ECONOMICS OF SHARED SERVICES WITH APPLICATION TO THE HOSPITAL LAUNDRY

A THESIS

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BY

GELENE H. BARNETT, B.S.

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CHAPTER I

INTRODUCTION

Health care is one of the largest industries in the United States, with annual expenditures approaching $220 billion in 1979. Nine percent of the nation's gross national product was allocated to health; up from five percent in 1960 (Cameron 1980:75). These rising costs have resulted in active concern by consumers and government, causing pressures to be applied to lower the costs for health care. These pressures have taken several forms: (1) cost containment legislation, (2) certificate of need regulations, (3) licensure requirements, and (4) alternatives to traditional delivery as seen by the emergence of group practice, health maintenance organizations, neighborhood clinics, and shared services. The presumption of these controls or constraints is that overall prices and/or expenditures can be moderated indirectly through alteration of the production process.

The sharing of services is one method of altering the production process that has been used to meet increasing demands without adding unreasonably to the already overburdened cost structure. The trend toward this form of organization is demonstrated in the survey conducted by The Health Services Research Center of the Hospital Research and Education Trust (Astolfi and Matti 1972). The report states that instances of shared services increased two percent in a fourteen month period between 1970 and 1971.

The pressures for cost containment now present in the industry require health care managers to examine the shared service organization as an alternative to the present production process. The decision to develop a shared service involves many considerations. Among these are the following:

1. Which services to share
2. When to develop the shared service
3. What organizational structure to follow
4. What quality of services will result
5. What will be the economic impact
6. What legal issues are involved, and
7. Who will participate in the new service.

Some of the above considerations must be made before a decision is finalized; thus, an organization whose objective is to develop a cost-effective shared service must utilize an economic evaluation of the proposal.

CHAPTER II

STUDY DESIGN

Statement of the Problem

The economic evaluation of a shared service is composed of two fundamental parts, as follows: (1) identification and quantification of revenue variables from the market place and (2) identification and quantification of the cost variables from the business/service structure. The excess of revenue (1) above cost (2) is defined as profit.

An organization plans to combine its resources (men, money, and material) to produce a profit. A proposed change in operations requires a recombination of organizational resources. The question explored by this paper was: What is the mix of revenues and costs for a proposed laundry shared service that will produce the desired level of profits and provide the level of production needed?

Purposes

The primary purpose of this thesis was to develop an economic model for shared services that quantifies revenues, costs, and production levels and predicts profits. A corporation can then make the decision to share services by comparing the predicted profits against the profit standard of its organization.

The secondary purpose of this thesis was to apply the economic model to a specific situation that existed in a health care management

corporation. It was anticipated that application of the model would determine what profits would result from development of a central facility for laundry services.

Method

The costs associated with the development of the central laundry were quantified. The revenue from the central facility was determined from current demand adjusted for trend and priced at or below present prices paid. The excess (if any) of revenues above costs determined the level of profits to be expected. The profit level was then compared to the corporate standard to assist in the decision to develop a central facility for laundry services.

Sample

Ten hospitals located in a city of the southcentral United States (see Figure 1) received laundry services from commercial linen companies. The ten hospitals were managed by the same corporation. Seven of the hospitals were general care institutions and three were for psychiatric care. The parent corporation continually acquires hospitals in this and other regions, but the ten hospitals comprised the sample of this study. The individual hospitals are designated by numbers "1" through "10" in Figure 1.

Instrumentation

Data from the ten hospitals were collected from operating reports filed with the regional office of the parent corporation as follows:

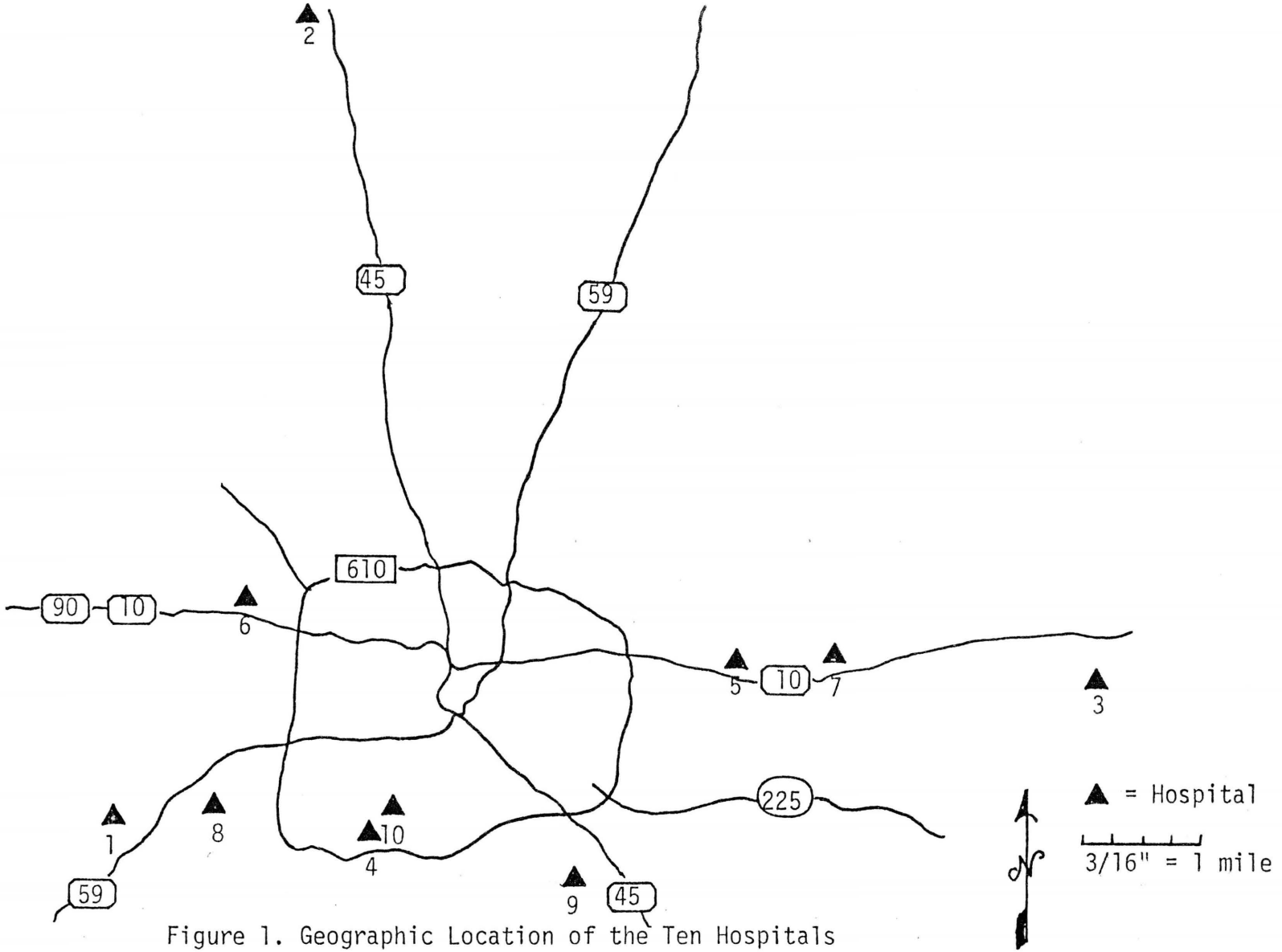

Figure 1. Geographic Location of the Ten Hospitals

1. Number of hospital beds
2. Average daily census
3. Total patient days
4. Present linen usage in pounds
5. Present linen cost per year
6. Present location, and
7. Future plans for expansion.

Those data formed the basis for determining the quantity of service required from a central laundry facility that was under consideration by the parent corporation. The data were also used to determine forecast demand and reserve capacity needed for future expansion of the central laundry.

Decision Rule

The revenues and costs associated with the central laundry facility were quantified and analyzed according to a proforma profit and loss statement and a proforma balance sheet. Thus, the variables which were of concern to the hospitals to be served were identified and quantified and a central laundry that would satisfy the hospital needs was developed, and the profit expected from the operation of the central facility was determined. The calculated profit was evaluated against corporate requirements to assist in the decision to develop a shared laundry service between the hospitals from which the data was derived.

CHAPTER III

BACKGROUND

> In the field of health care, the decade of the seventies and the last quarter of the century will be the era of the merger (Sieverts and Sigmond 1970:261).

Mergers are the logical response to the development of an appropriate size in the interest of efficiency and economy. The social forces for cost containment which have produced these trends in hospital care will not disappear. Health care institutions in the future will be more responsive to community needs and more accountable to the community for performance (Sheps 1971:31).

Social Forces

> The kind of doctor we have today; the way in which he is paid; his status in society; the way he is educated; what he expects of patients, of hospitals, of insurance companies is the fruit of past developments. So too, with patients(sic); what he expects in care; how he expects to be treated in the doctor's office and in the hospital; what and how he expects to pay for medical services--all of these have roots in the past (Silver 1976:12).

Until the beginning of this century most people looked on the hospital as a place where only the gravely ill were sent and probably would die (Jonas 1977:166). The changing nature of American society at that time, with urbanization, industrialization, and mechanization contained the seed for rising expectations for modern and improved services of all kinds. The union movement of the early 1900's strongly supported a health insurance approach to health care, and

ironically was supported by physicians (Silver 1976). However, entry into World War I put a stop to those activities, and not until after World War II was it possible for government to provide substantial support in the medical field.

Massive governmental entry into the financing of health services generated both new demand for services and stringent pressures to keep cost down. Viewing costs from the perspective of the past half century, it is clear that science and technology have imposed a heavy burden of cost and consequent expenditures upon the American people. To a considerable degree the burden has been minimized by the gradual increase of public expenditures (use of tax dollars), which lessens the impact on the individual at the time of required service (Brown 1974). It would seem that the reimbursement mechanism by which hospitals or providers are paid has an important influence on whether or not hospitals will manage with efficiency and economy. Payment on the basis of expenditures as billed, provides no incentive for either economy or efficiency (Silver 1976). The hospital in many ways is still the doctor's workshop, consequently, there are things that hospitals do in order to satisfy physicians that have nothing whatever to do with economy.

If the burden of medical care costs is to be lightened, we must have more efficient and economic use of facilities and resources. The problem then becomes identification of the elements that can be improved and selection of the components within those

elements that will offer the best leverage for economies. Hospitals must achieve a coordinated, cooperative attitude in order to remain flexible in response to those changes. Thus, technical feasibility plus cost containment pressures lead increasingly to integrative movements and sharing decisions among institutions.

Shared Services

> Although it might appear that with sufficient size a hospital system could become completely self-sufficient, considerations of quality and cost effectiveness show that this is simply not true. Even General Motors does not yet operate all of the services and product lines that make up the transportation system, nor does it insist on doing for itself what others can do better at lower cost (Brown and McCool 1980:xv).

The interests of efficiency and economy for the health care system have resulted in the development of shared services (Sheps 1971: 31). A number of factors generate pressures for considerations of sharing and cooperation. High costs, economy of scale considerations, capital equipment obsolescense, cost containment directives, and reimbursement program changes place new strains on the individual institutions (Brown 1974:42).

