

**MICROCOMPUTER USAGE IN PRODUCTION MANAGEMENT  
IN SMALL MANUFACTURING BUSINESSES**

By

**OSCAR ACUÑA**

Bachelor of Science

Costa Rica University

San José, Costa Rica

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IN SMALL MANUFACTURING BUSINESSES

Thesis Approved:

*Michael Branson*

Thesis Adviser

*John W. Reynolds*

*David E. Mandville*

*Thomas C. Collins*

Dean of the Graduate College

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## CHAPTER I

### THE PROBLEM AND ITS SETTING

#### Introduction

When the computer was first developed in the 1940's, only large, major business firms could afford to have a computer. This has changed since the 1970's with the introduction and development of the large scale integrated chips which made possible the manufacture of microcomputers. The result has been affordable computer power within the reach of every business. With the development of microcomputers, small businesses can now afford to buy a computer which has more computing power than the first commercial computer, UNIVAC I, delivered in 1949.

Past researchers (*Lai[10]*, *Raymond and Magnenat[15]*, *DeLone[4]*, *Ein-Dor and Segev[7]*) indicate that application of microcomputers to production management which has proved to be a very effective route to a significant improvements in efficiency in large companies, was not until recently easily achieved in small companies. The effect of computerization of small businesses in the field of production management is still very limited.

This study was designed to determine if small manufacturing businesses are actually purchasing and using microcomputers, and if so, for what production applications, the source of software used, and the level of satisfaction with the performance of the systems.

## **Statement of the Problem**

This research study evaluates how small businesses (less than 250 employees) use microcomputers in the field of production management and what specific applications they are currently using or are planning to use in the near future. The benefits of the use of microcomputer technology in that area, level of satisfaction with its utilization and the sources of the software are the issues that are analyzed.

This research develops guidelines for prioritizing areas to computerize when small businesses start computerizing the field of production management. A second benefit of this research is to serve as a guideline for design of marketing strategies for software development companies.

## **Subproblems**

1. The first subproblem is to analyze the areas in which microcomputers are used in production management and develop a list of the most widely computerized activities in the small-business environment. This list is used in the survey of this research to measure the level of computerization in each area.
2. The second subproblem is to determine which areas have already been computerized by companies and which areas they plan to computerize in the near future. The impact of computerizing production management activities is also discussed.
3. The third subproblem is to determine the main purpose of the companies in computerizing production management activities.

4. The fourth subproblem is to determine the source used to acquire the software: self-developed, off-the-shelf or custom programming.
5. The fifth and last subproblem is the evaluation of the level of satisfaction of the companies with the software used and the impact of computerizing the production management activities. We also assess whether or not the level of satisfaction differs with the source of the software.

## **The Importance of the Study**

The Small Business Administration of the United States estimates that 97% of all American firms are small businesses, and account for 43% of the GNP. The introduction of microcomputers into small businesses has a tremendous impact on their ability to operate efficiently. Prior research, on the influence of microcomputer use in small businesses was restricted almost exclusively to particular areas such as accounting, inventory and purchasing.

Given the importance of microcomputer usage, the field of production management application in manufacturing firms requires more attention in general and in specific areas such as production planning, production control, materials control, forecasting, production costing and quality control. Two specific benefits are expected from this research study:

1. The first benefit is to obtain guidelines that can be used as reference for new small or existing small businesses when these companies computerize their production management systems. These guidelines present:
  - The major areas in which management of small businesses invest resources, computerize methods and procedures and why they choose these areas within production.
  - The major sources from which small businesses obtain their software for production management.
  - The perception of the users and companies about the effectiveness of the applications of computers in the field of production management.

2. The second benefit of this research study is in the area of marketing strategy for software developing companies. The objective is to determine the applications for which software could be improved or developed using the feedback of the companies being surveyed. This research study is focused on production management. It also can be a base for potential software development and improvement of productivity based on computerization.

### **Definition of Terms**

For the convenience of the reader, terms used in this study are defined here.

Business: A particular money-earning activity or place, such as a shop, factory, etc. .

Computer: An electronic machine for processing information automatically and very fast.

Computer program: A set of instructions to computers written in a computer language, that tells it to perform a particular task.

Computerization: The installation of computers as part of a process of automation.

Costing: The establishment of the actual and predicted costs (labor, materials, overhead) of the manufactured products.

Combinations: Programs made using macros in off-the-shelf programs such as spreadsheets.

Custom programming: The firm contracts with computer/software consultants to develop specific software. Generally speaking, contractors will also provide support and training to the firm.

Effectiveness: The capacity to produce the desired result.



Forecasting: The prediction of future (unknown) values of certain parameters, e.g. quantities of new orders for products.

Mainframe: Large, powerful, centralized computer..

Manufacturing: To make or produce by machinery. For the purpose of this research, manufacturing excludes businesses like fast food, newspapers and copy centers, souvenirs and hand-crafted products including artistic products. The definition involves only organizations where a production department can be clearly identified and, most of the time, the articles, goods, or products for use or consumption are distributed to the customer indirectly through retail outlets.

Materials control: The management and control of work in progress and finished products.

Microcomputer: Is defined as Personal Computers (PC) of the series 286-386 or 486 (DX and SX), Pentium, and AT-XT compatibles, Macintosh microcomputers are included in this group.

Off-the shelf: Software obtained from discount or other computer stores; these come with little or no support from vendors but are generally inexpensive. Some support may be available from other organizations, such as community colleges, small accounting firms and small computer entrepreneurs offering training services.

PC: Personal Computer, equivalent to a microcomputer.

PC-LAN: Local Area Network. A group of microcomputers interconnected.

Production: (1) The output which is the result of the functioning of men, materials, machinery, and tools, as well as other equipment, working according to plan, and using

the machines, materials, and tools in the proper and most efficient manner. (2) All the processes involved in providing goods and services to the market, from the extraction of raw materials to the retailing of finished products.

Production Management: It consists of those functions associated with the production process and the administration of the resources involved (people, equipment, materials, energy, money and facilities ). Production Management includes direction of all the activities necessary to achieve the objectives of a production department or equivalent. It involves the use of equipment and people and the direction of individual effort in their accomplishment of their assigned duties. Production Management functions include planning, organizing, staffing, directing and controlling people, machinery, raw materials, energy, money, facilities, time and all the sources of the Production Department.

Production Management utilizes a multiplicity of principles and practices to develop a consistent way to accomplish desired results.

Production Control: It consists of the feedback of data indicating the current status of work which has been launched into manufacturing.

Quality control: The use of procedures to confirm that the products purchased and manufactured conform to specification.

Self-developed software: All software applications that may have been developed and maintained in-house by the business.

Small Business: A proper balancing of production and human resources, as well as facilities, so as to evolve the greatest amount of profits. The number of employees in this level of business is not over 250.

Smorgasbord: Labeled as “other” software sources.

Software: The computer programs, codes and other support materials available for use with particular hardware.

## **CHAPTER II**

### **REVIEW OF LITERATURE**

#### **Introduction**

This research considers the use of microcomputers in small manufacturing businesses. Therefore, the first part of this chapter explores the past and current state of microcomputers. The second part involves the effects of introducing microcomputer technology in small businesses and the computerization of production management applications. The third section deals with the software including variables such as sources and software applications. Finally, the chapter finishes with a summary of the aspects analyzed.

#### **The Microcomputer**

The first electronic computer was developed in 1943, but it was the development of microcomputers which established the boom of computerization in small businesses. The first commercial microcomputer, known as the MITS Altair 8800, was built in early 1975 by a group of engineers who operated a small electronics firm in New Mexico. At the same time, the microcomputer went almost unnoticed, except by scientists and hobbyists with the expertise to communicate with it in machine code, the most rudimentary, and hence difficult, of all computer languages.

The microcomputer revolution was well underway by the time the IBM PC (Personal Computer) arrived on the scene. The Apple II and VisiCalc had already initiated a small revolution in American business. Radio Shack's TRS-80 Models I and III and the various Commodore PET machines showed that personal computers could be cost-effective tools for business. A broad range of CP/M machines assembled from board-level products by system integrators provided some of the early high-end computing power in the micro market.

The original IBM came with 16KB memory, a floppy disk drive that held a scant 160KB, a monochrome monitor, and a copy of DOS that did little more than let you use your disk drive. All of this cost about \$2,900 [13].

The same amount of money (which has less value because of the inflation) can buy a mail order clone with a Pentium ® 80586 microprocessor (more powerful than the original PC) running at 66 MHz (roughly six times faster) with 8 MB of memory (512 times more), both 1.44 MB and 1.2 MB floppy disk drives, and a 200 MB hard drive (more than 1,500 times the storage capacity) [28]. These microcomputers can run applications in areas such as accounting, production planning, production control, materials control, quality control, forecasting, simulation, etc. Moreover, the use of software like Windows ® makes interaction between users and microcomputers easier. Small businesses can now afford to buy microcomputers and take advantage of this technology.

The almost-instant success of the IBM PC drew a flock of competitors. Many appeared for a moment and disappeared quickly; the Seequa Chameleon, the Columbia

MPC, and the Otrona Attach were among them. Others arrived in the market from a variety of directions and are still involved to varying degrees; Compaq and Texas Instruments are two good examples.

The second response to the business market was the IBM XT and compatibles. Essentially the same as PC, it came with a 10 MB hard disk. In recognition of the fact that users were stuffing their computers full of expansion cards for memory, I/O ports, interfaces for scanners, network adapters, and more, IBM also increased the number of slots to eight, which is the number of slots found in most computers today. The XT came with separate hard disk and floppy disk controllers and a small board with a single serial port included. Before long users demanded, more storage, more processing speed, and better displays. The IBM AT was born.

The AT case was taller than XT case to allow for taller expansion boards. The 80286 ran at a speed of 6 MHz, which was faster than the 4.77 MHz used by the PC and XT. IBM initially outfitted the AT with a 20 MB hard drive, but later offered a 30 MB drive as standard. A new floppy disk-the high density 5.25-inch drive with a 1.2 MB formatted capacity-made its first appearance. Users also got a better display from IBM. The Enhanced Graphics Adapter, or EGA, gave 16 colors with 640x350 resolution.

About this time, clone competition began in earnest. Clock speeds were one way clone manufacturers could offer better performance than IBM, so they began to produce XTs that ran at 6, 8 and 10 MHz. AT-compatible machines with 286 CPUs running at 10, 12, 16 and even 20 MHz were produced.

The quest for greater computing power continued. Intel produced the 80386 (and 80386 SX ) and searched for success through the PS/2 line with its new Micro Channel expansion bus and the OS/2 operating system. The 386 chip is a 32-bit processor with a 32-bit data bus. Running at speeds of from 16 to 33 MHz, it offers plenty of power for almost any desktop application. The chip has the magical ability to simulate multiple 8088 computers running at the same time. This allows users to run more than one program at a time and still retain the full value of standard DOS application without having to change over to new versions for more different operating systems. The release of Windows 3.0 in the summer of 1990 made it easy and practical to use this feature [28].

Intel wanted to bring 32-bit computing to more people, so in an effort to make it affordable, the company developed the 386 SX which is a 386 with a 16-bit data bus. The dream was to make a chip that was a plug-replacement for the 286, but the reality fell a little short. Still, SX motherboards are easier to design and cheaper to build, so the SX machines have replaced the AT-compatibles as the entry level machines for business. Typical configurations included 1 or 2 MB of memory and 40 to 90 MB hard disk, about the same as AT-compatibles of comparable speed were equipped [18].

The other major new development is in the area of displays. The PS/2 products came with VGA (Video Graphics Array) adapters built into motherboard. This can display up to 256 colors in 320x200 resolution or 16 colors in 640x480 mode [13].

The 386 microchip was supplanted by the 486 microchip. Intel's 486 incorporates functions, such as memory cache and math co-processor, which in the past were functions served by separate chips. Now comes the new development of Intel, the 80586 and 80686

microprocessors. The speed and power of the 80586 and 80686 (pentium) are even greater than their ancestors with speeds from 60 to 100 MHz [17].

The introduction of peripheral hardware such as CD-ROM permits easier and faster access to information. Typical configuration currently includes 8 or 16 MB of memory and a 1000 to 2000 MB hard disk.

Nowadays, microcomputers are cheaper, faster, more friendly and accessible for small businesses than they were in the past. The development of this technology will continue and the computerization of small businesses will be even easier. Applications in production management are also available for a reasonable price. The question now is how fast will small businesses absorb this technology and what their results will be.



## **The Introduction of Microcomputers in Small Businesses**

A number of researchers state the impressive growth of the use of microcomputers in small businesses during the last decade. Nazem [20] states that the remarkable progress in both hardware and software technology in the later 70's has made microcomputer technology a desirable management tool for small businesses. A similar opinion is given by Farhoomand and Hrycyk: "Because of the tremendous technological push in the computer market over the last few years, numerous small businesses have decided to automate their operations ([10] p. 15)."

Another aspect that is mentioned by Nazem [20] is the decline in price that has made computerized information processing not only available, but also affordable to small businesses. The fact is that over the years, small businesses have become a substantial force in the microcomputer industry. The trend of computerization of small businesses is likely to continue in the foreseeable future.

Looking at the future, Nazem [20] predicts that as technology matures and users become accustomed to it, opportunities will open up for many applications of benefit to management of small businesses. Also, as technology becomes less expensive, computerization should become affordable to many small businesses, particularly very small ones. Yet another force is fear of the unknown. Microcomputers are increasingly becoming a part of our lifestyle, both for pleasure and business. This changing environment eliminates resistance and more and more people will be knowledgeable in this technology and appreciate its potential benefits; they are therefore, more receptive to its use in the business environment.

A collateral important aspect related to computerization is competitiveness. Lai [14] states that the introduction of microcomputers into small businesses has had a tremendous impact on their ability to operate efficiently and enhance the decision-making process through the computer-based information system. If small businesses do not participate in this process, they can lose their market share. Computerization has become a requirement to modern life.

As it has been stated, the introduction of microcomputers in small businesses is an important issue that requires further attention, given the high speed level of change that computerization presents. The effects of the use of microcomputers in the area of production management is an interesting issue.

## Software: Sources and Applications

This section concerns two aspects of software; first, where it is acquired and second, the main software applications pursued by small businesses. About the first aspect, Nazem [20] states that while the computer industry is reaching maturity, the software industry still remains volatile. Then Nazem states:

Much of the success of small business computerization depends on the availability of the software that is both affordable and easily used. It is difficult to evaluate the software environment: sources of software vary substantially [20, p. 95.]

Although small businesses obtain their software from a variety of sources, some researchers such as Farzad-Hrycyk [10], Haugen [12] and Nazem [20] have defined four major source classifications that can be easily identified as follows:

- *self-developed*, which includes all applications software that may have been developed and maintained in-house by the business;
- *off-the-shelf*, software obtained from discount or other computer stores; these come with little or no support from vendors but are generally inexpensive. Some support may be available from other organizations, such as community colleges, small accounting firms and small computer entrepreneurs offering training services;
- *custom programming*, where the firm contracts with computer/software consultants to develop specific software. Generally speaking, contractors will also provide support and training although may not be able to provide adequate and prompt support;
- *smorgasbord*, including sources which are not included in the above, labeled as “others” .

Farzad-Hrycyk's research in small business presents the following results in this area (note that each company can use more than one source at the same time):

The market survey demonstrated that 66% of small businesses use packaged programs; 50% use customized programs; and 30% use self-programmed software. Over 58% cited software as the most or second important factor to consider in the computerization process [10, p.19].

The second aspect to be considered in the computerization process is software applications. The present research deals with production management applications; consequently, a list of production management applications has to be developed in order to evaluate the uses of micro-computers in manufacturing firms. Sharp-Muhlemann [26] deals with the identification of the principal (core) production management applications in which the computer could be used in small companies. Table I presents the list of applications defined in this paper.

**Table I**  
**Production Management Applications of Computers in Small Companies**

---

Forecasting	Production Planning
Production Progressing	Materials Control
Quality Control	Costing
Product Development	Personnel Health & Safety
Plant/Machine Maintenance	Transport and Distribution

---

Raymond [22] and Nazem [20] present two different lists of computerized applications in small firms. A comprehensive list is showed in Table II.

