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Implementing an Aerospace Information System for a developing Economy

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Abstract*—The Nigerian aviation industry is currently undergoing some reforms and it is the researchers' believe that Information system management can be deployed in addition to excellent personnel service to provide operational efficiency in an aerospace industry. The purpose of this paper is to describe our research experiences in building an Aerospace Information System aimed at providing a comprehensive range of commercial services to the aerospace and airline industries in Nigeria. In this effort, we designed and implemented an Aerospace Information System (AIS) as an enterprise resource planning platform to facilitate any desired level of integration. Using the Structured System Analysis and Design Methodology (SSADM) to conduct a systematic study of our country's aviation industry, we uncovered the underlining current problem areas and implemented a suite of software that was able to achieve, among other things, a transformation of the relationships in the supply chain and enhanced customers satisfaction, as transactions were made easier via the use of electronic communications.

Key Words: **Aerospace, information systems, SSADM, ER Model, DFD.**

I. INTRODUCTION

The Aerospace comprises the atmosphere of Earth and surrounding space. Typically the term refers to the industry that researches, designs, manufactures, operates, and maintains vehicles moving through air and space. Aerospace is a very diverse field, with a multitude of commercial, industrial and military applications [1]. In most industrialized countries, Nigeria included; the aerospace industry is a cooperation of public and private industries and several countries have a space program under the command of the government [2]. Along with these public space programs, many companies produce technical tools and components such as spaceships and satellites. Some known companies involved in space programs include Boeing, EADS, Lockheed Martin, MacDonald Dettwiler and Northrop Grumman [3].

Aerospace manufacturing is a high technology industry that produces "aircraft, guided missiles, space vehicles, aircraft engines, propulsion units, and related parts" [4]. The technology of aerospace permeates many other industries: travel and tourism, logistics, telecommunications, electronics and computing, advanced materials, civil construction, capital goods manufacture, and defense supply [5]. Timely movement of information is a core requirement for the timely movement of aircraft, passengers and cargo throughout commercial aerospace history. Logistic concerns in this industry involved the need to make rapid, well informed decisions and many organizations are finding it increasingly difficult, and expensive, to find and retain staff to meet the demands [6].

A. Background Information

Our study of the Nigerian Aerospace industry revealed that most of the industry operators used manual or partially automated information systems. The present manual and partially automated system used by aerospace operators in Nigeria were ineffective and the costs of running the business were very high. The system was such that the operators were over dependent on the manual processes. In this manual system, a team of eight operators would sort through a rotating file with cards for every aircraft. When a transaction was completed, the operators would place a mark on the side of the card, and knew visually whether it was full. This part of the process was not all that slow, but the entire end-to-end task of looking for an aircraft details and then writing up the report could take up to three hours in some cases, and 90 minutes on average. The system also had limited room to scale. It was limited to about eight operators because that was the maximum that could fit around the file, so in order to handle more queries the only solution was to add more layers of hierarchy to filter down requests into batches. The requested information is then removed from the inventory for that activity or event [6].

Using this system, a large number of operators could look up information simultaneously, so the managers could be told over the phone whether information was available. On the downside, a staff member was still needed at each end of the phone line, and actually handling the transaction information still took considerable effort and filing. Something much more highly automated was needed if transaction was going to enter the jet age. Most aerospace employees work as service agents and work at aerospace terminals. As a rule, assignments are rotated, with other employees serving behind the counter or at the boarding gate. They all use the same equipment and procedures. In addition, they issue receipts, by computer or by hand, collect payments, and make change. They must record all transactions and money exchanged and, at the end of the shift; prepares a daily report.

The researchers upon recognizing the inadequacies and inefficiencies of the present aerospace management system in Nigeria designed and implemented an aerospace information system that will provide guidance and assistance to management in planning, developing and implementing the technical infrastructure necessary to compete in today's aerospace industrial climate. The first section of this paper provided an introduction and a brief overview of the Nigeria aerospace management system, the adopted methodologies and tools were discussed in the second section, obtained results from this implementation were discussed in section four and the paper was concluded in the fifth section.

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II. METHODOLOGIES

The Structured System Analysis and Design Methodology (SSADM) and the prototyping methodology were adopted in this research work. The choice of the SSADM was hinged on its high availability for system study and preliminary design and implementation. The phases of the SSADM as was adapted in this research are as follows:

A. Preliminary investigation Phase

During this phase, the researchers identified the problems in the Nigerian aerospace and ascertained the project is worth embarking upon. The scope of the design was also defined.

