Study of Implementing Zachman Framework for Modeling Information Systems for Manufacturing Enterprises Aggregate Planning

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Abstract

Response time on orders of customers is becoming a critical issue to achieve a competitive advantage. A major problem is a lack of strategic perspective of information systems. A need for adequate tools and methodologies to model the system structure and to define integrated requirements is a must for the manufacturing enterprises. This paper presents a study of implementing Zachman Framework ZF to model information systems for aggregate planning activities within the manufacturing enterprises. An Information System for simulating the aggregate planning activities such as evaluating the various planes for determining the production rate, inventory levels, subcontracting and the required human resources is modeled. This is assumed to provide control over the order processes and reporting the orders status online. It is assumed that the customer can have access to the system to follow up with his order progressing status. Managers would have control on orders transactions, and workshop floor supervisors could monitor and control the orders processing online. Some artifacts are introduced to ZF to enhance its capability for modeling of information systems for Aggregate Planning in Manufacturing Enterprises.

Keywords: Manufacturing Information Systems, Zachman Framework, Enterprise architecture, Aggregate planning, Modeling.

1. Introduction

Nowadays, the enterprises encounter with numerous amount of data. This data can be used as information to decision making, increases profitability and customer satisfaction and help the manufacturing enterprises to compete in the global unstable and unpredictable market. The using of these data as information only will be usable if the information systems of enterprises be comprehensive and well-designed.

Ghang Lee et al. [1], proposed a new formal approach, called Process to Product Modeling (PPM) in which process and product modeling can be logically linked. This paper focuses on the semantics and syntax for the Requirements Collection and Modeling (RCM) of PPM. The new RCM method aims to model heterogeneous business processes and their information flows. A comparison has been done between RCM, and each of the IDEF0: Integrated DEFinition function modeling, DFD: Data Flow Diagram, UML: Unified Modeling Language, and Flowchart. Radwan, A. [2], transferred a process model to an entity relational ER model, and hence to SQL program. On the other hand, Radwan and Es-Saheb [3], formulated a relational model as a part of a complete expert-system software design for powder technology. Cheol-Han Kim et al. [4] Highlighted the similarities and the differences between IDEF and UML modeling approaches. Ahmari and Ridgway [5], presented a modeling method—GI-SIM (GRAI/IDEF-Simulation), this is developed to meet the requirements of manufacturing system analysis and design. It seems to be a good approach towards combining three important concepts of modeling methods; conceptual, functional and simulation in an integrated structure. Cathal Heavey and Shafi M.S. Khanian [6] introduced a process modeler to provide a tool tailored to model manufacturing operations, and claimed that, it provides a tool that uses a high semantic modeling, and can be used by non-expert personnel. Rafidah Abd.Razak et al. [7], studied on current Enterprise Information Architecture (EIA) practices in Malaysian organizations. Ten organizations from public and private sectors were chosen as a case study analysis. The Zachman Framework was chosen as a guideline to assess the current practice of EIA in these organizations. This study revealed a poor knowledge and understanding of EIA among the organizations, though there had been efforts at implementing EIA. The study also discovered gaps in the current practice and lack of

the knowledge about the frameworks at all. Melita Kozina [8], analyzed the Architecture of Integrated Information Systems (ARIS) and the Zachman frameworks, to define the criteria for comparison and evaluation of these approaches, and determine their level of complement. This resulted in that, both approaches were developed independently, but these are highly complementary. Adrian et al. [9], studied the definition of the appropriate set of information technology/information systems (IT/IS) proficiency characteristics. Moreover, their work studies the evolution of IT/IS in manufacturing and the importance of information systems to support a series of attributes widely recognized in the literature of agile manufacturing. Bipin Chadha et al. [10], studied and described a case study of implementing CIM information systems with using of IDEF0, EER diagrams, DBMS and SQL. Marek Fertsch et al. [11] discussed the potential of the new and emerging solutions that might be successfully applied for improvement of manufacturing system management in highly volatile environment of today's global economy. Authors discuss the conditions that have to be met by new standards of IT systems supporting the operations management. Andrew Martina et al [12] reviewed the literatures of the various architectures of the Information Systems to bring together a number of key issues within an overarching architectural perspective. They argue that its current topicality offers Information Systems practitioners a renewed opportunity and mandate to pursue an Information Architecture strategy, and offered academics a renewed incentive to research this area. David Chen at al [13] defined and clarified basic concepts of enterprise architectures. The main part of their research focused on the recent developments on architectures for enterprise interoperability. The main initiatives and existing works were presented. Future trends and some research issues were discussed and conclusions were given at the end of the paper. Hervé Panetto et al. [14] proposed mapping the IEC 62264 standard models to particular views of Zachman framework in order to make the framework concrete as a guideline for applying the standard and for providing the key players in information systems design, with a methodology to use the standard for traceability purposes.