**Table II**  
**General Applications of Computers in Small Companies**

---

Accounts receivable	Accounts payable
General ledger	Billing
Payroll	Sales analysis
Inventory	Fixed assets
Order entry	Cost accounting
Budgeting	Purchasing
Forecasting	Production control
Production scheduling	Word processing
Personnel	

---

Moreover, Haugen's research [12] referring to applications in small businesses says that 20% of the initial applications are accounts receivable/billing, 16% are general ledger accounting applications, 16% are payroll applications, 11% are accounts payable applications, and 11% of the applications are inventory control.

Therefore, about 75 % of the initial applications are one of these five types.

Haugen continues:

Approximately two-thirds of the current applications are from the same five types that were most used initially: accounts receivable/billing, general ledger accounting, payroll, accounts payable/writing checks, and inventory control. The decrease in percentage would indicate that the business has spread its computer usage to other types of business applications. The other four types of business applications receiving the most current usage beside those five listed above are: order processing, purchasing, sales forecasting, and budgeting. The two types of business applications with the largest gain in usage from current to future usage is budgeting and word processing ([20] p.105).

Haugen's research does not mention any production management applications for computers in small businesses. Certainly, the research includes not only manufacturing,

but also retailing business; however, applications in production management are not mentioned as an important application area in the survey.

### **Summary**

Micro-computers that have been developed after the 70's include: the IBM PC, AT, XT, and the 286, 386, 486 and 586 series. It includes clones and others which are not compatible to IBM such as Macintosh, Commodore, Amiga, etc.

Only a few researchers have addressed the case of the use of computers in small businesses. Past research (*Lai [14], Raymond and Magnenat [22], DeLone [5], Ein-Dor and Segev[9]*) indicates that the application of computers to production management has proved a very effective route to significant improvements in efficiency in large companies, was, until recently, not easily achieved in small companies. The study of the uses and effects of computerization in the field of production management in small businesses is still very limited. Moreover, the reasons promoting computerizing production management applications is not clear.

A review of the literature has shown that small businesses are being affected by the rapid changes in technology currently taking place in the computer industry. Therefore, it is important to asses the effect of microcomputers on small manufacturing businesses.

A review of software acquisition presents four basic sources. Moreover, a list of software applications is presented; it is used as a base for developing the questionnaire.

## **CHAPTER III**

### **METHOD OF INVESTIGATION**

#### **Introduction**

This study was designed as a descriptive study in order to obtain data from small manufacturing businesses in the state of Oklahoma concerning their utilization of microcomputers in production management. The present chapter presents the research tools used to gather data, the population and the sample size considered and the design and administration of the survey instrument used.

#### **Research Tools Used**

Two research tools that were used in this study are as follows:

1. A questionnaire was developed and pre-tested for mailing to small manufacturers. After mailing the questionnaire, a reminder was also mailed out to help increase the response rate. The survey instrument was sent to a randomly selected sample of small manufacturing businesses in Oklahoma. Questionnaires were directed to the Production Director (or equivalent) in the manufacturing firms.

The questionnaire includes:

- an individual, one page dated cover letter printed on headed paper;
- a four page questionnaire printed on both sides of the paper;
- questions laid out spaciouly with a vertical answer format;

- a self-addressed stamped envelope to return the questionnaire;

A postcard follow-up was sent several weeks after the first mailout to the companies that had not answered the questionnaire.

2. Due to an anticipated low response rate to the mail survey, a phone survey was used as a follow-up. The phone survey sample was randomly selected from businesses that did not return the questionnaire in the mail survey. The intention was to determine if there was a substantial difference between response and non-response with the mail survey. The questionnaire for this survey was the same as used in the mail survey.

A summary of the results of the research was sent to those companies that responded to the questionnaire.



## The Population

This research considers the use of microcomputers in the area of production management in small manufacturing businesses. In this context, the population to be analyzed is restricted to manufacturers with less than 250 personnel in the State of Oklahoma.

According to Fowler (1993), generally, little is known about the characteristics of individual population members before data collection, which is this case. Fowler (1993) states:

It is uncommon, however, for at least a few characteristics of a population to be identifiable at the time of sampling. When that is the case, there is the possibility of structuring the sampling process to reduce the normal sampling variation, thereby producing a sample that is more likely to reflect the total population than a simple random sample. The process by which this is done is called stratification (p. 15).

Thus, the stratified samples will produce sampling errors that are lower than those associated with simple random samples of the same size for variables that differ (on average) by stratum, if rates of selection are constant across strata. Given this reasoning, stratification is going to be performed in order to select the firms:

- The alternative of studying only certain manufacturing sectors is considered. Figure 1 shows the size distribution of manufacturing facilities in Oklahoma. The groups *Industrial Machinery (981 companies)*, *Printing and Publishing (805)*, *Metal Fabricating (573)*, *Food (353)* and *Stone-Clay & Glass (351)* are the most important sectors, based on the number of facilities [1]. However, most of these sectors will not be considered as part of the population of this research for the following reasons:

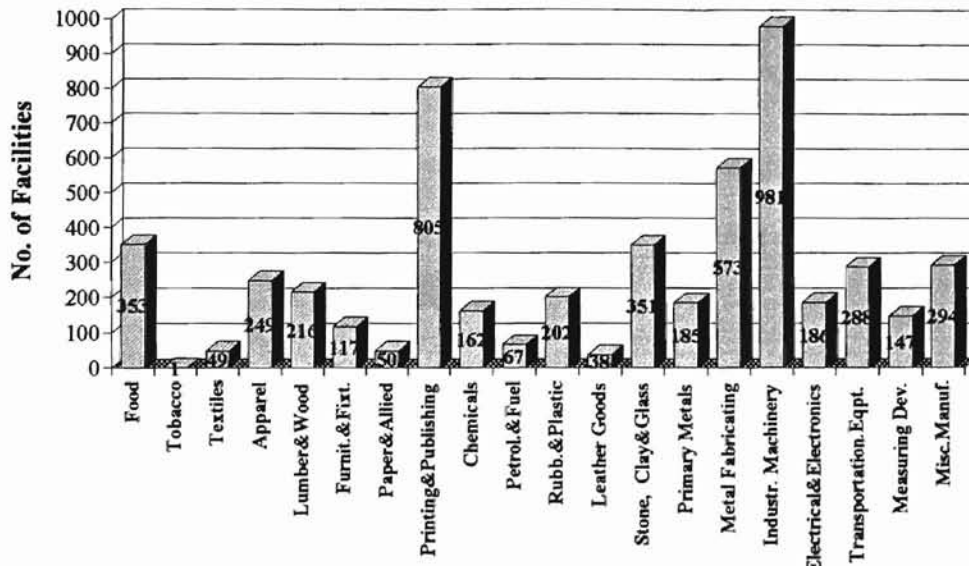
1. Many of the companies included in the sector *Printing and Publishing* are newspapers and magazines. These companies utilize microcomputers in production, but mainly in applications such as word processing which is not an area of interest for this research. If including this sector, the rate of use of microcomputers may appear higher than it really is. Moreover, the definition of “manufacturing” of this research (page 6) excludes these types of businesses.
2. The sector *Metal Fabricating* will not be included because of its similarity with the sector *Industrial Machinery*. In order to create a sample that is more likely to evaluate the total population, this sector will be substituted for another sector.
3. The sector *Food* includes an important number of companies in the fast food business. The definition of “manufacturing” of this research also excludes these types of businesses.
4. The sector *Stone-Clay & Glass* mainly involves production of souvenirs and hand-crafted products including artistic products. These types of products are not considered “manufacturing” products in this research.

The second group of sectors involving an important number of manufacturing facilities are: *Transportation Equipment (288)*, *Apparel (249)*, *Rubber&Plastics (202)*, *Electrical & Electronics (186)*, *Lumber and Wood (216)* and *Chemicals (162)*. All these sectors will be considered as part of the population except for *Transportation Equipment* and *Lumber and Wood*. The first will be excluded because that sector has a very small number of small manufacturers (10%), and the second *Lumber and Wood*

because it includes an important number of souvenirs and hand-crafted products, including artistic products. As it was stated before, these type of products are not considered as “manufacturing” products in this research.

In conclusion, the following sectors were surveyed: *Industrial Machinery, Apparel, Rubber and Plastics, Electrical & Electronics and Chemicals.*

**Figure 1. Oklahoma Manufacturing Facilities by Major Sector, 1994**

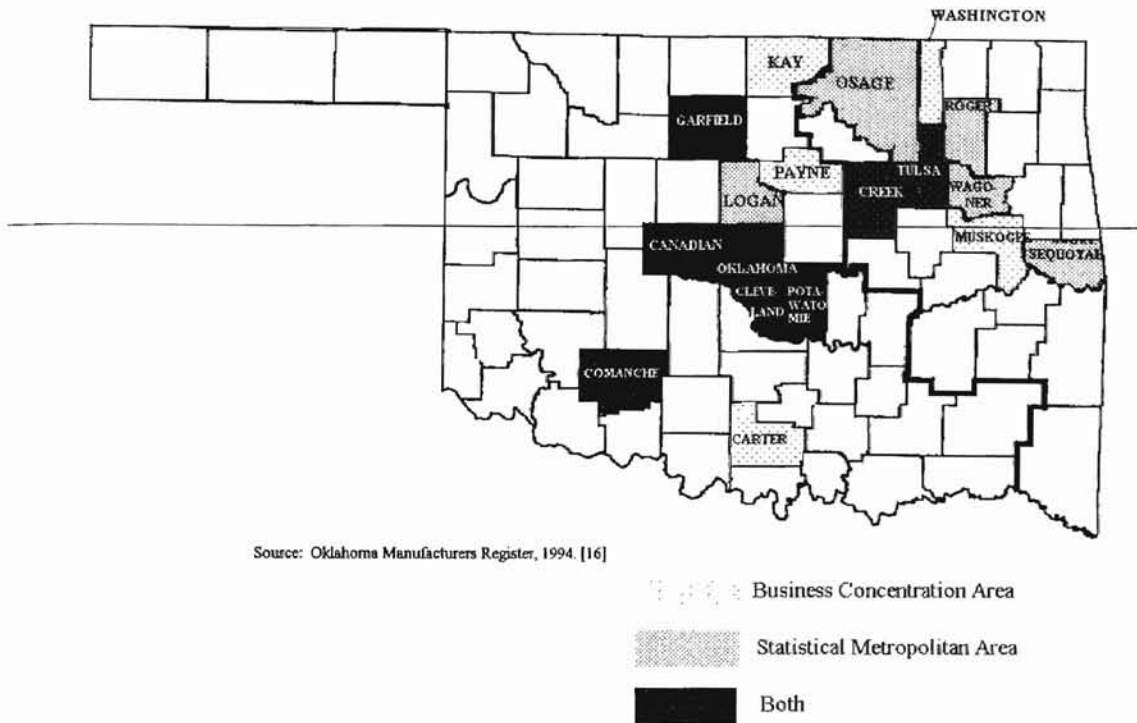


Source: US Manufacturers Directory, 1994. [1]

- Geographical Business Concentration and Statistical Metropolitan Areas: Figure 2 shows a map of Oklahoma divided by counties (with Business Concentration Areas and Statistical Metropolitan Areas). Since there is a high concentration of businesses in *Oklahoma county* (3373 businesses) and *Tulsa county* (3072 businesses) [16], these zones are selected for the study. In addition, counties in the Statistical Metropolitan Areas with more than fifty industries, counties in the Business

Figure 2. Oklahoma

Statistical Metropolitan and Business Concentration Areas



Concentration Areas and other counties with more than 50 industries are also included. These counties are: *Canadian, Carter, Cleveland, Comanche, Creek, Garfield, Grady, Kay, Mayes, Muskogee, Ottawa, Payne, Pontotoc, Pottawatomie, Rogers, Stephens and Washington*. The basic reason for the selection of this counties is to consider business in urban areas. It is assumed that the companies in these counties have better access to microcomputer hardware and software suppliers and higher level of support in the area of microcomputers. Moreover, the selected counties hold 80% of the industries of Oklahoma.

In conclusion, the sampled population of the present research is limited to certain industrial sectors of small manufacturing businesses in the urban areas of the State of Oklahoma. Table III shows the distribution of the population of the research by sector and county; as it can be seen the population of this research is 1349 small manufacturing businesses which represents 72% of the manufacturers of the sectors selected.

**Table III**  
**Population Used in this Research**  
**Industrial Sectors and Counties Selected**

COUNTIES SELECTED IN THE POPULATION	SECTORS SELECTED					TOTAL
	Apparel & Fabrics products	Chemicals	Rubber & Plastic Products	Industrial & Machinery Eqpt.	Electrical & Electronic Eqpt.	
	Canadian	3	2	3	13	
Carter	3	2	2	11	2	19
Cleveland	5	3	4	20	4	36
Comanche	3	2	3	12	2	23
Creek	5	3	4	20	4	36
Creek	5	3	4	20	4	36
Garfield	4	3	3	16	3	29
Grady	3	2	3	13	3	24
Kay	5	3	4	19	4	34
Mayes	3	2	3	12	2	23
Muskogee	4	3	4	17	3	31
Oklahoma	55	36	45	217	41	393
Ottawa	3	2	3	13	2	24
Payne	4	2	3	15	3	27
Pontotoc	3	2	2	12	2	22
Pottawatomie	3	2	3	13	2	24
Rogers	5	3	4	21	4	37
Stephens	3	2	3	14	3	25
Tulsa	65	42	53	256	49	464
Washington	3	2	2	12	2	22
Total Population used for the survey	189	123	153	743	141	1349
Total Manufacturers across all Oklahoma Counties	249	162	202	981	186	1876
Percentage of Manufacturers Included in the Survey	75%	76%	76%	76%	76%	72%

Source: Oklahoma Manufacturers Register, 1994. [16]

## The Sample

An important reason for selecting the sample size is the economical constraint for this research. The actual resources of the researcher can cover approximately 300 surveys, according to estimation of cost per survey. This will be the initial sample size of this research.

Table IV, taken from Fowler (1993) is a generalized table of sampling errors for samples of various sizes and for various proportions, provided that samples were selected as simple random samples. The standard error of a proportion can be calculated with the following formula:

$$e = \sqrt{\frac{p(1-p)}{n}}$$

*e = the standard error of a proportion with 95 % of confidence level.*

*p = proportion having a characteristic*

*n = size of the sample (number of surveys completed and returned)*

Each number in the table represents two standard errors of a proportion. The table gives 95% confidence intervals for various samples sizes ( $z=1.96$ ). As an example, given a sample of 100 with a proportion of 20/80 over certain variable, the table says we can be 95 % sure that the true figure is  $20\% \pm 8\%$ , i.e., 12% to 28%.

**Table IV**  
**Confidence Ranges for Variability Attributable to Sampling**

Sample Size	5/95	10/90	20/80	30/70	50/50
35	7	10	14	15	17
50	6	8	11	13	14
75	5	7	9	11	12
100	4	6	8	9	10
200	3	4	6	6	7
300	3	3	5	5	6
500	2	3	4	4	4
1000	1	2	3	3	3
1500	1	2	2	2	2

Note: This table describes variability attributable to sampling. Errors resulting from nonresponse or reporting errors are not reflected in this table. In addition, this table assumes a simple random sample. Estimates may be subject to more variability than this table indicates because of the sample design or the influence of interviewers on the answers they obtained; stratification might reduce the sampling errors below those indicated here.

Despite the fact that this research is not necessarily measuring proportions, the approximation of the confidence intervals given in the table are used. Expecting 25% of response, the sample size will be 75, with a 50/50 variance of a proportion (the worst case), the confidence interval of  $\pm 12\%$  is obtained. For the purposes of this research  $\pm 12\%$  was deemed acceptable.

An important issue in the sample discussion is the selection between simple random sampling design versus proportional stratified sampling design. The second approach is used when a comparison between segments has to be done. In this research, the objective of the stratification is to reduce variability in the sample design. There is no interest for comparing variables between the segments, for that reason a simple random sample is chosen.

## **Design of the Questionnaire**

The research instrument designed to gather data for this study is a four-page questionnaire developed through a review of the literature and of similar questionnaires used to obtain data from businesses, and through consultations with Oklahoma State University faculty members.

