THE EXTENT AND LIMITATIONS OF MANAGERIAL ACCOUNTING
FUNCTION WITHIN ERP SYSTEMS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

MUSTAFA HARMAN

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
INDUSTRIAL ENGINEERING

FEBRUARY 2022

Approval of the thesis

THE EXTENT AND LIMITATIONS OF MANAGERIAL ACCOUNTING FUNCTION WITHIN ERP SYSTEMS

submitted by **MUSTAFA HARMAN** in partial fulfillment of the requirements for the degree of **Master of Science in Industrial Engineering Department, Middle East Technical University** by,

Prof. Dr. Halil Kalıpçılar   _____
Dean, Graduate School of **Natural and Applied Sciences**

Prof. Dr. Esra Karasakal   _____
Head of Department, **Industrial Engineering Dept., METU**

Assoc. Prof. Dr. İsmail Serdar Bakal   _____
Supervisor, **Industrial Engineering Dept., METU**

Prof. Dr. Serhan Duran   _____
Co-Supervisor, **Industrial Engineering Dept., METU**

Examining Committee Members:

Prof. Dr. Sinan Gürel   _____
Industrial Engineering Dept., METU

Assoc. Prof. Dr. İsmail Serdar Bakal   _____
Industrial Engineering Dept., METU

Prof. Dr. Serhan Duran   _____
Industrial Engineering Dept., METU

Prof. Dr. Cem İyigün   _____
Industrial Engineering Dept., METU

Assist. Prof. Dr. Benhür Satır   _____
Industrial Engineering Dept., Çankaya University

Date: 11.02.2022

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name Last name : Mustafa Harman

Signature :

ABSTRACT

THE EXTENT AND LIMITATIONS OF MANAGERIAL ACCOUNTING FUNCTION WITHIN ERP SYSTEMS

Harman, Mustafa
M.S., Department of Industrial Engineering
Supervisor: Assoc. Prof. Dr. İsmail Serdar Bakal,
Co-Supervisor: Prof. Dr. Serhan Duran

February 2022, 117 pages

This thesis aims to investigate the extent and limitations of managerial accounting concepts within ERP systems for medium to big-sized companies, whose transactions and data generation are huge and require integrated, online, and real-time processing on a common database. The main purpose for managerial accounting within standard ERP systems is to automate costing, budgeting, and cost accounting by integrating with functional modules. This is not complete automation. The extent and limitations of this automation are studied and shown in this thesis. In this context, ABC which is developed in the 90s and integrated into ERP software in the 2000s is studied and data definitions, transactions, and data models are determined for better integration. As ERP software packages are regarded as dough to be shaped for each company, the results of this thesis are expected to help and/or improve the success of implementations of ERP systems and enterprise systems, especially for managerial accounting issues. Furthermore, it is aimed to have financially more functional ERP systems by better integrating managerial accounting concepts to enterprise systems.

ÖZ

ERP SİSTEMLERİNDE YÖNETİM MUHASEBESİ FONKSİYONLARININ UYGULAMA BOYUTLARI VE LİMİTLERİ

Harman, Mustafa
Yüksek Lisans Endüstri Mühendisliği Bölümü
Tez Yöneticisi: Doç. Dr. İsmail Serdar Bakal,
Ortak Tez Yöneticisi: Prof. Dr. Serhan Duran

Şubat 2022, 117 sayfa

Bu tez, işlemleri ve yaratılan verileri çok fazla olan, aynı zamanda ortak bir veri tabanında entegre, anlık ve gerçek zamanlı veri işlemesi yapan orta ve büyük ölçekli firmalarda kullanılan ERP sistemlerin, yönetim muhasebesi kavramlarını uygulama boyutlarını ve kısıtlarını belirlemeyi amaçlamaktadır. Standart ERP'lerde yönetim muhasebesinin temel amacı, fonksiyonel modüller ile entegrasyon yaparak maliyet belirleme, bütçeleme ve maliyet muhasebesi uygulamalarının otomasyonunu sağlamaktır. Bu tam bir otomasyon değildir. Bu otomasyonun boyutları ve kısıtları bu tezde gösterilmiştir. Bu kapsamda, 90'lı yıllarda geliştirilen ve 2000'li yıllarda ERP yazılımlarına entegre edilen aktivite bazlı maliyet uygulamaları çalışılmış ve daha iyi bir entegrasyon için veri tanımlamaları, işlemleri ve veri yapıları çıkarılmıştır. ERP yazılımlarının şekillendirilmesi gereken hamur gibi algılanması gerektiği, kapsamlı proje ekip çalışmaları ile firmalara uyarlandığı göz önünde bulundurulduğunda, bu tezin sonuçlarının yönetim muhasebesine entegre kurumsal ERP sistemlerin kurulmasını kolaylaştıracağı beklenmektedir. Ek olarak, yönetim muhasebesi uygulamalarını kurumsal sisteme daha iyi entegre ederek, finansal fonksiyonları arttırılmış ERP sistemlerinin oluşması hedeflenmiştir.

ACKNOWLEDGMENTS

TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF FIGURES

FIGURES

LIST OF ABBREVIATIONS

BI: Business Intelligence

TCS: Traditional Costing System

ABC: Activity Based Costing

ERP: Enterprise Resource Planning

MRP: Material Requirements Planning

MRP-II: Manufacturing Resources Planning

BOM: Bills of Materials

APS: Advanced Planning and Scheduling

CRM: Customer Relations Management

SCM: Supply Chain Management

BSC: Balanced Score Card

AIS: Accounting Information System

EOQ: Economic Order Quantity

ES: Enterprise Systems

CHAPTER 1

INTRODUCTION

Nowadays, medium to big sized companies are using (and are willing to use) Enterprise Resource Planning (ERP) systems to accomplish their business's vast operational transactions online, and use integrated real-time data to manage the operations of the functional business departments, including supply chain management, customer relations management, inventories management, finance, accounting (managerial and financial), human resources management, production planning and control, production and project management. As these companies want ERP software to operate and manage their complicated business operations better, online in real-time, the integration and level of detail that ERP software requires usually challenge the companies. Implementation and operation of such integrated software systems require expert consultancy support and programming for add-ons. Programming for add-ons is required wherever the ERP software applications and capabilities do not provide the tools necessary for company requirements.

There are commercial standard ERP software packages designed and sold worldwide. Some of these worldwide used ERP software are "SAP®"," EIS®", "Abas®", "Oracle ERP®". "Logo Tiger®", "Netsis®", "Likom Gusto®" are some of the locally developed ERP software in Turkey. Because of their complexity, these software packages are usually sold as part of an ERP Project for the target company. ERP Projects usually include the ERP software, consultancy work for implementation, and consultancy and programming work for add-ons. The "Standard ERP" phrase used in this thesis stands for a successfully implemented and operating ERP project of any business. Companies using ERP software benefit from them in different degrees. Additional software, add-on software, and

1

spreadsheet software (usually excel®) are used to support ERP software to achieve a successful "standard ERP" system for the company.

Costing, budgeting and cost-accounting are the transactional processes within ERP systems that are studied under managerial accounting in this thesis. Other concepts of managerial accounting, such as profitability analysis, performance analysis, incremental analysis, balanced scorecard are not transactional but business intelligence (BI) modules mounted on top of ERP systems.

The main purpose for managerial accounting within standard ERP systems is to automate cost accounting by integrating with functional modules. This is not complete automation. It has extents and limitations. The extent and limitations of this automation are studied and shown in this thesis. That is, we aim to discuss the extent and limitations of managerial accounting concepts within ERP systems for medium to big-sized companies, whose transactions and data generation are huge and require integrated, online, and real-time processing on a common database. As ERP software packages are regarded as mold dough to be shaped for each company, the results of this thesis are expected to help and/or improve the success of implementations of ERP systems and enterprise systems, especially for managerial accounting issues. The results of this thesis are also expected to help the development of ERP software packages that has simpler and better integrated managerial accounting functions to implement.

While managerial accounting functions for costing, budgeting, and cost-accounting are studied, their integration to financial accounting is also studied to show how to automate costing side debit and credit journal entries to the ledger for cost accounting accounts within ERP systems.

The direct labor cost of production is decreasing while overhead costs are increasing as more automated facilities are being installed. Accumulation and

allocation of overhead to products are getting more important for medium to big-sized companies that have high overheads with many products. While current ERP software packages are very capable of defining, planning, budgeting, and performing direct work using product bills of materials (BOM), routings, operations as master data definitions, master production scheduling (MPS), and material requirements planning (MRP) routines for planning and controlling production, they lack in defining, planning, budgeting and controlling indirect work of production.

Current ERP software packages are limited in their originating core modules to process overhead in product costing using Activity Based Costing (ABC) techniques. ABC techniques are mounted to current software packages by augmenting traditional costing techniques of ERP systems. It is required to have better and simpler ABC applications within ERP systems for standardizing indirect work and associating with products. A standalone approach to implement ABC, in parallel with traditional costing, within ERP systems is studied to be able to install better and simpler enterprise systems to process indirect work in product costing to overcome this limitation for the companies with high overhead amounts and many product types.

Literature is reviewed to understand the extent and limitations of integration and automation of business operations with managerial accounting within ERP systems, in Chapter 2. For this, first, the studies on the evolution of ERPs concerning accounting in parallel with the evolution and use of computers in business operations starting from the early 1960s are reviewed. We also review the studies on the ABC technique to be able to identify the current applications of ABC, for better product costing and suggest future revisions and enhancements on product costing applications within ERPs.

Integrating operational transactions to managerial accounting (and financial accounting) to automate accumulation, allocation, and consumption (expense) of costs of resources needed to run a business are explained in detail for core standard ERP modules, in Chapter 3. All the operational transactions (material receipts, purchases, production, sales, invoice creation, etc.) of any organization are processed within ERP systems as they occur. These transaction data are recorded within ERP systems to keep all the data in a common database to create required documents, printouts, reports, and information needed during the process accomplishments and afterward. If defined and processed properly, these transaction records are also used to generate costing and accounting transactions, automatically. In this thesis, operational and financial transactions and their correspondence in costing and accounting are analyzed and shown to properly define master data and transaction definitions to automate costing and accounting within ERP systems, so that manual document processing and journal creation by accountants is not needed anymore.

Revisions and enhancements on integrating and automating ABC techniques of cost accounting and their effect on the definitions and operations of the functional modules mentioned above are studied in Chapter 4. Integrating and automating standardization of indirect work and allocation of overhead within ERP systems is the main focus for enhancing future developments and improvements in standard and actual product costing within ERP systems.

Results of the study are checked with two commercial ERP software ("SAP®", "Likom Gusto®") to determine the extent and limitations as application examples, to further enhance the design and implementation capabilities of next-gen ERP systems on integrating managerial accounting to functional modules in chapters 3 and 4.

CHAPTER 2

LITERATURE REVIEW

In this chapter, we study the evolution of ERPs in relation to accounting in parallel with the evolution and use of computers in business operations starting from the early 1960s. To be able to understand the extent and limitations of managerial accounting routines within ERPs, the evolution of ERPs in relation to accounting is researched in chronological order. ABC technique for standardization of indirect work and allocation of overhead is researched in detail to identify the current applications of ABC and suggest future revisions and enhancements on ABC applications for product costing within ERPs.

The literature (related journal articles, conference articles, thesis articles, books, and readings) is classified and researched under "Evolution of ERP Systems in Relation with Accounting", "Managerial Accounting and ERP Systems", "Budgeting, Costing and Cost Accounting within ERP Systems", "ABC and ERP Systems" and "Future Directions for Managerial Accounting Routines within ERP's".

2.1. Evolution of ERP Systems in Relation with Accounting

ERP systems appeared in the late 1980s. Their evolution closely followed the spectacular developments in the field of computer hardware and software systems starting from the 1960s. During the 1960s most organizations started designing, developing, and implementing simple centralized computing systems for automation. For example, they succeeded in automating their inventory control systems using inventory control packages (IC) (Rashid et al., 2002).

In the late 1960s, the first MRP application software was developed for planning and scheduling materials for complex manufactured products by J.I. Case, a manufacturer of tractors and other construction machinery, in partnership with IBM. MRP has been the predecessor to and backbone of MRP-II and ERP (Jacobs et al., 2007).

Manufacturing Management and Account System (MMAS) is developed by IBM in 1975. MMAS is considered as a true precursor to ERP by Bill Robinson from IBM because it automated general ledger postings and job costing which are early integration efforts of managerial accounting to business processes. Manufacturing, Accounting, and Production Information and Control System (MAPICS) was suited on a new mini-computer (IBM System 34) smaller and less expensive than earlier mainframes released in 1978 (Jacobs et al., 2007).

In the early 1980s, new functions other than MRP processes are added to MRP systems. The phrase "manufacturing resource planning" started to be used to encompass all the functions of MRP systems (Jacobs et al., 2007). The phrase "Manufacturing Resource Planning" is abbreviated as MRP-II, not to mix with MRP.

In the early 1990s, the word "manufacturing" has been replaced by "enterprise" to emphasize the extent that software was integrated both across and within the various functional silos by the Gartner Group (Wylie, 1990). The new generic name for such software has been adopted as "enterprise resource planning" since then. The phrase "Enterprise Resource Planning" is abbreviated and used as ERP to name such software in short.

While MRP software packages are developed and used in the late 1960s, the first use of information systems is about accounting in the 1960s (Shields, 2001). It was the purpose of the first information systems to process accounting journals. For

example, accounting journals were created and sorted according to the chart of accounts of the general ledger in the 1960s (Rom et al., 2007). These systems were called Accounting Information Systems (AIS) in general.

Accounting systems (Financial Accounting) were first introduced to MRP systems in 1975, with MMAS software of IBM. MAPICS was released following MMAS in 1978 with extended features of integrated accounting. In the late 1980s, IBM's MAPICS hit its high water mark: Bill Robinson estimates that as many as 65% of all manufacturing installations were using the software running on IBM System 38 and AS400 computer systems (Jacobs et al., 2007).

In the 1990s, real-time accounting integrated MRP systems called ERP systems were released. These systems directly reflected accounting implications of inbound and outbound inventory movement, production from raw materials to work-in-process to finished goods inventory, plus shipping and receiving transactions to the general ledger in a near real-time manner, automatically. MAPICS software of IBM fell short on the criteria because it lacked the automatic interfaces between operational activities and the corresponding accounting transactions. Transactions were not directly reflected in the general ledger in a near real-time manner within MAPICS software. Instead, transactions were summarized and applied to the general ledger at month-end closing. By 1999 the dominance of IBM in the 1980s had slipped as J.D. Edwards, Oracle, PeopleSoft, Baan, and SAP controlled much of the ERP software market (Jacobs et al., 2007).

ERPs included accounting routines in core standard modules that are integrated with business processes. Although ERP systems are generally designed, introduced, and implemented by non-accountants, they are closely connected with the accounting processes (Chapman, 2005). As indicated by Sadagopan (2002), almost all of the managerial and financial accounting processes are included in an ERP system. These processes which are incorporated in an ERP system with

integrated modules are general ledger, accounts receivable, accounts payable, financial control, asset management, funds flow, cost centers, profit centers, profitability analysis, order and project accounting, product cost accounting, and performance analysis. Accordingly, ERP systems should have implications for all areas of managerial and financial accounting (Sutton, 2006).

During the late 1990s, ERP vendors added more modules and functions as "add-ons" to the core modules to fulfill the growing requirements of companies to process all integrated functions in one software, giving birth to the "extended ERP systems." These ERP extensions include advanced planning and scheduling (APS), e-business solutions such as customer relations management (CRM), and supply chain management (SCM) (Rashid et al., 2002). These extensions are integrated into separate core modules of ERP systems since then.

In the late 2000s, the enrichment of ERP systems with new enterprise systems (ES), such as BI systems, appears to have had a significant boost to the role of management accounting. BI systems normally sit on top of ERP systems and are intended to bridge transactional efficiency with strategic planning and managerial decision-making (Vakalfotis et al., 2011). Nowadays, ERP systems are extended to include Industry 4.0 integration tools. While all business processes by functional units are integrated using ERP systems, named as horizontal integration, production hardware (machines) are linked to ERP systems for Industry 4.0, named as vertical Integration of ERP systems. As an example of BI, an ERP system in an industry 4.0 environment is used to integrate life cycle inventory (LCI) to monitor inputs and outputs of production for a cleaner environment (Ferrari et al., 2021).

2.2. Managerial Accounting and ERP Systems

Information systems that can deliver support for management accounting are not a new idea. AISs were developed and used since the 1960s. However, research

within management accounting and information systems is repeated with the evolution of integrated information systems such as enterprise resource planning (ERP) systems.

With the introduction and widespread adoption of so-called ERP systems in the 1990s, new potential for information systems to support management accounting has emerged (Rom et al., 2007). Traditional costing methods were fully integrated into ERP systems in the 1990s. After the introduction of ABC, ABC was embedded in ERP systems in the 2000s.

Starting from the 2000s, research on the effectiveness of managerial accounting routines of ERPs within ERP implemented companies is started. For this, research surveys on ERP implemented companies are conducted and published at different times. According to a survey by Granlund et al. (2002) on 10 Finnish companies that have experience of integrated information systems in Finland at that time, the use of ERP systems had led to relatively small changes in management accounting and control procedures. Advanced management accounting techniques—and many of the traditional ones too (e.g. annual budgeting) were operated in separate systems in most of the cases. Management accountants had more time for analysis instead of routine tasks because of the integration of management accounting with business processes using ERP.

Spathis et al. (2004) surveyed 26 Greece companies using ERP. Specifically, they purport to provide answers to some questions about the impact of ERP systems on accounting processes, gathering evidence from the experiences of companies operating in Greece. The main questions were;

      1-What is the impact of ERP systems on accounting processes?

      2-Companies implementing an ERP system have, or have not, experienced changes in their accounting processes?

The real benefits of adopting ERP systems were concluded as "increased flexibility in information generation", "increased integration of accounts applications" and "improved quality of reports-financial statements". These benefits, together with the production of real-time information for decision making, clearly affected the business processes of ERP adopters.

Svobodova (2015) discussed the results of a questionnaire survey which is conducted in 2014 at the Faculty of Informatics and Management at the University of Hradec Kralove. Around 300 Czech enterprises were involved in the study. The questionnaire was focused on business intelligence tools used in managerial accounting in the interviewed enterprises. In conclusion, they could confirm two hypotheses that were set out at the beginning of the research. "Large enterprises use accounting software more in solving managerial problems. While large companies are implementing and using ERP systems more than SMEs, SMEs use MS Office Excel in 53% of surveyed companies." Due to the statistical results, they could not confirm the hypothesis that MS Office Excel is commonly used in Czech enterprises for solving managerial problems. They conclude that small companies should take inspiration from large companies and should try to benefit more from the implementation and utilization of advanced technologies. According to survey results, as data mining is one of the main components of business intelligence, it can be accomplished using specialized software, accounting software, and MS Excel, which is used in enterprises.

We will focus on the transactional routines of managerial accounting and their limitations within ERP systems in this study. By transactional routines of managerial accounting, we mean processes that are defined within ERPs that use data within ERP and whose results are also required to be used within ERPs for real-time valuations and/or calculations. These are mainly the budgeting, costing, and cost accounting routines of managerial accounting. Existing literature about the

extent and limitations of costing, budgeting, and cost accounting within standard ERP software routines is presented in the next section.

2.3. Budgeting, Costing and Cost Accounting within ERP Systems

Kaplan (1986) has examined 4 leading American companies representative of their sectors in the early 1980s for their managerial accounting system. The four companies described in this article provide good examples of the new procedures and equipment for contemporary manufacturing operations. Set-up and lead times of production operations have been reduced, personnel retrained to produce with greatly reduced defects, much WIP inventory removed entirely, suppliers trained to deliver items 100 percent in conformance with specifications and just when needed and large machinery modified and moved around to facilitate the smooth flow of products through the factory. But, the management accounting system was not responsive to these changes. This was mainly because financial accounting data was being used for managerial accounting. Costs of products being produced were not reflecting correct cost reductions by product types. As a solution, it was devised to separate managerial accounting from financial accounting and integrate it with manufacturing processes for data gathering. This integration has been done based on costing, budgeting, and cost accounting.

MRP-II systems at that time, and ERP systems afterward, provided a good background of manufacturing processes to integrate with managerial accounting for direct material and labor. This integration has been done on engineering master data (BOM, Routing) for costing and budgeting and transactional process data (work orders, production batches) for cost accounting within ERP software packages.

