Data Exchange Framework for Social Security System in the Ethiopian Context

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Abstract

Data exchange and management problem has always been a cause for inefficient and poor service delivery in the social security sector. The two Social Security Agencies (Public Servant Social Security Agency /PSSSA/ and Private Organizations Employees' Social Security Agency /POESSA/) of Ethiopia have taken different initiatives to find technological solutions. However, since services of social security organizations is fully dependent on data provided by other organizations (e.g. employers, tax authorities, etc.), technological solutions lack being holistic.

In this paper, services of the two Agencies and their operational activities have been assessed and an integrated data exchange framework is proposed as a solution. This solution considers other agent systems (human resource, payroll, etc.) that produce or capture data that can be used by the two Agencies and it also considers the social security services that exploit the systems. Creating a pension repository as a facilitator for the matching and mapping approach and a matching algorithm is the component of the solution in the data exchange framework.

To minimize mismatch at data exchange level, setting standard specification based on the Agency's requirement, and defining concepts and their relations in the social security domain using taxonomical structure is the other effort we made in providing the solution. To provide a solution for the problems caused by the current unique identification method, a pension identification number generator algorithm is developed. We have validated our solution by implementing one of the pension repositories, which is pension registry, from the solutions we have proposed.

Keywords: Data Exchange; Framework, Standard; Unique Identification; Schema Matching; Mapping; Social Security

1. Introduction

Social security may be defined as "any programme of social protection established by legislation, or any other mandatory arrangement, that provides individuals with a degree of income security when faced with the contingencies of old age, survivorship, incapacity, disability, unemployment or rearing children" [1]. Social security institutions and their services by their very nature require service delivery which is not bounded to specific organizations or specific geographic location, with different types of beneficiaries.

The fact that social security organizations being dependent on other institutions, has become a major challenge in their service delivery and technological solution they seek. When any employer failed to submit data (registration and contribution) of its employees in a timely manner, its employees face different problems in getting any service or benefit. It will be difficult for the social security institutions to provide any service or to respond to benefit request for those employees without a complete data. The effort made by the Agencies to request, collect, and validate those data in manual and formal communication with the employer takes significant amount of time before the employees get the service they requested or the benefit they are entitled to. This brings about the issue of electronic data exchange with agents involved in the service delivery. The core issue for fast and reliable service supported by ICT

for any social security organizations involves electronic data exchange.

In this paper, we have proposed a solution as a framework that enables data exchange among the social security Agencies and Agents involved in providing data to the Agencies. The rest of the paper is organized as follows: Section 2 presents the background information regarding social security service and technology. Section 3 assesses related works in data exchange. Section 4 discusses the proposed solution. Section 5 covers the prototype developed as validation. Finally, in Section 6, is the conclusion.

2. Background

The establishment of government institutions is related to the introduction of a strong central government [2]. The first pension proclamation was introduced in 1961 to tackle loss of income for civil servants caused by different contingencies (age, sickness, work injury, etc.).

As an independent institution, the Federal Democratic Republic of Ethiopia's Public Servants Social Security Agency (PSSSA) was first established as a ministry in1958 [2]. It was later in 2011 that it was re-established in accordance with regulation number 203/2011. Since its establishment, it has extended its services to civil servants, members of the police force as well as the armed forces [3].

The Federal Private Organizations Employees Social Security has been established by the council of ministers regulation no 202/2011 with the intent of extending the social security service, which had been limited to the public servants, to the private sector [4].

Old age pension, invalidity pension, work injury pension, and survivors' pension are given to the public and private sector employees [5, 6].

The two social security Agencies (PSSSA and POESSA), except their customer type, more or less deliver their services in the same manner. They have same federal and regional structure for their service delivery. Their major functions are registering their customers, collecting contribution from those covered by their scheme, and finally entitling different benefits to those who are qualified to get. The source of the data that is used for entitlement is collected, organized, and submitted by different institutions. Mainly, the government and private employers are sources of registration information; Federal and Regional institutions mandated to collect tax are other sources in providing contribution information.