The questionnaire went through numerous revisions by the researcher as it was reviewed and critiqued by graduate students at Oklahoma State University. A pilot study was conducted in Stillwater, Oklahoma; sending it to local manufacturers. A copy of the pilot questionnaire and cover letter is included in Appendix A. After the pilot questionnaires were collected, the questionnaire was again revised and critiqued. Every effort was made to develop a questionnaire that was easy to follow and complete, was not longer than four pages, was clearly stated, and was not ambiguous.

The final questionnaire was printed on both sides of 8 ½ x 11" white paper and the cover letter used Oklahoma State University's letterhead. Although the questionnaire has a place for the name of the company, the company name was only used to send follow-up post cards and summary of the results. The anonymity of the respondents was assured.

The questionnaire is divided into three sections. Section I of the questionnaire is designed to obtain a profile of the company. Specifically, the questions concern the company name, position of the person filling out the questionnaire and the number of employees in the company.

Section II of the questionnaire is designed to give the researcher a more detailed picture of each firm's data processing capabilities in the area of production management,



and is only completed by those firms which have computerized production management activities. This section contains questions concerning the type and size of the hardware used by the production department, the production management applications which are currently computerized and those planned for future computerization, the main purpose for computerizing these applications, the source of the production management application programs, and the impact and level of satisfaction regarding the general performance of the computer system (hardware and software) used by the production department. Explanation for “other” responses is solicited in all sections of the questionnaire.

Section III of the questionnaire is completed by businesses that do not have computerized production management activities. The section contains questions concerning future computerization of these companies, the main reason for computerizing or not computerizing, and possible sources of software. Moreover, it includes the production management applications which will be computerized for these companies. A copy of the final questionnaire and cover letter is included in Appendix B.

### **Procedures used to Administer the Questionnaire**

Three-hundred manufacturers were randomly selected from the population of 1349 companies (Table III). A questionnaire was sent to the production manager or equivalent for each one of the companies selected. The mailing envelopes used in mailing the cover letter, questionnaires, and return envelopes were professionally printed with the researcher's return address. Business Reply Mail envelopes were used with the indication "NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES". The mailing envelopes were metered. The researcher used first class mail for delivery and return of the questionnaires. A postcard follow-up was sent several weeks after the first mailout to the companies that had not answered the questionnaire

In order to improve the response rate, a phone survey was conducted of randomly selected businesses that did not return the questionnaire. Fifty-seven companies were selected to be called one time. The production manager or equivalent was contacted to answer the questionnaire by phone. After an introductory conversation about the purposes of the research, the researcher proceeded by asking the questions in the same order they appeared in the questionnaire. The questionnaire used for this phone survey was the same as used in the mail survey.

**CHAPTER IV**  
**OUTCOMES OF THE STUDY**

**Results of the Survey**

As it was explained in Chapter III, the mailing envelopes used in mailing the cover letter, questionnaires, and return envelopes were professionally printed with the researcher's return address. Business Reply Mail envelopes were used and the mailing envelopes were metered. The timetable for the original and follow-up mailing were as follows:

1. Original mailing: February 15, 1995

Date requested for return: February 24, 1995

2. Follow-up mailing: March 1, 1995

Date requested for return: as soon as possible

Responses were received from small manufacturing businesses in the state of Oklahoma. In the mail survey, there were 29 questionnaires returned which were not usable for the following reasons:

1. Twenty eight questionnaires were returned because they were undeliverable.
2. One questionnaire was returned because the company was not a manufacturing firm and did not have a production department.

There were 36 usable questionnaires returned from the 271 businesses contacted for a 13% level of response.

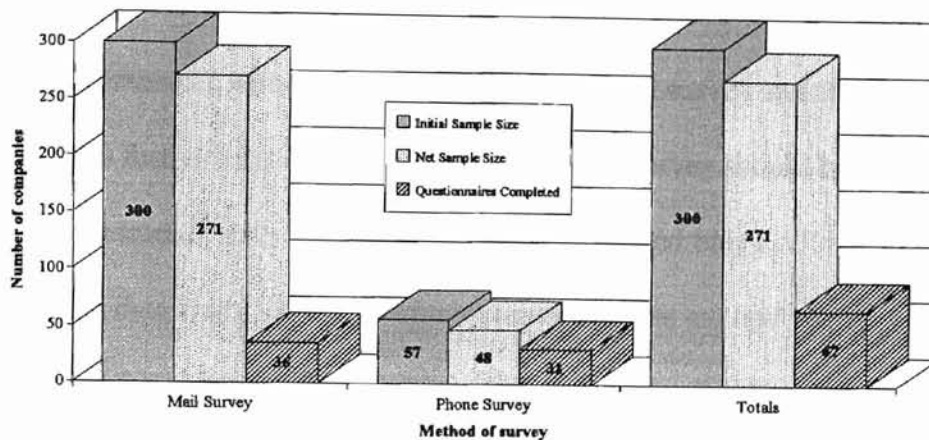
Due to a low response rate to the mail survey, a phone survey was used as a follow-up in order to increase the level of response. Moreover, the phone survey was used to see if non-respondents were similar to respondents in the mail survey; therefore, the businesses called were selected randomly from those who did not return the questionnaire in the mail survey. Three sessions were conducted for the phone survey, one in the morning and two in the afternoon. The production manager or equivalent was contacted to answer the questionnaire by phone. Fifty-seven calls were made with a response rate of 65%, which means 31 more questionnaires were completed. Eleven of the businesses phones were either unanswered or disconnected; therefore, they were unable to respond. Seventeen companies did not answer the questionnaire because the person responsible for production was not available. Since this was the third attempt to contact the company and it was a more personalized approach, the level of response was higher. Finally, a total of sixty seven questionnaires were completed. Table V and Figure 3 contains the levels of response for each method used.

**Table V**  
**Level of Response**  
**Mail vs. Phone survey**

<b>Method</b>	<b>Description of the steps</b>	<b>Results</b>
Mail Survey	Initial Sample Size	300
	Mail returned by the post office	29
	Net Sample Size	271
	Questionnaires returned	36
	Response rate	13%
Phone Survey	Initial Sample Size	57
	Unable to contact by phone	11
	Net Sample Size	48
	Questionnaires completed	31
	Response rate	65%
Totals	Businesses contacted	271
	Questionnaires completed	67
	Response rate	25%

Note: Phone Survey was a sample of 57 out of the original sample of non-response, 235 companies.

**Figure 3. Level of Response, Mail vs. Phone survey**



### **Analysis of Data**

As the questionnaires were returned, the responses were coded and entered into a data set. Minitab® and Excel® were used to tabulate the responses of each item in the questionnaire. The results from all responses to a question were tabulated according to frequency of occurrence. Some cross tabulations were performed to find relationships between variables. Moreover, graphics were developed for some of the outputs. The specific findings may be found in the various tables and graphs in the following discussion.

The first step of this analysis was to study if there was a significant difference between the answers reached by mail and by phone. Even though the sample size was small, chi-square analysis was used to compare the responses from the mail survey with those from the phone survey. The results of the analysis are presented in Appendix C. In all cases, a chi-square significance level of 10% indicated there was no significant

difference between the mail and phone survey responses. The phone survey was conducted for a random sample of non-respondents to the mail survey including a follow up reminder. These chi-square results indicated that there is not a significant difference between those companies who chose to respond to the mail survey and the ones that did not respond. This further indicates that the results of this survey should be representative of the population studied even though the mail survey yielded only a 13% response rate. Furthermore, the data was combined without considering the method used to obtain it.

The second step of this analysis is to study the relationship between the population selected (1349 companies), the original sample (300 companies), and the 67 questionnaire respondents. Chi-square analysis was calculated for both size and sectors of the companies (Appendix D). Table VI presents the distribution for the number of companies by sector, for the population, the original sample and the final respondents.

**Table VI**  
**Distribution of Companies by Sectors**  
**Population, Original Sample and Respondents**

Sector	Population		Number of Companies			
	Population	%	Original Sample	%	Respondents	%
Apparel	189	14%	10	4%	3	5%
Chemical	123	9%	23	8%	6	9%
Electr.&Electronics	141	11%	38	13%	14	21%
Industrial Machinery	743	55%	190	63%	32	48%
Rubber and Plastics	153	11%	39	13%	12	18%
<b>Total</b>	<b>1349</b>		<b>300</b>		<b>67</b>	

A chi-square significance level of 10% indicated there was a significant difference between the distribution of the population and the distribution of the original sample even though the original sample was randomly selected from the population. The most important difference is in the Apparel sector (14% vs. 4%) and Industrial Machinery (55%

vs. 63%). However, chi-square significance level of 10% indicated there was no significant difference between the distribution of the original sample and the distribution of the final respondents, which means the final respondents are representative of the original sample. Details of the chi-square analysis performed are presented in Appendix D.

Table VII presents the distribution for the number of companies by size, for the population, the original sample and the final respondents. A chi-square significance level of 10% indicated there was no significant difference between the distribution of the population, the original sample and the final respondents. This indicates that the final respondents represents a random sample of the population and the original sample. Details of this chi-square analysis performed are also presented in Appendix D.

**Table VII**  
**Distribution Size of Companies**  
**Population, Original Sample and Respondents**

<b>Ranges</b>	<b>Population</b>		<b>Number of Companies</b>		<b>Respondents</b>	
	<b>%</b>	<b>%</b>	<b>Original Sample</b>	<b>%</b>	<b>%</b>	<b>%</b>
Less than 50 Employees	1120	83%	246	82%	55	82%
51-100 Employees	81	6%	14	5%	2	3%
101-250 Employees	148	11%	40	13%	7	11%
More than 250 Employees	0	0%	0	0%	3	4%
<b>Total</b>	<b>1349</b>		<b>300</b>		<b>67</b>	

Note: Three respondents reported more than 250 employees in spite of the fact they are classified with less than 250 employees in the Oklahoma Manufacturers Register 1994 edition. The change in the number of employees in the companies during the last year explains the difference between the original sample and the respondents for that range.

The distribution of the size of the businesses that responded to the questionnaire is presented here in more detail. The main question was the “Number of employees”. Table VIII contains an analysis of the respondents according to the number of employees in their firms.

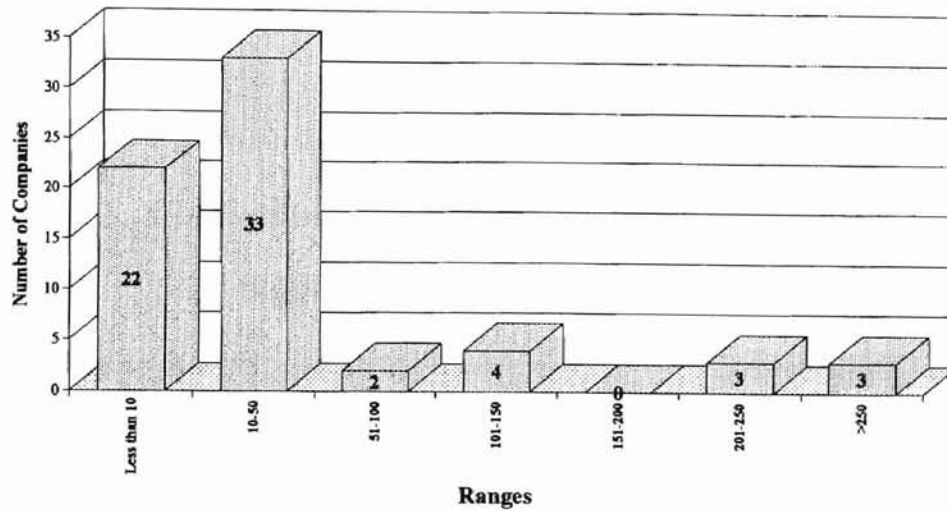
**Table VIII**  
**Distribution Size of the Companies Responding**

<b>Ranges</b>	<b>No. Companies</b>	<b>Percentages</b>
Less than 10	22	33%
11-50	33	49%
51-100	2	3%
101-150	4	6%
151-200	0	0%
201-250	3	5%
over 250	3	4%

Almost fifty percent of the respondents were in the range from 11-50 employees and 82% were below 50 employees. It means the small businesses surveyed present a concentration in the range 1-50 employees with only 18% of the businesses having more than 50 employees. This small number of employees reported by the majority of respondents indicates a concentration of small businesses between 1-50 employees in the state of Oklahoma. Three companies reported more than 250 employees in spite of the fact they are classified with less than 250 employees in the Oklahoma Manufacturers Register 1994 edition. The change in the number of employees in the companies during the last year explains the difference between the original sample and the respondents for that range. Figure 4 graphically displays the distribution of the size of the companies surveyed.



**Figure 4. Distribution Size of the Companies Responding**



The remaining data analysis is divided in three sections. One is the distribution of the companies with computerized production management activities versus companies without computerized production management activities. The second section analyses the data obtained from the companies with computerized production management activities. The third section presents the guidelines for prioritizing areas to computerize when small business start computerizing the field of production management and the guidelines for design of marketing strategies for software development companies.

Questions proposed in the statement of the problem and subproblems are answered in the second section. The procedure used presents each question from the problem and subproblems statements and the corresponding results. The data is presented using tables and graphs. Guidelines proposed in the statement of the problem are presented in the third section. Data that justify the statements is presented with each guideline.

Descriptive statistics were the approach used for analyzing data because it is the best alternative when studying multiple selection questionnaires with a small overall number of responses.

### **Computerization versus non Computerization of Production Management Activities**

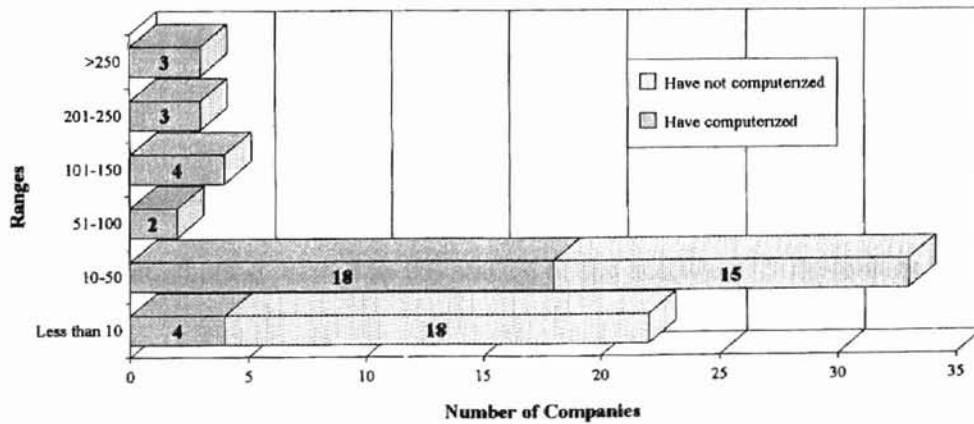
This section presents an analysis of the companies with computerized production management activities versus companies without computerized production management activities

Forty-nine percent of the small manufacturing businesses have computerized management activities in the production department. Table IX and Figure 5 show the distribution of the size of the company for companies with computerized production management activities versus those without computerized production management activities. Small companies (less than 10 employees) present a lower level of computerization of production management applications than companies between 1-50 employees.

**Table IX**  
**Analysis of Computerized and Non Computerized Companies**  
**vs. Size of the Company**

Size of company	Have		Have Not		Total	%
	Computerized	%	Computerized	%		
less than 10	4	12%	18	53%	22	33%
10-50	18	55%	15	44%	33	49%
51-100	2	6%	0	0%	2	4%
101-150	4	12%	0	0%	4	6%
201-250	3	9%	0	0%	3	4%
more than 250	2	6%	1	3%	3	4%
<b>Total</b>	<b>33</b>		<b>34</b>		<b>67</b>	
<b>Percent</b>	<b>49%</b>		<b>51%</b>			<b>100%</b>

**Figure 5. Analysis of Computerized and Non Computerized Companies vs. Size of the Company**



## **Analysis of Companies which have Computerized**

### **Production Management Activities**

In this section, answers to the questions presented in the statement of the problem and subproblems of this thesis are presented. The specific statements discussed are as follows:

1. The specific production management applications that small manufacturing businesses have already computerized (Subproblem 2).
2. The specific production management applications that small manufacturing businesses are planning to computerize in the near future (Subproblem 2).
3. The perceived impact of computerizing production management activities.  
(Subproblem 2).
4. The main purpose of the companies in computerizing production management activities (Subproblem 3).
5. The source used to acquire software for computerizing the applications  
(Subproblem 4).
6. The level of satisfaction the companies have with software used (Subproblem 5).
7. The level of satisfaction related to the source of the software (Subproblem 5).