Taylor (1977) reports that approximately sixty percent of all hospitals share some services. The number of hospitals sharing purchasing services increased from 606 before 1970 to 1,927 in 1975, a 218 percent increase. Similar gains occured in education, and training, management engineering, electronic data processing, cardiac intensive care, renal dialysis, and a variety of other services. Blood banking, laboratory services, and diagnostic radiology increases

were less dramatic during the same time period but still represented three of the ten most widely shared services.

There is also an increase in multi-institutional systems--a broad term used to describe a variety of collaboration arrangements (Barrett 1979:50). These organizational structures range from a loosely organized, informal agreement to actual merger of facilities or of parent corporations (Starkweather 1971:473). An integrated approach to management and governance can set current operations in the contest of long-range plans, and, to the extent that the system's organization structures (board, management, and medical staff) support integrated management and governance processes, they contribute to the overall institutional effectiveness and efficiency. Effectiveness measures how well the institution performs in relation to its stated goals, and efficiency constitutes minimizing the amount of resources and operating costs associated with achieving stated goals (Reynolds and Stunden 1978:30).

An area of common concern is the antitrust ramifications present whenever the number of providers is reduced within some segment of a market, as occurs when sharing of services is implemented. Different methods of sharing may also have distinct legal consequences in areas of taxation, corporate law, and government regulations (Thompson 1979:72).

While no single correct way of "putting it all together" exists, certainly administrators must be willing to move beyond

traditional rhetoric. Individual administrators carry with them a whole set of working assumptions. To become more effective they must establish standards and state objectives. The manager as producer, director, and creator is responsible for putting all the pieces together. Thus comes the proverbial bureaucracy, comes the issue of economies of scale, of continuity and comprehensiveness of care, of cost containment, and of similar concerns that underlie the mandate to integrate the nations health care activities (Kraus 1978).

Laundry Services

> The hospital laundry and linen service, which, too often in the past, has been relegated to a basement operation, is one area of hospital services that increasingly . . . will be looking for new ways to streamline their operation for maximum efficiency and effectiveness and to decrease their expenditures (Ellis 1978:141).

Laundry services have developed through the years from crude methods of beating linens on rocks and boiling them in solutions containing lye and some form of chloride to the effective and sophisticated modern laundry methods (Cooper 1975:24). The main goal of this modern laundry is to supply linen needs economically and satisfactorily, recognizing that clean linens and garments contribute to the progress and well being of patients in health care institutions (Cooper 1975; Giancola 1978).

A high quality linen service can be defined as "a clean, good-looking textile product in adequate supply, used where needed to perform a predetermined function (Giancola 1978)." Laundry and linen

services fall short of this goal because of (1) the perpetuation of costly traditional linen use practices, (2) the lack of managerial effectiveness and authority, (3) the lack of administrative interest in, and support of the linen service, and (4) the lack of adequate factual information with which to pinpoint problems and make managerial decisions (Ellis 1978:141). The first of these has financial impact and the remaining three are managerial in nature.

Financial Characteristics

Laundry and linen service generally constitute no more than two percent of a hospital's budget (Ellis 1978:141). Recognizing that labor with fringe benefits approximate 65-70 percent of a service industry's costs, it follows that labor reduction becomes the primary target. In the laundry industry technological advantages can be taken to increase productivity (Barrett 1976:29). Although laundry machinery prices have been rising at the rate of twelve percent per year (Tuite 1978:12), the conversion of a variable cost factor to a fixed cost factor through capital expenditure, is a sound investment (Barrett 1976:29). Purchase of laundry equipment involves knowledgable consideration of several key factors, as follows (Tuite 1978:12-15):

1. Machine capacity - depends on workload broken down into the various production processes: wash-extract, tumble dry, flat iron, press, and other processes
2. Machine mix - depends on type of work to be processed: percentage relative to total volume, reserve capacity, and institutional

objectives for quality and finish

3. Machine selection - depends on availability of spare parts, service, extent of maintenance, and skill of available operators

4. Available utilities supply - utility connection and line sizes must accommodate the laundry's water, air, and steam demands.

Exclusive of equipment, linen is the most expensive single item of inventory in a hospital (Cooper 1975:26). Linen replacement costs presently range from twenty to forty percent of the total cost of a hospital laundry and linen service (Ellis 1978:141; Rittenhouse 1980). Eighty percent of the replacement cost is due to linen misuse, including theft, with the remaining twenty percent due to actual wear. Thus, the cost for linen service falls into two categories: (1) the processing plant and facility and (2) product (linen) costs.

Managerial Characteristics

Laundry activities can be classified broadly into two categories (Bartscht, Grimes, and Rothenbuhler 1966:107) as follows:

1. Direct work - activities where employee efforts contribute directly to some measurable output, such as loading and unloading equipment, folding linen, and pressing uniforms

2. Indirect work - activities where no quantitative measures of output can be related to the amount of time needed to accomplish the task, such as attending committee meetings, and supervision.

Coordinating the laundry's function with other departments is the role of management. Traditional laundry systems fail in this coordination

because they are supply systems, not control systems. Managers must develop policies and procedures that control inventory levels and replacement costs and that establish linen usage standards. Then quality laundry services are produced (Duffy 1978; Ellis 1978; Emerzian and Coleman 1977; Berger 1978; Cooper 1975; Lambrech 1975; Latimer 1976; Malmgren 1978; Mara 1977; Pohle 1976). Success in these areas has been reported by organizations which have developed shared laundry services (Barrett 1976; Benn 1978; Kruizinga 1977; Pick 1971) so that now laundry services are the third most commonly shared service behind purchasing and laboratories (Astolfi and Matti 1972; Taylor 1977).

Economics

Economics is the study of the allocation of scarce resources among the factors of production. Thus, economics furnishes a technique for thinking about decisions. Many economic problems, particularly in microeconomics, take the form of maximizing some variable (such as profit) subject to a constraint (such as the production function). The first problem is to determine what goods are to be produced, and the second, in what quantities. Although resources can be combined in an infinite variety of ways, technology and manpower set ultimate limits on the total size of the final output. Producers strive to keep costs at a minimum by adopting the most efficient methods of production. Demand, supply, and cost curves are recognized as functions that fall within a range of possibilities with the market establishing an equilibrium price. Thus, it has, in effect, allocated

the scarce resources among some buyers and withheld them from others (Colberg, Forbush, and Whitaker 1970; Haynes 1969; Heilbroner and Thurow 1978; Samuelson 1973).

There are, however, certain limitations on the use of economic theory in the health care industry. While a number of industries that sell their goods in a competitive market may exhibit one or more of the following characteristics, each of them applies to the health care industry (Sorkin 1975:4-5); thus, market place allocation is excluded.

1. Consumer ignorance - the consumer is dependent on the producer for information concerning quality and those judgements are made independent of financial or cost considerations
2. Nonprofit motive - the majority of health care providers do not operate on a profit making basis which, in turn, leads to inefficient operations
3. Restrictions on competition - advertising is prohibited and price competition is extremely rare, resulting in higher prices than would occur if restrictions on competition were eliminated
4. Lack of productivity gains - in other industries wage increases are usually offset with productivity gains, but hospitals have not been able to accomplish significant gains in productivity.

The above factors are not the only ones that exclude market allocation in the health care industry; but serve as a general framework for extrapolation to other factors.

The rise in the price of health care is accompanied by increasing demand; evidence that price is not determined in the market place. Factors contributing to this increased demand include a large number of older persons in the population, higher educational levels and concomitant greater health awareness, urbanization of the population, a relative increase in the number of health care providers so that patients have easier access to medical care, and the growth of third party payments (Sorkin 1975:10).

A number of economists familiar with hospitals have suggested that the hospital acts as if its objective were to maximize output subject to certain constraints, such as quality of care and capacity (Dowling 1976:20). Two methods used to allocate resources and maximize output are (1) cost-benefit analysis and (2) cost-effectiveness analysis. These two methods are discussed below.

Cost-benefit analysis is a series of mathematical calculations that provide an estimate of the potential value of undertaking a given course of action such as instituting a new program or revising an old one. In cost-benefit analysis, the monetary cost of a program is compared normally with its expected benefits, and usually these benefits are expressed in dollars. In a cost-benefit analysis of alternative programs, one compares the expected benefits and costs of each to determine which should receive priority funding (Crystal and Brewster 1966:4).

Cost-effectiveness analysis differs from cost-benefit analysis in that costs are calculated and alternative ways are compared for achieving a specific set of results. The objective is not just how to use funds most efficiently, it also includes the constraint that a specified output must be achieved. Cost-effectiveness analysis is used in a comparison of different ways of reaching the same objective. From a managerial standpoint, cost-effectiveness analysis is directed by two basic economic considerations: (1) that for the program being considered there will be a dollar of return for each dollar of investment, returns being measured in either social or economic terms and (2) that, optimally, the program's return will be greater than expenditures (Smith 1968:899-900). The economic analysis undertaken by this paper will be a cost-effectiveness analysis.

Although not every study in health economics fits cost-effectiveness, it has been used in many areas; primarily, in the analysis of production or productivity. Early studies concentrated on the computation of elasticity or responsiveness of output to changes in input (Katzman 1967; Reder 1969). Other studies in output/input analysis are concerned with benefits of health vs. illness (Reder 1969; Scitovsky 1967). Services provided by hospitals and their effect on physician productivity (Baron 1974; Musgrave 1978) plus utilization of paramedic personnel have been studied extensively (Musgrave 1978; Smith, Miller, and Golladay 1967; Zeckhauser and Eliastam 1974). These studies have not resolved whether personnel or ancillary services produce the greater efficiency. Musgrave (1978) discusses

the need for more work on cost and outputs, particularly the need to identify and measure final outputs. He also points to the failure to include third party payment effects in many cost analyses. Nevertheless, the use of both cost-benefit analysis and cost-effectiveness analysis has great utility by telling decision makers what they will be giving up if they follow alternative plans (Smith 1968:902).

Summary and Conclusions

The pressures from society and government to contain the upward spiraling costs of health care in the United States effectively gives a mandate to health care managers to integrate their decisions within their organizations and with other institutions (Brown 1974; Cameron 1980; Kraus 1978; Sheps 1971; Sieverts and Simond 1970; Sorkin 1975). The laundry service along with purchasing and laboratories has demonstrated that economies can be gained through cooperative sharing organizations for these services (Astolfi and Matti 1972; Barrett 1979; Benn 1978; Ellis 1978; Kruizinga 1977; Taylor 1977).

The capability of substituting technology for manpower along with more efficient management would seem to account for the cost effectiveness of shared service production processes such as the laundry (Barrett 1976; Berger 1978; Cooper 1975; Duffy 1978; Ellis 1978; Emerzian and Coleman 1977; Lambrech 1975; Latimer 1976; Malmgren 1978; Mara 1977; Pohle 1976; Tuite 1978). Although shared laundry services have been successful in other situations, each setting where it

might be employed must be investigated. Any situation has parameters that uniquely affect the outcome, so that shared services are not always a desirable alternative. Before the decision to develop a shared service is made, there should be some indication of improvement over the present system. The improvement may be financial, quality of service related, or in efficiency of resource allocation (Barrett 1976; Cooper 1975; Ellis 1978; Giancola 1978; Thompson 1979).

