Ontological-Based Model for Human Resource Decision Support System (HRDSS)

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Abstract. This research concerns the development of Ontology-based model as an input to Human Resource Decision Support System (HRDSS) and to assist in the efficient and effective data analysis and leveraging the semantic content of ontology. These are to give intelligence support in decision-making and to proposed and develop suitable system architecture of the intelligence DSS model for the Human resource planning at national level. The initial model was developed based on the literature review on issues related to Human resource planning complex unstructured decision making process. We have been working on ontology to manage knowledge in human resource and integrate multiple data resources in order to support decision making in forecasting and projection for supply and demand in Human Resource Development.

Keywords: Decision support System, Ontology, Human resource planning, Supply and demand.

1 Introduction

Labour environment and employment trend change constantly due to domestic and global influence. Creating, establishing and maintaining job opportunities in conducive investment climate is important in ensuring healthy working environment and thus benefits the manpower. Globalization and economic liberalization has created a borderless labour market. Thus, planning of national development has to consider global and regional development. The Government's role in analyzing the national employment market situation and identifying labour policy will create job opportunities effectively. Human Resource planning or manpower planning is crucial to address the problem of imbalance between demand and supply.

The goal of this research is to leverage the semantic content of ontology to provide intelligence support in forecasting job opportunities based on supply and demand. We proposed an DSS model for the Human Resource Planning (HRP) which represents a new, interdisciplinary approach to the management of knowledge in a problem-solving process and to improve human resource decision-support systems (HRDSSs) that employ model-based module approaches. Even if the application studied is specific, it can serve as a basis for any human resource planning whether at organizational level or industry level. This vision is achieved by managing knowledge in human resource and integrates multiple data resources of data and information

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from internal and external organization. Based on the identified data requirement, we develop an ontology-based model for supply and demand. We show and explain how the addition of ontologies and semantics results in a more reliable and practical management of complex problems.

This paper is structured as follows. The next section provides general background on Human Resource planning, and on the needs for forecasting using DSSs, ontologies and its application in DSS and HR. Section 3 focuses on the Framework of DSS model for Human resource planning decision support system (HRDSS) proposed and, finally, Section 4 presents the conclusions.

2 Theoretical Background

2.1 Human Resource Planning (HRP)

The Human resource planning (HRP) provides annual projections of the major macroeconomic and industry dimensions of the economy and detailed analysis of the labour requirements and labour supply. HRP is a complex unstructured decision making process [1, 2] because information related to manpower problems is inadequate[2] and issues on business environment are dynamic and uncertain [3, 4]. Quantifiable data is limited because developmental and evolutionary nature of manpower process itself impact human resource planning decisions [5] and allocations [6].

2.2 Need for HRP Forecasts

Forecasts must be developed to identify the mismatch between HR supply and HR demand. The basic rationale for making HRP forecasts is the long gestation lags in the production of skilled professional people. HRP forecasts made well in advance, facilitate planning of education/training is the effort to ensure that manpower required and job opportunities are available at the time when they are needed. This is important especially for development country.

The basic rationale for making HRP forecasts are to identify the mismatch between HR supply and HR demand and to reduce the cost of job loss and associated loss. This also to overcome the reliance on foreign labour and the long gestation lags in the production of skilled professional people. Advanced HRP facilitate the planning of education/training by ensuring that manpower required and job opportunities are available in a timely manner. This is important especially for country development.

The second major reason is the observed imperfections in the labour market. Markets for manpower with long lead time for production are characterised by cobweb cycles, because of long lags in the supply side and short lags, on the demand side. If the event supply is not planned to meet the requirement, cobweb cycles [7] in the labour market may ultimately lead to distortions in occupation-education correspondence, the fallout of which could either result in huge educated unemployment or with people taking up occupations for which they are not adequately prepared or both. HR forecast is expected to facilitate correction of labour market distortions.

The third major reason is that in the short-run at least, elasticities of substitution among various skills have been observed to be either zero or near zero. Production of goods and services, therefore, requires various categories of skilled manpower in fixed proportion. Shortage of any skilled category of manpower, in such a situation would adversely affect the production of goods and services within the economy. HRP forecasts would help avoid such a situation by facilitating anticipation of skill shortages and planning skill supplies accordingly.