The questions are answered in the order presented above and they are supported by the data collected from the survey.

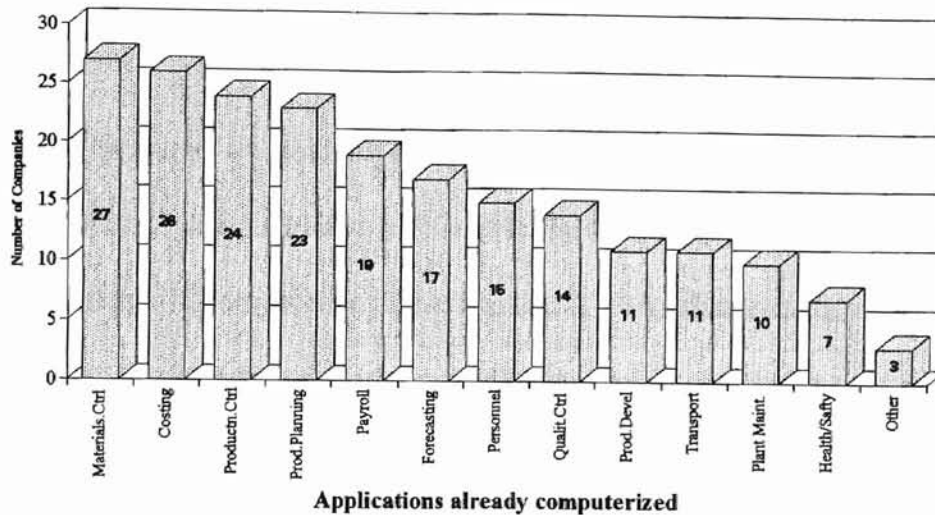
- **Production management applications small manufacturing businesses have already computerized:**

The four applications that companies have computerized most within the production department are: Materials Control (13%), Costing (13%), Production Control (12%), and Production Planning (11%). The second group of production management applications that have been computerized are: Payroll (9%), Forecasting (8%), Personnel (7%), Quality Control (7%), Product Development (5%), Transport and Distribution (5%), Plant/Machine Maintenance (5%). The third group that represents the least computerized applications is composed of: Personnel Health and Safety (3%) and Other (1%). The explanation for “other “ was “Product Labeling + Material Data Sheets”. Those applications which are currently in use by the production department computer systems are tabulated in Table X and displayed in Figure 6.

**Table X**  
**Applications Computerized**

<b>Application</b>	<b>No. Businesses</b>	<b>Percentages</b>
Materials Control	27	13%
Costing	26	13%
Production Control	24	12%
Production Planning	23	11%
Payroll	19	9%
Forecasting	17	8%
Quality Control	14	7%
Personnel	15	7%
Product Development	11	5%
Plant/Machine Maintenance	10	5%
Transport and Distribution	11	5%
Personnel Health and Safety	7	3%
Other	3	1%

**Figure 6. Applications Computerized**



- **Production management applications small manufacturing businesses are planning to computerize:**

Respondents were also asked to indicate those applications they intend to use in the future. For those companies with computerized production management activities, product development was indicated most often. Forecasting, quality control, costing and personnel represents the second most attractive alternatives for computerizing in the near future. Seven companies do not have plans to computerize any other application in the future; this represents 20% of the companies which have computerized production management activities. The respondents classified the applications into three groups, according to the importance and priority of computerizing. Table XI is the summary of the answers for the question “Which of the applications is the company planning to

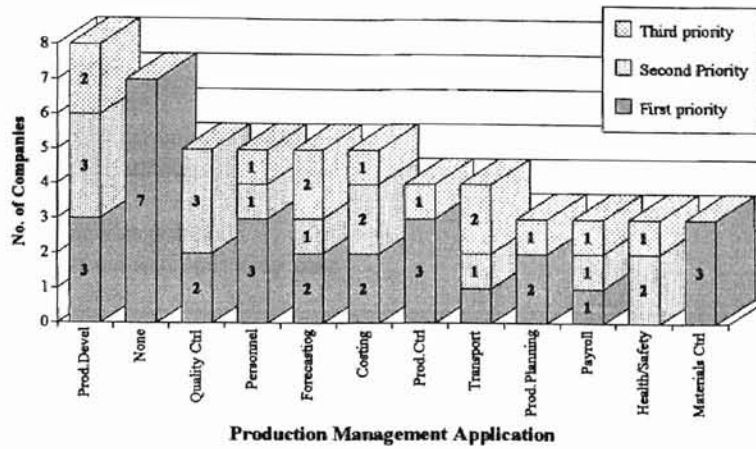
computerize in the near future?" for companies with computerized production management activities. Figure 7 shows the distribution of future applications in production management for companies with computerized production management activities

Most of the companies without computerized production management activities answered they will not computerize any activity in the near future (76%). Only seven companies said they will computerize in the future and the applications they mentioned were: forecasting, production planning, production control (6 companies each one), quality control (5 companies), materials control and payroll (4 companies). Each company with plans to computerize mentioned more than one application.

**Table XI**  
**Future Computerization vs. Priorities**

<b>Application</b>	<b>First Priority</b>	<b>Second Priority</b>	<b>Third Priority</b>	<b>Total</b>	
<b>Percentages</b>					
Production Development	3	3	2	8	14%
None	7	0	0	7	13%
Quality Control	2	3	0	5	9%
Personnel	3	1	1	5	9%
Forecasting	2	1	2	5	9%
Costing	2	2	1	5	9%
Production Control	3	0	1	4	7%
Transport and Distribution	1	1	2	4	7%
Production Planning	2	0	1	3	5%
Materials Control	3	0	0	3	5%
Personnel Health and Safety	0	2	1	3	5%
Payroll	1	1	1	3	5%
Other	1	0	0	1	2%
Plant/Machine Maintenance	0	0	0	0	0%

**Figure 7. Future Computerization vs. Applications**



- **The impact of computerizing production management activities:**

A list of variables were presented to the respondents. They ranked each one from 1 to 5 where 1 means very satisfactory performance and 5 means very unsatisfactory. The general score for the perceived impact is 2.1 which means “good”. However, analyzing the data, two extremes can be found. The perceived impact in areas such as “Improved customer service”, “Better and faster information access”, “Less paper work”, and “Increased productivity” is better than areas such as “Improved competitive position” and “Decreased personnel and operating cost”..

The distribution of the perceived impact resulting from computerizing the production department is presented in Table XII. Moreover, box plots for each question were calculated and are presented in Figure 8.





- **The main purpose of the companies in computerizing production management activities:**

Respondents were also asked about the main purpose in computerizing the production department. In this particular section, a single selection was permitted for a number of alternatives presented.

Twelve respondents (36%) said the main purpose in computerizing was to improve coordination between departments; other answers were “to reduce high operation costs” (18 %), “competitive improvement” (18%), “to reduce information overload” (15%), and “other” (12%). The respondents which selected “other” explained:

1. To coordinate production planning with production sales.
2. Save time and money and easy access to information.

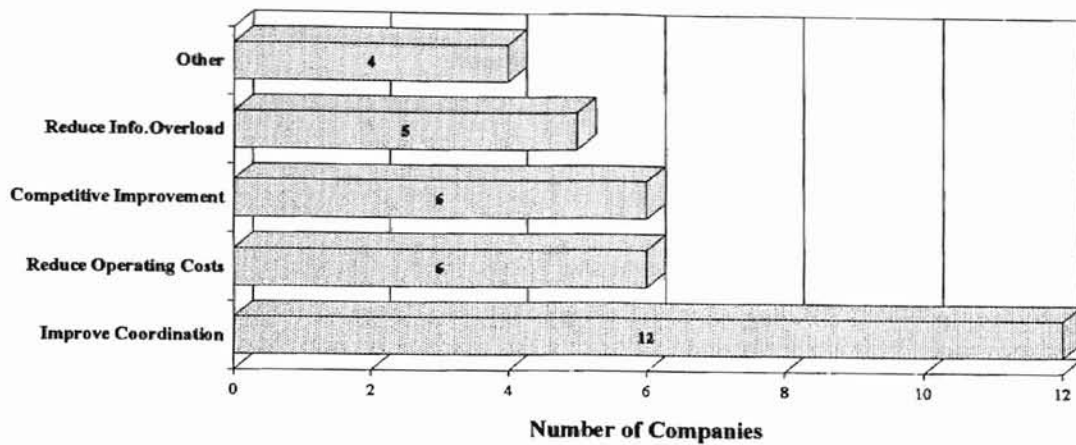
Table XIII presents the summary of the answers given by companies with computerized production management activities.

**Table XIII**  
**Main Purpose in Computerizing the Production Department**

Purpose	No. Businesses	Percentages
To improve departmental coordination	12	36%
To reduce high operating costs	6	18%
Competitive improvement	6	18%
To reduce information overload	5	15%
Other	4	12%

Figure 9 shows the distribution of the main purpose in computerizing production management activities.

Figure 9. Purpose in Computerizing



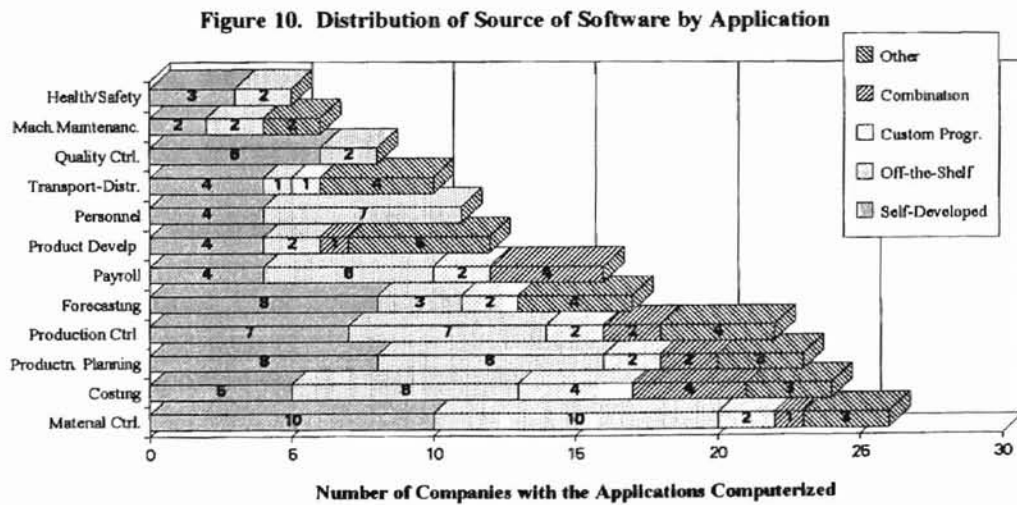
- **The source used to acquire software for computerizing the applications:**

One of the questions was designed to identify the source of the production management application programs. Many respondents indicated more than one source for their programs. Sixty-five production management applications (36%) were self-developed. This represents the source most widely used for materials control and other areas such as production planning, production control, forecasting and costing. Fifty-eight applications (32%) were purchased off-the-shelf, principally in areas such as material control, production planning and quality control. Custom programming seems to be less popular for small businesses (8%). Sixteen percent of the applications have been computerized using other sources. In general, the users of “other” sources are talking about “industry specific canned programs” as one of the respondents said.

The distribution of the source of software for each production application computerized is contained in Table XIV and Figure 10.

**Table XIV**  
**Distribution of Source of the Software by Application**

Applications	Number of Companies by Sources				
	Self-Developed	Off-the-shelf	Custom Progr.	Combination	Other
Production Development	4	2	0	1	5
Forecasting	8	3	2	0	4
Production Control	7	7	2	2	4
Transport and Distribution	4	1	1	0	4
Production Planning	8	8	2	2	3
Costing	5	8	4	4	3
Materials Control	10	10	2	1	3
Plant/Machine Maintenance	2	2	0	0	2
Personnel Health and Safety	3	2	0	0	0
Quality Control	6	2	0	0	0
Personnel	4	7	0	0	0
Payroll	4	6	2	4	0
<b>Total</b>	<b>65</b>	<b>58</b>	<b>15</b>	<b>14</b>	<b>28</b>
<b>Percentage</b>	<b>36%</b>	<b>32%</b>	<b>8%</b>	<b>8%</b>	<b>16%</b>



- **The level of satisfaction the companies have with software used:**

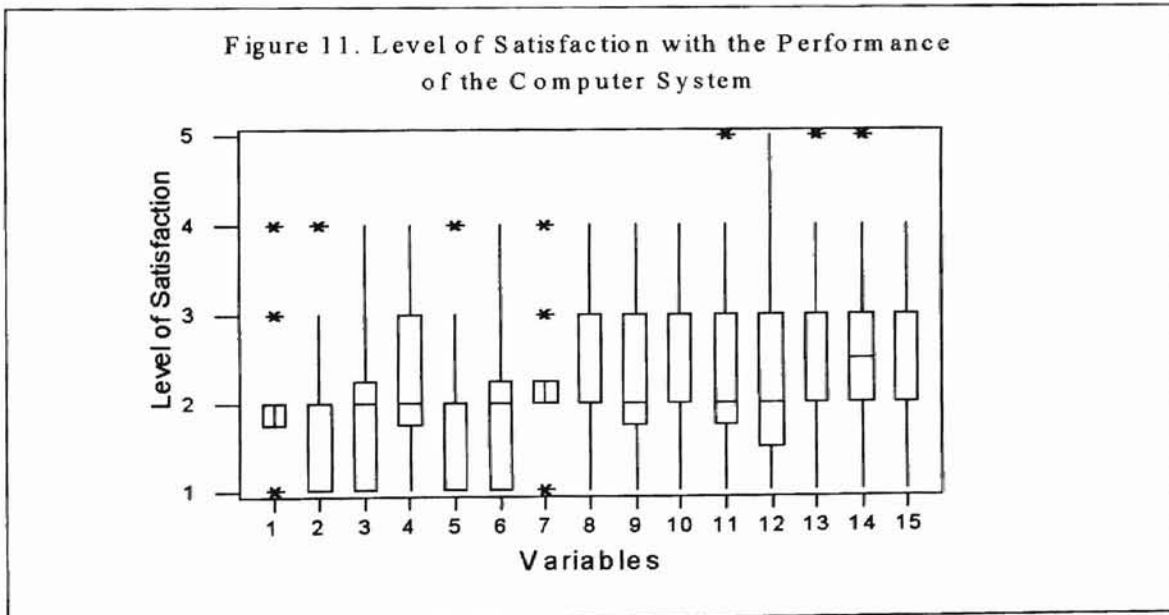
This question concerns the evaluation of the level of satisfaction regarding the general performance of the computer systems used by the production department.

A list of variables were presented to the respondents. They ranked each one from 1 to 5 where 1 means very satisfactory performance and 5 means very unsatisfactory. Table XV presents an analysis of the level of satisfaction in three categories: output quality, user-system relationship, and user-developer relationship. Figure 11 is a boxplot of the responses of this questions. The variables concerned with the output quality of the system (variables 1 to 7) presents a higher level of satisfaction (boxes between 1 and 2) than the variables concerned with the user-system relationship and the user-developer relationship. The level of satisfaction regarding output quality of the systems is positive. An average of 2.0 for this section means a “good” performance of the output of the system. In this area, the lowest rating was given to the variables precision, accuracy, and completeness of the output with 2.1 each one, which means that some systems provide some information which is not precise, accurate or complete.

In the sections, User-System relationship and User-Developer relationship, the average of the responses was 2.3 and 2.4. As can be seen, the level of satisfaction for these areas is lower than output quality. The level of satisfaction in relation to the service given for developers of software is not the best, especially in areas such as time required for system development (2.5 ), training provided to users (2.5), and vendor support (2.5). These areas should be improved by the software developers.