B. Problem Analysis Phase

The primary objective of this phase was to produce system environment objectives that will address the problems identified in the previous phase. This system environment objectives identified here were to design an information system that will solve all the problems in the Nigerian aviation industry.

C. Requirements Analysis Phase

In this phase, functional and non-functional expectations such as performance, reliability, usability, integrity, and interoperability were also identified.

D. Design Phase

The aerospace information system was designed at this phase and a prototype system was developed. The design covered most aspects of aerospace industry requirements in modular structure and effectively created a paper-less office. It consisted of various modules that handled operations such as flights operation and maintenance schedule; inventory and customer relationship management; supply chain management; and finance and human resources management.

The high-level model (HLM) of the design is given below (Fig 1). The prototype system was implemented using the Visual Basic .NET application programming interface (API). The choice of this API was used due to its capabilities to handle large volume of data, enhancement of data integrity, speed and control of data inconsistency and redundancy and its suitability for implementing an interactive web-based environment such as aerospace information system.

III. RESULTS AND DISCUSSIONS

A prototype AIS which consisted of various modules, which were presented with aesthetically pleasing interfaces using standard windows style menu and toolbar was developed in this work. The modules worked independently as well as in an integrated environment; sharing data among themselves and the resultant system was truly a client/server and multi-user environment one. The system was robust enough to handle the large volume of data in the aerospace industry.

The HLM (Fig 1) is presented below as a hierarchy of design entities (Fig 2). Top in the hierarchy of the design is the introduction screen. This is a graphical flash screen that welcomes the user to the application. The screen is ubiquitous as the display is set to match the mood of the user and simulate his interest in the application. At one time, it may play soft number when he is edgy or inspirational messages when he seemed discouraged.

The user authentication helps to ensure that only authorized personnel can access and use the application. Also several levels of access are set to different schemas and user views. The administrator has a global access. The main menu consisted of four items; finance and human resources management (HRM), flight operation and maintenance, supply chain management and inventory and customer relations management. Finance and HRM option in turn contained four sub-menu items: accounting, payroll, recruitment and training. Flight operation and maintenance was sub-divided into flights and maintenance; while supply chain management option led to order control and transport management sub items. Finally, inventory and customer relations management expanded to spare parts, equipments, requests and customer relations management options. The databases of the prototype AIS was designed built and populated with data for a specific purposes and they represented most aspect of the real world in the aerospace industry. The databases were integrated, self-describing collection of related data. The Entity-Relationship approach was deployed in the design of the database for this system. The data model obtained its inputs from the planning and analysis stage and the modeler, along with system analysts, collects information about the requirements of the database by reviewing the existing documentation and interviewing end-users.

The overall Data Flow Diagram of the AIS is given in fig 3 below: Interactions between the various components of the system were depicted with arrows according to the convention specified in [7]. This is further broken down to show the data flow in the individual module of the application. Fig 4, Fig 5, Fig 6. The AIS program design adopted the top-down approach, in which the main program was defined first, followed by the specification of the sub-systems. Here, the program design progressed from the general to the particular, each program unit (module) being progressively refined. Each program module was designed and listed separately. The modules were integrated together in a way that a program could branch to another module, executes the program there and returns to the main (calling) program after execution (Fig 1).

IV. CONCLUSION

Information systems do not have to be computerized, but with today's large, multinational corporations, computerization is a must for a business to be successful. [8]. In this work, we studied the Nigerian aerospace industry and discovered that most industry operators use manual or partially automated information systems this had resulted in an ineffective system and increased costs of running business. These observations necessitated the design of an aerospace management system for the Nigerian aerospace industry. A prototype system was implemented the core of

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which took into account the needs of both the managerial and end-user. The system successfully covered most aspects of aerospace industry requirements in modular structure and effectively created a paper-less office.

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Oladipo, Onaolapo Francisca holds a Ph.D in Computer Science from Nnamdi Azikiwe University, Awka, Nigeria; where she is currently a faculty member. Her research interests spanned various areas of Computer Science and Applied Computing. She has published numerous papers detailing her research experiences in both local and international journals and presented research papers in a number of international conferences. She is also a reviewer for many international journals and conferences. She is a member of several professional and scientific associations both within Nigeria and beyond; they include the British Computer Society, Nigerian Computer Society, Computer Professionals (Regulatory Council) of Nigeria, the Global Internet Governance Academic Network (GigaNet), International Association Of Computer Science and Information Technology (IACSIT), the Internet Society (ISOC), Diplo Internet Governance Community and the Africa ICT Network.

