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INTEGRATED WORKFORCE PLANNING MODEL
A PROOF OF CONCEPT

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ABSTRACT

Recently, the Workforce and Diversity Management Office at KSC have launched a major initiative to develop and implement a competency/skill approach to Human Resource management. As the competency/skill dictionary is being elaborated, the need for a competency-based workforce-planning model is recognized. A proof of concept for such a model is presented using a multidimensional data model that can provide the data infrastructure necessary to drive intelligent decision support systems for workforce planning. The components of competency-driven workforce planning model are explained. The data model is presented and several schemas that would support the workforce-planning model are presented. Some directions and recommendations for future work are given

1. Introduction

Workforce planning simply defined as “getting the right number of people with the right skills, experiences, and competencies in the right jobs at the right time”. As KSC redefines its mission and goals as a center for space innovation through the KSC Roadmap, the Workforce and Diversity Management Office has undertaken several initiatives to better support the Center’s goals . One of the major tasks being undertaken is the deployment of a competency model that eventually will drive major HR (Human Resource) activities. Currently, the listing of the core competencies is being drawn. As the work progresses, the need for a Workforce Planning Model that integrates the competency dimension with other human resource dimensions is being envisioned.

This project presents a proof of concept for an integrated workforce-planning model that incorporate a competency-based approach to other Human Resource management (HRM). In particular, it examines the requirements for a competency-based approach to workforce planning, and the current data infrastructure and data requirements for workforce planning. To guide this project, a set of questions was drawn by the Workforce Planning Unit and was used as business drivers. These questions were used to identify the data infrastructure that would best drive intelligent decision support systems for workforce planning. A multidimensional data model is presented to support a competency-based approach to workforce planning. The model can provide guidelines to design and implement a data infrastructure that will drive desktop tools for workforce planning and other HR activities.

This paper is organized as follows: The remaining part of this section provides some background information and motivation for this project. Section 2 describes the components of a competency-based workforce-planning model. These components provide a context for identifying the data requirements for a workforce-planning model. Section 3 summarizes the existing databases, the current data support and the data handling for workforce planning processes, and the methods in use. Section 4 presents a multidimensional data model and several star schema models that integrate the HR dimensions required for workforce planning. Section 5 provides some discussion and recommendations for future work to implement an Integrated Workforce Planning System, and some concluding remarks are made.

1.1 Background.

NASA reorganization initiatives to better position KSC as a center for future space exploration has resulted into a matrix organizational structure with a more streamlined workforce. The mission and objectives of The Workforce and Diversity Management Office has been linked to KSC Roadmap Goal 4.0 - “Continually enhance core capabilities (people, facilities, equipment and systems) to meet NASA objectives and customers needs”, and Objective 4.1A - “Develop and implement systems and approaches to attract, develop and retain a high quality, diverse workforce to meet current and future challenges”.. The need for a framework to make HR decisions based on KSC mission, strategic plan, budgetary resources, and a pool of desired competencies, is greater than ever..

The Workforce and Diversity Office has undertaken several initiatives to implement KSC objectives. The office is in the process of elaborating the set of core competencies for KSC. Other initiatives include the design of a data warehouse that integrates data from various sources to support HR activities. A data model to capture KSC workforce competencies have been demonstrated, pending the completion of the competency listing. There is also an initiative to develop a center-wide knowledge management system.

2. Integrated Workforce Planning Model

2.1 Components

In reviewing literature on workforce model, it has been observed that there are great similarities in their contents although the terminology may vary. Essentially, all workforce-planning models consist of the following processes:

- Supply Analysis consists identifying present workforce competencies, analyzing staff demographics, and identifying employment trends. Competency analysis provides baseline data on the existing organization and present staff. Trend analysis provides both descriptive and forecasting models describing how turnover will affect the workforce in the absence of management action. Trend analysis is essential to the solution analysis phase defined below.
- Demand Analysis deals with measures of future activities and workloads, and describing the competency set needed by the workforce of the future. Demand analysis must take into account not only the workforce changes driven by changing work but also workforce changes driven by changing workload and changing work processes. Technology will continue to have an impact on how work is performed and must be considered in the demand analysis process.
- Gap analysis is the process of comparing information from the supply and demand analysis to identify the differences, the “gaps” between the current organizational competencies and the competency set needed in the future workforce. The comparison requires the competency sets developed in the supply analysis and demand analysis phases to be comparable, not independently developed.
- Solution analysis is the process of developing HR plans, including hiring, training, and training, to close gaps in competencies and to reduce surplus competencies. Solution analysis must take into account employment trends.
- Evaluation involves a periodic and systems review of the workforce plan, reviewing mission and objectives to assure the plans remain valid by making adjustments as required by changes in mission, objective, and workforce competencies.