**Table XV**  
**Level of Satisfaction with the Performance of the Computer System**

Variables	Average level of satisfaction 1= very satisfactory...5= very unsatisfactory
<b>OUTPUT QUALITY</b>	
1. Currency of output (being in general acceptance)	2.0
2. Timeliness of output (happening at just the right time)	1.9
3. Accuracy of output (exactness or correctness)	2.1
4. Completeness of output (having all necessary )	2.1
5. Reliability of output (Trustworthiness)	2.0
6. Relevancy of output (Connected with the subject)	1.9
7. Precision of output (regard to the smallest details)	2.1
Average	2.0
<b>USER-SYSTEM RELATIONSHIP</b>	
8. User's participation in the design or purchase	2.2
9. Convenience of access	2.1
10. Training provided to users	2.5
11. User's understanding of system	2.3
Average	2.3
<b>USER-DEVELOPER RELATIONSHIP</b>	
12. Relationship with the source (developer)	2.3
13. Communication with the source of the software	2.4
14. Vendor support	2.5
15. Time required for system development	2.5
Average	2.4



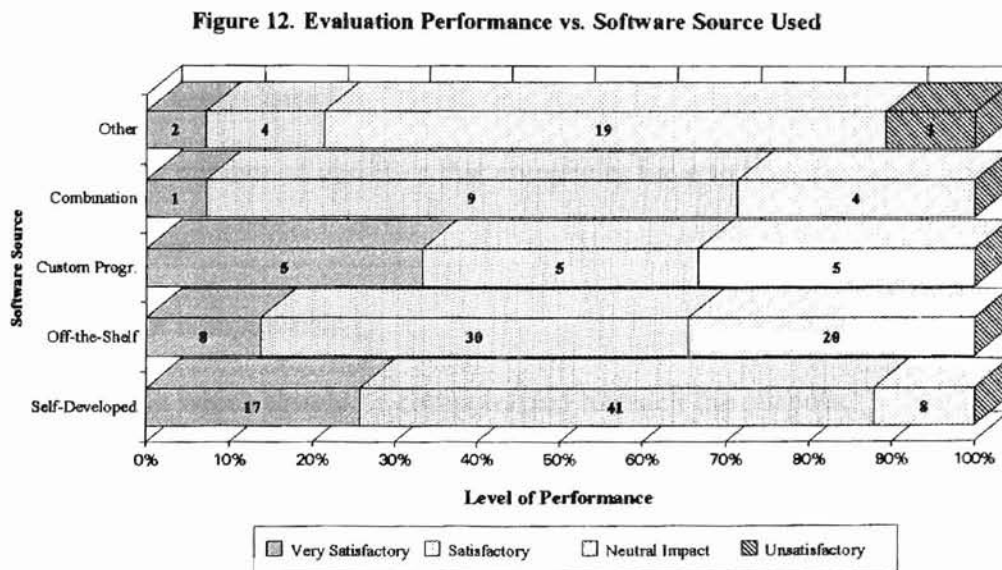
Level of Satisfaction : Rates: 1-Very Good 5-Very Bad

Variables:

1-Currency of Output	8-User's Participation in the Design or Purchase
2-Timeliness of Output	9-Convenience of Access
3-Accuracy of Output	10-Training Provided to Users
4-Completeness of Output	11-User's Understanding of System
5-Reliability of Output	12-Relationship with the Source of Software
6-Relevancy of Output	13-Communication with the Source of Soft
7-Precision of Output	14-Vendor Support
	15-Time required for System Development

- **The level of satisfaction related to the source of the software:**

The last question presented in the statement of the problem is the level of satisfaction related to the source of the software. It is important to clarify in this evaluation the lower the score, the greater the level of satisfaction. Self-developed software presents a better level of satisfaction than off-the-shelf (1.8 vs. 2.2 ). The level of satisfaction for custom-programming (2 ) is greater than off-the-shelf software (2.2 ), but not more than self-developed (1.8). The lowest level of satisfaction was in the area of User-Developer relationship, particularly for self-developed software, this aspect presents a better average (2.2). It seems that self-developed software offers better customer service than the rest of sources, maybe because the programs are developed within the company and the communication and access with the developer is easier. “Combination” and “other sources” present the lowest level of satisfaction. Figure 12 presents a proportion of the levels of satisfaction for each software source.



In this part of the chapter, survey results were presented. The remainder of the chapter presents the guidelines for prioritizing areas to computerize when small business start computerizing the field of production management and the guidelines for design of marketing strategies for software development companies based on the survey results.

### **Guidelines for Small Manufacturers and Software Developers**

A goal of this thesis was to develop guidelines. The first guideline is for prioritizing areas to computerize when small businesses start computerizing the field of production management; the second one is to develop guidelines for the design of marketing strategies for software development companies. The guidelines are developed based on data collected in section III of the questionnaire, “Future Users” and data already presented in this chapter. The guidelines will introduce data obtained from the survey and will recommend approaches for prioritizing areas to computerize and for designing marketing strategies.

### **Guidelines for Prioritizing Areas to Computerize**

There are a number of variables that companies have to consider when prioritizing areas to computerize:

1. The purpose of computerizing,
2. The application which should be computerized to reach the purpose,
3. The source of the software that will be used, and
4. The hardware that will be used.



- **Purpose of computerizing:**

Considering the purpose of computerizing, listed in Table XIII presented three main reasons companies had in computerizing production management activities, they are:

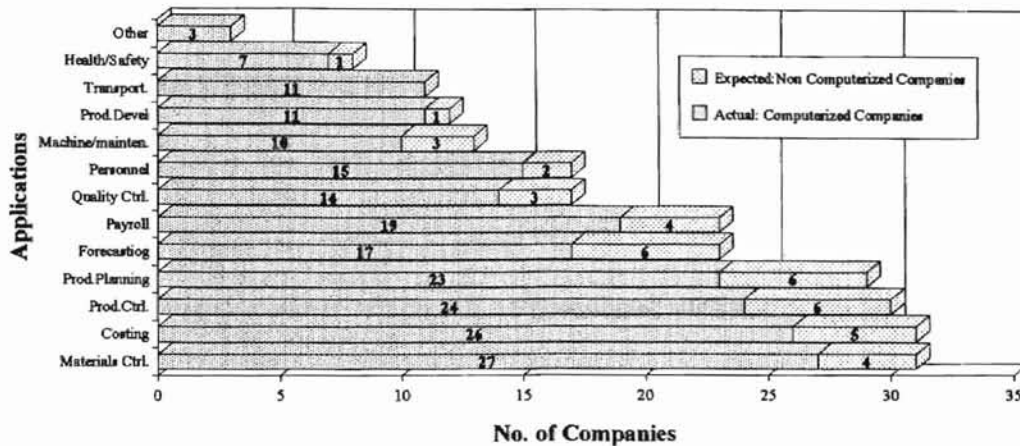
- Improve departmental coordination (36%),
- Reduce high operating costs (18%), and
- Competitive improvement (18%).

These three reasons should be considered by companies when computerizing production management activities. After deciding the main objective in computerizing, the company has to develop procedures for measuring the results obtained by computerizing the application. Feedback from the results is necessary to know if the goals are reached.

- **The applications which should be computerized in order to reach the purpose:**

Figure 13 presents the distribution of the applications already computerized by companies which have computerized production management activities and the applications that will be computerized by companies which have not computerized production management activities. Interestingly, the applications that non computerized companies expect to computerize in the future coincide with the applications that companies have already computerized. This confirms the importance of these applications.

Figure 13. Actual vs. Future Computerization



The five applications most computerized within the production department are: Forecasting (15%), Production Planning (15%), Production Control (15%), Materials Control (10%), Costing (11%) and Payroll (10%). The second group of production management applications expected to be computerized are: Quality Control (7%), Plant/Machine Maintenance (7%) and Personnel (5%). The third group represents the least computerized applications and is composed of: Personnel Health and Safety (2%), Product Development (2%), and Transport and Distribution, (0%). Based on this data, a number of applications can be associated with each one of the purposes presented earlier. Three groups of the most important applications can be classify as follows:

1. The first group of applications includes “Materials Control”, “Production Control” and “Production Planning”. These applications are related to one of the most important purposes to computerize which is “improve departmental coordination.” Consequently, these applications have to be considered for computerizing the companies who want to improve departmental coordination.

2. The second group includes “Costing”, which is directly related to the purpose “reduce high operating costs.” This type of application generally appears to control the effective and efficient use of resources in order to reduce costs. However, all the applications in some way have the goal of reducing costs.
3. The third and final group includes the applications “Forecasting”, “Quality Control” and “Product Development” which can be associated with the purpose of competitive improvement .

The above classification is an approach that could be used when computerizing production management applications and is a guideline for small manufacturing companies.

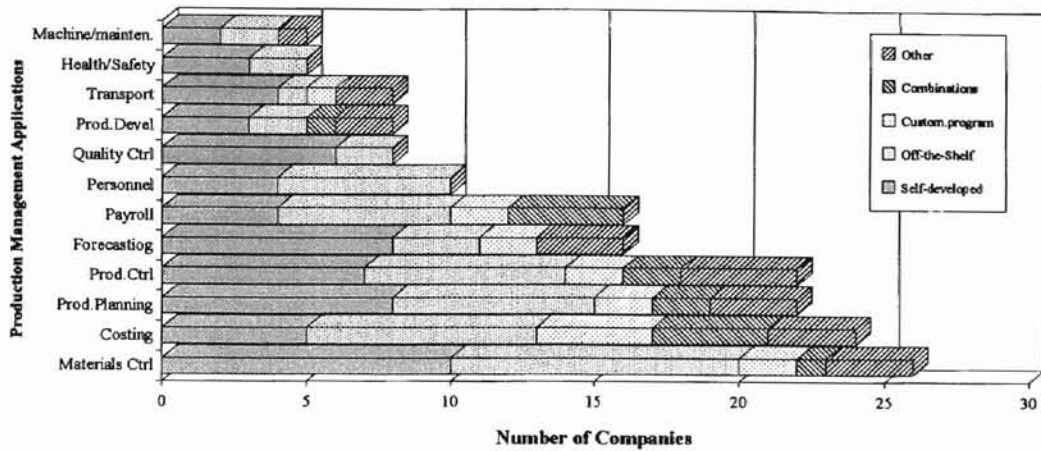
- **The source of the software that will be used:**

An important consideration when computerizing production management activities is the source of the software. This is an important consideration and a number of variables should be reviewed when selecting the source of the software. Some results from this research could help companies to decide the best software source for specific applications. Figure 14 presents the relationship between software sources and production management applications. In this case, the most important comparison is between the use of off-the-shelf and self-developed software for production management applications.

Forecasting, quality control and transportation-distribution appear to use self-developed software more often than off-the shelf programs. On the other hand, costing appears to use more off-the-shelf rather than self-developed software. The rest of the

applications present a similar proportion between the use of self-developed software and off-the-shelf software.

**Figure 14. Production Application vs. Software Source Used**



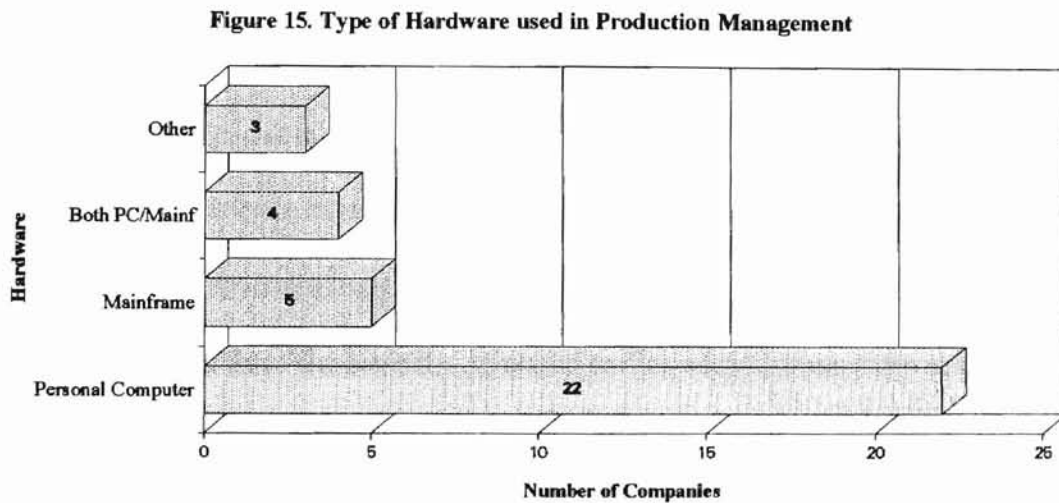
- **The source of the hardware that will be used:**

Respondents who have already computerized some production management activities were asked about the type of hardware utilized by the production department. Table XVI contains the analysis of the utilization of computers and microcomputers in production management activities.

**Table XVI  
Type of Hardware Used in Production Management**

Hardware	No. Businesses	Percentages
Personal Computer	22	65%
Mainframe	5	15%
PC and Mainframe	4	12%
Other	3	9%

Of the 34 respondents who indicated they utilize computerized data processing, twenty two (65%) reported the use of microcomputers (PC). Five respondents (15%) used mainframes, 3 respondents (9%) used other hardware, and 4 (12%) used a combination of mainframe and microcomputer. The three “other” responses mentioned Local Area Networks as the hardware utilized. Figure 15 shows the distribution hardware type used in production management computerization



Based on the above information, the recommendation for small manufacturing business is to introduce microcomputers when computerizing production management activities. Microcomputers are becoming the hardware most used by small businesses because of their power and their price, as stated in Chapter II. However, this recommendation depends on the company setting, for example, if the company stands alone or if it is a branch of larger company.

## **Guidelines for Design of Marketing Strategies for Software Development Companies**

The second guideline presented is for software development companies when designing marketing strategies. The present guidelines are divided in two sections.

1. Marketing strategies for companies who have already computerized some production management activities and
2. Marketing strategies for companies who have not computerized production management activities.

- **Marketing strategies for companies who have already computerized production management activities:**

Software development companies have to analyze the applications that small manufacturing businesses are expecting to computerize in the near future in order to respond to the demands of the market. As stated earlier, respondents were asked to indicate applications they intend to use in the future.

Twenty three companies (35% of the companies surveyed) have computerized production management activities and are planning to computerize other applications. The recommendations for software developing companies who want to approach this market sector are:

- ◆ Offer software in areas such as product development, forecasting, quality control, costing and personnel.
- ◆ Offer improvement of applications already computerized such as materials control, costing, production control, and production planning.

- ◆ Software developers should provide training, improve support of the product, and reduce time for system development.

Seven companies do not have plans to computerize any other application in the future; this represents 20% of the companies who have computerized production management activities. These companies require a special treatment, because they already have hardware and they are satisfied with the software they are currently using. A good strategy for these companies would be to offer free consultation to evaluate the status of the system and the cost of the introduction of new applications or improvement of the system they already have. Customer service, communication, training and quality of the product are order winners in this case. The software development company should focus on customer satisfaction to be successful.

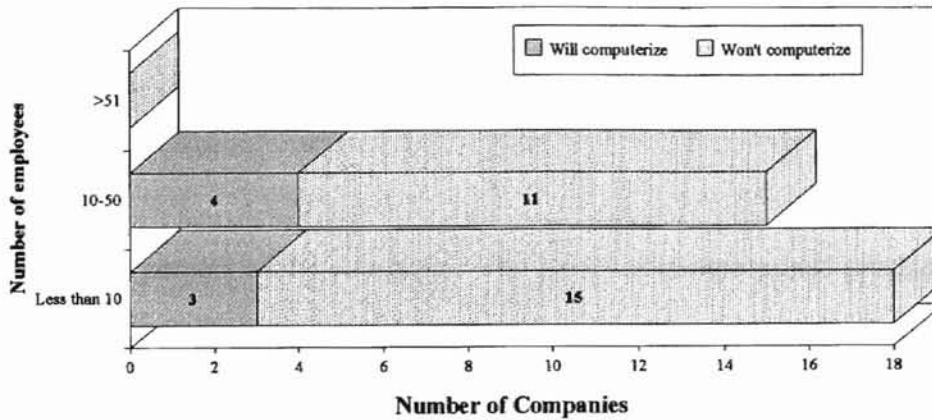
- **Marketing strategies for companies that have not computerized production management activities:**

Of those businesses that participated in the study, 51% have not yet computerized production management activities. Of the 15 businesses who reported they did not utilize any type of computerized data processing, 76% indicated they were not considering the acquisition of computers or microcomputers, while only 24% indicated they were considering the acquisition of hardware and software. Figure 16 and Table XVII display the distribution of future computerization of production management activities.

