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Purchasing Function Data Modeling

Abstract: *The evolution of purchasing and supply system, from an administrative task to a strategic value chain, makes contribution for creating competitive advantages for organizations on market. Considering the increasing significance of purchasing role and with the idea that this function has the ability to influence corporate profitability favorably, the way purchasing function develops within organizations has been a topic of great interest. Management has a fundamental task to identify and direct general and specific processes within purchasing function, applying the up-to-date information infrastructure. After implementing process approach as a systematic identification in management processes employed with the organization and particularly – relationships among the processes, next stage should be aimed to data model.*

The process model is to be converted into ***data model*** *which is essential for implementation of the information system enabling automation, monitoring, measuring, inspection, analysis and improvement of key purchase processes. Both the process and data model are part of Information Engineering, an architectural approach to planning, analyzing, designing and implementing applications within an enterprise. Data model is realized as an entity relationship diagram on logical level and should be physically implemented in different database management system applications.*

Keywords: *purchasing function, data model, software engineering, entity relationship diagram*

1. INTRODUCTION

Information Engineering is an integrated and evolutionary set of tasks and techniques that enhance business communication throughout an enterprise enabling it to develop people, procedures and systems to achieve its vision. Most major corporations are utilizing some form of system development methodology that could be tied back to Information Engineering. The first step in any Information Engineering project is the Information Strategy Plan or ISP. The ISP would look at the data, process, organization, technology and interactions of an enterprise. Three key deliverables of an ISP are a **data model**, functional decomposition and an interaction (CRUD) matrix. The data model is an entity relationship diagram that encompassed the purchasing function, the functional decomposition diagram examine the business functions and decompose to a process level and the CRUD matrix exams the interaction of data and process. These three deliverables provide a basis for top down analysis.

Software systems develop within complex information systems. Complexity being essential feature of information systems results from both complexity of domains and their environment. Key components of the environment are related to methods, language and operating systems. Software systems are programming systems in industrial and financial operating procedures which are necessary and highly indispensable. They are designed for a particular task and require considerable investment. They need to be of reliable, safe and predictable behavior. Their maintenance is getting more difficult, thus suitable methodologies need to be applied in order to untangle software 'chaos'.

Nowadays a vast array of products and services greatly depends on the software complexity, so their high quality is inconceivable without good quality software. Data modeling is a method used to define and analyze data requirements needed to support the business processes of an organization. Entity relationship modeling is a relational schema database modeling method, used in software engineering to produce a type of conceptual data model (or semantic data model) of a system, often a relational database, and its requirements in a top-down fashion.

This paper deals with data modelling of purchasing processes on the grounds of previously realized CRUD matrix given in Table 1.

2. PURCHASING FUNCTION PROCESS ANALYSIS

The analysis relies on the results obtained in stage of strategic planning of information system, first of all, well-established organizational model, analysis of targets and problems within the organization, critical factors of success, critical assumptions, critical decisions and information. In the context of architectural frame and result obtained in the analyses, each separated business area is profoundly analyzed in order to facilitate the information sub-systems design within the system as a whole; requests are specified regarding particular sub-systems and the whole system, and information needs which ought to be satisfied by the system-to-be in an effective and efficient way are detected, defined and established.

Diagrams may be used for system analysis. It should not be too complex or time-consuming. There are four kinds of diagrams used in the analysis:

a) Process Decomposition Diagrams,
b) Data Modelling Diagrams,
c) Process Flow Diagrams and
d) Data Flow Diagrams.

Diagrams generated, customers' information needs identified and samples of input/output documents are necessary and required for the following stage – system design.

In designing process and data model their interactive connections, necessary for efficient and effective operation, become noticeable. Analysis is based on the existing object and information system, but it should not depend on the existing organizational structure and existing information system.

Technology is getting change and developed very fast, but processes – however – remain stable organizational structure, no matter the technological environment they are carried out in. Organizational structure and formal communication system also change. General processes and data classes (entities), nevertheless, remain relatively the same, so process and data model should be valid and independent enough from the existing organizational structure. The existing information system should not affect the construction of model and data flow, process model and their connections. Finding answers for questions

such as: what decisions must be made in a particular operation area, what information is necessary and why, who makes decisions, what communications are rational; almost always result in changes of business procedure, organizational structure and information system. New integral information system based on up-to-date information architecture in most cases requires new organizational forms substantially different in comparison with the previous ones.

System analysis in this methodology is aimed at:

a) Process modelling,
b) Data modelling,
c) Analysis of data flow and information flow in the system and
d) Customers' information needs research.