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APPENDIX

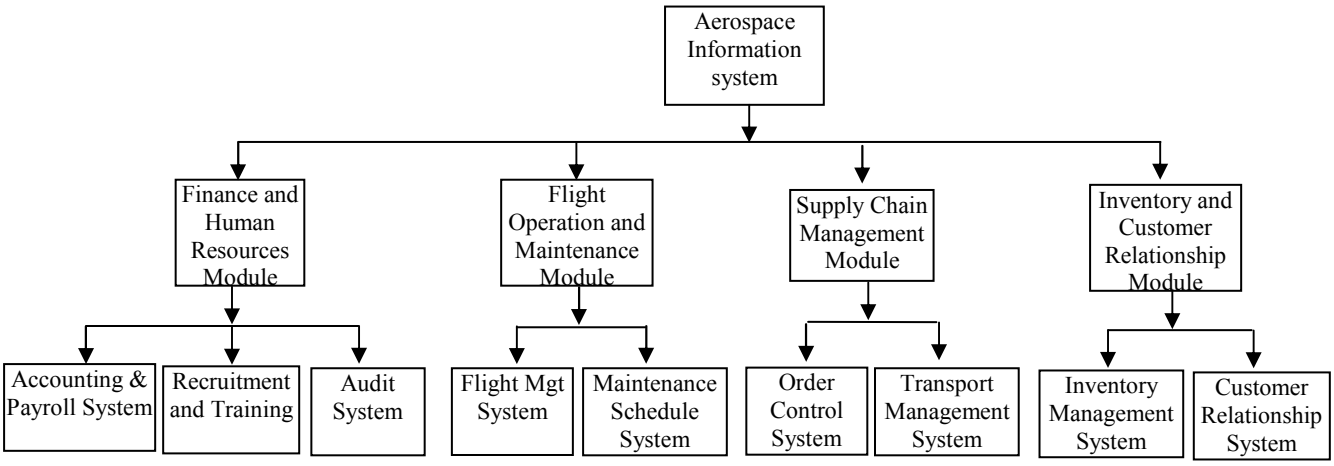

Fig. 1. The high level model of the system

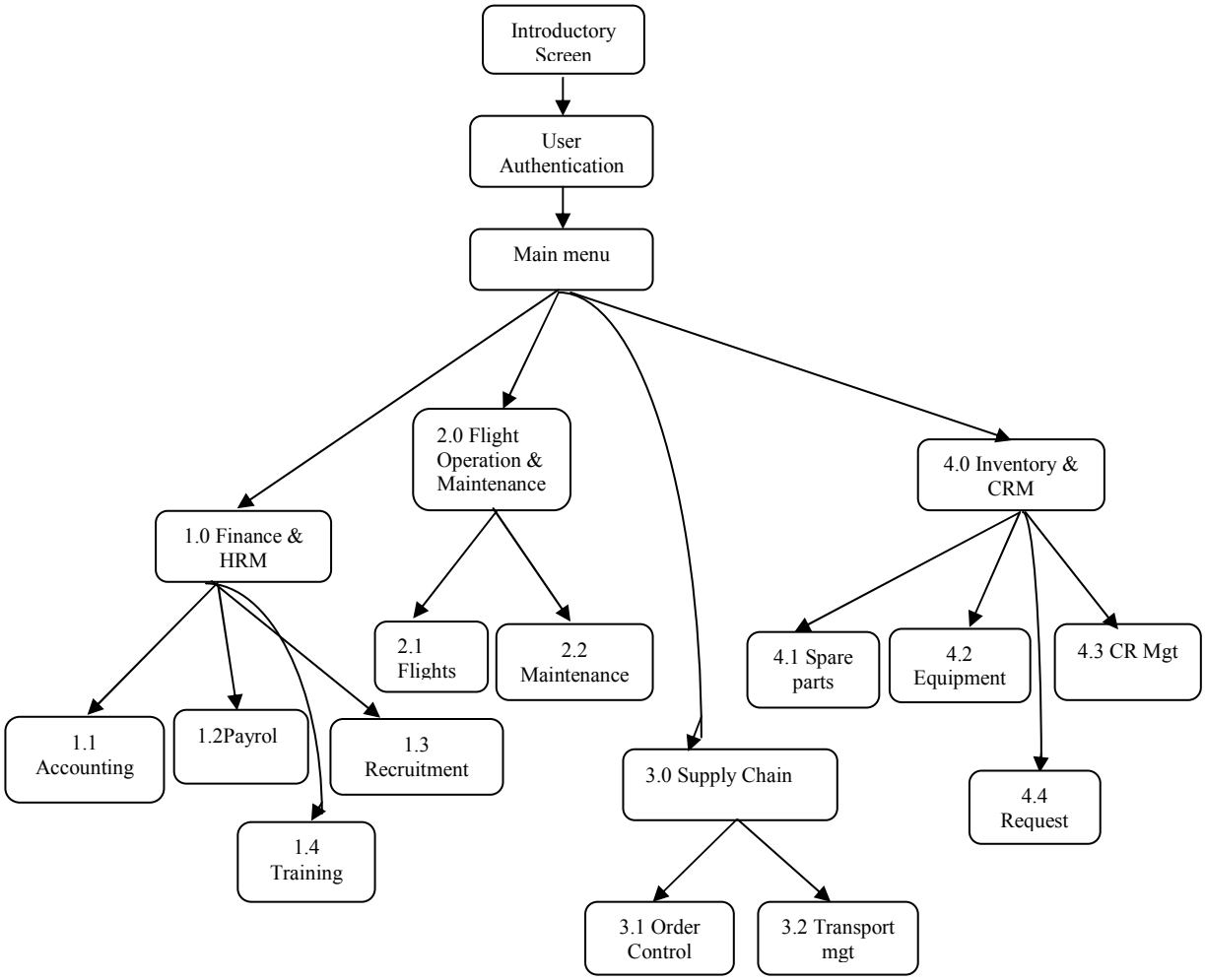