Indirect processes were not standardized and integrated within ERP systems until the late 1990s. Cooper and Kaplan (1998) published a paper on how Integrated Accounting Systems should handle budgeting, costing, and cost accounting together for indirect work. They defined the ABC system as the standardization of business processes and resources for costing and budgeting, operational control system as the measurement of actual performance including actual costing and accounting. They argue that enterprise resource planning systems promise to integrate (actually they mean unite not integrate) ABC system and operational control system by delivering online, real-time information. They argue that while it's true that there is great promise in integrated cost systems, there is also great peril. Some real-time cost information will be highly beneficial, but some will cause confusion and error. Integrated cost systems have the potential to deliver distorted information every single day. To avoid this, they suggested that operational-control and activity-based cost systems should be separate and partially integrated. ERP systems should handle them separately because they have fundamentally different purposes. While the ABC system (Standardization of business processes and resources) and operational control are implemented separately, budgets are used to link the two systems to measure performance, comparing standards with actuals. Operational control data is used in reverse to evaluate, update, and/or correct standards. Nowadays, ERP systems comply with this logic.

Cooper and Kaplan (1998) made no distinction between direct and indirect costs regarding budgeting within ERP systems. They argued that Activity-based budgeting demolishes standard conventional thinking about fixed and variable costs. The costs that accountants and economists have traditionally believed were most variable or flexible within short periods were resources purchased from outside suppliers: materials, services, energy, and labor paid for on an as-needed or piece-work basis. Left unaddressed by such conventional thinking is the entire organizational infrastructure of people, equipment, facilities, and information

systems. What determines the level of spending on those resources? Managers make most decisions to acquire or maintain them during the annual budgeting process. Once the decision has been made, the level of spending on those resources will of course appear to be fixed and thus unrelated to local, short-term decisions about products and customers. Activity-based budgeting gives managers much greater control over their cost structure, particularly over how to transform so-called fixed costs into variable ones. After all, what makes a cost variable isn't inherent to the resource; rather, it's a function of managers' decisions about how much to spend to supply a resource and how quickly to adjust the supply of that resource as demands for its services change. With activity-based budgeting, managers can make those supply decisions during the budgeting process (Cooper and Kaplan, 1998).

Malinic and Todorovic (2012) surveyed 9 large Serbian industrial enterprises that use leading ERP software, to determine the effects of ERP systems on management accounting processes. Their empirical results showed that ERP systems have little effect on enforcing advanced managerial accounting techniques, such as ABC, balanced scorecard (BSC), benchmarking, customer satisfaction surveys, financial key performance indicators, non-financial key performance indicators, target costing, and lifecycle costing. On the other hand, ERP systems extremely changed the way traditional techniques are handled. By integrating costing budgeting and cost accounting with business processes and automating data analysis and performance measurement using reporting tools, the role of management accountants is changed. Management accountants' role has shifted more to business analysts according to them.

2.4. ABC and ERP Systems

Kaplan (1986) made a study on 4 leading American companies for their accounting systems effectiveness in measuring costs which were expected to be decreased because of the improvements in manufacturing processes at the beginning of the 1980s. The old and traditional way of allocating overhead through direct labor hours was used and it could not measure the cost reductions expected (achieved) by the improvements in manufacturing processes. Variable direct labor and inventory were vanishing from the factory. It was more meaningful to provide detailed costs on the resources and business processes that are much more critical to manufacturing success than being able to keep track of and allocate all costs to direct labor. Existing cost accounting systems would become even more obsolete as companies invest further in computer-integrated manufacturing processes. With this technology, almost all relevant manufacturing costs would become fixed costs; in fact, they were not only fixed, but they were also largely sunk costs because the expenditures on the equipment and on the extensive software required to operate this equipment had to be incurred before production. Accounting systems (software developed in the 1960s) were being used in these companies for cost accounting. These systems were using the cost accounting logic of simple manual cost accounting techniques of the past 75 years. They were not flexible enough to use more effective cost accounting techniques, either. The early indications for the need to determine the product costs, more correctly, by using the ABC technique were documented (Kaplan, 1986).

When Accounting systems were first introduced to MRP systems at the end of the 1970s, traditional costing methods used in these accounting systems are applied in MRP software as they were. Traditional costing methods (work order costing and period costing) were using direct labor hours and/or machine hours to allocate manufacturing overhead. Direct labor and machine hours were already defined in the routings of the products for production and capacity planning within MRP

14

systems. So, it was easy to integrate product costing into MRP systems. Lahikainen et. al. (2000) state this fact as "MRP systems (and hence ERP) handle bills of material and routing efficiently. Direct product costs are calculated quickly and correctly". On the other hand, the allocation of overhead using different cost drivers (other than that resources defined in BOM and routing of products), would require additional analysis, software design, and definitions within MRP systems.

Lahikainen et al. (2000) documented a case study on the applicability of the ABC technique within ERP systems. First, standard product costing studies are implemented on a separate cost accounting system, using the ABC technique for indirect work, for a production company in Finland. Then, the standard costing data of indirect work (activities) is input to the company's ERP system by appending indirect activities to product routing data structures of ERP to find out whether the same product costs could be achieved. The exact definitions made on the ERP product routing for two indirect activities are given in Table 2.1. 'Product Design' and 'Supervise work' activities are defined as indirect operations and appended to product routings as shown in the figure.

Table 2.1. Standard Routing data of the Final Product modified for ABC in an ERP (IFS) (Lahikainen et al., 2000)

Routing: Product X				
Operation Name	**Work Center**	**Usage in Unit**	**Allocation**	**Operation Type**
Sawing	Work Center 1	1.25	Unit	Direct
Drilling	Work Center 2	0.75	Unit	Direct
Product Design*	Designer**	1.00	Batch	Indirect
Supervise work*	Foreman**	1.50	Batch	Indirect

* 'Product Design' and 'Supervise work' activities are defined as indirect operations.

** 'Designer' and 'Foreman' resources are defined as single resources defined within indirect work centers 'Designer' and 'Foreman'.

Lahikainen et al. (2000) conclude that even correct product costs are achieved using these structures, an integrated complete software module is required to define indirect work and allocate overhead to products, within ERP systems. With the wide adoption of ABC in the 1990s, ERP software companies started studies to integrate the ABC technique into their software. Lahikainen et al. (2000) state that "In 1998 SAP AG invested in ABC Technologies company and strengthened its know-how in ABC to integrate ABC to its core ERP".

In the coming years, SAP provided software tools to integrate ABC techniques to their core costing, budgeting, and cost accounting routines. Their software solutions for the ABC technique are materialized on two sources. First, activities are defined on cost centers using resources of associated work centers. Second, more general activity definitions (independent of cost centers) are made using cross resources of all work centers of all cost centers. These general activity definitions are named business processes (activities with cross resources) within SAP (SAP SE 2021).

Aytaç and Eker (2017) state the ABC technique as one of the advanced managerial accounting techniques that could be successfully implemented within ERP systems by using the data these systems provide. Online, real-time master, and transactional, data about all functions of a company are supplied ready within ERP systems to be used in ABC technique as activity and resource driver's data.

Pazarceviren and Ozsuer (2015) published an article on a model suggestion for ABC within ERP systems. They have successfully implemented their ABC model for different companies within the local ERP software designed by Selim Yuksel Pazarceviren. They presented their ABC model on flow charts and ABC definitions and results on example reports. ABC master data integration definitions for accounting to automate accounting within the ERP system are not studied in the

16

article. Where us, they applied ABC to calculate both manufacturing cost and commercial cost of products. They conclude that increasing overall overhead costs of companies, because of automation in production, are better handled using ABC.

2.5. Future Directions for Managerial Accounting Routines within ERP's

Cooper and Kaplan (1998) described how information technology in the form of enterprise systems promises to increase the relevance and contribution of managerial accounting. They also point out the danger of using online, real-time data of ERP systems that may combine strategic costing with operational control. They state that budgets should be used to link strategic costing (standard costing with ABC for indirect costs) and operational control to evaluate the performances by comparing actuals with standards. Transactional managerial accounting routines pursued this logic for future developments within ERP systems.

Kitsantas et al. (2020) made a literature review on the benefits of integrating ABC techniques within ERP systems. They conclude that enterprise systems can significantly increase the availability and reliability of activity cost drivers which help improve the ABC system using online, real-time data of all business functions under a common database.

Malinic and Todorovic (2012) survey results show that new information technology causes changes in the system of managerial accounting by the emergence and implementation of ERP systems. ERPs will continue to integrate managerial accounting routines with business processes to automate managerial accounting transactions to a higher degree. BI tools mounted on top of ERP systems will produce more relevant information using reporting tools. As a result, accountants' roles will also continue to change more like business analysts.

2.6. Contribution to Literature

The literature review has shown that ERP systems are based on MRP and MRP-II systems developed and used in the 1960s and 1970s. These systems evolved in the late 1980s by integrating (and automating) accounting and transactional routines of managerial accounting (mainly budgeting, costing, and cost accounting) to MRP and MRP-II systems.

The literature review has also shown that ERP systems are adopted as business operating systems by mostly medium to big companies. Results of surveys on the success and adoption of managerial accounting routines within ERP systems are documented in the articles regularly, starting from the 2000s.

There is little literature about how accounting and transactional routines of managerial accounting are integrated into MRP, MRP-II, and ERP systems. The literature is mostly about guidelines for correct approaches to integrate accounting and transactional routines of managerial accounting for computerized accounting systems. In this thesis, integrating accounting and transactional routines of managerial accounting to business operations within ERP systems are documented in detail to contribute to existing literature. Besides using the literature, some commercial ERP software packages are also checked for their applications of integration. Experience in working as a leading consultant in many MRP-II and ERP development and implementation projects for about 30 years, is also reflected.

The applications of ABC within ERP systems exist. But its implementation to have successful cost accounting systems within enterprise systems is rare. This is because ABC systems are not integrated with core modules initially during core module designs. Instead, they are mounted (integrated) to ERP systems after core

module designs. Secondly, companies are reluctant in using ABC systems because of their complexity compared with TCS. Third, it requires expert consultancy to integrate into business processes. To help all this, standardization and integration of indirect work are studied in detail for automating costing, budgeting, and cost accounting using the ABC system within ERP systems.

Nowadays, ERP software also includes low-code and/or no-code development environment modules to integrate add-on modules to the enterprise systems, easily. Even so, it is necessary to include the ABC technique as a common core submodule of cost accounting, as most organizations will benefit from the ABC technique to improve overhead allocation in their product costing routines.

CHAPTER 3

INTEGRATING FUNCTIONAL MODULES TO MANAGERIAL ACCOUNTING WITHIN ERP SYSTEMS

ERP systems included accounting processes in core standard modules a long time ago in the 1990s. These accounting modules are incorporated in ERP systems as general ledger, accounts receivable, accounts payable, financial control, asset management, funds flow, cost centers, profit centers, profitability analysis, order and project accounting, product cost accounting, budgeting, and performance analysis. ERP systems included these financial modules together with integration to operational modules. Proper integration of financial modules with operational modules led to automation in most financial processes which is the main benefit of using ERP systems in financial processes.

Integrating operational transactions to managerial accounting to automate accumulation, allocation, and consumption (expense) of costs of resources needed to run a business as they occur are studied in detail to show the extent of this integration by core ERP modules. The core ERP modules discussed are Logistics, Human Resources, Fixed Assets, Production Planning and Control. Master data definitions and transactions are explained for each module to show the integration between the modules and managerial accounting for costing, budgeting, and cost accounting. Integration to financial accounting is also studied to automate costing side journal entries to the ledger for cost accounting.

In accounting terms, proper integration definitions within ERP systems that have these (explained in this chapter) capabilities ensure automatic generation of costing side (debit or credit) entries of journals posting to the general ledger after recording business transactions. Examples for such business transactions are;

- ✓ Material receives to warehouses from purchasing. Generating managerial accounting transactions are calculating unit costs and debiting defined warehouse accounts,

- ✓ Material issues from warehouses to production. Generating managerial accounting transactions are crediting defined warehouse accounts using calculated unit costs and quantities,

- ✓ Labor time spent and materials used for products production. Generating managerial accounting transactions are debiting defined WIP accounts using calculated costs of materials and labor.

- ✓ Services purchased and consumed (expensed) in production. Generating managerial accounting transactions are debiting defined production expense accounts using purchase invoice cost records.

For ERP functional modules, we first introduce their purpose and operations. Then, managerial accounting activities, extent, and limitations involved in the module operations are explained in the 'Master Data Definitions', 'Transactions' and 'ERP Database Data Model' sections. Proposed revisions and enhancements are also stated and explained within these sections to keep concepts and processes compact and complete.

Results of the study are checked with two commercial ERP software (one local and one worldwide leading) to determine the extent and limitations as application examples, to further enhance the design and implementation capabilities of next-gen ERP systems on integrating managerial accounting to functional modules.

3.1. Logistics

Logistics modules of ERP systems are used in defining, planning, supplying (purchasing, producing, and outsourcing), stocking, moving, and selling all types of

materials and services in an organization. Managerial accounting activities involved in the Logistics transactions are studied in detail to integrate the logistics module into managerial accounting. Proper integration of logistics transactions to managerial accounting automates accumulation, allocation, and consumption (expense) of costs of materials and services needed to run a business as they occur.

In accounting terms, proper integration definitions within Logistics modules of ERP systems ensure automatic generation of costing (debit or credit) or expense side entries of journals posted to the general ledger from logistics transactions, after recording logistics transactions. For example, materials receives to a warehouse from purchasing cause (trigger) automatic calculation of unit inventory costs and debiting of defined warehouse inventory accounts using receipt costs and quantities. Materials issues from warehouse to production cause automatic crediting of defined warehouse inventory account using calculated inventory unit cost and issue quantity.

Logistics definitions and transactions of materials are discussed in Section 3.1.1. Service definitions and transactions are presented in Section 3.1.2. Within these sections, enhanced database data models of key concepts about the accumulation, allocation, and expense of costs of materials and services and their integration definitions to financial accounting are also explained. Enhanced data models are given to ensure database data relations are required for integration.

3.1.1. Materials and Inventories Management

In cost accounting, logistics materials are classified as raw materials, materials, semi-finished products, products, and merchandise for cost calculations and ledger account definitions. In this section "materials" word is used to stand for logistics materials.

ERP systems provide means to automate unit cost calculations of materials for inventory valuation and generate journal entries in financial accounting for debiting and crediting general ledger accounts by using the transactions made within Logistics. This is achieved by integrating materials and inventories to cost accounting and financial accounting using related master data integration definitions within ERP systems during installation. Flexible integration definitions that are supplied by some ERP systems help this automation to be more effective and easier during installation.

In this section, we first explain master data integration definitions. Then, resulting automated cost accounting transactions are explained. Finally, database data models of managerial accounting data are discussed.

Master Data Definitions

Master data types defined and used in materials and inventories management for integrating and automating (as a result of integration) material inventory costing and accounting are Materials, Warehouses, Inventory ledger, and sub-ledger accounts, Material cost classification types, Warehouse cost classification types.

Materials and warehouses are defined in logistics modules. Ledger and sub-ledger accounts are defined in financial accounting. Material cost classification codes and warehouse cost classification codes are defined for module interfaces to integrate materials and warehouses (material costs) with associated ledger and sub-ledger accounts for automating cost accounting. These master data integration definitions are explained in this section for proper integration of materials and inventories management to cost accounting.

From a logistics viewpoint, a material is any stocking good that has its physical distinguishing characteristics. Materials are defined, coded, and classified according to materials' physical characteristics for logistics operations within ERP systems. On the other hand, materials are classified as raw material, material, semi-finished product, product, or merchandise in cost accounting (these classifications are a must in financial accounting and are defined in highest level ledger accounts for inventory cost classifications). Lower level (sub-ledger) classifications also may not be the same as the material classifications made in Logistics.

From a cost accounting viewpoint within ERP systems, any material within a defined raw materials warehouse is taken as raw material. The same material within a defined merchandise warehouse is taken as merchandise. Or, the same material within the finished goods warehouse is regarded as a product. In other words, the same material can be purchased to be used in production, purchased for selling, or produced for selling at the same time. So, material definitions, coding, and classification codes should never include raw material, WIP, and/or manufactured product classification codes used in ledgers for accounting. Instead, warehouses should be classified according to these classifications and warehouse classes should be used together with material types for integration to cost accounting. Otherwise, potential duplications in the definitions and coding of the same material will arise in Logistics.

While it is necessary to classify warehouses according to inventory ledger accounts at the highest level such as raw materials, WIP, finished goods, and merchandise inventories, it is also necessary to consider business requirements to further classify warehouses cost-wise. For example, the same material at different locations of a country or region will not cost the same for a company's operating plants or warehouses at different locations of a country or region. Different locations of a country or region will supply materials at different cost rates. Even purchasing cost

is the same, transportation, insurance, and customs costs will differ unit cost of the same material for selling at different locations of a country.

ERP systems include interfaces between the logistics module and financial accounting to handle the classification differences in linking materials and warehouses to associated ledger accounts to automate cost accounting transactions. The most flexible way to integrate materials and inventories to cost accounting is to define material cost classification codes and warehouse cost classification codes as interface master data definitions and use these codes to classify materials and warehouses cost-wise. This integration also requires unit cost calculation of materials by warehouse cost classification codes for correct inventory accounts quantity and cost balances.

Materials may be tracked by lots in inventories. Material Lots are mainly defined for materials to identify/distinguish purchasing and/or production batches of material within inventories to be able to trace the materials by batches throughout the life cycle for lot traceability of materials in quality management. Lots are created automatically for "lot trace required" materials during the first inventory entry from purchasing or production within ERP systems. Inventories are required to be handled with lot codes together with material codes for all lot trace materials. So, the transaction processing burden will be multiplied by the number of lots of each material for inventory transactions. Material Lots are sometimes defined also for lot costing in inventories to accumulate costs by each lot (for not mixing costs of each purchase or production) of the same material within ERP systems. Keeping unit costs by lot (batch) within inventories is useful for tracing and calculating the actual profitability of make-to-order production. Tracing the cost of purchased material inventories to suppliers is also possible by keeping costs and quantities by batch within inventories. Material lot code IDs are used together with material code IDs to calculate and keep unit costs by batches within ERPs for cost accounting.

Material lot code IDs are not used (and not needed) in integrating Logistics to financial accounting. However, some ERP systems have this capability as well.

Receiving transaction types are also used in integration definitions together with material cost codes and warehouse cost codes to further classify inventory materials in accounting according to the transaction type. For example, local purchases and imports of the same material are recorded with different transaction types (imports receipts and local receipts), so that their automatic accounting is directed to the correct accounts through transaction type. This requires unit cost calculation by transaction types and issues of materials have to be done separately from inventories for each transaction type. It is not practical, usually not possible, to distinguish inventory of the same material by receiving transaction type during issuing. So, transaction types should not be used in integration definitions for automating inventory cost accounting, even some ERP systems let integration by transaction types in addition to material and warehouse cost codes.

Figure 3.1 shows the general hierarchical relationship of material inventories to ledger inventory accounts on which master data definitions for integration are also shown. Warehouse cost classification codes should include Raw materials and materials, Spare parts, Work in Process, Finished Goods, and Merchandise as ledger inventory accounts, at minimum. Material cost classification codes are defined according to accounting requirements of companies by referencing the sub-ledger inventory accounts defined under ledger inventory accounts.

