evaluation has been proposed to test a developed system and therefore, the most significant distinctive of the paper is that the developed Amharic Locale Extension module, am_ET, has been tested and verified by real users, namely database admins and end-users. There are many researchers that have used the 5-point Likert scale format questionnaire for the assessment of the efficiency of any developed applications.
designed and implemented in their studies [30]. Pensabere-Rodrigueza et al. [31] used a usability assessment to define the efficiency of a developed system and applications. Almost all of these studies have proved that numerous methods and techniques can be used to assess and evaluate the efficiency of developed applications and hence they are used for localization systems.

VI. CONCLUSION AND FUTURE WORKS

While most of the technologies are often similar across customization of different software from source language to the target locales but the cultural and linguistic factors (locale development) are different. There is a need to localize DBMS that support Ethiopian locales, that could attracts users based on common and public language or shared ethnic, racial, gender, or nationality-based identities for integrating the cultural beliefs and attributes. The developed extension was tested and the result showed that its usefulness, reliability and quality has been earned a positive opinion. Also, the constructive assessment results pointed out that the database admins and end-users were gratified with the am_ET Amharic Locale Extension module’s tasks and helpfulness. Both end-users and database admins appeared to have encouraged opinions about the developed Amharic Locale Extension module. Moreover, the investigational results of this research affirmed that, since the means of the end-users and database admins opinions were very high, the am_ET Amharic Locale Extension module was well designed and implemented technically.

The result of this research work would be important the experts of the indicated and selected organization for their day to day works as well as for database developers and users of database in local language. The advantages of the proposed work would enable to easily manage data formatted to suit Amharic locales system (such as collating sequence, calendar and date/time etc...); to reduce costs for developers since they can focus only on handling Amharic locale system instead of dealing with conversions after developing the whole DBMS in English locale; and to local language development in the digital world and to better understanding of product functionalities of DBMS; and used as an input for other works. It is anticipated that the integrated extension module would be helpful to anyone who may have an interest in localization and design applications, and all organizations that used Amharic locales in open source databases. Apart from government efforts, individual developers also need to be motivated to take part in the localized data management development processes. In this study, we have made the first step towards the vital or ultimate objective of achieving and attaining complete multi-locale functionality in database systems.

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