A data model to support workforce planning must capture the data requirements to support the processes described above.

3. Existing systems and supports for workforce planning

With limited access to the data sources, it has been extremely difficult to identify all HR related data in the databases and various data store. There was no data dictionary or proper documentation for the various databases. Therefore, the following characterization of the present systems and supports for workforce planning may not reflect the complete situation.

Currently, the Workforce Planning Unit draws it Data from the NPPS Database that holds HR related data, and from monthly file downloaded from the Labor System database containing FTE (Full Time Equivalent) hours of KSC employee on the different projects. The downloaded files are fed into Excel spreadsheet to generate monthly FTE reports by organizations and projects.

There is a set of pre-defined parametrized queries or stored procedures that can be used to crank out subset of the NPPS database for further manual data processing to generate other HRM reports. The times spent on shifting through the data to satisfy some reports requirements are enormous. There is practically no decision support system or tools in place to facilitate data analysis, except for a few spreadsheet applications.

4. Proposed data model

In order to support a competency based integrated workforce planning model, the necessary data infrastructure has to be established. The data architecture that can drive desktop decision support tools is presented.

It is based on a multidimensional data schema. The star schema transforms the de-normalized relational tables into a multidimensional space through the fact table. An example of a star schema is presented below. The OLAP services build hyper-cubes of pre-computed additive and semi-additive data and create access path to back-end data store, using highly sophisticated indexing scheme. The OLAP services allow browsing of multidimensional data at different levels of detail

4.1 A Star Schema for HR Transaction Data Mart

In order to perform trend analysis for workforce planning, HR historical data is required. Currently, the NPPS database holds some historical data but it does not capture all HR transactions, which are important for other reporting needs.

A star schema for an HR data mart that captures all HR transactions is presented below in Figure 4-1-1. An HR transaction can be any HR related event, such as a promotion, retirement, the starting date for a leave, change from full time status, etc. A set of complex HR profile of 100 or more attributes can be captured in an employee transaction dimension table to record every transaction performed on an employee record. This table is shown as the Emp_Trans_Dim table. The attributes with a plus sign indicate these attributes may consist of multiple fields. The month and organization dimensions are shown as Month Dim and the Org_Dim.

In the Emp_Trans_Dim table, there are two important attributes, Trans_End_Date and Last_trans_flag, that are crucial. The Trans_End_Date for each record is the date for the next transaction on that particular employee. The Trans_End_Date together with Trans_Date/Time provide a span of time during which the employee description is exact. Last_Trans_Flag is used to indicate the last transaction made against an employee profile. This method allows the most current or final status of an employee to be retrieved. If a new transaction for that employee needs to be recorded, this flag is set to false.

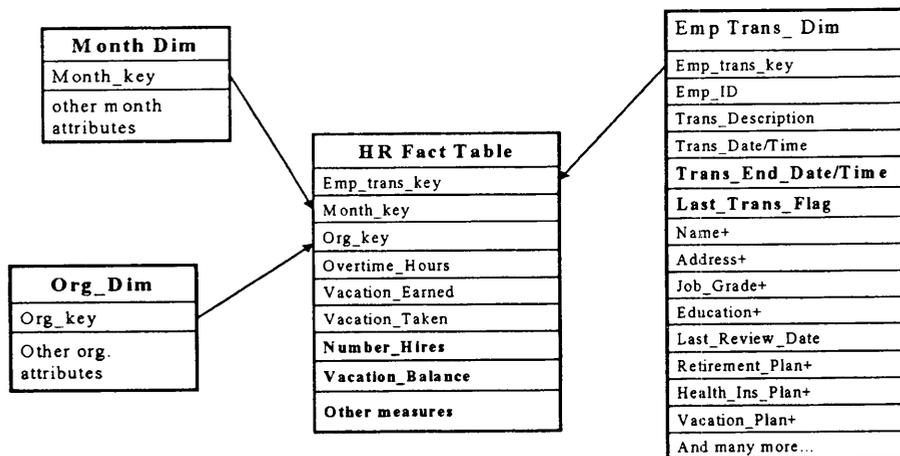


Table 4-1-1 HR Transaction Data Mart

The schema of the HR Transaction Data Mart can provide the data for supply analysis and many reporting needs. The schema addresses three fundamental type of queries:

1. Status report summaries on a monthly basis for all possible slices (& combinations) of data
2. Detailed profiles on employee population at any point in time (snapshots)
3. -Every action taken on a particular employee with the correct transaction sequence in time

4.2. A Star Schema for FTE on Projects

Using multidimensional data modeling described above, a star schema is created for FTE on current projects at KSC. This schema integrates the required dimensions to support current HR monthly reporting requirements on FTE.

A Star Schema for FTE on Projects

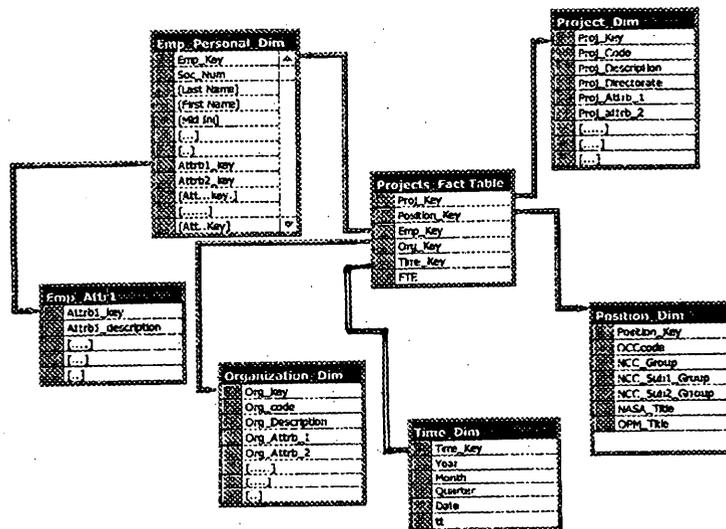


Figure 4-2-1 A Star Schema for FTE on Projects

4.3. Competency Modeling

The table below shows how the competency dictionary can be captured in a de-normalized table so that it be integrated into a star schema with other dimensions. This mapping is significantly different from the in-house model, which contained normalized tables with hierarchies – more appropriate for a transaction based operational systems. In the table below, the hierarchies have been collapsed. The first field, Comp_Key, is a system-generated key that uniquely identifies each row in the table. This representation

allows for subgroups within a field. The Tier_Item_Num field represents the item number in a particular Tier.

Comp_Key	Comp_Code	Description	Subgroup	Tier_Level	Tier_Item_Num	Comp_Item_Description
1020	CRE	Cryogenic	Cryogenic Science	3	7	Demonstrate knowledge of low temp molecular ..
1020	CRE	Cryogenic	Cryogenic Technology	2	5	Demonstrate skills in handling low temp containers

Note: Hierarchies collapsed
 Table de-normalized for performance
 Typical for Dimension tables

Table 4-3-1 Competency Descriptions

4.3.1 Modeling Competency Gap with Job Profile

Competency clusters from the Competency Dictionary can be mapped into a table as shown below to capture each job profile. The Comp_Key is from the Competency Dictionary table shown above. The Job_Profile_Id is unique for each job as described by the NASA Classification Code or OPM Code. Again the Job_Profile_Key is a system-generated key that uniquely identifies each row. The Required_Comp field contains a scaled measure of the competency level required of a particular competency for a particular job. This field allows to capture the fact that different jobs may require the same competency but at different scale. The Priority_Indicator field is used to indicate the priority of a particular competency in a particular job profile. This field allows to create ranked competencies within a job profile, which is useful in matching algorithms to create weighed profile on employees or job applicants. The Skill_set_Id may be used to represent a set/additional skills descriptions to supplement the competency dictionary, which normally produces 80% fit for job profile. The skill_set_Id may be tied to a matching Training_set_Id to identify the relevant training. This model does not explore the training requirement further.