2.3 Ontology

Hopkins [8] highlighted that data availability for HRP is poor at the national level in developing countries. There is much confusion over the meaning of employment and unemployment mainly to suit the interests of one political party or another [8]. However, with global interconnectivity we now need to deal with more heterogeneous information resources consisting of a variety of digital data. Data from HR information systems has a number of limitations including in availability, lack of consistency, and not expressed in a general way to be shared between systems, ambiguous terminology, and semantic integration of information does not exist. Furthermore, there are no standard understanding on the structure of knowledge for a domain for certain term in HR [9, 10]

Ontology can facilitate knowledge sharing and reuse. In this research, ontology can provide: (1) a shared and common understanding of the knowledge domain that can be communicated among agents and application systems, and (2) an explicit conceptualization that describes the semantics of the data [11]. Ontology is a formal specification of domain knowledge and has been used to define a set of data and their structure for experts to share information in a domain of interest. It is well suited for the representation and utilization of relations among data, and is efficient in knowledge reasoning. Ontology-based method is a new and promising approach to manage knowledge in HR, integrate multiple data resources, and facilitate the consideration of the complex relations among concepts and slots in decision making [12].

Decision support System (DSS) applications can be used to extract information to structure data and readable machine format [13]. The current challenges of HR planning model is the need of domain experts to extract the input manually from unstructured text. Based on that research on automated development of ontologies from texts [14, 15] has become increasingly important because manual construction of ontologies is labour intensive and costly, and, at the same time, large amount of texts for individual domains is already available in electronic form.

Hence, it is the interest of this research to explore the usefulness of ontology-based model as an input to DSS and as an aid to analyse data efficiently and effectively as well as leveraging the semantic content of ontology. These features are meant to provide intelligence support in decision-making for the Human Resource Development Planning.

2.4 Ontology-Based DSS

Ontology-based implementation to support decision making process has been addressed in a number of research involving various domains such as financial, product design, Geographical Information System (GIS), plant treatment and medical.

OntoWEDSS decision-support system for waste water management design by [16] helps to improve the diagnosis of faulty states of a treatment plant, provides support for complex problem-solving and facilitates knowledge modelling and reuse. Meanwhile [17] developed ontology-based approach to structure information in order to support management system audit in gathering, translating and consistency checking to generic management system standard. Ontology-based approach used to parse semantic query in order to do data integration of product design from different heterogeneous format. and decision support environment for e-Design [12]. [18] explores the of use ontology as a technical solution to integrate heterogeneous systems and subsequently to support decision-making in Engineer-To-Order (ETO) products design phase. Similar research by Shue et al. (2009) apply ontology model to assess financial quality of an enterprise. In dealing with the complexity of financial statement analysis, this approach separates knowledge content into domain knowledge of financial statements and operational knowledge of analysts' analytical process [19]. While Niararki and Kim (2009) studies on ontology-based architecture using a multi-criteria decision making technique to design a personalized route planning system using information system such as geographic information system (GIS) in order to identify the best route for travelling based on user preferences stored on mobile appliances [20].

Thus the need to anticipate and integrate ontologies to DSS in order to improve decision-support systems and forecasting is crucial in HRP. Many researches focus on human resource development based on competency ontology without anticipate it with DSS [21-26].

2.5 Ontologies in Human Resource

Knowledge based automation in the domain of HR faces some daunting challenges. Information technology scientists and practitioners involved in the HR domain have to quantify and qualify the common knowledge that underlies meaningful conversations about human resources. The common language used to describe jobs, functional roles and staff vacancies is generally well understood and formalised, at least within specific enterprise domains or regional scopes. Models and emerging standards for the description of tasks and responsibilities have been used with various degrees of success.

Various standardisation efforts also support capturing the combination of tasks and responsibilities that make up a typical job description or job vacancy. The existing ontologies in HR has been built such as : ProPer Ontology [27] on skills management, KOWIEN Ontology [28] on competence and skills management, Knowledge Nets [29] on national and international classifications for jobs and branches, “ePeople” [30] on Skills, Skill Profiles of Employees and Job Skill Requirements, LIP Ontology [31] for on-demand learning support, CommOnCV [32] on competencies from CV descriptions, TOVE (Toronto Virtual Enterprise Ontologies) which is an integrated ontologies for the modelling of commercial and public enterprises, PROTON (PROTO-Ontology) upper-level ontology for a number of tasks in different domains, and COKE [33] a three-level ontology containing a top-level HR ontology (representing employees and their social groups), a middle-level Business Process

ontology and a lower-level Knowledge Objects ontology which are related to organizational entities.

In summary, there are several approaches to elaborating ontologies in the HR domain, each of them with a different focus. These researches try to combine the strengths of different approaches like the Professional Learning Ontology, the TOVE ontologies, and the HR-XML initiative.

3 The Approach

In this section, the proposed HRDSS framework and ontological-based model are reviewed.

3.1 Overall Framework of HRDSS

The proposed framework of DSS model for Human resource planning is depicted in Figure 1. This framework is made up of ontological-based model, modules of model based (HRD modelling), and user interface. The Ontology will be used for interpretation and extraction of information from heterogonous resources for the development of its knowledge structure. The knowledge produced from such a process will be used as an input to HRD Modelling System. The model base module is the core of the system; it consists of balancing of labour supply and labour demand (HBF), system control of input and outputs (HSC) and Market and Policy.