2. The Zachman Framework and Manufacturing Aggregate Planning

The Zachman Framework: In 1987, John Zachman introduced his framework for modeling of information systems. The ZF, describes six Perspectives (rows): *Planner's View*, *Owner's View*, *Designer's View*, *Builder's View*, *Subcontractor View*, *Actual System View,* and six Dimensions (columns): *What, How, Where, Who, When, Why* pertinent to enterprise modeling. The rows of the framework represent the aspects or views of different types of stakeholders and the columns represent different perspectives of its architecture [15].

Aggregate planning in manufacturing enterprises

Aggregate planning is concerned with determining the quantity and timing of production for the intermediate future, often from 3 to 18 months [16]. Why do organizations need to do aggregate planning? The answer is twofold. One part is related to *planning*: It takes time to implement plans. For instance, if plans call for hiring (and training) new workers, that will take time. The second part is *strategic*: Aggregation is important because it is not possible to predict the timing and volume of demand for individual items accurately [17].

The strategies of aggregate planning: Two main strategies are used in aggregate planning: *Chase strategy* and other, *Level strategy*. The chase strategy sets production that match the forecasted demand. The level strategy is focused on production in uniform during the different periods. This strategy is mainly adopted by manufacturing companies.

Chase Strategy: This strategy that also called "Just-In-Time", tries to adjust production to meet demand. As a result, minimal levels of inventory are maintained. While this feature is positive for many industries that require reflexive adaption, employment of this strategy decreases the ability to the company to meet unexpected demand increases and increases the risk of backorders.

Level Strategy: This strategy that also called "Just-In-Case", basically moderates the fluctuations, holding inventory or placing backorders as needed levels. The philosophy of the producers with this strategy is that a stable workforce leads to a better quality product, less turnover and absenteeism, and more employee commitment to corporate goals [16].

Mixed Aggregate Strategy: Mixed Aggregate Strategy offers the best strategy by combining Chase Strategy with Level Strategy. However, because there are a huge number of possible mixed strategies, managers find that aggregate planning can be challenging task. Finding the one "optimal" plan is not always possible [16]. The most companies use the mixed aggregate strategies to evaluate the needs of the business.

Techniques for Aggregate Planning: There are numerous techniques to aggregate categories planning that can be divided in two categories: Graphical Methods (Trial-and-error approaches), Mathematical Approaches, and Simulation Methods [16-18].

3. Implementing Zachman Framework for Manufacturing Aggregate Planning

In general, the basic entities and interfaces of a manufacturing Aggregate Planning activity for small and medium-sized enterprises may be summarized as shown in Figure 1. Thus, it is necessary to identify the interfaces between all the activities internally and externally, for the sake of achieving the required integration. Otherwise, the result will be incomplete an information system. Table 1 shows the implementing of ZF, with some artifacts are introduced to ZF to enhance its capability for modeling of information systems for Aggregate Planning in Manufacturing Enterprises.

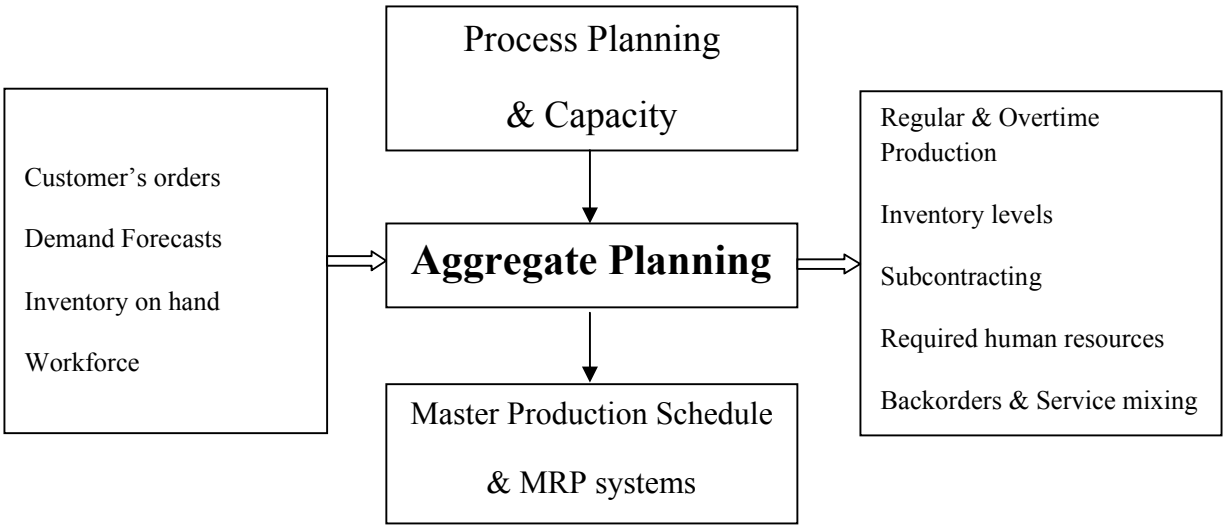

Figure 1: Basic entities and interfaces of a manufacturing Aggregate Planning activity