**Table XVII**  
**Companies who do not have Computerized Production Management Activities**  
**Prospective about Future Computerization**

Prospective	No. Employees			Percentage
	Less than 10	10-50	More 50	
Will computerize	3	4	1	24%
Will not computerize	15	11	0	76%

**Figure 16. Companies that Do Not have Computerized Production Management Activities**



Companies planning to computerize production management activities in the future represent a potential market for software development companies. The strategy is to offer quality software at reasonable prices because generally these companies have limited budget. Moreover, the software companies should be ready to offer service in the areas manufacturers are expecting to computerize. Table XVIII presents the answers given by the manufacturers about the applications they will expect to computerize in the future.



**Table XVIII**  
**Non Computerized Companies**  
**Applications Which will be Computerized**

Application	No. Businesses	Percentages
Forecasting	6	15%
Production Planning	6	15%
Production Control	6	15%
Costing	5	12%
Materials Control	4	10%
Payroll	4	10%
Plant/Machine Maintenance	3	7%
Quality Control	3	7%
Personnel	2	5%
Product Development	1	2%
Personnel Health and Safety	1	2%

Seventy-six percent of the companies who have not computerized production management activities indicated they were not considering the acquisition of computers or microcomputers. This is an important sector and represents 38% of the responses of this survey. The main reason presented for companies who will not computerize production management activities is that the company's size does not justify the expenditure (54%). Table XIX shows the reasons given by the respondents for not computerizing.

**Table XIX**  
**Companies who do not have Computerized Production Management Activities**  
**Reasons for Not Computerizing in the Future**

Reason	No. Employees Number of companies	Percentage
Company's size does not justify the expenditure	21	54%
Other	6	16%
Hardware is too expensive	4	10%
Software is too expensive	4	10%
Computerization is not required in the department	4	10%

This group of companies represents the most difficult sector of the market for software development companies. The strategy used by developers must convince manufacturers about the benefits of computerization. The developers have been able, not only to offer its product, but also to educate the customer in the benefits of computerizing production management activities. Another reason these businesses are not thinking about computerizing could be their lack of familiarity with microcomputers and use of software. Consequently, software developers must create “friendly” software and be able to show how easy is to use it. An approach could be to offer free consultation to evaluate the possible benefits could be obtained if computerizing production management activities. This is important to evaluate the economical benefits of computerizing.

These are some guidelines for software development companies, these guidelines may be useful, but to be effective, strategies should also include activities such as customer service focus, quality products and continuous improvement.

Software development companies have to be aware of the risk that every sector involves. Companies who have computerized production management activities represent lower risk but lower volume market because they have hardware, software and experience about the use of this resources. Companies who have not computerized production management activities represent higher risk but higher volume market because they do not have software and knowledge about this matter.

## **Summary**

This chapter has answered the questions stated in the problem and subproblems of this research. In order to answer these questions, the responses of the survey were tabulated and reported using frequencies, percentages, two-way and one-way tables when it was required.

Moreover, the chapter has developed guidelines for computerizing production management activities and guidelines for marketing strategies have also been presented.

## **CHAPTER V**

### **SUMMARY AND CONCLUSIONS**

This study was designed to look at the effect of microcomputers in the area of production management in small businesses in the state of Oklahoma. It has been said that for small manufacturing businesses to stay competitive and maintain a bright financial future, they should computerize their information systems in order to survive and compete within the business world. The purpose of this study was to obtain information concerning computer utilization by small manufacturing businesses, the type of computerized production applications, and the types of data processing employed by small businesses

The problem and subproblem statements presented a number of questions that this research would answer; this chapter concerns the answers to those questions. The following is a summary of the questions.

- How small businesses use microcomputers in the field of production management.
- What specific applications they are currently using or are planning to use in the near future.
- The benefits of the use of microcomputer technology in that area.
- The level of satisfaction with the utilization of microcomputer in production management activities.

- The sources of the software used for computerizing production management activities.
- The main purpose of the companies in computerizing production management activities.

Other objectives of these research were:

- To analyze the areas in which microcomputers are used in production management and develop a list of the most widely computerized activities.
- To evaluate the benefits of computerizing and the level of satisfaction of the users with both the production management area selected and the software used. It also attempt to assess whether or not the level of satisfaction differs with the resource of the software.
- Another goal of this thesis is to develop guidelines. The first one is for prioritizing areas to computerize when small businesses start computerizing the field of production management; the second one is to develop guidelines for the design of marketing strategies for software development companies.

### **Results of the Study**

In order to answer the questions posed, the results of the study are summarized in five sections according to 1) The type of respondents, 2) The usage of computers or microcomputers 3) The types of production management applications and software sources utilized, 4) The level of satisfaction with computerizing the applications, 5)The guidelines for prioritizing areas to computerize when small businesses start computerizing

the field of production management and the guidelines for the design of marketing strategies for software development companies.

### **The Type of Respondents.**

Almost fifty percent of the respondents were in the range from 11-50 employees and 82% were below 50 employees. It means that the small businesses surveyed present a concentration in the range 1-50 employees, just 18% of the businesses have more than 50 employees. Moreover, one third of the respondents have less than 10 employees and they represent a large segment of the small manufacturing businesses in Oklahoma.

### **Usage of Computers and Microcomputers.**

- Of those businesses that participated in the study, 49% reported utilized data processing in production management activities. The other 51% have not yet computerized production management activities.
- 81 % of companies with less than 10 employees have not computerized production management activities and 83% of them do not plan to computerize in the near future. The main reason for not computerizing is “the size of the company does not justify the expenditure”
- Microcomputers are the most common type of hardware used in production management (65%), especially for businesses with less than fifty employees (86%). Mainframes are used generally for companies with more than 51 employees. Of the 15 businesses that reported they did not utilize any type of computerized data processing,

76% indicated they were not considering the acquisition of computers or microcomputers, while only 24% indicated they were considering the acquisition of hardware and software. The main reason for not acquiring microcomputers was “Company’s size does not justify the expenditure” (64%).

### **The Types of Production Management Applications And Software Source Utilized**

Respondents were asked to indicate the type of computerized production management applications.

- The applications already computerized were: materials control (13%), production control (12%), costing (13%) and production planning (11%). The other types of production management applications receiving the most current usage besides those four listed above are: forecasting, product development, personnel health and safety, plant/machine maintenance, quality control, personnel and payroll received percentages around 6%.
- Fifty percent of the future production management applications would be in the following six areas: forecasting, production development, quality control, personnel and costing.
- The applications already computerized by computerized companies and those applications that are expected to be computerized in the future by companies are similar. The applications that non-computerized companies expect to computerize in

the future coincide with the applications that computerized companies have already computerized, it confirms the importance of these applications.

- Thirty-six percent of the programs were self-developed, 32 % were purchased off-the-shelf and only 8% were customized. Forecasting, quality control and transportation-distribution appear to use self-developed software more often than off-the shelf programs. On the other hand, costing appears to use more off-the-shelf than self-developed software. The rest of the applicants present a similar proportion between the use of self-developed software and off-the-shelf software.

### **The Level of Satisfaction with Computerizing**

#### **Production Management Activities**

- Overall, the level of satisfaction regarding the output quality of the computer system is positive. The performance of the systems were qualified “good”. However, user-system and user-developer relationships scored lower. The level of satisfaction regarding the service provided by the developers of the software is not the best. The general qualification for the perceived impact is “good”, especially in areas such as “improved customer service”, “better and faster information access”, “less paper work”, and “increased productivity”.
- Self developed software presents a better level of satisfaction than off-the-shelf. The level of satisfaction for custom-programming is greater than off-the-shelf software, but not more than self-developed. In this evaluation the lower the score,



the greater the level of satisfaction. “Combination” and “other sources” present the lowest level of satisfaction.

- The general score for the perceived impact is good. However, two extremes can be found. The perceived impact in areas such as “Improved customer service”, “Better and faster information access”, “Less paper work”, and “Increase productivity” is better than areas such as “Improved competitive position” and “Decreased personnel and operating cost”.

### **The Guidelines for Prioritizing Areas to Computerize and Guidelines for Marketing Strategies**

This section presents guidelines for prioritizing areas to computerize when small businesses start computerizing the field of production management and guidelines for the design of marketing strategies for software development companies.

- **Guidelines for prioritizing areas to computerize :**

Variables that companies have to consider:

- ◆ The purpose of computerizing.

- Improve departmental coordination.

- Reduce operating costs.

- Competitive improvement.

- ◆ The applications for computerization.

- Materials control, production control, production planning, payroll, costing, forecasting, quality control, and product development.

- **Guidelines for marketing strategies:**

*Companies who have computerized and are planning to computerize other applications.*

- ◆ Offer software in areas such as product development, forecasting, quality control, costing and personnel.
- ◆ Offer improvement of applications already computerized such as materials control, costing, production control, and production planning.
- ◆ Software developer should provide training, improve support of the product, and reduce time for system development.

*Companies who have computerized and are not planning to computerize other applications.*

- ◆ Offer free consultation to evaluate the status of the system and the cost of the introduction of new applications and improvement of the existent applications.

*Companies who have not computerized and are not planning to computerize.*

- ◆ Offer free consultation to evaluate the possible benefits could be obtained if computerizing production management activities. This is important to evaluate the economic benefits of computerizing.
- ◆ Approach small manufacturing businesses with software developed specially for them. The cost of the software is a very important issue in this case.

*Companies who have not computerized and are planning to computerize.*

- ◆ Offer software in areas such as forecasting, production planning, production control and materials control primarily.
- ◆ The cost of the software is also a very important issue in this case.

## **Conclusions**

The following conclusions and recommendations are based on the results from analyzing utilization of small computers by small manufacturing businesses as reported in the returned questionnaire, and also on the review of the related literature.

1. Fifty percent of small businesses currently utilize computerized data processing in production management activities.
2. A majority of small manufacturing businesses who do not have any computerized data processing capabilities in production management indicated they are not currently considering microcomputer use.
3. Small businesses with less than 50 employees are more likely not to acquire microcomputers.
4. The types of production management applications used are production planning and control, material control, and costing.
5. More programs for production management applications were purchased off-the-shelf than were written by contracted programming consultants.
6. The microcomputers are the most popular hardware for small business.
7. Competitiveness and reduction of costs are the main goals of computerizing.
8. The perception of the general performance of computers and microcomputers used in production management is good.

## **Researcher's Experiences**

The experience of performing this survey has been very interesting and there are some comments that the researcher would like to share.

The definition of the objective, problem and subproblems are the main part of the research. The researcher has to be clear about what he/she is looking for and has to answer all the possible questions about extension of the research and its possible constraints. An important point is that after beginning the questionnaire, define the population and the sample size, it is very difficult to modify the objectives of the research because they represent the base of that work.

After a clear definition of objectives, the design of the questionnaire is the next goal. Population and sample size are important but requires less time and effort than the questionnaire design. However, the questionnaire requires literature review in different areas such as survey design, previous research about the topic in study and general information about the topic.

The process of data collection can be painful especially if the response rate is not what was expected. The questionnaire and cover letter are important to get a good response level. However, the researcher has to consider other variables such as the type of people completing the questionnaire, their background, education level, etc. The researcher has to be creative to confront and design tools that will assure a good response level.

Finally, it is important to design the data-analysis procedures and the questionnaire together in order to be consistent and to prevent future problems when analyzing data.

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**APPENDIX A**  
**PILOT QUESTIONNAIRE AND PILOT COVER LETTER**



February 2, 1995

Dear Production Manager and/or Production Director:

SUBJECT: MICROCOMPUTER USAGE SURVEY

Enclosed you will find a questionnaire which deals with the utilization of microcomputers by small manufacturing businesses and their applications. The research is performed in the State of Oklahoma in the Chemical, Industrial Machinery, Rubber and Plastics, Electrical and Electronics and Apparel sectors. This information will be of value for both, educators and industries. A summary with the results of this research will be sent to those companies that respond to the questionnaire. The answers to the questionnaire, company name and personal names are confidential, only general results will be presented in the conclusions of the research.

Your business has been selected at random from the Industrial Directory to be part of the research study. By taking a few minutes of your valuable time to answer the questionnaire, you will be providing data that will be used to determine the type and effectiveness of information processing that small industries are using nowadays. Therefore, I would appreciate it very much if you would complete the questionnaire and return it to us before February 8.

Thank you very much for being a part of this study, and contributing to the overall effectiveness of this research. If I can be of any further assistance to you, please do not hesitate to contact us at Oklahoma State University, School of Industrial Engineering and Management (405) 744-6055 or e-mail [oscar@osuunx.ucc.okstate.edu](mailto:oscar@osuunx.ucc.okstate.edu)

Sincerely,

Oscar Acuña C.  
Graduate Student.

Dr. Michael Branson  
Associate Professor

**QUESTIONNAIRE ON MICROCOMPUTER USE IN PRODUCTION MANAGEMENT BY  
SMALL MANUFACTURING BUSINESS**

This questionnaire is a survey to determine the status and trends of microcomputer usage in the area of production management of small manufacturing business in Oklahoma. Please complete the questionnaire by checking (√) or circle (O) the appropriate response and filling in the blanks when necessary. A summary with the results of this research will be sent to those companies that respond the questionnaire. Thank you for your cooperation.

---

**Section I. General Information**  
**—Company profile—**

---

1. Company name \_\_\_\_\_

2. Your position in the company \_\_\_\_\_

3. Number of employees:

\_\_\_\_\_ Less than 10 employees

\_\_\_\_\_ 10 - 50 employees

\_\_\_\_\_ 51 - 100 employees

\_\_\_\_\_ 101 - 150 employees

\_\_\_\_\_ 151 - 200 employees

\_\_\_\_\_ 201 - 250 employees

\_\_\_\_\_ more than 250

---

**Section II. Current Use of the system**

**Complete this section only if production department HAS COMPUTERIZED production management activities. If NOT, go to section III.**

---

4. What type of hardware does the Production Department currently use?

\_\_\_\_\_ Personal Computer (IBM or compatible PC: pentium-486-or smaller, Apple-Macintosh, etc.)

\_\_\_\_\_ Mainframe (A large, powerful, centralized computer)

\_\_\_\_\_ Other, please explain \_\_\_\_\_

5. What was the main purpose in computerizing the production department?

*Check only one*

\_\_\_\_\_ To reduce information overload

\_\_\_\_\_ To reduce high operating costs

\_\_\_\_\_ Competitive improvement

\_\_\_\_\_ To improve coordination between departments

\_\_\_\_\_ To use equipment similar to the competitors

\_\_\_\_\_ Take advantage of low price of hardware or software

\_\_\_\_\_ Take advantage of hardware and software quality

\_\_\_\_\_ Other, please explain \_\_\_\_\_

6. What of the following production management application(s) have you computerized within the production department?

*You may check more than one*

- |  |  |
|--|--|
| <input type="checkbox"/> Forecasting                 | <input type="checkbox"/> Product Development         |
| <input type="checkbox"/> Production Planning         | <input type="checkbox"/> Personnel Health and Safety |
| <input type="checkbox"/> Production Control          | <input type="checkbox"/> Plant/Machine Maintenance   |
| <input type="checkbox"/> Materials Control           | <input type="checkbox"/> Transport and Distribution  |
| <input type="checkbox"/> Quality Control             | <input type="checkbox"/> Costing                     |
| <input type="checkbox"/> Personnel                   | <input type="checkbox"/> Payroll                     |
| <input type="checkbox"/> Other, please explain _____ |  |

7. Which of the applications, that you did not select before, is the company planning to computerize in the near future?

*Rank three using numbers (1= first, 2= second, 3= third)*

- |  |  |
|--|--|
| <input type="checkbox"/> Forecasting                 | <input type="checkbox"/> Product Development         |
| <input type="checkbox"/> Production Planning         | <input type="checkbox"/> Personnel Health and Safety |
| <input type="checkbox"/> Production Control          | <input type="checkbox"/> Plant/Machine Maintenance   |
| <input type="checkbox"/> Materials Control           | <input type="checkbox"/> Transport and Distribution  |
| <input type="checkbox"/> Quality Control             | <input type="checkbox"/> Costing                     |
| <input type="checkbox"/> Personnel                   | <input type="checkbox"/> Payroll                     |
| <input type="checkbox"/> Other, please explain _____ |  |
| <input type="checkbox"/> None                        |  |

8. For the applications you have computerized: What was the main source of software for the production department? (Software includes spreadsheets, specific programs, packages, etc.)