In the Figure, 'Enterprise' is used to stand for the ERP system of any organization. Enterprises usually have more than one legal unit (hence more than one ledger). The warehouse costing hierarchy is valid for each legal unit of any organization. Warehouse costing hierarchy levels are classified and coded as 'Warehouse cost codes' and 'Material cost codes' on the right side of Figure 3.1. Ledger and sub-

ledger hierarchy levels are given on the left side of Figure 3.1 to show the correspondence for integration within the hierarchy.
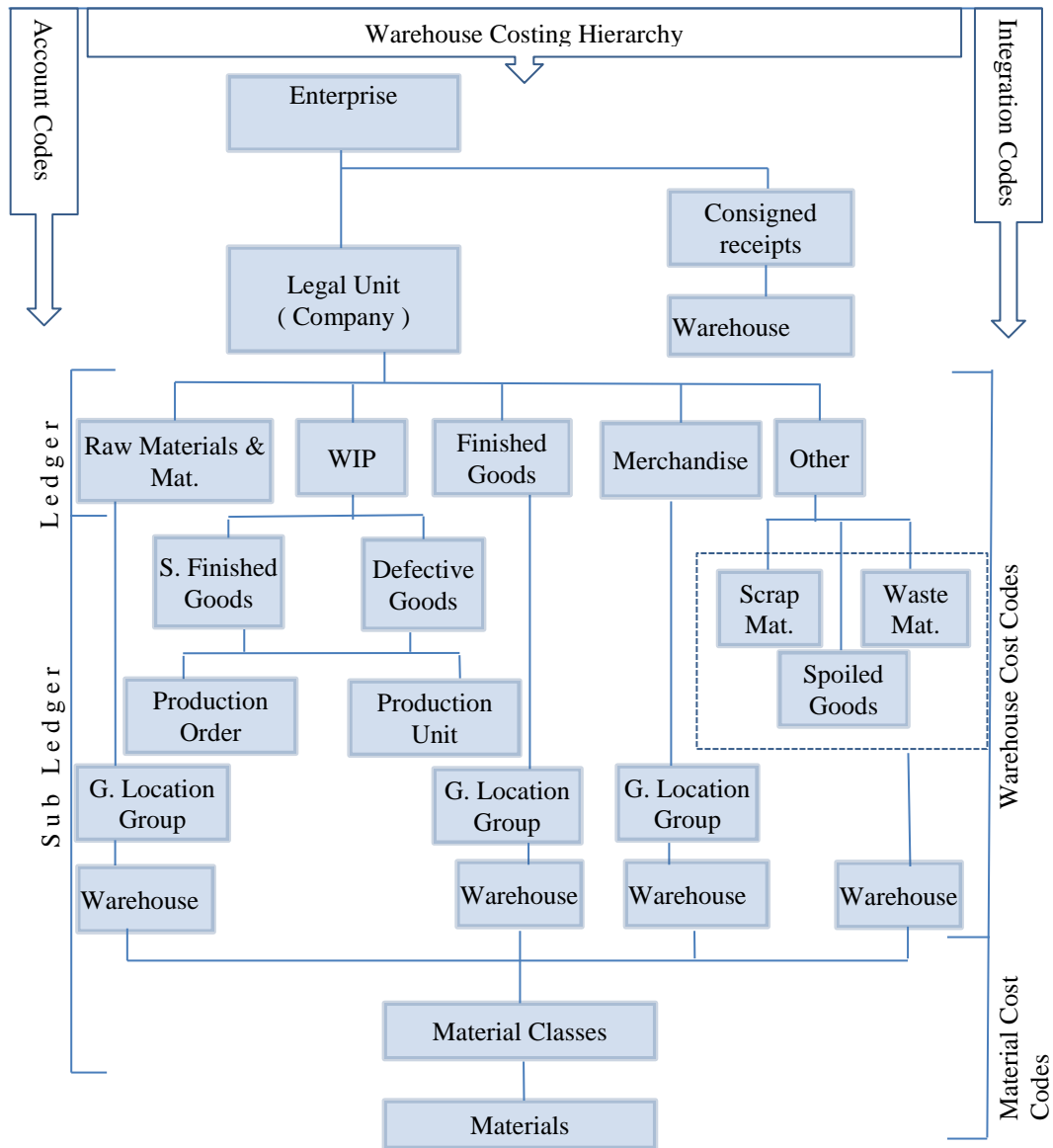
Figure 3.1. The hierarchical relationship of inventories master data to ledger inventory accounts for integration

A manufacturing company processing metal sheets is used to show the requirement for 'Material cost classification code' and 'Warehouse cost classification code' definitions. The company purchases both flat sheet metal and flat roll metal as raw materials to be processed in production. If the flat metal is purchased in rolls, it is cut in with the required dimensions. Flat sheet metals purchased and the same flat sheet metals cut from rolls are stored together to be used in production. It is enough to define one warehouse with locations to keep a record of flat sheet metal stock, businesswise.

It is required to separate stocks of flat sheet metals purchased and stocks of flat sheet metals cut from rolls because cost-wise one is raw material inventory and the other is WIP inventory. To automate this process for all such cases in costing transactions within ERP systems, we need to define 2 warehouse cost classification codes (one for purchased material and one for produced same material) and link with associated logistics warehouse locations. It is also needed to classify the materials by type using material cost classification codes according to sub-ledger accounts defined for raw materials and WIP, which are linked to material types.

Table 3.1 is presented as an example for the master data integration definitions of a company for logistics material transactions. All mentioned material's 'receipts to' and 'issues from' the warehouses' transactions are accounted for automatically using unit costs and accounts defined in the master data definitions for the materials.

Table 3.1. Integration definitions for material inventories costs between ERP logistics and accounting modules of a Turkish manufacturing company.

Logistics Module – Materials And Inventories Management			
Material Cost Codes:			
Code	*Name*		
001	Flat metal rolls		
002	Flat metal sheets		
…			
Warehouse Cost Codes:			
Code	*Name*		
001	Raw materials		
002	Processed materials		
…			
Materials:			
Code	*Name*	*Unit*	*Material Cost Code*
00001	1500x0.2 mm flat metal roll	ton	001
00002	1500x0.3 mm flat metal roll	ton	001
…			
01000	1500x1500x0.2t mm flat metal sheet	each	002
01001	1500x1600x0.2t mm flat metal sheet	each	002
…			
Warehouse Locations:			
Code	*Name*	*Warehouse Cost Code*	
01.001	Center Warehouse 1 Location 1	001	
01.001	Center Warehouse 1 Location 2	002	
002	Region 1 Warehouse 1	001	
…		…	
Accounting Module			
Inv. Ledger and Sub-ledger Accounts:			
Account Code	*Account Name*	*Account type*	
150	Raw materials and materials	Inventory	Ledger
150.001	Flat metal rolls	Inventory	Sub-ledger
150.002	Flat metal sheets purchased	Inventory	Sub-ledger
151	Semi-finished products in production	Inventory	Ledger
151.100	Flat metal sheets produced	Inventory	Sub-ledger
…			
Integration Definitions			
Material Cost Code	*Warehouse Cost Code*	*Account Code*	
001	001	150.001	
002	001	150.001	
002	002	151.100	
…			

The interface between logistics and managerial accounting is established by assigning associated financial accounts to each pair of 'Warehouse cost classification code' and 'Material cost classification code' during master data definitions as shown in Table 2.1. Inventory transactions are automated for costing side journal entries within ERP systems using these integration tools. Examined ERP systems do this integration in different ways which are complex and do not cover all integration cases properly. One way is to use material classes defined in logistics together with warehouse cost classification codes. This requires the same material classification in financial accounts as in logistics, which is not the case always. Another way is to activate warehouse management together with segmentation, whose integration definitions are complex and inflexible.

ERP systems that have these integration capabilities will ensure automatic unit cost calculations, automatic account determination, and correct quantity and cost balance of inventory accounts associated with warehouses. These integration definitions provide correct costing amounts and associated accounts to create automatic costing side (debit or credit) journal entries to general ledger (financial accounting) from logistics transactions.

Inventory Costing Transactions

Material inventory receipt and issue transactions are defined within logistics of ERP systems to record material receipts and issues from inventories. These records are also used to keep inventory transaction cost data in most detail (besides associated invoice and production order and/or batch cost data) within ERP systems. A material's actual unit cost of Inventory is calculated and recorded for each cost type (LIFO, FIFO, average, moving average, and weighted moving average) and warehouse cost classification code. One of the unit cost types is selected for the fiscal year to use in inventory costing transactions and cost accounting, which is set by a parameter within ERP systems for each fiscal year.

31

Inventory Unit cost types that can be selected for the fiscal year are 'Period Average Unit Cost', 'FIFO Unit Cost', 'LIFO Unit Cost', and 'Weighted Moving Average Unit Cost'. 'Period Average Unit Cost' requires all issuing transactions to be costed at the end of each period when the unit cost is calculated for the period. This costing type is not suitable for online, real-time costing transactions within ERP systems. 'Weighted Moving Average Unit Cost' is the most suitable, and usually selected for financially costing online real-time inventory transactions, and inventory valuation validation within ERP systems.

All material inventory issue transactions are costed using the selected unit cost type of the issuing warehouse cost classification code. Inventory material transfers between locations are costed only if issuing and receiving inventory location's warehouse cost classification codes are different.

Finally, Costed inventory transactions, warehouse cost classification codes, and material cost classification codes (defined and explained in the master data definitions section) are used together to determine the inventory amounts and accounts to be debited and credited in generating costing side postings of journals for financial accounting.

Inventory material receipt transactions cause material inventory quantities and values to increase. Inventory unit costs of materials are calculated (updated) after material receipts to inventories. Material receipt notes are used to record material receipts. Basic material receipt note types (screens) within ERP systems concerning cost accounting are;
- Receipt notes from purchasing; Purchase invoices are used to determine purchasing costs in calculating inventory actual unit costs of materials received to inventories from purchasing.
- Receipt notes from production; Production costs are used to determine actual unit costs of semi-finished and finished products in calculating

inventory unit costs of in-house produced materials received to inventories from production. The costing of production is explained in detail in the 'Production Control' section.

- Receipt notes of transfers between inventories; Unit costs of issuing inventory are used to determine transfer costs in calculating inventory actual unit costs of materials received to inventories from issuing inventories if warehouse cost classification costs are different.

- Receipt notes of sales returns; Unit costs used in "cost of goods sold" of associated sales invoices are used to determine sales returns costs of returned materials to inventories from sales.

Inventory material issue transactions cause material inventory quantities and values to decrease. Unit costs of materials calculated from receipts are used to determine inventory values issued. Basic material issue note types (screens) within ERP systems concerning cost accounting are;

- Issue notes to sales

- Issue notes to production (Work orders, Batches, Departments, and Activities)

- Issue notes of transfers between Inventories; Issuing inventory's current unit cost at the transfer date is used to credit the issuing inventory with transfer quantity if warehouse cost classification costs of issuing and receiving inventories are different.

- Issue notes for returns to suppliers (purchasing); The same unit purchase price of materials billed (associated with the receipt note) by the supplier during purchasing is used to price returned materials for billing. The current unit cost of returning materials at the return date is used to credit inventory with return quantity. The difference between return price and current material cost at return date is used to calculate value differences from material returns. This difference should be credited or debited to purchase

returns profit or loss account defined for purchase returns at master data accounting integration definitions during installation within ERP systems.

As a result, Inventory cost calculation methods used in ERP systems provide the requirements for financial accounting, as well as ensure the basic inventory valuation rule, which is that issues should consume inventory value in direct linear proportion to quantity consumption. Total quantity and value consumed by issues have to be equal to total quantity and value accumulated by receipts so that inventory balance drops to zero both by quantity and cost in warehouses and associated financial inventory accounts.

On the other hand, delaying transactions or instant operator errors cause wrong real-time inventory valuation within ERP systems. Correcting wrong historic data/information when realized is not also an easy task within ERP systems. Usually, correcting virtual new receipts and issue transactions are entered to correct unit costs and quantities, when the inconvenience is realized. Receipt and issue transactions remain and accumulate with wrong data within ERP systems which may cause misunderstanding at time spans when analyzed.

If the wrong date, quantity, or unit cost data of historic receipt note transactions data are corrected on the transactions data when realized, it causes all inventory unit cost and quantity records to be recalculated for all new receipt transactions (weighted moving average unit cost type is assumed to be used). All new issue notes are also re-costed according to new unit cost with corresponding correct date sequence. As a result, correcting wrong data on transactions with old dates requires too much systems processing and locks ERP systems, at times. So, ERP systems have 'correction date allowed' flags to restrict too old corrections.

ERP Database Data Model of Inventory Transactions and Material Costs

Database data structures needed within ERP systems for installing and integrating Logistics to cost accounting are introduced in Figure 3.2 to show logistics module materials and inventories management data designs and installations of ERP systems concerning cost accounting. This relational data model is proposed to be used to record the transactions and inventory costs described in the materials and Inventories Management section within ERP systems. Database Table and field names are regenerated to be self-explanatory to show the integration data relationships on database data table and field level. Underlined fields are foreign key fields that show the relations among costs, transactions, and master data definitions.

InventoryReceiptNoteLines table:

ReceiptNoteLineRecord_Id, ReceiptNote_id, Transactiontype_id, Material_id, MaterialLot_id, Warh_Id, Warhcostcode_id, ReceiptDate, Quantity, Unitcost, TotalCost, AddedCost, ReceivedTotalCost, Invoice_id, Unitprice

InventoryIssueNoteLines table:

IssueNoteLineRecord_Id, IssueNote_id, Material_id, MaterialLot_id, Transactiontype_id, Warh_Id, Warhcostcode_id, IssueDate, Quantity, InventoryUnitcost, TotalCost, Invoice_id, UnitPrice, AccountedUnitCost

InventoryCost table:

InventoryCostRecord_id, Material_id, MaterialLot_id, Warhcostcode_id, CurrentOnHandQuantity, CurrentUnitCost

InventoryperiodAverageCost table:

InventoryCostRecord_id, Material_id, MaterialLot_id, Warhcostcode_id, FiscalPeriod_id, Period_id, PeriodEndOnHandQuantity, PeriodEndUnitCost

InventoryMovingAverageCost table:

InventoryCostRecord_id, Material_id, MaterialLot_id, Warhcostcode_id, ReceiptNoteLineRecord_Id, WeightedmovingAverageCost

InventoryFifoCost table:

InventoryCostRecord_id, Material_id, MaterialLot_id, Warhcostcode_id, ReceiptNoteLineRecord_Id, ReceiptDate, ReceiptSequence, Quantity, ConsumedQuantity, RemainingQuantity, FifoUnitCost

InventoryLifoCost table:

InventoryCostRecord_id, Material_id, MaterialLot_id, Warhcostcode_id, ReceiptNoteLineRecord_Id, ReceiptDate, ReceiptSequence, Quantity, ConsumedQuantity, RemainingQuantity, FifoUnitCost

Note : Underlined fields denote foreign keys.

Figure 3.2. ERP database data model of inventory transactions and material costs

The data model for integration definition of Logistics warehouses to the related ledger and sub-ledger accounts of financial accounting is given in Figure 3.3 to show the integration data relations on the database data table and field level.

InventoryLedgerAccounts table:

InventoryLedgerAccounts_Id, Materialcostcode_id, Warhcostcode_id, LedgerAccount_id

Note : Receipt note transaction types use this account for debiting inventories. Issue note transaction types use this account for crediting inventories.

Figure 3.3. The data model for integration definition of warehouses to related ledger and sub-ledger account

Inventory receipt and Issue transaction records are separated (recorded in two different tables) in the data model as an enhancement for current ERP data models. Basic material receipt and issue transaction records are usually kept within one table within standard ERP systems by using a field (for example, field value 0 for receipt, 1 for the issue) on record level to separate receipt and issue transactions. It is known that for companies having too many Inventory transactions, this table grows very rapidly, causing performance problems, especially during online, real-time transaction recording by the users. Another reason to separate receipts and issue transaction records in two different tables is the different processing of the costs for receipts and issues. Cost in receipts is used to calculate unit inventory cost, whereas calculated unit cost is used in issues. Cost values in receipts are raw

data, but the costs in issues are generated (and can be regenerated). The level of importance for receipts cost data is higher in this sense.

3.1.2. Services Management

Services are non-stock able products that are purchased, produced, sold, and serviced in a business. Cargo and passenger transportation (railways, airlines, seaways, land), health care services (hospitals) are examples of industrial-scale service sectors that use ERP systems in their business operations.

Cargo load types in defined units, passenger ticket types, health care service types with defined treatments, and consultancy service types for management are examples of service types purchased, produced, and sold. They are predefined and identified with service type codes within ERP systems.

Purchase, production, and sale of service products are similar to that of material transactions explained in Section 3.1.1. Service product transactions are processed without warehouses. Instead of warehouses, expense types and cost centers are used to accumulate purchasing costs, and income types and profit centers are used to accumulate revenue from service products within ERP systems.

Service receipts from purchasing and service issues (sales) to customers are recorded using the same receipt and issue note transaction types as materials. Service type codes (instead of material type codes) are used to identify service products and service lines within the notes (and associated invoices). Sometimes, both service products and materials share the same notes transaction with some lines of materials and some lines of service products within the same notes transaction. Such transactions are recorded with material lines having warehouse

information and service lines having cost (profit) center and expense (revenue) type information as must within ERP systems.

In this section, we first explain master data definitions for services costing and accounting. Then, resulting automated services costing transactions are explained. Finally, database data models of service transactions and service costs are discussed.

Freight, insurance, customs service expenses, and outsourcing services are examples of some special service types whose costs are directly allocated to inventories or production after service receipt (purchase). They require some special treatment in cost accounting which is also explained in the services costing transactions section.

Internal services (Business processes) defined for indirect work of production are not subject to this section. Internal services are studied in the 'Production Control' and 'ABC capabilities of ERP systems' sections. They are used in cost accounting for standardizing indirect work and accumulating periodic production overhead costs for ABC.

Master Data Definitions for Services Costing and Accounting

Master data types defined and used in services management for integrating and automating (as a result of integration) service costing and accounting are Service types, Cost centers, Business Processes, Service expense types, Service expense accounts.

Service type codes are defined in Logistics within ERP systems (purchasing and sales modules) for service types purchased and sold. These codes are used in transaction lines to identify service lines and service types. Some examples for

purchasing service types are the types of outsourcing production machines maintenance expenses, types of outsourcing production facilities maintenance expenses, types of outsourcing production consulting expenses, types of non-stocking item expenses (electricity, water, etc.) used to support production, types of insurance purchases, material transportation expense types, etc. Some examples for sales service types are types of consulting sales (such as junior ERP consulting sales and senior ERP consulting sales for an ERP software company), types of maintenance sales given to demanding companies, types of insurance sales, types of passenger transportation, types of freight transportation, etc.

Cost centers and Expense types are defined and used to integrate the purchasing service costs (some of which are mentioned above) to cost accounting. For each combination of Cost center and Expense type, the associated ledger service expense account in financial accounting is predefined during the installation of ERP systems as integration definitions.

Cost of Service sales is usually debited to 'cost of goods sold' accounts by crediting WIP (WIP service order or cost center accounts depending on production costing method) manually within ERP systems.

Table 3.2 is presented as an example for the master data integration definitions between the ledger service expense accounts and cost centers of a company for direct 'Electricity usage' expense of a cost center. The cost center code is entered in the receipt note lines of logistics service transactions to accumulate direct service costs in the cost centers. Cost center codes and expense type codes are used together in automating the accounting of the logistics service transactions for selecting correct ledger accounts to debit using the master data integration definitions within ERP systems.

40

Table 3.2. Integration definitions for service costs between ERP logistics and accounting module of a Turkish manufacturing company

Logistics Module – Services Management			
Expense Types:			
Code	*Name*		
001	Electricity		
…			
Cost Centers:			
Code	*Name*		
0001	Production Hall 1		
…			
Services:			
Code	*Name*	*Unit*	*Expense Type*
00001	Electricity usage	kws	001
00002	Freight Service	unit	Stock
…			
Accounting Module			
Ledger and sub-ledger accounts:			
Account Code	*Account Name*	*Account Type*	
730	Production expenses	expense	ledger
730.001	Production Hall 1	expense	Sub-ledger
730.001.050	Production Hall 1 Electricity expense	expense	Sub-ledger
…	…		
Integration			
Cost Center	*Expense Type*	*Sub-ledger Account*	
0001	001	730.001.050	
…			

Services Costing Transactions

In purchasing, while costs of materials are debited to Inventories, costs of services are either distributed and debited to overhead expense accounts or allocated to inventories (material receipt note lines) or production (work orders) after service receipt note transactions are recorded.

Overhead accounts associated with service expenses are usually classified as service expenses by Cost centers. Together with other accumulated overhead costs

for the period, these costs are allocated to the period's production using the selected criteria in traditional costing, explained in section 3.4. ABC technique for overhead allocation is further studied in chapter 4.

Service receipt transactions integration to cost accounting is not automatic for service costs. Associated Cost center codes and expense type codes are entered manually to service transaction lines for the costs to be accumulated in Cost Center- Expense type code records. Service costs accumulated in Cost Center-Expense type code records are transferred to ledger expense accounts (for journal expense accounts and debit amounts side) automatically using the integration definitions, afterward.

In logistics, some add-on services for material movements (purchases from suppliers, transfers between locations, and warehouses), are purchased like customs, freight, and Insurance expenses. These are service purchases from different organizations besides material purchases from suppliers. These material movement service costs should be allocated (distributed and added) to accompanying material unit costs to determine the actual unit cost of materials to be used in inventory unit cost calculation from receipt notes, instead of recording these service costs as material expenses of material movements. ERP systems should have the following application tools to handle these allocation operations easily within ERP systems;

- Service invoices are linked to accompanying receipt notes,
- Service invoice amounts are distributed to the receipt note lines according to material quantities, volumes, or moving material cost amounts,
- Added unit cost is calculated by dividing receipt note lines added amounts by receipt note line material quantities.
- Actual unit cost used in inventory unit cost calculation from receipt notes is determined by adding issuing unit cost (purchase unit cost, inventory unit cost) and added unit cost.