Scope (Planner's View) Perspective – Data (What): The things that are important for business are identified in this cell of Zachman Framework. This cell includes the resources that are currently available and needed by enterprise for efficient functioning of business. Besides, the favorite output of it. In the case of *Aggregate Planning Information Systems*, the content of this cell may be: *Forecasted Demand, Capacity Constraints, Inventory on hands, Aggregate Production Plan Items* (Such as: Output per month or quarter by product or service family; Size of the workforce; Amount of regular and overtime production, supplier bids and subcontracted productions; Inventory levels; Backlog levels are projected; Number of units or pieces to be backordered or lost and other necessary data for master scheduling).

Scope (Planner's View) Perspective – Function (How): The related functions of Aggregate Planning are represented here; Techniques & Solutions (e.g. Graphical methods & Trial and error, Transportation method of linear programming & Optimization, Management coefficients model & Heuristic).

Scope (Planner's View) – Location (Where): The diagram of locations (e.g. Aggregate Planning Department) that system operates within or is related to (e.g. Master Production Schedule and MRP Departments).

Scope (Planner's View) – People (Who): The audiences and organization diagram that the system operates within them. The audiences in manufacturing information systems can be: Top managers (Strategists), Middle Managers (Operational managers), Shop Floor staffs. Also the organization diagram of that these audiences and system are operating in that can be represented in this cell.

Scope (Planner's View) Perspective – Time (When): As known aggregate planning is also referred to as aggregate scheduling, it is concerned with determining the quantity and timing. The scheduling of operations, and the Material Requirement Planning (MRP), these are designed according to these events and times, resulted from the aggregate planning process.

Scope (Planner's View) – Rationale (Why): The list of incentives must be in this cell. In aggregate planning information systems this cell is filled with: *Reducing the processing time, reducing the response time to the*

Table 1: The suggested modeling artifacts for the cells of Zachman Framework

	What	How	Where
Scope (Planner's View)	List of things that are important for Aggregate Planning Infosys. - *List as explained below*	List of Methods and Techniques - *List as explained below*	List of Locations which the system operates - Tree of Departments (Hierarchical list)
Business/ Enterprise Model (Owner's View)	Semantic Model - Entities Relationship Diagram - UML/UEML Class Diagram - Entities Dictionary - IDEF1X	Process Model - Sys/Sub.sys. vs. Processes Matrix - Processes Dictionary - Activity Diagram -Work Flow - UML Act. Diag. - GRAI Nets	Logistics System - Functional Logistic System Decomposition -UML Packages
System Model (Designer's View)	Logical Data Model - Class Diagram - ERD/ERM/IDEF1X	Application Architecture - Processes vs. Entities Matrix - Sys. Process Dictionary - Use Case	The Distributed Systems Architecture - Systems Diagram - UML Component
Technology Model (Builder's View)	Database design - IDEF1X (Inf. Model)	Program structure - IDEF0 - Activity Struct. Chart - UML/UEML Class	Technology Architecture - UML Deployment
Detailed Description (Programmer/Sub-Contractor's View)	Data definition - DB Schema - SQL	Program design - Programming Languages	Network Architecture - URL - IP - TCP/IP
Actual System (Functional View)	Usable Data	Working Functions	Usable Network

Table 1(continued): The suggested modeling artifacts for the cells of Zachman Framework

	Who	When	Why
Scope (Planner's View)	List of audiences in Aggregate Planning information systems - *List as explained below* - T diagram	List of Significant Events for Aggregate Planning InfoSys. - *List as explained below*	List of Goals - *List as explained below*
Business/ Enterprise Model (Owner's View)	Work Flow Model - Organization Chart - GRAI Grid - Processes vs. Organization Matrix - Use Case	Master Schedule Plan - Business Execution Plan - GANTT/PERT - IDEF3 OSTN (Object State Transition Network)	Business Plan - Business Table
System Model (Designer's View)	Human Interface Architecture - Roles Matrix - GRAI grid - Use Case	Processing Structure - State Diagram - IDEF3	Setup Rules Model - FOL (First Order Logic) - Decision Table
Technology Model (Builder)	Interface & Security Design - Use Case	Controlling Structure - UML Sequence & collaboration Diag.	Design Rules - FOL (First Order Logic) - Decision Table
Detailed Description (Programmer/Sub-Contractor's View)	Security Code	Time order Setting Conditions	Described Rules
Actual System (Functional View)	Functioning Organizations	Implemented Schedule	Working Strategy

market changes, increasing the QOS, organizing and improving the performance of the inside people of the enterprise, increasing the customers satisfaction, decreasing the total cost of production, decreasing the lost sale, and so forth.