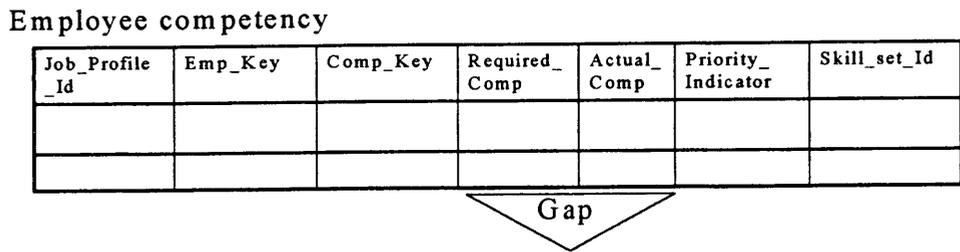
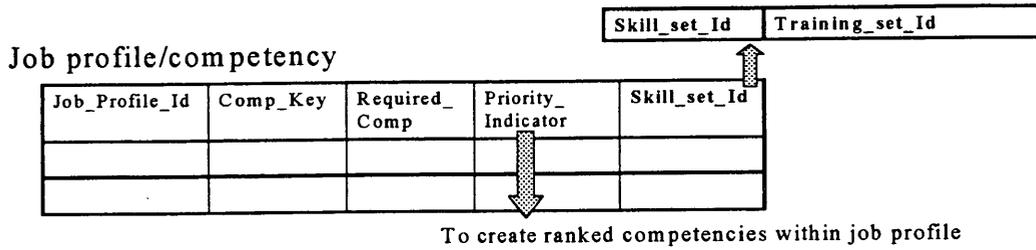


Figure 4-3-1-1 Capturing Competency Gaps

5.3.2. Measuring Competency Gap

The employee competency can be captured using the Employee Competency table shown above. This table contains all the fields of the job profile table; in addition the Emp_Key identifies each employee, and the Actual_Comp field holds the actual competency for the particular employee. The competency gap is a derived data from the two adjacent fields.

5.4. A Competency Star Schema

Using the three de-normalized tables shown above, competency data can be captured in a very easily-understood form by the users; more importantly, it can be integrated into a star schema with other dimensions like employee, position, organization, projects, and other HR related dimensions as shown in the diagram below.

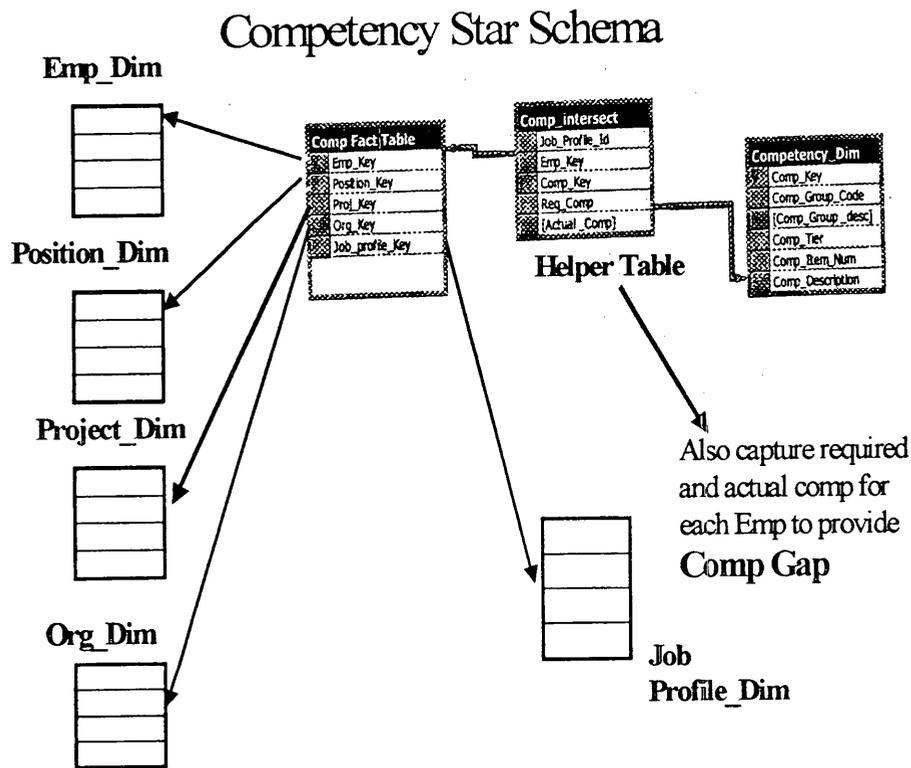


Figure 4-4-1 Competency Star Schema

The Competency Dimension is linked to the Competency Fact table using the Helper Table, which is the Employee Competency Table shown in the previous diagram. The helper allows the implementation of the many-to-many relationship between the Fact Table and the Competency Dimension.