The economic analysis of the proposed central laundry project of this study becomes necessary to insure the accomplishment of the intended result. To be cost effective both managerial and financial needs must be satisfied, so that the allocation of scarce resources leads to a maximization of profit and/or a minimization of cost (Colberg et al. 1970; Dowling 1976; Haynes 1969; Heilbroner and Thurow 1978; Samuelson 1973). A cost effectiveness analysis is readily accomplished in the situation where services are currently being provided and an alternative process is under investigation, as occurs with the ten hospitals and the proposed central laundry of this study.

Cost effectiveness analysis includes the constraint that a specified output must be achieved and that, optimally, the return will be greater than expenditures (Crystal and Brewster 1966; Reynolds and Stunden 1978; Smith 1968). In the analysis to share laundry services between the ten hospitals of this study, careful quantification of present expenditures and shared laundry expenditures is

required. Allocation of resources must be quantified so that returns can be measured against expenditures. Long range supply and demand functions must be carefully quantified to minimize the historical deterrent of sharing services--poor planning, actual increases in costs, and decreased quality of service (Barrett 1979; Brown 1974; Brown and McCool 1980; Ellis 1978; Fitschen 1978; Kerr 1978; Martin 1978).

Although resources can be combined in many ways, technology and manpower set limits on the total size of final output (Barrett 1976; Brown and McCool 1980; Dowling 1976; Tuite 1978). Therefore, it seems logical to start with the desired output and develop the underlying organization and production process needed to achieve the desired objective. Thus, the subsequent development of the shared laundry service in this paper begins with the production requirement and quantifies the resources (men, money, materials) necessary to support that output. Subsequent quantification of the cost of the resources needed to produce the necessary output and determination of the revenue expected will determine if a central laundry shared service is a cost effective alternative to commercial linen service.

CHAPTER IV

FINDINGS

The economic analysis of a proposed central laundry for the ten hospitals of this study began with a compiling of data for the year 1979 from records that are filed in the regional office of the parent corporation. Those original data established the base from which volume requirements for the central laundry were calculated. The data are tabulated in Appendix A. The rate of growth (projected trend) was determined by comparing patient days for January and February of 1979 with the same months of 1980. The results of the determination are tabulated in Appendix B. This calculated trend is used throughout the study to make annual projections for 1980 through 1985.

The following variables were identified as having an economic impact on the hospitals and/or the corporation for the central laundry under study:

1. Production capacity of the central laundry
2. Price paid to the central laundry
3. Location of the central laundry
4. Inventory held in the system
5. Fixed costs of the central laundry
6. Variable costs of the central laundry.

Cost data related to the above variables were acquired from representatives (construction, real estate, laundry, and automobile) in the

business community. The quantification of the variables determines the revenue and profit to be expected from the central laundry.

The Hospitals

The ten hospitals collectively have 1,375 beds and range in size from 48 beds to 232 beds. Seven hospitals have medical-surgical services and five hospitals have obstetrical services. Three are psychiatric hospitals. The total patient days of the ten hospitals for 1979 were 343,423. Their laundry usage was 3,044,640 total pounds, at a cost of $1,091,843, or $0.395 per pound and $2.82 per patient day, on the average. Hospital 8 did not report pounds of laundry, so an estimate was used, based on approximately one pound per patient day as for Hospital 10 (both are psychiatric hospitals). Hospital 9 was acquired in January of 1980, so data were not available for 1979. However, because of the number of beds, estimated data (again, based on Hospital 10) were developed. The overall pounds per patient day were 7.9, but the weighted average was 8.8 pounds per patient day. The rate of growth for the hospitals from 1979 to 1980 was 16.9 percent calculated as follows:

(1) Rate of Growth = [(Patient Days for January + February, 1980) minus (Patient Days for January + February, 1979)] divided by (Patient Days for January + February, 1979).

$$= \frac{(30,585 + 29,363) - (26,107 + 25,150)}{(26,107 - 25,150)}$$

$$= \frac{59,948 - 51,257}{51,257}$$

$$= 16.9\% \text{ per year}$$

This growth rate expresses the increase in utilization experienced by the ten hospitals during the year 1979. The 16.9% growth rate is used throughout this study to make the annual projections for the variables previously identified as having an economic impact for purposes of this study.

Current Costs

Total laundry expense for 1979 paid by each of the ten hospitals is tabulated in Appendix A and again in Appendix C. The 1979 cost per pound, cost per patient day, and pounds per patient day were calculated for each hospital and are tabulated in Appendix C. The weighted average costs per patient day and per pound was \$3.18 and \$0.395, respectively, for the ten-hospital group. The price to be charged by the central laundry will be developed later in this study, and will be evaluated against the current costs to determine the financial impact of the central laundry to both the individual hospitals and the corporation.

Future Demand

Demand will determine the design capacity for the central laundry. To calculate future demand in patient days the following formula was used (Buffa 1973:484-485):

(2) Expected demand $E(d_j) = F_t + \frac{(1 - \alpha)T_t}{\alpha}$

Where: F_t = last period demand

α = fraction of the difference between actual current demand and the last period average demand between 0 and 1.

Example:

$$E(d_j) \text{ 1980 patient days (PD)} = \text{1979 PD} + \frac{(1 - \alpha)\text{Trend}}{\alpha}$$

Where:

$$\text{Trend} = (PD_{\text{Jan. 1980 - Jan. 1979}}) + (PD_{\text{Feb. 1980 - Feb. 1979}}) \div 2$$

$$= \frac{(30{,}585 - 26{,}107) + (29{,}363 - 25{,}150)}{2}$$

$$= 4{,}346 \text{ patient days}$$

To calculate α

(PD 1980 calculated at 16.9% above PD 1979)

$$= \text{PD 1979} + \frac{(1 - \alpha)\text{Trend}}{\alpha}$$

$$343{,}423 \times 1{,}169 = 343{,}423 + \frac{(1 - \alpha)4{,}346}{\alpha}$$

$$\alpha = 0.0697$$

Thus:

$$E(d_j) \text{ 1980 PD} = 343{,}423 + \frac{(1 - 0.0697)4{,}346}{0.0697}$$

$$= 401{,}430 \text{ patient days}$$

$$\text{pounds for 1980} = 401{,}430 \text{ PD} \times 8.8 \text{ pounds per patient day}$$

$$= 3{,}532{,}584 \text{ pounds}$$

The results of the calculations for patient days and pounds of laundry for 1980 through 1985 are tabulated in Appendix D. The

pounds of laundry needed per year are converted to production units as follows:

(3) pounds per day = pounds per year ÷ 365 days

(4) pounds per work day = (pounds per day x 7 days per week) ÷ 5 working days

(5) pounds per hour = pounds per work day ÷ 7.5 hours per day

Examples:

(3) $\text{pounds per day}_{1980} = 3{,}532{,}584 \div 365$

$= 9{,}678$

(4) $\text{pounds per work day}_{1980} = (9{,}678 \times 7) \div 5$

$= 13{,}550$

(5) $\text{pounds per hour}_{1980} = 13{,}550 \div 7.5$

$= 1{,}807$

These production requirements will be used to determine the equipment needs, manpower levels, utility costs, and space requirements for the central laundry and are tabulated in Appendix D for 1980 through 1985.

Equipment

Only basic equipment needs (washer extractors, dryers, and ironers) were specified in this study. It is not possible to process all linen by the same method because of different fabrics and uses of the linen (Tuite 1978). Therefore, several sizes of all types of equipment should be available. The specification of equipment was made by allocating the production required between

decreasing sizes of equipment as follows:

(6) pounds per day = pounds per cycle x cycles per hour x 7.5 hours per day (Pellerin Milnor 1979)

(7) pounds to be processed by smaller units = total pounds of production minus pounds per day from equation (6)

Example for washer extractors for 1980:

one, 600-pound unit = 600 x 1.5 x 7.5
= 6,750 pounds per day

pounds to be processed by smaller units = 13,550 - 6,750
= 6,800

one, 400-pound unit = 400 x 1.5 x 7.5
= 4,500 pounds per day

pounds to be processed by smaller units = 6,800 - 4,500
= 2,300

one, 200-pound unit = 200 x 1.5 x 7.5
= 2,250

pounds to be processed by smaller units = 2,300 - 2,250
= 350

Because it may be necessary to process loads smaller than 200 pounds, a 50-pound washer extractor is also allocated for the start up equipment. It can easily process the 350 pounds left over from the above calculations. Thus, the central laundry will need washer extractors for 1980 production levels as follows:

1. one, 600-pound unit
2. one, 400-pound unit
3. one, 200-pound unit, and
4. one, 50-pound unit.

The size, quantity, and cost for washer extractors, dryers, and ironers are tabulated in Appendix E. The size and quantity of equipment will be used to calculate utility costs.

No investigation of costs were made for other equipment such as typewriters, desks, chairs, shelves, files, and other laundry equipment such as carts, mops, and sewing machines. Since these items may account for a significant amount of expense, an estimate is given in Appendix E. The estimate is based on this author's personal knowledge of such costs and may or may not be accurate.

The costs for the laundry equipment was obtained from a leading laundry equipment manufacturer (Pellerin Milnor Corporation). Both quantities and costs are tabulated in Appendix E. The cost to equip the central laundry in 1980 was $333,000. The five-year total expenditure for equipment was $559,800, and is the sum of the start up laundry equipment ($277,500), other ($55,500) plus expansion

equipment of $226,800. The equipment costs are based on increases in projected production levels and a change to two shifts of operation in 1983.

Utilities

Calculations for utilities were based on pounds of laundry processed per hour as follows:

Water in gallons per hour = 2.4 gal per pound x pounds per hour (Pellerin Milnor 1973)

1980 gallons per hour = 2.4 x 1,807

= 4,337 gallons per hour

1980 gallons per year = gallons per hour x 2,080 hours per year

= 4,337 x 2,080

= 9,020,960 gallons per year

1980 water cost = $\frac{\text{gallons x rate}}{1{,}000}$ (City of Houston 1980)

= $\frac{9{,}020{,}960 \times \$1.55}{1{,}000}$

= $13,982 per year

Natural gas, BTU per hour = 50,000 BTU per 100 pounds (Pellerin Milnor 1973) per hour

1980 BTU per hour = 50,000 x 18.07

= 903,500 BTU

1980 BTU per year = BTU per hour x 2,080 hours per year

= 903,500 x 2,080

= 1,879,280,000 BTU

(SCF) standard cubic feet = BTU ÷ 100

(MCF) Thousand cubic feet = SCF ÷ 1,000

= 1,879,280,000 ÷ 100,000

= 18,793 MCF

1980 natural gas cost = MCF x rate (Entex Inc. 1980)

= 18,793 x $2.42

= $45,480 per year

Electricity in KW per hour = 0.103 KW per 100 pounds (Pellerin Milnor 1973) per hour

1980 KWH = 0.103 x 18.07

= 1.86 KWH

1980 KWH per year = KWH x 2,080 hours

= 1.86 x 2,080

= 3,871 KWH

1980 electricity cost = KWH per year x rate (HL&P 1979)

= 3,871 x $2.40

= $9,291

The usage and cost of utilities for 1980 through 1985 are tabulated in Appendix G. The cost of utilities are used to determine the variable cost per unit developed later in this study.