One of the most essential characteristics of the system theory is that each whole should be taken as a part of a larger whole. Using Top-Down methodology, a complex system is decomposed into simpler components and this way they are resolved. Here **functional modelling** is performed using Standard ***IDEF0*** *(Business Process Modelling)* and ***DFD*** *(Data Flow Diagramming)*. ***BPwin*** (Business Process for Windows) by *Logic Works* is a software and CASE tool available for this purpose. After, using the same Top-Down methodology, **information modelling** applies two standards ***IDEFIX*** (*Integration DEFinition for Information Modelling*) or ***IE*** (*Information Engineering*). A CASE tool which significantly simplifies information modelling is ***ERwin*** (*Entity Relations for Windows)*.

Functional modelling (Top-Down) is performed from the standpoint of the management, using interview method. Then aims, processes, resources etc. are determined. Reversibly, Bottom-Up methodology (document analysis) is performed by database generating. Top-Down methodology provides wider approach, and Bottom-Up methodology provides precision.

Primary processes are connected with entities i.e. data classes they create, update and use. Applying an algorithm in cluster analysis each unique and integral operating area is defined. Initial model in strategic information planning is further analyzed.

This analysis deals with **'purchase'** sub-system. Strategic information planning identifies the following primary processes:

1. PURCHASE PLANNING
2. PURCHASE AGREEMENT
3. PURCHASE REALIZATION

First step of process modelling is decomposition of primary processes into lower-level processes up to elementary ones presenting the smallest business operations from the final customer's view. Each system is decomposable into sub-systems and elements. Simultaneously, each system makes part of a larger system. Hierarchism should be taken into account while behavior investigation, functioning, development, building and running the system.

Decomposition is performed through the tree structure diagram. 'Parent' is in the root, and 'offspring' branches producing from it give a complete description. Creating a diagram 'it-consists-of' goes on up to elementary processes that are not further decomposable. Name of the process should always suggest what the process involves.

Following example is related to process decomposition in purchase sub-system:

1. PURCHASE PLANNING
1.1. Resource Purchase Planning
1.1.1. Purchase requirement receipt
1.1.2. Purchase requirement analysis
1.1.3. Purchase plan creation and approval
1.1.4. Current purchase agreements analysis
1.2. Call for Bids
1.2.1. Call for bids preparation

1.2.2. Adjustments with suppliers
1.2.3. Acceptance and registration of bids
2. PURCHASE AGREEMENT
2.1. Choice of suppliers
2.1.1. Gathering and processing data on possible suppliers
2.1.1.1. Gathering data on supplier
2.1.1.2. Supplier data analysis
2.1.2. Evaluation and choice of suitable suppliers
2.1.2.1. Supplier Evaluation
2.1.2.1.1.1. Evaluation Team Building
2.1.2.1.1.2. Inspection Plan Evaluation
2.1.2.1.1.3. Quality System Assessment
2.1.2.1.1.4. Corrective Measures Inspection
2.1.2.1.1.5. Monitoring Delivery Quality
2.1.2.2. Supplier Ranking
2.2. Bid Agreement
2.2.1. Creating Contract Relationship
2.2.1.1. Bids Analysis
2.2.1.2. Best Bid Choice
2.2.1.3. Contract Agreement
2.2.2. Batch Production/Delivery agreed
2.2.2.1. Planning on Launching New Products
2.2.2.2. First Sample Verification
2.2.2.3. Sample Delivery Verification
3. PURCHASE REALIZATION
3.1. Ordering and Receiving
3.1.1. Ordering
3.1.2. Invoice Control and Approval
3.1.3. Quantitative Receipt
3.1.4. Qualitative Receipt
3.2. Complaints
3.2.1. Receipt Minutes Analysis
3.2.2. Additional Processing / Selection Request Analysis
3.2.3. Additional Processing / Selection Realization

Results obtained from planning and analyses of the information system controlling purchasing processes are given in CRUD matrix.

CRUD matrix is given in its final stage, after clusterization supposing processes listed in the first column by order of appearance in the system analyzed. Processes in the third level of decomposition and appropriate data classes are given by order of their creation. This results in diagonal matrix with separate parts presenting processes of the first level of decomposition.