The Competency Star Schema shown above is necessary to create an integrated data model for workforce planning. This schema provides all the data to drive desktop solutions to answer questions 1, 4 and 5 from the Appendix, A which were used as business drivers to guide this project.

5. Discussions/Recommendations for future work

Developing a proof of concept for an integrated workforce-planning model requires significant exploratory work, examining current systems and desirable systems. This section summarizes a development strategy for the design and implementation of the workforce planning model and some recommendations.

5.1 Current Data Warehouses

In examining the current data warehouse design containing corporate employees data and competency data, it is noted that the tables are normalized and some of them have hierarchical structure. A data warehouse is designed fundamentally different from operational databases, which are highly normalized to support transactions. Analytical processing often dictates that a

de-normalized approach be taken to gain access efficiency in order to perform online analytical processing. OLAP technology exploits the star schema structure, which usually generate thin and tall fact table containing the data of interest, to create highly efficient indexing scheme to support online processing. Thus, the existing design will have to be re-visited to ensure the desired characteristics

The most effective approach to the design and implementation of a workforce planning system is to use a system engineering approach to create the design process of a data warehouse through the development of a Meta data system. Meta data is the most crucial element in the effective management of data. A Meta data system provides a framework to define the data warehouse requirements, and can be used iterative ly during the life of the data warehouse to update and integrate new dimensions. Tracking Meta data from sources to data warehouse, to applications is a very important principle. The current data warehouse has no documentation of a Meta data system

5.2 Implementation and Development strategy

Key planning decisions include selecting an implementation strategy and a development methodology. A top down approach is preferable because the business requirements for the system can be identified clearly and used as drivers for the implementation of the data warehouse. However, it is being recognized that in most environment, the managers and users take some times to learn the capabilities, usefulness and values of a data warehouse as an OLAP resource. Then, it can be expected that the data warehouse will grow rapidly as more data is required for more applications. Given this situation, the development method preferred is the spiral method, which recognizes that requirements are not always clear or available when the sytem first implemented. The recommended steps of Requirement Analysis, Design, Integration, Verification and Maintenance should be followed iterative ly. Creating OLAP applications can be time consuming.

Developing the business objectives of the system can become difficult, as potential users cannot always describe the type of information desired out of the warehouse. In these situations, examining the current data and data analysis used may provide a starting point that can be further refined.

In identifying the requirements for the system, it is important to identify the owner's requirements, the architectural requirements, the developer' requirements as well as the end user requirements. Owner's requirements include identifying, beside cost, development duration, the impact of the users, their skills and the organization, and the risk involved. Important architectural requirements include functions and features to be offered, platform needed for implementation, standards and open interface to be used, and how much flexibility for enhancement is required. Developer's requirements are further elaborations of the architectural requirements, including deployment, connectivity, access and delivery methods, and client platform requirements. End users requirements include identifying how the functionality of the data warehouse fit the user daily workflow, query requirements; types of analysis performed, and reports requirements.

5.3 Conclusion

There are considerable advantages of using a competency-based approach to drive HR planning. A proof of concept presented. Competency-based approach to HRM and the components of a workforce-planning model are examined. A multidimensional data model that would provide the data infrastructure to support intelligent decision support applications for workforce planning is presented. Several modeling examples are provided a proof of concept for a competency-based workforce-planning model .

This project is an exploratory work for the design and implementation of a competency-based workforce-planning model. A formal design will require more exhaustive and detailed analysis of the requirements of such a system. The development of a workforce planning system is evolutionary. An initial iteration can produce a minimal system. An important consideration is to stay focus on methodology. This work provides the data architecture to launch a design and subsequent implementation.

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