Inventory

Inventory held by the central laundry is a function of frequency of delivery, pick up, and stock out risks. These frequencies, are a function of truck capacity and delivery routes. Inventory

levels for every day delivery and pick up (five days per week) were projected for 1980 through 1985, using the following formula (Van Horne 1971:490):

(8) Inventory (I_j) = $S(L) + F\sqrt{SR(L)}$

where: S = usage (pounds per day)

L = lead time

F = stockout acceptance factor from Figure 2. [For purposes of this study a stockout factor of 4 (least stockout percentage) is chosen.]

R = average number of units (pounds) per order

Example:

I_j for 1980 = $9,678\ (1) + 4\sqrt{9,678 \times 13,549\ (1)}$

= 55,482 pounds of linen

The operation schedule (five days per week) and the delivery frequency of the central laundry in this study determines the order size as follows:

(9) order size (R) = [usage (S) x 7 days per week] ÷ 5 work days per week

The total pounds in the system are the sum of inventory held by the central laundry, plus clean linen delivered, plus dirty linen picked up. In 1980, this adds up to 82,580 pounds of linen in the ten hospital system, if delivery is made five days per week. The total number of pounds of linen in the system are tabulated in Appendix G. The initial volume of linen required (82,580 pounds) more than doubles

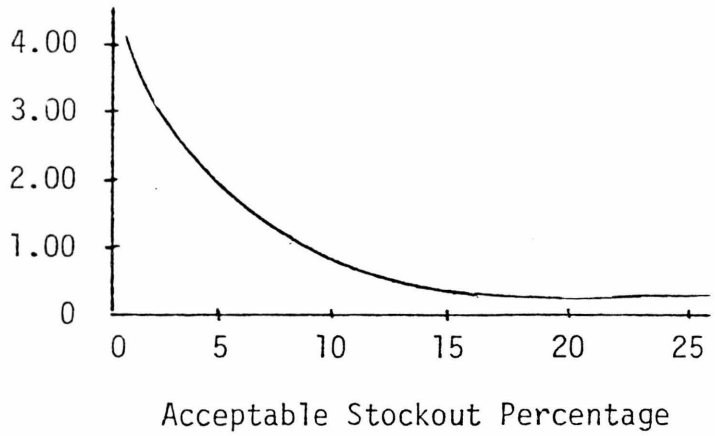

Figure 2. Value of F (Acceptable Stockout Factor) for Inventory Levels.

SOURCE: James C. Van Horne. Financial Management Policy. Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1971, p. 490.

(180,292 pounds) by 1985. Inventory levels for delivery schedules of one, two, and three days are tabulated in Appendix G. The quantity of linen in the system will be used to calculate linen expense for the central laundry.

Linen Cost

The following formula was developed to arrive at linen cost on a per pound basis.

(10) cost per pound = price to purchase items of linen (National Hospital Linen Systems 1980) ÷ weight in pounds of the same items (Pellerin Milnor 1979)

= \$38.57 ÷ 9.50

= \$4.06

This method of calculation was verified by comparing the average cost per pound to rent the same items (National Hospital Linen Systems 1980) to the average cost per pound paid by the hospitals for all linen in 1979. The average cost per pound to rent the linen items was \$0.33 (\$2.65 ÷ 8), while the average cost per pound for all linen paid by the hospitals in 1979 was \$0.395. The two costs (\$0.33 and \$0.395) are not significantly different at $p < 0.05$ (see Appendix H). Thus, at the same confidence level, the calculated cost per pound to purchase all linen (\$4.06) is not significantly different from the actual cost per pound to purchase all linen for the central laundry.

The projected linen cost for the central laundry from 1980 to 1985 was calculated from the total inventory in the system, plus

replacement purchases, plus purchases necessary to meet increasing demand; all at $4.06 per pound. The projected linen costs for the central laundry are tabulated in Appendix I. The initial cost for linen is $333,275, decreases to $154,830 in the second year, and increases to $288,771 by 1985, the final year for this study.

The expense for linen purchases to maintain inventory levels will be included in fixed cost calculations, while replacement purchases will be included in variable cost calculations. The linen expense in 1980 is greater than the manpower expense (calculations appear later in this paper) for the same year. Therefore, manpower expense ranks second to linen expense in 1980.

Supply Cost

Supply costs are estimated at $0.0096 per pound, and include such items as detergent, bleach, toilet paper, and pencils. These costs may be significant when compared to other variable costs, however, the accuracy is limited to personal knowledge of the cost of such items and seems appropriate for the present estimates, considering the fractional portion of costs associated with such items. Supply costs are tabulated in Appendix M.

Location

The location of the central laundry is a function of the time spent on delivery and pick up or the cost of land. Sites based on time (site X) and cost (site Y) are indicated in Figures 3 and 4, respectively. A third site based on both time and cost would involve

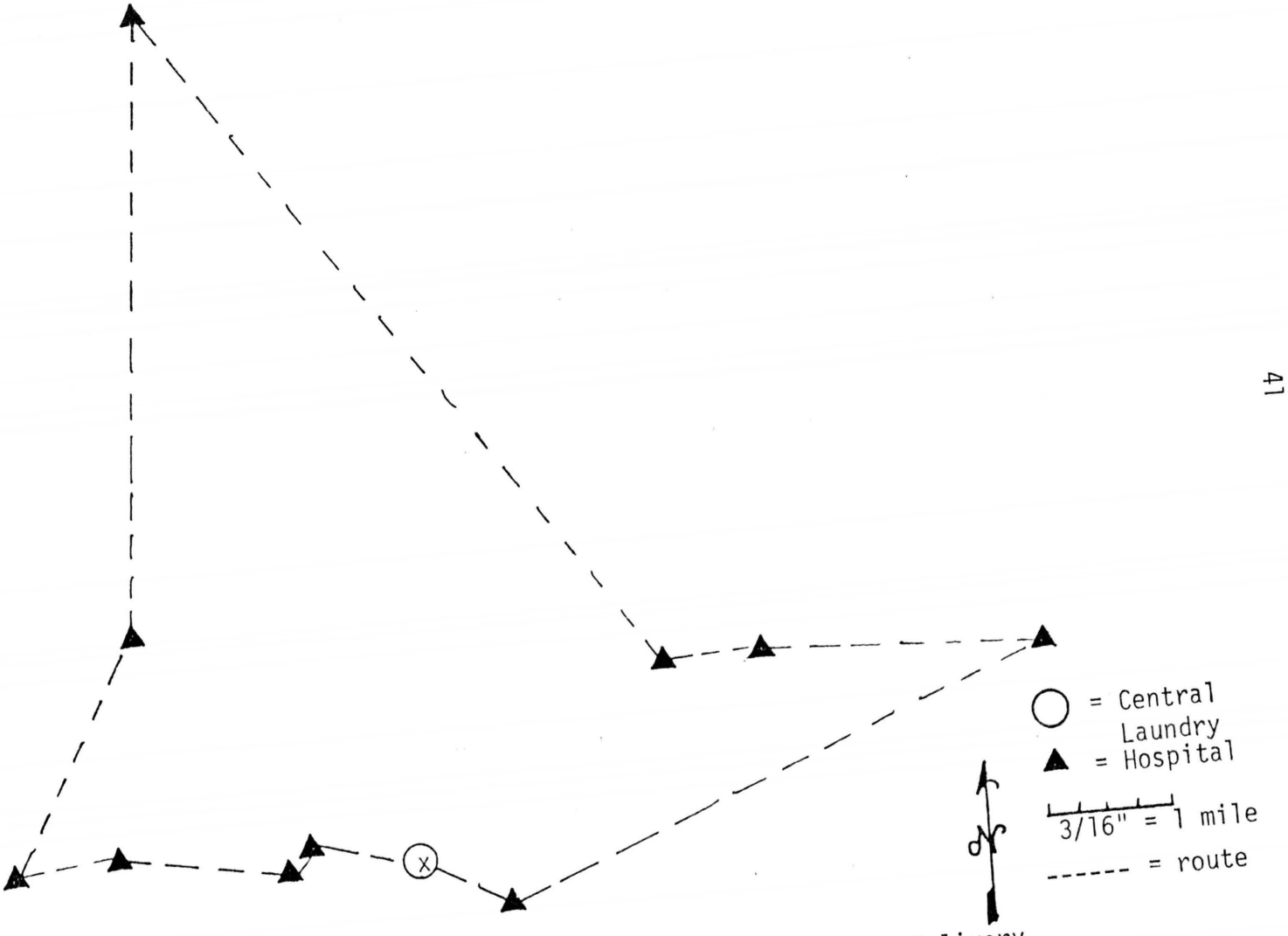

Figure 3. Location of Central Laundry-Based on Time of Delivery.

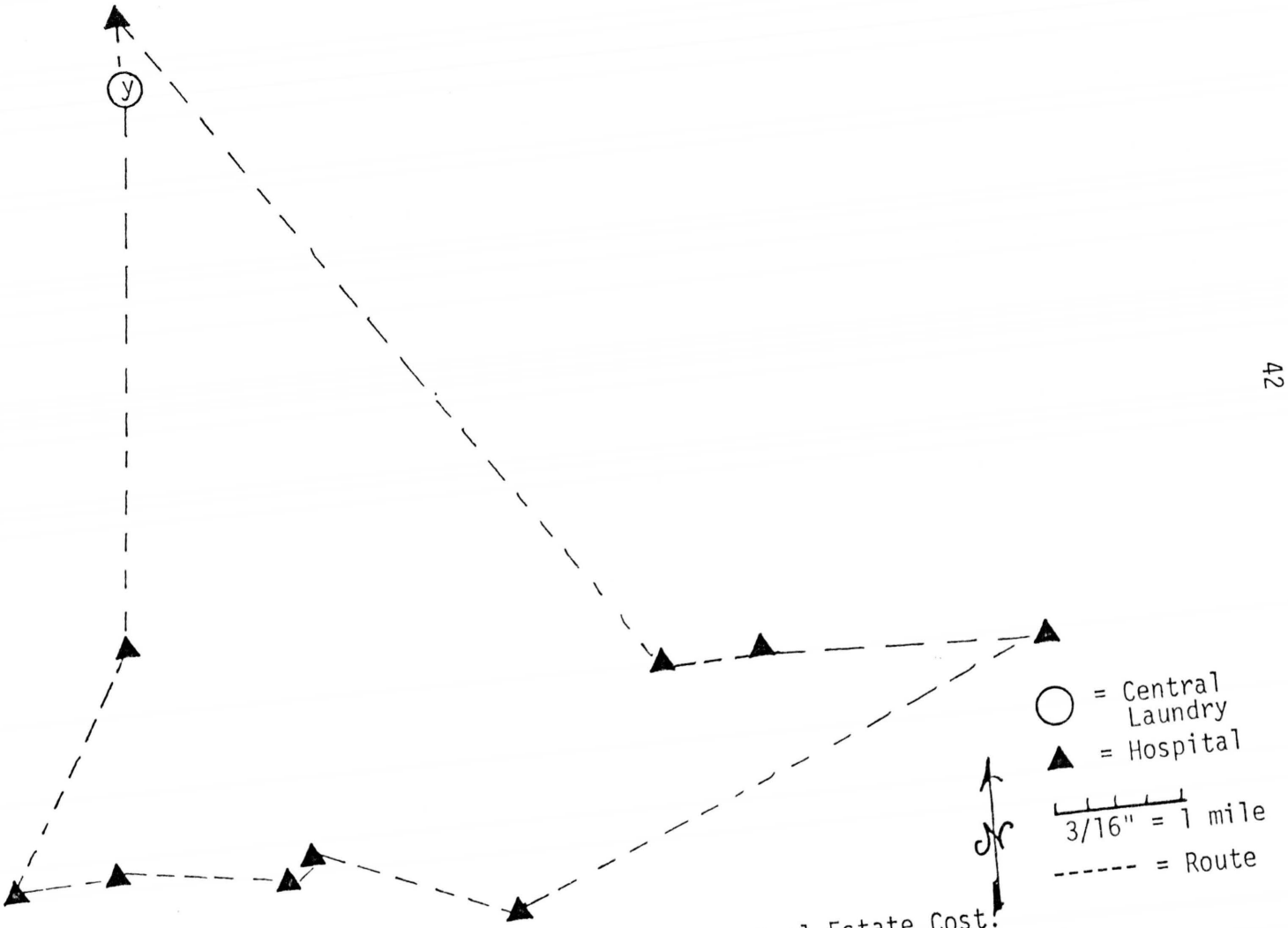

Figure 4. Location of Central Laundry-Based on Real Estate Cost.

solving a multivariate linear programming problem and is beyond the scope of this study.