- Service invoice amounts that are linked to accompanying receipt notes are debited to the inventory accounts of related materials and warehouses, instead of debiting as standalone service invoices of material expenses for financial accounting.

Outsourcing production is the process of outsourcing some production processes by sending owned materials to an outsourced company, in cost accounting. It causes consigned material movement transactions between companies. Cost-wise, the ownership of materials does not change. After the materials are processed in the outsourced company, they are returned to the outsourcing company for further production processing. The outsourced production processes are defined as service type codes to be used in service bills to identify outsourced production processes billed. These service type codes are also linked to associated outsourcing production operations to debit outsourcing service expenses to associated work orders. ERP systems should have the following application tools to handle outsourcing operations easily within ERP systems;

- Service type codes are defined to identify different outsourcing production operations for service billing,
- Outsourcing production operations are defined within routings and linked to related service type codes for cost assignment to associated production processes,
- Consigned issue note transactions are used to record the materials sent for outsourcing operations. Issuing and shipping documents are produced using these issue note records,
- Consigned receipt note transactions are used to record the materials returned from outsourcing operations,
- Outsourcing service bills are recorded with associated service type codes and linked to associated production routing operation for the outsourcing expense amount to be debited to the operation in WIP.

In sales, service type codes are defined to identify service products within ERP systems. Airline passenger transportation types between two terminals as tickets, railway freight types between two nodes as rail freight types, consulting services of a consulting company as consulting service types, the progress of a construction project as milestones are all examples of service types that are defined as service type codes to be used in associated business transactions to identify different service products processed.

Service type codes are used in issue note transaction lines to identify service products produced and sold. Issue note transaction lines are linked to sales invoices to record the revenue by service products.

Cost-wise, issue note transaction lines are linked to associated WIP service orders or Cost centers (depending on production costing method) manually to get the costs by service type codes. Using these records, cost of service sales is debited to 'cost of goods sold' accounts by crediting linked service orders or the cost center's WIP account within ERP systems.

ERP Database Data Model of Service Transactions and Service Costs

ERP database data model of service receipt and issue transactions and costs are given in Figure 3.4 to show the relationships on database data field level.

ServiceReceiptNoteLines table:

ServiceReceiptNoteLineRecord_Id, ReceiptNote_id, Transactiontype_id, Servicetypecode_id, ReceiptDate, Quantity, Unitcost, ReceivedTotalCost, DistributedCost, AllocatedCost, Invoice_id, Unitprice

ServiceReceiptNoteLinesCostDistribution table:

ServiceReceiptNoteLinesCostDistributionRecord_id, ServiceReceiptNoteLineRecord_Id, Costcentercode_id, Expensetypecode_id, DistributedCost

ServiceReceiptNoteLinesCostAllocation table:

ServiceReceiptNoteLinesCostAllocationRecord_id, ServiceReceiptNoteLineRecord_Id, ReceiptNoteLineRecord_Id, AllocatedCost

ServiceIssueNoteLines table:

ServiceIssueNoteLineRecord_Id, IssueNote_id, Transactiontype_id, Servicetypecode_id, Costcentercode_id, IssueDate, Quantity, Unitcost, TotalCollectedCost, Invoice_id, Unitprice

ServiceIssueNoteLinesCostCollection table:

ServiceIssueNoteLinesCostCollectionRecord_id, ServiceIssueNoteLineRecord_Id, CostingMethod, Costcode_id*, ProgressPercent, CollectedCost

Note 1: Underlined fields denote foreign keys.

Note 2: Costcode_id* field is used to hold the id of either cost center, service order (WIP) or activity depending on production costing method (order costing or period costing) or project activity based costing method used.

Figure 3.4. The data model for service receipt and issue note transactions in relation with cost accounting

The data model for integration definition of service expenses to the related ledger and sub-ledger account of financial accounting is given in Figure 3.5 to show the integration on the database data table and field level

45

ExpenseLedgerAccounts table:

ExpenseLedgerAccounts_Id, Costcentercode_id, Expensetypecode_id, LedgerAccount_id

Note 1: Service receipt note transactions use this account for debiting service expenses. Product costing overhead allocation use this account for crediting (studied in 'Production Control' section).

Note 2: Service (service products) issue note transactions do not use this account for crediting. WIP Service order or WIP Cost Center is used to determine the WIP accounts to credit after service completion crediting (studied in 'Production Control' section).

Figure 3.5. The data model for integration definition of service costs to related ledger and sub-ledger accounts

3.2. Human Resources

In any organization, human resource is needed as direct and indirect labor for production. Human resources are also needed for research and development, marketing and sales, and general administration. Job types and capacities required are determined by demanding functional units. This demand is supplied by hiring and assigning employees to job types and positions. In the case of outsourcing human resources instead of hiring, the case turns out to be the outsourcing of production operations. Outsourcing operations (and hence outsourcing labor) is the subject of and studied in Section 3.1.2. In this section, supplying human resources by hiring and assigning employees to jobs for production will be studied from a managerial accounting perspective.

Human resources departments are mainly responsible to recruit proper people as employees. They keep a record of all data about employees including wages and monthly working hours. Wages and monthly working hours are used in jobs to determine hourly job rates (costs). Hourly job rates are used in normal labor cost calculations of production operations. Actual rates are also determined by calculating salaries from wages and actual working hours worked for production operations to be compared with standard and normal labor costs for performance analysis.

Human resources modules within ERP systems are used to define employees, job types, and departments. Employees are assigned to job types and departments for labor rate and capacity calculations. Employee timekeeping cards and employee payroll data are used together to calculate the actual monthly salaries of employees. Payroll results are used to calculate actual hourly job rates. These are the definitions and transactions that are also used in payroll accounting and cost accounting for labor cost integration to accounting and product costing. Integration and automation to accounting are done through payroll using human resource module integration interfaces to general ledger module. Integration and automation to production operations are done through job types using human resource module integration interface to production operations.

These cost accounting activities involved in the human resources transactions are studied in detail for integrating human resource modules to accounting and cost accounting within ERP systems. Proper integration of human resources to cost accounting will automate the accumulation, allocation, and consumption (expense) of labor costs needed to run a business.

In accounting terms, proper integration definitions within Human Resource modules of ERP systems that have these capabilities ensure automatic generation of costing side (debit) payroll journal entries posted to general ledger generated

automatically from payroll transactions, after recording payroll transactions. For example, month-end payroll calculation results cause (trigger) automatic calculation of actual job type rates (hourly labor costs) and debiting of defined labor cost accumulation (repository expense) accounts.

The definitions, transactions, and interfaces are introduced to automatically accumulate periodic actual labor costs in repository ledger expense accounts properly, for managerial and financial accounting, to be allocated to production (WIP) correctly. Correct accumulation (debit), allocation (debit, credit), and consumption (credit) of labor costs will minimize associated repository reflection account residuals. Minimization of these residuals together with correct timekeeping of direct labor use by work orders, batches, or periods by the products increases the accuracy of the allocation of labor costs to products. Timekeeping of direct labor use by work orders, batches, or periods is explained in Section 3.4.

Human resources master data integration definitions are explained in Section 3.2.1. The resulting automated cost accounting transactions are explained in Section 3.2.2. Finally, database data models of managerial accounting data are explained in Section 3.2.3.

3.2.1. Master Data Definitions for Human Resource Costing and Accounting

Master data types defined and used in human resources management for integrating and automating (as a result of integration) labor costing and accounting are Employees, Job Types, Departments (Cost Centers, Work centers), Labor cost ledger, and sub-ledger accounts.

Employees working for a company are defined by assigning unique employee codes to each employee within human resources modules of ERP systems. Agreed

working hours (Shift hours) and wages are defined for each employee within employee records for calculating salaries and related costs as labor costs.

Job types are defined to assign employees to jobs according to their qualifications in general. Hourly labor cost rates are calculated for job types to be used in standardizing production work. Job types are used in defining job qualifications and standard working hours needed for production operations and processes.

Departments are used to assign employees to management units for responsibility accounting. Departments are also used as means (together with cost centers) for automatically posting accounting entries for accumulating labor costs.

Hierarchical relationships of human resources master data definitions from a cost accounting perspective are given in Figure 3.6. In the Figure, 'Enterprise' is used to stand for the ERP system of any organization. Enterprises usually have more than one legal unit (hence more than one ledger). The labor costing hierarchy is valid for each legal unit of any organization. Labor costing hierarchy levels are classified and coded as 'Cost center codes' and 'Job type codes' on the right side of Figure 3.6. Ledger and sub-ledger hierarchy levels are given on the left side of Figure 3.6 to show the correspondence for integration within the hierarchy.
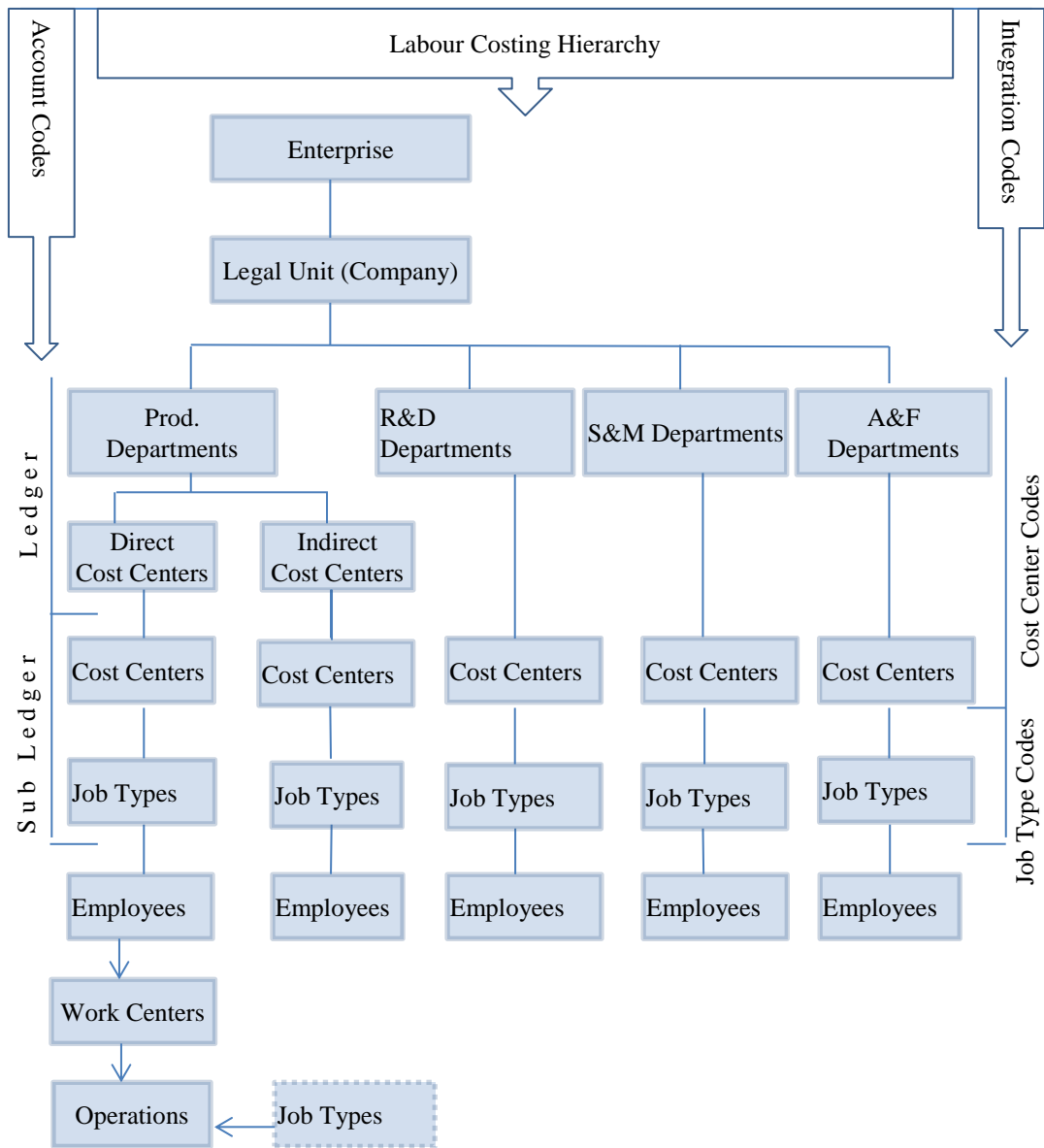
Figure 3.6. The hierarchical relationship of labour cost master data to ledger labour expense accounts for integration

Table 3.3 is an example to present the master data integration definitions between the ledger production labor expense accounts and human resource employees for labor costs of a company. 3 job types and a cost center of the company are shown in the example. The cost center codes and job type codes are used together in automating the accounting of monthly payroll accruals for selecting correct ledger accounts to debit using the master data integration definitions within ERP systems.

Table 3.3. Integration definitions for service costs between ERP human resources and accounting modules of a Turkish manufacturing company

Human Resources Module			
Cost Centers:			
Code	*Name*	*Type*	
0001	Production Hall 1	Direct	
…			
Job Types:			
Code	*Name*	*Unit*	*Cost Type*
01.001	Production Manager	day	indirect
01.002	Materials Handling clerk	day	indirect
01.003	Plasma Cutting Machine operator	hour	direct
…			
Employees:			
Code	*Name*	*Job Type*	
00001	İsmet Koçak	01.001	
00002	Ahmet Koç	01.003	
….			
Accounting Module			
Ledger and sub-ledger accounts:			
Account Code	*Account Name*	*Type*	
720	Production Direct Labor Cost	expense	ledger
720.001	Production Hall 1 Direct Labor Costs	expense	Sub-ledger
730	Production General Expenses	expense	ledger
730.002	Production Indirect Labor Costs	expense	Sub-ledger
730.002.001	Production Hall 1 Indirect Labor Costs	expense	Sub-ledger
…	…		
Integration			
Cost Center	*Job Type*	*Sub-ledger Account*	
0001	01.001	730.002.001	
0001	01.002	730.002.001	
0001	01.003	720.001	

3.2.2. Labor Costing Transactions

Monthly payroll accruals (employee salaries, taxes, retire premiums, health insurance premiums, etc.) are generated from agreed employee wage definitions and periodic timekeeping cards. Calculations for payroll differ from country to country. So, timekeeping and payroll modules are usually locally developed for each country as add-on modules within ERP systems, especially for worldwide leading ERP software. Local ERP software usually has these modules better suited and integrated to the company and the specific country needs because they are developed originally according to company and country legislation rules.

Cost-wise, gross wages of workers and legal tax, social security, and other payments to third parties (government, social institutions, and others) made for workers by the company constitute actual labor costs of a company. Companies usually use hourly or monthly wage rates to calculate payroll accrual amounts by multiplying working hours with hourly wage rates. Employee normal working hours are determined from timekeeping records. Overtime working hours are determined from time card records. Overtime work is rated hourly (overtime factor x hourly wage rate x overtime hours) and added to payroll accruals for overtime payments. Employee overtime working hours are usually determined from time card records.

Employee timekeeping records are produced from daily employee arrival and leave data collected from timekeeping recording systems for monthly salary calculations of employees within ERP systems. Timekeeping systems are usually integrated into ERP payroll modules to automatically collect daily working hours of employee data to be used in monthly salary calculations. Even though actual normal working hours are determined from a timekeeping system for payroll, time card records are usually used for determining actual cost centers worked to accumulate (and debit associated ledger account) labor costs. When time card records are not kept, default

current cost centers of employees are used for accumulation. This assures the allocation or consumption of labor cost from where it is accumulated.

Time cards are used usually for direct workers by production departments to track employee labor hours worked for each operation of production orders for order costing (and operations of products for period costing). Time cards are also used to record the overtime work for all employees. These records are used to calculate direct labor costs of production orders which are studied in section 3.4. Time cards allocate and/or consume (credit) labor costs accumulated in cost centers as a result of payroll accounting using the same integration definitions explained in master data definitions for human resource costing and accounting.

In financial accounting, labor cost is classified at the ledger level as 'Direct labor cost of manufacturing', 'Indirect labor cost of manufacturing', 'Labor cost of sales', 'Labor cost of research and development', and 'Labor cost of general management and administration'. Master data definitions for human resource costing and accounting are also used to automatically determine the ledger expense accounts to create monthly payroll journal costing (expense) entries from payroll results of all employees within human resource modules of ERP systems.

3.2.3. ERP Database Data Model of Labor Transactions and Costs

Database data structures needed within ERP systems for installing and integrating human resources to cost accounting are introduced to enhance human resources module designs and installations of ERP systems concerning cost accounting. Table and table field names are regenerated to be self-explanatory to show the integration data relationships on database data table and field level.

ERP database data model of human resource definitions and labor costs are given in Figure 3.7 to show the relationships on database data table and field level.

Employee table:

Employee_Id, Employeecode, EmployeeName, EmployeeSecondName, EmployeeLastName,
EmployeeJobcurrentrecord_id, EmployeeWagecurrentrecord_id,
EmployeeShiftcurrentrecord_id

JobType table:

JobType _Id, JobTypecode, JobTypeName, JobTypeDescription, JobTypeStandardcurrentrate,
JobTypeNormalcurrentrate, JobTypeActualcurrentrate

JobTypeRate table:

JobTypeRate _Id, JobType_id, DateStart, DateEnd, JobTypeStandardrate,JobTypeNormalrate,
JobTypeActualrate

EmployeeJob table:

EmployeeJob_Id, Employee_id, JobType_id, Department_id, Costcenter_id, Workcenter_id,
DateStart, DateFinish

EmployeeWage table:

EmployeeWage_Id, Employee_id, DateStart, DateFinish, WageRatetype, WageRate,
WageCurrency, WageRatePeriod

Figure 3.7. The data model of labor cost definitions and transactions

EmployeeShift table:

EmployeeShift_Id, Employee_id, Shift_id, DateStart, DateFinish

EmployeeTimeCard table:

EmployeeTimeCard_Id, Employee_id, NormalOvertime, DateStart, DateFinish, TimeStart, TimeFinish, Department_id, CostCenter_id, WorkCenter_id, WorkOrder_id, Product_id, Operation_id

EmployeeTimekeeping table:

EmployeeWageAccrual table:

Note : Underlined fields are foreign keys

Figure 3.7(Continued). The data model of labor cost definitions and transactions

The data model for integration definition to automatically determine the costing ledger accounts and create monthly payroll journal costing entries from payroll results of human resources modules within ERP systems is given in Figure 3.8 to show the integration on the database data table and field level.

LaborCostLedgerAccounts table:

LaborCostLedgerAccounts_Id, CostCenter_id, JobType_id, LedgerAccount_id

Note : Underlined fields are foreign keys

Figure 3.8. The data model for integration definition of payroll costs to related ledger and sub-ledger accounts

Fixed assets are items supplied once and used in production for more than one period, usually more than one year, throughout their number of years of useful life. Because they are used in production for more than one year, their initial cost is reflected in production in proportion to their useful life. Fixed assets are supplied in 3 different ways. These are purchasing, leasing, and in-house production. In all cases, the total cost of supplying is recorded with the supply date for each fixed asset to be used in depreciation. During initial recording, useful life in years and depreciation method is also recorded needed for depreciation calculations.

In accounting, initial costs of fixed assets are consumed (expensed) according to the depreciation method selected for useful life. Two depreciation methods are used widely. These are 'Normal Depreciation' and 'Fast Depreciation'. The useful life of any fixed asset is determined by legal authorities by their type. Each fixed asset has to be categorized by these types to legally determine its useful life for financial accounting.

In cost accounting, reflecting costs of fixed asset's depreciation to production is done in two categories. These are direct reflection according to usage in production and indirect reflection according to allocation (distribution) criteria selected for product costing.

Fixed assets modules within ERP systems are used to define each fixed asset, their categories for depreciation, and their association with departments and cost centers for their integration with accounting. Depreciation calculations and accounting postings are made automatically within Fixed Assets modules of ERP systems using these definitions whenever needed, usually done periodically (monthly, quarterly and yearly). Fixed assets integration and automation to accounting are done using fixed assets module integration interfaces to the accounting module. Proper integration of fixed assets to cost accounting automates the accumulation,

allocation, and consumption (expense) of costs associated with fixed assets needed to run a business.

Integration of fixed assets to production for automating reflection of standard fixed asset costs to production operations is done through cost centers and machine types. This integration is done by linking fixed assets to production machines within ERP systems. Fixed assets linked to associated production machines to determine hourly machine rates to be used in standard product costing are studied in Section 3.4.