Business/Enterprise Model (Owner View)-Data (What): The Data Map gives the picture of the business and is represented using Entity Relationship Diagram (ERD), IDEF1X model (or Conceptual level Class Diagram). Thus, considering the required **Entities** in the aggregate planning such as: *demand forecasts, workforce & human resources, production capacity, inventory, subcontractors and external capacity.* Then, IDEF1X Model is constructed to show the attributes of each entity.

Business/Enterprise Model (Owner View)-Function (How): The top level activities and process model can be designed with using of IDEF0 as the function modeling tools.

Business/Enterprise Model (Owner View)-Location (Where): The owner is interested in the conceptual model of "where", which includes the location of and place where stakeholders, use from the system and also the operations that they can do related to this. For each location or each place, there are specific operations assigned to this location or place (e.g. operations related to Aggregate Planning Department).

Business/Enterprise Model (Owner View)-People (Who): Organization charts, roles, set of skills and security issues. Some tools such as box charts/ rich picture can be put in this cell. Thus, specific operations are assigned for each person according to its skill and its role in the system. Thus, there is a specific *authority* for each person in the system (managers, planers, supervisors, etc.).

Business/Enterprise Model (Owner View)-Events (When): The sequences and time phases for processes or activities are presented (e.g. Gantt Charts).

Business/Enterprise Model (Owner View)-Rationale (Why): The expected outcomes from this system for each entity (person) in the system. For the aggregate planner, the variable data may be; customer's orders, Demand Forecasts, inventory on hands, and the present workforce. Once, these data are available online, and the aggregate planning process is also automated. This will provide immediate output data about; Regular & Overtime Production size, and subcontracting requirements to the staff involved in the Master Production Schedule (MPS) and the staff of MRP. In turn, this will lead to a fully integrated production system. The characteristic of this system may be summarized on the following:

- *Top management* can have access to the all information about the production status online.

- *Supporting the sales personals for increasing the market share*: due to the system capability to deliver a high-quality, on time, fast and error free information, and providing reports about the optimized aggregate plan.

- *Decreasing of the total cost of production*: The system ability to produce plans providing the lowest inventory rate, backorder lost, manufacturing, human resource expenses, raw materials and other costs that effects on the total cost of products.

-*Increase the satisfying of the internal people of enterprise*: The system has to provide the necessity information for obtaining the optimized payroll, hiring and laying off the workers and so on for improving the satisfaction of internal people.

In the next perspectives and dimensions (for the cells) in the Zachman Framework table, the mentioned modeling tools (Table 1) can be used to represent the details. Finally according the fifth row, the system can be implemented and operated as indicated on the table.

4. Conclusion

The Zachman Framework is one of the renowned frameworks that are comprehensive and simple to understand. Nevertheless, during our study we encountered some drawbacks of this framework for the modeling of information systems for manufacturing enterprises aggregate planning. These may be summarized as the followings:

- ZF has large amount of documentations: There are documents in detailed texts, modeling diagrams and charts for each of ZF's cell (for each of 36 cells) that it will be a bureaucratic approach in this framework.
- Besides, ZF doesn't have any consideration to As-Is of the Information Systems: That's mean ZF considers only the establishing of new architectures for information systems of enterprises without considering the

previous systems (As-Is status of systems). Whereas, the manufacturing enterprises information systems need to consider to As-Is status before implementing it.

- Further, ZF doesn't have complete consideration to all possible stakeholders in enterprises: there are some other stakeholders that ZF didn't have any perspective to them. In the latest version of ZF there are views of Strategists, Executive leaders, Architects, Engineers, Technicians and Workers [19] (that can be considered as Users), but there aren't any consideration to some manufacturing enterprises necessity views for example: Customers, Competitors and so on.
- ZF doesn't have any consideration to Evaluation and Control for each perspective: The deliverables from each perspective must provide sufficient detail to define the solution at the level of perspective and these need some evaluation parameters or control paradigms.
- ZF doesn't have any consideration to continuous development of information systems and especially in manufacturing enterprises such as Deming's PDSA cycle (Plan-Do-Study-Act).

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