Fig. 2 The hierarchy chart of the prototype AIS program design

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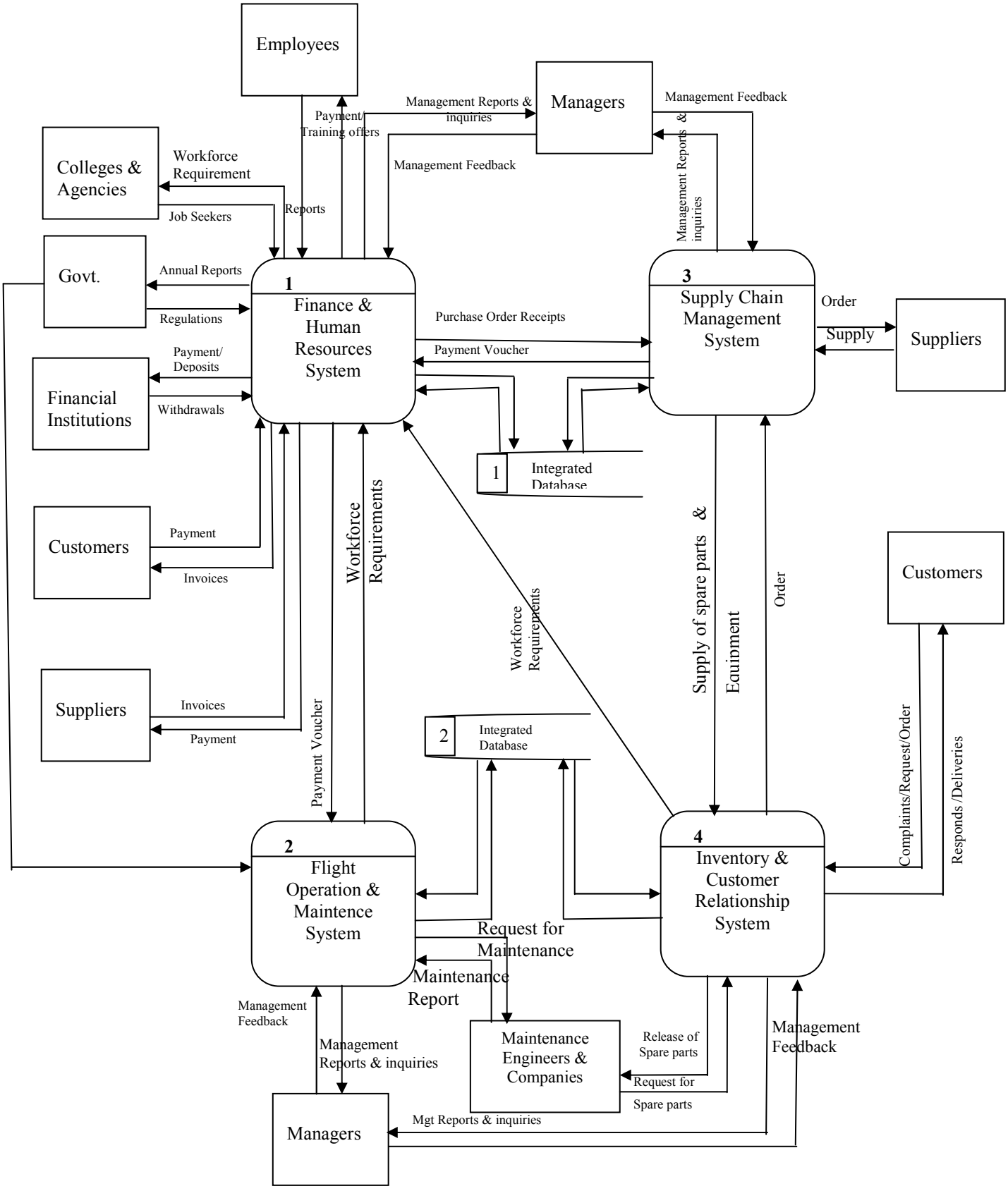