In accounting terms, proper integration definitions within fixed assets modules of ERP systems ensure automatic generation of costing side (debit) depreciation journal entries posted to the general ledger. Journals are generated automatically after depreciation is calculated and recorded at period ends, for debiting defined depreciation (repository expense) accounts within the ledger and sub-ledger. Example integration definitions for depreciation accounting are given in Table 3.4.

The definitions, transactions, and interfaces are introduced to automatically accumulate periodic actual depreciation costs in repository ledger expense accounts properly, for managerial and financial accounting, to be allocated to production (WIP) correctly. Proper accumulation (debit), allocation (debit, credit), and consumption (credit) of depreciation costs will minimize associated repository reflection account residuals. Minimization of these residuals, together with correct timekeeping of machines' use by production orders and production units for products increase the accuracy of the allocation of depreciation costs to products.

Fixed assets master data integration definitions are explained in Section 3.3.1. The resulting automated cost accounting transactions are explained in Section 3.3.2. Finally, database data models of managerial accounting data are explained in Section 3.3.3.

3.3.1. Master Data Definitions for Fixed Assets Costing and Accounting

The master data types defined and used in fixed assets modules for integrating and automating (as a result of integration) fixed assets costing and accounting are Fixed Assets, Fixed Asset Categories, Machines, and Machine types, Departments, Cost Centers, Work centers, and Ledger and Sub-ledger expense accounts for depreciation.

Fixed assets needed for a company are defined by assigning unique fixed asset codes to each fixed asset within fixed assets modules of ERP systems. Useful life and depreciation method are defined for each fixed asset within fixed asset records by linking associated fixed asset categories for calculating depreciation. The depreciation period (month, quarter, or year) is determined for all fixed assets by setting a fixed assets depreciation period flag.

Fixed Asset Categories for depreciation are defined to set fixed asset depreciation years (legal useful life) by category for fixed assets. Fixed Asset Categories and depreciation years to expense fixed asset costs are usually determined by legislation for financial accounting.

Like job types in human resources, machine types (fixed asset types) in fixed assets are defined to assign fixed assets according to their usage in operations. Hourly machine usage cost rates are calculated for machine types to be used in standardizing production work. Fixed asset types are used in defining machine types and standard usage hours needed for production operations and processes.

Departments are used to assign fixed assets to management units for responsibility accounting. Departments are also sometimes used in integration definitions (together with cost centers) for automating depreciation postings to accounting.

Hierarchical relationships of fixed assets master data definitions for cost accounting are given in Figure 3.9. In the Figure, 'Enterprise' is used to stand for the ERP system of any organization. Enterprises usually have more than one legal unit (hence more than one ledger). Fixed assets depreciation hierarchy is valid for each legal unit of any organization. Fixed assets depreciation hierarchy levels are classified and coded as 'Fixed asset type codes' and 'Cost center codes' on the right side of Figure 3.9. Ledger and sub-ledger hierarchy levels are given on the left side of Figure 3.9 to show the correspondence for integration within the hierarchy.
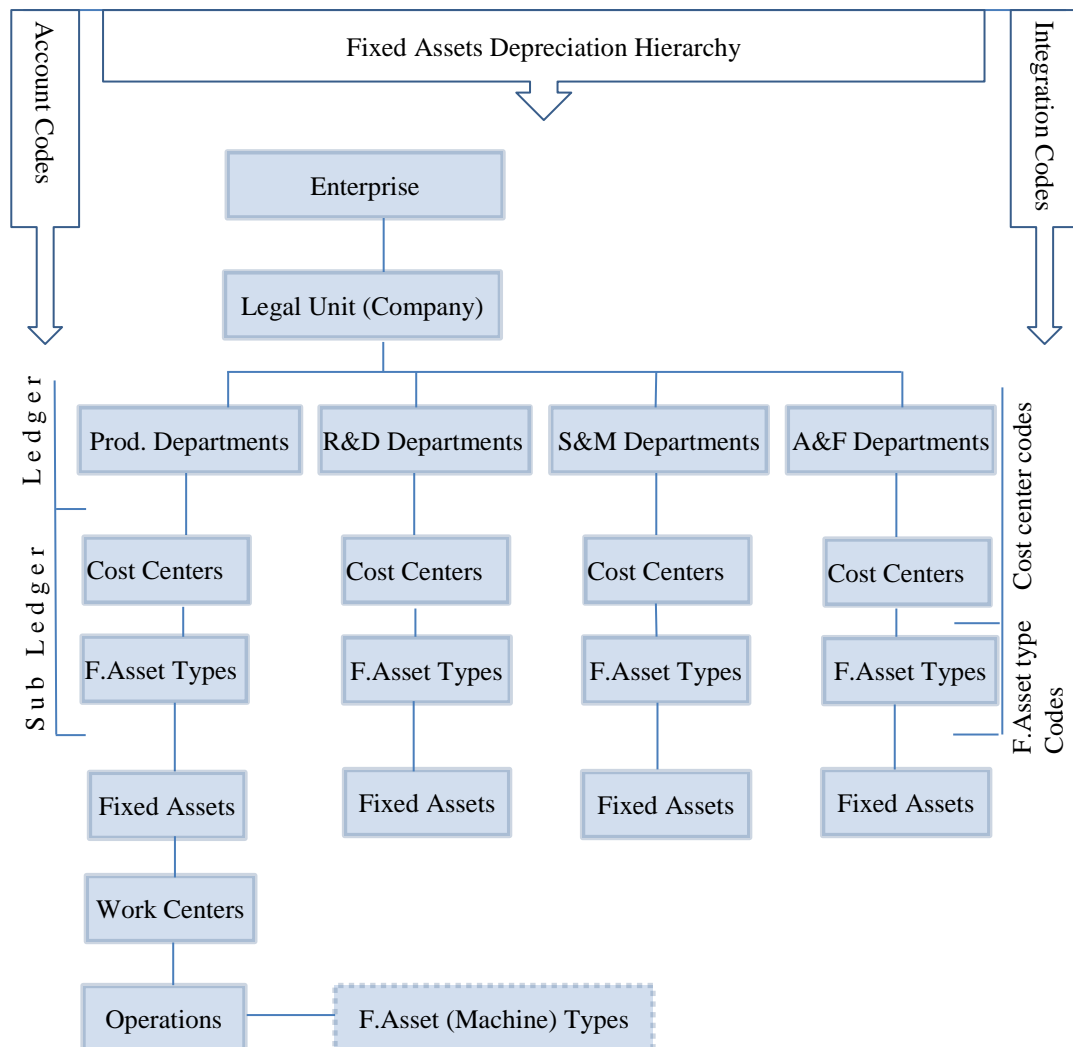
Figure 3.9. The hierarchical relationship of fixed assets master data to ledger depreciation accounts for integration

Table 3.4 is an example to present fixed assets master data integration definitions for 2 production machines of a company. These two machines are used in 2 work centers that are linked to a common cost center named 'Production Hall 1'. The cost center code and machine type codes are used together in automating the accounting of machine depreciation for selecting correct ledger accounts to debit, within the ERP system of the company.

Table 3.4. Integration definitions for service costs between ERP logistics and accounting module of a Turkish manufacturing company

Fixed Assets Module				
Cost Centers:				
Code	*Name*			
0001	Production Hall 1			
…				
Machine Types:				
Code	*Name*	*Unit*		
01.001	Plasma Cutting	hour		
01.002	Welding	hour		
…				
Production Machines:				
Code	*Name*	*Machine Type*		
00001	Plasma Cutting Machine 1	01.001		
…				
00002	Welding Robot 1	01.002		
….				
Accounting Module				
Ledger and Sub-ledger Accounts:				
Account Code	*Account Name*	*Type*		
730	Production general expenses	expense	ledger	
730.003	Fixed assets depreciation	expense	Sub-ledger	
730.003.001	Production hall 1 machines depreciation	expense	Sub-ledger	
…	…			
Integration				
Cost Center	*Machine Type*	*Sub-ledger Account*		
0001	01.001	730.003.001		
0001	01.002	730.003.001		

3.3.2. Fixed Assets Costing and Depreciation Transactions

Fixed assets may be supplied (purchased, leased, or in-house produced) in lots. For example, if three machines of the same type are purchased, receipt notes and invoices are recorded with the fixed asset category code with 3 units, as in material purchases, in one line. But, they are coded and recorded for each unit in fixed asset modules. For that, in recording receipt notes, lines filled with fixed asset type codes manually are asked for fixed asset detail code for each total quantity during line entry within ERP systems. Fixed asset codes are usually generated automatically by combining fixed asset type codes with fixed asset detail codes. Total line cost is also divided into the total quantity to determine each fixed asset's cost as fixed asset value in the fixed assets module. So, in fixed assets modules of standard ERP systems, each fixed asset record is created automatically from receipt notes with receipt date (invoice date upon invoice recording) and receipt value (date and cost are taken from associated invoice line), depreciation period, and method (taken from fixed asset type of receipt note line).

Periodic depreciation calculation transactions are made automatically by using data recorded for each fixed asset on fixed assets creation. Accounting integration definitions explained in Section 3.3.1 are used together with periodic depreciation calculation transactions to automatically create depreciation journal entries in financial accounting.

Fixed asset time cards are usually used for rentable, scarce, and expensive fixed assets by responsible departments to track machine hours used for each project and/or cost center and rented. Time card records are used to distribute depreciation directly according to usage.

3.3.3. ERP database data model of labor transactions and costs

Database data structures needed within ERP systems for Installing and integrating fixed assets to cost accounting are introduced to enhance fixed assets module designs and installations of ERP systems concerning cost accounting. Table and table field names are regenerated to be self-explanatory to show the integration data relationships on database data table and field level.

ERP database data model of fixed assets definitions and depreciation calculations are given in Figure 3.10 to show the relationships on the database data table and field level.

FixedAsset table:
FixedAsset _Id, FixedAssetcode, FixedAssetName, FixedAssetDescription, FixedAssetDate, FixedAssetCostValue, FixedAssetCategory_Id, DepreciationMethod, DepreciationRate

FixedAssetType table:
FixedAssetType_Id, FixedAssetTypeCode, FixedAssetTypeName, FixedAssetTypeDescription, CurrentStandardRate, CurrentNormalRate, CurrentActualRate

FixedAssetTypeRate table:
FixedAssetTypeRate_Id, FixedAssetType_id, DateStart, DateEnd, StandardRate, NormalRate, ActualRate

FixedAssetCategory table:
FixedAssetCategory_Id, CategoryName, CategoryDescription, DepreciationYears, DepreciationNormalRate, DepreciationFastRate

FixedAssetDepreciation table:
FixedAssetDepreciation_Id, FixedAsset_id, TotalValue, DepreciationAmount, RemainingValue

FixedAssetDepreciationTransaction table:
FixedAssetDepreciationTransaction_Id, FixedAsset_id, TransactionDate, Period, DepreciationAmount

FixedAssetTimeCard table:
FixedAssetTimeCard_Id, FixedAsset_id, NormalOvertime, DateStart, DateFinish, TimeStart, TimeFinish, Department_id, CostCenter_id, WorkCenter_id, WorkOrder_id, Product_id, Operation_id

Figure 3.10. The data model of fixed assets cost definitions and transactions

The data model for integration definition to automatically determine the costing ledger accounts and create periodic depreciation journal costing entries from depreciation calculation results of fixed assets modules within ERP systems is given in Figure 3.11 to show the integration on the database data table and field level.

63

Figure 3.11. The data model for integration definitions of depreciation to related costing
side ledger and sub-ledger accounts

3.4. Production Planning and Control

Products (goods or services) are defined within ERP systems to identify the
deliverables to customers that are supplied by producing or purchasing by a
company. In this section, the production and production costing definitions and
transactions of exact products within production planning and control modules of
ERP systems are studied. How resources should be defined, supplied, and cost
within standard ERP systems are explained in the previous sections of Chapter 3.
How these resources are used to plan and produce exact products are studied to
show how product costing through integration and automation should be done
within standard ERP systems.

When all the characteristics of a product are predetermined during the design, the
product can be predefined as exact. Exact products are created and their production
data (BOM, Routing) are defined according to the standards using production
resources already defined within ERP systems usually after the design. When
combinations of characteristic values of a designed product are unlimited or too
much to be defined for each combination during design, the product is defined as

configurable (generic) within standard ERP systems. Exact products are automatically generated from configurable products, when optional characteristics and/or values are determined by the customer, usually after sales order entry. After exact products are automatically generated, their exact production (engineering) data are also created automatically from generic BOM and Routing, usually before production starts, when production orders are created.

Resources defined, supplied, and cost within the modules of standard ERP systems are materials and services defined in Logistics modules, Job types, and employees defined in human resources modules, fixed asset types, and fixed assets defined in fixed asset modules. Now, according to the usage definitions of these resources in production, they are defined and classified as direct or indirect, fixed or variable in production definitions within production planning and control modules of ERP systems.

Products, semi-finished products, products BOMs, and Routings are defined as master data definitions within production modules of ERP systems to formulate and plan the resources needed to produce the products. Direct materials are defined within product BOMs to formulate and determine material types and quantities needed to produce per decided units of products. They also dictate the hierarchical order of product formation stages as semi-finished and finished products. Product BOMs and Routings are used together in MPS to plan the production of end products to supply the demand. Semi-finished product BOMs and Routings are used together in MRP to plan the production of semi-finished products for the dependent demand of end products. Results of MPS and MRP are used for production planning, materials supply planning, and budgeting of all resources used in production. BOMs and Routing are also used in determining the standard and normal costs of semi-finished and finished products of production. Actual costs of semi-finished and finished products are calculated after production is

completed, from materials and resources used that are recorded on work orders and/or production process departments.

Routings are defined for semi-finished and finished products to define production operations within BOM's hierarchical product formation order to formulate resources needed to transform materials and semi-finished products to upper-level semi-finished and finished products. Direct machine and labor hours needed to transform materials are defined in routing operations by using direct job types of associated job types defined in human resources and machine types of associated fixed asset types defined in fixed assets modules of standard ERP systems. Job types and machine types used in routing operations are defined and classified as direct automatically. These types establish the link between the resources and requirements to plan direct and indirect resource requirements in planning and budgeting for human resources and fixed assets.

Nowadays, indirect work of production is also formulated and defined using business processes. This formulation has led to planning and hence budgeting of resources used in indirect work as in direct work. Business processes are also used in ABC activities to allocate the cost of resources used in indirect activities (overhead) to production directly like direct work as much as can be. This leads to less residual cost in overhead to be distributed to production using distribution criteria. Allocating overhead costs using business processes for indirect work leads to more correct product costs, especially if types of products are high. Business process (Activity in ABC terms) definitions are studied in detail in Chapter 4, ABC capabilities of ERP systems.

Product costing (standard, normal and actual costing) activities involved in the definitions and transactions of production planning and control modules of ERP systems are studied in detail for integrating production planning and control modules to accounting within ERP systems. Proper integration of production

planning and control to cost accounting will automate the calculation of product costs.

In accounting terms, proper integration definitions within production planning and control modules of ERP systems that have these capabilities ensure automatic generation of Work in Process (WIP) and finished product accounts, journal entries for credits and debits within WIP accounts, and debits to finished product accounts posted to general ledger generated automatically from production transactions, after recording production transactions. For example, recording the work of an employee (resource usage) to a production order in hours, cause (trigger) automatic calculation of actual labor cost of the employee, and debiting of the defined WIP account associated with the work order. Recording completion of a product in a production triggers the calculation of the product cost and debiting of WIP or finished goods account depending on whether the product is semi-finished or finished.

Production is studied for both goods and services. While WIP and finished goods inventory accounts are usually used in Goods Production to account, the same ledger accounts with different sub-ledgers should be used to account for services WIP and finished service products before sale, also (Kabataş and Pamukçu, 2010).

The definitions, transactions, and interfaces made within ERP systems are introduced to automatically determine resource costs of production transactions recorded and create journals to transfer these costs to WIP accounts from cost centers and transferred to finished products accounts by product types for managerial and financial accounting. Correct accumulation (debit), allocation (debit, credit), and consumption (credit) of production costs will assure zero residuals of WIP and finished products inventory accounts.

Production planning and control product costing integration-related master data definitions are explained in Section 3.4.1. The resulting automated cost accounting transactions are explained in Section 3.4.2. Finally, database data models of managerial accounting data are explained in Section 3.4.3 to present the extent and limitations of managerial accounting within production planning and control modules of ERP systems.

3.4.1. Master Data Definitions for Production Costing and Accounting

Master data types defined and used in production planning and control to integrate and automate (as a result of integration) production costing and accounting are exact products, work centers, operations, routings, bills of materials (BOM), production units (for process costing), semi-finished goods (WIP) and finished goods inventory ledger and sub-ledger accounts. Production orders are also used in integration for order costing which are not defined during master data definitions in order costing production environments. They are usually created as a result of MPS and MRP runs for production planning, control, and cost.

Exact products (finished and semi-finished products) are the materials classified as "make" from a logistics perspective. Material and service codes defined in logistics are classified as "Make" or "Buy" according to their main supply by production or purchasing. These materials are supplied for inventories and/or sale mainly by producing in-house. These materials may also be purchased at times, to supply the demand. From a production planning and control perspective, finished and semi-finished products are the materials that have active BOMs and routings attached to material codes of logistics within ERP systems. Exact product material codes (exact product codes) are generated and defined manually or generated automatically from configurable product formulations for configurable products. Unit production costs (standard, normal and actual) are calculated and recorded by exact product codes within ERP systems.

68

Work centers are the smallest production units where production operations are conducted to transform materials to higher-level semi-finished and finished products. Employees of associated job types and machines of associated machine types are assigned to work centers to be used in operations defined to be conducted in the work center. Labor and machine capacities are determined and traced under work centers by job types and machine types.

Each work center is associated with a cost center to get defined job type and machine type rates for standard and normal costing. The cost center is also used to take (credit) the actual cost of using work center labor and machine hours from associated reflection accounts to WIP production order or department accounts. Reflection accounts are used in accounting to reconcile costs (usually standard cost) reflected WIP during real-time transaction dates to actual expenses accumulated in temporary expense accounts, at period ends. Residuals of reflection accounts are allocated to (add to) WIP at period ends according to allocation criteria. Figure 3.12 shows the data definitions made on work centers and cost centers within ERP systems used in product costing and budgeting.
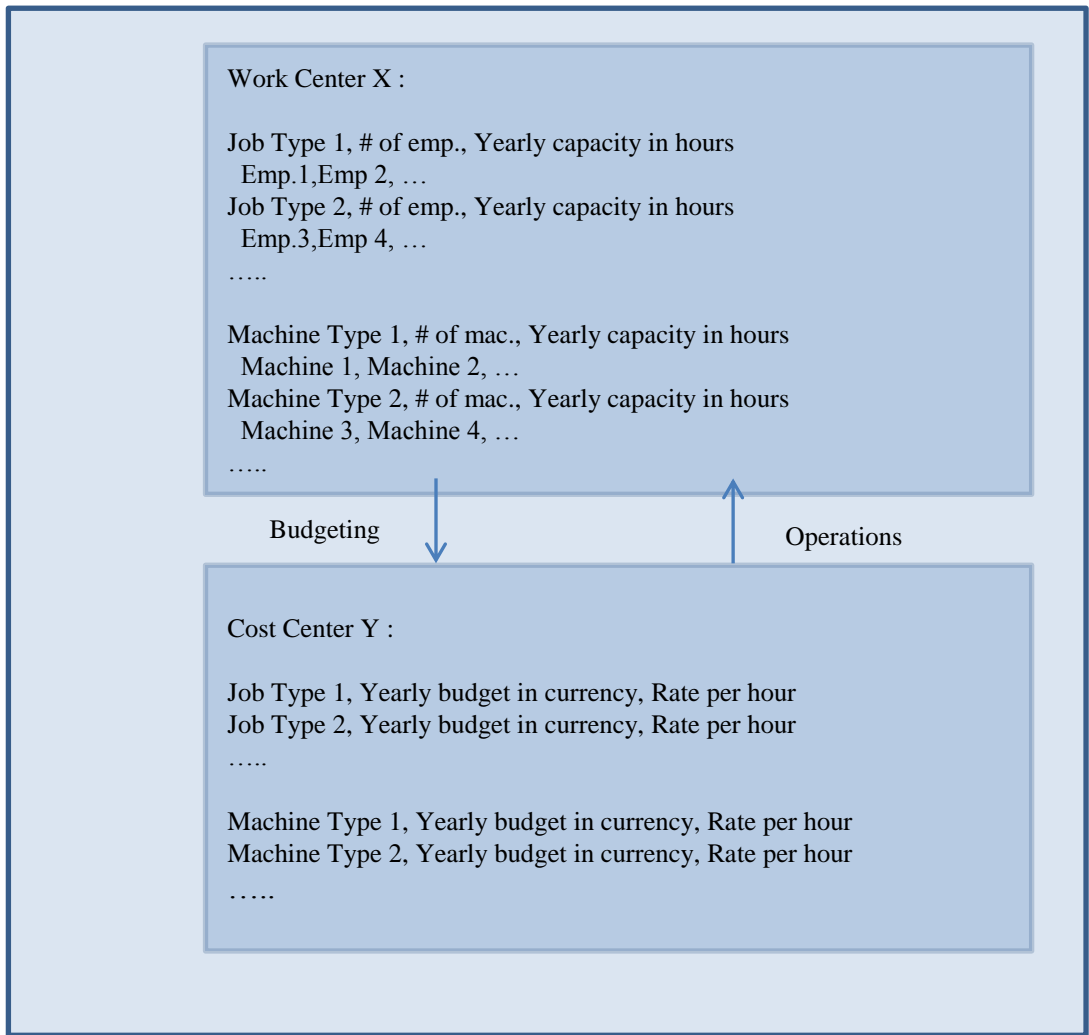
Figure 3.12. Work center and cost center data definitions used in product costing and budgeting.