As indicated in the introduction the social security agencies' service delivery and mandate depends on the information captured and transferred by the stakeholders. Automated tax collection system, human resource system, finance system, birth registration system, etc., have data relevant for social security purpose. So any attempt of developing a technological solution by the social security agencies or the stakeholders demands a solution which considers issues of data exchange. In addition to this, national ICT initiatives, like Ethiopian e-Government Interoperability Framework (EeGIF) and e-Government strategy and implementation plan, also have strong role in providing any solutions.

According to [7], Ethiopia is working to elevate citizen participation which basically has a capacity to bring open and transparent environment. For this achievement, integrating different government information services and systems is considered. Also, to realize this achievement, Ethiopia "has taken up the development and implementation of ICT standards and preparation of e-Government Interoperability Framework (EeGIF)".

With the intent of integrating different initiatives, Ethiopia has designed e-Government strategy to provide a strategic direction for e-Government implementation in the country. As indicated in [8], the strategy envisages implementation of 219 e-services comprising of 77 informational and 134 transactional services over a five year period.

To improve customer satisfaction in benefit services, benefit management is considered as one of priorities of the government. Since benefits are offered by different organizations, benefit management is identified as priority project by the e-government strategy [8].

All the challenges and institutional and national initiatives imply the dynamic nature of social security scheme and services need a holistic solution.

Therefore, a generic solution as a framework applicable to existing and future needs and challenges in an integrated social security administration system will be the main focus of this paper.

However, exchanging information which resides in heterogeneous systems and databases will not be easy. The nature of the systems, which means the purpose that they are initially designed for, the structure and technology of the database systems and challenges related to infrastructure are identified as the major challenges in electronic data exchange.

3. Related Work

The gap in the desire of acquiring and reusing data from different systems, and heterogeneity of data sources made data exchange to be a focus in different researches for quite a long time. Based on the purpose of data and data exchange, different approaches have been discussed in different researches. Data exchange using model driven framework, data exchange framework using unified format and a conceptual model proposed by International Social Security Association (ISSA) are major works that are covered in this section.

The research works in [9, 10] focus on model driven data exchange framework based on source and target data models. Database technology is the main focus in [9], which is basically on transforming models of different data sources from technology dependent to technology independent, and then into technology dependent so that data exchange can be achieved. The basic focus of the work in [10] is match and map schema information in same application domains data model.

In [11] the main focus is the problems available in a transport system for effective data exchange. Based on this focus, the work identified the problems of data format and protocol differences in every equipment used in intelligent transport systems. Due to this [11] proposed a framework that changes the different data formats in different equipment into a unified data format in XML for data exchange. Automated Schemas Matching for Documents Exchange (ASMAD) is a platform proposed in [12] with its extended functionality. In addition to the four layers, which are matching layer, mapping layer, filtering and transformation layer, it adds constraints called process and intrinsic constraints to avoid weak matches. Document exchange is the main focus and its input and output is limited to the XML schema.

Conceptual model for social security interoperability is proposed in [13] which is a three layer model from bottom to top composed of basic public services, secure data exchange and aggregate public services. The basic public services is the layer which has components of core data of the social security, interoperability facilitator that enables interoperability (gateways, format translators and integration platforms) and external service (data, payment service, infrastructure, etc.) [13].

Data exchange is the second layer focused on secured way of exchanging data among the social security institutions and other entities. Aggregation of public services is the third layer which can be developed by grouping different public services that can be accessed in a controlled and secure way. All the literature works do not provide solution that tackles heterogeneity at data level, with holistic approach that includes components to tackle the challenge at different level.

4. The Proposed Solution

Our solution considers Agent and Agent systems, mainly because it helps to attain demand of the two Agencies on technological solutions, and to tackle challenges in data exchange in their services. The proposed solution also considers the national framework and ICT strategies of the government of Ethiopia.

Efficient service delivery and quality of data exchange depends on an integrated solution which is the result of coordination among different organizations. As described in [14], it requires system's ability in information exchange, communication with other systems and the ability of exploiting other system functionality. To attain this, we have proposed a data exchange framework as a major component of the solution for an integrated social security system in the Ethiopian context. Within this we have also proposed three other components as part of the solution.