Fig. 3 Overall Data Flow Diagram (DFD) of the System

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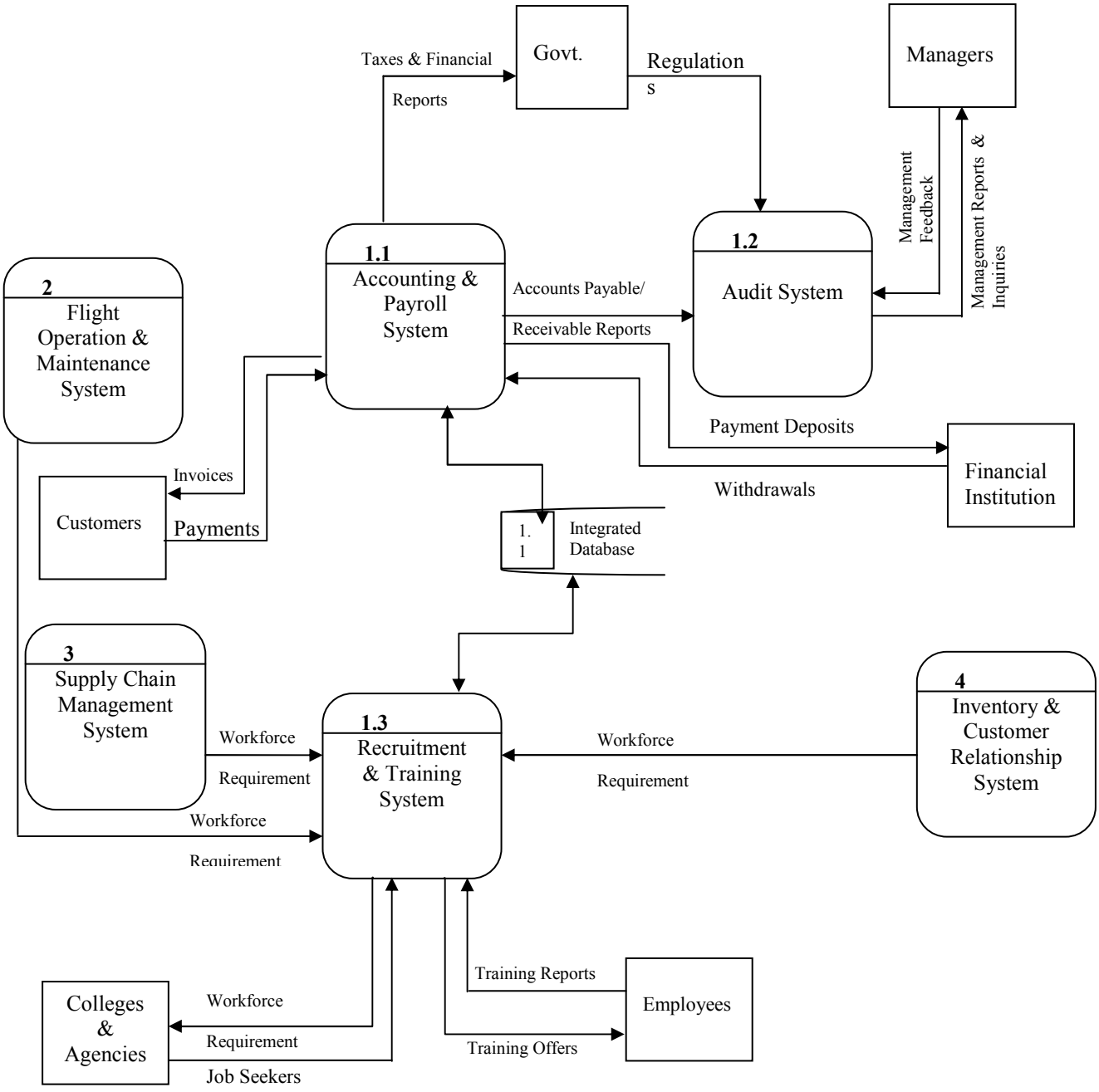