Transportation

The location of the central laundry also determines the actual number of vehicles needed to service the ten hospitals. Anticipating the location at either site X or site Y makes the route approximately one hundred miles. It seems feasible to make a pick up and delivery once daily at each hospital. A total of seven hours is needed to load or unload at each hospital. With 7.5 hours in a work day, one truck can accomplish pick up or delivery. If one truck picks up and another delivers, clean linen can be segregated from dirty linen. Therefore, two trucks would be needed to travel the route on a once-a-day schedule in 1980. A truck with a 100,000 pound capacity is more than adequate to handle projected pick up and delivery quantities for several years (after 1990). Two trucks will cost $26,000 to purchase and $34,240 to operate in 1980. The fleet size will double by 1983, resulting in an operating expense of $42,936 by 1985. Vehicle purchases will be included in fixed costs, and operating expenses will be part of variable costs that will be developed later in this paper. The annual costs for vehicles plus operating costs are indicated in Appendix J.

Manpower

Manpower was divided into three categories as follows:

1. Direct Production (Class A) - consists of process personnel such as sorters, washers, and ironers

2. Indirect Non-Production (Class B) - support personnel such as janitors, maintenance, drivers, and clerks

3. Administration (Class C) - managers, supervisors, and accounting personnel.

Levels of those three classes of personnel were determined from production required each hour from the central laundry and production per hour for each class (Pellerin Milnor 1973). The production rate of the central laundry required twenty-one employees in 1980 and increased to fifty-eight by 1985.

The annual salary costs for the above numbers of employees were based on the wage and salary program of the parent corporation as follows:

Class	Wage Per Hour
A	$4.00
B	7.00
C	9.00

An annual increase of seven percent (corporate wage and salary program) was included in the salary cost projections. No provision for the cost of turnover was made in the salary cost figures. The mix of Class A, Class B, and Class C employees resulted in $247,520 in 1980 and triples in 1985. Salary costs are the highest ranked expense after the initial start up costs in 1980. The employee mix and annual salary costs are tabulated in Appendix K.

Building

Hospital laundry facilities are comprised of two types of space: (1) production space and (2) soil storage space. Size was based on the number of beds served and pounds of laundry used per day for the ten hospitals. The space required in 1980 for the central laundry was as follows:

(11) production space = number of beds x 10 square feet (Pellerin Milnor 1979)

= 1,609 x 10 square feet

= 16,090 square feet

(12) soil storage space = $\frac{\text{pounds per day x 1 ft}^3 \text{ per pound}}{8 \text{ feet}}$

(Pellerin Milnor 1979)

= $\frac{13,778 \times 1}{8}$

= 1,722 square feet

Total minimum space required = 16,090 + 1,722 square feet

= 17,812 square feet

The building needed in 1980 was calculated to be 17,812 square feet. The production needs of 1985 (and additional shifts by 1983) would require a building of 39,199 square feet plus 17,512 square feet for parking.

The construction cost per square foot is a function of the material used and the type of construction (block, brick, wood siding). A building adequate to house the central laundry of this study will be

a warehouse constructed on a slab with tilt up sides. Construction costs for such a building are approximately $16 per square foot (Heimsath 1980). The 1985 building was expected to serve for twenty years and would cost $627,184 to build. The $627,184 cost was used to determine fixed costs for the central laundry in this study. Space requirements for 1980 through 1990 are projected in Appendix L.

Real Estate

Real estate costs in the area of this study varied according to the distance from the inner city. Generally, costs decrease as distance from the inner city increases. Costs per square foot for improved realty (utility hook up and street access) ranged from $4 per square foot in Area A of Figure 5 to $1.50 per square foot in Area D of Figure 5 (Henderson 1980). Real estate costs were escalating at twelve percent per year (Associated General Contractors 1980).

The size of the lot purchased must include space for parking as well as the building, plus loading zone areas for the trucks. Parking space is calculated as follows:

(13) parking space = total number of employees x car size in square feet x 1.10 percent of visitors (Barnett 1980)

parking space in 1980 = 21 employees x (10 feet x 24 feet) x 1.1%

= 6,644 square feet

(14) loading zone area = number of trucks x truck size in square feet (Barnett 1980)

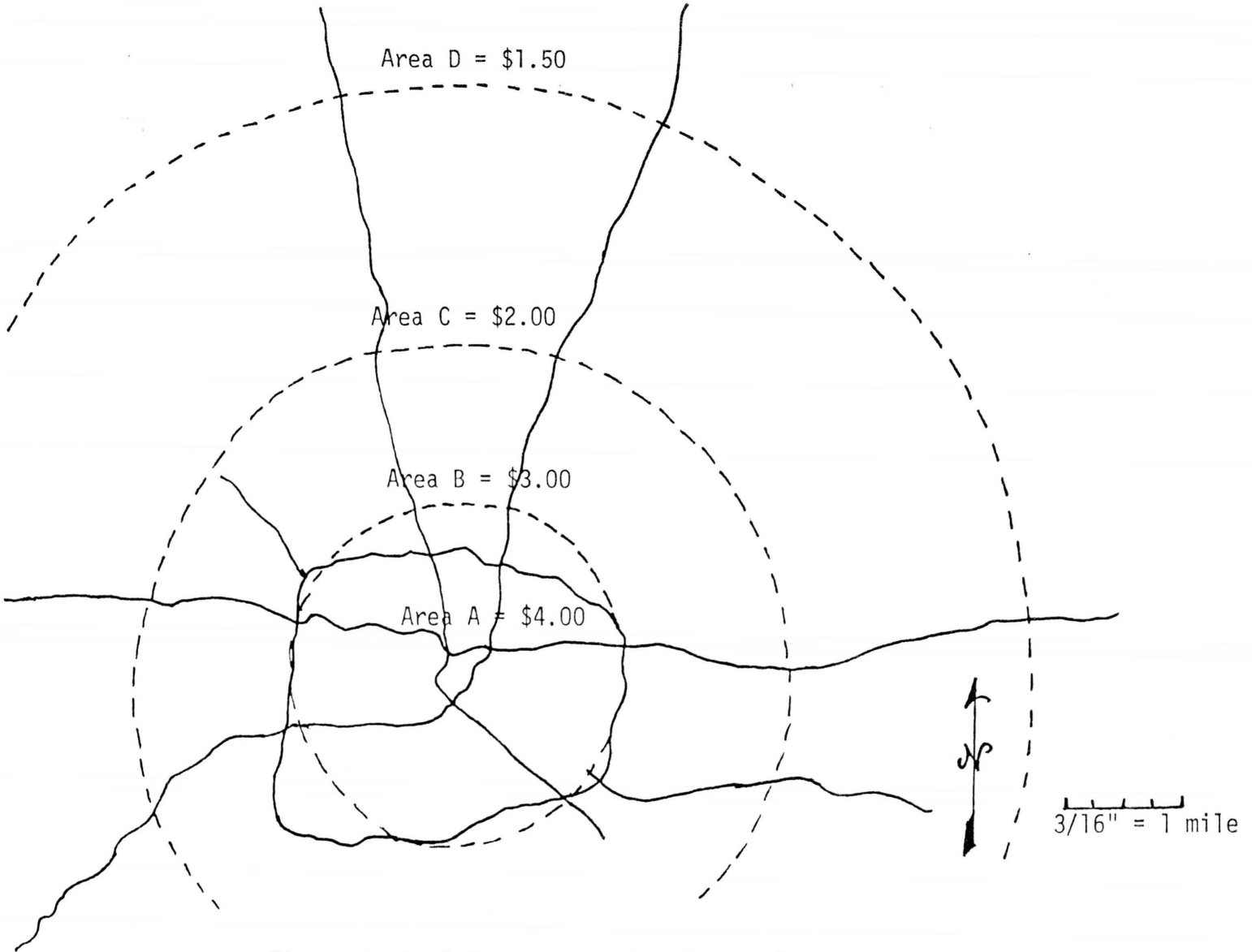

Figure 5. Real Estate Cost Per Square Foot.

loading zone 1980 = 2 trucks x (10 feet x 24 feet) x 1.1%

= 1,000 square feet

(15) lot size = building space + parking space + loading area

= 17,812 square feet + 6,644 square feet + 1,000 square feet

= 24,456 square feet or 0.56 acres

Projections are made for 1980 and 1985 only. It is assumed that plant and equipment will be changed to multiple shifts around 1983, and that purchase of land would accommodate the building and parking need of 1985. The cost of building plus real estate for locations in Area A through Area D of Figure 5, are tabulated in Appendix M. The cost of real estate to accommodate the building needed by 1985 was $85,066 in Area D, and is used to determine fixed costs for 1980 through 1985.

Price

Optimum economic pricing is where marginal cost is equal to average cost, and will allow an operation to remain in business over the long run (Samuelson 1973). The economic price will generate revenue to cover both fixed and variable costs, but there will be no contribution to profit.

Average total cost for the central laundry in this study was between $0.1514 and $0.1961 per pound (see Appendixes N, O, and P for this determination). Marginal costs were calculated as follows:

(16) $$\text{Marginal costs} = \frac{\text{change in average total cost}}{\text{change in quantity}}$$

(Heilbroner and Thurow 1978:135).

The incremental marginal costs are tabulated Appendix P. It was not possible to calculate the marginal cost curve or the average cost curve past the design capacity of the central laundry, because the associated costs were not known. Neither the marginal cost curve, nor the average cost curve turned upward, so that the point of intersection was indeterminate. Therefore, it was not possible to determine the optimum economic price for this central laundry from the data available.

The hospitals paid $0.395 per pound in 1979 for laundry service. and any price below that would lower operating costs . A business seeking to maximize profits would set its price at the maximum that the market would support (Samuelson 1973), thus, further analysis was based on $0.395 as the price to be charged by the central laundry.