4.1 Data Exchange Framework

The integrated data exchange framework has different services at its different layers. Presentation layer is the first layer that provides interaction service with the system. The second layer, secure access, constitutes the secure access and data exchange service which mainly captures, provides privilege, and identifies users who are accessing the system.

Social security services layer is the layer which holds the major services which are the ones that create and manage agents, capture data, generate unique identification, manages models, extract and import agent data, update any change and the service which manages documents sent as an attachment.

The fourth layer is the research layer that includes services that do the checking and matching on the schema information being acquired from heterogeneous sources. This service provides mapping of the extracted schema information and data from the source on the specific model, and checks the compatibility. Finally, it provides data exchange service for every data that is mapped and proved for compatibility.

4.2 Unique Identification

The pension identification number which has been in place for the last five decades by PSSSA or the current temporary pension identification number allocation used by POESSA cannot qualify as unique identification. Its manual and decentralized allocation scheme made it lack the basic characteristics of unique identification of being Single, Exhaustive, and Stable over time.

In the new social security legislation, Tax Identification number (TIN) is proposed to be used as a pension identification number by the Agencies [5, 6]. However, TIN has its own limitations to be used as a social security number. For example, TIN is issued only for those that pay tax, employed or run business [15]. Pensioners (retired employees) don't pay taxes. It would be difficult to use deceased scheme member TIN for survivors (children) under 18 years old (who are not eligible to have TIN number).

Due to the problems of the current unique identification systems and the requirement of a new approach, we have proposed scheme member identification (pension identification number) which is generated with a single system that can be used by both agencies. By considering the core information needed in any social security service and in addition, to avoid confusion with TIN and duplication, pension identification number with 13 characters is considered. The first eight will be formed from the date of birth of the employee and the rest five will be randomly generated. Since, everyone has one date of birth and this date of birth is not considered variable character it is taken to be part of the unique identification. The five randomly generated digits are used to avoid "Birth day paradox". Birth day paradox is about "the probability that, in a set of n randomly chosen people, some pair of them will have the same birthday" [16].

4.3 Data Standard Specification

In social security, the data exchanged and integrated with the system are data acquired from heterogeneous organizations and data sources. So, in order to make the data exchange and update simpler and easier, it is important to identify the critical data captured by other data sources which is later on important for reusability. Therefore, we have proposed data standard specification that enforces the minimum requirement of data from the Agencies' side. The required list of data on the employer and the employee, the minimum requirement of data type, structure, and size that needs to be exchanged are part of the propose solution.

4.4 Matching and Mapping

As indicated in Figure 2, the matching and mapping approach has the following components. It has Agent and social security databases including the pension repository. Schema information extraction and matching, value extraction, and finally exchanging data will be carried out.

The repository has the data standard set by the Agencies for reference. For reusability, it stores mapping result of social security schema and agent schema in the "Agent vs social security database model matrix". Storing the mapping result for reuse is very useful to avoid frequent matching and

mapping every time data exchange service is initiated by the agents. A dictionary table that stores synonyms that represent the same concepts are also parts of the pension repository. Primary transaction registry holds and maps basic Agent and Agent employees' data that facilitate data exchange and updates after value extraction is made.