3.2 Ontological-Based Model

In the following, an ontological-based model is discussed to demonstrate the application of the ontology to HRDSS.

3.2.1 The Domain and Scope of the Ontology

The aim of this research is to integrate ontology in the process of decision making for HR planning. As HR planning relies on various forms of heterogeneous data and information, the ontology will act as a mediator between the HRD modelling system and the heterogeneous data resources as illustrated in Figure 1. In this case the data and information will be mapped and integrated into the ontology and serves as dynamic knowledge bases for supporting the forecasting and projection for supply and demand in HRD system.

3.2.2 Design of Ontology Model

In order to reuse of (parts of the) existing domain knowledge in HR this research will adopt an ontological approach, in which we plan to use levels of increasing specialization [34]. The classic ontological approach consists of an ontological structure with concepts and relations and instances of the concepts, which contain the knowledge content. The approach will provide an ontological framework, in which the more generic ontological levels can be reused easier. The proposed levels are as follows:

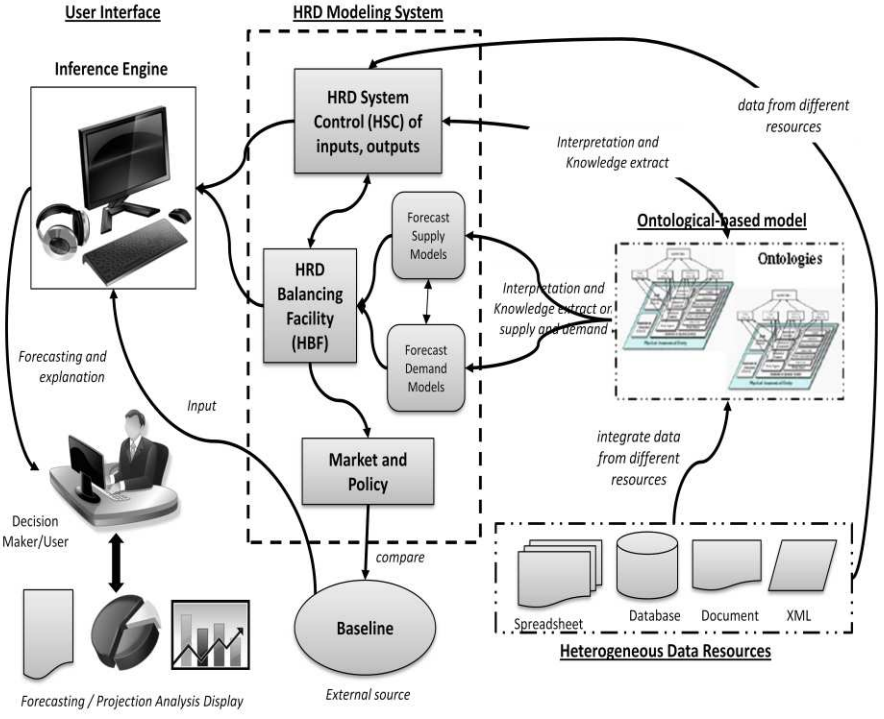

Fig. 1. Proposed framework of DSS model for Human Resource Development (HRP)

- Level 0: Upper-level ontology with basic terminology (*ontology*, *concept*, *relation*, *instance*, *property*, *process*);
- Level 1: generic process knowledge (*steps*, *task*, *activity*, *method*, *user type*, *domain*, etc.);
- Level 2: specialized process knowledge (in the Human Resource: generic modelling knowledge with a generic description of what to do and methods on how to do it);
- Level 3: domain specific process knowledge (in the HRP Modelling system: modelling knowledge specialized for specific HR domains);

A stepwise ontology specialization with the modelling ontology expanded to some more particular ontological concepts. The top (Upper-level ontology) is the most generic ontological level and the concepts at the bottom the most specialized ones.

3.2.3 Competency Questions

In developing the domain ontology, the TOVE [39] ontology engineering approach will be adopted. This approach consists of six phases: motivation scenario, informal competency question, terminology, formal competency question, axioms, and completeness theorem. The six phases encompass the identification of problem domain, the analysis of knowledge content, and the development of relationships and related reasoning processes.

Since the major reasoning part of the completed system, which is the diagnostic process, will be handled by the rule-based module, hence the development of reasoning process will be excluded, which includes formal competency question and axioms. It is common however to design informal competency questions in such a way that the ontology developed fulfil the systems requirements. These questions are initially expressed in the motivation scenario and later become informal competency questions. Among the competency questions for this research are as follows:

i) What is the population by gender by age by citizenship?
ii) What is the labour force projection by education by citizenship?
iii) What is the forecast of the labour force by occupation and the explanation for the projection?
iv) What are the forecasts of Gross Domestic Product (GDP), interest rates, and price and wage inflation?
v) What is the forecast of employment by industries?
vi) What is the forecast of employment by occupation?