Operations are defined at work centers to formulate the required usage of labor and machines to accomplish a stage of production or process. Operations are definitions of direct work of production within ERP systems. Direct labor and machine usage hours are defined within operations to be linked to products through routings. Direct costs of products are also formulated on operations that are linked to products through routings. Since operation definitions are so important within ERP systems for production planning, scheduling, budgeting, and product costing, their

definition within ERP systems will be studied in detail to introduce how they should be defined to serve all.

Operation ID, operation name, operation description, work center, average production quantity, set-up hours, and run hours are defined as operations header data for each production operation. When linked to exact products through routings, these data are used in production planning and costing of exact products. Figure 3.13 shows the relationships of data elements of production operations.

Resource usage data definitions and data relations of a production operation of a product for costing:

Setup:
Planning Setup Time,
Setup Lot Quantity

Run:
Planning Run Time,
Run Quantity

Time

Setup Labor Hours:
  Job Type, #of Emp., Total
  Labor Hours

Run Labor Hours:
  Job Type, #of Emp., Total
  Labor Hours

Setup Machine Hours:
  Machine Type, Hours

Run Machine Hours:
  Machine Type, Hours
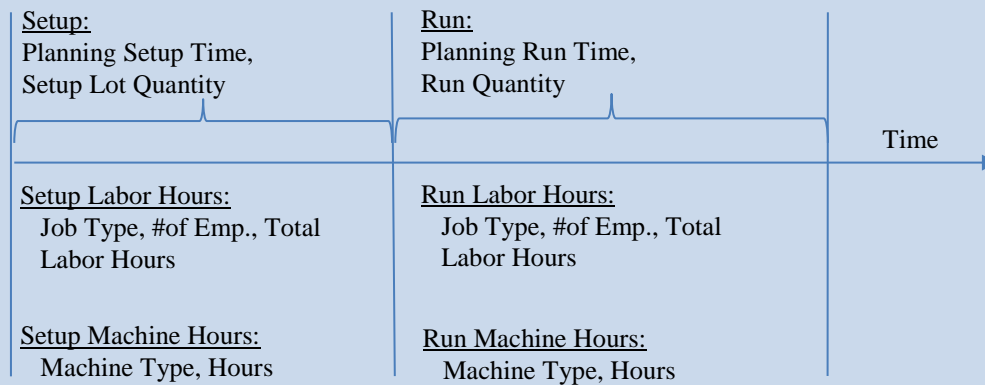
Formulations of operations data for costing:

$\text{Operation Lot Standard Labour Cost} = \sum_{\text{Setup Job Types}}(\text{Setup Job Type Rate} * \text{Labour Setup Hours}) + \sum_{\text{Run Job Types}}(\text{Setup Lot Quantity} / \text{Run Quantity} * \text{Run Job Type Rate} * \text{Labour Run Hours})$

$\text{Product Standard Labor Cost} = \sum_{\text{Operations}}(\text{Order Quantity(EOQ)} / \text{Setup Lot Quantity} * \text{Operation Lot Standard Labor Cost}) / \text{Order Quantity(EOQ)}$

$\text{Operation Lot Standard Machine Hours} = \text{Machine Setup Hours} + (\text{Setup Lot Quantity} / \text{Run Quantity} * \text{Machine Run Hours})$

Note : 'Run Quantity' is usually taken as 1 product unit.

Figure 3.13. The relationships of data elements of production operations used in costing and budgeting formulas within ERP systems

All the data defined within production operations are variable because operations are defined for per unit production of products. Labor hours defined within operations are used together with job type rates to calculate standard and normal direct labor cost of products. But, even machine-hours defined within operations are variable, machine depreciation and some associated costs (calculated by multiplying machine hours and machine type rates) are taken to be indirect in product costing. While production operations are defined to model direct work of production as defined above within ERP systems, Business processes are defined to model indirect work of production which is studied and introduced in chapter 4.

Routings are groups of production operations required to be accomplished in precedence sequence to produce a semi-finished or finished product defined within the hierarchy of a BOM structure. Labor costs, machine costs, and other costs of operations of a product's routing are summed up to determine standard (and normal) labor and overhead costs of products.

Bills of materials (BOM) are hierarchical structures of materials, semi-finished and finished products with quantities required to produce defined units, usually 1 unit, of each finished (end) product. Each semi-finished and finished product's 1 lower-level material type and quantity requirements (including 1 lower level semi-finished product) are determined and recorded as a product's single-level BOM within ERP systems. After all semi-finished and finished products' single-level BOMs are independently recorded, the whole hierarchical BOM structure of end products is virtually generated depending on semi-finished products definitions as materials within upper-level semi-finished or finished products single level BOMs.

These virtual BOM structures of end products are leveled from bottom to up to determine semi-finished products' production levels. Leveling is started from the lowest level materials recorded as level 0 to the highest level end products recorded as level N determined for each product. Any semi-product leveled first is not

leveled again in upper levels if exists. These level numbers are recorded within each semi-finished and finished product single-level BOMs to be used in MPS, MRP, and product costing for determining production sequence from single-level BOMs, within ERP systems.

For MPS and MRP, material requirements (and production requirements of semi-finished products) are determined starting from highest level end products to downward. For semi-finished and finished product standard and normal costing, direct material, direct labor, and overhead costs are summed up from the lowest level (coded as level 0) up to each end products level according to leveling hierarchy determined. This assures costing calculations of semi-finished products, used at different products at different levels, not missed and done once when first needed.

BOM structures together with routing operations of semi-finished and finished products show the production stages of a manufacturing company. So, semi-finished products and their hierarchical levels should be determined carefully. Unnecessary semi-finished products and hierarchies are the main reasons for inefficiencies in production planning and control, product costing, and accounting within ERP systems. A manufacturing company's WIP accounts should also be determined according to this structure to have proper integration and automation between production and ledger accounts. A virtual BOM structure together with routing operations generated from a manufacturing company's ERP system is shown in Table 3.5. This table is generated by chaining up single-level BOMs using the ERP system reporting tool's dynamic embedded reporting technique. Calculated costs from cost roll-up results or costs summed up while reporting dynamically are possible to be shown in the 'Cost roll-up' column.

Table 3.5. A virtual product's full BOM structure and routing operations generated from a manufacturing company's ERP system used in cost roll-up.

Indented Bills of Materials with Routing Operations for Product A

Indented Bills of Materials:

Product/Material	Quantity	Unit	Level	Cost Rollup Material
Product A	1	ea	4	
Product B	1	ea	3	
Product D	2	ea	2	
Product F	4	ea	1	
Material 4	4	ea	0	
Material 5	2	Kg	0	
Material 1	8	Meter	0	
Material 2	4	ea	0	
Product C	2	ea	2	
Product E	2	ea	1	
Material 6	2	ea	0	
Product F	2	ea	1	
Material 4	2	ea	0	
Material 5	1	Kg	0	
Material 1	4	Meter	0	
Material 3	8	Liter	0	
Material 1	2	Meter	0	

Indented Routing Operations:

Product/Operation	Quantity	Unit	Level	Work Center Cost Rollup
Product A	1	ea	4	
Operation 01				WC01
Product B	1	ea	3	
Operation 02				WC02
Operation 03				WC03
Product D	2	ea	2	
Operation 09				WC09
Product F	4	ea	1	
Operation 10				WC10
Operation 11				WC10
Product C	2	ea	2	
Operation 04				WC04
Product E	2	ea	1	
Operation 05				WC05
Operation 06				WC06
Product F	2	ea	1	
Operation 07				WC07
Operation 08				WC07

Production units are the groups of work centers defined to aggregate production stages. If only one main product (and by-products) is produced as the output of the production unit for a period, assuming all defined routing operations are done in the work centers of the production unit in sequence as in flow-shop production formation, the production unit is referenced to a WIP account to record resource usage to the unit and receive (debit WIP account) associated costs recorded to the unit from resource sources (cost centers). As the products are completed, the unit cost of the product is calculated by batches and this cost is transferred (credit WIP account) to the next unit to continue production or finished goods inventory for end products.

On the other hand, if the work centers could not be grouped to form production units, that is more than one end product is produced at the work centers with job shop production formation, production orders are used to separate the product costs. In this case, production orders are associated with ledger WIP accounts to record resource usage to the production orders and receive (debit WIP account) associated costs recorded to the production order from resource sources (cost centers). As the products are completed, the unit cost of the product is calculated for each production order and this cost is transferred (credit WIP account) to the next production order to continue production or inventory for end products.

BOMs, from a product formation perspective, and work centers, from a resource usage perspective, should be considered together in deciding costing technique (order costing or period costing) to be used. In practice, even production orders are used to plan and control production, production units are used to account for the production for manufacturing companies. The case gets to be more complex to integrate WIP to accounting when semi-finished products are used in common by more than one end product and produced in common in large quantities to stock to be used in upper-level products later.

Hierarchical relationships of production master data definitions for integration from a cost accounting perspective are given in Figure 3.14. In the Figure, 'Enterprise' is used to stand for the ERP system of any organization. Enterprises usually have more than one legal unit (hence more than one ledger). Production costing hierarchy is valid for each legal unit of any organization. Production costing hierarchy levels are classified and coded as 'Production unit codes' and 'Production order codes' on the right top side of Figure 3.14 for correspondence with WIP accounts. 'Material cost codes', 'Job type codes', 'Machine type codes', 'Cost center codes' and 'Expense type codes' on the right bottom side of the Figure 3.14 are used for correspondence with periodic temporary production expense and reflection accounts. Ledger and sub-ledger hierarchy levels are given on the left side of Figure 3.14 to show the correspondence for integration within the hierarchy.

Account Codes | **Production Costing Hierarchy** | **Integration Codes**

Ledger

Sub Ledger (wip)

Sub Ledger (expense)

- Enterprise
- Legal Unit (Company)
- Work In Process(WIP)
- Production Units
- Production Orders
  - Material Reflection
    - Material Cost
      - Cost Centers
        - Material Types / Materials
  - Labor Reflection
    - Labor Cost
      - Cost Centers
        - Job Types and Workers
  - Overhead Reflection
    - Overhead Cost
      - Cost Centers
        - Machine Types And Machines
        - Indirect Resources
- Operations
- Work Centers

Production Unit Codes, Production Order Codes

Material Cost Codes, Job Type Codes, Machine Type Codes, Cost Center Codes, Expense type codes

Figure 3.14. The hierarchical relationship of production master data for integrating production costs to ledger accounts

Table 3.6 is an example to present the master data integration definitions between the ledger WIP accounts and production resource expenses that are used in automating the accounting of the production costs of a production order within an ERP system. The production order (cutting 1500x1500x0.2t mm flat metal sheets from rolls) is scheduled and released to the 'roll metal sheet cutting unit' for production. The WIP account (151.001 - Semi-finished products in production) is automatically selected from integration definitions to debit all resource costs to WIP from the expense reflection accounts. Expense reflection accounts are also automatically selected using integration definitions for each resource cost type used.

Table 3.6. Master data integration definitions of a Turkish manufacturing company's ERP system for automating cost absorption from accounting module.

Production Module				
Production Units:				
Code	*Name*			
01	Roll metal sheet cutting unit			
…	…			
Production Orders:				
Code	*Name*		*Production Unit*	
00001	1500x1500x0.2t mm flat metal sheet		01	
…				
Accounting Module				
Ledger and Sub-ledger Accounts:				
Account Code	*Account Name*		*Reflection Accounts*	
151	Semi-finished goods in production (WIP)			
151.001	WIP Roll metal sheet cutting Unit			
…				
710	Direct raw materials period expenses			
710.001	Roll flat metal sheet expenses		711.001	
…				
720	Direct Labor period expenses			
720.001	Cutting unit direct labor expenses		721.001	
…	…			
730	General production period expenses			
730.003	Period depreciation expenses			
730.003.001	Hall 1 machines period depreciation expenses		731.003.001	
…	…			
Integration for cost absorption				
Cost Type	*Account code*			
Production Unit – 01	151.001			
Material Cost Code -001	711.001			
Job Type Code - 001	721.001			
Machine Type Code - 001	731.003.001			

Direct materials issued and direct labor hours used are recorded manually on the production order and accounted real-time using selected accounts and costs of materials and labor hours. When there are too many production orders being processed at the same time, manually recording direct resources for each production order is difficult within ERP systems. This is usually the case when there are too many products or BOM semi-finished product levels and numbers at each level. This sometimes happens when engineering BOMs are not interpreted well for production and cost use. Engineering BOMs are required to be modified

by considering production stages and semi-finished products stocking requirements. Unnecessary semi-finished products should be eliminated from engineering BOMs for production.

MRP runs produce too many production orders for products and semi-finished products. These production orders are used in planning, scheduling, and accomplishing production. But resources used in these production orders are not recorded by order, correctly. Actual resource usages are tracked by production units, not production orders usually within ERP systems. As a result, even direct resources are not usually tracked in production by production orders (and products). Instead, all materials issued and resources used in production are absorbed into production orders using BOMs for consumed materials and routing operations for labor hours. In this respect, ERP systems use standard direct material quantities and labor hours with actual unit costs to calculate actual product costs which are explained in Section 3.4.2.

3.4.2. Production Costing Transactions

In this section, we explain the transactions related to production costing to show their use and relation to cost accounting within standard ERP systems. Job shop production and flow shop production environment transactions are studied for automating costing. Production orders created for planning are released to production to accumulate production costs under WIP in job shop production environments. Whereas, production batches created usually during production completions are used to accumulate production costs for different products under production departments (named as production units in this thesis) within WIP in flow shop and/or continuous production environments. The real-time production cost flow diagram of an ERP system is presented in Figure 3.15 at the end of this

section to show the costing and accounting relations of production transactions on a summary reference diagram.

Production costing transactions can be listed as follows in common:
1. Production orders release for job-shop production costing and accounting,
2. Production batches generation (back-flash) for flow-shop production costing and accounting,
3. Material issues to production transactions,
4. Employee timekeeping and machines usage transactions,
5. Product completion transactions,
6. Product costing transactions.

We next discuss each of these under the following sub-sections.

Production orders release for job-shop production costing and accounting

Production orders are created manually or as a result of MPS-MRP runs of production planning for each product and semi-finished product defined within BOM structures at Production planning and control modules of ERP systems by using production order creation transactions. When a production order is created as planned, the product that will be produced, production quantity, completion date, material requirements list created from current BOM, and operations list created from current routing are recorded together with production order as its planning production data. This planning data is used in production as guides for material retrievals and work center production operations performances when production orders are released to production. Actual materials used, labor hours worked and Machine hours used are recorded on the same production orders to compare actual to planned resource usages. Actual material retrievals and labor hours worked are also used to determine the actual direct material and actual direct labor cost of the

production order after production completion. WIP accounts are defined for each work order to be debited for material, labor, and overhead costs.

Production batches generation (back-flash) for flow-shop production costing and accounting

Instead of production orders, production batches are created to record and accumulate production costs in flow-shop production environments. Production batches are created under production units (departments) which are defined during master data definitions and explained in Section 3.4.1. While production batches are used to keep costs of products for each batch in production, batch costs are aggregated to associated production units in accounting. So, WIP sub-ledger accounts are usually defined for each production unit in accounting for flow shop production environments.

Production batches are created while recording product completions at shift ends, or whenever requested within production shifts, called back-flushing. Batches record and keep actual data about product completed, quantity, completion date, and resources used in the production as in production orders. Back-flash transactions usually pull materials and other resources automatically using planned data arranged for production units of flow production. It is possible to edit and modify recorded actual production data manually on batches, afterward.

These batches are used to create production journals to debit defined WIP production unit accounts for direct material, direct labor, and standard overhead cost of the production.

Material Issues to production transactions

There are 2 main transaction types of material issues to production as direct material issues and indirect material issues within ERP systems. Material issues to production orders and batch orders (production orders and batch orders together will be referenced as orders) are taken as direct material issues. Material issues to cost centers are taken as indirect material issues. Materials are issued from material inventories to WIP. Semi-finished products are issued from lower-level production orders or WIP inventories to this level orders. Materials and semi-finished products are consumed in quantity within orders or cost centers (for indirect materials) to produce this level of semi-finished or finished products. Unit costs and quantities of issued materials (materials and semi-finished products) are recorded under the orders for calculating direct material costs.

Material issue transactions are manual material pushes to production. Material pulls are also possible by automatically calculating material requirements using planning BOMs copied to orders, upon recording the completion of products within ERP systems. For automatic material pull transactions to happen, dedicated WIP inventories are usually defined on planned product BOMs within ERP systems. Material transfers to these dedicated WIP Inventories are done manually with actual material transfer quantities. But, the material pulls from these inventories are done automatically using planned quantities. So, variance in remaining material quantities between the system quantity and count quantity is interpreted as less or more material pull to orders than actual material consumption. This variance is determined by making physical counting at period ends. Less pulls causing excess inventory quantities are corrected using counting issue transactions (excess cost in inventory can be transferred to overhead with counting transactions accounting within ERP systems). More pulls causing negative inventory quantities are corrected using counting receipt transactions (negative cost in inventory is removed

by creating (getting) cost from counting accounts using counting transactions accounting within ERP systems).

Employee timekeeping and machines usage transactions

Actual labor hours worked for released production orders or production units are recorded using employee time card transactions, by employee and job types. Actual labor hours recorded under the production orders or the production units are used for calculating direct labor costs.

Actual machine hours used for released production orders or production unit batches are recorded using machine usage transactions by machines and machine types. Actual machine hours used are recorded under the production orders or the production units for allocating overhead associated with machines depreciation and related cost. While unique machine depreciation and related costs are periodically determined and debited to the associated cost centers at period ends, it is possible in ERP systems to allocate this cost to production orders or production units using machine type rates at the time machine usage transactions are recorded like direct materials and direct labor. So, machine depreciation and related costs are also defined as a variable in this respect. But the cost type of machine depreciation and related costs are taken to be indirect costs and classified in overhead costs. This is because production machines as part of fixed assets are defined as long-term assets with sunk costs to be depreciated periodically in total as indirect and fixed costs regardless of their direct use in production processes, throughout their predetermined life.

Product Completion transactions

Product completion transactions are used to complete and transfer produced products to next-level production orders, production units, or inventories from this

level production orders or batches. Production batches are also created when product completion transactions are executed to record product completion data within batches for repetitive or flow shop production environments, while production orders are created during production planning for job shop production environments. Service products are usually produced using production orders.

Product costing transactions

After product completions are recorded using product completion transactions explained above, the unit costs of completed products are calculated automatically and used in inventory costing and accounting by integrating product completion transactions to accounting within ERP systems. This is the case when the number of product types (and orders) processed in production at the same time is not too many. In practice, it is not usually possible to correctly assign direct material quantities and direct labor hours to orders for costing when the number of orders processed in production at the same time is too many. So, the unit costs of completed products are usually not correct when product completion transactions are recorded. It is empirically proven that this data needs to be analyzed before use. Partial product completions and overhead allocations according to incomplete direct material and/or labor hour data (used as allocation criteria) also cause difficulties in calculating real-time product costing and accounting within ERP systems. This data is usually collected from production and recorded to production orders continuously as production proceeds. Electronic barcode systems are installed in warehouses and production floors to collect this data correctly, in real-time.