Table 1: CRUD matrix

Data classes / Processes	Purchase request	Normative and product specification	Inventory level	Manufacturing plan	Purchase plan	Public Procurement Law	Call for bids	Supplier's Bid	Supplier record	Information questionnaire	Suitability assessment request	Evaluation team	Inspection plan	Quality system assessment report	Delivery assessment	Agreement and Annex	Master request	Master plan	Verification program	Verification report	Verification record	Purchasing realization record	Reception record	Order	Invoice	Bill of lading	Complaint	Verification plan	Return order	Additional Processing / Selection request	Additional Processing / Selection procedure	Additional Processing / Selection order	Invoice request	Additional Processing / Selection report
Purchase requirement receipt	C	C																															
Purchase requirement analysis	U	U																															
Purchase plan creation and approval	R	R	C	C	C																												
Current purchase agreements analysis					U											R																	
Call for bids preparation	R	R	R	R	R	C	C		R																								
Adjustments with suppliers	U	U					U																										
Acceptance and registration of bids								C																									
Gathering and processing data on possible suppliers									C	C	C																						
Evaluation and choice of suitable suppliers					R				U		R	C	C	C	C	R																	
Creating Contract Relationship						R		R	U		C					C																	
Batch Production/Delivery agreed		U							U							R	C	C	C	C	C	C	C										
Ordering		R			R				U							R						U		C									
Invoice Control and Approval																								R	C		C						
Quantitative Receipt																						U	U	R	R	C	C						
Qualitative Receipt																						U	R			R	C	C					
Receipt Minutes Analysis																							U			U		C	C				
Additional Processing / Selection Request Analysis		U																					U						U	C	C		
Additional Processing / Selection Realization		U																					U							U	R	C	C

3. THE ENTITY RELATIONSHIP DIAGRAM

The entity relationship diagram is the standard data technique for creating data models. The entity relationship diagram enables an analyst to create a graphical view of the data concepts of an organization and their relationships. Traditional system development dictates creation of an entity relationship diagram that is converted to a database design of a relational database.

The main objective when a purchasing process data model is developing is to supply it with purchasing and supplier information as much as it possible. Important consideration when designing the model is to include large number of future users in the discussions. Knowledge of people familiar with data which they use in every day operations can provide meaningful input to the data model design.

It is important to include as many fields as possible in data model, but problem could be if too many fields are included. If data model is too complex, it will be difficult to provide the necessary data. If the vast majority of the users cannot provide data for a specific field, it may be better to not include that field at all.

Each of the entities must be able to be joined through the use of key fields.

In addition to specify what entities are going to be needed for data model, the data model should also document what data columns or attributes are going to be included in each entity. Adding or changing attributes can be tricky after begin populating the data model. Additionally, changes requested by one user that may adversely affect another user should be avoided.

It may also be necessary to freeze the data model at some point in time during development because the stability of the data model can be jeopardized by constant change. It should not be forgotten that the data model is designed with an implementation in mind.

By nature a normalized entity relationship diagram tends to separate the data concepts into separate entities. A traditional approach to entity relationship modeling is concerned with three concepts: entities, relationships, and attributes.

4. COMPONENTS OF THE ENTITY RELATIONSHIP DIAGRAM

There are many works that describe entity relationship diagramming in detail. It is not the intention of this paper to present exhaustive details instead a brief description of the component is presented.

Entity – A data concept which has relevance to the enterprise. An entity can be a person, place, thing or concept. Typically an entity consists of a single identifiable concept such as EMPLOYEE, STUDENT, CLASS, PURCHASE ORDER or SHIPMENT. An entity can consist of subtypes. Sub types are a decomposition of an entity into its various types. For example an EMPLOYEE entity can be modeled with subtypes FULL-TIME and PART-TIME. Sub typing is necessary when clarity is required about the data (and to some respect the behavior) of the Super type entity.

Relationship – A relationship, as the name suggests, is a description about the relationship that exists between two entities. Information about how the entities relate, in particular, the type and cardinality of the relationship is modeled. A relationship should only be modeled when the relationship has relevance. If one desired, any entity could loosely be related to any other entity, but this is not the intention of modeling relationships. A special relationship, known as a recursive relationship, exists between an entity and itself, such as an EMPLOYEE to EMPLOYEE related by REPORTS TO relationship.

Attributes – Attributes are details about a specific entity. These details provide greater clarification about the data that can or will be captured regarding an entity. One must be careful not to confuse entities and attributes. Entities can exist without attributes, but attributes can not exist without entities.

5. PURCHASING FUNCTION DATA MODELLING

Data classes given in Table 1 are potential entities in future data model. Some of them could be decomposed and presented with separate data model while other classes represent only one entity.

After analysis of the data classes created and managed by previously identified processes, data model revealed 51 main entities such as Agreement, Call for Bids, Delivery Assessment, Invoice, Order, Measuring Equipment, Purchase Plan and so on. For each entity candidate primary keys and principal attributes are identified and mapped the relationships between the entities, including resolving any many-to-many relationships. The identification of these entities and their relationships was driven by the functional analysis being carried out in parallel.