3.2.4 Domain Knowledge of Supply and Demand

In this research, the ontology will be used to demonstrate the analysis of the domain knowledge and the development of its knowledge structure from heterogeneous resources such as databases, XML file and textual document as well. Extraction knowledge from databases, document and XML file will be use the facilities provided in protégé - importing data from files or spreadsheets. In fact Protégé will be the tool used for modelling the ontology for supply and demand. Available ontologies [40] relating to demographic, education and temporal will also be used and integrated as they contain non-trivial knowledge for supporting the decision making process. An ontology model containing relationships between inputs of forecast supply model is as depicted in Figure 2.

The Forecast Labour Supply Model consists of three components; which are the demographic component (HDM) for projecting the population by age group and gender; the educational attainment component (HEM) for projecting the labour force by educational attainment; and The occupational supply component (HOSM) for converting the projection from HEM of the labour force by educational attainment to a projection of the labour force by occupation. Meanwhile, the Forecast Labour Demand Model consists of two components: (i) Macro-models (HMM) for projecting labour demand by industries, following the industry classification used in the national accounts and later will constructed to initially project labour demand by industries; (ii) the occupational demand model (HODM for converting the forecasts of labour demand by industry to labour demand by occupation.

The second model, the HSC, is a control centre where scenario inputs are provided and scenario outputs are collected from the system. The HSC models introduce and examine the effects of alternative policies. The HSC mode; then collects the results for these alternative policy scenarios and compares them with the baseline scenario. Meanwhile, the HBF model takes the labour demand and supply predictions from the respective models and identifies any structural shortages and surpluses for labour markets.

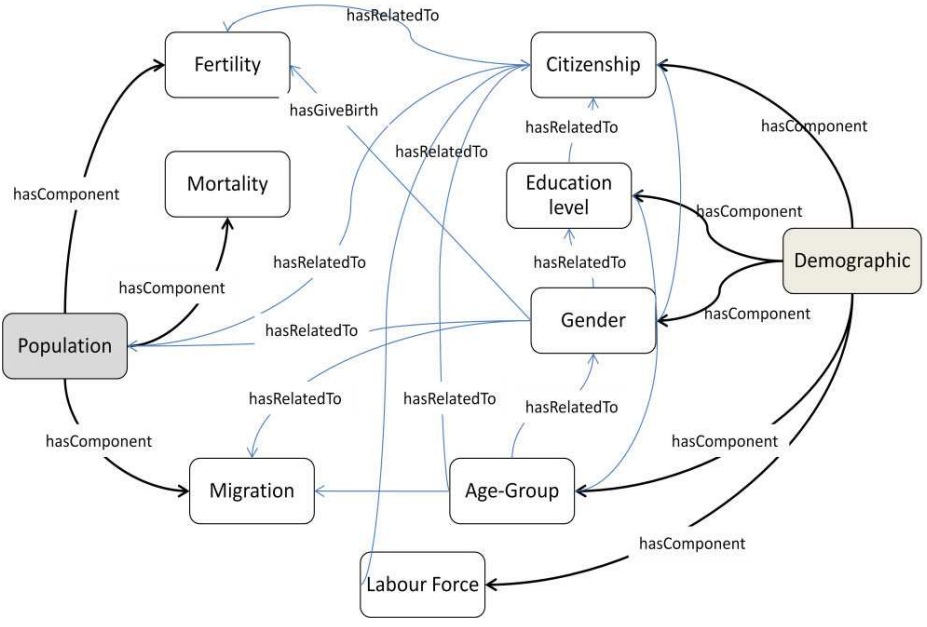

Fig. 2. An ontology model containing relationships between inputs of forecast supply model

4 Conclusions

Efficient and effective decisions are largely supported by sufficient and relevant data from heterogeneous resources. The domain knowledge produced from ontology will be used as input in as proposed in HRDSS framework.

The framework of the HRDSS proposed in this research can be useful in providing guidelines for Human resource planners to consider when developing a HRDSS. The need for automated computerised tools is paramount with respect to improving decision making processes. This will be useful when planners need to carry out forecasting and other statistical analysis of the required decision. Furthermore, it also provides information for DSS developers on managing quantitative model in the HRDSS system. Prototype will be developing to validate the proposed framework and the output of HRDSS will be compared against the output from other similar systems to evaluate the performance. For the future, the framework can be improved by automatically extracting all the knowledge from each level of HR planning to support the decision making.

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