Fig.4. Data Flow Diagram of the Finance and Human Resources Management (HRM) Module

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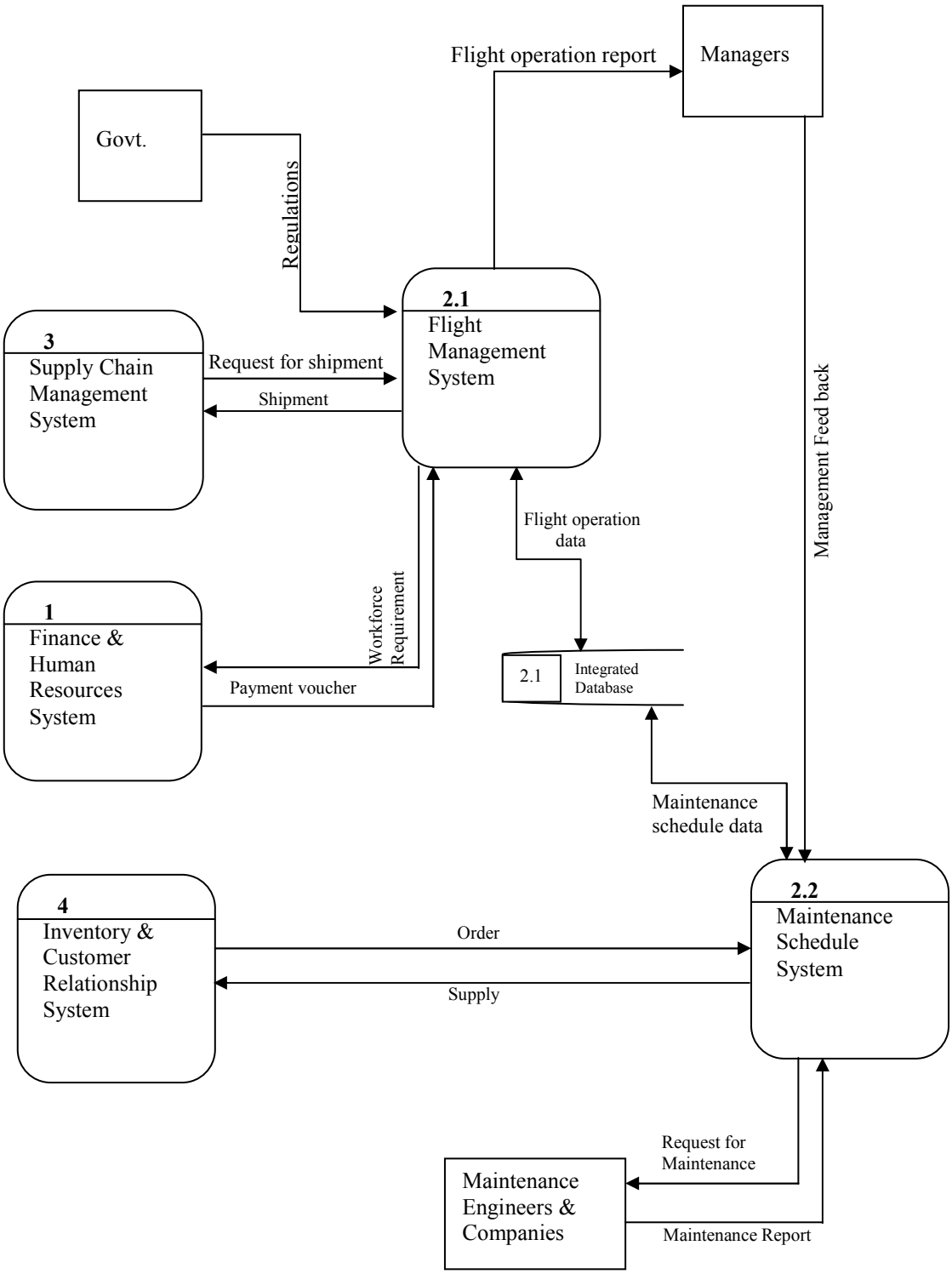