The companies successfully using ERP systems usually calculate actual unit costs of products produced at period ends (monthly or quarterly) without making any cost calculations of produced products within the period. As a result, WIP accounts, finished goods inventory accounts, and cost of goods sold accounts are

86

debited and credited by generating batch journals at period ends. To overcome this challenging task, different applications of standard and normal costing techniques can be used for real-time actual product costing and accounting within ERP systems.

When the number of orders processed in production at the same time is too many for recording material issues and labor usage for each, automatic pulling systems are devised for products with BOM and routing operations defined within ERP systems. Production order product completion transactions can trigger material issues and labor and machine usage transactions for issues of BOM materials and routing operation labor and machine hour usages to production orders as in back-flashing transactions used in flow-shop or repetitive production. This assures the direct material, direct labor and overhead costs to be transferred to WIP in equal proportions of product completions using standard costing, real-time. One drawback of this practice is the late debit of WIP accounts if lead times are long for product completions. Even so, it is better than order costing and period costing where partial costing is not possible. Another drawback is that variances between actuals and standards can't be analyzed for each production order. Instead dedicated Inventory and cost center (linked to work centers) residuals (remaining balances) are analyzed for variances.

Excess residuals in dedicated inventory accounts for direct material costs and cost center accounts for labor costs are processed at period ends to be allocated to completed products of the period as updates to standard costs. WIP accounts, finished goods inventory accounts, and cost of goods sold accounts are debited and credited by generating order journals at period ends in accounting for these excess variances. The quantity and amount of these residuals are also used as indicators of the correctness of standard costs.

A real-time production cost flow diagram generated from production transactions of an ERP system is given in Figure 3.15.

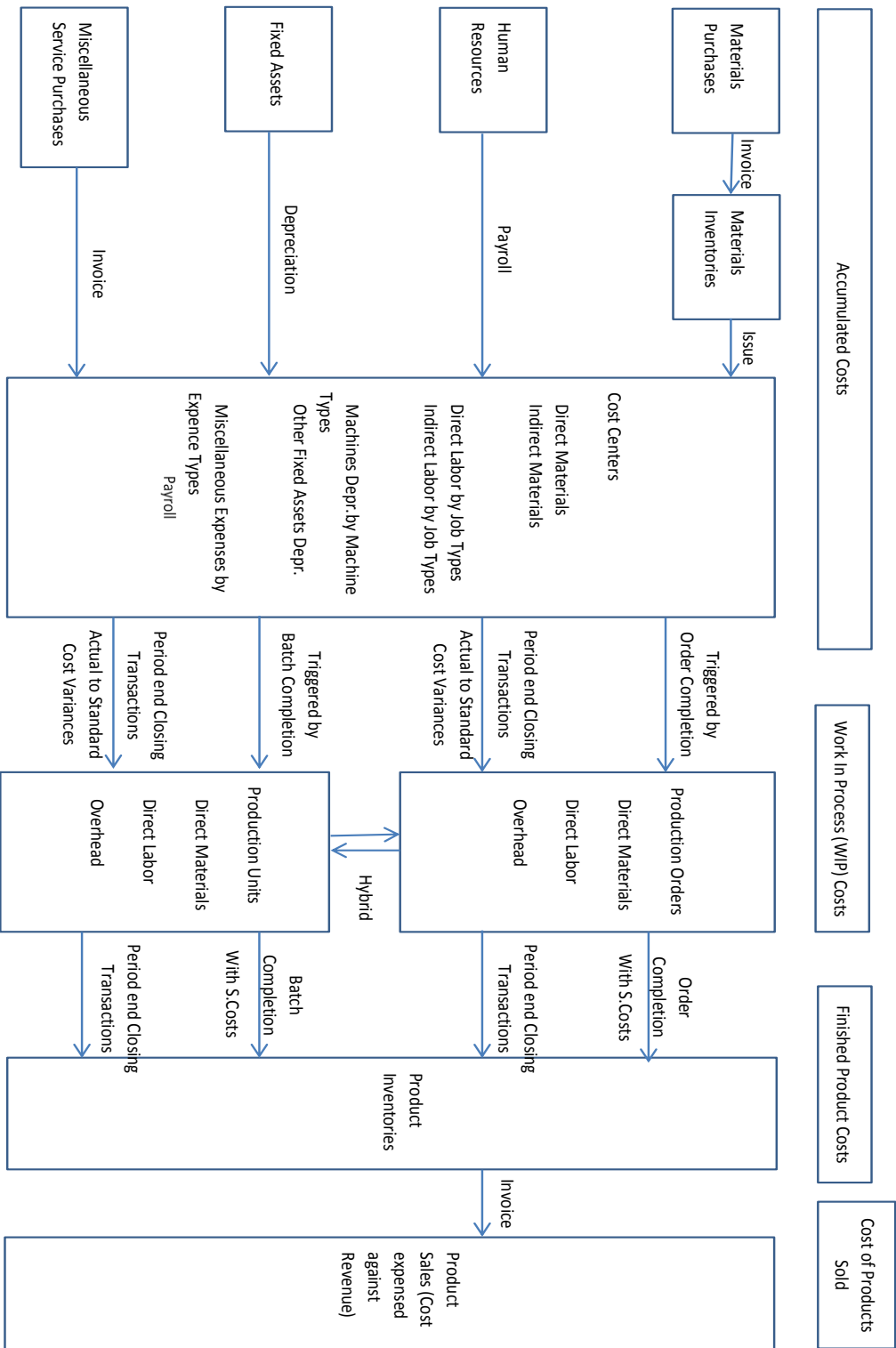**Automatic Real Time Production Cost Flow with Integrated Transactions within ERPs:**

Figure 3.15. Standard ERP real-time production cost flow diagram

3.4.3. ERP database data model of production transactions and costs

Database data structures needed within ERP systems for Installing and integrating production to cost accounting are introduced to enhance production module designs and installations of ERP systems concerning cost accounting. Table and table field names are regenerated to be self-explanatory to show the integration data relationships on database data table and field level.

ERP database data model of production definitions and production costs are given in Figure 3.16 to show the relationships on the database data table and field level.

BomHeader table:
BomHeader _Id, BomCode, BomName, ValidityStart, ValidityFinish, Status

BomProduct table:
BomProduct _Id, BomHeader _Id, ProductCode_id, BomProductQuantity

BomMaterial table:
BomMaterial_Id, BomHeader _Id, MaterialCode_id, BomMaterialQuantity

Operation table
Operation_id, OperationCode, OperationName, OperationDescription

BomRouting table:
BomHeader Id, OperationPrecedence, Operation_id, WorkCenter_id,
AverageProductionQuantity, PlanningSetupHours, PlanningRunHours,

BomRoutingOperationResource table
BomRoutingOperationResource_id, Operation_id, ResourceType, ResourceType_id,
ResourceQuantity, ResourceSetupHours, ResourceRunHours

ProductStandardCost table
ProductStandardCost_id, ProductType, Product_id, CostType, ResourceType, Resource_id,
ResourceQuantity, ResourceRate, ResourceCost

Figure 3.16. The data model of production master data definitions and transactions used in costing

WorkCenter table
WorkCenter_id, WorkCenterCode, WorkCenterName, CostCenter_id

WorkCenterResource table
WorkCenterResource_id, WorkCenter_id, ResourceType, ResourceTypeCode_id,
ResourceUnit, ResourceCapacity

ProductionUnit table
ProductionUnit_id, ProductionUnitCode, ProductionUnitName

ProductionUnitWorkCenter table
ProductionUnitWorkCenter id, WorkCenter_id, PrecedenceOrder

CostCenter table
CostCenter_id, ResourceType, ResourceTypeCode_id, ResourceUnit, ResourceUnitRate

ProductionOrderCost table
ProductionOrderCost_id, ProductionOrder_id, CostType, ResourceType, Resource_id,
ResourceQuantity, ResourceRate, ResourceCost

ProductionBatchCost table
ProductionBatchCost_id, ProductionUnit_id, Batch_id, CostType, ResourceType, Resource_id,
ResourceQuantity, ResourceRate, ResourceCost

Note1: Underlined fields are foreign keys
Note2: ProductionOrderCost table is filled for order costing records created during product
completions. ProductionBatchCost table is filled for process costing records created during
batch completions.

Figure 3.16(continued). The data model of production master data definitions and
transactions used in costing

The data model for integration definition to automatically determine the Work In
Process costing ledger accounts and create journal entries from production costing
results of Production planning and control modules within ERP systems is given in
Figure 3.17 to show the integration on the database data table and field level.

WorkInProcessCostLedgerAccounts table:

WorkInProcessCostLedgerAccounts_Id, ProductionOrder_id,
ProductionUnit_id, ProductionBatch_Id, LedgerAccount_id

Note : Underlined fields are foreign keys

Figure 3.17. The data model for integration definition of production resource costs to related WIP ledger and sub-ledger accounts.

In this chapter, we discussed how all the resources used in production are defined, integrated, and used for cost accounting within ERP systems. It is intended to show that while common master data definitions and integration of direct resources and processes are powerful and complete, indirect resource and process definitions are not practical and complete within ERP systems.

CHAPTER 4

ABC CAPABILITIES OF ERP SYSTEMS

As all the industries in the world are moving toward more automated production processes, overhead amounts are getting bigger and bigger compared with direct costs. ERP systems have limitations in processing overhead by standardizing indirect work. For this reason, we discuss how ABC can be utilized in ERP systems to better process overhead and have a more correct product costing and budgeting of overhead with standardization. Indirect material, resource, and process cost (overhead) definitions for standardization and integration to cost accounting within ERP systems are hypothesized to be not complete. Overhead definition and integration to accounting using the technique of activity based costing (ABC) within ERP systems are studied and presented in this chapter to overcome this limitation for the companies that have high overhead amounts and many product types.

In this chapter, we study and apply ABC logic to ERP systems to have proper system tools to formulate (standardize) indirect work and allocate overhead costs to products using common master data definitions, like direct costs. Standardization of indirect work also lets budgeting of indirect work by resource types as in direct work within ERP systems. For example, machine costs (depreciation and other machine-related indirect costs like maintenance) are regarded as indirect costs and are accumulated and allocated to products within the overhead. But, machine types and machine hours used in direct work are defined within production operations and this data can be used to calculate machine usage costs of products, using unit usage hours and usage rates as in direct labor cost calculation, by applying the ABC technique.

In accounting terms, the ABC technique is the allocation of overhead using multiple cost pools and cost drivers, in contrast to using one cost pool and driver to allocate overhead in TCS. Each cost pool accumulates a categorized cost of overhead. A cost driver is defined for each cost pool to allocate the accumulated cost to all common products according to the cost driver's usage in products production. Here, unit cost driver rates are determined by dividing budgeted cost pool amounts by total budgeted cost driver quantities to be used in standard costing as overhead costs of products within the budgeting period. This interpretation (and application) of the ABC technique in determining overhead costs of products is insufficient business-wise, which is the extension of TCS to allocate overhead where total overhead is distributed to all products by a single (or few) cost driver. ABC is not just a costing technique that allocates and/or distributes manufacturing overhead using different (multiple) distribution criteria for categorized manufacturing overhead costs, but its logic mainly includes the techniques used to standardize indirect work (Cooper and Kaplan, 1998).

Integrating indirect resources to cost pools to automate overhead accumulation and allocation is done by standardizing indirect work (activity definitions), named business process definitions within ERP systems. Business processes can also be regarded as dynamic categorization definitions of overhead costs (cost pools) through indirect resource usage formulations. The applications of ABC within ERP systems exist. But its implementation to have successful cost accounting systems within enterprise systems is rare. Companies are reluctant in using ABC systems because of their complexity compared with traditional costing systems (TCS). ABC technique is studied to introduce further improvements and enhancements in the design and implementation of the technique within ERP systems.

Standardization of indirect work and allocation of overhead as the application of the ABC technique is discussed in Section 4.1. An integrated ABC module proposal is presented in Section 4.2.

4.1. Standardization of Indirect Work and Allocation of Overhead

In traditional costing within ERPs, indirect work is not standardized as in direct work. So, resource requirements used in indirect work can't be determined (planned) using budgeting rules of direct resources and direct costs. Capacity requirements and availability checks of these resources used in indirect work (including variable resources) are ignored during budgeting periods (yearly budgets).

The types, quantities, and amounts of resources needed in indirect work are not generated from budgets within ERPs, because indirect work is not standardized and related to the products. Indirect work is not standardized because it is not necessary in traditional costing (work order costing and period costing) where direct labor hours are usually used to distribute overhead to products. When ABC has been introduced in the 1990s, implementation for standardization of indirect work has also been a necessity to be able to apply ABC properly within ERP systems.

Standardization of indirect work is not as easy as that of direct work within ERP systems. The difficulty arises from relating indirect work with products correctly. Another difficulty is the lack of appropriate modules designed for this purpose within ERP systems.

Periodic indirect resource costs that comprise production overhead costs are indirect materials, indirect labor, production facilities and equipment (fixed assets),

and miscellaneous direct purchases (service expense types) whose definitions within ERP systems are studied in Chapter 3.

Overhead can't be categorized properly and used in allocating overhead to the products because the categorization is made with ease of expense budgeting in accounting. Instead, overhead categorization should be done according to resource usage by indirect processes within production. Business processes (activities in ABC terms) are defined to make this categorization dynamically as part of production master data definitions for integration within ERP systems.

Standardization (formulation) of some specific common indirect work will be presented to show how to define activities to implement ABC techniques within ERP systems. Activities are defined in master data integration definition screens named business processes within ERP systems, to dynamically allocate formulated indirect resource costs (depreciation, maintenance, etc.) to products processed.

4.1.1 Formulation of hourly costs of production machines to dynamically allocate machine-related indirect costs (depreciation, maintenance, etc.) to products processed

➢ Classify the machines according to the usage and production rate. Machines used for the same purpose with the same production rates need to be taken as a unit for simplicity. These machine classes are also going to be used in planning (production and capacity) and standard cost calculations.

➢ Define activities (using business process master data definition screens within ERP systems) for each machine class with machine class names, define usage unit as hours, and # of separate machines of the machine class. Note: It is useful (but not a must for costing) to link each separate machine to its machine class one by one together with its available capacity in hours. Then available capacity hours (# of separate machines x available capacity

of one machine in hours) can be calculated automatically by summing the capacity of each machine.

➢ Define allocation bases (drivers) for defined activities of machine classes. Machine hours defined within product routing's operations should be defined as allocation base since machines usage hours are already defined in operations setup and run hours by machine types.

➢ Arrange and define separate manufacturing overhead accounts for the depreciation costs of each machine class under associated cost centers of work centers.

➢ Calculate per hour average energy consumption rates in kWh for each machine class and link to the defined activities for each machine class, as a resource.

➢ Link the related "maintenance of machines" activity as a sub-activity to the associated machine class's activity definition by determining the # of maintenance order units of the sub-activity needed per 1-hour usage of the machine class.

➢ Determine the average m2 area of the production facility occupied by 1 machine and link the production facility usage resource to the activities defined for each machine class with the area determined.

➢ Define separate production facilities depreciation and facilities maintenance manufacturing overhead accounts.

An example activity definition is defined and presented in Figure 4.2 for plasma cutting machines of a manufacturing company using ABC logic and master data definitions within the proposed ERP system, virtually.

4.1.2 Formulation of the cost of 1 purchase order's processing to dynamically allocate purchase order processing costs to associated products

➢ Classify purchase orders according to the processing difficulty and procurement lead time of the orders. Define activities for each purchase

order class with purchase order class names. Define allocation unit as each order, allocation base as the material or service being purchased.

➢ Define allocation base as the material or service being purchased.

Note: Purchase order processing costs should be allocated (added) to the cost of the material or service being purchased. But in cost accounting, because this cost class is considered within manufacturing overhead, this cost has to be allocated to related subassembly or product, somehow. This can be done by dividing period material purchase quantities to EOQ of materials and summing the results for each lowest level semi-finished product of the materials using BOM data, dynamically. Purchase order processing cost per 1 order of each class defined for ABC is also used in EOQ calculation of materials as the coefficient for the cost of placing 1 order.

➢ Classify purchasing personnel working in purchase order processing work by job type. Determine labor hours by job types needed for processing 1 purchase order of each class, as a resource. Link the resource to the activity defined for its class.

➢ Determine office supplies and related purchasing department expenses needed for processing 1 purchase order of each class, as a resource. Link the resource to the activity defined for its class.

The studies of this section are taken as analysis documents to be used in the definitions of integrated ABC module proposal within ERP systems explained and presented in Section 4.2.

SAP® and Likom Gusto® are checked for the standardization of indirect work using these guidelines. One has no tools to define ABC activities properly for standardizing indirect work. Instead, cost pools are defined in accounting, and drivers are used as allocation criteria to allocate actual costs from cost pools to

WIP at period ends, which is the extension of TCS. It can be said that TCS is used for standard costing within this software. SAP has tools to define ABC activities using business process definition screens within the software. This software links activities to products by making manual data definitions between activity allocation units and product cost drivers for each product, as direct cost definitions. Manual data definition between activity allocation units and product cost drivers for each product is not necessary for indirect work. Definition tools are required to link activity units to cost drivers in general (independent of products), since cost drivers are parameters taken from product-related data already defined for products within BOMs, routing operations, product definitions, etc. All these limitations are considered in Section 4.2 for the requirements of the proposed ABC module within ERP systems.

4.2. An integrated ABC module proposal within ERP systems

An integrated ABC module design is suggested to overcome the limitations and improve the extent of ABC within standard ERP systems. Master Data Definitions for the suggested ABC module are presented in Section 4.2.1. ERP database data model of the ABC module is presented in Section 4.2.2.

4.2.1. Master Data Definitions for ABC module within ERP systems

Activity cost driver types are variable production parameters that are used to relate business processes with products. While drivers are determined by analyzing the product's variable production data, drivers should not be referenced to any product. Drivers should be general variable production parameters that are used to allocate unit business process costs to all applicable products sharing the parameter in common. Some common variable production parameters as mentioned before are "Direct labor hours for a job type", "Direct labor cost for a job type", "Direct

material cost", "Machine hours of a machine type", "Unit product volume" and "# of orders of products".

Activity types are formulations to relate indirect resources to unit indirect work. They function like operations of direct work. Operations defined for direct work are linked to products through routings directly. In contrast, activities should be linked to all associated products automatically through activity cost drivers (named allocation base in ABC) using allocation logic, programmatically. An example activity definition for PCM machines of a manufacturing company is given in Table 4.1

Table 4.1. Example activity definition for ABC within ERP systems

Activity Type	Activity Unit	Activity Driver	Resource Type	Quantity	Cost per unit
PCM Maintenance	Order	Order		1 order	500 USD/order
			Foreman	10 hours	23.00 USD/hr
			Cutting head (spare)	1 each	270.00 USD/each

Indirect resources are the resources used in indirect work. Some main indirect resource types are indirect materials, indirect labor as job types, fixed asset types as machine types, and miscellaneous service expenses defined as service expense types. These resources are defined hierarchically in resource units (named resource drivers in ABC) to calculate resource costs in units to be used in activity unit cost calculation formulations. An example indirect resource definition for 'foreman' indirect labor type is given in Table 4.2

100

Table 4.2. Example resource definition for ABC within ERP systems

Resource Type	Resource Driver	Item Type	Quantity	Cost per Hour
Foreman	Hour		1 hour	23.00 USD/hr
		Salary	1 each	20.00 USD/hr
		Office Space	12 m2	0.10 USD/m2/hr
		Computer and supplies	1 each	1.80 USD/hr

Indirect cost centers (named cost pools in ABC) are sources where indirect costs are accumulated by resource types. These costs are allocated from these cost centers to the product's overhead through activity definitions.

Hierarchical relationships of ABC master data definitions together with production planning and control master data definitions from a cost accounting perspective are presented in Figure 4.1. In the Figure, 'Enterprise' is used to stand for the ERP system of any organization. Enterprises usually have more than one legal unit (hence more than one ledger). Production costing hierarchy with ABC is valid for each legal unit of any organization. Production costing hierarchy with ABC levels are classified and coded as 'Production unit codes' and 'Production order codes' on the right top side of Figure 4.1 for correspondence with WIP accounts. Indirect resource costs are allocated to WIP through 'Activity codes' shown on the right-center side of the figure, using resource formulations within activities, and activity cost drivers shown on the production costing hierarchy. Ledger and sub-ledger hierarchy levels are given on the left side of Figure 4.1 to show the correspondence for integration within the hierarchy.