Revenue and Profit

The projected demand from the hospitals (see Appendix D), priced at $0.395 per pound would produce revenues for the central laundry as follows:

Year	Revenue
1980	$1,395,371
1981	1,631,243
1982	1,906,966
1983	2,225,715
1984	2,606,043
1985	3,046,471

The components of the profit and loss statement for the central laundry are tabulated in Appendix Q and the effect on the corporation balance sheet for 1980 through 1985 is given in Appendixes R through X. The contribution to the profits of the parent corporation were 30.8 percent in 1980 and decreased to 25.2 percent in 1985 (assuming no change in costs per pound or revenue per pound). The contribution margins from 1980 to 1985 compared favorably to the corporate standard of 20 percent for a central laundry (Parent Corporation Controller's Manual 1980). The assets and net worth of the corporation steadily increased from $1,481,525 at start up, to $5,105,242 in 1985.

Summary

The data obtained from records on file at the regional office of the parent corporation indicated that the 1,375 beds of the ten hospitals generated a 1979 demand for 8.8 pounds of laundry per patient day, paid $0.395 per pound or $3.18 per patient day for laundry service from commercial linen companies, and were growing at a rate of 16.9 percent per year. Projections of a five-year demand for linen usage by the hospitals were calculated. A central laundry to process and distribute the linen demanded by the hospitals was developed.

The central laundry was determined to have the following parameters:

1. Production capability - 3,532,584 pounds per year in 1980, increasinto to 7,712,584 pounds in 1985
2. Lot size - 56,711 square feet or 1.3 acres

3. Building - 39,199 square feet in 1985

4. Laundry equipment - in 1980: 600-pound, 400-pound, 200-pound, and 50-pound washer extractors, plus dryers of 400-pound (two needed) and 50-pound capacity and one, 2-roll ironer; by 1985 two 400-pound washer extractors should be added, plus two, 200-pound dryers, and two, 1-roll ironers

5. Linen inventory - 82,580 pounds in 1980 increasing to 180,292 pounds in 1985

6. Trucks - two, 100,000-pound van trucks in 1980 and doubling by 1985

7. Personnel - twenty-one employees in 1980 expanding to fifty-eight employees in 1985.

Costs for the above parameters were obtained from real estate (Henderson 1980), construction (Heimsath 1980), administrative (Parent Corporation 1980), and linen service (Pellerin Milnor 1980) representatives from the business community. Total costs were determined to be $0.1514 per pound in 1980, and $0.1961 per pound in 1985. Total operating expense in 1980 was determined to be $383,719 and increased to $1,236,853 by 1985. Wage and salary costs were the largest component of operating costs.

If the central laundry charged the same price per pound as was paid by the hospitals in 1979 ($0.395), expected revenues would be $1,395,371 in 1980 and increased to $3,046,471 in 1985. The resulting contribution to the profits of the parent corporation would be 30.8 percent of revenue in 1980, but would decrease to 25.2 percent by 1985 (assuming no change in costs per pound or revenue per pound).

The percent contribution margin was compared to the corporate standard for a central laundry. The corporate standard of twenty percent indicated that the decision to develop a central laundry would be an acceptable investment. Therefore, the mix of revenue and costs specified in this study for the central laundry will produce the desired level of profits and provide the level of production needed.

CHAPTER V

DISCUSSION AND CONCLUSIONS

The burden of medical care costs on the American consumer has resulted in a demand for efficient and economical use of facilities and resources (Sheps 1971:31). This demand by consumers causes the managers of the health care industry to seek alternative methods for production processes (Cameron 1980:76). Seiverts and Sigmond (1970), point out that shared services will develop in increasing numbers in the last quarter of this century, and this is evident in Taylor's survey (1977). The sixty percent of hospitals currently sharing services is a response to the social forces for cost containment (Brown 1974:42). Institutions that have developed shared laundry services report gains in efficiency and quality that result in an economic use of resources (Barrett 1976; Benn 1978; and Pick 1971). This thesis arose from the need for the parent corporation to determine if the decrease in operating expense reported by others was available to them from development of a central laundry for the ten hospitals of this study. The decision to invest in a central laundry would be based on a comparison of expected profit from the central laundry with the corporate standard for expected profit for a central laundry.

Profit, defined as the excess of revenues above cost (Heilbroner and Thurow 1978:119) would require that an economic model used to predict profit would need to identify and quantify the variables that

determine revenue and cost (Naylor 1971:186-190). In addition, a production process requires the specification of output (Buffa 1973:33). Output required from a production process (central laundry) is a function of supply and the cost of production (Dowling 1976:142). These demand, supply, and cost curves are recognized as functions that fall within a range of possibilities with the market establishing an equilibrium price (Samuelson 1973:63-67). However, the health care industry has features that exclude price determination in the market. These include, but are not limited to: (1) consumer ignorance of the product, (2) the nonprofit motive of the producers, and (3) ethical restrictions on competition (Sorkin 1975:4-8). Health care managers who strive to answer the social forces for cost containment must analyze the cost-effectiveness of developing alternate processes for delivery of health care (Crystal and Brewster 1966). Cost-effectiveness analysis was used in this thesis to compare present cost for linen service to the hospitals with expected profit for the corporation from development of the central laundry.

The cost resulting from the use of commercial linen service was determined from records on file at the regional office of the parent corporation. Current demand levels and the growth rate of the ten hospitals was also obtained from the regional records. These data served as the base for determining the capacity design and associated costs of the central laundry needed to service the ten hospital group for a five-year period. Profit levels were determined and analyzed

according to a proforma profit and loss statement and a proforma balance sheet.

Limitations

The analysis of any problem is accurate only to the level of accuracy of the data on which it is based (Wagner 1969:639). To verify the data obtained from the regional office records, a separate question was made to housekeeping directors in the hospitals of this study. Three housekeeping directors supplied pounds of laundry used in 1979. Two of these independent verifications differed from corporate regional records. Therefore, all calculations of expected demand should not be considered as absolute and are not intended as such in this study. The demand, as stated, serves only to establish a range of production required from the central laundry. The growth rate calculated in this study was also based on corporate regional records, and is accurate for the period 1979 to 1980 only.

There are other areas of the research that also limit the evaluation of the absolute quantities on which this thesis is based. One of the areas of limitation is the cost information used in this study. Many of the cost figures were obtained from business representatives (real estate, construction, equipment, and linen) and are subjects for reevaluation when actual operations of the central laundry are developed. None of the cost information is adjusted for inflation, and is based solely on costs effective in 1980. Another area of limitation is the nonconsideration for the bargaining power of the

parent corporation for purchases it makes. When a final decision to develop the central laundry is reached by the corporation, actual costs will result from negotiations conducted between businesses that will seek to maximize their profits. A third area of consideration that was not explored was the effect of reimbursement formulas on the profit predicted in this study.

This study was based on hospitals in a city of the southcentral United States. The geographic location of this study area has factors in operation that may not be present in other locales and may have a significant effect on the development of a shared service. Among these, are such areas as, the presence of a large medical center in the metropolitan area, the condition of routes (roads) that delivery trucks will use, the state tax structure, limited unionization among health care personnel in the area, the climatic conditions, and the availability of energy sources.

Short run economic studies more often indicate constant marginal cost and decreasing average cost as the pattern that best describes the data that have been analyzed (Haynes 1969:232). But theorists have been unwilling to abandon the law of diminishing returns which implies a rise in marginal cost (Samuelson 1973). However, if diminishing returns exist, lack of operational cost data beyond the design capacity of the central laundry do not allow for determining the point of diminishing return (rising marginal cost) for the laundry facility of this study. Without rising marginal cost, the point of equality with average cost

cannot be determined, therefore, it was not possible to develop the optimum economic price for the production levels of the central laundry.

The economic model developed in this study is a deterministic model and limited in its application. A deterministic model does not reflect randomness of the variables--there is no frequency distribution of variables from which to establish a range for each variable (Naylor 1971:316). Instead, the range has been represented by a parameter taken to be the mean of the range. The interaction of the variables has not been considered--the substitution of technology for manpower beyond the levels quantified in this thesis. Nor has the problem been constructed in an operations research format, so that the advantages of linear quadratic or curvilinear programming are not included. The use of operations research techniques would require maximizing profit subject to several constraints (Wagner 1969:13) and the only constraint used in this study was output (production level).

Conclusions

The deterministic model used in this thesis, when combined with experienced management, can be used to determine the economic impact on a group of hospitals that develop a shared service. It has been demonstrated in this thesis that the proposed central laundry can produce the level of services demanded and the level of profits required by the parent corporation. The profit is, however, based on the price currently paid for linen service by the ten hospitals.

It has been demonstrated that corporate management can choose to price the central laundry product between $0.395 and $0.1961 per pound. A price of $0.395 per pound will not affect the cost of health care attributed to laundry service for the ten hospitals, since the cost as reflected by hospital charges to the patient has not changed. A price at less than $0.395 should result in a lower operating cost for the hospitals, and if charges to the patient are based on cost, there should be a lower cost of health care for the patient population of the ten hospitals.

Many parameters have been quantified in this study, but it was not possible to quantify the optimum economic price per pound to be charged by the central laundry. Every effort was made to design the central laundry for maximum production to meet projected demand. Throughout the production range analyzed in this paper, the marginal cost per pound is decreasing. Decreasing marginal cost leads to the conclusion that capacity of the central laundry has not been reached. When capacity is reached, the costs of production per unit should rise, resulting in increasing marginal costs. That point of production cannot be calculated from the data available. However, an experienced manager will have some idea of the actual capacity of the central laundry designed in this study. The combination of thorough analysis and competent management can provide the economic costs needed to determine the optimum economic price of this central laundry.

Future Research

Pressures to contain costs in the health care industry have led to many instances of shared service. Yet, individual managers are reluctant to consider the shared service organization as an alternate production process as they develop long range plans for their organizations. The fear of lost autonomy as discussed by Brown (1974) and Cook (1973) seems to be wide spread. Implementation of the central laundry developed in this study, may provide insight into the underlying forces of lost autonomy fears. The ten hospitals, managed by the same corporation, may have the cohesiveness and lack the competition that can overcome autonomy kinds of fears.

Musgrave (1978) has noted the lack of consideration for third party payments in many cost studies. Consideration of government and insurance company reimbursement formulas is also not included in this study. The effect of reimbursement on the profit prediction for the central laundry should be investigated before implementation of a decision to develop the central laundry.

The divergence of simulated values from historical values is, in part, a result of excess capacity that is not determined in a short run analysis (Naylor 1971:318). Comparison of actual operation of the central laundry with the simulation developed in this study would provide data toward resolution of the magnitude of that divergence. Review by experienced managers who can assign a numerical magnitude to

actual operations without the aid of deterministic models (Hare 1967:318), would also provide an element of usefulness not gained by model building alone.

Since manpower expense ranks as the highest operational cost for the central laundry, it would be of interest to determine the effect on total cost from substitution of additional technology (equipment) for manpower. The laundry industry has technology available that can lead to increased productivity. Financial experts would consider replacing manpower with capital expenditures to be a sound investment (Barrett 1976: 29). However, as the number of machines rises, the cost of maintenance and repairs rise, thus, the economic trade off of machines for men in the central laundry should be investigated.

Reevaluation of the central laundry with regard to autonomy problems, reimbursement formulas, and substitution of machines for men, should be made. That reevaluation may lead to a different conclusion with regard to the desirability to develop the central laundry shared service. Comparison of this study with the actual operation of the central laundry is warranted.