Since it is difficult to present so many entities in one diagram (Figure 1 and 2), the 51 entities could be allocated on many different smaller subject areas based on the cohesion of the entities in terms of the relative strengths of the mutual relationships, as well as logical subsystems defined in process modelling. These subject areas for purchasing function could be: Purchase Planning (Figure 3), Gathering and processing data on possible suppliers (Figure 4), etc. If subject area consist not so many entities, entity attributes with keys would be presented too.

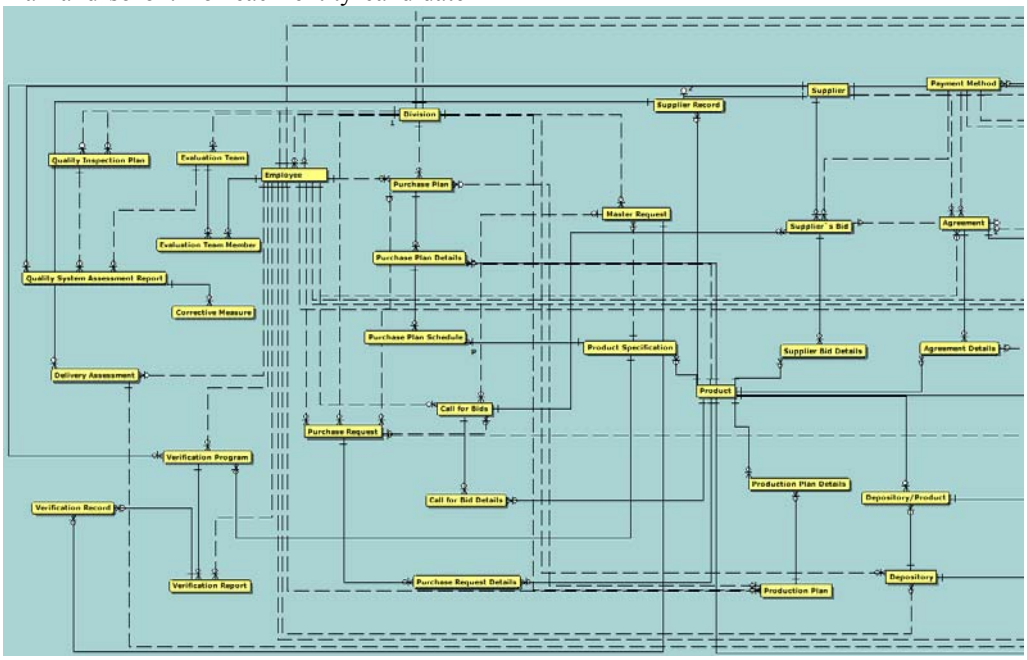

Figure 1: Entity relationship diagram – left part

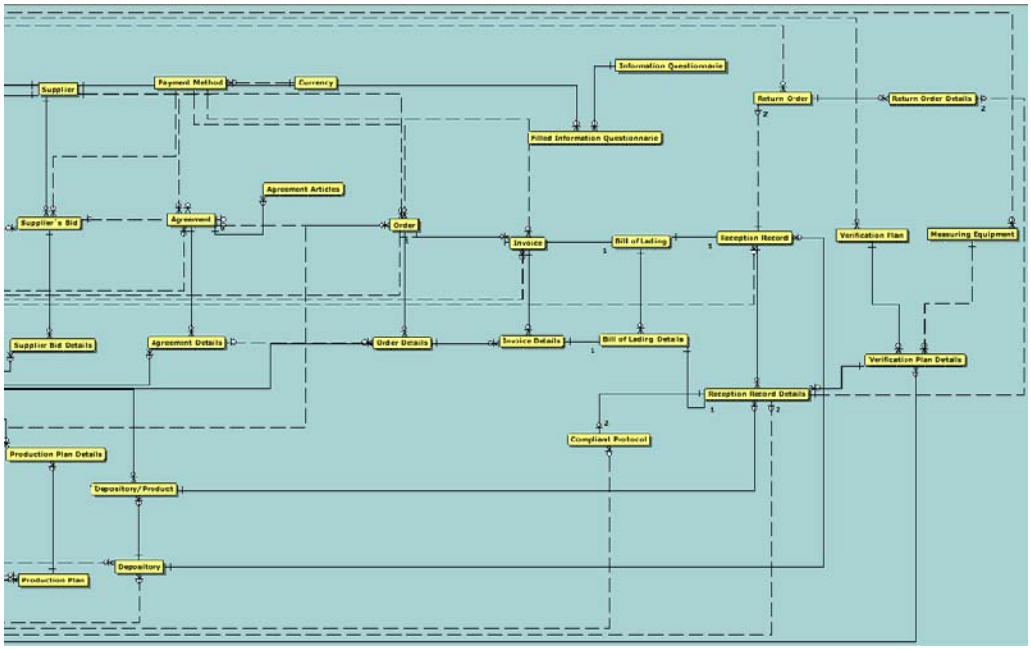

Figure 2: Entity relationship diagram – right part

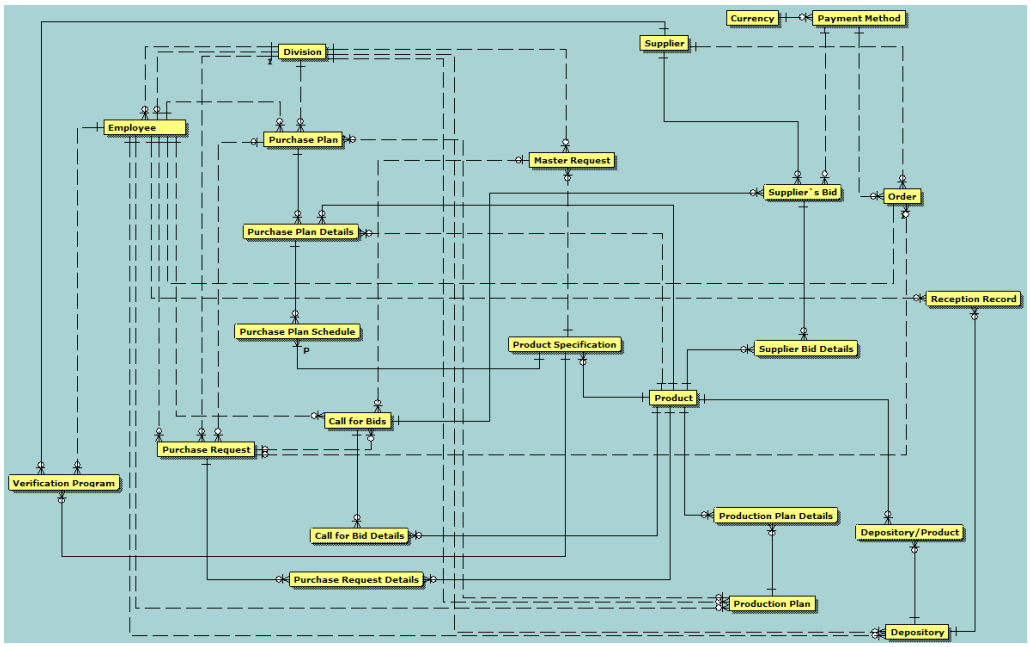

Figure 3: Purchase planning subject area

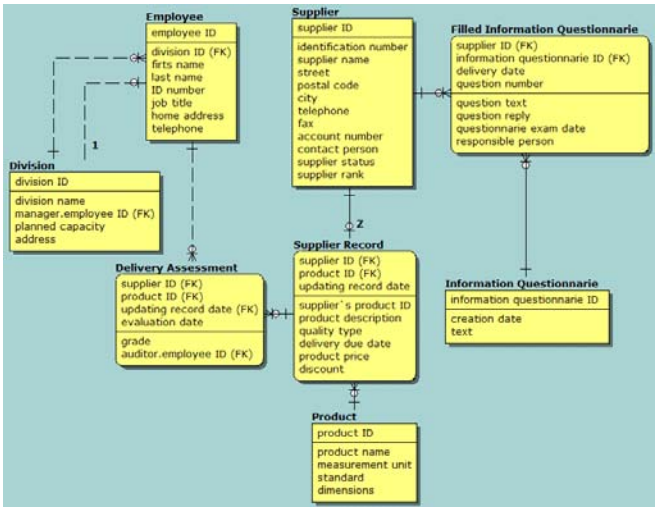

Figure 4: Gathering and processing data on possible suppliers subject area

Subject area contains entities that could be easily redefined in accordance with system analysis requirements.

During the design of subject area each entity could be included with first level or all its ancestors and with first level or all its descendants. Chosen method was all ancestors and only first level of descendants.

Following pictures shows some results of data modeling for purchasing function.

6. CONCLUSION

From practical view data model should be the most important issue in Information Engineering because it should be implemented and used in physical realization as database. But it can not be accurately developed without process model. Practically it is possible but only by very experienced designer. In that case process model could be developed and used for data model verification.

Eventually data model could be done simultaneously with process model. Synchronous development of both is aimed to best result.

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