The figure contains the following elements:

Top banner: Production Costing Hierarchy with ABC

Left side labels: Account Codes; Ledger; Sub Ledger(wip); Sub Ledger(expense)

Right side labels: Integration Codes; Production Unit Codes, Production Order Codes; Activity codes; Material Cost Codes, Job Type Codes, Machine Type Codes, Cost Center Codes, Expense type codes

Central hierarchy:
- Enterprise
- Legal Unit (Company)
- Work In Process(WIP)
- Production Units (Cost Driver05)
- Production Orders (Cost Driver04)
  - Material Reflection → Material Cost → Cost Centers → Material Types / Materials (Cost Driver01)
  - Labour Reflection → Labor Cost → Cost Centers → Job Types and Workers (Cost Driver02)
  - Overhead Reflection → Overhead Cost → Cost Pools → Machine Types And Machines (Cost Driver03) / Indirect Resources
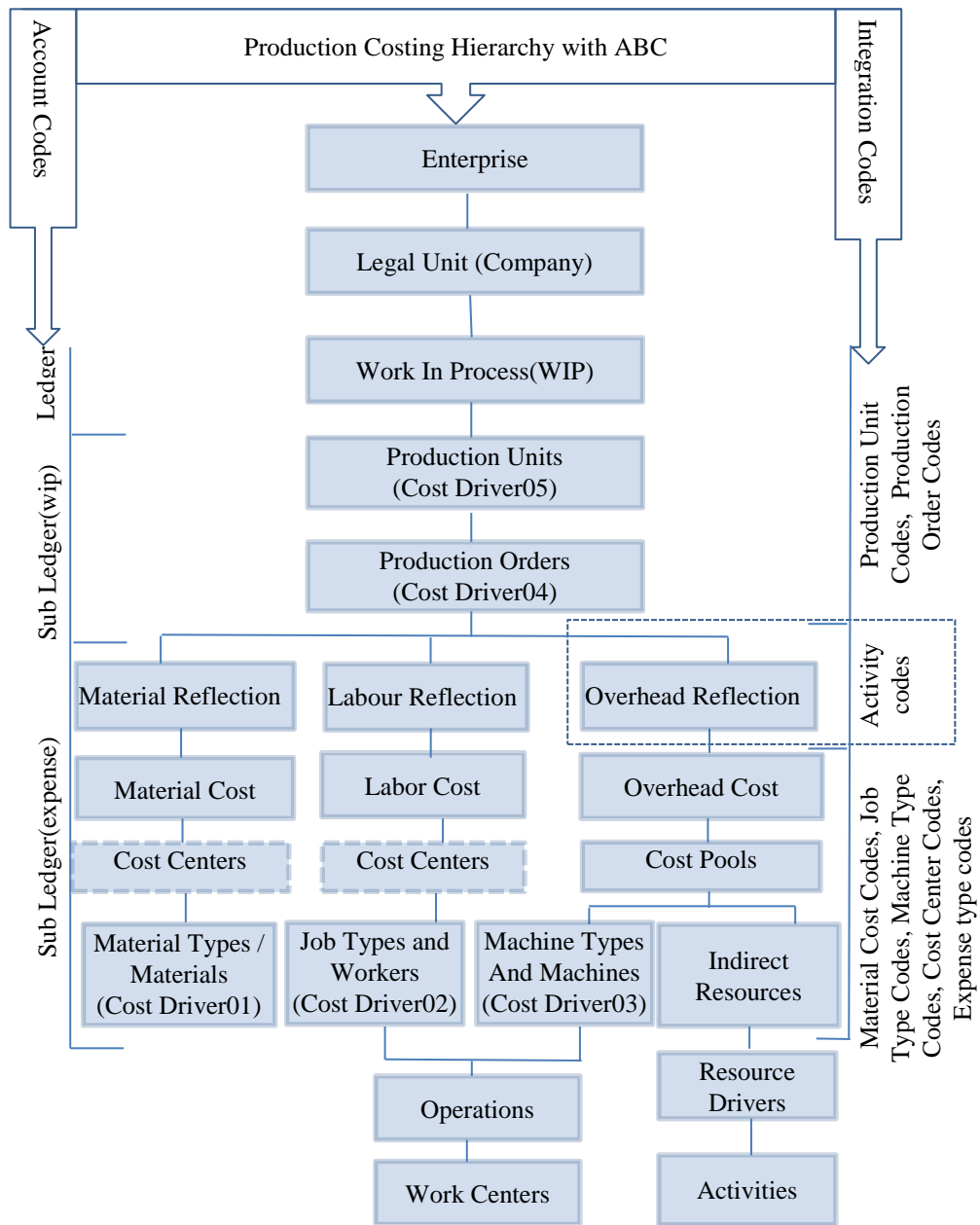- Operations → Work Centers
- Resource Drivers → Activities

Figure 4.1. Hierarchical relationship of production costs to ledger WIP inventory accounts including ABC

Master data definitions are made for hourly usage costs of a manufacturing company's Plasma Cutting Machines (PCM) with the guidelines given in section 4.1.1, as an example for ABC master data definitions within ERP systems. Definitions are shown on a report output format given below in Figure 4.2.

ABC master data definitions for plasma cutting machines (PCM)

Activity Code: BP-001

Activity Name: Plasma Cutting Machines usage   Unit: Hours

Driver Type: Resource Usage   Resource Name: Plasma Cutting Machines   Unit: hours

Driver Scope: All Operations   Activity Unit to Driver Conversion Formula: 1

Resource Type	Resource Name	Unit	Quantity	Cost Center	Cost Type	Rate
Machine	Plasma Cutting	Hour	1	CC-001	Depreciation	20.00 $
Misc.Expense	Electricity	kws	10	CC-001	Expense	0.10 $
Activity	PCM MaintenanceOrder		0.001*		Internal Service	500.00 $
Facility	Production Hall 1 M2		15**	CC-099	Depreciation	2.00 $

* 1 Maintenance order is placed for each 1000 hours usage of 1 PCM Machine

** 15 m2 is occupied by 1 PCM Machine together with WIP stocking area in Production Hall 1

Figure 4.2. ABC master data definitions within proposed ERP system for machines usage in production.

4.2.2 ERP database data model of ABC implementation within ERP systems

Database data structures needed within ERP systems for Installing and integrating ABC techniques to cost accounting are introduced to enhance ABC capabilities of ERP systems concerning cost accounting. Table and table field names are regenerated to be self-explanatory to show the integration data relationships on database data table and field level.

ERP database data model of ABC definitions and overhead allocation calculations are given in Figure 4.3 to show the relationships on the database data table and field level.

AllocationBases table:
AllocationBases _Id, TargetType, TargetScope, TargetQuantity, TargetUnit

BusinessProcess table:
BusinessProcess _Id, BusinessProcessName,

BusinessProcessDrivers table:
BusinessProcessDrivers_Id, BusinessProcess _Id, InternalService_Id, Quantity, Unit,
AllocationBase_id, AllocationBaseQuantity, AllocationBaseUnit

BusinessProcessOutcome table:
BusinessProcessOutcome_Id, BusinessProcess _Id, InternalService_Id, Quantity, Unit

BusinessProcessMaterials table:
BusinessProcessMaterials_Id, BusinessProcess _Id, MaterialType_id, CostCenter_Id, Quantity, Unit

Note : Underlined fields are foreign keys

Figure 4.3. The data model of ABC definitions and transactions

BusinessProcessJobTypes table:
BusinessProcessJobTypes_Id, BusinessProcess _Id, JobType_id, CostCenter_Id, RequiredHours

BusinessProcessFixedAssetTypes table:
BusinessProcessFixedAssetTypes_Id, BusinessProcess _Id, FixedAssetType_id, CostCenter_Id, Quantity, Unit

BusinessProcessMiscellaneousResources table:
BusinessProcessMiscellaneousResources _Id, BusinessProcess _Id, MiscellaneousResource_id, CostCenter_Id, Quantity, Unit

BusinessProcessesInternalServices table:
BusinessProcessesInternalServices _Id, BusinessProcess _Id, InternalService_Id, CostCenter_Id, Quantity, Unit

Note : Underlined fields are foreign keys

Figure 4.3(continued). The data model of ABC definitions and transactions

The data model for integration definition to automatically determine overhead ledger accounts and create journal entries from overhead allocation calculation results of ABC modules within ERP systems is given in Figure 4.4 to show the integration on the database data table and field level.

WorkInProcessCostLedgerAccounts table:
WorkInProcessCostLedgerAccounts_Id, ProductionOrder_id, ProductionUnit_id, ProductionBatch_Id, LedgerAccount_id

Note : Accounting integration table defined in Production Control Module is also used for overhead allocation to products using business processes. Business Processes function as resource cost collectors from cost centers and allocators of these costs to WIP products using drivers.

Figure 4.4. The data model for integration definitions of ABC to ledger and sub-ledger accounts

CHAPTER 5

CONCLUSION

In this thesis, the extent and limitations of managerial accounting within standard ERP systems are studied to show how to design and implement accounting integrated enterprise systems using ERP software, for medium to large companies. The study is conducted for all functional modules of a standard ERP. Master data definitions, transactions, and data relations on a relational database data model are presented for each module to show how to integrate module operations to automate product costing and accounting.

Two commercial ERP software packages are checked for their master data definitions, transactions, and data relations as examples for the current extent of integration and automation. A manufacturing company's virtual ERP system data is used to present examples of integrating business operations to managerial and financial accounting within ERP systems.

ERP systems are demanded and used by medium to big companies in the world. While they are used to operate and manage all business operations in one common system in real-time, there are some drawbacks of using them also. Delaying transactions or instant operator errors realized late cause wrong real-time data within ERP systems. Further, ERP systems have real-time data processing tools to process this wrong data to be used in all functional modules. ERP systems are argued to be dangerous in this respect for supplying real-time data and information for decision-making. Correcting wrong historic data/information is not also an easy task within ERP systems. Usually, correcting virtual new transactions are entered to correct results, when the inconvenience is realized. As a result, wrong data and information in periods remain and accumulate within ERP systems. This causes

inconveniences in business operations that are mentioned in the articles and is witnessed by myself working as MRP-II and ERP functional consultant for more than 25 years.

As technology grows, more automated organizations (factories) are being installed. The direct labor cost of production is decreasing while overhead costs are increasing with automation. Accumulation and allocation of overhead to products are getting more important for medium to big-sized companies with many products. By standardizing indirect work and associating the standardized work with products using drivers, budgeting of indirect resources and direct allocation of the cost of resources (used in indirect work) to products is made possible within standard ERP systems.

ABC implementations of current ERP systems are regarded as an accounting activity where multiple cost pools are defined in accounting and multiple drivers are used as allocation criteria to allocate actual overhead costs from cost pools to WIP at period ends, which is the extension of TCS. Instead, tools for activity and resource formulations and definitions on business processes within functional modules are required within ERP systems. For this, a separate integrated sub-module (named as business process definition and integration) is proposed to define indirect work using the ABC technique for activity and resource definitions within ERP systems. Some common indirect work examples are studied and presented for explaining how to standardize and define indirect work within ERP systems, using ABC techniques to help understand the logic. Then, integrated business process sub-module master data definitions, transactions and database data models within ERP systems are studied and presented.

Developers and implementers of ERP systems are expected to take this study as a reference in their ERP projects for integrating business processes to managerial accounting for automating product costing, budgeting, and accounting to have real-

time costing and accounting. Database data models are presented to help developers to see master data integration definitions on the database data table and field level. Table and field names are specifically given as self-explanatory by using the same master data type names described within the sections. So, table and field explanations are not given explicitly.

REFERENCES

Aytaç, A., Eker M., 2017. The Role of ERP in Advanced Managerial Accounting Techniques: A Conceptual Framework, Business and Economics Research Journal, Volume 8, Number 1, pp. 83-100.

Chapman, C.S., 2005. Not because they are new: developing the contribution of enterprise resource planning systems to management control research, Accounting, Organizations and Society, Vol. 30, No. 7/8, pp. 685-689.

Cooper, R. and Kaplan, R. S., 1998. The Promise - and Peril - of Integrated Cost Systems, Harvard Business Review, July-August.

Ferrari, A. M., Volpi, L., Settembre-Blundo, D., García-Muina, F. E., Dynamic life cycle assessment (LCA) integrating life cycle inventory (LCI) and Enterprise resource planning (ERP) in an industry 4.0 Environment, Journal of Cleaner Production Volume 286, 1 March 2021, 125314.

Grabski, S. V., Leech, S. A., Schmidt, P., J., 2011. A Review of ERP Research:A FutureAgenda for Accounting Information Systems, Journal of Information Systems, Vol. 25, No. 1, Spring 2011, pp. 37–78.

Granlund, M. and Malmi, T., 2002. Moderate impact of ERP SYSTEMS on management accounting: a lag or permanent outcome?, Management Accounting Research, 13, 299–321.

Gunasekaran, A., Sarhadi, M., 1998. Implementation of activity-based costing in manufacturing, Int. J. Production Economics, 5657, 231-242.

Jacobs, F. R., Ted, F.C., Weston, Jr., 2007. Enterprise resource planning (ERP)—A brief history, Journal of Operations Management, 25 357–363.

Kabataş Y., Pamukçu A., 2010. TMS – 2 Stoklar Standardı Kapsamında Hizmet Üretim Maliyetlerinin Muhasebeleştirilmesi, Muhasebe ve Finansman Dergisi, dergipark.org.tr, 191-199.

Kaplan, R. S., 1986. Accounting Lag: The Obsolescence of Cost Accounting Systems, CALIFORNIA MANAGEMENT REVIEW Volume XXVIII, Number 2.

Kitsantas,T., Vazakidis, A. and Stefanou, J. C., 2020. Integrating Activity Based Costing (ABC) with Enterprise Resource Planning (ERP) for Effective Management: A Literature Review, Technium Vol. 2, Issue 7 pp.160-178.

Lahikainen, T., Paranko, J. & Seppanen, M. 2000. "Implementing Activity-Based Costing in an Enterprise Resource Planning System", 11th International Working Seminar on Production Economics, 1, p. 158.

Meigs, R. F., Meigs, W. B., Meigs, M. A., 1995. Financial accounting, 8th edition

Malinic, S., Todorovic, M., 2012. How Does Management Accounting Change under the Influence of ERP?, Economic Research-Ekonomska Istraživanja, 25:3, 722-751, DOI: 10.1080/1331677X.2012.11517531

Pazarceviren S. Y., Ozsuer U., 2015. A MODEL SUGGESTION FOR ACTIVITY BASED COSTING IN THE ERP SYSTEM, European Scientific Journal August 2015 /SPECIAL edition/

Polimeni, R. S., Fabozzi, F. J., Adelberg, A. H., 1991. Cost accounting: concepts and applications for managerial decision making, 3rd edition, pages 3, 5.

Rashid, Hossain and Patrick, 2002. The Evolution of ERP Systems: A Historical Perspective, Idea Group Publishing, page 3.

Rom, A., Rohde, C., 2007. Management accounting and integrated information systems: A literature review, International Journal of Accounting Information Systems, 8 40–68.

Sadagopan, S., 2002. Enterprise Resource Planning, in Encyclopedia of Information Systems, Academic Press, Volume II, pp 169-184

SAP SE, 2021. Sap Documentation. Activity-Based Costing (CO-OM-ABC), https://help.sap.com/doc/704ad953189a424de10000000a174cb4/3.6/en-US/frameset.htm,"Copyright © 2021 SAP SE, All rights reserved."

Shields, M. G., 2001. E-business and ERP: Rapid Implementation and Project Planning, John Wiley & Sons, 2001, p. 2

Spathis, C., and Constantinides, S., 2004. Enterprise resource planning systems' impact on accounting processes, Business Process Management Journal Vol. 10 No. 2, pp. 234-247.

Sutton, S.G., 2006. Enterprise systems and the re-shaping of accounting systems: a call for research", International Journal of Accounting Information Systems, Vol. 7, No. 1, pp. 1-6.

Svobodova, L., 2015. Managerial Accounting and Utilization of Software, American Scientific Publishers Advanced Science Letters.

Troche, G., 2009. Activity-Based Rail Freight Costing: A model for calculating transport costs in different production systems, Doctoral thesis.

Vakalfotis, N., Ballantine, J., Wall, A., 2011. A Literature Review on the Impact of Enterprise Systems on Management Accounting, 8thInternational Conference on Enterprise Systems, Accounting and Logistics (8th ICESAL 2011), Thassos Island, Greece.

Wylie, L., 1990. ERP: a vision of next generation MRP II. Computer integrated manufacturing. Scenario, Gartner Group, Stamford, CT, Internal report 12 Apr 1990, S-300–339.

APPENDIX A: Definitions

Enterprise Resource Planning (ERP): The integrated operation and management of all business processes of an organization in real-time, by using the software. Enterprise resource planning (ERP) software standardize and integrate all business processes across finance, human resources, procurement, production, distribution, and all other departments. Real-time operation and management of business processes by using ERP software integrate and continuously update views of core business data within common databases maintained by a relational database management system. ERP systems contain selectable software modules, such as accounting and finance, human resources, manufacturing, project management, CRM (Sales), Supply Chain Management (Purchasing), and distribution. Organizations select among these modules according to their business requirements. Usually, purchasing, sales, distribution, finance, and accounting are the core bundled modules that have to be purchased and used together.

Managerial Accounting: The accounting system that provides the information to measure product costs and performance and control the operations of a firm (Polimeni et al., 1991). There is not a separate Managerial Accounting Module within ERPs. Budgeting and Cost Accounting modules of ERPs include most of the processes of Managerial Accounting.

Cost Accounting: The traditional term used for Managerial Accounting is Cost Accounting (Polimeni et al. 1991). Managerial Accounting and Cost Accounting terms are used interchangeably in the literature. ERP Cost Accounting module includes processes that use Budgeting, Financial Accounting, Production, Purchasing, Sales and Inventory modules data to calculate and evaluate product costs. Calculated product costs are used, in reverse, for inventory valuation,

pricing, profitability analysis and cost of goods sold transactions automatically, within ERPs.

Product: In production terms, a product is defined as a "thing produced by human labor or effort" or the "result of a human act or a process". In marketing, a product is any good, service, or idea that can be offered to a market to satisfy a want or need. Goods are physical products. A service is a non-material action. Ideas are any creation of the intellect (like patents). In cost terms, a product is anything that is created or value added by using resources classified as Direct Materials, Direct Labor, and Overhead. In retail, products are called merchandise. In project management, products are the formal definition of the project deliverables that form the objectives of the project. When all the characteristics of a product are predetermined during the design, the product is predefined as exact within ERP systems. When combinations of characteristic values of a designed product are unlimited or too much to be defined for each combination during design, the product is defined as configurable (generic) within ERP systems.

Product costing types in accounting: Product costing types in accounting are determined according to the inclusion of variable and fixed manufacturing overhead and period costs to unit product costs as given in the following formulas. "Absorption Costing" is used in core accounting and inventory valuation within ERP systems, which is also a must for financial accounting according to "Generally Accepted Accounting Principles (GAAP)". "Variable Costing" is used in Contribution Margin, Break-Even, and CVP Analysis calculations.

> "Absorption Costing" = "Direct Material Costs" + "Direct Labor Costs" + "Variable Manufacturing Overhead Cost" + "Fixed Manufacturing Overhead Cost".
>
> "Direct Costing" = "Direct Material Costs" + "Direct Labor Costs" + "Variable Manufacturing Overhead Cost" ("Fixed Manufacturing Overhead Cost" is excluded).

"Variable Costing" = "Direct Material Costs" + "Direct Labor Costs" + "Variable Manufacturing Overhead Cost" + "Variable Period Expense Costs".

Product costing types in cost accounting: "Absorption Costing" is used in cost accounting with "Actual Costs". Actual costs are used in financial accounting. But actual product costs cannot be determined until the end of costing periods. For real-time costing used in ERP systems, standard or normal product costs are used in transactions to allocate costs to production and products. At period ends, variances are determined and accounted to achieve actual costs. Standard Cost, Normal Cost, and Actual Cost calculation formulas are as follows.

Standard Cost = Standard Material Cost + Standard Labor Cost + Standard Manufacturing Overhead Cost

Normal Cost = Actual Material Cost + Actual Labor Cost + Standard Manufacturing Overhead Cost

Actual Cost = Actual Material Cost + Actual Labor Cost + Actual Manufacturing Overhead Cost

Activity Based Costing (ABC): is the name for the technique used to allocate production overhead to products using multiple allocation criteria, in accounting. It is also the name of the technique used to standardize indirect work by defining activities. Within ERP systems, activity types of indirect work are named as "Business Process", not to mix with activity definitions of project-based production.