APPENDIXES

APPENDIX A.--Type of service, occupancy, laundry pounds and location in 1979 for the ten hospitals plus plans for the future

Hospital	Type of Service	Number of beds	Average Daily Census	Total Patient Days	Laundry Pounds Used	Laundry Expense	Location (Figure 1)	Future Plans
1	MS,OR OB-GYN	140	79	28,755	196,199	$ 75,768	1	To replace Hospital 8
2	MS,OR OB-GYN	104	62	22,476	225,534	72,171	2	Add 30 beds in 1981-1982
3	MS,OR OB-GYN	129	90	32,830	411,800	139,836	3	NA
4	MS,OR	232	145	52,919	649,186	199,645	4	NA
5	MS,OR	165	103	37,419	406,040	148,270	5	Partial bed replacement in 1981-1982
6	MS,OR OB-GYN	215	174	63,709	883,014	320,484	6	Add 150 beds in 1981-1982
7	MS,OR OB-GYN	87	52	18,916	189,531	37,531	7	Replace 87 beds in 1981
8	PSYCH	48	31	11,303	11,303	8,667	8	To be closed in 1981-1982
9	PSYCH	105	(90)	(32,850)	(32,850)	(68,656)	9	NA
10	PSYCH	150	116	42,226	39,254	20,815	10	Add 10-25 beds in 1982-1983
Total		1,375	942	343,423	3,044,640	$1,091,843		

SOURCE: Operating Report. Parent Corporation, 1979.

NOTES:
MS = Medical Surgical services
OR = Operating Rooms
OB-GYN = Obstetrical Services
Psych = Psychiatric Services
NA = Not applicable to this study
() = estimated data based on Hospital 10

APPENDIX B.--Projection of patient days, laundry pounds, and laundry expense in 1980 for the ten hospitals.

Hospitals	Patient Days 1979		Patient Days 1980		Percent Change 1979 to 1980	Estimated Patient Days for 1980	Estimated Laundry Pounds for 1980	Estimated Laundry Expense For 1980
	Jan.	Feb.	Jan.	Feb.				
1	1,454	1,712	3,302	3,115	+103.0	58,373	308,104	$158,261
2	2,046	2,080	2,271	2,168	+ 7.6	24,206	242,706	77,701
3	3,035	2,668	3,114	3,014	+ 7.4	35,259	442,148	150,203
4	4,590	4,328	5,380	5,552	+ 22.6	64,879	796,065	244,594
5	3,311	3,366	3,738	3,613	+ 10.1	41,198	446,998	163,144
6	5,715	5,203	6,107	5,617	+ 7.4	68,423	948,343	478,393
7	1,741	1,452	2,128	1,653	+ 18.4	22,396	224,408	44,344
8	1,243	1,027	978	965	- 14.4	9,675	9,675	5,736
9			2,800	2,612		33,481[a]	33,481[a]	69,975[a]
10	2,972	3,314	3,567	3,666	+ 15.1	48,602	45,200	23,815
Total	26,107	25,150	30,585	29,363	+ 17.0	406,473	3,587,194	$1,411,398

[a] based on 1980 data

APPENDIX C.--Usage and costs in 1979 for the ten hospitals.

Hospital	Total Patient Days	Total Pounds Used	Total Laundry Expense	Cost Per Pound	Cost Per Patient Day	Pounds Per Patient Day
1	28,755	196,197	$ 75,768	$ 0.39	$ 2.63	6.82
2	22,496	225,534	72,171	0.32	3.21	10.03
3	32,830	411,800	139,836	0.34	4.26	12.54
4	52,919	649,186	199,645	0.31	3.77	12.27
5	37,419	406,040	148,270	0.36	3.96	10.85
6	63,709	883,214	320,484	0.36	5.03	13.86
7	18,916	189,460	37,531	0.20	1.98	10.03
8	11,303	(11,303)	8,667	0.59	(0.77)	(1.00)
9	(32,850)	(32,850)	(68,656)	(0.55)	2.09[a]	(1.00)
10	42,226	39,254	20,815	0.53	0.49	0.93
Total	343,423	3,044,640	$1,091,843	$ 3.95	$28.19	79.32
Weighted Average				$0.395	$ 3.18	8.80

NOTES: ( ) = estimate based on Hospital 10.
[a] based on 1980 cost per patient day.

APPENDIX D.--Five-year projection for demand from the ten hospitals and production required for the central laundry.

Year	Total Patient Days[a]	Total Laundry Pounds[b]	Pounds Per Day Demand[c]	Pounds Per Day Production 5 Day-Week[d]	Pounds Per Hour Production 5 Day-Week[e]
1980	401,430	3,532,584	9,678	13,550	1.807
1981	469,287	4,129,729	11.314	15,840	2,112
1982	548,609	4,827,763	13,227	18,517	2,469
1983	641,332	5,643,722	15,462	21,647	2,886
1984	749,725	6,597,577	18,076	25,306	3,374
1985	876,430	7,712,584	21,130	29,582	3,944

[a] $E(d_j) = F_t + \frac{(1 - \alpha)T_t}{\alpha}$

[b] $E(d_j)$ x 8.8 pounds per patient day

[c] total pounds ÷ 365 days per year

[d] (pounds per day x 7 days) ÷ 5 days

[e] pounds per production day ÷ 7.5 hours

APPENDIX E.--Five-year projection of laundry equipment and cost to meet demand from the hospitals and production required for the central laundry.

Year	Production Per Day	Washer Extractors			Dryers[a]			Ironers[b]			Other Equipment[f]	Total Equipment Cost
		Number of Units	Size in Pounds	Cost[c]	Number of Units	Size in Pounds	Cost[d]	Number of Units	Size in Rolls	Cost[e]		
1980	13,500	1	600	$70,000	2	400	$26,000	1	2	$82,000	$55,500	
		1	400	42,000	1	50	1,500					
		1	200	24,000								
		1	50	5,000								$333,000
1981	15,840	1	400	42,000	1	200	24,000				13.200	79.200
1982	18,517	1	400	42,000	1	200	24,000	1	1	57,000	24,600	147,600
1983	21,647	(a change from one shift to two shift operations in 1983 will result in no additional expense for equipment)										
1984	25,806											
1985	29,582											
Total												$559.800

[a] assumed that 50 percent of production will be dried.

[b] assumed that 50 percent of production will be ironed.

[c] David Adams. Pellerin Milnor Corporation. Kenner, Louisiana, 1980. (Interview).

[d] Normal Dryer Company, Inc Crystal Lake, Illinois, 1980. (Interview).

[e] Jensen Corporation, Fort Lauderdale, Florida, 1980. (Interview).

[f] estimated at 20 percent of laundry equipment costs.

APPENDIX F.--Five-year projection of utility usage and cost for the central laundry.

Year	Electricity		Natural Gas		Water		Total Utility Cost
	Usage[a] KWH	Cost[b]	Usage[c] MCF	Cost[d]	Usage[e] Gallons per hour	Cost[f]	
1980	3,871	$ 9,291	18,793	$45,480	4,337	$13,982	$ 68,753
1981	4,525	10,859	21,964	53,154	5,069	16,203	80,216
1982	5,290	12.659	25,677	62,120	5,926	19,105	93,920
1983	6,183	14,839	30,014	72,635	6,926	22,729	109,803
1984	7,228	17,348	35,089	84,917	8,098	26,108	128,373
1985	8,449	20,279	42,017	99,263	9,466	30,518	150,060

[a] 0.103 KWH per 100 pounds processed

[b] KWH x $2.40

[c] 50,000 BTU per 100 pounds processed ÷ 1,000 = MCF

[d] MCF x $2.42

[e] 2.4 gallons per 100 pounds processed ÷ 1,000

[f] gallons x $1.55

APPENDIX G.--Five-year projection of pounds of linen in inventory and the delivery schedule for the central laundry.

Year	Usage per Day (S)	Order Size Five-Day Delivery (R_1)	One Day Lead Time[a] (I_j)	Order Size Three-Day Delivery (R_3)	Two Day Lead Time (I_j)	Total Pounds System[b]
1980	9,678	13,549	55,482	22,894[c]	132,162[c]	82,580
1981	11,314	15,840	64,861			96,542
1982	13,227	18,518	75,830			112,866
1983	15,462	21,647	88,542			131,936
1984	18,076	25,306	103,627			154,239
1985	21,130	29,580	121,132			180,292

[a] $I_j = S(L) + F\sqrt{SR(L)}$
where:
S = pounds per day
R = seven-day usage delivered on five days
F = 4 (least stock out level from Figure 3.)
L = delivery schedule

[b] order delivered (R_1) plus order picked up plus I_j

[c] quantities are too large to consider three-day delivery further.

APPENDIX H.--Calculation to determine cost per pound for linen to be Purchases by the central laundry plus the test for significant variance from the 1979 cost to rent linen paid by the hospitals.

Item	Weight in Pounds[a] (1)	Price Each[b] (2)	Price To Rent[c] (3)	Price to Rent per Pound (4)	xd (5)	x^2 e (6)
Draw sheet	1.17	$ 4.00	$0.25	$0.21	-0.12	0.0144
Bath towel	0.49	1.33	0.12	0.24	-0.09	0.0081
Patient gown	0.64	3.17	0.40	0.62	0.29	0.3844
Scrub suit	1.00	8.00	0.30	0.30	-0.03	0.0009
Regular sheet	1.48	4.16	0.37	0.25	-0.08	0.0064
Pillow case	0.32	1.83	0.12	0.38	0.05	0.0025
Mattress pad	2.75	7.25	0.42	0.15	-0.18	0.0324
Blanket	1.65	8.83	0.79	0.48	0.15	0.0221
Total	9.50	$38.57	$3.27	$2.65	. . .	0.4712

[a] Pellerin Milnor Corporation. Laundry Planning Guide for Dealer Salesman. Kenner, Louisiana: Pellerin Milnor Corporation, 1979.

[b] Jim Tobacco. Inhouse Laoundry Proposal. Northshore Medical Plaza. 1980. (memeographed).

[c] National Hospital Linen Systems, Houston, Texas, 1980.

[d] column (3) divided by column (1)

[e] column (5) x column (5)

CALCULATION OF SIGNIFICANCE

(1) $SD = \sqrt{\frac{\sum x^2}{n}}$

where: $x^2 = 0.4712$

$n = 8$

$SD = 0.2427$

(2) $S_{\bar{x}} = \frac{SD}{\sqrt{n - 1}}$

$= 0.0917$

(3) $t = \frac{\bar{x} - \mu_h}{S_{\bar{x}}}$

where: $\bar{x} = \$2.65 \div 8$

$= \$0.33$

$\mu_h = \$0.395$ (cost per pound from Appendix D)

$t = 0.7088$

From table B-5 (Kazmire 1973:269-276) with 7 degrees of freedom (df) and $p < 0.05$, $t = \pm 2.365$.

Therefore, no significant difference between the mean values of $\bar{x}$ ($0.33) and μ_h ($0.395) and no significant difference between $4.06 and the price per pound to be paid for linen by the central laundry.

APPENDIX I.--Five-year projection of linen purchases for the central laundry.