Fig . 5. Data Flow Diagram of the Flight Operation and Maintenance Module

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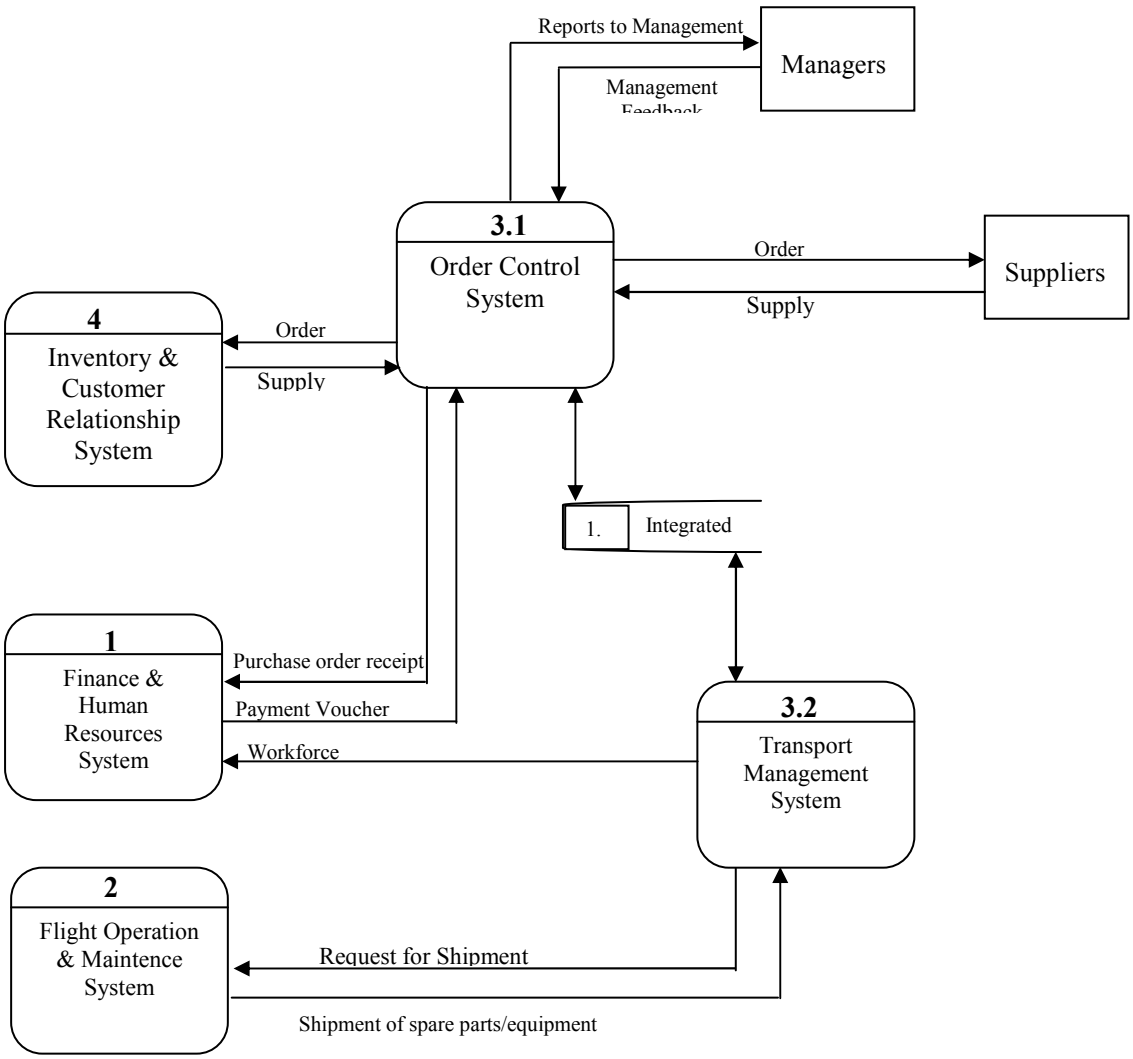