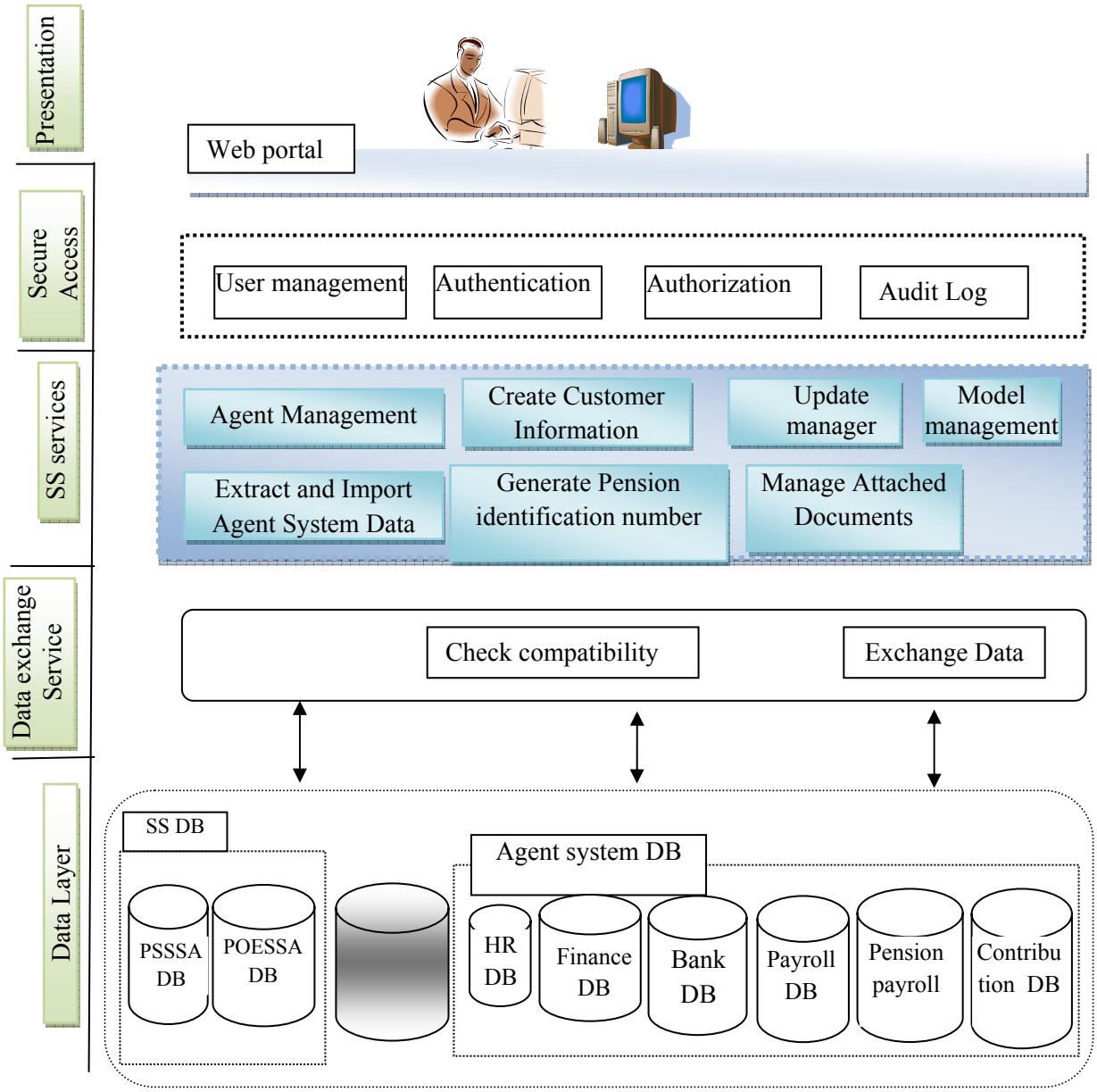

Figure 1: Data Exchange Framework

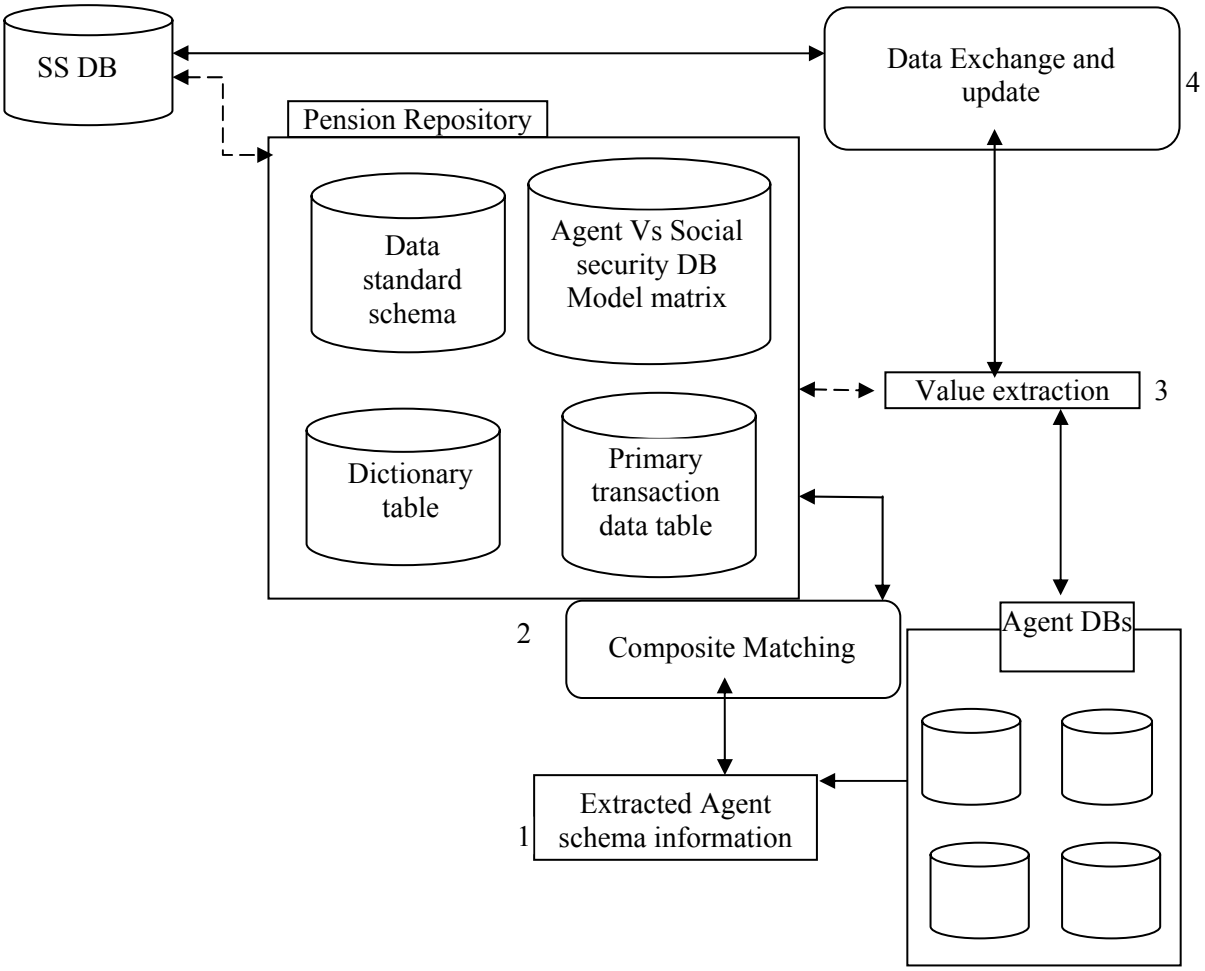

Figure 2: Schema Matching and Mapping Approach

In general, the agent schema information extracted depends on the schema information and using composite matching, one or all of the tables will be checked and updates will be made. Depending on the matching on schema, information value extraction will be made on the agent database followed by data exchange and update on the social security databases.

5. Prototype

Due to time limitation, we are not able to show all the implementation in the pension repository. However, by creating separate agent system and social Security system, we have tried to show how the mapping works, how the social security data is created from the agent system and how later the primary registry data is created form the social security. Sample unique pension identification can also be generated. The prototype is developed using NetBeans IDE 7.0.1 and MySQL is used for the back end.

6. Conclusion

By assessing the nature of the services of the Agencies, by identifying the Agents and the problem, we have found that it requires a solution that follows different approaches. The lack of unique identification in current pension identification number allocation has been identified as the major issue that requires a focus. We propose a national unique identification for social security. We, in this work, learnt that the nature and type of data required by the services of the Agencies' need to be exchanged with a certain set of standards that leads us to specify initial standards. However, the standard set by the Agencies is valid as long as it doesn't have any conflict with the national e-government interoperability framework standard. The

heterogeneous nature of agents and agent systems and services of the Agencies make our solution to follow an approach that provides a solution that organizes the concepts in a framework. This, different but autonomous nature of agents system and data, gear our effort to provide a solution as an integrated data exchange framework which uses schema matching and mapping approach.

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