*Possible sources:*

- (1) Self-developed (programs developed by in-house programming personnel)
- (2) Off-the-shelf (Purchased in retail stores or from retailers)
- (3) Custom programming (Programs developed by contract programming consultants)
- (4) Combinations (for example: creating complex macros in a spreadsheet)
- (5) Other, please explain \_\_\_\_\_

*Use the numbers provided above*

- |  |  |
|--|--|
| <input type="checkbox"/> Forecasting         | <input type="checkbox"/> Product Development         |
| <input type="checkbox"/> Production Planning | <input type="checkbox"/> Personnel Health and Safety |
| <input type="checkbox"/> Production Control  | <input type="checkbox"/> Plant/Machine Maintenance   |
| <input type="checkbox"/> Materials Control   | <input type="checkbox"/> Transport and Distribution  |
| <input type="checkbox"/> Quality Control     | <input type="checkbox"/> Costing                     |
| <input type="checkbox"/> Personnel           | <input type="checkbox"/> Payroll                     |

9. Please evaluate the level of satisfaction with the general performance of the computer system (hardware and software) used by the production department.

*Use circles to select*

	Very Satisfactory (good)		Neutral Impact		Very Unsatisfactory (bad)
<u>OUTPUT QUALITY</u>					
Currency of output (being in general acceptance)....	1	2	3	4	5
Timeliness of output (happening at just right time)..	1	2	3	4	5
Accuracy of output (exactness or correctness).....	1	2	3	4	5
Completeness of output (having all necessary).....	1	2	3	4	5
Reliability of output (Trustworthiness).....	1	2	3	4	5
Relevancy of output (Connected with the subject)....	1	2	3	4	5
Precision of output (regard to the smallest details)....	1	2	3	4	5

USER-SYSTEM RELATIONSHIP

User's participation in the design or purchase.....	1	2	3	4	5
Convenience of access.....	1	2	3	4	5
Training provided to users.....	1	2	3	4	5
User's understanding of system.....	1	2	3	4	5

USER-DEVELOPER RELATIONSHIP

Relationship with the source (developer).....	1	2	3	4	5
Communication with the source of the software.....	1	2	3	4	5
Vendor support.....	1	2	3	4	5
Time required for system development.....	1	2	3	4	5

10. What is the perceived impact resulting from computerizing the production department?

	Very Positive Impact		Neutral Impact		Very Negative impact
Increased productivity.....	1	2	3	4	5
Better and faster information access.....	1	2	3	4	5
Improved customer service.....	1	2	3	4	5
Less paperwork.....	1	2	3	4	5
Improved competitive position.....	1	2	3	4	5
Decreased personnel and operating cost.....	1	2	3	4	5
Other, please explain.....	1	2	3	4	5

11. Please add any comment about future computer utilization that may be helpful in evaluating this questionnaire.

---



---

*Thank you (if you filled out this section you are finished with the questionnaire).*

---

**Section III. Future Users**

**COMPLETE this section ONLY if the Production Department DOES NOT HAVE COMPUTERIZED production management activities.**

---

12. Is the production department considering purchasing, or using in-house computers or microcomputers in the near future? (Computer: A large, powerful, centralized mainframe. Microcomputer: IBM or compatible PC / pentium-486-or smaller, Apple-Macintosh, etc.)

- Yes (go to question #14)  
 No (answer question #13 and finish)

13. Why not?

*You may check more than one*

- hardware is too expensive (computers/microcomputers)  
 software is too expensive (programs)  
 computerization is not required in the department  
 companies' size does not justify the expenditure  
 other, please explain \_\_\_\_\_

**\*\*\* if the production department does not plan to computerize any production management activity, please stop here.\*\*\***

14. What will be the main purpose in acquiring computers or microcomputers in the production department.

*Check only one*

- To reduce information overload  
 To reduce high operating costs  
 Competitive improvement  
 To use equipment similar to the competitors  
 Take advantage of low price of hardware or software  
 Take advantage of hardware and software quality  
 Others, please explain \_\_\_\_\_

15. What would be the main source to obtain software when you have a microcomputer? (Software includes spreadsheets, specific programs, packages, etc.)

*Rank using numbers (1= first, 2= second, 3= third)*

- Self-developed (programs developed by in-house programming personnel)  
 Off-the-shelf (Purchased in retail stores or from retailers)  
 Custom programming (Programs developed by contract programming consultants)  
 Combinations (for example: creating complex macros in a spreadsheet)  
 Other, please explain \_\_\_\_\_

16. What production management application(s) will you expect to use in the near future?

*You may check more than one.*

- |  |  |
|--|--|
| <input type="checkbox"/> Forecasting                 | <input type="checkbox"/> Product Development         |
| <input type="checkbox"/> Production Planning         | <input type="checkbox"/> Personnel Health and Safety |
| <input type="checkbox"/> Production Control          | <input type="checkbox"/> Plant/Machine Maintenance   |
| <input type="checkbox"/> Materials Control           | <input type="checkbox"/> Transport and Distribution  |
| <input type="checkbox"/> Quality Control             | <input type="checkbox"/> Costing                     |
| <input type="checkbox"/> Personnel                   | <input type="checkbox"/> Payroll                     |
| <input type="checkbox"/> Other, please explain _____ |  |

**APPENDIX B**  
**FINAL QUESTIONNAIRE AND FINAL COVER LETTER**

February 14 , 1995

Dear Production Manager and/or Production Director:

SUBJECT: MICROCOMPUTER USAGE SURVEY

Enclosed you will find a questionnaire which deals with the utilization of microcomputers by small manufacturing businesses and their applications. The research is performed in the state of Oklahoma in the Chemical, Industrial Machinery, Rubber and Plastics, Electrical and Electronics and Apparel sectors. This information will be of value for both, educators and industries. A summary with the results of this research will be sent to those companies that respond to the questionnaire. The answers to the questionnaire, company name and personal names are confidential, only general results will be presented in the conclusions of the research.

Your business has been selected at random from the Industrial Directory to be part of this research. By taking a few minutes of your valuable time to answer the questionnaire, you will be providing data that will be used to determine the type and effectiveness of information processing that small industries are using nowadays. Therefore, we would appreciate it very much if you would complete the questionnaire and return it to us before February 24. A self-addressed, postage paid envelope has been enclosed for your convenience.

Thank you very much for being a part of this study, and contributing to the overall effectiveness of this research. If we can be of any further assistance to you, please do not hesitate to contact me at Oklahoma State University, School of Industrial Engineering and Management (405) 744-6055 or e-mail [oscar@osuunx.ucc.okstate.edu](mailto:oscar@osuunx.ucc.okstate.edu)

Sincerely,

Oscar Acuña C.  
Graduate Student.

Dr. Michael Branson  
Associate Professor.

**QUESTIONNAIRE ON MICROCOMPUTER USE IN PRODUCTION MANAGEMENT BY  
SMALL MANUFACTURING BUSINESS**

This questionnaire is a survey to determine the status and trends of microcomputer usage in the area of production management of small manufacturing businesses in Oklahoma. Please complete the questionnaire by checking (✓) or circle (O) the appropriate response and filling in the blanks when necessary. A summary with the results of this research will be sent to those companies that respond to the questionnaire. Thank you for your cooperation.

---

**Section I. General Information**

**—Company profile—**

---

1. Company name \_\_\_\_\_

2. Your position or title in the company \_\_\_\_\_

3. Number of employees:

\_\_\_\_\_ Less than 10 employees

\_\_\_\_\_ 10 - 50 employees

\_\_\_\_\_ 51 - 100 employees

\_\_\_\_\_ 101 - 150 employees

\_\_\_\_\_ 151 - 200 employees

\_\_\_\_\_ 201 - 250 employees

\_\_\_\_\_ more than 250

---

**Section II. Current Use of the system**

**Complete this section only if production department HAS COMPUTERIZED production management activities. If NOT, go to Section III.**

---

4. What type of hardware does the Production Department currently use?

*Check all that apply*

\_\_\_\_\_ Personal Computer (IBM or compatible PC, Apple-Macintosh, etc. It includes PC-LAN)

\_\_\_\_\_ Mainframe (Large, powerful, centralized computer) or Workstations.

\_\_\_\_\_ Other, please explain \_\_\_\_\_

5. What was the main purpose in computerizing the production department?

*Check only one*

\_\_\_\_\_ To reduce information overload

\_\_\_\_\_ To reduce high operating costs

\_\_\_\_\_ Competitive improvement

\_\_\_\_\_ To improve coordination between departments

\_\_\_\_\_ To use equipment similar to the competitors

\_\_\_\_\_ Take advantage of low price of hardware or software

\_\_\_\_\_ Take advantage of hardware and software quality

\_\_\_\_\_ Other, please explain \_\_\_\_\_



6. Which of the following production management application(s) have been computerized within the production department?

*You may check more than one*

- |  |  |
|--|--|
| <input type="checkbox"/> Forecasting                 | <input type="checkbox"/> Product Development         |
| <input type="checkbox"/> Production Planning         | <input type="checkbox"/> Personnel Health and Safety |
| <input type="checkbox"/> Production Control          | <input type="checkbox"/> Plant/Machine Maintenance   |
| <input type="checkbox"/> Materials Control           | <input type="checkbox"/> Transport and Distribution  |
| <input type="checkbox"/> Quality Control             | <input type="checkbox"/> Costing                     |
| <input type="checkbox"/> Personnel                   | <input type="checkbox"/> Payroll                     |
| <input type="checkbox"/> Other, please explain _____ |  |

7. Which of the applications, that you did not select before, is the company planning to computerize in the near future?

*Rank three of the following using numbers (1= first, 2= second, 3= third)*

- |  |  |
|--|--|
| <input type="checkbox"/> Forecasting                 | <input type="checkbox"/> Product Development         |
| <input type="checkbox"/> Production Planning         | <input type="checkbox"/> Personnel Health and Safety |
| <input type="checkbox"/> Production Control          | <input type="checkbox"/> Plant/Machine Maintenance   |
| <input type="checkbox"/> Materials Control           | <input type="checkbox"/> Transport and Distribution  |
| <input type="checkbox"/> Quality Control             | <input type="checkbox"/> Costing                     |
| <input type="checkbox"/> Personnel                   | <input type="checkbox"/> Payroll                     |
| <input type="checkbox"/> Other, please explain _____ |  |
| <input type="checkbox"/> None, why _____             |  |

8. For the applications that have been computerized: What was the main source of software for the production department? (Software includes spreadsheets, specific programs, packages, etc.)

*Possible sources:*

- (1) Self-developed (programs developed by in-house programming personnel)
- (2) Off-the-shelf (Purchased in retail stores or from retailers)
- (3) Custom programming (Programs developed by contract programming consultants)
- (4) Combinations (for example: creating complex macros in a spreadsheet)
- (5) Other, please explain \_\_\_\_\_

*Use the numbers provided (1,2,3,4,5) to show the source*

- |  |  |
|--|--|
| <input type="checkbox"/> Forecasting         | <input type="checkbox"/> Product Development         |
| <input type="checkbox"/> Production Planning | <input type="checkbox"/> Personnel Health and Safety |
| <input type="checkbox"/> Production Control  | <input type="checkbox"/> Plant/Machine Maintenance   |
| <input type="checkbox"/> Materials Control   | <input type="checkbox"/> Transport and Distribution  |
| <input type="checkbox"/> Quality Control     | <input type="checkbox"/> Costing                     |
| <input type="checkbox"/> Personnel           | <input type="checkbox"/> Payroll                     |

9. Please evaluate the level of satisfaction regarding the general performance of the computer system (hardware and software) used by the production department.

*Use circles to select*

	Very Satisfactory (good)		Neutral Impact		Very Unsatisfactory (bad)
<u>OUTPUT QUALITY</u>					
Currency of output (being in general acceptance)....	1	2	3	4	5
Timeliness of output (happening at just right time)	1	2	3	4	5
Accuracy of output (exactness or correctness).....	1	2	3	4	5
Completeness of output (having all necessary).....	1	2	3	4	5
Reliability of output (Trustworthiness).....	1	2	3	4	5
Relevancy of output (Connected with the subject)....	1	2	3	4	5
Precision of output (regard to the smallest details)....	1	2	3	4	5

USER-SYSTEM RELATIONSHIP

User's participation in the design or purchase.....	1	2	3	4	5
Convenience of access.....	1	2	3	4	5
Training provided to users.....	1	2	3	4	5
User's understanding of system.....	1	2	3	4	5

USER-DEVELOPER RELATIONSHIP

Relationship with the source (developer).....	1	2	3	4	5
Communication with the source of the software.....	1	2	3	4	5
Vendor support.....	1	2	3	4	5
Time required for system development.....	1	2	3	4	5

10. What is the perceived impact resulting from computerizing the production department?

	Very Positive Impact		Neutral Impact		Very Negative impact
Increased productivity.....	1	2	3	4	5
Better and faster information access.....	1	2	3	4	5
Improved customer service.....	1	2	3	4	5
Less paperwork.....	1	2	3	4	5
Improved competitive position.....	1	2	3	4	5
Decreased personnel and operating cost.....	1	2	3	4	5
Other, please explain _____	1	2	3	4	5

11. Please add any comment about future computer utilization that may be helpful in evaluating this questionnaire.

---



---



---

*Thank you (if you filled out this section you are finished with the questionnaire).  
Please return the questionnaire in the self addressed envelope.*

---

**Section III. Future Users**

**COMPLETE this section ONLY if the Production Department DOES NOT HAVE COMPUTERIZED production management activities.**

---

12. Is the production department considering purchasing, or using in-house computers or microcomputers in the near future? (Computer: A large, powerful, centralized mainframe. Microcomputer: IBM or compatible PC / pentium-486-or smaller, Apple-Macintosh, etc.)

- Yes (go to question #14)  
 No (answer question #13 and finish)

13. Why not?

*You may check more than one*

- hardware is too expensive (computers/microcomputers)  
 software is too expensive (programs)  
 computerization is not required in the department  
 company's size does not justify the expenditure  
 other, please explain \_\_\_\_\_

**\*\*\* if the production department does not plan to computerize any production management activity, please stop here. \*\*\***

14. What will be the main purpose in acquiring computers or microcomputers in the production department.

*Check only one*

- To reduce information overload  
 To reduce high operating costs  
 Competitive improvement  
 To use equipment similar to the competitors  
 Take advantage of low price of hardware or software  
 Take advantage of hardware and software quality  
 Others, please explain \_\_\_\_\_

15. What would be the main source to obtain software when you have a microcomputer? (Software includes spreadsheets, specific programs, packages, etc.)

*Rank using numbers (1 = first, 2 = second, 3 = third)*

- Self-developed (programs developed by in-house programming personnel)  
 Off-the-shelf (Purchased in retail stores or from retailers)  
 Custom programming (Programs developed by contract programming consultants)  
 Combinations (for example: creating complex macros in a spreadsheet)  
 Other, please explain \_\_\_\_\_

16. What production management application(s) will you expect to use in the near future?

*Check all that apply.*

- |  |  |   |
|--|--|---|
| <input type="checkbox"/> Forecasting                 | <input type="checkbox"/> Product Development         | T |
| <input type="checkbox"/> Production Planning         | <input type="checkbox"/> Personnel Health and Safety | H |
| <input type="checkbox"/> Production Control          | <input type="checkbox"/> Plant/Machine Maintenance   | A |
| <input type="checkbox"/> Materials Control           | <input type="checkbox"/> Transport and Distribution  | N |
| <input type="checkbox"/> Quality Control             | <input type="checkbox"/> Costing                     | K |
| <input type="checkbox"/> Personnel                   | <input type="checkbox"/> Payroll                     | S |
| <input type="checkbox"/> Other, please explain _____ |  |   |

**APPENDIX C**  
**COMPARISON: MAIL SURVEY VS. PHONE SURVEY**  
**CHI-SQUARE ANALYSIS**

Table XX  
 Chi Square Analysis  
 Mail Survey vs. Phone survey  
 Size of Businesses Surveyed

Ranges			
No. Empl.	Mail	Phone	Total
<10	6 9.13	11 7.87	17 ->>>No. Employees ->>>Estimated expected cell frequency
10-50	22 20.42	16 17.58	38
51-100	2 1.07	0 0.93	2
101-150	1 2.15	3 1.85	4
201-250	2 1.61	1 1.39	3
>250	3 1.61	0 1.39	3
Total	36	31	67

ChiSq = 8.425

df = 5

ChiSq (5) 0.1= 9.236

Objective: To test the hypothesis that the number of companies per range reached by phone and by mail are not different.