Fig. 6. Data flow diagram of the Supply Chain Management Module

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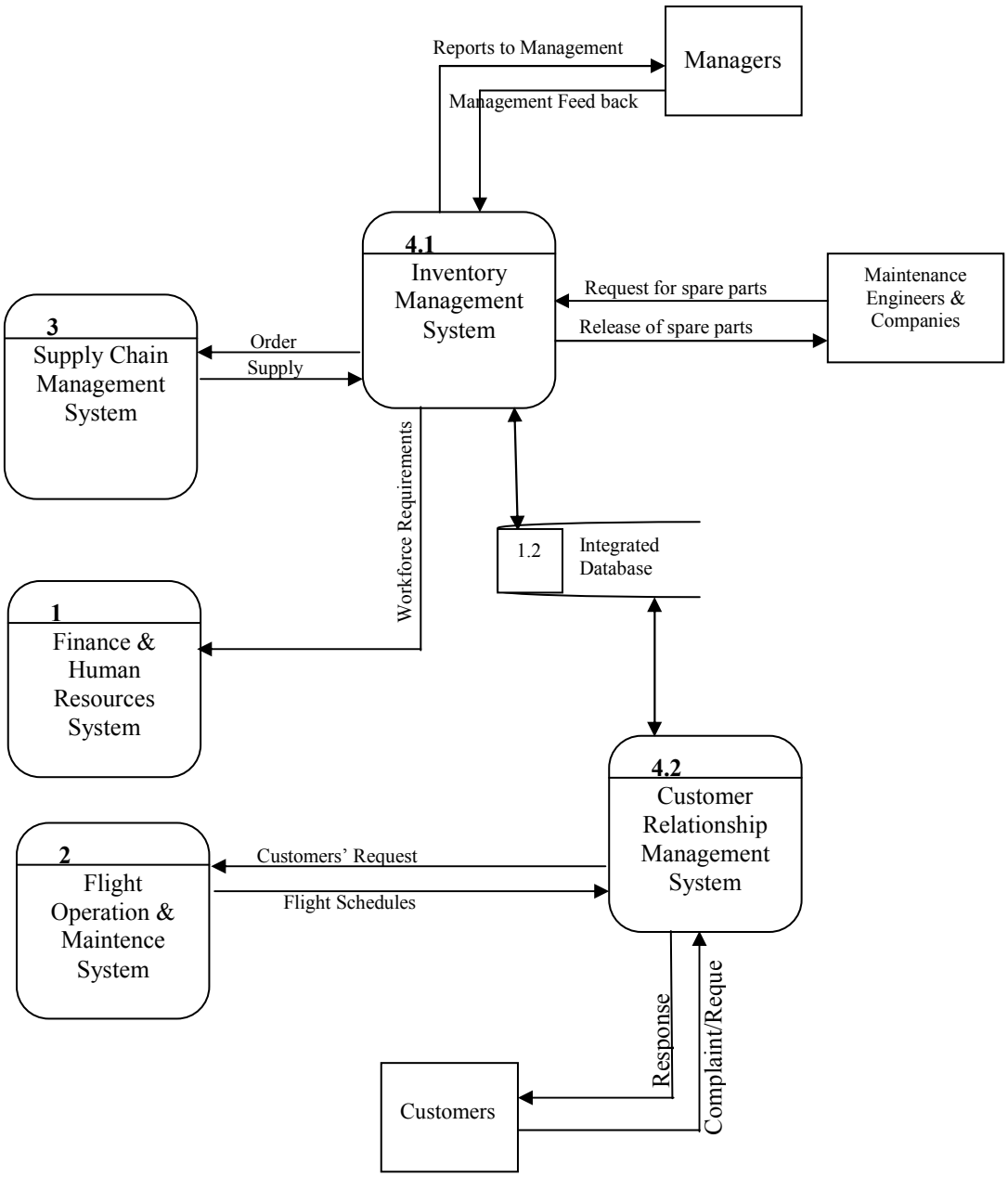

Fig .7. Data Flow Diagram of the Inventory and Customer Relationship Module