Year	Total Pounds in System	New Purchases[a]	Replacement Purchases[b]	Total Expense
1980	82,580	$335,275	$ 83,819	$419,094
1981	96,542	56,840	97,990	154,830
1982	112,866	66,275	114,559	180,834
1983	131,936	77,424	133,915	211,339
1984	154,239	90,550	156,553	247,103
1985	180,292	105,775	182,996	288,771

[a] inventory increase per year to meet increasing demand at $4.06 per pound.

[b] twenty-five percent replacement per year at $4.06 per pound.

APPENDIX J.--Five-year projection of the number of trucks, frequency of delivery, and transportation expense for the central laundry.

Year	Number of Delivers Per Day	Number of Trucks	Fixed Expense[a]	Variable Expense[b]	Total Expense
1980	1	2	$26,000	$34,240	$60,240
1981	1	2		34,240	34,240
1982	1	3	13,000	39,816	52,816
1983	2	4	13,000	42,936	55,936
1984	2	4		42,936	42,939
1985	2	4		42,936	42,936

[a] 100,000 pound van truck at $13,000 each

[b] 10 MPG at $1.20 per gallon plus $1,000 for insurance per vehicle plus 10 percent of cost for maintenance per year.

APPENDIX K.--Five-year projection for number, classification, and expense of personnel for the central laundry.

Year	Pounds Production	Employees			Total Employees[a]	Annual Salary Expense[b]
		Class A	Class B	Class C		
1980	13,778	12	5	4	21	$247,520
1981	16,292	15	6	5	27	327,163
1982	19,232	17	7	6	30	407,218
1983	22.680	20	8	7	36	507,070
1984	26,715	24	10	8	42	648,897
1985	31,433	34	13	11	58	971,359

[a] Pellerin Milnor Corporation. Details for Calculating Hospital Laundry Equipment, Utilities, and Other Requirements. Kenner, Louisiana: Pellerin Milnor Corporation, 1973.

[b] Parent Corporation. Wage and Salary Program, 1979.

APPENDIX L.-- Ten-year projection of building and lot size for the central laundry.

Year	Beds[a] Served	Pounds Production Per Day	Production Space[b]	Soil Storage Space[b]	Building Space Needed[b]	Parking Space Needed[b]	Lot Size Needed	
							Total Square Feet	Acres
1980	1,609	13,778	16,090	1,722	17,812	6,644	24,456	0.56
1985	3,527	31,433	35,270	3,929	39,199	17,512	56,711	1.30
1990	7,731	71,434	77,310	8,929	104,177	. . .	. . .	. . .

[a] at a growth rate of 16.9 percent per year.

[b] in square feet.

APPENDIX M.--Five-year projection of building and real estate costs for the central laundry.

Year	Lot Size[a]	Real Estate Cost Per Square Foot[b]				Building Size[a]	Building Cost	Minimum Total Building And Land Cost[c]
		Area A	Area B	Area C	Area D			
1980	24,456	97,824	77,368	48,912	36,684	17,812	$284,992	$321,676
1985	56,711	226,844	170,133	113,422	85,066	39,199	627,184	712,250

[a] square feet.

[b] at $16.00 per square foot. Heimsath, Charles. Houston, Texas: Rice Center, June, 1980. (Interview).

[c] for Area D at $1.50 per square foot. Mike Henderson Realty. Houston, Texas, 1980. (Interview).

APPENDIX N.--Five-year projection of variable costs for the central laundry.

Year	Utilities	Supplies	Manpower	Transportation[a]	Total Variable Cost	Variable Cost per Pound
1980	$ 68,753	$33,706	$247,520	$34,240	$ 383,719	$0.1086
1981	80,216	38,819	327,163	34,240	480,438	0.1163
1982	93,920	45,381	407,218	39,816	586,335	0.1215
1983	109,803	53,051	507,070	42,936	712,860	0.1263
1984	128,373	62,017	648,897	42,936	882,223	0.1337
1985	150,060	72,498	971,359	42,936	1,236,803	0.1604

[a] operating costs only.

APPENDIX O.--Five-year projection of fixed costs for the central laundry.

Year	Real[a] Estate	Building[b]	Equipment Laundry Plus Other	Linen	Trucks	Total Fixed Cost	Amortized Fixed Cost per Pound
1980	$85,066	$627,184	$333,000	$335,275	$26,000	$1,383,125	$0.0428
1981	85,066	627,184	79,200	56,686	. . .	135,886[c]	0.0418
1982	85,066	627,184	147,600	66,275	13,000	226,875[c]	0.4268
1983	85,066	627,184	. . .	77,424	13,000	90,424[c]	0.0411
1984	85,066	627,184	. . .	90,550	. . .	90,550[c]	0.0379
1985	85,066	627,184	. . .	105,775	. . .	105,775[c]	0.0357

[a] It is assumed that land will be purchased in 1980 sufficient for the building size in 1985.

[b] It is assumed that a building will be build in 1980 sufficient for the building size in 1985.

[c] Additional expenditures each year.

APPENDIX P.--Average costs and marginal costs for the pounds of laundry to be produced by the central laundry from 1980 to 1985.

	1980		1981		1982		1983		1984		1985	
	AC[a]	MC[b]	AC[a]	MC[b]	AC[a]	MC[b]	AC[a]	MC[b]	AC[a]	MC[b]	AC[a]	MC[b]
1,000,000[c]	0.5347	. . .	0.6536	. . .	0.7895	. . .	0.9393	. . .	1.1313	. . .	1.5124	. . .
2,000,000	0.2674	26.73	0.3268	32.68	0.3947	39.48	0.4697	46.96	0.5687	56.56	0.7562	60.49
3,000,000	0.1783	8.91	0.2179	10.89	0.2632	13.15	0.3131	15.66	0.3771	18.86	0.5041	25.21
3,532,584	0.1514	5.05	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
4,000,000			0.1634	5.45	0.1974	6.58	0.2348	7.83	0.2828	9.34	0.3781	12.60
4,139,729			0.1579	3.93	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
4,827,763					0.1635	4.09	. . .	. . .	. . .	. . .	. . .	. . .
5,000,000							0.1879	4.69	0.2263	5.65	0.3025	7.56
5,643,732							0.1664	3.33	. . .	. . .	. . .	. . .
6,000,000									0.1886	3.77	0.2521	5.04
6,597,577									0.1715	2.86	. . .	. . .
7,000,000											0.2161	0.36
7,712,584											0.1916	0.28
TFC[d]	$151,078		$173,208		$205,827		$226,476		$249,108		$ 275,547	
TVC[e]	$383,719		$480,438		$586,335		$712,860		$882,223		$1,236,853	

[a] Average Cost per pound

[b] Marginal Cost x 10^{-8}

[c] pounds

[d] Total fixed cost per year

[e] Total variable cost per year

APPENDIX Q.-- Proforma profit and loss statements for the central laundry from 1980 through 1985.

	1980	1981	1982	1983	1984	1985
Revenue[a]	$1,395,371	$1,631,243	$1,906,966	$2,225,715	$2,606,043	$3,046,471
Less: Operating Cost[b]	(383,719)	(480,438	(586,335)	(712,860)	(882,223)	(1,236,853)
Less: Depreciation[c]	(151,078)	(173,208)	(205,827)	(226,476)	(249,128)	(275,547)
Before Tax Profit	860,574	977,297	1,114,804	1,286,379	1,474,712	1,534,071
Less: Income Tax[d]	(430,287)	(488,648)	(557,402)	(643,189)	(737,356)	(767,035)
After Tax Profit	430,287	488,648	557,402	643,189	737,356	767,035
Contribution Margin[e]	30.8%	30.0%	29.2%	28.9%	28.3%	25.2%

[a] pounds x $0.395

[b] amortized fixed costs plus variable costs

[c] depreciation expense closes to two places on the balance sheet: (1) cash and (2) asset account

[d] fifty percent tax rate

[e] after tax profit ÷ revenue

APPENDIX R.--Beginning proforma balance sheet for the central laundry.

Assets		Liabilities	
Current:		Current	0
Cash[a]	$ 75,000	Long Term Debt:	0
Fixed:			
Iventory	335,275	Owner's Equity	
Equipment	359,000		
Real Estate	85,066	Contributed Capital	$1,481,525
Plant	627,184	Retained Earnings	0
	$1,481,525		$1,481,525

[a] approximately two months operating expense.

APPENDIX S.--December, 1980 proforma balance sheet for the central laundry.

Assets		Liabilities	
Current:			
Cash	$ 656,365		
Fixed:			
Inventory	335,275		
Less Depreciation	(83,819)		
Equipment	359,000	Owner's Equity	
Less Depreciation	(35,900)		
Real Estate	85,000	Contributed Capital	$1,481,525
Plant	627,184		
Less Depreciation	(31,359)	Retained Earnings	430,287
	$1,911,812		$1,911,812

APPENDIX T.--December, 1981 proforma balance sheet for the central laundry.

Assets		Liabilities	
Current:			
Cash	$1,182,183		
Fixed:			
Inventory	392,115		
Less Depreciation	(181,850)		
Equipment	438,200	Owner's Equity	
Less Depreciation	(79,770)		
Real Estate	85,066	Contributed Capital	$1,481,525
Plant	627,184		
Less Depreciation	(62,718)	Retained Earnings	918,935
	$2,400,460		$2,400,460

APPENDIX U.--December, 1982 proforma balance sheet for the central laundry.

Assets		Liabilities	
Current:			
Cash	$1,718,576		
Fixed:			
Inventory	458,351		
Less Depreciation	(296,438)		
Equipment	598,800	Owner's Equity	
Less Depreciation	(139,600)		
Real Estate	85,066	Contributed Capital	$1,481,525
Plant	627,184		
Less Depreciation	(94,007)	Retained Earnings	1,476,337
	$2,957,862		$2,957,862

APPENDIX V.--December, 1983 proforma balance sheet for the central laundry.

Assets		Liabilities	
Current:			
Cash	$2,497,846		
Fixed:			
Inventory	535,746		
Less Depreciation	(430,375)		
Equipment	611,800	Owner's Equity	
Less Depreciation	(200,780)		
Real Estate	85,066	Contributed Capital	$1,481,525
Plant	627,184		
Less Depreciation	(125,436)	Retained Earnings	2,119,525
	$3,601,050		$3,601,050

APPENDIX W.--December, 1984 proforma balance sheet for the central laundry.

Assets		Liabilities	
Current:			
Cash	$3,393,782		
Fixed:			
Inventory	626,275		
Less Depreciation	(486,945)		
Equipment	611,800	Owner's Equity	
Less Depreciation	(261,960)		
Real Estate	85,066	Contributed Capital	$1,481,525
Plant	627,184		
Less Depreciation	(156,795)	Retained Earnings	2,856,882
	$4,438,407		$4,438,407

APPENDIX X.--December, 1985 proforma balance sheet for the central laundry.

Assets		Liabilities	
Current:			
Cash	$4,230,405		
Fixed:			
Inventory	723,034		
Less Depreciation	(669,953)		
Equipment	611,800	Owner's Equity	
Less Depreciation	(323,140)		
Real Estate	85,066	Contributed Captial	$1,481,525
Plant	627,184		
Less Depreciation	(188,154)	Retained Earnings	3,623,917
	$5,105,242		$5,105,242

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