Conclusion: 8.425 < 9.236 => Hypothesis accepted with significance level of 0.1.

**Table XXI**  
**Chi Square Analysis**  
**Mail Survey vs. Phone survey**  
**Type of Hardware used in Production Management**

Ranges No.Empl.	Mail	Phone	Total
<10	13 13.59	9 8.41	22
10-50	3 3.09	2 1.91	5
51-100	2 1.85	1 1.15	3
101-150	3 2.47	1 1.53	4
<b>Total</b>	<b>21</b>	<b>13</b>	<b>34</b>

ChiSq = 0.400

df = 3

ChiSq (3) 0.1= 6.251

**Objective:** To test the hypothesis that the answers reached by phone and by mail are not different.

**Conclusion:**  $0.4 < 6.25 \Rightarrow$  Hypothesis accepted with significance level of 0.1.

Table XXII  
 Chi Square Analysis  
 Mail Survey vs. Phone survey  
 Main Purpose in Computerizing the Production Department

Purpose	Mail	Phone	Total
Red. Inf. Overl.	3 3.18	2 1.82	5
Red. Oper. Costs	4 3.82	2 2.18	6
Competitiv. Improv.	4 3.82	2 2.18	6
Improv. Coordinat.	8 7.64	4 4.36	12
Price Hard-Soft.	0 0.64	1 0.36	1
Other	2 1.91	1 1.09	3
<b>Total</b>	<b>21</b>	<b>12</b>	<b>33</b>

ChiSq = 1.886

df = 5

ChiSq (5) 0.1 = 9.236

Objective: To test the hypothesis that the answers reached by phone and by mail are not different.

Conclusion:  $1.886 < 9.236 \Rightarrow$  Hypothesis accepted with significance level of 0.1.

Table XXIII  
 Chi Square Analysis  
 Mail Survey vs. Phone survey  
 Applications have been Computerized within the Production Department

Application	Mail	Phone	Total
Forecasting	8	7	15
	8.76	6.24	
Prod.Plann.	13	7	20
	11.68	8.32	
Prod.Ctrl.	15	7	22
	2.84	9.16	
Materls.Ctrl.	15	9	24
	14.01	9.99	
Qualit.Ctrl	8	4	12
	7.01	4.99	
Personnel	6	7	13
	7.59	5.41	
Other	1	1	2
	1.17	0.83	
Prod.Develop.	6	5	11
	6.42	4.58	
Health/Safety	2	3	5
	2.92	2.08	
Maintenance	5	3	8
	4.67	3.33	
Tranp.Distr.	5	5	10
	5.84	4.16	
Costing	14	10	24
	14.01	9.99	
Payroll	10	9	19
	11.09	7.91	
<b>Total</b>	<b>108</b>	<b>77</b>	<b>185</b>

ChiSq = 4.117

df = 12

ChiSq (12) 0.1= 18.549

Objective: To test the hypothesis that the answers reached by phone and by mail are not different.

Conclusion:  $4.117 < 18.549 \Rightarrow$  Hypothesis accepted with significance level of 0.1.



Table XXIV  
 Chi Square Analysis  
 Mail Survey vs. Phone survey  
 Future Computerization of Production Management Application

Application	Mail	Phone	Total
Forecasting	4 3.36	1 1.64	5
Prod.Plann.	1 1.35	1 0.65	2
Prod.Ctrl.	3 2.69	1 1.31	4
Materls.Ctrl.	1 2.02	2 0.98	3
Qualit.Ctrl	4 3.36	1 1.64	5
Personnel	4 3.36	1 1.64	5
Other	0 0.67	1 0.33	1
Prod.Develop.	6 5.38	2 2.62	8
Health/Safety	2 2.02	1 0.98	3
Maintenance	3 2.69	1 1.31	4
Tranp.Distr.	3 3.36	2 1.64	5
Costing	2 2.02	1 0.98	3
Payroll	4 4.71	3 2.29	7
<b>Total</b>	<b>37</b>	<b>18</b>	<b>55</b>

ChiSq = 5.881

df = 12

ChiSq (12) 0.1= 9.236

Objective: To test the hypothesis that the answers reached by phone and by mail are not different.

Conclusion:  $5.881 < 9.236 \Rightarrow$  Hypothesis accepted with significance level of 0.1.

Table XXV  
 Chi Square Analysis  
 Mail Survey vs. Phone survey  
 Distribution of Source of the Software

Source	Mail	Phone	Total
Self-Developed	32 36.60	29 24.40	61
Off-the-Shelf	39 33.60	17 22.40	56
Custom Progr.	7 8.40	7 5.60	14
Combinations	6 7.20	6 4.80	12
Other	18 16.20	9 10.80	27
Total	102	68	170

ChiSq = 5.198

df = 4

ChiSq (4) 0.1 = 7.779

Objective: To test the hypothesis that the answers reached by phone and by mail are not different.

Conclusion:  $5.198 < 7.779 \Rightarrow$  Hypothesis accepted with significance level of 0.1.

Table XXVI  
 Chi Square Analysis  
 Mail Survey vs. Phone survey  
 Level of Satisfaction with the Performance of the Computer System

Variables	Mail	Phone	Total
Currency	2	2	4
	2.14	1.86	
Timeliness	2	2	4
	2.14	1.86	
Accuracy	2	2	4
	2.14	1.86	
Completeness	2	2	4
	2.14	1.86	
Reliability	2	2	4
	2.14	1.86	
Relevancy	2	2	4
	2.14	1.86	
Precision	2	2	4
	2.14	1.86	
Participat.	2	2	4
	2.14	1.86	
Access	2	2	4
	2.14	1.86	
Training	3	2	5
	2.68	2.32	
User Und.	2	2	4
	2.14	1.86	
Relationship	2	2	4
	2.14	1.86	
Communicat.	3	2	5
	2.68	2.32	
Support	3	2	5
	2.68	2.32	
Time Dev.	3	2	5
	2.68	2.32	
<b>Total</b>	<b>37</b>	<b>32</b>	<b>69</b>

ChiSq = 0.641

df = 15

ChiSq(15)0.1 = 22.307

Objective: To test the hypothesis that the answers reached by phone and by mail are not different.

Conclusion:  $0.641 < 22.307 \Rightarrow$  Hypothesis accepted with significance level of 0.1.

Table XXVII  
 Chi Square Analysis  
 Mail Survey vs. Phone survey  
 Perceived Impact resulting from Computerizing Production Applications

Variables	Mail	Phone	Total
Increased Product	2 2.07	2 1.93	4
Better Inf. Access	2 2.07	2 1.93	4
Improv. Cust. Serv	2 2.07	2 1.93	4
Less Paperwork	2 2.07	2 1.93	4
Competit. Posit.	3 2.59	2 2.41	5
Decreas. Costs	3 2.59	2 2.41	5
Other	1 1.55	2 1.45	3
<b>Total</b>	<b>15</b>	<b>14</b>	<b>29</b>

ChiSq = 0.700

df = 6

ChiSq (6) 0.1 = 10.644

Objective: To test the hypothesis that the answers reached by phone and by mail are not different.

Conclusion:  $0.700 < 10.644 \Rightarrow$  Hypothesis accepted with significance level of 0.1.

**Table XXVIII**  
**Chi Square Analysis**  
**Mail Survey vs. Phone survey**  
**Computerized vs. Non Computerized Companies in Production Management**  
**Activities**

Situation	Mail	Phone	Total
Have computerized	21 18.27	13 15.73	34
Haven't computerized	15 17.73	18 15.27	33
Total	36	31	67

ChiSq = 1.792

df = 1

ChiSq (1) 0.1= 2.705

Objective: To test the hypothesis that the answers reached by phone and by mail are not different.

Conclusion:  $1.792 < 2.705 \Rightarrow$  Hypothesis accepted with significance level of 0.1.

Table XXIX  
 Chi Square Analysis  
 Mail Survey vs. Phone survey  
 Perspective about Future Computerization of Non Computerized Companies

Perspective	Mail	Phone	Total
will	4 3.18	3 3.82	7
won't	11 11.82	15 14.18	26
Total	15	18	33

ChiSq = 0.490

df = 1

ChiSq (1) 0.1= 2.705

Objective: To test the hypothesis that the answers reached by phone and by mail are not different.

Conclusion:  $0.490 < 2.705 \Rightarrow$  Hypothesis accepted with significance level of 0.1.

Table XXX  
 Chi Square Analysis  
 Mail Survey vs. Phone survey  
 Reason of Non Computerized Companies for not Computerizing in the Future

Reason	Mail	Phone	Total
Hardware Expens.	1 1.16	3 2.84	4
Software Expens.	1 1.16	3 2.84	4
Comp.not Requir.	1 1.16	3 2.84	4
Company too Small	7 6.08	14 14.92	21
Other	1 1.45	4 3.55	5
<b>Total</b>	<b>11</b>	<b>27</b>	<b>38</b>

ChiSq = 0.482

df = 4

ChiSq (4) 0.1= 7.779

Objective: To test the hypothesis that the answers reached by phone and by mail are not different.

Conclusion:  $0.482 < 7.779 \Rightarrow$  Hypothesis accepted with significance level of 0.1.

Table XXXI  
 Chi Square Analysis  
 Mail Survey vs. Phone survey  
 Main Purpose of Non Computerized Companies for Computerizing in the  
 Future

Purpose	Mail	Phone	Total
Red. Inf. Overl.	1 1.25	1 0.75	2
Reduce Costs	2 1.87	1 1.12	3
Low Price Hard.	1 1.25	1 0.75	2
Hard. Soft. Qualit.	1 0.62	0 0.38	1
<b>Total</b>	<b>5</b>	<b>3</b>	<b>8</b>

ChiSq = 0.889

df = 3

ChiSq (3) 0.1 = 6.251

Objective: To test the hypothesis that the answers reached by phone and by mail are not different.

Conclusion:  $0.889 < 6.251 \Rightarrow$  Hypothesis accepted with significance level of 0.1.



Table XXXII  
 Chi Square Analysis  
 Mail Survey vs. Phone survey  
 Source of Software for Future Computerization of Non Computerized  
 Companies

Source	Mail	Phone	Total
Shelf-Devel.	1 1.47	1 0.53	2
Off-the-Shelf	3 2.93	1 1.07	4
Custom Prog.	3 2.20	0 0.80	3
Combinat.	4 4.40	2 1.60	6
Total	11	4	15

ChiSq = 1.790

df = 3

ChiSq (3) 0.1= 6.251

Objective: To test the hypothesis that the answers reached by phone and by mail are not different.

Conclusion:  $1.790 < 6.251 \Rightarrow$  Hypothesis accepted with significance level of 0.1.

Table XXXVIII  
 Chi Square Analysis  
 Mail Survey vs. Phone survey  
 Future Applications that Non Computerized Companies will Computerize

Source	Mail	Phone	Total
Forecast.	5	1	6
	5.12	0.88	
Prod.Plann.	5	1	6
	5.12	0.88	
Prod.Ctrl.	5	1	6
	5.12	0.88	
Mat.Ctrl	4	0	4
	3.41	0.59	
Quality Ctrl	3	0	3
	2.56	0.44	
Personnel	2	0	2
	1.71	0.29	
Prod.Develop.	1	0	1
	0.85	0.15	
Health/Safety	1	0	1
	0.85	0.15	
Maintenance	2	1	3
	2.56	0.44	
Costing	4	1	5
	4.27	0.73	
Payroll	3	1	4
	3.41	0.59	
<b>Total</b>	<b>35</b>	<b>6</b>	<b>41</b>

ChiSq = 3.244

df = 10

ChiSq (10) 0.1= 15.987

Objective: To test the hypothesis that the answers reached by phone and by mail are not different.

Conclusion:  $3.244 < 15.987 \Rightarrow$  Hypothesis accepted with significance level of 0.1.

**APPENDIX D**

**COMPARISON: POPULATION, ORIGINAL SAMPLE AND RESPONDENTS  
VS. SECTOR DISTRIBUTION AND SIZE DISTRIBUTION**

**CHI-SQUARE ANALYSIS**

Table XXXIV  
 Chi Square Analysis  
 Population vs. Original Sample  
 Distribution Sector of the Companies

Sectors	Population	Original Sample	Total
Apparel	189 162.80	10 36.20	199
Chemical	123 119.44	23 26.56	146
Elect&Electron.	141 146.43	38 32.57	179
Ind. Machin.	743 763.26	190 169.74	933
Rubber&Plast.	153 157.07	39 34.93	192
Total	1349	300	1649

ChiSq = 28.412

df = 4

ChiSq (4) 0.1= 7.779

Objective: To test the hypothesis that the sector distribution of the population and the original sample are not different.

Conclusion:  $28.412 > 7.779 \Rightarrow$  Hypothesis rejected with significance level of 0.1.

Table XXXV  
 Chi Square Analysis  
 Original Sample vs. Respondents  
 Distribution Sector of the Companies

Sectors	Population	Original Sample	Total
Apparel	10 10.63	3 2.37	13
Chemical	23 23.71	6 5.29	29
Elect&Electron.	38 42.51	14 9.49	52
Ind.Machin.	190 181.47	32 40.53	222
Rubber&Plast.	39 41.69	12 9.31	51
<b>Total</b>	<b>300</b>	<b>67</b>	<b>367</b>

ChiSq = 6.081

df = 4

ChiSq (4) 0.1= 7.779

**Objective:** To test the hypothesis that the sector distribution of the original sample and the respondents are not different.

**Conclusion:**  $6.081 < 7.779 \Rightarrow$  Hypothesis accepted with significance level of 0.1.

Table XXXVI  
Chi Square Analysis  
Population, Original Sample and Respondents  
Distribution Size of the Companies

Ranges		Original			
No. of Employees	Population	Sample	Total		
<10	1120	246	55	1421	
	1119.05	248.86	53.09		
51-100	81	14	2	97	
	76.39	16.99	3.62		
101-250	148	40	7	195	
	153.56	34.15	7.29		
Total		1349	300	64	1713

ChiSq = 2.849

df = 4

ChiSq (4) 0.1= 7.779

Objective: To test the hypothesis that the size distribution of the population, original sample and the respondents are not different.

Conclusion:  $2.849 < 7.779 \Rightarrow$  Hypothesis accepted with significance level of 0.1.

VITA <sup>2</sup>

Oscar Adrián Acuña C.

Candidate for the Degree of

Master of Science

Thesis: MICROCOMPUTER USAGE IN PRODUCTION  
MANAGEMENT IN SMALL MANUFACTURING BUSINESSES

Major Field: Industrial Engineering and Management

Biographical:

Personal Data: Born in San José, Costa Rica, On September 25, 1963, the son of Oscar and Flory de Acuña.

Education: Graduated from Colegio Salesiano Don Bosco, San José, Costa Rica in November 1980; received Bachelor of Science degree in Industrial Engineering and a Licentiate in Industrial Engineering from Universidad de Costa Rica, San José, Costa Rica in July 1987 and November 1989, respectively.

Completed the requirements for the Master of Science degree with major in Industrial Engineering and Management at Oklahoma State University in July 95.

Experience: Accesorios Plásticos Centroamericanos, San José-Costa Rica.

Production Manager, from 05/01/91 to 07/25/92.

Plásticos Para la Construcción, San José-Costa Rica. Production Manager Assistant, from 06/01/89 to 04/30/91.

Colegio Federado de Ingenieros y Arquitectos de Costa Rica. Part time, Executive Secretary, Construction Materials Quality Control Office, from 06/01/91 to 01/15/92.

Desarrollos Técnicos S.A., San José-Costa Rica. Production Manager Assistant, from 07/01/87 to 05/30/89.

Professional Memberships: Colegio Federado de Ingenieros y Arquitectos de Costa Rica, Institute of Industrial Engineering.